Does Airport Size Matter?

Hub Airports and Local Economic Outcomes

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Abstract

This paper considers the marginal effect of an airport hub on a metropolitan area's economy over the period 1978-2012. Evidence from panel regression evidence indicates that airline hub airports increase personal income by at least 2.3 percent, and also increase establishment counts by at least 1.6 percent, within their respective commuting zone (CZ). Sectors most likely to experience employment growth are air travel and hotels and lodging; amusement and recreation are more likely to experience employment declines. Evidence from an event study analysis corroborates these findings. It additionally suggests hub loss causes significant decreases in service sector employment, service establishments, aggregate wages/payroll and wages per worker in the wake of hub closures. These effects appear to operate, especially for hubs dominated by major airlines, through changes in access to markets served by non-stop flights. These findings suggest that the effects of hub airports, in most cases, operate through their ability to facilitate efficient business travel.

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1 Introduction

In an era of high fuel prices, high operating costs and increased competition, airlines have found themselves culling their networks to maximize efficiency and reduce costs. Over the past decade, a number of large mergers in the domestic airline industry, such as United Continental, Delta Northwest, American and U.S. Airways, and Southwest and AirTran. According to the U.S. Department of Transportation, these mergers have led these four combined carriers to have just under 70 percent of market share.[1]

Post-deregulation, airlines moved quickly to establish hubs, seeking to establish a market share advantage at various airports, hoping that this would drive profitability. While this drove operational efficiency, competitive pressures kept pricing advantages in check for the most part (Button, 2002). For travelers, hubs are also popular as they allow access to most domestic destinations with no more than one connection. Time-sensitive business travelers appreciate the ability to travel non-stop to a variety of destinations. Various studies suggest cities may benefit from these hub airports. For example, Giroud (2013) has shown that new non-stop air routes have the potential to increase plant level investment by 8 percent and productivity by 1.3 percent. to headquarter companies because of the availability of direct flights. Similarly, Bowen (2010) notes that airline hubs have facilitated the consolidation of corporate headquarters and, additionally, job growth. Button et al. (1999) argue that high-technology companies also have a clear preference for locating in cities with hub airports.

However, since it is costly to establish and maintain hub airports, air carriers have a strong incentive to minimize the number of hubs they operate. In recent years, cities such as St. Louis, Memphis, Cleveland, and to a lesser extent, Cincinnati, all have experienced hub closures as a result of merger reorganizations. To date, little empirical research has been conducted to understand the effects these actions have had on local communities. This study is the first to use data from the entire post-deregulation period of aviation to assess the (relatively) exogenous change in hub status of major cities, resulting from airline mergers or bankruptcies, on economic outcomes such as population and employment within a city. Specifically, I create a database of hub openings and closings, and also define a set of "hub potential" airports - airports that carried similar amounts of traffic, but did not become hubs. I exploit the temporal variation in hub openings and closings to estimate these effects.

Using an event-study research design, supplemented by panel fixed-effects regressions, I show that airline hub airports do have a causal effect on commuting zone (CZ) level outcomes. Namely, I show that hubs increase personal income by at least 1.6 percent and establishment counts by at least 2.3 percent, with the non-traded sector accounting for most of this effect. I also show that positive employment outcomes are

[1] U.S. Department of Transportation, Bureau of Transportation Statistics: http://www.transtats.bts.gov/

observed most strongly in related industries, such as air travel and hotels and lodging, while the amusement and recreation sector is more likely to experience employment declines. Evidence from an event study analysis corroborates these findings. It additionally suggests hub loss causes significant decreases in service sector employment, service establishments, aggregate wages/payroll and wages per worker in the wake of hub closures. These effects appear to operate, especially for hubs dominated by major airlines, through changes in access to markets served by non-stop flights. In sum, these findings suggest that the effects of hub airports, in most cases, operate through their ability to facilitate efficient business travel.

The rest of this paper proceeds as follows: Section 2 reviews the literature on air hubs and provides some background. Section 3 presents case studies to illustrate how a hub might affect a local economy in practice. Section 4 provides information about the data, section 5 presents the results and discussion, and section 6 concludes.

2 Background

Airports in general have been shown to be important contributors to the health of their local economies. In McGraw (2016), I showed that that employment in the nontraded business and professional services sector grew, on average, 3.2 percent more per decade since 1950 in cities with an airport. I also demonstrated that the effects are roughly similar for airports regardless of city size; however, they were not identical. Sheard (2014), in a study examining the linkages between airport size and urban growth, finds that while airport size has some effect on employment in tradable sectors, it has no effect on employment in manufacturing or other non-tradable services. He also finds that airport size has practically zero effect on overall local employment. If this is true, than one might expect the loss (or gain) of a hub airport to matter little to a city's economy.

However, another strand of literature finds that hub airports, specifically, have characteristics that may prove to be unique to cities with hub airports. Button et al. (1999) examines employment data between hub and non-hub cities by year. They find an overall increase in high-tech, high paying jobs in hub cities. They also find a possible link between rapid growth in high-tech employment in cities that are hubs compared to those that are not, further suggesting that having a hub airport might be beneficial to a city's economy, at least when it comes to the technology sector. Neal (2011) finds that urban growth is driven by a city's "centrality" in business networks. This finding relies on estimation of a lagged dependent variable model, which does not necessarily prove causality. Giroud (2013) shows that new non-stop air routes have the potential to increase plant level investment by 8 percent and productivity by 1.3 percent. This implies that companies are much more likely to establish headquarter and other operations in cities partly based on the availability of direct flights to a city. Bowen (2010) notes that airline hubs have facilitated the consolidation of corporate headquarters and, correspondingly, job growth in cities, the majority of which have an airline hub. Neal (2012) and Neal (2014) examine the potential effects hubs may have on urban creative economies. He categorizes hubs into various types: closeness hubs that offer non-stop services, betweenness hubs that offer intermediate connections, and degree hubs, or terminal destination hubs. He finds that only the latter type can substantially impact economic development and attract creative workers to a city.

In terms of hub location, O'Kelly (1998) finds that an optimal hub has few direct links between hubs, suggesting a motive for airlines to keep their number of hubs as small as possible. Others propose that location might be the most important factor in an airline's choice of hub. Jaillet et al. (1996) argues that candidacy for hubs depends more on geographic position than local demand level, leading to the conjecture that at least some hubs were created independent of city characteristics. As noted by Button and Lall (1999), business travelers are time-sensitive rather than price-sensitive, caring more about the frequency of flights, ease of rescheduling, and the services offered at airports than the price of a flight. Redding et al. (2011) provide a model and empirical analysis of the shift in Germany's main hub from Berlin to Frankfurt following the reunification of East and West Germany in 1990. They conclude that the location of an air hub is not uniquely determined by fundamentals; that is, multiple steady states exist. The chosen location likely has more to do with airlines' sunk costs than city fundamentals.

It is important to note that there is no single definition of a hub airport. For example, the U.S. General Accounting Office classifies an airport as a hub if more than 60 or 85 percent of its traffic is controlled by one or two dominant carriers, respectively. (In some studies, the respective numbers used change, such as 50 to 75 percent). The Federal Aviation Administration, by contrast, divides airports into large hub and medium hub subcategories based on the share of passenger traffic (enplanements) at an airport.[2] Academic research often defines a hub as an airport such that carriers feed three or more banks of traffic daily through it from 40 or more cities (Button, 2002).

Given these considerations, particularly the differing definitions of a hub, and the goal of this study, I will define a hub simply by the label given to it by air carriers. If, in its annual report or other public-facing documentation, an airline considers a particular airport to be a hub in a particular year, it will be considered a hub for the purposes of this study. This paper will utilize the salient features of a hub - the large amount of traffic generated, the choice of location being primarily based on airline sunk costs and operational needs, and operation for the sake of maximizing airline profit, not local city outcomes - to provide credible causal evidence on the relationship between an airport hub and local economic development. Openings and closings

[2]A large hub has one percent or more of domestic passenger enplanements. A medium hub has 0.25 - 1.00 percent. A small hub has 0.05 - 0.249 percent, and a non-hub airport has less than 0.05 percent enplanements.

will allow for causal identification of the effects of interest.

3 Data and Methods

I construct a panel data set consisting of a city's airport hub status, passenger enplanements and operations, market access, employment and payroll data. To select the airports included in this study, I began with the sample of 157 airports from the 1964 *FAA Statistical Handbook*, as this provides a set of airports that could feasibly become hubs at some future time.[3] After eliminating airports in cities with multiple airports, I keep those that in 1977 carried at least 0.2 percent of air traffic, and/or that would ever become airport hubs.[4] I also eliminated Atlanta, as this became a "hub" much earlier than other airports. Finally, to facilitate the empirical work, I dropped two airports that were hubs for less than six years.[5] This yields a sample of 48 airports - 26 that functioned as hubs for some part of their history, and 22 that were never designated as hub airports. The map below shows the locations of the airports in this analysis.

[FIGURE 1 ABOUT HERE]

Details of each hub airport are given in Table A.1, while those for hub potential airports are given in Table A.2 in the Appendix.

