On Sources of Market Power in the Airline Industry:

Panel Data Evidence from the US Airports

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Abstract

A firm can obtain market power through its dominant position on the product market, or via control of a key resource. In particular, it has been argued that airport dominance was a more important source of market power in the US airline industry than route dominance. We examine this contention by analyzing a 17-year panel of airport-level prices in the United States. We demonstrate that even though on average airport-level concentration appears to be the strongest source of market power; concentration on routes originating at an airport is the strongest predictor of price levels for large and medium hub airports. There is little evidence that either airport or route dominance significantly affect prices at medium and small hub airports. There is also little evidence that an airport's dominant carrier exerts market power beyond the level predicted by the airport or route dominance. Our results imply that consumer welfare losses due to airline consolidation can be concentrated in smaller communities, and related to changes in airport-level concentration. We provide a simple evaluation of the possible effects of two recent mergers (Delta – Northwest and United – Continental) in light of this finding, and suggest that the former consolidation event can potentially lead to non-trivial consumer welfare losses to travelers in over 30 small communities.

Keywords: Market Power, Airline Industry, Airport Concentration

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Introduction

This study takes a 30,000-feet view at the issue of sources of market power in the US airline industry. We take a fairly straightforward approach. Consider a passenger contemplating a trip that originates at a local airport. The question we ask is: will this passenger pay a higher price, other things equal, if his local airport is served by a few airlines, or if there is little competition on the individual markets originating at this airport? To give ourselves a clearer perspective, we can ask another question: will trips originating at an airport served by only two airlines that compete on each market originating from this gateway be priced higher than tickets for flights, originating at an airport served by four airlines, where each carrier is a monopolist on the respective routes it serves? Additionally, we inquire whether ticket prices will be higher if one of the carriers serving the airport has a dominant position at this gateway, meaning that it carries most of the passengers out of and into the airport. In other words, we examine the role airport dominance, airport concentration, and route concentration play in determining the prices for airline tickets originating at a particular airport.

While research on pricing in the U.S. airline industry has been extensive, a simple question of the interplay of airport and route dominance has not been examined across the entire industry and over time. Most studies to date have either focused on a limited number of markets, or examined the issue of sources of market power over relatively short time period. As a result, for instance, little is known about the sources of market power at small airports. Further, a simple question of the relationship between price and airport concentration has been overlooked in the literature, as researchers have focused on estimating market power of the dominant airline at an airport. Our study starts filling these gaps.

We have constructed a 17-year long panel of airport-level average airfares for domestic trips originating at all US airports, using the data collected by the US Department of Transportation (DOT). We have then used a different DOT dataset to construct measures of concentration, at both the airport level and for routes with non-stop services originating at the airport. Applying conventional panel data analysis techniques, and accounting for endogeneity of the key market concentration variables, we determine that, on average, airport concentration stands out as the most important driver of airport-level fares. The size of the effect is however not impressive: a 10 percent increase in airport-level HHI only raises the average fares by 1 percent. Further analysis reveals that the airport concentration-price relationship is primarily driven by the small airports. Data analysis for large and medium hubs[3] (airports that have traditionally been the focus of hub dominance premium studies) reveals route dominance as the primary source of market power: coefficient estimates suggest that a 10 percent increase in mean HHI for non-stop routes originating from such airports increases average airfares by around 7 percent. We also found sporadic evidence suggesting that increase in the market share of the largest airline in the airport may increase airfares.

Our research has implications, in particular, for analyzing effects of mergers in the airline industry. Recent debates over this important issue have focused on addressing the question of the impact of mergers on route-level competition (Brueckner, Lee, and Singer, 2011). We show that analyzing effects

[3] According to Federal Aviation Administration (FAA) classification. See Data section for details.

of airline consolidation on airport-level concentration is also important. Specifically, our analysis shows that Delta-Northwest merger is projected to substantially increase concentration at about three times as many airports as the Continental-United merger. We further demonstrate that Delta-Northwest merger can potentially lead to about quarter of a billion dollars per year in terms of consumer welfare losses through increased airport-level concentration at about thirty small airports. More generally, we suggest that gains and losses from airline consolidation may not be distributed evenly across the US airline industry; and in particular losses from consolidation could be disproportionately borne by smaller communities.

The rest of the study is organized as follows. Next section reviews the relevant literature. This is followed by the description of the data and discussion of the analysis methodology. After this, data analysis results are presented and discussed, paying specific attention at the implications of our exercise for analysis of the airline mergers. The last section of the paper offers some concluding remarks.

Relevant Literature

Looking at the rather extensive literature on the sources of market power in the US airline industry, two stylized facts stand out. First, low-cost carriers, in particular Southwest Airlines, push average fares down on the routes they enter. Second, airport dominance appears to play an important role as a source of market power; perhaps more important than the route dominance. These facts reflect the focus of the empirical studies on low cost carriers and – to a larger extent – hub operators, which typically dominate the airports they serve. This focus is understandable, as emergence of hub-and-spoke networks and explosive growth of low-cost carriers have been the two most important innovations in the airline industry since deregulation. The path along which the literature developed has, however, led to the following important gaps, which our study intends to start filling. First, airport-concentration-price relationship has received substantially less attention than the dominant-carrier's-market-share-price correlation[4]. Second, smaller airports, which are as likely to be dominated by a single carrier, received little coverage. Third, aggregate level studies examining the issue of sources of market power over longer time periods are scarce: a recent paper (Borenstein, 2011) offers such an analysis, focusing on airline-market-level fares, and demonstrating that the magnitude of hub premium has declined over the recent years. Finally, studies of the effects of airline mergers tend to assess average system-wide effects of the consolidation events, paying relatively little regard to potentially important differences between groups of routes or origin airports.

While addressing the implications of the hub-and-spoke networks, early post-deregulation studies of the airline industry focused on testing the market contestability hypothesis, which asserted that potential competition could put pressure on the exercise of market power by the incumbent carriers. Notable

[4] The one study offering a direct evaluation of the relationship between airport-level fares and airport-level airline concentration is Van Dender (2007). That study uses a simultaneous equation system approach to present an analysis of determinants of airport-level prices, delays, frequency of service, and operating revenues at 55 large US airports. Van Dender does not find any significant relationship between airport-level concentration and prices. Compared to that study, our analysis provides a more comprehensive coverage of the US airline industry with a longer panel; we also analyze price effects of the largest carrier's market share and competition on routes originating at an airport.

studies include Bailey and Panzar (1981); and Hurdle et al. (1989), which rejected the hypothesis that all city-pair markets are equally contestable, and found that the number of potential entrants had a significant negative effect on yields.

Following establishment of hub-and-spoke networks, seemingly higher fares at concentrated hub airports turned researchers' attention to the hub premium. The General Accounting Office's (GAO) widely cited 1990 study was the first to quantify the hub premium when it found that, in 1988, yield for trips originating at dominated hub airports was 27.2 percent higher than yields at airports that were not concentrated.[5] However, the GAO's study is also criticized for implicitly assuming that trips taken from the two groups of airports were identical; not taking into account route distance, the number of plane changes, passenger mix, carrier identity, unit cost differences, and frequent flier programs. Similar analysis that controlled for some of these factors were carried out and found more modest levels for the hub premium as they controlled for more factors.[6]

Borenstein (1989) is regarded as the seminal econometric study examining the airport dominance premium. He used three percentile groups to run a median fare regression by carrier and by route for the third quarter of 1987. Among the operational and market measures he included were airport and route concentration, stage length, frequency, passenger mix, airport constraints, and other competition measures. Airport dominance and route dominance were found to significantly affect the fares in markets where a carrier is dominant at the originating hub airport.[7] In a follow-up study, Borenstein (1991) showed that an airline with a dominant position at an airport has a larger share of the overall originating traffic and thereby also has a larger share of any market originating at the hub. Dominant airlines were shown to have substantial advantage over other carriers in attracting passengers whose trips originate at the dominated hub, regardless of their specific market.[8]

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[5] See General Accounting Office, *Airline Competition*, p. 3. A filtered DB1A database was used, comparing fifteen dominated hub airports to a control group of thirty-eight non-concentrated airports.

