Hubs versus Airport Dominance

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Abstract

This study separates what is known in the literature as the airport dominance effect (dominant airline's ability to charge higher fares for trips to/from the airport at which it has the dominant position) into what can be interpreted as quality and market power based components, using price data for trips to/from/through five US airports, each serving as a hub for two US carriers. We find market power based component of the dominance premium is smaller than the quality based one. We also determine that dominant carriers exercise their market power on an average customer rather than a price insensitive business traveler. This is in contrast to what previous studies suggested.

Keywords: Airlines, Hub Premium, Airport Dominance, Frequent Flier Programs

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1. Introduction

Of the possible sources of market power in the airline industry, airport dominance is pointed to as a very important one. Evans and Kessides (1993) concluded that airport dominance is a far more important source of market power than route dominance. At a basic level, the airport dominance effect refers to an airline's ability to charge higher fares for travel to or from an airport, where it has a dominant position, relative to the fares it charges for travel elsewhere within its network. Of the offered explanations of this effect, airlines' frequent flier programs appears the most plausible. The argument goes that customers living around the airport dominated by a certain carrier will value this airline's frequent flier program more highly, since they will be able to both earn awards (free trips, upgrades, premium status) faster and redeem them for travel to more destinations (since dominated airports are also respective airlines' hubs). This simply means that the dominant carrier offers a *higher quality product* to its repeat customers as compared to other airlines that might serve the same airport.

With this in mind, we can argue that the airport dominance effect may be a reflection of market power, higher quality of the product offered by the dominant carrier, or both. The purpose of this study is to disentangle the contribution of these two potential sources to what manifests itself (and is referred to in the literature) as the airport dominance effect.

Identifying the source of the observed airport dominance effect on fares has important policy implications. If the dominant carrier is indeed found to exercise its market power on the ground to charge air travelers more, appropriate action by regulators may be required. However, if the apparent fare premium can be explained by the customers' valuation of the carrier's frequent flier program and/or access to the airline's extensive network of non-stop flights out of the hub airport; then airlines are utilizing a "quality-based" approach to pricing. Indeed, major businesses value locating at cities that house hubs of major airlines precisely to have access to the carriers' networks. For example, when Boeing decided in late 1990s to move its corporate headquarters from Seattle, the two candidate cities were Denver and Chicago, both major airline hubs. The company completed its move to Chicago in September 2001.

To separate the fare premium into quality and market power components, we consider five airports (Atlanta, Denver, Dallas-Fort Worth, Chicago O'Hare and Phoenix), each of which serves as a hub for two major airlines. Of the five gateways, three have a clearly defined dominant carrier. We claim that the "quality" component of the airport dominance effect (related to access to a network of non-stop flights and/or higher value of loyalty program) should be observed for both carriers using an airport as a hub. We use the term *hub premium* for this component of fare premium. The "market power" component of the airport dominance premium can then be defined as the difference between the hub premiums observed for the two airlines using the respective airport as their hub. This component of fare premium will be called the *airport dominance premium*. Previous studies, discussed below, do not make such a distinction, instead lumping the two effects together, and using the two terms interchangeably.

For our analysis, we use a sample of actual itineraries collected quarterly by the US Department of Transportation (this dataset is known as the DB1B). From this sample, we select non-stop and one-stop roundtrip itineraries that originate, terminate or go through one of the five hub airports. We apply a relatively simple difference-in-difference identification strategy, focusing on airport-pair-market (APM) fixed effects model, and applying the instrumental variable technique to control for possible endogeneity in market concentration and market share. We also conduct our analysis focusing on both average fares and prices representative of the upper end of the distribution[3].

Our results suggest that while the airline's dominant position at an airport is associated with market power; dominant carriers exercise this power on an average customer rather than a price-insensitive business traveler. Moreover, some specifications suggest travelers at the upper end of the price distribution pay (on average) higher premiums for traveling with the non-dominant hub operator than with the dominant airline. Existence of a hub premium is thus clearly established. Across-airport differences in estimates of both hub and dominance premiums are observed. Our results effectively suggest that, unlike implied by Lee and Luengo-Prado (2005) and Berry et al.

[3] We only use restricted economy class fares for reasons discussed in the appropriate section of this paper; however, the spectrum of prices within this category is substantial.

(2006), it is the average traveler who is paying the “marker power based” airport dominance premium, while the price-insensitive business traveler pays an equal premium for traveling to/from an airline’s hub, whether the airline has a dominant position at its hub airport or not. In other words, a substantial share of the premium paid by travelers at the upper end of the price distribution appears to be “quality based.“

Severin Borenstein was the first researcher to point to the link between dominant airlines and high fares. His 1989 study showed that an airline dominating an airport was able to charge higher fares. Airport dominance was not, however, found to provide an “umbrella” for other carriers serving the same airport to charge high fares. Borenstein attributed the airport dominance effect to the airlines’ frequent flier programs and a feature of the ticket distribution market prevalent at that time[4]. Further, Borenstein (1991) showed that a dominant airline had a disproportionately large market share of hub-originating passengers (as opposed to passengers terminating at the same hub). Evans and Kessides (1993) asserted that airport dominance was a more important source of market power than route dominance (Borenstein’s 1989 study suggested route market share was also an important determinant of observed fare premiums).

Government also paid attention to the airport dominance effect. In a 1990 report, the GAO noted that airlines’ transition to the hub-and-spoke networks following deregulation resulted in important airports being dominated by a single airline. The report further claimed that this position allowed the dominant airlines to charge a premium for their flights to/from the respective airport. Estimates of dominance premiums were also provided. In their 1995 book, Morrison and Winston criticized the GAO report for not controlling for all the relevant factors (their analysis produced smaller hub premiums than those calculated by the GAO).

Recently, there has been a revival of interest in the issue of airport dominance. Berry et al. (2006)[5], having estimated a structural differentiated product model of the airline industry, suggested that airlines’ ability to command airport dominance premium

[4] Most of the tickets were then distributed by ‘brick-and-mortar’ travel agents, receiving commission from the airlines. Further, airlines often paid so-called TACOs (travel agent commission overrides), or payments to agents booking more than a certain share of itineraries with a single airline. Airlines discontinued commission payments to travel agents in 2001-2002; currently, travel service distributors charge their customers fixed per booking fees (see Bilotkach and Pejcinovska (2008) for further discussion).

[5] While recently published, this study goes back to 1995 as an NBER Working Paper.

was limited to the upper end of the price distribution. Consistent with this finding, Lee and Luengo-Prado (2005) showed that the observed hub premiums could be explained by the passenger mix (proportion of leisure versus business travelers). Bilotkach (2007) demonstrated that the airport dominance effect applied to a number of transatlantic routes. Lederman (2008) showed that uniting frequent flier programs was a way non-dominant airlines could get under the ‘umbrella’ available to the dominant carriers, thereby providing evidence of importance of frequent flier programs as a factor behind the airport dominance premium.

Considering a set of important airports where such identification is feasible, our study disentangles what is known as the airport dominance effect into market power and quality based components. We show that both market power and higher quality contribute to higher fares charged by dominant carriers[6]; the market power component is more pronounced at average fares/yields; while the quality-based hub premium dominates at the upper end of the price distribution. Carriers operating a hub at an airport, but not enjoying the dominant position are still able to charge a quality-based hub premium. Thus, the ‘umbrella’ initially thought to be available only to dominant carriers applies to any hub operator.