For each airport, I obtain air traffic data - enplanements (passenger counts) and operations (flights) from 1964, 1970, and 1976 - 2012 from the Federal Aviation Administration.[6] Given the importance of non-stop flights to business travelers, I use U.S. Department of Transportation DB1B market data to generate two simple measures of market access: counts of the number of cities that can be reached from any originating airport with no stops, and with no more than one connection. I also use this to generate a measure of one-way fares by originating airport.[7]

Primary data on city employment outcomes are derived from the County Business Patterns.[8] Data were obtained for each year from 1964 to 2012 for total employment and industry employment in a variety of sectors - tradable and non-tradable, mining, manufacturing, construction, transportation, air transportation, wholesale trade, retail trade, eating and drinking places, finance, insurance, and real estate, services, hotels and lodging, amusement and recreation, and museums, zoos, and other similar establishments. I also obtain

[3]To the best of my knowledge, this is the earliest comprehensive classification of hub cities in the United States by a governmental entity.

[4]This cutoff was chosen after examining the traffic levels of hub airports in the study, and noting that the smallest airport at the time to become a hub, San Jose (SJC), had a 1977 traffic level of 0.2 percent. 1977 was chosen as this was just prior to deregulation in 1978.

[5]These are Kansas City (MCI) and Colorado Springs (COS).

[6]FAA Terminal Area Forecast, https://aspm.faa.gov/main/taf.asp

[7]I am grateful to Severin Borenstein for providing this data. These fares exclude first-class or other special coupons, an important limitation to bear in mind. For more details: https://sites.google.com/site/borenstein/airdata

[8]U.S. Census Bureau, Obtained from the National Historical Geographic Information System (NHGIS), www.nhgis.org..

the data for establishments by sector, and total payroll. I use the Standard Industrial Classification (SIC) categories, throughout the entire study period to classify employment.[9] Where necessary, data were converted from NAICS groups to SIC groups.[10][11] Finally, all county-level data was aggregated to the Commuting Zone (CZ) level.[12][13]

Data on population and personal income are obtained from the U.S. Bureau of Economic Analysis.[14] for each of the industries listed above, at the metropolitan area level.[15] I also obtain this data for personal income, earnings, earnings per worker and per-capita personal income.[16]

3.1 Methodology

As noted in Section 2, there are a variety of definitions of hub airports. In this study, I consider the consequences of an airline labeling an airport as their hub. To create the database of airline hubs, we culled airline web sites, annual reports, newspaper articles, aviation trade publications and other historical sources. As the baseline for the events affecting hub status, e.g. mergers, bankruptcies, and acquisitions, I use the list compiled by Airlines for America, the aviation industry trade group.[17] Relevant events were compiled into a timeline shown in Figure 2. The timing of resulting hub openings and closings is summarized in Appendix Table A.1.

[FIGURE 2 ABOUT HERE]

Identification is based on the assumption that hub closures were due to plausibly exogenous changes in the network structure resulting from industry activity - mergers, acquisitions, airline closures, airline openings, hub openings or closings for competitive reasons, etc. Hub downsizings that include reductions in traffic, but not a complete closure, are not included. I use both fixed effects regression as well as event-study methods to identify the effects of these airports on their cities. I run the following specifications:

[9] These industries correspond to the following SIC codes: 10-14 (Mining), 15-17 (Construction), 20-39 (Manufacturing), 45 (Air Travel), 50-51 (Wholesale Trade), 52-59 (Retail Trade), 60-67 (Finance, Insurance and Real Estate), 70-89 (Services), 71 (Hotels and Lodging), and 79 (Amusement & Recreation Services). Tradable sector employment is defined as the sum of mining, manufacturing, and wholesale trade employment. Non-tradable sector employment is defined as the sum of construction, retail trade, finance, insurance and real estate, and services employment.

[10] SIC to NAICS conversions were accomplished using the fixed point equations provided by the U.S. Department of Housing and Urban Development: http://socds.huduser.org/CBPSE/note.htm

[11] Missing data was imputed using establishment counts and the midpoint for the number of employees at each establishment. Missing data affected substantially fewer than one percent of the data points in the analysis.

[12] As a robustness check, I repeated the analysis at the County and Census-Based Statistical Area (CBSA) levels, and found the results to be virtually indistinguishable.

[13] Commuting zones are clusters of counties that are created using Census bureau data on journey-to-work to delineate groups of local labor markets. I use the 2000 version of the CZs. More information can be found here: https://www.ers.usda.gov/data-products/commuting-zones-and-labor-market-areas/.

[14] Tables CA5 and CA5N, Regional Economic Accounts, Bureau of Economic Analysis, U.S. Department of Commerce: http://www.bea.gov/regional/

[15] Service industries were excluded, as numerous changes were made to the taxonomy of component industries in 2000.

[16] Census Based Statistical Areas, based on 2010 definitions, are the primary unit of observation in this analysis.

[17] http://airlines.org/data/u-s-airline-mergers-and-acquisitions/

$$Y_{it} = \alpha + \beta(H = 1) + \kappa \boldsymbol{X} + \gamma_i + \tau_t + \epsilon_{it} \tag{1}$$

where β identifies the (log) change in the employment, payroll, population or aviation-related outcome of interest Y_{it}; γ_i is a city fixed effect and τ_t is a year fixed effect. The primary unit of observation is the Commuting Zone (CZ). In the specifications that follow, controls that may be included in the vector of $\boldsymbol{X}$ include the possibility of a time trend (linear and quadratic), and city-specific time trends where allowed by the data. Standard errors are clustered at the CZ (airport) level.

As a check on the values given by equation 1, I also use an event-study methodology. After normalizing the data to the time of airport opening or closing, I run the following event-time specification, separately for opening and closing events:

$$Y_{it} = \alpha + \gamma_i + \tau_t + \sum_{k=-6}^{6} \beta_{k,it} + \epsilon_{it} \tag{2}$$

where I incorporate a series of dummy variables indicating time relative to the year of certification. In the results reported here, the time-since-hub-change dummies are capped at $k_{min} = -6$ and $k_{max} = 6$, respectively. The omitted category is the last year prior to the hub opening or closing. Cluster-robust standard errors are estimated, clustered at the CZ (airport) level. In both cases, city-specific trends are accounted for in the final specifications.

4 Results and Discussion

4.1 Panel Evidence (Entire Sample)

The panel regression analysis considers the combined effect of hub openings and closings as a source of identification. All findings here include controls for commuting zone/airport fixed effects, a linear and quadratic time trend, and city-specific time trends. It is important to note at the outset that estimates reported here should generally be considered lower bounds. In many cases, hub openings could have been fairly predictable based on prevailing economic conditions. Thus, employment may have changed in anticipation of the hub opening, and thus would dampen the effect estimated here. In recent years, some hub closings were also anticipated based on prior downsizing or other actions. Still, employment responses on hub closures suffer can be thought of as being closer to a plausibly exogenous shock. It is for this reason that the event studies are presented in the next section.

The panel regression analysis consists of three groups of airport hubs. The primary group consists of the entire set of airports identified by the methodology in Section 3.1. The second is a subset of those 26 airports that I call “major hubs”. These are simply hubs that were labeled as hubs by predecessor airlines which would eventually merge into one of the current legacy airlines (American, Delta, or United). Detailed airline genealogies used for this purpose are found in Figures A.1 through A.5 in the Appendix.

Finally, I consider a third sample of “M&A Airports”. These are five airports for which the change in its status as a hub was entirely attritutable to the immediate, direct effect of a merger or acquisition. In the other cases, hubs may have closed for other reasons, some of which may have been anticipated.[18] Both of these additional groups, but particularly the M&A group, serves to provide a check on the main analysis. Because mergers and acquisitions are unexpected shocks from the perspective of cities, isolating these cases could (potentially) allow for cleaner identification.

Table 1 summarizes the key findings at the airport level. I find that, as expected, passenger enplanements and flight operations increase as expected, between 20 and 30 percent, as a result of the hub. Data limitations do not allow for this passenger traffic to be separated into connecting and origin/destination passengers, unfortunately, but I assume some portion of that traffic will spend time in the respective hub airport city. Employment in the air travel sector rises proportionately with passenger traffic, and hotels and lodging employment increases in the city as well. In the “major hubs” group, the number of non-stop destinations reachable from the airport increases by 12 percent, a large increase that would be very attractive to business travelers. While other evidence indicates that non-stop destinations reachable does not necessarily change across the entire sample, it is possible that market access could be a key factor in driving the results that follow.

[TABLE 1 ABOUT HERE]

Table 2 summarizes key findings that hubs have on cities. The main results here are that the number of establishments increase by at least 1.6 percent, while per-capita personal income increases by at least 2.3 percent. Although there are estimated coefficients on employment and payroll figures, these are likely attenuated. This will be shown in the event study. Additionally, the “cleaner” M&A sample identifies a 3.4 percent increase in wages per worker, which is not picked up in the other two, noisier, samples.

[18]The majority of hub closings were made as a result of airline operational optimization. In some cases, hubs were considered duplicative and so were removed. In others, behavior of rivals may have made the costs of operating a hub too large. Still, others may have failed to lure enough traffic to make them worthwhile. In order to understand how these factors might affect identification of the effects presented above, I consider a model where only hub closures as a result of mergers and acquisitions are included. Of the 29 hub airports considered in the study, 14 experienced closures prior to 2012. Of those, only five could be said to be solely a result of merger or acquisition activity. These are: Dayton (DAY), Syracuse (SYR), San Jose (SJC), Reno (RNO), and San Diego (SAN). Dayton and Syracuse were both shut in the early 1990s as a result of Piedmont and American Airlines’ merger in 1989. Reno Air had a hub at RNO during the mid-1990s, but was acquired by American in 1998, leading to subsequent hub closures at Reno. Also, with its absorption of Reno Air, American’s San Jose hub became redundant and was de-hubbed. San Diego was a hub for Pacific Southwest Airlines (PSA) prior to its merger with USAir in 1988. Although the number of airports considered is small, identification is still possible given the long timeline considered in this analysis.