[6] U.S. Department of Transportation performed a similar analysis in 1990, where only routes of equal distance were compared between the two airport groups, and estimated an average hub premium of 18.7 percent and 8.9 percent for airports dominated by one and two airlines, respectively. Morrison and Winston (1995) revised the GAO study controlling for the five factors mentioned above. They found a significantly lower hub premium of 5.2 percent. In particular, corrections for distance and the number of plane changes reduced the estimated premium by 18.6 percentage points; carrier-specific comparisons shed off another 4.6 percentage points; correcting for FFPs and passenger mix removed each removed yet another 2.5 percentage points off the premium. Dresner and Windle (1992) controlled for distance and airport-level characteristics when comparing yields on flights from hubs to yields on flights to hubs. The premise of the study was that flights *from* a hub would render higher yields than those *to* a hub since market power is more pertinent at the origin airport. Their results showed the existence of a small but significant hub premium.

[7] Airport dominance was measured by a carrier's average share of daily passenger originations at the two endpoints of an observed route, and route dominance was measured by a carrier's share of all local origin-to-destination passengers on the observed route.

[8] Fruhan (1972) was the first to address the underlying idea of this effect by showing that an airline with a large share of available route capacity would disproportionately attract more traffic on that route. This route-based capacity advantage was also supported by Bailey, Graham, and Kaplan (1985) in their review of the deregulated

Subsequent research provided new evidence on the hub reliability premium issue: Simat, Helliesen and Eichner (1989), analyzing a smaller sample of airports, concluded that airfares were not associated with airport concentration. Their study was however revised by Abunassar and Koford (1994), who reached the opposite conclusion by including more control variables and using a different econometric technique.[9] Both studies also found that the presence of Low Cost Carriers (LCCs) reduces fares significantly. Evans and Kessides (1993) concluded that airport dominance is a far more important source of market power than route dominance.[10] Lee and Luengo-Prado (2005) found that the hub effect increases as the share of premium class passengers rises; presence of a LCC reduces premium fares by as much as 6%, while reducing coach fares by as much as 14%. Overall, they suggested that much of the observed hub premium could be explained by the passenger mix. Hofer, Dresner, and Windle (2004) suggested that hub premiums have decreased over time. Bilotkach (2007) demonstrates that dominant carriers command the corresponding premiums on the international routes. Lederman (2008) suggests that frequent flier programs account for 25% to 37% of the hub premium that carriers command. Cilberto and Williams (2010) show that control of the airport's resources appears to be an important source of the dominant carriers' market power.

Two studies documenting the impact of low-cost carriers are Morrison (2001) and Brueckner et al. (2011). Morrison (2001), commissioned by Southwest Airlines, suggests that actual and adjacent competition from this airline has saved passengers $12.9 billion in 1998. Brueckner et al. (2011), commissioned by United Airlines to provide evidence in support of its merger with Continental Airlines, demonstrates that competition from the legacy carriers does not affect airfares, while competition from the low-cost airlines does.

Looking at the literature on effects of airline mergers, the following studies should be noted. Borenstein (1990) and Kim and Singal (1993) examine the price and market power effects of the 1980s wave of airline mergers. Clougherty (2002) suggests that U.S. airline mergers improve the international competitiveness of U.S. carriers. Richard (2003) examines the welfare effects of a hypothetical merger between American Airlines and United Airlines for Chicago-originating routes, focusing on the carriers' choice of prices and frequency. Kwoka and Shumilkina (2010) focus on effects of elimination of potential competition following a US airline merger in the 1980s. Bilotkach (2011) examines the effects of changes in multimarket contact following a recent US airline merger on intensity of competition, effectively evaluating coordinated effects of that consolidation event. Most recently, Luo (2012) examined effects of Delta-Northwest merger, suggesting that this event resulted in small increase in airfares at the market level (looking at both non-stop and connecting routes). Our study does not disagree with these findings; we however specifically point to those markets, where this merger could have resulted in increased

industry. They went on to show that the strong evidence that they found for route-based capacity advantage prior to deregulation had diminished by 1981.

[9] Their new estimates found hubs dominated by one airline rendered 10% higher fares than unconcentrated hubs.

[10] In the other study, these authors (Evans and Kessides, 1994) demonstrated that the level of multimarket contact affects prices in the US airline industry.

airfares. We also suggest that any adverse effects of an airline merger could indeed be localized to smaller communities.

Data

Data for our research exercise comes predominantly from the US Department of Transportation (DOT). This agency collects information on airline operations and airfares in the US airline industry. Average airport-level airfares we will use as the dependent variable are computed by the DOT from the 10 per cent sample of actual itineraries. We have chosen to use annual average airfares for seventeen years, from 1993 until 2009, making adjustment for inflation using 1993 as the base year. Thus, our dependent variable represents annual average ticket price, in constant dollars, paid by a passenger departing from an airport.

The majority of our independent variables are computed from the DOT's databank T100 Segment. This dataset includes information about all commercial airline services departing from US airports. The information is provided monthly at the airline-origin-destination-aircraft type level (e.g., Delta Air Lines Boeing-757 services from Los Angeles International to New York John F. Kennedy airport in January of 2000 are recorded separately from the Boeing-737 services of the same carrier on the same route) and includes the number of flights performed, seats provided, and passengers carried. We have aggregated the data at the annual level; and merged regional airlines with the respective major carriers[11]. After this, we have computed the following variables from T100 dataset, at the airport-year level.

Airport level Herfindhal-Hirschmann Indices (HHI). HHI is the sum of squared market shares, across all the airlines at an airport. We have computed two such indices, based on frequency and passenger volumes.

Highest market share. This variable represents the share of passengers, handled by the largest airline at an airport. This is effectively a one-firm concentration ratio.

Route HHI. This variable is computed as the passenger-weighted average HHI on all non-stop routes originating at the airport. This serves as a measure of route dominance. We should however note that this is an imperfect measure of competition between the airlines. In particular, many smaller airports may only offer services to the major carriers' hub; but some passengers originating at those smaller airports will continue their journeys beyond those hubs. Then, even if we find that all individual routes originating at an airport are monopolized; the airlines might still be competing on one-stop markets going through their hubs.

[11] Some services, in particular on thinner routes, are delegated by the major carriers to regional airlines, typically using smaller jet and/or turboprop aircraft. Original T100 dataset codes regional airlines differently from the majors. Details on the procedure used to merge regionals with the majors are available from the authors upon request.

The three variables above will be the key measures of market structure; impact of those variables on the mean airport-level price will be the focus of our research. The following control variables have also been computed from T100 dataset.

Total airport-level passenger volume. This variable will control for possible scale effects.

Mean distance. This variable was calculated as the passenger-weighted mean distance of a non-stop flight from the airport. This distance clearly underestimates the total one-way distance in an average passenger's itinerary.

Market shares of individual airlines. Those have been computed for thirteen individual major carriers, some of which have not been in existence for the entire duration of our panel. The main purpose of these variables will be to account for possible price changes due to growth of low cost carriers (most importantly, Southwest Airlines and JetBlue Airways). See notes to Table 6 for more details.

Other control variables we will use include population, average weekly wage, and unemployment rate. These variables are measured at the corresponding Metropolitan Statistical Area (MSA) level, and have been obtained from the U.S. Census Bureau and the Bureau of Labor Statistics.

Table 1 below includes basic descriptive statistics of our variables. We present means and standard deviations for the entire samples, as well as for the three sub-samples we will focus on later in this study. To define sub-samples, we use the Federal Aviation Administration's (FAA) classification of airports. The FAA classifies airports as primary and non-primary, using 10,000 passenger boardings per year as the cut-off. For our analysis, we will only focus on primary airports, which are further subdivided into non-hub airports, small hubs, medium hubs, and large hubs based on the percentage of total passenger boardings handled by the airport. Specifically, non-hub airports are primary airports which handle less than 0.05% of total passenger traffic on the US market; small hubs handle 0.05 to 0.25% of all passengers. In order to be classified as a medium hub, the airport needs to handle more than 0.25%, but less than 1% of all passengers. Finally, airports that handle over 1% of all passenger boardings in the US market are classified as large hubs. Note that some airports may change their classification over the years. Overall, there are 442 airports in our dataset, which are classified as primary in at least one year. Given the data analysis methodology we use, in particular utilization of lagged endogenous variables as instruments, 399 of those airports are actually included into our regressions.

The following facts are apparent from the data. First, an average airport is rather concentrated. Higher values of HHI based on passenger volumes simply mean that larger carriers on average use larger aircraft. At the same time, smaller airports are much more concentrated than larger hubs. In all fairness, large hubs are more concentrated than medium hubs; however, average passenger-based HHI for this group, at 0.35, is still half of same for small hubs and non-hub airports. Airports' largest carriers are pretty large, as evidenced by the average values of the highest market share variable. Note that the largest carriers at smaller airports tend to carry larger share of passenger traffic as compared to same for bigger gateways. Further, non-stop markets tend to be highly concentrated. Last but not least, smaller airports tend to be located in less populous areas (which is hardly surprising in itself) with lower wages and higher rates of unemployment.