The rest of the paper is organized as follows. Section 2 discusses identification strategy in general terms. Section 3 describes the data. Section 4 discusses results of the data analysis. Section 5 concludes.

2. Identification – General

The terms “airport dominance premium” and “hub premium” have been used interchangeably in the literature. This is understandable, as the dominant airline often (if not always) uses the corresponding airport as its hub; on the other hand, airports that serve as hubs are often (though not always) dominated by a single carrier. Our study makes a clear distinction between the two possible sources of price premium. “Dominance premium” will be associated with exercise of market power by the dominant carrier; while “hub premium” will be precipitated by higher quality of the product offered

[6] We should note that technically we may not be able to disentangle the market power and quality components. We will discuss this in further detail in the discussion section.

by the hub operator, due to higher valuation of the carrier's frequent flier program and/or access to an extensive network of non-stop flights.

One can think of two approaches to measuring airport dominance effect (both have been employed in the literature). The first approach is to compare an airline's fares for flights to and from the airport where it has a dominant position to fares elsewhere within the airline's network. The second approach compares the dominant airline's fares for travel to or from the corresponding airport to prices charged by other airlines flying into or from the same airport, but not enjoying the dominant position. Neither of the two approaches, however, is able to disentangle what we consider to be quality based fare premium from that due to market power of the dominant carrier.

Our aim is to separate market power based dominance effect on observed fares (and yields) from the quality based hub airport effect, by studying price setting at airports serving as hubs for two carriers. We can say that our exercise combines the two above-discussed approaches to measuring airport dominance in the following way. In an airport used by two carriers as a hub, any premium charged by the dominant airline for non-stop flights to or from this hub relative to fares charged over the remainder of that airline's network includes both the quality based hub effect and the market power based dominance effect. The key identifying assumption is that the same difference for the non-dominant hub operator only includes quality based hub effect[7]. Then, the difference between the two above-mentioned differences identifies the market power based airport dominance effect (or rather, the difference between the two for the two hub operators). To identify the quality based hub effect from the data we will use the same "airport-network remainder" fare difference for other carriers offering services to a given airport. Subtracting this difference from the smaller one of the same for both hub operators will give an estimate of an average quality based hub effect.

A potential drawback of this strategy is possible inability to separate the quality based effect and the airport dominance effect. At mean fare levels, there may be, in fact, no quality based fare premiums. Thus, the difference between the fares charged by the two airlines may simply be the difference in market power effects. While we consider

[7] Or, it would be more correct to claim that market power based component (if any) for the non-dominant hub operator is supposed to be smaller in magnitude than same for the dominant carrier.

this an extreme case, it may very well be an issue that will suggest drastically different implications of our results than those that follow from our supposed identification strategy. We will revisit this issue when discussing the results.

Thus, our identification strategy is a simple difference-in-differences. Successful implementation of this strategy will require data on fares for travel to/from, as well as through the hub airports selected for the analysis. Note that this strategy is similar to that applied by Bilotkach (2007) to analyze price setting (including obtaining estimates of the airport dominance effect) on several transatlantic airline markets.

3. Data

3.1 Airports – background

Since our aim is separating the hub airport price premium from that due to airport dominance; we selected five airports, each of which serves as a hub for two airlines. These are Atlanta Hartsfield International (airport code ATL); Chicago O'Hare (ORD); Dallas-Ft. Worth International (DFW); Denver International (DEN); and Phoenix Sky Harbor (PHX) airports. Of the five airports, three are clearly dominated by one of the two hub operators. Specifically, ATL, being the world's busiest airport in terms of passenger volume, is the largest hub for both Delta Air Lines and lower cost carrier Air Tran, and is dominated by the former airline; American Airlines has a clear dominant position at DFW, while Delta also used this airport as one of its hubs until about 2004; United is the dominant carrier at DEN, though the airport is also used by Frontier Airlines as its only hub. Chicago O'Hare and Phoenix Sky Harbor are not dominated by any single hub operator. ORD is a hub for both American and United; US Airways[8] and Southwest Airlines channel their passenger traffic via PHX.

According to the US Department of Transportation, in 2007 the five airports we selected for our study handled over 270 million passengers in the US market (and another 40-plus million international travelers). To put these numbers in perspective, US airlines carried about 660 million passengers in the domestic market in 2007. In that same year, the five airports included in our study handled about 1.7 million of the 10.3 million

[8] Historically, America West Airlines was the carrier that established its hub at PHX; in 2005 America West acquired US Airways and kept that airline's name after the acquisition.

commercial passenger flights performed within the United States; thus one in six flights within the US that year took off from (or landed at) one of the five above listed airports. The disparity between apparent shares of passengers (it appears from the above numbers that 45 percent of all US passengers fly to/from/via the five gateways we selected) and flights most probably stems from the likely double-counting of connecting passengers at hub airports (once as arriving, and once more as departing, while on the same trip) in reported airport-level traffic statistics.

Table 1 lists the number of destinations served by each airport's two leading carriers (including regional airlines using carriers' brands) in July of every year from 1999 to 2005 (the time period that our data spans). From that table, we can clearly observe that in ATL, DEN, and DFW a dominant carrier offers a much broader network as compared to the other hub operator at the same airport; note also how fast Delta Air Lines dismantled its hub at DFW. It is also interesting that Air Tran and Frontier managed to grow their networks substantially, in spite of competing with such heavyweights as Delta and United on their home turf (or rather, home tarmac). In ORD and PHX we observe relative parity between the two biggest carriers, in terms of the number of destinations served. At Chicago O'Hare, both American and United added endpoints over the years. While the number of airports served by America West from Phoenix Sky Harbor did not change, Southwest added new destinations quite aggressively (though not nearly as aggressively as Frontier did at Denver).

3.2 Sample and Variables

Data for our study come from the US government databases, including the 1990 US Census, 2000 US Census, and the DOT's Origin and Destination Survey, databank DB1B. A brief description of the databases and variable construction follows. The DB1B is a 10 percent sample of actual itineraries, collected by the US Department of Transportation; in the databank, the itineraries are grouped at the fare-airline-service class-routing level, with the number of passengers found to pay a certain fare flying a certain airline on a certain route also reported in the database. The data is collected quarterly and is made available for download from the Department's web site free of charge[9].

Each entry in the DB1B includes fare paid (net of taxes and fees), class of service[10], and detailed information on routing, including identity of airlines selling the ticket and operating each flight, distance traveled, and all intermediate airports visited. The destination of the trip is coded through the directional break in the itinerary. Also, the number of passengers observed paying the same fare for the same routing on the same airline in the same quarter (e.g., $400 for trip from Los Angeles to Denver to Boston and back to Los Angeles via Denver on United Airlines in the third quarter of 2003) is reported.

Our sample consists of trips that originate, terminate, or connect through Denver, Atlanta, Dallas-Ft. Worth, Phoenix, or Chicago O'Hare airports. We apply the following limitations to arrive at the final sample of itineraries that will be used for analysis.