[TABLE 1 ABOUT HERE]

Table 3 summarizes key outcomes for employment, establishments, and payroll, focusing only on the full panel of data. Generally, payroll outcomes track employment outcomes, as expected. While establishment growth is significant overall, the model is unable to substantiate these effects in individual industries. Again, the hub closing event study will be more illustrative here. Note that wholesale trade payroll incrases by 3.4 percent, indicating the role that shipping operations play at many of these large airport hubs. Interestingly, the coefficient on amusements and recreation is negative, indicating that hubs decrease employment in the sector by nine percent. This result is not substantiated in the event study that follows.[19]

[TABLE 3 ABOUT HERE]

Appendix Tables A.3 through A.11 provide detailed estimates for all the outcomes considered in the study.

4.2 Event Study

To better understand the findings presented above, I also use an event-study design to separately estimate the effects of hub openings and hub closings on the local economy. In each specification, I control for six years prior to and after hub opening and closings. In what follows below, I present the findings from hub closings; hub opening data is presented in the Appendix. Each specification includes city and year fixed effects, as well as city-specific linear time trends. For each event study, I focus on four air-travel related factors: passenger and aircraft traffic, non-stop market access, and average ticket price. Each panel of outcomes focuses on employment, establishment, or payroll measures for a variety of industries.

I normalize such that all estimates are relative to $t = -1$; that is, one year prior to the hub opening or closing. Because most hubs were opened in the 1980s and 1990s, this set was restricted to the set of hubs that opened and remained open for at least six years. This is to reduce the potential of contaminating the estimates of hub openings via hub closings.[20] Similarly, hub closing events were included only if prior to 2004, to ensure that event studies of at least six lags could be run. This also helps mitigate the fact that the competitive dynamics of the airline industry began to change substantially in the early 2000s, as airlines began to seek increased profitability over market share. Below, I discuss the results of the hub closing study, which are more instructive.

[19] This is a consistent and robust result across all samples and specifications; see Appendix Table A.5 for all estimates. The likeliest explanation is that this sector over-expanded before the airport hubs opened. If nothing else, this result serves as further evidence that business travel, less than tourism, is driving the observed results.

[20] City-by-year trends are included in the specifications, to reduce the potential severity of this issue.

Figure 3 presents the results of the event studies for hub closings on employment in nine selected sectors.[21] Just as in the regression analysis, we find that air travel and hotel employment are most significantly affected by the hub closure. In contrast to the regression analysis, it appears that there is at least some possibility of declining employment in total, as well as in the wholesale trade and services sector. Additionally, there is no evidence of an employment increase in the amusements and recreation sector, indicating that while business travel is likely driving much of the observed responses, employment related to tourism is responsive to the presence of the hub airport as well.

[FIGURE 3 ABOUT HERE]

Figure 4 presents the event study results for establishments. Hub closures have a significant effect on the number of establishments in a city, with the decline driven substantially by a decline in nontradable, primarily service sector, establishments. Additionally, there is a decline in establishments in the amusements and recreation sector, which is consistent with a loss in visitors to a city.[22]

[FIGURE 4 ABOUT HERE]

Finally, I consider payroll output measures. In Figure 5 I consider three related sources of income data - payroll from the County Business Patterns, personal income from the BEA, and wage and salary earnings, also from the BEA. The bulk of the evidence indicates that closure of a hub results in reduced wages, both in aggregate and on a per-worker basis, and reduces total payroll and personal income as well. [23] This is strong evidence that hub airports can play an important role in a local economy's fortunes. It also suggests that municipalities may be justified when providing subsidies for air service; that is, if the costs of the subsidy are justified by the associated income and employment benefits.

[FIGURE 5 ABOUT HERE]

Figures A.8- A.11 show the outcomes for hub openings. As hub openings may have been anticipated at the time, or highly predictable based on trends and market dynamics, these results may not be as instructive. With the exception of per-capita personal income and air transport employment, other results are inconclusive. Puzzlingly (but in line with the results presented previously), amusements and recreation

[21] Figure A.12 in the Appendix shows the effect on the airport-related factors.

[22] This is inconsistent with the negative employment effect estimated on the amusements and recreation sector in the panel regressions. However, this is consistent with the estimated establishment response for the M&A sector airports (see Table A.7in the Appendix). The only plausible way to reconcile the results is to assume that somehow, the sector overbuilt before the hub-and-spoke system took hold.

[23] In the Appendix, I show that Personal Income increases dramatically upon hub opening.

employment shows a downward trend at hub opening. This corroborates with downward bias in the panel regression results. Nevertheless, key patterns hold as expected in traffic measures, air travel and hotels employment, and in personal income growth. Additionally, I find no evidence that hub openings increased fares; in fact, the evidence suggests that competitive pressures may have led to lower fares.

5 Conclusion

This paper is the first to use the data from the entire post-deregulation period of aviation to assess the causal effects of hub airports on local economies. Using panel regression and event-study techniques coupled with the plausibly exogenous changes in the labeling of hub airports by air carriers, I show that airline hub airports do have a causal effect on commuting zone (CZ) level outcomes. Namely, I show that hubs increase personal income by at least 1.6 percent and establishment counts by at least 2.3 percent, with the non-traded sector accounting for most of this effect. I also show that positive employment outcomes are seen strongly in related industries, such as air travel and hotels and lodging, while the amusement and recreation sector is more likely to experience employment declines.

Evidence from an event study analysis corroborates these findings. It additionally suggests hub loss causes significant decreases in service sector employment, service establishments, aggregate wages/payroll and wages per worker in the wake of hub closures. These effects appear to operate, especially for hubs dominated by major airlines, through changes in access to markets served by non-stop flights. In sum, these findings suggest that the effects of hub airports, in many cases, operate through their ability to facilitate efficient business travel. Evidence also indicates tourism likely plays a complementary role. Indeed, having an airport hub appears to confer substantial economic benefits to a city. Local municipalities interested in persuading airlines to maintain hubs would be wise to weigh the cost of any subsidies against the benefit to the local economy provided by the hubs. Further research in this vein will examine the extent to which these benefits could be localized spillovers.

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Table 1: Results - Panel Regression - Airport Outcomes by Sample Group

	All Hubs	"Major" Hubs	Only M&A
	($n = 26$)	($n = 22$)	($n = 5$)
Enplanements	0.243***	0.286***	0.301***
	(0.051)	(0.066)	(0.076)
Operations	0.213***	0.254***	0.281***
	(0.044)	(0.048)	(0.077)
Non-Stop Destinations	0.060	0.121***	0.031
	(0.040)	(0.040)	(0.087)
Air Travel Employment	0.233***	0.182**	0.344**
	(0.085)	(0.089)	(0.149)
Hotel Employment	0.093***	0.080**	0.070
	(0.034)	(0.038)	(0.058)

Note on all columns: Dependent variable is a dummy variable for whether an airline has labeled an airport as a hub in a particular year. Each coefficient from fixed-effects regression which includes airport (city) and year fixed effects, city-specific trends. "Major" hubs refers to those hubs at which an airline which would eventually be absorbed into a major legacy airline family operated. Note on Column 3: Only five hub closures could be definitively said to be solely a result of M&A activity: Dayton (DAY), Syracuse (SYR), San Jose (SJC), Reno (RNO), and San Diego (SAN). All samples include "airport potential" airports which do not affect estimation of the coefficient on the dependent variable, but (may) improve efficiency. All standard errors clustered at the CZ level.

Table 2: Results - Panel Regression - Summary of Key Economic Findings

	All Hubs	"Major" Hubs	Only M&A
	($n = 26$)	($n = 22$)	($n = 5$)
Total Employment	0.007	0.008	-0.019
	(0.015)	(0.017)	(0.016)
Total Establishments	0.016**	0.017	0.025
	(0.008)	(0.011)	(0.017)
Total Payroll	0.016	0.009	0.008
	(0.015)	(0.017)	(0.020)
Per Capita Personal Income	0.030**	0.023**	0.048**
	(0.011)	(0.010)	(0.019)
Wage and Salary Per Worker	0.011	0	0.034***
	(0.008)	(0.008)	(0.012)

Note on all columns: Dependent variable is a dummy variable for whether an airline has labeled an airport as a hub in a particular year. Each coefficient from fixed-effects regression which includes airport (city) and year fixed effects, city-specific trends. "Major" hubs refers to those hubs at which an airline which would eventually be absorbed into a major legacy airline family operated. Note on Column 3: Only five hub closures could be definitively said to be solely a result of M&A activity: Dayton (DAY), Syracuse (SYR), San Jose (SJC), Reno (RNO), and San Diego (SAN). All samples include "airport potential" airports which do not affect estimation of the coefficient on the dependent variable, but (may) improve efficiency. All standard errors clustered at the CZ level.

Table 3: Results - Panel Regression - Sectoral Local Economic Outcomes (Full Panel)

	Employment	Establishments	Payroll
	(n =26)	(n = 26)	(n = 26)
Aviation	0.233**	0.043	0.295***
	(0.085)	(0.034)	(0.099)
Lodging	0.093***	0.008	0.121***
	(0.034)	(0.019)	(0.036)
Services	-0.007	0.009	-0.001
	(0.012)	(0.007)	(0.012)
Wholesale Trade	0.024	0.017	0.034**
	(0.018)	(0.014)	(0.017)
Retail Trade	0.012	0.012	0.014
	(0.012)	(0.017)	(0.016)
Amusements and Recreation	-0.085**	-0.004	-0.067*
	(0.039)	(0.013)	(0.035)

Note on all columns: Dependent variable is a dummy variable for whether an airline has labeled an airport as a hub in a particular year. Each coefficient from fixed-effects regression which includes airport (city) and year fixed effects, along with city-specific trends. All 26 hub airports are included in the estimations above. All samples include "airport potential" airports which do not affect estimation of the coefficient on the dependent variable, but (may) improve efficiency. All standard errors clustered at the CZ level.