The purpose of Figure 1 below is to give the reader an idea of the behavior of our main variables over time. Observe that both airports and non-stop markets have exhibited the highest concentration measures in the 1990s. The dips in all HHIs and the highest market share that can be observed after 2001 can be attributed to a series of high-profile airline bankruptcies and reorganizations following the events of September 11, 2001. Specifically, United, Delta, Northwest, and US Airways spent some time under Chapter 11 bankruptcy protection, which resulted in downsizing and some hub closures[12]. At the same time, low-cost carriers, most notably Southwest Airlines, used temporary weakness of the legacy carriers to encroach on their territory. JetBlue Airways has also been growing rapidly after being founded in 2001 (see Bilotkach, Hueschelrath, and Mueller, 2011, for a discussion of JetBlue network development).

Another interesting observation that can be made from Figure 1 is the growing gap between frequency and passenger HHI at the airport level. An easy explanation of this trend is that over time more dominant carriers have been increasingly using larger aircraft and/or achieving higher load factors as compared to the airlines with less pronounced presence at an airport.

Hypotheses and Methodology

As we mentioned earlier, the focus of our study will be on the relationship between airport-level prices, airport concentration, largest carrier's market share, and concentration on routes originating at the airport. We clearly expect higher concentration and an increase in the dominant airline's market share to increase the fares. The issue then is which of these three factors is a more important predictor of prices. We will also investigate whether sources of market power at the origin airport level differ across groups of airports.

The two econometric problems we will need to tackle are airport-level heterogeneity and potential endogeneity of the three measures of market concentration. We have chosen classical approaches to addressing those. Specifically, airport-related idiosyncrasies will be captured by the airport fixed effects model; and instrumental variable approach will be employed to address the endogeneity concern. Lagged endogenous variables will be used as instruments in all specifications. Among the control variables, airport-level passenger volume is potentially endogenous; lagged passenger volume will be used as an instrument for this variable. Finally, standard errors we report are robust to both heteroscedasticity and autocorrelation – our data structure clearly points to the threat of both unequal error variances across, and correlation of the current error with its past realizations within the cross-sections.

Before we proceed, we should note that our choice of methodology drives the interpretation of our coefficient estimates. Use of airport-level fixed effects – a logical choice given the dataset we have – implies that identification of our regression coefficients will be driven by the variation in variables within airports, not across them. For instance, our coefficient on airport-level HHI will tell us how the airport-level price will respond to the increase in airport-level concentration within an airport over time, *not*

[12] US Airways dismantled Pittsburgh and Baltimore hubs; Delta pulled out of Dallas-Ft.Worth.

whether more concentrated airports tend to be associated with higher average fares at any given point in time. The latter is an appropriate interpretation of the regression coefficient in a cross-section.

We have described in the previous section of this paper the control variables we will be using. These include total passenger volume, mean non-stop distance of a flight originating at an airport, airport-level market shares for the major players in the US airline industry, and three demographic measures for the corresponding metropolitan statistical area. In addition to these, we will also use year dummy variables to control for the corresponding heterogeneity.

We will perform our analysis for both the entire sample, as well as for the three sub-samples of airports, based on their relative size in the US aviation system. One sub-sample will include large and medium hubs; the second sub-sample will contain small and medium hub airports; and the third sub-sample will include small hubs and primary non-hub airports. Note that we are using FAA classification of airports – see details in the previous section of this paper. We have chosen not to conduct the analysis separately for large, medium, and small hubs, as each individual category includes rather few airports (37, 48, and 84, respectively[13]). You can see that most primary airports are, not surprisingly, classified in the non-hub category.

For both the entire sample and each individual sub-sample, we will run nine specifications, which will differ in terms of the combinations of the key concentration variables employed. Two specifications will only include airport-level HHI (computed on frequency and passenger basis). There will be two specifications including both airport-level and route-level HHI, as well as two regressions that will include all three concentration measures (both HHIs and the largest carrier's market share). In addition to this, we will run three specifications without airport-level HHI – these will include route HHI, largest carrier's market share, and the two variables together. To enable interpretation of regression coefficients as respective elasticities, natural logarithms of all measures of concentration will be used. Other control variables, except for the airline market shares and year dummies, will be also included in logarithms.

To test for possible structural changes following the events of September 11, 2001; we have conducted our analysis for the entire sample for both pre-2001 and post-2001 time periods. That is, we have re-run our specifications for 1993-2000 and 2002-2009 time periods.

Research hypotheses with respect to our key variables are quite clear – higher concentration is expected to lead to higher average fares. Indeed, our aim is to see which of the measures, if any, are more robust predictors of airport-level airfares, other things equal. With respect to control variables, we expect higher total passenger volume to lower airfares, presumably due to scale effects; higher real weekly wages and population will be expected to lead to higher fares, whereas higher unemployment rate in the airport's MSA should lower the level of fares going out of the airport. The three demographic variables can be thought of as demand shifters. Higher average non-stop flight distance should increase

[13] These represent counting of the airports, which fell into the said categories in at least one year. Due to the nature of the classification criterion used, airports can change their affiliation across the categories over time.

average fares. Increases in market shares of the low cost carriers, such as Southwest Airlines or JetBlue Airways) will be expected to lower average airfares.

Results and Discussion

Estimation Results

Results of our data analysis exercise are presented in the following tables. Table 2 reports results for the entire sample, or rather population of airports. That table is split into three panels. Panel 2a depicts estimation results for the entire 17-year panel. Panels 2b and 2c report results for years 1990-2000 and 2002-2009, respectively. The purpose of this exercise is to examine whether events of September 11, 2001 might have led to any structural changes in the concentration – price relationships under study. Tables 3, 4, and 5 present estimation results for the three groups of airports we identified above. Results for large and medium hub airports are shown in Table 3, while Tables 4 and 5 depict results for medium and small hubs; and small hubs and non-hub primary airports, respectively. Table 6 reports results for the airline market share variables – these come from selected specifications from tables 2 through 5. Let us examine the results in the order they are presented.

Results for all airports for the entire 17-year panel show airport-level concentration index as the most robust predictor of airport-level average airfares. The results are especially vivid for the passenger-based HHI. Numerically, a ten percent increase in the airport-level HHI leads to one percent increase in average airfares for flights departing from an airport; a with one standard deviation increase in this measure of concentration associated with about 5% increase in average airfares. There is also some evidence to suggest that highest carrier's market share at an airport could be associated with higher average prices paid by the traveling public. Here, a one standard deviation increase in the dominant airline's market share is associated with about 3.5% increase in average fare, other things equal. Results reported in panels 2b and 2c demonstrate apparent significant differences in the concentration-price relationship before and after 2001. Before 2001, airport HHI shows as the main concentration measure explaining price levels; and highest carrier's market share also appears to have some effect. However, sizes of the effects reported in panel 2b are over three times those shown in panel 2a. Panel 2c, however, demonstrates lack of relationship between airport or route concentration and average prices. While this result could be interpreted as a break-down of the established relationship; we cannot rule out that for most of the post-2001 period the airline industry could have been out of equilibrium. Indeed, financial stress airlines found themselves under following the 9/11 events and subsequent increase in jet fuel price has led to a series of Chapter 11 bankruptcy reorganizations and mergers in the US airline industry. We will therefore center our interpretation and discussion of the data analysis results on coefficients reported in Table 2a, while keeping in mind the possibility that the relationship between airport concentration and airfares could have broken down post-2001.

Comparing results for different groupings of airports, we can notice rather substantial differences across them. Results for large and medium hub airports suggest that competition on the routes going into and out of an airport is the most robust driver of airport-level airfares. Note also that statistical significance of both airport HHI and largest carrier's market share vanishes when we include mean route HHI into our specifications. Numerically, our estimates suggest that one standard deviation increase in mean route HHI, holding other things constant, will be associated with 4.4-5.3% increase in mean airfare for flights originating at a given airport. Results for the group of medium and small hub airports suggest that concentration at either the airport or the route level does not appear to affect airfares. Further, the effect of the changes in the largest carrier's market share is marginally significant and not robust. The magnitude of the effect is also not too impressive – one percent increase in airport level airfares would require about 17 percent increase in the share of the largest carrier at the airport. Results for the group of small hub and non-hub airports largely replicate the outcome observed for the entire sample, in terms of statistical significance and magnitude of the coefficients on the key variables. However, differences in the average and standard deviations across the entire sample and the sub-sample of small hubs and non-hub airports imply rather different magnitudes of the corresponding effects. Specifically, one standard deviation increase in airport-level HHI in the sample of small hub and non-hub airports will be associated with about 4.2-5.2% increase in average fares (generally somewhat lower than the corresponding estimate for the entire sample).