- To ensure consistency across all years and quarters, we only include restricted economy class itineraries for all airlines except Southwest Airlines (which reports all its itineraries as restricted first class). Lee and Luengo-Prado (2005) used data from the third quarter of 2000 and separated restricted economy class itineraries from unrestricted economy class and first class itineraries as a way to capture passenger mix on the markets. We, however, found that the carriers are rather inconsistent in reporting unrestricted economy itineraries across the quarters in our sample. At the same time, the restricted economy classification is used most frequently (over 85 percent of the time); and restricted economy fares appear to span the expected range of economy class fares rather well.
- We converted all fares into real dollars (with year 2000 used as the base year), using seasonally adjusted GDP price index, reported by the Bureau of Economic Analysis.
- In line with previous studies (e.g., Lee and Luengo-Prado, 2005), itineraries with fares less than 2 cents per mile in year 2000 prices (e.g., about $100 for a coast-to-coast roundtrip ticket) were dropped. There were many zero-fare itineraries in the

[9] This relates to the dataset for the US market. The International DB1B remains a restricted dataset – permission from the Department of Transportation is required to obtain access to this data.
[10] Technically, services as classified as first unrestricted, first restricted, business unrestricted, business restricted, economy unrestricted, economy restricted.

sample, indicating either trips purchased by frequent fliers or reroutes due to missed connections. We also suspect that some of the low fare itineraries might reflect charges for rebooking on restricted fares (a new ticket with a unique ticket number is technically issues in these cases, so it has the chance of getting into this dataset).

- We only selected non-stop or one-stop roundtrip flights without open jaws (i.e., return trips to the same airports) and with a single directional break (i.e., no multi-city trips).
- One-stop roundtrip itineraries had to connect through the same airport in both directions.
- To avoid contamination of our data by small markets (for which obtaining a representative picture will be difficult, given the data we use), we only chose those markets where 100 or more passengers were observed in our sample in a given year. This means, roughly speaking, that we only look at markets with annual passenger traffic of over 1000 passengers, or about three passengers per day. It should be noted that looking only at sufficiently large market is a typical practice in airline industry studies.

We then constructed our dependent variable as the passenger-weighted mean fare at the airline-routing-quarter level (we will use the natural logarithm of this in our regressions). This means, for instance, that American Airlines' fares between the same airports via different hubs (Chicago and Dallas-Ft. Worth) are viewed separately. We also computed passenger-weighted standard deviations at the airline-routing-quarter level; we will use natural logarithm of average plus standard deviation fare (as well as of the corresponding yield) in some specifications. Finally, passenger-weighted mean yields (fare per mile) were computed; natural logarithm of passenger-weighted yield (as well as of "high yield", based on mean fare plus standard deviation) will be used as another revenue measure in specifications to be reported in the next section.

Having applied the above restrictions, we ended up with over 600,000 observations, spanning over 5400 unique directional airport-pair markets. We are thus looking at approximately 2700 largest airport-pair markets in the country – a typical restriction the literature is to consider top 1000 city-pair or airport-pair routes.

Before we continue with discussion of control variables, it pays to clarify our definition of airlines. On the US market, some of the commercial passenger services (particularly on thinner markets) are performed by so-called regional carriers, effectively operating as agents of major airlines. These carriers' business model relies on operating smaller aircraft on shorter-haul routes, exploiting cost savings due to less diverse fleet and outsourced marketing. Interestingly enough, recent research by Jordan (2008) showed that, by looking at exit rates in the US airline industry since deregulation, regional airlines' model appears the most successful one – fewer regional carriers exited, both in absolute and relative terms, as compared to both legacy, new full-service, and discount airlines. Those regional carriers can be either independent companies (SkyWest, Atlantic Southeast); or fully owned subsidiaries of major carriers (American Eagle); some of them (ExpressJet) market services under their brands in addition to acting as major carriers' agents. Moreover, several of those regional carriers perform services for more than one major airline (e.g., SkyWest flies as a Delta, United, and Midwest agent). We decided to assign regional carriers' services to respective major airlines (since pricing decisions are made at the major airline level). Where a regional carrier was known to perform flights for more than one major airline, classification was made according to the hub airport to/from/through which the service was performed. Services between hubs are typically performed by the majors themselves; and airlines sharing hub airports have not been found to share a regional carrier.

Across-markets heterogeneity will be controlled for by employing a directional airport-pair market fixed effects model. We will use respective indicator variables to control for year-specific, quarter-specific, year-quarter-specific, and airline-specific heterogeneities[11].

Distance and an indicator for non-stop flights are the two itinerary-specific controls we use. In the airport-pair market fixed effects model, we expect the coefficient on distance to have a negative sign, as it measures effect of a more circuitous (and therefore less desirable) route on the fares between two airports. Non-stop flights, however, should be more expensive than one-stops, other things equal.

We will use (and will also have to find instruments for) measures of market concentration and market power. For the measure of market concentration, we will use

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[11] We have repeated our analysis excluding last two quarters of 2001 and first two quarters of 2002 to control for the shock associated with events of September 11, 2001. Results were similar to those reported here.

the regular Herfindhal-Hirschmann Index (HHI). Market share is used as the measure of the airline's market power. The measures were calculated from DB1B passenger numbers. As far as market boundaries are concerned, for each origin-destination airport-pair we consider non-stop services separately from one-stop flights. As an example, for the Los Angeles-Atlanta airport-pair market we calculated HHI and market shares for non-stop and one-stop services separately. We defer discussion of instruments for these measures to the next section of the paper.

Finally, market-specific controls we use are geometric averages of endpoints' population and per capita income, at the Metropolitan Statistical Area level. We used Census data for 1990 and 2000, as well as population and per capita income estimates for 2006, interpolating for other years in our sample.

4. Data Analysis

4.1 Methodology

We will use two price measures as a dependent variable: natural logarithm of fare, as well as natural logarithm of yield (fare per mile). Fare is, as discussed above, the passenger-weighted average price aggregated at the airline-routing-quarter level. In addition to the passenger-weighted average price, we calculated standard deviation of the same. To be in line with previous studies considering airport dominance effect at the upper tail of the price distribution, we use natural logarithm of average plus standard deviation fare (as well as of the corresponding yield) in some specifications. Using this measure to get an idea of how prices behave at the upper tail of the distribution might be unorthodox[12]; also, it cuts off observations for airlines observed offering a single fare on a given airport-pair market. But then, small players are also likely to introduce noise into our data, as we observe their behavior in non-systematic way. In fact, having cut off the small players when analyzing upper tail of the price distribution; our sample still spanned exactly as many airport-pair markets (5434) as before.

Our estimation technique of choice is the airport-pair-market fixed-effects (note that airport-pair markets are directional). We estimated both regular fixed effects and instrumental variable specifications. We had to find instruments for the measures of

[12] Upper percentiles (such as upper quartile, 80^{th} or 90^{th} percentile) of observed price distributions have been typically used in the literature. If we believe that distribution of fares is close to log-normal; our measure corresponds to approximately 85^{th} percentile (based on one-sigma rule for normal distributions).

market concentration (Herfindhal-Hirschmann Index) and market power (airline's market share). Consistent with the previous literature, one-year lagged HHI was used as an instrument for the former. Evans and Kessides (1993) note that finding an appropriate instrument for market share is a difficult task. We decided to instrument airline's route market share with the average of the airline's market shares across the routes originating at the respective airport, excluding the current route. This measure is generally in the spirit of using variables from other markets the firm operates in to instrument for the same measure on the current market; it also potentially suffers from the possibility of being correlated with the error term in case of a shock affecting airline's flights to all destinations from a given airport (such as an unusually aggressive advertising campaign at the city of origin – just as using a variable from another market as an instrument can make it correlated with the error term if a firm undertakes a nation-wide advertising campaign). Using the firm's intra-route rank of the market share as the instrument, as done by Evans and Kessides (1993), is complicated in our case by the fact that we calculate market shares for one-stop trips separately from those for non-stop flights. Markets end up being quite competitive at the one-stop level, meaning that demand and other unobservable price shocks can lead to change in ranks of the firms' market shares – according to Evans and Kessides, in such a case intra-route rank will no longer be a valid instrument for the market share. In our data, our instrument of choice turned out reasonably well correlated with the variable it instruments for – with correlation coefficient of 0.51.