Figure 1: Map of Hub and Hub Potential Airports in Study

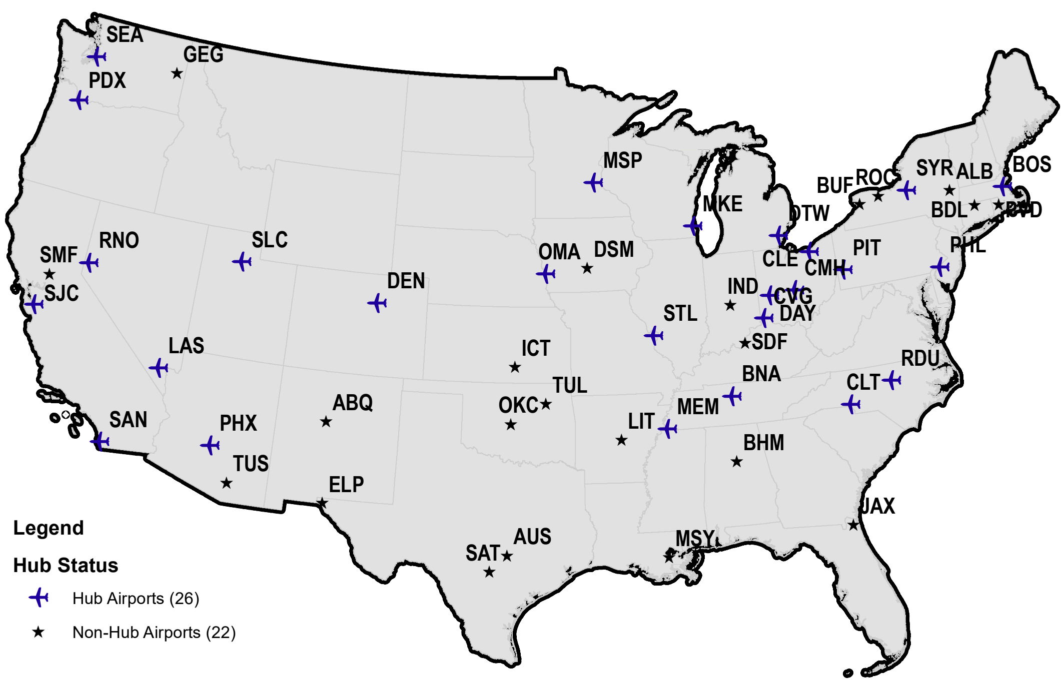
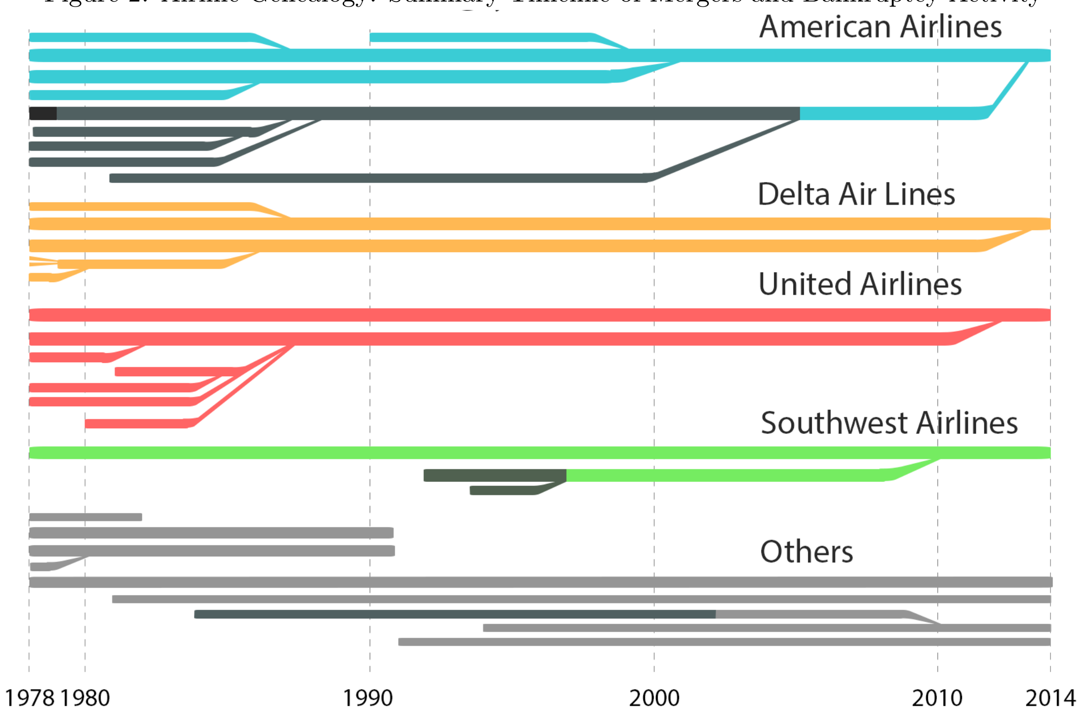


Figure 2: Airline Genealogy: Summary Timeline of Mergers and Bankruptcy Activity



Individual genealogies for each airline group are provided in figures given in the Appendix. Shading corresponds to the eventual airline individual predecessor airlines would merge into.

Figure 3: Hub Closing Event Study: Employment

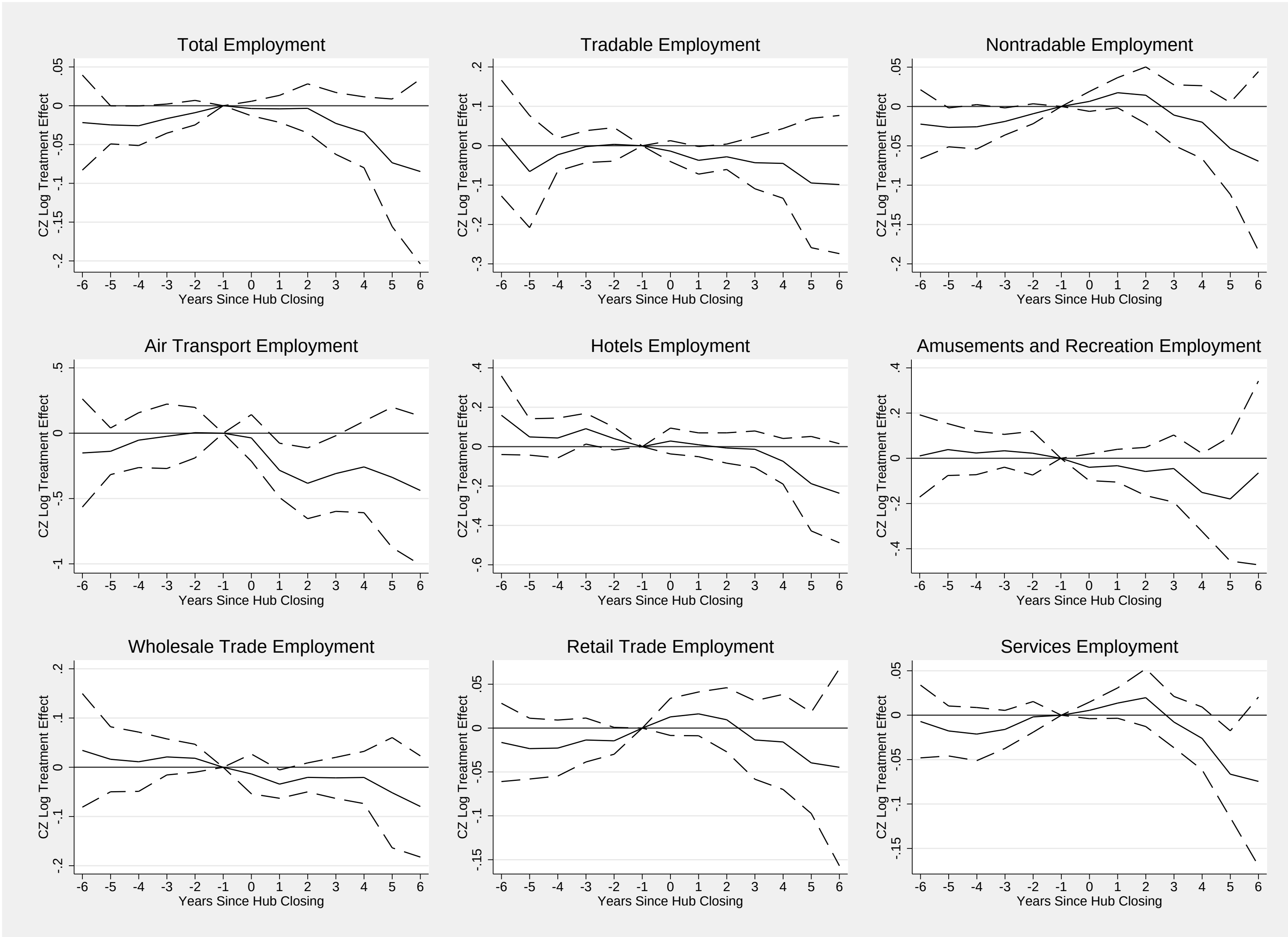


Figure shows event study outcomes on the quantities indicated above. Event studies include airport (city) and year fixed effects, as well as city specific trends. Standard errors are clustered at the city level. Dotted lines indicate 95 percent confidence intervals.