There are no surprises present in the coefficients for control variables. It is true that statistical significance of most variables is patchy, and coefficient magnitudes are not stable across sub-samples; however, where variables are significant, the corresponding coefficients show the expected signs. Specifically, passenger volume exhibits evidence consistent with the scale effects (this result is also present in Van Dender, 2007); greater flight distance is associated with higher fares, even though we have indicated that distance of a non-stop flight underestimates the distance of an itinerary flown by a passenger commencing his/her trip at a given airport. Demographic variables also show expected behavior. There are no surprises in effects of the airline market shares either. Southwest Airlines' market share shows the largest downward pressure on airfares, with some of the other low cost carriers (JetBlue and Frontier) also producing price reduction in some of the samples we analyzed. Evidence suggesting that Alaska Airlines and TWA could exert downward pressure on airport-level prices can be viewed as the only real surprise coming from control variables. Of the legacy carriers, American Airlines, Northwest Airlines, and US Airways appear to produce price increases as they expand their airport presence, other things equal.

In summary, our results demonstrate the following. First, effects of airport-level concentration on airfares for trips originating at that airport depend on the airport size. Specifically, the relationship is the strongest in smaller airports; there is also some evidence suggesting airport concentration might affect fares in the largest airports. In mid-sized airports, however, concentration does not appear to affect average fares for trips originating at those gateways. Second, route-level concentration appears to be a robust predictor of airport-level fares at the larger airports. Third, the pure airport dominance effect (as proxied by the airport-level market share of the largest carrier) does not appear to be robust to including airport-level and/or route-level concentration measures into specifications. Fourth, the concentration-price relationship appears to have broken down after 2011, which could either signal a change in the nature of airline competition, or simply reflect an industry in an out-of-equilibrium situation. Coming back to our question of whether airfares will be higher at airports served by few airlines competing on each market, or at the gateways served by many carriers, each being a monopolist on the respective route; it appears that the answer will also be different for large and small airports. At large airports, new entry (or reduced airport-level concentration) will only bring down the airfares if it also increases competition on individual routes. That is, only entry at those routes where the entrant competes with the incumbent will affect airport-level fares. In smaller airports, however, new entry will bring average fares down regardless of whether the new carrier comes in with new services, or competing with the incumbents.

There are some potentially important issues that our analysis does not address. Most importantly, when it comes to measuring competition on routes originating at an airport, we only look at non-stop markets. It is however a well-known fact that airlines operating hub-and-spoke networks may compete for passengers on one-stop markets. Then, even though non-stop markets might not be competitive, airlines will compete for passengers on one-stop routes. Further, the airport-concentration-price relationship we observe might work through competition on one-stop markets; examining this relationship can be an interesting topic for a future project. Also, a quick look at Figure 1 shows that airline markets are rather concentrated at the non-stop level. On top of this, within-airport variation in the route-level concentration measure is not high, especially for the sub-sample of smaller airports. This leads us to suggest that there is a possibility that variation of route-level concentration within airports has simply not been sufficient for us to observe any appreciable effect of route-level competition on airport-level airfares in the panel data setting. To put things into clearer perspective, consider this fact. Average coefficient of variation for within-airport route-level concentration in our data is a bit more than eight percent[14]. The same measure for passenger-based airport-level HHI is close to sixty percent. Thus, there is simply more within-variation in airport-level concentration than in the route concentration to enable potential identification of the corresponding effects. At the same time, the facts above make it even more remarkable that we have been able to observe a strong effect of route-level competition on airfares in the sample of larger airports.

Application – Delta/Northwest and United/Continental Mergers

Our data analysis results may have interesting implications for the analysis of airline consolidation. Three high-profile mergers occurred in the US airline industry over the last five years. In 2008 Delta Air Lines acquired Northwest Airlines, in 2010 Continental Airlines and United Airlines merged, keeping the latter carrier's name and redesigning their logo to reflect legacy of both merger partners. The former merger was approved largely thanks to the partner airlines' complementary networks. To build a case for the latter merger, United Airlines commissioned a study that demonstrated that the extent of route-level competition between the legacy carriers did not affect market-level airfares (Brueckner, Lee, and Singer, 2011). Last but not least, in 2011 Southwest Airlines bought AirTran – a fellow low cost carrier based in Atlanta.

It is generally true that individual non-stop routes in the US airline industry are quite concentrated – our data clearly demonstrates this. Such high concentration at the route level is related predominantly to the fact that most airlines operate hub-and-spoke networks, thus many if not most of the non-stop

[14] We computed coefficients of variation for this variable for each individual airport, and then calculated a simple non-weighted average of these coefficients.

flights out of smaller airports link these airports with the respective airlines' hubs. Then, while recent mergers have probably not affected the extent of non-stop competition on most routes – except for markets connecting the merger partners' hub airports – competition on one-stop markets has probably decreased. Another likely outcome of the airline mergers is increased concentration at the airport level, especially at smaller airports served by many of the major carriers to feed passenger traffic to the respective airlines' hubs. Our results demonstrate clear relationship between airport level concentration and average fares for trips originating at small hubs and non-hub airports. In this sub-section, we will try to quantify the consumer welfare implications of Delta – Northwest and United – Continental mergers, suggested by our estimation results.

To evaluate the projected changes in airport-level concentration, we have taken the corresponding data (airport-level passenger-based HHI and merger partners' airport-level market shares) for 2007 in case of Delta-Northwest and 2009 for United-Continental mergers. We assumed, quite naively, admittedly, that the post-merger airport-level market share would be equal to the sum of the partners' pre-merger numbers, everything else being equal. Then, the change in the HHI as a result of the merger would be computed as:

$$\Delta HHI = S_i^2 + S_j^2 - S_i S_j$$

Where S_i and S_j are the partner airlines' pre-merger market shares.

We have then proceeded to identify the airports, where a merger would result in a five or higher percent increase in passenger-based airport-level HHI[15]. For Delta-Northwest merger, 54 such airports have been identified. Interestingly, the corresponding number for the Continental-United consolidation event was only 14. Further, we have identified six airports (Boston Logan, Los Angeles International, Orlando, New Orleans, Hayden, CO, and Harrisburg, PA), which were projected to experience more than five percent increase in HHI as a result of each of the two mergers.

Our analysis will be based on the premise that airport-level HHI was found to be a significant determinant of airport-level fares only for those gateways which were classified as small hubs or non-hub primary airports, according to the share of total US domestic traffic handled. This consideration effectively made us lose interest in studying the effects of Continental-United merger, as of the fourteen airports which we identified as candidates for increased concentration level following the event, only three belonged to this category. Also, projected average price increase following the merger for flights originating at those airports was only between 0.8 and 1.4 percent.

Effects of Delta – Northwest merger, however, warranted further investigation, as we determined that 32 small hub and non-hub airports, handling nearly 20 million passengers in total in 2007 (this corresponds to about 3 percent of the US market's total passenger traffic in that year), would become significantly more concentrated after this merger. As can be seen from Table 7, nine of those small airports were projected to experience 50 percent or higher increase in HHI, which would translate in price increases of up to eleven percent for trips originating at those endpoints.

[15] Five percent increase in airport-level HHI would correspond to about 0.5 percent increase in average airfare.

To evaluate the projected percentage changes in price levels corresponding to the projected post-merger change in HHI, we used the corresponding regression coefficients from specifications (4) and (6) in Table 5 (recall that this is the table which reported results for the sub-sample of small hub and non-hub airports). Then, assuming a unitary price elasticity of demand for air travel (according to Brons et al., 2002, unitary price elasticity lies in the middle of the range of values for price elasticity of demand for air travel, as reported by various studies), change in consumer surplus will be calculated as:

$$\Delta CS = Q_0 P_0 (\%\Delta P)(1 - 0.5(\%\Delta P))$$

Where Q_0 and P_0 correspond to pre-merger passenger volume and average price, taken directly from our dataset. The term $\%\Delta P$ denotes percentage change in price, computed by multiplying the corresponding elasticity estimate from the regression results by the projected change in airport-level HHI.