In all specifications, we make a distinction between the following indicators of airlines' hub and dominant positions (these will be our key variables):

- Hub operator's non-stop flight indicator – takes value of 1 for direct flights by an airline operating a hub at the airport (i.e., Delta at ATL and DFW; American at DFW and ORD; United at ORD and DEN; America West and Southwest at PHX; Air Tran at ATL; and Frontier at DEN);
- Dominant airline's non-stop flight – takes value of 1 for direct flights by an airline dominating the airport (Delta at ATL; United at DEN; and American at DFW);

- Non-dominant hub operator's non-stop flight – takes value of 1 for direct flights by an airline operating a hub at the airport, but dominated by another carrier (Delta at DFW; Frontier at DEN; and Air Tran at ATL).

In line with our discussion in Section 2; the "quality-based" hub effect will be captured by the difference between the hub operator's non-stop flight indicator and the non-stop flight dummy for other carriers (not operating a hub at a given airport). The dominant airline's non-stop flight indicator will inform us about the extent of the dominant carrier's pricing power beyond the hub effect. Differences between the coefficient on this and the same indicator for the non-dominant hub operator will measure the "market power based" dominance effect. Note that for "symmetric" airports (Chicago O'Hare and Phoenix) this dominance effect should technically not be observed; therefore, there should be no formal distinction between "dominant" and "non-dominant" carrier in regressions for the relevant sub-samples.

4.2 Results and Discussion

The following seven tables report our estimation results. In Table 2 we report results for the 'pooled' regressions, i.e., combining all itineraries in our sample. Tables 3 through 6 report results of regressions for the three airports with two hub operators and a dominant carrier (Atlanta, Denver, and Dallas-Ft. Worth). Each table reports results of regressions with different dependent variable (natural logarithm of average fare, high fare, average yield, high yield). Finally, Tables 7 and 8 report estimation results for the two airports with two hub operators but without a clearly defined dominant carrier (Chicago O'Hare and Phoenix).

Looking at the tables with estimation results, we can make the following general observations.

- Any airport dominance effects observed are pronounced in average fares rather than at the upper end of the price distribution.
- When potentially endogenous measures of market structure and market power are instrumented for, estimated pricing power of the dominant airline tend to diminish.
- Results vary across the airports.

Let us examine these observations in more detail, focusing (for the purposes of better illustration) on specifications with natural logarithm of yield as the dependent variable, and considering results for two-stage least squares regressions with instruments for HHI and market share as described above. From the pooled regression (Table 2) it is evident that for the average yield hub operators enjoy about a 8.3 percent premium above other carriers flying into the same hub (recall that coefficient on Hub Operator*Direct interaction variable in Table 2 measures the effect over and above the individual airline effects). At the same time, non-dominant hub operators' average yields are about 5.5 percent lower than their dominant counterparts.

At the upper tail of the price distribution, however, non-dominant hub operators, as we defined them, enjoy about 6 percent premium over dominant airlines – so there is no expected market power based dominance effect; at the same time, the hub premium (comparing fares for non-stop flights by hub operators to those of other carriers) is higher at the upper tail of the distribution than closer to the average yields.

In individual airport regressions, a very similar picture is observed in Atlanta and Denver. In Dallas-Ft. Worth regressions, the picture is reversed, and the dominant airline there is found to command *lower* yields as compared to its competitors (this result is sensitive to excluding the time period after Delta dismantled its hub at DFW from the sample). We are not sure what drives this result. One possible explanation is that DFW was a secondary hub for Delta Air Lines, whereas ATL and DEN are main hub airports for the respective non-dominant hub operators. It is also possible that our results may reflect the cost side of the market (hub operators at DFW may enjoy substantial cost savings); alternatively, the nature of competition between airlines hubbed at DFW may be different (i.e., less 'cooperative') than in other airports[13].

Airports that are not clearly dominated by any single carrier (Chicago O'Hare and Phoenix) yielded results that are generally consistent with our expectations. At Chicago O'Hare, the two major carriers exhibit symmetric pricing and do not enjoy much of a premium above other airlines flying into that airport. At Phoenix, America West commands some premium over Southwest Airlines (a well-established low-cost leader) and other carriers. Southwest Airlines' average yields appear lower than the comparable figure for direct flights by other airlines; yet, at the upper end of the distribution

[13] Another explanation could relate to presence of Southwest Airlines at Dallas Love Field airport; however, that carrier faces significant restrictions due to Wright Amendment.

Southwest appears to be able to capitalize on its hub operations to command a premium over "other" carriers.

In general, we found that airlines enjoying the dominant position at an airport are able to extract the "market power based" dominance premium from an *average* traveler; premium charged to the higher paying customers appears to be more "quality-based", as evidenced by insignificant differences between dominant airline and non-dominant hub operator effects in specifications where higher fares and yields are used as dependent variables.

We noted earlier that our results may be subject to a different interpretation, in case our identifying assumption that fares charged by non-dominant hub operator only include quality based hub effect does not hold. In this case, what we have been interpreting throughout this paper as the quality-based hub premium might be nothing more than the difference between the two market-power based premiums, making separation of the market-based dominance premium from the quality based one all but impossible.

To assess the effects of this potential identification issue, let us conduct the following thought experiment, considering two somewhat extreme cases. In the first case, suppose there are no quality-based fare premiums (in this case, our estimates can be interpreted merely as differences in market power based premiums between the two hub operators). Then, at the upper tail of the distribution, our results imply that the non-dominant operator's market power strengthens to a larger degree as compared to the market power of the dominant airline (relative to estimates obtained for average fare levels). This would certainly be in contrast to findings of the previous studies (Berry et al., 2006; Lee and Luengo-Prado, 2005) and would effectively suggest that extent of airline's market power at the upper end of price distribution does not depend on whether the hub operator is a dominant carrier. In the second case, suppose the market based premium does not change from the middle to the upper tail of the price distribution (in the most extreme case, we can suppose market-power based premiums do not exist). In this case, our results imply that the quality-based premium will grow more for the non-dominant hub operator than for the dominant airline, as compared to results at the mean fares. Alternatively, our findings would imply that passengers at the upper end of price distribution value quality (in the sense we defined it here) more than those purchasing average-priced tickets. This actually makes sense, since higher-paying passengers are more likely to be frequent travelers, and therefore are more likely to be able to take advantage of frequent flyer programs. Intuitively, the case of passengers valuing quality differently is more plausible (or at least looks less artificial) than that of varying market power differences across the airlines depending on where in the distribution of ticket prices we are at a given time.

In light of the discussion above, we can not rule out the possibility our estimation results have not weeded out market-power based premiums completely. At the same time, our findings are still consistent with quality-based premium being more important at the upper end of the pricing distribution, and the market power based premium prevailing in the middle of observed price spectrum.