Figure 4: Hub Closing Event Study: Establishments

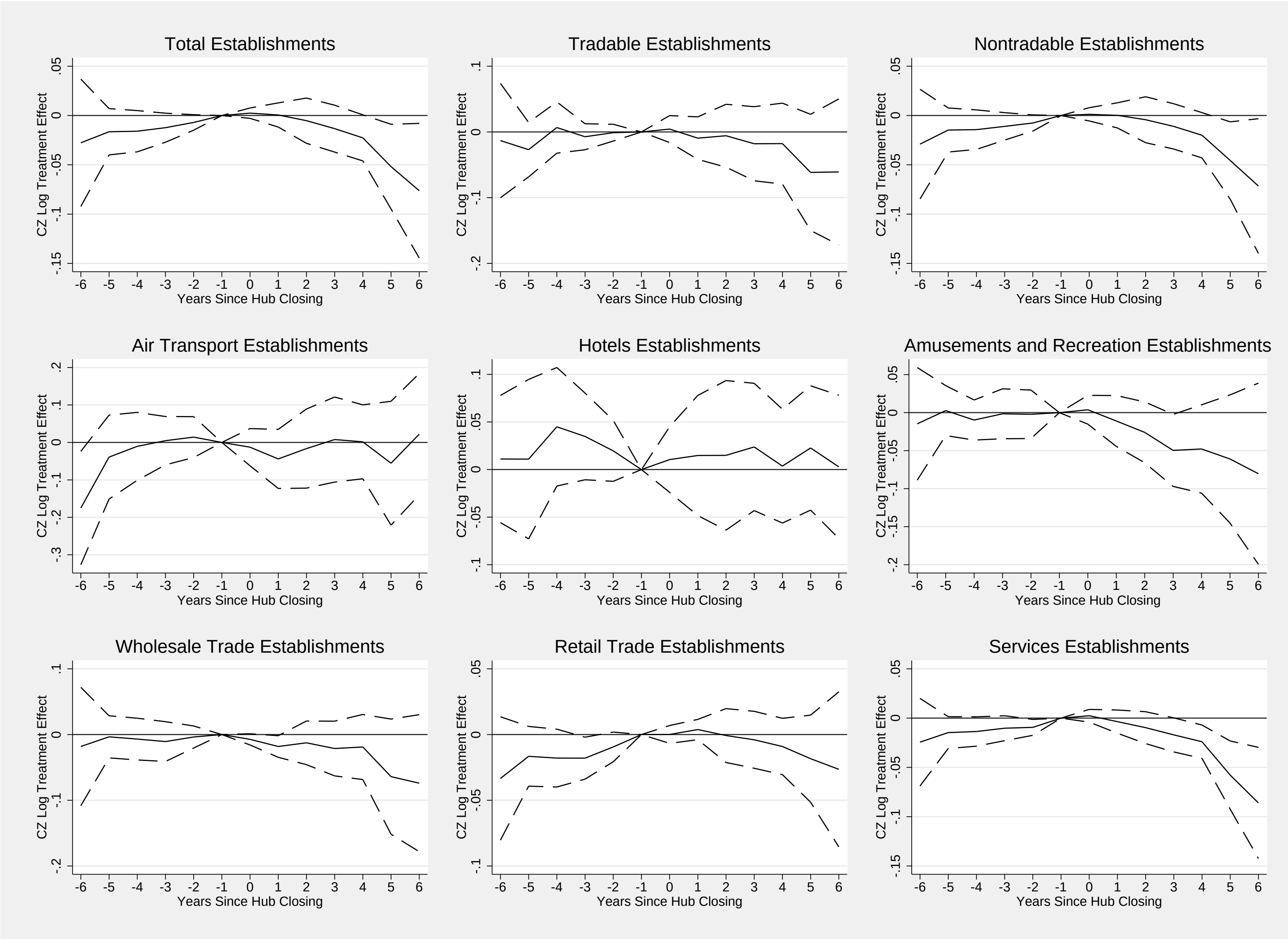


Figure shows event study outcomes on the quantities indicated above. Event studies include airport (city) and year fixed effects, as well as city specific trends. Standard errors are clustered at the city level. Dotted lines indicate 95 percent confidence intervals.

Figure 5: Hub Closing Event Study: Payroll and Wage Measures

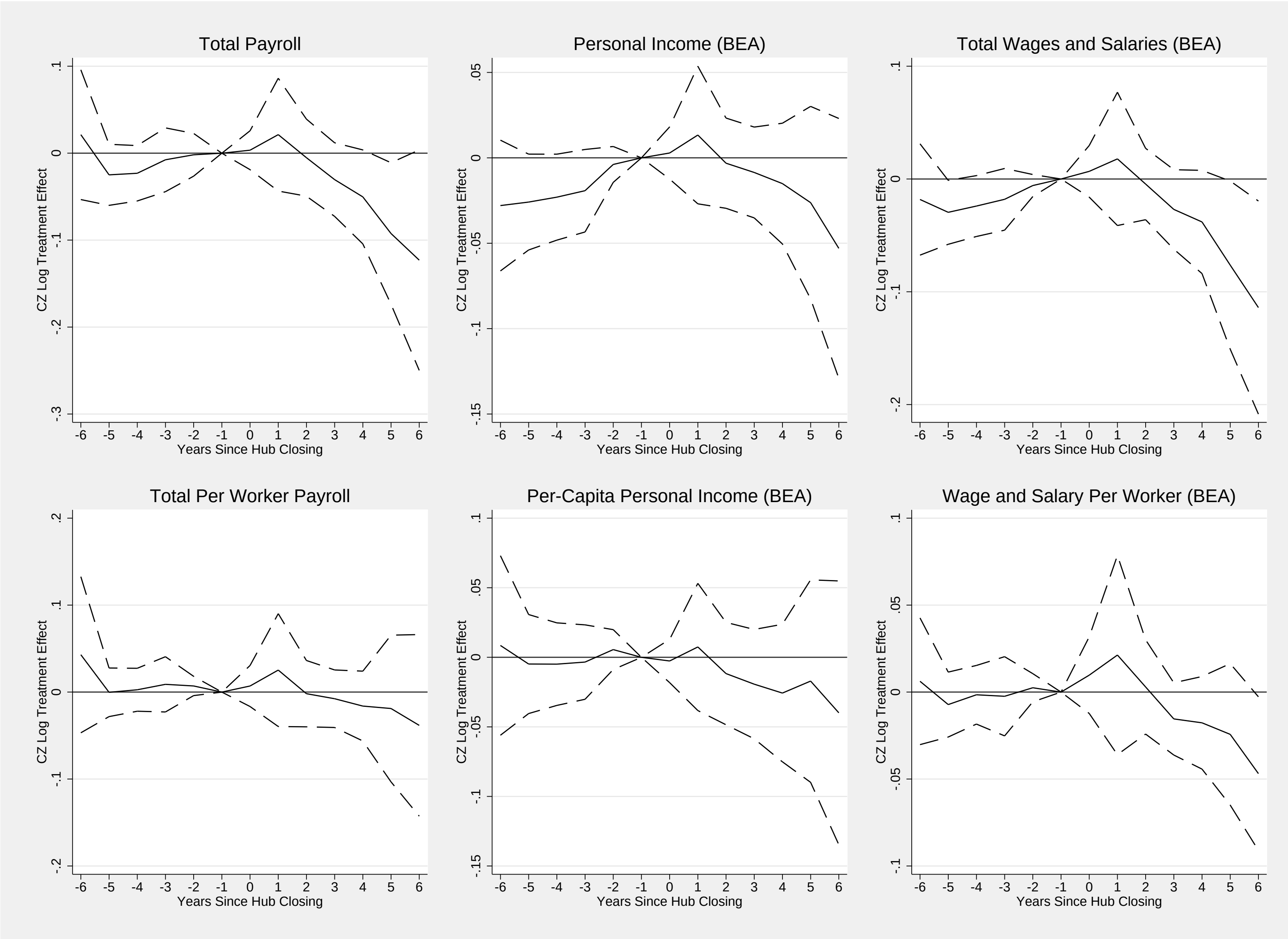
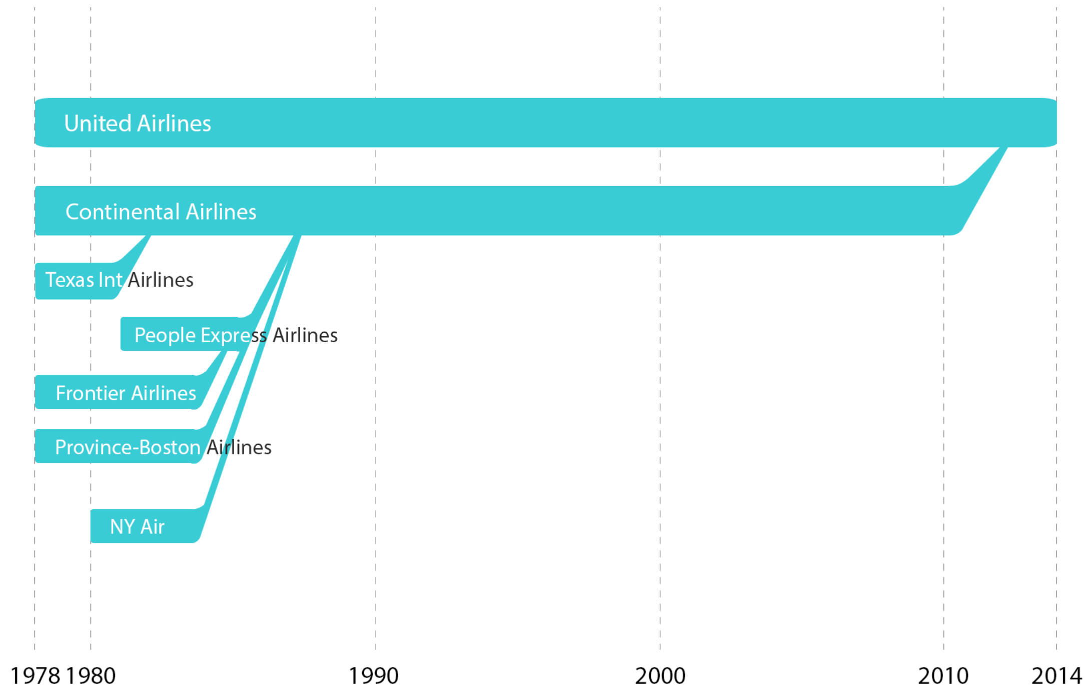