Table 7 reports our estimates of consumer welfare losses following the Delta – Northwest merger for each of the 32 small airports, which were projected to experience more than 5 percent increase in the value of the airport-level concentration measure (passenger based HHI). Over these 32 airports, we discover consumer welfare losses totaling about one quarter of a billion dollars per year. In all honesty, this number should be halved, as the effect we observed applies to trips originating at an airport. Then, it is reasonable to assume that half of the passenger traffic reported in Table 7 corresponds to passengers originating at a given airport; whereas the other half are passengers whose trips originated elsewhere. We can also safely assume that connecting traffic at the airports listed in Table 7 is minimal if at all existent.

The figure for consumer welfare loss we have come up with, while in hundreds of millions dollars per year, appears miniscule if put into context of the multi-billion-dollar US airline industry. According to the US Department of Transportation, total operating revenue of US airlines on the US domestic market in 2007 amounted to nearly $130 billion dollars. This means that the welfare loss we computed corresponds to about one tenth of one percent of the US airlines' total annual revenue. Our results, however, suggest that adverse effects of the merger might be concentrated in a handful of metropolitan areas rather than being dispersed across the entire US domestic airline industry. In fact, on average a traveler starting her journey from either of the 32 small airports expected to experience price increases as a result of the merger, is expected to experience a nearly $13 welfare loss following the consolidation event, following an expected $13.29 passenger weighted average increase in airfare for travel originating at those airports. Price changes and per traveler welfare losses of this magnitude, occurring across the whole airline industry, would probably make front page headlines.

Of course, our estimate of consumer welfare effects of the Delta-Northwest merger across a number of small airports is naïve and does not take account of possible changes in the airlines' conduct post-merger, as well as of generally increased degree of price competition in the industry in the recent years – see Table 2c, along with Berry and Jia (2010). Peters (2006) also shows that naïve approaches to merger simulations did not yield satisfactory results when applied to a series of 1980s airline consolidation events. Indeed, following a merger, we could see overall reduction in frequency by the merged airline, along with entry or expansion by other carriers, which would suggest that we might have over-estimated the projected increases in airport-level HHIs. Further, we have effectively assumed that any potential efficiency gains due to the merger would not be passed along to the passengers. Further studies might be needed to elaborate upon these points.

Despite all the potential problems we have outlined above, we can say that our research contributes to understanding effects of consolidation in the airline industry by pointing out the possibility of unequal distribution of gains and losses due to mergers. Specifically, our findings imply that consumer welfare losses might be concentrated in smaller communities, and may be related to increased concentration at the respective airports, even where competition on individual non-stop routes might not be affected by the consolidation event. An interesting question for further study is whether increased airport-level concentration leads to higher fares for trips originating at an airport via decreased competition on one-stop markets.

Conclusions

Our study differs from most papers examining pricing in the airline industry in one important way. Instead of looking at prices at the airline-route level, we examine determinants of an average airfare for trips originating at an airport. Examining price setting at the airport level allows us to explore whether airport-level concentration, competition on routes originating at an airport, and the largest carrier's market share will affect the airfare an average passenger will pay. We also take a comprehensive look at the US airline industry, examining price setting at both large and smaller airports – in this way, we differ from many studies which choose to focus on larger airports and/or denser markets.

Overall, our results demonstrate the following. First, effects of airport-level concentration on airfares for trips originating at an airport depend on the airport size. Specifically, the relationship is the strongest in smaller airports; there is also some evidence suggesting airport concentration might affect fares in the largest airports. In mid-sized airports, however, concentration does not appear to affect average fares for trips originating at those gateways. Second, route-level concentration appears to be a robust predictor of airport-level fares at the larger airports. Third, pure airport dominance effect (as proxied by the airport-level market share of the largest carrier) does not appear to be robust enough to including airport-level and/or route-level concentration measures into specifications. Fourth, the concentration-price relationship appears to have broken down after 2011, which could either signal a change in the nature of airline competition, or simply reflect an industry in an out-of-equilibrium situation.

The take-away message from our study is that sources of market power appear to be different for trips originating at airports of different size. Also, the nature of airline competition may change over time, leading to breakdown of the previously observed relationships (see also a recent study by Borenstein (2011)). Further, consolidation currently being observed in the US airline industry can have different effects on travelers living near larger and smaller airports, which means estimates of industry-wide effects of changes in competitive environment in the US airline industry should be taken with an understanding that gains and losses might not be distributed equally. In particular, our analysis points to a number of small communities which may end up with non-trivial consumer welfare losses following recent mergers.

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Table 1 Descriptive statistics

	All airports	Large and medium hubs	Medium and small hubs	Small hubs and non-hub
Real airfare (year 1993 dollars)	323.20 (129.68)	247.61 (67.17)	280.54 (85.35)	350.56 (139.95)
Frequency HHI	0.5756 (0.3219)	0.2832 (0.1736)	0.2989 (0.1686)	0.7124 (0.2856)
Passenger HHI	0.6134 (0.3146)	0.3137 (0.1920)	0.3481 (0.1836)	0.74450 (0.2716)
Highest market share	0.6775 (0.2775)	0.4446 (0.1942)	0.4347 (0.1989)	0.7878 (0.2375)
Route HHI	0.9257 (0.0819)	0.8502 (0.0569)	0.8930 (0.0604)	0.9515 (0.0770)
Total passenger volume	1,783,273 (4,302,732)	7,520,611 (6,666,942)	654,037 (334,820)	60,225 (75,698)
Mean distance, miles one-way	411.80 (396.18)	880.84 (453.91)	460.35 (230.31)	285.21 (310.67)
Real wage, constant S/week	483.56 (102.69)	589.67 (108.84)	499.19 (77.69)	451.43 (84.41)
Population	1,006,101 (2,634,735)	3,663,681 (4,160,709)	1,235,492 (3,385,086)	238,378 (783,881)
Unemployment rate, percent	5.43 (2.50)	5.00 (1.70)	5.17 (2.25)	5.62 (2.71)

Note: this table includes mean values, with standard deviations in parentheses. Only data for primary airports (those handling over 10,000 passengers per year) are used in calculations. We use FAA airport classification, as described in this section of the paper. We have a total of 442 unique airports that are classified as primary at least once.