A plausible explanation of our main result comes from the argument that a hub operator offers customers served by the hub airport a wider menu of non-stop flight options as compared to any other carrier serving the same airport. This quality is more likely to be valued by price-insensitive business travelers (who are also more likely to have the highest valuations of the hub operator's frequent flier programs); what we effectively find is that for a customer purchasing a ticket at the upper tail of the price distribution, availability of this menu of non-stop flights is about as important as the number of destinations served. An average customer, however, will be paying more for a trip with the carrier that has a dominant position at the airport. Effectively, in contrast to studies by Berry et al. (2006) and Lee and Luengo-Prado (2005), we claim that the airport dominance effect applies to an average passenger rather than to a price-insensitive business traveler.

Our findings suggest different policy implications of our result as compared to conclusions of the two above mentioned studies. Both Berry et al. and Lee and Luengo-Prado effectively suggested that market power associated with the airport dominance is applied by the respective carriers only to a certain segment of the market (which implicitly means that an "average" traveler pays the same price whether or not he/she is traveling with the dominant carrier). This implies that correlation between the market power and consumers' willingness to pay, which from the policy point of view means that market power is targeted at the "right" segment of the market (you will most probably not punish a price-discriminating firm simply for being able to successfully identify the price-insensitive segment of the market).

Our results, however, indicate that premiums charged by the dominant airlines to higher-paying passengers simply reflect those travelers' willingness to pay for higher quality and are therefore *not* a manifestation of those carriers' market power (subject to a qualification as discussed above). At the same time, premiums charged by the dominant carrier to an average consumer are market power based. Our results then imply that dominant airlines appear not to be charging quite according to the passengers' willingness to pay for their services.

The only real surprise in coefficients on the control variables is lower fares for direct flights in some specifications. The possible explanation of this result is that direct flights in our sample are shorter than one-stop itineraries, in which case the logarithm of distance alone does not cope with this well. Note that this counterintuitive relationship is less common in regressions where yield is used as a dependent variable.

One may find it strange that our results appear to suggest that firms on more concentrated markets charge lower fares. However, one has to note that our specifications include both market share and HHI, and that we examine price-setting at the individual airline rather than the market level. Holding market share fixed, higher HHI simply means that competitors an airline faces on the market have become stronger. Expected effect of this change on fares charged by an individual carrier is actually uncertain. On one hand, more concentration can lead to all airlines involved raising their fares due to higher market power; on the other hand, stronger competitors may mean fiercer competition and lower fares to keep market share intact. The latter effect appears to dominate, reinforcing the widely held belief that the airline business is very competitive. Note also that higher market share holding HHI constant leads to higher fares, as expected. As an illustration, our results for the pooled regression indicate that, other things equal, a monopoly airline's average yield will be 3.7 percent higher than same for an airline operating on a symmetric duopoly market. For an airline holding 50 percent market share, a merger between the two competitors each holding 25 percent market share will imply – assuming the carrier still has 50 percent market share after the merger – a 4.5 percent decrease in average yield (HHI changes from 0.375 to 0.5 as a result of such a merger). The merged airline, however, will be able to command 6.4 percent higher average yield as compared to what the carriers would have charged before the merger.

5. Conclusions

This paper comes back to a seemingly settled issue of the airport dominance effect. Since Borenstein (1989) study, airlines' ability to charge higher fares for flights to/from airports where they enjoy a dominant position has been a rather established fact. More recent studies (Lee and Luengo-Prado, 2005; Berry et al., 2006) suggested that the observed airport dominance premium appears to apply to price-insensitive business travelers, reinforcing the frequent-flier-program explanation of the phenomenon originally proposed by Borenstein.

Our study's aim is separating "hub effect" from the "dominance effect". We note that every airport which is dominated by a single carrier also serves as a hub in the respective carrier's network. The "hub effect" may exist due to the fact that the airline operating a hub at an airport will offer its customers access to a larger network of non-stop flights, or generally a higher quality product. Customers residing in the hub airport's area will probably value hub operator's frequent flier program more than same offered by other carriers. Thus, we define "hub effect" as "quality-based" premium charged by a hub operator; and "dominance effect" is then the "market power based" price premium charged by the dominant airline. Identification of the two effects requires studying airports that serve as hubs for more than one carrier.

We use a sample of actual itineraries collected quarterly by the US Department of Transportation (this dataset is known as DB1B). For our analysis, we select non-stop and one-stop roundtrip itineraries that originate, terminate or go through one of the five airports which serve (or served) as a hub for two carriers: Atlanta, Chicago O'Hare, Dallas-Ft. Worth, Phoenix, and Denver. Data analysis shows that while airport dominance premium exists, it manifests itself in regressions with average price/yield as the dependent variable rather than at the upper end of the price/yield distribution; across-airport differences are also observed. Our results effectively suggest that, unlike implied by Lee and Luengo-Prado (2005) and Berry et al. (2006), it is the average traveler who is paying the airport dominance premium; the price-insensitive business traveler pays equal premium for traveling to/from an airline's hub, whether the airline has a dominant position at its hub airport or not.

We are aware that our main finding hinges on our identifying assumption of no market power premium for non-dominant hub operator being defensible. At the same time, even if we are wrong and non-dominant hub operator's fares for non-stop flights to/from the hub airport also include market power based premium, our results would still suggest that quality-based premium is more important at the upper end of price distribution than at the mean (our estimates of quality-based premium would of course be exaggerated in this case).

One will be right to question applicability of our results outside of our sample, especially in light of substantial differences in estimation results across airport-specific sub-samples (this result is not especially striking by itself – significant differences in fare premiums across dominated airports have been reported in prior studies). Especially interesting is the question of our study's implications for airports which are dominated by a single hub operator. Since identification of "quality-based" and "market power based" components of apparent fare premium will be impossible for such airports; we can only speculate on the distribution of fare premium into "hub effect" and "dominance effect" for those airports. We can, however, state that what this premium reflects is not only airlines exercising their market power, but also consumers' willingness to pay for the extensive network of non-stop flights not available from other cities and/or having access to frequent flier programs which enable customers to accumulate miles faster, other things equal.

To sum it all up, our study has separated what was previously considered the airport dominance effect (and a manifestation of dominant carriers' market power) on airfares into two components. We based our study on the premise that previous research has not taken into account (or rather has not clearly empirically identified) the fact that residents of the area near an airport serving as a hub for certain carrier will view this carrier's services as a higher quality product as compared to other carriers. Existence of airports serving as hubs for two carriers allowed us to separate the quality based component of what has been known the airport dominance premium from the market power based one.