Figure shows event study outcomes on the quantities indicated above. Event studies include airport (city) and year fixed effects, as well as city specific trends. Standard errors are clustered at the city level. Dotted lines indicate 95 percent confidence intervals.

Figure A.1: Airline Genealogy: United



Shading corresponds to the eventual airline predecessor airlines would merge into.

A Appendix

Table A.1: Study Hub Airport Characteristics

ID	Name	City	State	NDestNS	Enpl	Avg Tkt	Open	Closed
BNA	Nashville Intl	Nashville	TN	129	3	153	1987	1995
CLE	Cleveland-Hopkins Intl	Cleveland	OH	123	3	163	1978	
CLT	Charlotte/Douglas Intl	Charlotte	NC	116	7	189	1979	
CMH	Port Columbus Intl	Columbus	OH	105	2	148	1991	2003
CVG	Cincinnati/Northern Kentucky Intl	Covington	KY	112	3	201	1986	
DAY	James M Cox Dayton Intl	Dayton	OH	82	1	171	1982	1992
DEN	Denver Intl	Denver	CO	143	14	163	1979	
DTW	Detroit Metropolitan Wayne County	Detroit	MI	130	9	155	1984	
GSO	Piedmont Triad Intl	Greensboro	NC	60	1	171	1993	1995
LAS	Mc Carran Intl	Las Vegas	NV	77	11	106	1986	2008
MEM	Memphis Intl	Memphis	TN	64	3	198	1985	
MKE	General Mitchell Intl	Milwaukee	WI	52	2	163	1985	
MSP	Minneapolis-St Paul Intl/Wold-Chamberlain	Minneapolis	MN	60	9	189	1978	
OMA	Eppley Airfield	Omaha	NE	36	1	151	1994	2009
PDX	Portland Intl	Portland	OR	38	4	131	1980	
PHL	Philadelphia Intl	Philadelphia	PA	46	7	182	1985	
PHX	Phoenix Sky Harbor Intl	Phoenix	AZ	39	11	116	1983	
PIT	Pittsburgh Intl	Pittsburgh	PA	39	6	182	1979	2003
RDU	Raleigh-Durham Intl	Raleigh/Durham	NC	27	3	185	1987	2003
RNO	Reno/Tahoe Intl	Reno	NV	18	2	99	1992	1999
SAN	San Diego Intl	San Diego	CA	22	5	103	1978	1988
SEA	Seattle-Tacoma Intl	Seattle	WA	22	8	140	1980	
SJC	Norman Y. Mineta San Jose Intl	San Jose	CA	11	3	112	1988	1999
SLC	Salt Lake City Intl	Salt Lake City	UT	13	5	155	1982	
STL	Lambert-St Louis Intl	St Louis	MO	12	8	143	1980	2009
SYR	Syracuse Hancock Intl	Syracuse	NY	6	1	163	1983	1991

Notes: ID = Airport location ID. NDestNS = Number of destinations that can be reached with a non-stop flight from the airport. Enpl = Enplanements (passenger boardings) in millions. Avg Tkt = (inflation-unadjusted) average one-way fare. Open = Year hub opened. Closed = Year Hub Closed. Dates of closures during or after year 2012 are not included.

Table A.2: Study Hub Potential (Control) Airport Characteristics

ID	Name	City	State	NDestNS	Enpl	Avg Tkt
ABQ	Albuquerque Intl Sunport	Albuquerque	NM	119	2	133
ALB	Albany Intl	Albany	NY	97	1	173
AUS	Austin-Bergstrom Intl	Austin	TX	113	2	139
BDL	Bradley Intl	Windsor Locks	CT	114	2	173
BHM	Birmingham-Shuttlesworth Intl	Birmingham	AL	99	1	160
BUF	Buffalo Niagara Intl	Buffalo	NY	95	2	137
DSM	Des Moines Intl	Des Moines	IA	69	1	177
ELP	El Paso Intl	El Paso	TX	70	1	138
GEG	Spokane Intl	Spokane	WA	60	1	134
ICT	Wichita Mid-Continent	Wichita	KS	50	0	179
IND	Indianapolis Intl	Indianapolis	IN	75	2	146
JAX	Jacksonville Intl	Jacksonville	FL	60	2	156
LIT	Bill And Hillary Clinton National/Adams Fi	Little Rock	AR	46	1	156
MSY	Louis Armstrong New Orleans Intl	New Orleans	LA	46	3	158
OKC	Will Rogers World	Oklahoma City	OK	37	1	160
PVD	Theodore Francis Green State	Providence	RI	23	1	174
ROC	Greater Rochester Intl	Rochester	NY	18	1	193
SAT	San Antonio Intl	San Antonio	TX	19	2	165
SDF	Louisville Intl-Standiford Field	Louisville	KY	16	1	154
SMF	Sacramento Intl	Sacramento	CA	9	3	125
TUL	Tulsa Intl	Tulsa	OK	3	1	189
TUS	Tucson Intl	Tucson	AZ	2	1	248

Notes: ID = Airport location ID. NDestNS = Number of destinations that can be reached with a non-stop flight from the airport. Enpl = Enplanements (passenger boardings) in millions. Avg Tkt = (inflation-unadjusted) average one-way fare. Open = Year hub opened. Closed = Year Hub Closed.

Table A.3: Results - Panel Regressions - Airport Factors

	All Hubs (n = 26)				Major Airline (n =22)	M&A (n = 5)
Dependent Variable/Sample:	(1)	(2)	(3)	(4)	(5)	(6)
Log Enplanements	0.531****	0.319****	0.322***	0.243****	0.310****	0.287****
	(0.090)	(0.088)	(0.093)	(0.051)	(0.065)	(0.066)
n	1680	1680	1680	1680	1680	1680
R^2	0.876	0.914	0.921	0.967	0.968	0.966
Log Flights	0.414****	0.289***	0.288***	0.213****	0.274****	0.283****
	(0.081)	(0.086)	(0.089)	(0.044)	(0.047)	(0.073)
n	1680	1680	1680	1680	1680	1680
R^2	0.886	0.901	0.907	0.957	0.959	0.956
Log Non-Stop Destinations	0.148***	0.089***	0.051*	0.060	0.134***	0.032
	(0.045)	(0.031)	(0.028)	(0.040)	(0.043)	(0.087)
n	1622	1622	1622	1622	1622	1622
R^2	0.946	0.962	0.974	0.969	0.969	0.969
Log One-Stop Destinations	0.010	0.030	0.031	0.023	0.024*	0.007
	(0.030)	(0.021)	(0.022)	(0.016)	(0.013)	(0.024)
n	1632	1632	1632	1632	1632	1632
R^2	0.986	0.993	0.994	0.995	0.995	0.995
Log Average One-Way Fare	0.060	0.023	0.009	0.012	0.052	-0.022
	(0.048)	(0.037)	(0.036)	(0.043)	(0.039)	(0.103)
n	1632	1632	1632	1632	1632	1632
R^2	0.445	0.728	0.796	0.766	0.768	0.766
CZ (Airport) Fixed Effects	Y	Y	Y	Y	Y	Y
Time Trend (Linear and Quadratic)	N	Y	N	Y	Y	Y
Year FE	N	N	Y	N	N	N
City-Specific Trends	N	N	N	Y	Y	Y

Cluster robust standard errors in parentheses, clustered at the commuting zone (airport) level.
*** p < 0.01, ** p < 0.05, * p < 0.1

This table presents results from various specifications of OLS regressions run on the panel dataset, specifically, the estimated effect of having a hub on the dependent variable shown within a given sample group of hub airports. Specifications 1-4 present results for the entire sample considered in the analysis. Specification (1) includes only commuting zone (CZ)/airport level fixed effects. Specification (2) adds a time trend. Specification (3) substitutes a year fixed effect for the time trend. While year fixed effects would be preferable in the final specification (4), limitations on the degrees of freedom make this impossible. Hence, Specification (4), the preferred specification, accounts for CZ/airport fixed effects, time trends, and city-specific time trends. The reader may compare the results in specifications (2) and (3) to confirm the reasonableness of this choice. Specification (5) repeats specification (4), but restricted to the sample of hub airports that were served by an airline which would eventually be folded into a "major" airline family (American, Delta, or United). Specification (6) repeats specification (4), but for a specially selected set of five airports: Dayton (DAY), Syracuse (SYR), San Jose (SJC), Reno (RNO), and San Diego (SAN). This "M&A" sample consists of the airport hub closures that could be definitively said to have occurred solely a result of M&A activity. All samples include "airport potential" airports which do not affect estimation of the coefficient on the dependent variable, but (may) improve efficiency. All standard errors clustered at the CZ level.