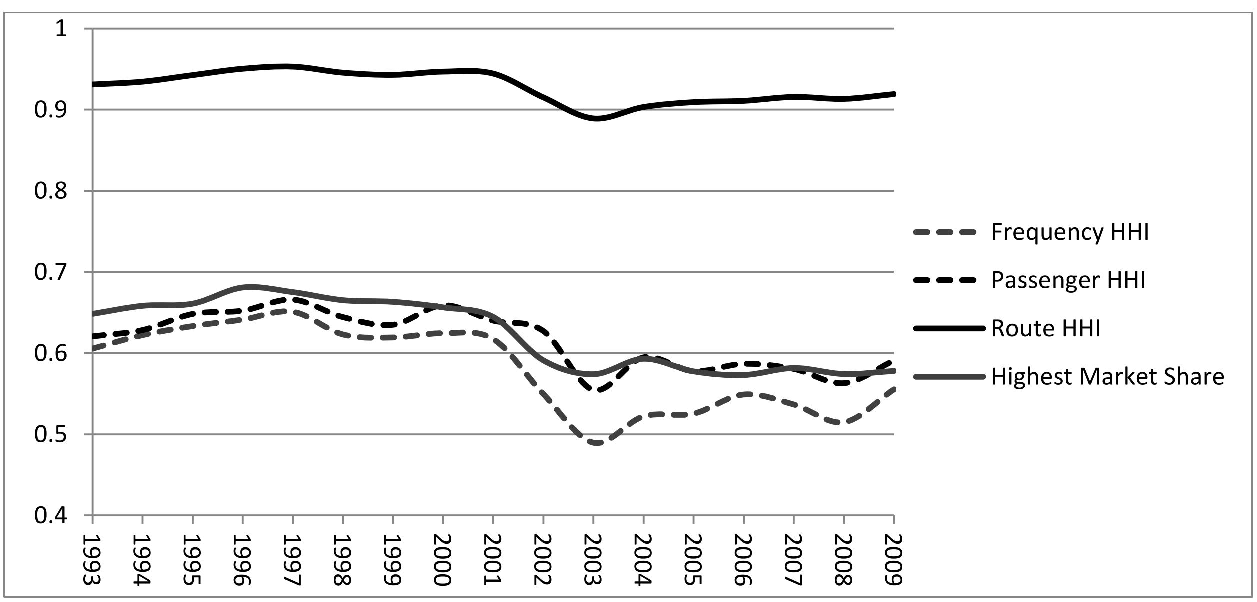

Figure 1 Dynamics of Concentration Measures

Table 2a Results for all airports and all years

	Frequency HHI			Passenger HHI			Without airport HHI		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Constant	2.7204** (1.3559)	2.6613** (1.3174)	2.725** (1.3163)	2.4821* (1.3800)	2.4483* (1.3562)	2.4010* (1.3604)	2.5232* (1.3447)	2.7363** (1.3843)	2.5363* (1.3585)
HHI	0.0517* (0.0283)	0.0248 (0.0358)	-0.0009 (0.0363)	0.1110** (0.0339)	0.0950* (0.0487)	0.1177** (0.0543)	---	---	---
Highest Market Share	---	---	0.0734 (0.0455)	---	---	-0.0317 (0.0446)	---	0.0868** (0.0301)	0.0618 (0.0457)
Mean Route HHI	---	0.4485 (0.3631)	0.2735 (0.4217)	---	0.2042 (0.4107)	0.2360 (0.4228)	0.5146 (0.3144)	---	0.3195 (0.4143)
Total passenger volume	-0.0486* (0.0278)	-0.0483* (0.0277)	-0.0469* (0.0281)	-0.0529 (0.0332)	-0.0535 (0.0334)	-0.0526 (0.0335)	-0.0672** (0.0296)	-0.0632** (0.0314)	-0.0562* (0.0305)
Mean distance	0.0200 (0.0449)	0.0138 (0.0462)	0.0185 (0.0466)	0.0213 (0.0468)	0.0180 (0.0479)	0.0176 (0.0479)	0.0051 (0.0471)	0.0160 (0.0472)	0.0126 (0.0484)
Real wage	0.1825 (0.1247)	0.1757 (0.1261)	0.1721 (0.1264)	0.1789 (0.1271)	0.1766 (0.1275)	0.1776 (0.1278)	0.2006 (0.1244)	0.1814 (0.1259)	0.1702 (0.1273)
Population	0.2207* (0.1184)	0.2300** (0.1156)	0.2234* (0.1156)	0.2483** (0.1216)	0.2534** (0.1203)	0.2556** (0.1205)	0.2493** (0.1178)	0.2354* (0.1217)	0.2544** (0.1205)
Unemployment rate	-0.2454** (0.0540)	-0.2275 (0.0583)	-0.2264** (0.0576)	-0.2420** (0.0550)	-0.2534** (0.0600)	-0.2360** (0.0597)	-0.2200** (0.0585)	-0.2348** (0.0549)	-0.2255** (0.0593)
Adjusted R-squared	0.7662	0.7650	0.7661	0.7657	0.7654	0.7654	0.7644	0.7659	0.7666

Notes:

1. Method used – airport-level fixed effects two-stage GLS. One-year lags are used as instruments for HHI, highest market share, route HHI, and passenger volume.
2. All specifications use natural logarithms of all dependent variables reported here, except for constant.
3. Standard errors, robust to heteroscedasticity across and autocorrelation within cross-sections, are reported in parentheses.
4. Airport-level airline market shares and year dummy variables are included in all specifications, but not reported.
5. Included observations: 4771.
6. Significance: * - 10%; ** - 5%

Table 2b Results for all airports and years before 2001

	Frequency HHI			Passenger HHI			Without airport HHI		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Constant	2.2340 (2.088)	3.0450 (2.7814)	2.2842 (2.6116)	2.0570 (2.2284)	2.325 (2.508)	2.4273 (2.7092)	3.8127 (3.1127)	1.7648 (1.8013)	2.4186 (2.9888)
HHI	0.2792** (0.0961)	0.1898 (0.1780)	0.1083 (0.1705)	0.3458** (0.1679)	0.3307* (0.1772)	0.4145 (0.3502)	---	---	---
Highest Market Share	---	---	0.2195 (0.2281)	---	---	-0.1150 (0.4115)	---	0.3593** (0.1051)	0.2906 (0.2172)
Mean Route HHI	---	2.0849 (3.6321)	0.9924 (3.1722)	---	0.6008 (2.1679)	0.8005 (2.8522)	3.2898 (3.1734)	---	1.0847 (3.4873)
Total passenger volume	0.0059 (0.1124)	0.0410 (0.1392)	0.0334 (0.1325)	-0.0110 (0.1321)	0.0003 (0.1363)	0.0071 (0.1476)	-0.0058 (0.1416)	-0.0045 (0.0143)	-0.0023 (0.0172)
Mean distance	0.0589 (0.0425)	0.0314 (0.0691)	0.0478 (0.0657)	0.0637 (0.0449)	0.0588 (0.0522)	0.0564 (0.0541)	-0.0057 (0.0559)	0.05164 (0.0422)	0.0383 (0.0617)
Real wage	0.2245* (0.1362)	0.3473 (0.2549)	0.2908 (0.2279)	0.2320* (0.1335)	0.2666 (0.1862)	0.2753 (0.2063)	0.4170* (0.2141)	0.2376* (0.1250)	0.3015 (0.2381)
Population	0.1573 (0.1551)	0.0173 (0.3082)	0.1022 (0.2663)	0.1837 (0.1592)	0.1398 (0.2248)	0.1228 (0.2727)	-0.0207 (0.3266)	0.1974 (0.1412)	0.1218 (0.2887)
Unemployment rate	-0.0283 (0.0285)	-0.0330 (0.0357)	-0.0271 (0.0324)	-0.0267 (0.0298)	-0.0285 (0.0314)	-0.0294 (0.0325)	-0.0391 (0.0413)	-0.0235 (0.0274)	-0.0284 (0.0326)
Adjusted R-squared	0.9291	0.8923	0.9173	0.9264	0.9212	0.9176	0.8522	0.9281	0.9175

Notes:

1. Method used – airport-level fixed effects two-stage GLS. One-year lags are used as instruments for HHI, highest market share, route HHI, and passenger volume.
2. All specifications use natural logarithms of all dependent variables reported here, except for constant.
3. Standard errors, robust to heteroscedasticity across and autocorrelation within cross-sections, are reported in parentheses.
4. Airport-level airline market shares and year dummy variables are included in all specifications, but not reported.
5. Included observations: 1804.
6. Significance: * - 10%; ** - 5%

Table 2c Results for all airports and all years after 2001

	Frequency HHI			Passenger HHI			Without airport HHI		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Constant	6.4881** (1.7281)	6.1734** (1.8980)	5.8726** (2.0033)	3.4401 (2.6338)	5.7873** (1.8248)	5.6494** (1.8170)	6.3414** (1.8403)	6.1043** (1.7022)	6.1798** (1.8092)
HHI	0.0106 (0.0275)	0.0413 (0.0997)	-0.0075 (0.0863)	0.3586 (0.2322)	0.0921 (0.0973)	0.1596 (0.1108)	---	---	---
Highest Market Share	---	---	0.0114 (0.0424)	---	---	-0.0991** (0.0478)	---	0.0181 (0.0337)	0.0346 (0.0733)
Mean Route HHI	---	-0.5103 (1.6578)	-0.3713 (1.5669)	---	-0.7421 (1.7619)	-0.5232 (1.7120)	-0.1643 (1.1673)	---	-0.3969 (1.5871)
Total passenger volume	-0.0025 (0.0331)	0.0055 (0.0471)	-0.1195** (0.0266)	-0.0164 (0.0493)	-0.0309 (0.0764)	-0.0350 (0.0754)	-0.0403 (0.0674)	-0.0445 (0.0553)	-0.0363 (0.0736)
Mean distance	-0.0014 (0.0385)	0.0091 (0.0434)	0.0287 (0.0420)	0.0777 (0.0718)	0.0311 (0.0423)	0.03117 (0.0415)	0.0044 (0.0348)	0.0055 (0.0371)	0.0114 (0.0358)
Real wage	0.1662 (0.1366)	0.2071 (0.1881)	0.2806 (0.2051)	0.2211 (0.1844)	0.2373 (0.1786)	0.2279 (0.1752)	0.2148 (0.1576)	0.1977 (0.1424)	0.2219 (0.1688)
Population	-0.1499 (0.1180)	-0.1600 (0.1303)	-0.0580 (0.1209)	0.0689 (0.1933)	-0.1166 (0.1898)	-0.0959 (0.1883)	-0.1298 (0.1910)	-0.0961 (0.1264)	-0.1276 (0.1966)
Unemployment rate	-0.0405** (0.0200)	-0.0409* (0.0210)	-0.0585** (0.0226)	-0.0508* (0.0302)	-0.0464 (0.0224)	-0.0453** (0.0216)	-0.0415** (0.0204)	-0.0435** (0.0204)	-0.0443** (0.0214)
Adjusted R-squared	0.8072	0.7979	0.8059	0.7839	0.7937	0.8001	0.8069	0.8090	0.8025