References

Berry, S. T., M. Carnall and P. T. Spiller (2006) "Airline Hubs: Costs, Markups, and the Implications of Customer Heterogeneity", in Darin Lee (ed.) *Advances in Airline Economics*, Vol. 1, Elsevier

Bilotkach, V (2007) "Asymmetric Regulation and Airport Dominance in International Aviation: Evidence from the London-New York Market", *Southern Economic Journal*, 74, 505-523

Bilotkach, V. and M. Pejcinovska (2008) "Distribution of Airline Tickets: A Tale of Two Market Structures", working paper

Borenstein, S. (1989) "Hubs and High Fares: Dominance and Market Power in the US Airline Industry", *RAND Journal of Economics,* 20, 344-65

Borenstein, S. (1991) "The Dominant Firm Advantage in Multiproduct Industries: Evidence from the U.S. Airlines", *The Quarterly Journal of Economics,* 106, 1237-1266

Evans, W. N. and I. N. Kessides (1993) "Localized Market Power in the U.S. Airline Industry", *The Review of Economics and Statistics,* 75, 66-75

Jordan, W. (2008) "How Scheduled Passenger Airlines Left the Industry under Deregulation 1979-2006", working paper

Lederman, M. (2008) "Are Frequent Flyer Programs a Cause of the "Hub Premium"? *Journal of Economics and Management Strategy*, 17, 35-66

Lee, D. and M.J. Luengo-Prado (2005) "The Impact of Passenger Mix on Reported 'Hub Premiums' in the U.S. Airline Industry" *Southern Economic Journal*, 72, 372-394

Morrison, S. and C. Whinston (1995) "The Evolution of the Airline Industry", Brookings Institution Press

Table 1 Domestic Destinations Served by Main Airlines

	Atlanta		Denver		Dallas		Chicago		Phoenix	
	Delta	Air Tran	United	Frontier	AA	Delta	AA	United	America West	South west
July 1999	124	30	86	17	120	58	91	88	53	32
July 2000	134	29	80	20	120	63	96	96	54	37
July 2001	138	32	83	29	118	65	93	103	56	38
July 2002	138	36	80	29	119	60	96	84	55	43
July 2003	137	38	81	30	116	66	82	91	58	41
July 2004	137	42	75	36	126	72	109	116	56	42
July 2005	154	45	75	39	135	6[3]	110	119	56	45

Notes:

1. Numbers obtained from analysis of dataset T100 Segment for the US market
2. Includes destinations served by regional carriers operating under the major airline's name
3. In July of 2005, US Airways was technically the second-largest airline in terms of destinations served from DFW, with flights to seven airports.
4. America West merged with US Airways in September of 2005; transition to the "new" US Airways with PHX as one of the hubs was completed over the next two years.
5. No other carrier serves more than thirteen unique airports from any of the above gateways in July of any given year.

Table 2 Pooled Regressions

Variable	Price				Yield			
	Average		High		Average		High	
	FE	IV	FE	IV	FE	IV	FE	IV
Log(Distance)[5]	-0.146 (0.003)	-0.051 (0.006)	-0.039 (0.003)	0.116 (0.005)	-0.0004 (1.2E-06)	-0.0003 (2.0E-06)	-0.0003 (1.0E-06)	-0.0003 (1.7E-06)
Direct Flights	0.021 (0.004)	-0.074 (0.006)	0.240 (0.003)	0.079 (0.005)	0.086 (0.004)	-0.013 (0.006)	0.294 (0.003)	0.126 (0.005)
HHI	0.051 (0.005)	-0.363 (0.040)	0.048 (0.004)	-0.391 (0.033)	0.043 (0.005)	-0.363 (0.040)	0.041 (0.004)	-0.394 (0.034)
Market Share	0.141 (0.003)	0.441 (0.014)	0.185 (0.002)	0.711 (0.012)	0.141 (0.003)	0.437 (0.014)	0.185 (0.002)	0.714 (0.012)
Population Average	5.99E-09 (5.2E-10)	6.14E-09 (5.3E-10)	5.78E-09 (4.1E-10)	6.13E-09 (4.3E-10)	5.84E-09 (5.3E-10)	5.99E-09 (5.3E-10)	5.79E-09 (4.1E-10)	6.12E-09 (4.4E-10)
Hub Operator*Direct	0.092 (0.002)	0.111 (0.002)	0.069 (0.002)	0.095 (0.002)	0.101 (0.002)	0.120 (0.002)	0.078 (0.002)	0.102 (0.002)
Dominant Airline*Direct	0.031 (0.006)	-0.005* (0.006)	0.062 (0.005)	0.007* (0.005)	0.072 (0.006)	0.033 (0.006)	0.098 (0.005)	0.038 (0.005)
Non-dominant*Direct	-0.141 (0.008)	-0.078 (0.009)	-0.071 (0.006)	0.051 (0.007)	-0.078 (0.008)	-0.021 (0.009)	-0.014 (0.006)	0.101 (0.007)
Other Carriers*Direct	0.022 (0.006)	0.039 (0.006)	-0.093 (0.004)	-0.079 (0.004)	0.020 (0.006)	0.037 (0.006)	-0.092 (0.005)	-0.078 (0.005)
Adjusted R-squared	0.448	0.462	0.482	0.411	0.614	0.604	0.712	0.673
Number of Observations	634,895		538,501		634,895		538,501	

Notes:

1. Dependent variable is natural logarithm of price or yield. Average price/yield corresponds to passenger-weighted mean, as discussed in text; high price/yield is passenger-weighted mean plus standard deviation, as discussed in text.
2. FE stands for airport-pair market fixed effects model; IV is fixed effects model with instrumental variables.
3. All specifications include other control variables as indicated in the text, which are not reported.
4. Star indicates *lack of statistical significance* at 5 percent level.
5. Distance was used instead of log(distance) as independent variable in specifications with yield as the dependent variable.

Table 3 Logarithm of Average Fare as Dependent Variable – Dominated Airports

Variable	Atlanta		Denver		Dallas	
	FE	IV	FE	IV	FE	IV
Log(Distance)	-0.076 (0.008)	-0.064 (0.009)	-0.072 (0.008)	-0.022 (0.010)	-0.151 (0.010)	-0.079 (0.012)
Direct Flights	0.046 (0.020)	0.007* (0.021)	0.055 (0.019)	-0.042 (0.022)	0.052 (0.018)	0.017* (0.019)
HHI	0.105 (0.009)	-0.463 (0.053)	0.062 (0.013)	0.134* (0.125)	0.015* (0.011)	-0.411 (0.099)
Market Share	-0.004* (0.005)	0.152 (0.034)	0.085 (0.007)	0.714 (0.062)	0.093 (0.006)	0.683 (0.051)
Population Average	8.57E-09 (9.59E-10)	9.14E-09 (9.75E-10)	1.28E-08 (1.43E-09)	1.39E-08 (1.48E-09)	4.62E-09 (1.06E-09)	2.79E-09 (1.17E-09)
Dominant Airline	0.124 (0.006)	0.114 (0.006)	0.125 (0.006)	0.119 (0.006)	0.115 (0.006)	0.105 (0.006)
Non-dominant hub operator	-0.031 (0.007)	-0.040 (0.008)	0.088 (0.008)	0.132 (0.009)	0.078 (0.006)	0.154 (0.009)
Dominant*Direct	0.064 (0.022)	0.050 (0.024)	0.096 (0.022)	0.013* (0.024)	-0.025* (0.019)	-0.279 (0.031)
Non-dominant hub operator*Direct	-0.053 (0.024)	-0.046 (0.024)	-0.103 (0.023)	-0.126 (0.024)	-0.111 (0.021)	-0.174 (0.022)
Other Carriers*Direct	0.023* (0.022)	-0.003* (0.024)	0.013* (0.021)	-0.107 (0.024)	-0.027* (0.023)	-0.057 (0.024)
Adjusted R-squared	0.529	0.514	0.453	0.420	0.460	0.426
Number of Observations	158,329		123,319		151,799	

Notes:

1. Dependent variable is natural logarithm of passenger-weighted mean price.
2. FE stands for airport-pair market fixed effects model; IV is fixed effects model with instrumental variables.
3. All specifications include other control variables as indicated in the text, which are not reported.
4. Star indicates *lack of statistical significance* at 5 percent level.