Table A.4: Results - Panel Regressions - Payroll and Wages

	All Hubs ($n = 26$)				Major Airline (n =22)	M&A ($n = 5$)
Dependent Variable/Sample:	(1)	(2)	(3)	(4)	(5)	(6)
Log Payroll Per Worker	0.185*	0.010	0.009	0.009	0.001	0.029*
	(0.103)	(0.014)	(0.013)	(0.008)	(0.009)	(0.015)
n	1680	1680	1680	1680	1680	1680
R^2	0.102	0.979	0.984	0.992	0.991	0.992
Log Wages and Salaries	0.321**	0.044	0.049	0.020	0.013	0.027
	(0.152)	(0.035)	(0.035)	(0.013)	(0.016)	(0.021)
n	1680	1680	1680	1680	1680	1680
R^2	0.591	0.981	0.982	0.996	0.996	0.996
Log Per Worker Wages and Salaries	0.192*	0.008	0.007	0.011	0.003	0.037***
	(0.104)	(0.012)	(0.011)	(0.008)	(0.008)	(0.013)
n	1680	1680	1680	1680	1680	1680
R^2	0.089	0.983	0.986	0.993	0.993	0.993
Log Personal Income	0.334**	0.047	0.047	0.026**	0.023	0.037**
	(0.160)	(0.034)	(0.034)	(0.012)	(0.014)	(0.017)
n	1680	1680	1680	1680	1680	1680
R^2	0.541	0.984	0.985	0.998	0.998	0.998
Log Per Capita Personal Income	0.263*	0.021*	0.018*	0.030**	0.027**	0.047**
	(0.131)	(0.011)	(0.010)	(0.011)	(0.010)	(0.022)
n	1680	1680	1680	1680	1680	1680
R^2	0.078	0.990	0.993	0.993	0.993	0.993
CZ (Airport) Fixed Effects	Y	Y	Y	Y	Y	Y
Time Trend (Linear and Quadratic)	N	Y	N	Y	Y	Y
Year FE	N	N	Y	N	N	N
City-Specific Trends	N	N	N	Y	Y	Y

Cluster robust standard errors in parentheses, clustered at the commuting zone (airport) level.
*** p $<$ 0.01, ** p $<$ 0.05, * p $<$ 0.1

This table presents results from various specifications of OLS regressions run on the panel dataset, specifically, the estimated effect of having a hub on the dependent variable shown within a given sample group of hub airports. Specifications 1-4 present results for the entire sample considered in the analysis. Specification (1) includes only commuting zone (CZ)/airport level fixed effects. Specification (2) adds a time trend. Specification (3) substitutes a year fixed effect for the time trend. While year fixed effects would be preferable in the final specification (4), limitations on the degrees of freedom make this impossible. Hence, Specification (4), the preferred specification, accounts for CZ/airport fixed effects, time trends, and city-specific time trends. The reader may compare the results in specifications (2) and (3) to confirm the reasonableness of this choice. Specification (5) repeats specification (4), but restricted to the sample of hub airports that were served by an airline which would eventually be folded into a "major" airline family (American, Delta, or United). Specification (6) repeats specification (4), but for a specially selected set of five airports: Dayton (DAY), Syracuse (SYR), San Jose (SJC), Reno (RNO), and San Diego (SAN). This "M&A" sample consists of the airport hub closures that could be definitively said to have occurred solely a result of M&A activity. All samples include "airport potential" airports which do not affect estimation of the coefficient on the dependent variable, but (may) improve efficiency. All standard errors clustered at the CZ level.

Table A.5: Results - Panel Regressions - Sectoral Employment

	All Hubs ($n = 26$)				Major Airline (n =22)	M&A ($n = 5$)
Dependent Variable/Sample:	(1)	(2)	(3)	(4)	(5)	(6)
Log Total Employment	0.151**	0.032	0.042	0.007	0.008	-0.023
	(0.061)	(0.032)	(0.034)	(0.015)	(0.017)	(0.016)
R^2	0.890	0.969	0.972	0.994	0.994	0.994
Log Tradable Employment	0.029	-0.006	0.038	-0.037	-0.076*	-0.114*
	(0.052)	(0.053)	(0.047)	(0.042)	(0.043)	(0.065)
R^2	0.870	0.875	0.958	0.908	0.908	0.908
Log Nontradable Employment	0.189**	0.025	0.033	0.005	0.016	-0.020
	(0.077)	(0.027)	(0.028)	(0.014)	(0.016)	(0.017)
R^2	0.824	0.977	0.979	0.995	0.995	0.995
Log Air Travel Employment	0.662****	0.359****	0.380****	0.233***	0.182**	0.336**
	(0.105)	(0.078)	(0.081)	(0.085)	(0.089)	(0.136)
R^2	0.768	0.898	0.904	0.937	0.936	0.936
Log Hotels and Lodging Employment	0.196**	0.096	0.096	0.093***	0.080**	0.059
	(0.075)	(0.057)	(0.060)	(0.034)	(0.038)	(0.059)
R^2	0.901	0.946	0.948	0.973	0.973	0.973
Log Amusements and Recreation Employment	0.121	-0.091**	-0.052	-0.085**	-0.100***	-0.173***
	(0.144)	(0.037)	(0.040)	(0.039)	(0.034)	(0.051)
R^2	0.585	0.931	0.944	0.968	0.968	0.968
n	1680	1680	1680	1680	1680	1680
CZ (Airport) Fixed Effects	Y	Y	Y	Y	Y	Y
Time Trend (Linear and Quadratic)	N	Y	N	Y	Y	Y
Year FE	N	N	Y	N	N	N
City-Specific Trends	N	N	N	Y	Y	Y

Cluster robust standard errors in parentheses, clustered at the commuting zone (airport) level.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

This table presents results from various specifications of OLS regressions run on the panel dataset, specifically, the estimated effect of having a hub on the dependent variable shown within a given sample group of hub airports. Specifications 1-4 present results for the entire sample considered in the analysis. Specification (1) includes only commuting zone (CZ)/airport level fixed effects. Specification (2) adds a time trend. Specification (3) substitutes a year fixed effect for the time trend. While year fixed effects would be preferable in the final specification (4), limitations on the degrees of freedom make this impossible. Hence, Specification (4), the preferred specification, accounts for CZ/airport fixed effects, time trends, and city-specific time trends. The reader may compare the results in specifications (2) and (3) to confirm the reasonableness of this choice. Specification (5) repeats specification (4), but restricted to the sample of hub airports that were served by an airline which would eventually be folded into a "major" airline family (American, Delta, or United). Specification (6) repeats specification (4), but for a specially selected set of five airports: Dayton (DAY), Syracuse (SYR), San Jose (SJC), Reno (RNO), and San Diego (SAN). This "M&A" sample consists of the airport hub closures that could be definitively said to have occurred solely a result of M&A activity. All samples include "airport potential" airports which do not affect estimation of the coefficient on the dependent variable, but (may) improve efficiency. Tradable sector employment is defined as the sum of mining, manufacturing, and wholesale trade employment. Non-tradable sector employment is defined as the sum of construction, retail trade, finance, insurance and real estate, and services employment.All standard errors clustered at the CZ level.

Table A.6: Results - Panel Regressions - Sectoral Employment

	All Hubs (n = 26)				Major Airline (n =22)	M&A (n = 5)
Dependent Variable/Sample:	(1)	(2)	(3)	(4)	(5)	(6)
Log Manufacturing Employment	0.068	0.040	0.048	0.022	0.009	-0.038*
	(0.059)	(0.049)	(0.050)	(0.027)	(0.024)	(0.019)
n	1632	1632	1632	1632	1632	1632
R^2	0.925	0.953	0.956	0.989	0.989	0.989
Log Wholesale Trade Employment	0.126**	0.021	0.025	0.024	0.023	-0.022**
	(0.057)	(0.046)	(0.048)	(0.018)	(0.023)	(0.010)
n	1680	1680	1680	1680	1680	1680
R^2	0.929	0.953	0.956	0.990	0.990	0.990
Log Retail Trade Employment	0.137**	0.029	0.029	0.012	0.030**	-0.012
	(0.052)	(0.026)	(0.027)	(0.012)	(0.015)	(0.020)
n	1680	1680	1680	1680	1680	1680
R^2	0.887	0.969	0.971	0.994	0.994	0.994
Log Finance/Insurance/Real Estate Emp.	0.167**	0.044	0.052	-0.009	0.014	-0.012
	(0.063)	(0.035)	(0.036)	(0.020)	(0.021)	(0.040)
n	1680	1680	1680	1680	1680	1680
R^2	0.893	0.969	0.972	0.991	0.991	0.991
Log Services Employment	0.240**	0.010	0.016	-0.007	0.001	-0.035***
	(0.101)	(0.028)	(0.030)	(0.012)	(0.011)	(0.008)
n	1680	1680	1680	1680	1680	1680
R^2	0.745	0.979	0.980	0.996	0.996	0.996
CZ (Airport) Fixed Effects	Y	Y	Y	Y	Y	Y
Time Trend (Linear and Quadratic)	N	Y	N	Y	Y	Y
Year FE	N	N	Y	N	N	N
City-Specific Trends	N	N	N	Y	Y	Y