Notes:

1. Method used – airport-level fixed effects two-stage GLS. One-year lags are used as instruments for HHI, highest market share, route HHI, and passenger volume.
2. All specifications use natural logarithms of all dependent variables reported here, except for constant.
3. Standard errors, robust to heteroscedasticity across and autocorrelation within cross-sections, are reported in parentheses.
4. Airport-level airline market shares and year dummy variables are included in all specifications, but not reported.
5. Included observations: 2677.
6. Significance: * - 10%; ** - 5%

Table 3 Results for large and medium hub airports and all years

	Frequency HHI			Passenger HHI			Without airport HHI		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Constant	1.9049 (2.6440)	2.5265 (2.4431)	2.3755 (2.3326)	1.8832 (2.7893)	2.5415 (2.5819)	2.5253 (2.4781)	2.3037 (2.3580)	1.3319 (0.1014)	2.3324 (2.5614)
HHI	0.0854* (0.0478)	0.0254 (0.0587)	0.0055 (0.0838)	0.1125** (0.0440)	0.0509 (0.0460)	0.0469 (0.1079)	---	---	---
Highest Market Share	---	---	0.0362 (0.0669)	---	---	0.0045 (0.0964)	---	0.1014** (0.0451)	0.0391 (0.0405)
Mean Route HHI	---	0.7486* (0.3821)	0.7041** (0.3526)	---	0.6701* (0.3421)	0.6694** (0.3399)	0.8124** (0.3336)	---	0.7108** (0.3294)
Total passenger volume	-0.1945** (0.0611)	-0.1554** (0.0641)	-0.1600** (0.0636)	-0.2042** (0.0623)	-0.1664** (0.0632)	-0.1663** (0.0632)	-0.1500** (0.0662)	-0.1941** (0.0650)	-0.1588** (0.0651)
Mean distance	0.5954** (0.1221)	0.5830** (0.1189)	0.5763** (0.1230)	0.5798** (0.1246)	0.5770** (0.1213)	0.5767** (0.1225)	0.5729** (0.1167)	0.5750** (0.1267)	0.5756** (0.1220)
Real wage	-0.2290 (0.1881)	-0.2439 (0.1880)	-0.2404 (0.1844)	-0.2299 (0.1820)	-0.2440 (0.1844)	-0.2436 (0.1836)	-0.1908 (0.1830)	-0.2180 (0.1855)	-0.2397 (0.1863)
Population	0.3077** (0.1535)	0.2439 (0.1500)	0.2493* (0.1431)	0.3279** (0.1585)	0.2476 (0.1520)	0.2485* (0.1479)	0.2223 (0.1433)	0.3475** (0.1557)	0.2505* (0.1476)
Unemployment rate	-0.1571** (0.0612)	-0.1139** (0.0488)	-0.1131** (0.0475)	-0.1483** (0.0585)	-0.1147** (0.0516)	-0.1146** (0.0507)	-0.1126** (0.0505)	-0.1468** (0.0563)	-0.1123** (0.0525)
Adjusted R-squared	0.8983	0.8900	0.8906	0.8893	0.8911	0.8910	0.8871	0.8887	0.8907

Notes:

1. Method used – airport-level fixed effects two-stage GLS. One-year lags are used as instruments for HHI, highest market share, route HHI, and passenger volume.
2. Reported results are for sub-sample of airports handling more than 0.25% of all passenger boardings within US in a given year.
3. All specifications use natural logarithms of all dependent variables reported here, except for constant.
4. Standard errors, robust to heteroscedasticity across and autocorrelation within cross-sections, are reported in parentheses.
5. Airport-level airline market shares and year dummy variables are included in all specifications, but not reported.
6. Included observations: 1029.
7. Significance: * - 10%; ** - 5%

Table 4 Results for medium and small airports for all years

	Frequency HHI			Passenger HHI			Without airport HHI		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Constant	-1.7236 (2.3248)	-1.4059 (2.3652)	-1.5009 (2.3743)	-1.7429 (2.2972)	-1.4932 (2.3384)	-1.5509 (2.3490)	-1.5837 (2.2521)	-1.7900 (2.3045)	-1.5487 (2.3432)
HHI	-0.0044 (0.0507)	-0.0234 (0.0594)	-0.0501 (0.0617)	0.0524 (0.0449)	0.0297 (0.0563)	-0.0154 (0.0793)	---	---	---
Highest Market Share	---	---	0.0598* (0.0358)	---	---	0.0494 (0.0483)	---	0.0580* (0.0299)	0.0397 (0.0365)
Mean Route HHI	---	0.5163 (0.5526)	0.3961 (0.5575)	---	0.4303 (0.5796)	0.3991 (0.5790)	0.4931 (0.5138)	---	0.3920 (0.5678)
Total passenger volume	-0.3779** (0.0565)	-0.3640** (0.0503)	-0.3759** (0.0501)	-0.3748** (0.0524)	-0.3621** (0.0478)	-0.3690** (0.5790)	-0.3627** (0.0488)	-0.3817** (0.0521)	-0.3678** (0.0480)
Mean distance	-0.3990** (0.0726)	0.4027** (0.0720)	0.4071** (0.0701)	0.4082** (0.0720)	0.4108** (0.0723)	0.4126** (0.0714)	0.4100** (0.0725)	0.4109** (0.0711)	0.4131** (0.0717)
Real wage	0.5751** (0.2124)	0.5537** (0.2108)	0.5467** (0.2055)	0.5620** (0.2083)	0.5475** (0.2090)	0.5464** (0.2074)	0.5837** (0.2100)	0.5590** (0.2062)	0.5457** (0.2076)
Population	0.5034** (0.1603)	0.4729** (0.1616)	0.4936** (0.1660)	0.5087** (0.1598)	0.4818** (0.1599)	0.4915** (0.1632)	0.4705** (0.1514)	0.5180** (0.1628)	0.4910** (0.1623)
Unemployment rate	-0.2515** (0.0494)	-0.2282** (0.0369)	-0.2271** (0.0363)	-0.2519** (0.0508)	-0.2331** (0.0373)	-0.2303** (0.0363)	-0.2305** (0.0383)	-0.2469** (0.0502)	-0.2314** (0.0381)
Adjusted R-squared	0.9077	0.9085	0.9098	0.9082	0.9088	0.9093	0.9078	0.9089	0.9093

Notes:

1. Method used – airport-level fixed effects two-stage GLS. One-year lags are used as instruments for HHI, highest market share, route HHI, and passenger volume.
2. Reported results are for sub-sample of airports handling between 0.05% and 0.25% of all passenger boardings within US in a given year.
3. All specifications use natural logarithms of all dependent variables reported here, except for constant.
4. Standard errors, robust to heteroscedasticity across and autocorrelation within cross-sections, are reported in parentheses.
5. Airport-level airline market shares and year dummy variables are included in all specifications, but not reported.
6. Included observations: 1457.
7. Significance: * - 10%; ** - 5%