Table 4 Logarithm of High Fare as Dependent Variable – Dominated Airports

Variable	Atlanta		Denver		Dallas	
	FE	IV	FE	IV	FE	IV
Log(Distance)	-0.019 (0.008)	-0.012* (0.008)	0.020 (0.007)	0.086 (0.008)	-0.005* (0.008)	0.055 (0.009)
Direct Flights	0.199 (0.018)	0.181 (0.018)	0.197 (0.014)	0.042 (0.018)	0.201 (0.014)	0.159 (0.015)
HHI	-0.546 (0.048)	-0.567 (0.049)	0.064 (0.009)	-0.029* (0.102)	-0.033 (0.008)	-0.348 (0.079)
Market Share	0.118 (0.006)	0.356 (0.027)	0.128 (0.005)	1.083 (0.053)	0.177 (0.005)	0.837 (0.038)
Population Average	7.30E-09 (8.12E-10)	7.39E-09 (8.32E-10)	7.77E-09 (1.05E-09)	9.44E-09 (1.20E-09)	4.66E-09 (8.42E-10)	3.68E-09 (9.43E-10)
Dominant Airline	0.229 (0.005)	0.217 (0.005)	0.264 (0.005)	0.252 (0.005)	0.215 (0.005)	0.205 (0.005)
Non-dominant hub operator	-0.081 (0.006)	-0.051 (0.007)	0.061 (0.006)	0.121 (0.007)	0.149 (0.005)	0.234 (0.007)
Dominant*Direct	0.111 (0.019)	0.049 (0.021)	0.172 (0.016)	0.065 (0.018)	0.018* (0.015)	-0.253 (0.023)
Non-dominant hub operator*Direct	0.047 (0.021)	0.035 (0.020)	0.039 (0.017)	0.016* (0.019)	-0.020* (0.016)	-0.075 (0.018)
Other Carriers*Direct	-0.112 (0.019)	-0.178 (0.021)	-0.052* (0.015)	-0.231 (0.020)	0.073 (0.018)	0.036* (0.019)
Adjusted R-squared	0.532	0.519	0.505	0.357	0.472	0.397
Number of Observations	136,598		104,578		130,634	

Notes:

1. Dependent variable is natural logarithm of passenger-weighted mean price plus corresponding standard deviation.
2. FE stands for airport-pair market fixed effects model; IV is fixed effects model with instrumental variables.
3. All specifications include other control variables as indicated in the text, which are not reported.
4. Star indicates *lack of statistical significance* at 5 percent level.

Table 5 Logarithm of Average Yield as Dependent Variable – Dominated Airports

Variable	Atlanta		Denver		Dallas	
	FE	IV	FE	IV	FE	IV
Distance	-0.0004 (3.68E-06)	-0.0003 (3.85E-06)	-0.0003 (2.81E-06)	-0.0003 (3.37E-06)	-0.0004 (3.82E-06)	-0.0003 (4.89E-06)
Direct Flights	0.056 (0.021)	0.015* (0.021)	0.075 (0.019)	-0.022* (0.022)	0.083 (0.018)	0.049 (0.019)
HHI	0.097 (0.009)	-0.479 (0.054)	0.053 (0.013)	0.145* (0.126)	0.015* (0.011)	-0.392 (0.099)
Market Share	-0.008* (0.005)	0.175 (0.034)	0.087 (0.007)	0.716 (0.063)	0.079 (0.006)	0.671 (0.052)
Population Average	8.57E-09 (9.68E-10)	9.15E-09 (9.85E-10)	1.25E-08 (1.45E-09)	1.36E-08 (1.49E-09)	4.48E-09 (1.06E-09)	2.91E-09 (1.17E-09)
Dominant Airline	0.137 (0.006)	0.124 (0.006)	0.133 (0.006)	0.125 (0.006)	0.109 (0.006)	0.101 (0.006)
Non-dominant hub operator	-0.019 (0.007)	-0.026 (0.008)	0.091 (0.008)	0.134 (0.009)	0.068 (0.006)	0.145 (0.009)
Dominant*Direct	0.166 (0.022)	0.144 (0.024)	0.163 (0.022)	0.078 (0.024)	0.031* (0.019)	-0.227 (0.031)
Non-dominant hub operator*Direct	0.087 (0.024)	0.091 (0.024)	-0.010* (0.023)	-0.036* (0.024)	-0.044 (0.021)	-0.110 (0.023)
Other Carriers*Direct	0.084 (0.022)	0.048 (0.024)	0.072 (0.021)	-0.052 (0.024)	-0.032* (0.023)	-0.062 (0.024)
Adjusted R-squared	0.701	0.691	0.551	0.523	0.613	0.589
Number of Observations	158,329		123,319		151,799	

Notes:

1. Dependent variable is natural logarithm of passenger-weighted mean yield.
2. FE stands for airport-pair market fixed effects model; IV is fixed effects model with instrumental variables.
3. All specifications include other control variables as indicated in the text, which are not reported.
4. Star indicates *lack of statistical significance* at 5 percent level.

Table 6 Logarithm of High Yield as Dependent Variable – Dominated Airports

Variable	Atlanta		Denver		Dallas	
	FE	IV	FE	IV	FE	IV
Distance	-0.0004 (3.24E-06)	-0.0003 (3.46E-06)	-0.0003 (2.22E-06)	-0.0003 (2.85E-06)	-0.0003 (3.26E-06)	-0.0003 (4.00E-06)
Direct Flights	0.233 (0.018)	0.173 (0.019)	0.216 (0.014)	0.059 (0.018)	0.227 (0.014)	0.187 (0.015)
HHI	0.104 (0.007)	-0.591 (0.049)	0.056 (0.010)	-0.014* (0.104)	-0.034 (0.008)	-0.333 (0.079)
Market Share	0.054 (0.004)	0.377 (0.027)	0.127 (0.006)	1.090 (0.054)	0.165 (0.005)	0.830 (0.039)
Population Average	7.00E-09 (7.96E-10)	7.61E-09 (8.36E-10)	7.50E-09 (1.07E-09)	9.18E-09 (1.22E-09)	4.51E-09 (8.47E-10)	3.60E-09 (9.49E-10)
Dominant Airline	0.244 (0.005)	0.225 (0.006)	0.269 (0.005)	0.256 (0.005)	0.211 (0.005)	0.202 (0.005)
Non-dominant hub operator	-0.046 (0.006)	-0.039 (0.007)	0.062 (0.006)	0.123 (0.007)	0.141 (0.005)	0.227 (0.007)
Dominant*Direct	0.187 (0.018)	0.146 (0.021)	0.234 (0.016)	0.124 (0.019)	0.067 (0.015)	-0.208 (0.023)
Non-dominant hub operator*Direct	0.163 (0.019)	0.171 (0.021)	0.122 (0.017)	0.095 (0.019)	0.038 (0.016)	-0.019* (0.018)
Other Carriers*Direct	-0.051 (0.019)	-0.117 (0.021)	0.003* (0.015)	-0.182 (0.020)	0.072 (0.018)	0.034* (0.019)
Adjusted R-squared	0.773	0.750	0.653	0.550	0.687	0.644
Number of Observations	136,598		104,578		130,634	

Notes:

1. Dependent variable is natural logarithm of passenger-weighted mean price plus corresponding standard deviation.
2. FE stands for airport-pair market fixed effects model; IV is fixed effects model with instrumental variables.
3. All specifications include other control variables as indicated in the text, which are not reported.
4. Star indicates *lack of statistical significance* at 5 percent level.