Table 5 Results for small hub and non-hub airports for all years

	Frequency HHI			Passenger HHI			Without airport HHI		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Constant	3.5859** (1.3221)	3.5266** (1.3117)	3.5500** (1.3350)	3.0762** (1.4436)	3.0923** (1.4432)	3.0568** (1.4438)	3.6000** (1.3888)	3.4657** (1.4136)	3.4507** (1.4127)
HHI	0.0445 (0.0292)	0.0301 (0.0409)	0.0043 (0.0390)	0.1121** (0.0397)	0.1176* (0.0647)	0.1408** (0.0626)	---	---	---
Highest Market Share	---	---	0.0901 (0.0623)	---	---	-0.0358 (0.0541)	---	0.0818** (0.0341)	0.0784 (0.0651)
Mean Route HHI	---	0.2684 (0.5000)	-0.0101 (0.6370)	---	-0.0731 (0.6015)	-0.0185 (0.6482)	0.3353 (0.4337)	---	0.0411 (0.6307)
Total passenger volume	-0.0391 (0.0291)	-0.0382 (0.0287)	-0.0368 (0.0293)	-0.0424 (0.0360)	-0.0423 (0.0361)	-0.0413 (0.0362)	-0.0596* (0.0309)	-0.0546 (0.0332)	-0.0544* (0.0326)
Mean distance	-0.0072 (0.0439)	-0.0103 (0.0456)	-0.0039 (0.0464)	-0.0053 (0.0460)	-0.0043 (0.0476)	-0.0050 (0.0477)	-0.0208 (0.0458)	-0.0114 (0.0464)	-0.0119 (0.0481)
Real wage	0.2304 (0.1509)	0.2150 (0.1543)	0.2291 (0.1564)	0.2260 (0.15523)	0.2298 (0.1582)	0.2262 (0.1585)	0.2228 (0.1523)	0.2349 (0.1526)	0.2326 (0.1559)
Population	0.1408 (0.1324)	0.1535 (0.1343)	0.1405 (0.1356)	0.1910 (0.1421)	0.1874 (0.1453)	0.1918 (0.1460)	0.1667 (0.1415)	0.1647 (0.1404)	0.1671 (0.1445)
Unemployment rate	-0.2575** (0.0633)	-0.2482** (0.0691)	-0.2463** (0.0677)	-0.2531** (0.0643)	-0.2553** (0.0706)	-0.2571** (0.0699)	-0.2417** (0.0691)	-0.2451** (0.0639)	-0.2442** (0.0690)
Adjusted R-squared	0.7397	0.7386	0.7390	0.7380	0.7378	0.7378	0.7378	0.7386	0.7385

Notes:

1. Method used – airport-level fixed effects two-stage GLS. One-year lags are used as instruments for HHI, highest market share, route HHI, and passenger volume.
2. Reported results are for sub-sample of primary airports handling less than 0.05% of all passenger boardings within US in a given year.
3. All specifications use natural logarithms of all dependent variables reported here, except for constant.
4. Standard errors, robust to heteroscedasticity across and autocorrelation within cross-sections, are reported in parentheses.
5. Airport-level airline market shares and year dummy variables are included in all specifications, but not reported.
6. Included observations: 3742.
7. Significance: * - 10%; ** - 5%

Table 6 Individual airline market share effects

	All airports	Large and medium hubs	Medium and small hubs	Small hubs and non-hub
American Airlines	0.2889** (0.1046)	-0.0946 (0.4844)	0.5332** (0.2224)	0.3614** (0.1004)
Alaska Airlines	-0.2577** (0.0562)	-0.2353 (0.5575)	-0.1356** (0.0586)	-0.2373** (0.0559)
JetBlue Airways	-0.4721** (0.2343)	-0.8607 (0.5770)	-1.1475** (0.5303)	-0.3374 (0.2196)
Continental Airlines	0.0592 (0.1025)	0.4896 (0.5546)	0.1856 (0.1614)	-0.0082 (0.0931)
Delta Air Lines	0.1145 (0.0833)	-0.7058 (0.5722)	-0.0882 (0.2111)	0.1299 (0.0878)
Frontier Airlines	0.0636 (0.1355)	-0.8154** (0.3087)	-0.0262 (0.2204)	0.0849 (0.1375)
Air Tran Airways	0.0457 (0.1625)	-0.0544 (0.2857)	0.0262 (0.2698)	-0.0301 (0.1534)
America West Airlines	-0.0134 (0.1503)	0.6469 (0.4642)	-0.0425 (0.2302)	-0.0915 (0.1259)
Northwest Airlines	0.0414 (0.11105)	1.5827* (0.8078)	0.6636** (0.2601)	-0.0423 (0.0992)
TWA	0.1462 (0.1088)	-1.2833** (0.5699)	0.3257 (0.2058)	0.1038 (0.1056)
United Airlines	-0.0210 (0.1568)	-0.2956 (0.4564)	-0.1226 (0.2815)	0.0137 (0.1590)
US Airways	0.3234** (0.0808)	1.5107** (0.5487)	1.2218** (0.2318)	0.2683** (0.0737)
Southwest Airlines	-1.2077** (0.2585)	-2.8615** (0.5344)	-1.4250** (0.3803)	-0.7446** (0.2085)

Notes:

1. This table reports coefficients for airline market share variables from regression (4) in Tables 2a, 3, 4, and 5, respectively.
2. Prior to 1997 merger of Valujet Airlines with Airtran Airways, Airtran's market share corresponds to Valujet's, as it has been computed using the carrier's IATA code FL.
3. Some carriers were not present in the data for the entire duration of our panel. In particular:
    a. JetBlue Airways was founded in 2001.
    b. Frontier Airlines was founded in 1994.
    c. America West Airlines merged with US Airways in 2005.
    d. Northwest Airlines merged with Delta Air Lines in 2008.
    e. TWA merged with American Airlines in 2000.

Table 7 Welfare effects of Delta – Northwest merger in small hubs and non-hub airports

Airport Code	Percentage change in airport HHI	Percentage change in price, low limit	Price change, high limit	Passenger enplanements, 2007	Average airfares, year 2007 prices	Consumer welfare loss, low limit	Consumer welfare loss, high limit
AVP	41.16	4.61	5.79	220,190	421.14	4,180,384	5,218,903
AZO	13.17	1.47	1.85	189,276	471.01	1,306,496	1,637,863
BIS	55.61	6.23	7.83	183,787	455.54	5,057,026	6,299,410
CID	6.86	0.76	0.96	531,864	406.69	1,659,008	2,081,688
DLH	79.46	8.90	11.18	175,429	416.42	6,218,046	7,716,783
FAR	44.21	4.95	6.22	303,563	492.84	7,231,577	9,023,921
FCA	6.36	0.71	0.89	196,839	532.74	745,885	935,989
FNT	32.13	3.60	4.52	534,774	281.36	5,322,480	6,653,757
FSD	48.20	5.40	6.78	399,533	433.12	9,099,383	11,347,757
GFK	63.43	7.11	8.93	85,196	564.55	3,298,524	4,103,914
GTF	10.25	1.14	1.44	190,203	489.11	1,062,939	1,333,099
HDN	8.88	0.99	1.25	139,573	475.21	657,079	824,248
LAN	76.17	8.53	10.72	257,893	364.39	7,682,117	9,538,725
LSE	63.11	7.07	8.88	123,753	465.38	3,930,880	4,890,910
MBS	68.23	7.64	9.60	187,290	441.07	6,076,868	7,554,972
RAP	12.61	1.41	1.77	239,642	476.61	1,603,599	2,010,483
RST	33.20	3.72	4.67	166,853	378.20	2,305,276	2,881,418
TVC	64.08	7.18	9.02	202,330	479.08	6,713,259	8,351,569
ALB	8.15	0.91	1.14	1,423,672	337.41	4,371,882	5,484,720
BHM	5.51	0.61	0.77	1,810,455	336.62	3,758,685	4,717,239
BTR	26.28	2.94	3.70	485,765	412.80	5,822,431	7,285,096
DSM	8.42	0.94	1.18	969,290	394.75	3,594,787	4,509,647
GPT	22.76	2.55	3.20	452,485	362.06	4,128,078	5,167,795
GRB	68.91	7.72	9.70	447,344	401.46	13,337,443	16,579,804
GRR	69.24	7.76	9.74	1,001,098	420.67	31,420,924	39,057,373
MDT	10.31	1.15	1.45	644,469	433.27	3,209,172	4,024,789
MSN	38.23	4.28	5.38	789,832	424.99	14,078,715	17,584,023
PWM	9.78	1.09	1.37	819,997	367.71	3,290,537	4,127,148
ROC	10.53	1.18	1.48	1,428,543	304.50	5,105,448	6,402,803
SRQ	9.24	1.03	1.30	775,056	288.80	2,307,731	2,894,694
SYR	22.74	2.54	3.20	1,184,155	359.16	10,706,240	13,402,807
VPS	66.09	7.40	9.30	381,477	547.21	14,894,541	18,523,587
Total consumer welfare loss						194,177,450	242,166,950

Note: we only include airports, for which projected increase in HHI following the merger was higher than 5% from the pre-merger level. Estimates of consumer welfare loss are based on passenger HHI coefficient from Table 5, specifications (4) and (6) for low and high limit, respectively. Unitary demand elasticity is assumed in all calculations.