Table 7 Logarithm of Fare as Dependent Variable – "Symmetric" Airports

Variable	Average Fare				High Fare			
	Chicago O'Hare		Phoenix		Chicago O'Hare		Phoenix	
	FE	IV	FE	IV	FE	IV	FE	IV
Log(Distance)	0.029 (0.008)	0.042 (0.008)	-0.067 (0.009)	0.049 (0.015)	0.077 (0.006)	0.087 (0.007)	0.042 (0.008)	0.163 (0.012)
Direct Flights	-0.057 (0.024)	-0.106 (0.025)	0.030* (0.019)	-0.122 (0.025)	0.119 (0.018)	0.024* (0.021)	0.205 (0.013)	0.041 (0.019)
HHI	0.054 (0.010)	-0.715 (0.093)	0.118 (0.012)	-0.278 (0.091)	0.061 (0.007)	-0.744 (0.075)	0.140 (0.009)	-0.353 (0.071)
Market Share	0.026 (0.006)	0.399 (0.037)	0.072 (0.007)	0.861 (0.086)	0.071 (0.005)	0.729 (0.029)	0.165 (0.005)	1.000 (0.065)
Population Average	5.09E-09 (9.4E-10)	5.03E-09 (9.6E-10)	2.59E-09 (1.3E-09)	2.4E-09* (1.4E-09)	5.25E-09 (7.2E-10)	5.52E-09 (7.8E-10)	5.02E-09 (1.0E-10)	5.10E-09 (1.1E-09)
Hub Carrier 1	0.026 (0.007)	0.079 (0.009)	0.051 (0.006)	0.010* (0.008)	0.094 (0.006)	0.201 (0.007)	0.063 (0.004)	0.034 (0.006)
Hub Carrier 2	0.078 (0.007)	0.107 (0.008)	-0.127 (0.008)	0.063 (0.011)	0.151 (0.006)	0.206 (0.007)	0.032 (0.008)	0.109 (0.009)
(Carrier 1)*Direct	0.204 (0.025)	0.094 (0.029)	0.027* (0.021)	-0.019* (0.023)	0.179 (0.022)	0.003* (0.023)	0.144 (0.015)	0.102 (0.017)
(Carrier 2)*Direct	0.194 (0.026)	0.124 (0.027)	0.001* (0.022)	-0.165 (0.030)	0.216 (0.020)	0.019 (0.022)	0.121 (0.016)	-0.044 (0.023)
Other Carriers*Direct	0.172 (0.027)	0.132 (0.027)	0.053 (0.021)	-0.084 (0.028)	0.159 (0.021)	0.012 (0.025)	-0.070 (0.015)	-0.234 (0.023)
Adjusted R-squared	0.431	0.404	0.481	0.422	0.476	0.381	0.508	0.371
Number of Observations	174,325		107,119		143,580		90,413	

Notes:

1. Dependent variable is natural logarithm of price. Average price corresponds to passenger-weighted mean, as discussed in text; high price is passenger-weighted mean plus standard deviation.
2. FE stands for airport-pair market fixed effects model; IV is fixed effects model with instrumental variables.
3. All specifications include other control variables as indicated in the text, which are not reported.
4. Star indicates *lack of statistical significance* at 5 percent level.
5. Carrier 1 is American Airlines for Chicago O'Hare sub-sample and America West for Phoenix sub-sample; Carrier 2 is United Airlines for Chicago O'Hare sub-sample and Southwest for Phoenix sub-sample.

Table 8 Logarithm of Yield as Dependent Variable – “Symmetric” Airports

Variable	Average Yield				High Yield			
	Chicago O’Hare		Phoenix		Chicago O’Hare		Phoenix	
	FE	IV	FE	IV	FE	IV	FE	IV
Distance	-0.0003 (2.9E-06)	-0.0003 (3.0E-06)	-0.0003 (3.0E-06)	-0.0002 (5.8E-06)	-0.0003 (2.3E-06)	-0.0003 (2.5E-06)	-0.0003 (2.5E-06)	-0.0002 (4.6E-06)
Direct Flights	-0.052 (0.024)	-0.102 (0.025)	0.045 (0.019)	-0.101 (0.025)	0.089 (0.019)	-0.009* (0.021)	0.022 (0.014)	0.064 (0.019)
HHI	0.050 (0.010)	-0.726 (0.094)	0.116 (0.013)	-0.271 (0.091)	0.057 (0.008)	-0.755 (0.077)	0.134 (0.009)	-0.355 (0.071)
Market Share	0.021 (0.006)	0.413 (0.037)	0.052 (0.007)	0.809 (0.087)	0.065 (0.005)	0.752 (0.029)	0.154 (0.005)	0.955 (0.067)
Population Average	5.06E-09 (9.4E-10)	5.02E-09 (9.7E-10)	2.89E-09 (1.3E-09)	2.70E-09 (1.4E-09)	5.40E-09 (7.3E-10)	5.71E-09 (8.0E-10)	5.57E-09 (1.0E-09)	5.59E-09 (1.1E-09)
Hub Carrier 1	0.027 (0.007)	0.083 (0.009)	0.063 (0.006)	0.023 (0.007)	0.091 (0.006)	0.203 (0.008)	0.071 (0.005)	0.042 (0.006)
Hub Carrier 2	0.082 (0.007)	0.112 (0.008)	-0.118 (0.008)	-0.057 (0.011)	0.149 (0.006)	0.206 (0.007)	0.039 (0.006)	0.113 (0.009)
(Carrier 1)*Direct	0.298 (0.026)	0.179 (0.029)	0.052 (0.021)	0.006* (0.023)	0.299 (0.019)	0.113 (0.023)	0.162 (0.015)	0.121 (0.017)
(Carrier 2)*Direct	0.265 (0.026)	0.190 (0.027)	0.029* (0.022)	-0.132 (0.031)	0.313 (0.020)	0.133 (0.022)	0.138 (0.016)	-0.019* (0.023)
Other Carriers*Direct	0.243 (0.027)	0.200 (0.028)	0.064 (0.021)	-0.068 (0.028)	0.256 (0.021)	0.106 (0.023)	-0.062 (0.015)	-0.219 (0.023)
Adjusted R-squared	0.607	0.588	0.580	0.536	0.712	0.658	0.686	0.607
Number of Observations	174,325		107,119		143,580		90,413	

Notes:

1. Dependent variable is natural logarithm of yield. Average yield corresponds to passenger-weighted mean, as discussed in text; high yield is passenger-weighted mean plus standard deviation.
2. FE stands for airport-pair market fixed effects model; IV is fixed effects model with instrumental variables.
3. All specifications include other control variables as indicated in the text, which are not reported.
4. Star indicates *lack of statistical significance* at 5 percent level.
5. Carrier 1 is American Airlines for Chicago O’Hare sub-sample and America West for Phoenix sub-sample; Carrier 2 is United Airlines for Chicago O’Hare sub-sample and Southwest for Phoenix sub-sample.