Cluster robust standard errors in parentheses, clustered at the commuting zone (airport) level.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

This table presents results from various specifications of OLS regressions run on the panel dataset, specifically, the estimated effect of having a hub on the dependent variable shown within a given sample group of hub airports. Specifications 1-4 present results for the entire sample considered in the analysis. Specification (1) includes only commuting zone (CZ)/airport level fixed effects. Specification (2) adds a time trend. Specification (3) substitutes a year fixed effect for the time trend. While year fixed effects would be preferable in the final specification (4), limitations on the degrees of freedom make this impossible. Hence, Specification (4), the preferred specification, accounts for CZ/airport fixed effects, time trends, and city-specific time trends. The reader may compare the results in specifications (2) and (3) to confirm the reasonableness of this choice. Specification (5) repeats specification (4), but restricted to the sample of hub airports that were served by an airline which would eventually be folded into a "major" airline family (American, Delta, or United). Specification (6) repeats specification (4), but for a specially selected set of five airports: Dayton (DAY), Syracuse (SYR), San Jose (SJC), Reno (RNO), and San Diego (SAN). This "M&A" sample consists of the airport hub closures that could be definitively said to have occurred solely a result of M&A activity. All samples include "airport potential" airports which do not affect estimation of the coefficient on the dependent variable, but (may) improve efficiency. All standard errors clustered at the CZ level.

Table A.7: Results - Panel Regressions - Sectoral Establishment Counts

	All Hubs ($n = 26$)				Major Airline (n =22)	M&A ($n = 5$)
Dependent Variable/Sample:	(1)	(2)	(3)	(4)	(5)	(6)
Log Total Establishments	0.158***	0.034	0.030	0.016**	0.017	0.020
	(0.053)	(0.028)	(0.028)	(0.008)	(0.011)	(0.016)
R^2	0.895	0.976	0.977	0.997	0.997	0.997
Log Tradable Establishments	0.111**	-0.005	0.009	-0.006	-0.020	-0.038
	(0.049)	(0.041)	(0.041)	(0.020)	(0.017)	(0.044)
R^2	0.933	0.951	0.971	0.977	0.977	0.977
Log Nontradable Establishments	0.167***	0.031	0.031	0.010	0.013	0.012
	(0.059)	(0.027)	(0.028)	(0.008)	(0.010)	(0.012)
R^2	0.866	0.977	0.978	0.997	0.997	0.997
Log Air Travel Establishments	0.257**	0.038	0.040	0.043	0.046	0.093
	(0.102)	(0.040)	(0.041)	(0.034)	(0.045)	(0.067)
R^2	0.669	0.933	0.934	0.955	0.955	0.955
Log Hotels and Lodging Establishments	0.101**	0.029	0.032	0.008	-0.004	0.007
	(0.042)	(0.032)	(0.033)	(0.019)	(0.021)	(0.009)
R^2	0.855	0.948	0.952	0.983	0.983	0.983
Log Amusements and Recreation Establishments	0.204**	0.008	0.016	-0.004	-0.008	0.029*
	(0.089)	(0.033)	(0.035)	(0.013)	(0.012)	(0.016)
R^2	0.736	0.972	0.974	0.994	0.994	0.994
n	1680	1680	1680	1680	1680	1680
CZ (Airport) Fixed Effects	Y	Y	Y	Y	Y	Y
Time Trend (Linear and Quadratic)	N	Y	N	Y	Y	Y
Year FE	N	N	Y	N	N	N
City-Specific Trends	N	N	N	Y	Y	Y

Cluster robust standard errors in parentheses, clustered at the commuting zone (airport) level.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

This table presents results from various specifications of OLS regressions run on the panel dataset, specifically, the estimated effect of having a hub on the dependent variable shown within a given sample group of hub airports. Specifications 1-4 present results for the entire sample considered in the analysis. Specification (1) includes only commuting zone (CZ)/airport level fixed effects. Specification (2) adds a time trend. Specification (3) substitutes a year fixed effect for the time trend. While year fixed effects would be preferable in the final specification (4), limitations on the degrees of freedom make this impossible. Hence, Specification (4), the preferred specification, accounts for CZ/airport fixed effects, time trends, and city-specific time trends. The reader may compare the results in specifications (2) and (3) to confirm the reasonableness of this choice. Specification (5) repeats specification (4), but restricted to the sample of hub airports that were served by an airline which would eventually be folded into a "major" airline family (American, Delta, or United). Specification (6) repeats specification (4), but for a specially selected set of five airports: Dayton (DAY), Syracuse (SYR), San Jose (SJC), Reno (RNO), and San Diego (SAN). This "M&A" sample consists of the airport hub closures that could be definitively said to have occurred solely a result of M&A activity. All samples include "airport potential" airports which do not affect estimation of the coefficient on the dependent variable, but (may) improve efficiency. Tradable sector establishments is defined as the sum of mining, manufacturing, and wholesale trade establishments. Non-tradable sector establishments is defined as the sum of construction, retail trade, finance, insurance and real estate, and services establishments. All standard errors clustered at the CZ level.

Table A.8: Results - Panel Regressions - Sectoral Establishments

	All Hubs ($n = 26$)				Major Airline (n =22)	M&A ($n = 5$)
Dependent Variable/Sample:	(1)	(2)	(3)	(4)	(5)	(6)
Log Manufacturing Employment	0.126***	0.010	0.009	0.017	0.018	-0.005
	(0.046)	(0.038)	(0.040)	(0.017)	(0.016)	(0.034)
n	1632	1632	1632	1632	1632	1632
R^2	0.960	0.973	0.975	0.996	0.996	0.996
Log Wholesale Trade Employment	0.142***	0.013	0.013	0.017	0.011	-0.015
	(0.051)	(0.044)	(0.046)	(0.014)	(0.010)	(0.023)
n	1680	1680	1680	1680	1680	1680
R^2	0.937	0.962	0.966	0.993	0.993	0.993
Log Retail Trade Employment	0.106***	0.031	0.024	0.012	0.024***	0.009
	(0.034)	(0.027)	(0.027)	(0.007)	(0.007)	(0.016)
n	1680	1680	1680	1680	1680	1680
R^2	0.950	0.976	0.978	0.997	0.997	0.997
Log Finance/Insurance/Real Estate Emp.	0.156**	0.032	0.048	-0.004	-0.016	-0.004
	(0.074)	(0.031)	(0.032)	(0.016)	(0.020)	(0.030)
n	1680	1680	1680	1680	1680	1680
R^2	0.791	0.968	0.973	0.990	0.990	0.990
Log Services Employment	0.212***	0.025	0.021	0.009	0.009	0.015
	(0.077)	(0.027)	(0.027)	(0.007)	(0.009)	(0.010)
n	1680	1680	1680	1680	1680	1680
R^2	0.809	0.979	0.979	0.998	0.998	0.998
CZ (Airport) Fixed Effects	Y	Y	Y	Y	Y	Y
Time Trend (Linear and Quadratic)	N	Y	N	Y	Y	Y
Year FE	N	N	Y	N	N	N
City-Specific Trends	N	N	N	Y	Y	Y

Cluster robust standard errors in parentheses, clustered at the commuting zone (airport) level.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

This table presents results from various specifications of OLS regressions run on the panel dataset, specifically, the estimated effect of having a hub on the dependent variable shown within a given sample group of hub airports. Specifications 1-4 present results for the entire sample considered in the analysis. Specification (1) includes only commuting zone (CZ)/airport level fixed effects. Specification (2) adds a time trend. Specification (3) substitutes a year fixed effect for the time trend. While year fixed effects would be preferable in the final specification (4), limitations on the degrees of freedom make this impossible. Hence, Specification (4), the preferred specification, accounts for CZ/airport fixed effects, time trends, and city-specific time trends. The reader may compare the results in specifications (2) and (3) to confirm the reasonableness of this choice. Specification (5) repeats specification (4), but restricted to the sample of hub airports that were served by an airline which would eventually be folded into a "major" airline family (American, Delta, or United). Specification (6) repeats specification (4), but for a specially selected set of five airports: Dayton (DAY), Syracuse (SYR), San Jose (SJC), Reno (RNO), and San Diego (SAN). This "M&A" sample consists of the airport hub closures that could be definitively said to have occurred solely a result of M&A activity. All samples include "airport potential" airports which do not affect estimation of the coefficient on the dependent variable, but (may) improve efficiency. All standard errors clustered at the CZ level.

Table A.9: Results - Panel Regressions - Payroll

	All Hubs ($n = 26$)				Major Airline (n =22)	M&A ($n = 5$)
Dependent Variable/Sample:	(1)	(2)	(3)	(4)	(5)	(6)
Log Total Payroll	0.335**	0.042	0.050	0.016	0.009	0.006
	(0.159)	(0.040)	(0.041)	(0.015)	(0.017)	(0.020)
R^2	0.610	0.978	0.979	0.996	0.995	0.995
Log Tradable Payroll	0.215*	0.010	0.046	-0.022	-0.075*	-0.118
	(0.113)	(0.060)	(0.056)	(0.042)	(0.044)	(0.071)
R^2	0.771	0.896	0.953	0.927	0.927	0.927
Log Nontradable Payroll	0.388**	0.036	0.042	0.015	-0.002	0.005
	(0.187)	(0.031)	(0.032)	(0.018)	(0.028)	(0.028)
R^2	0.512	0.983	0.984	0.993	0.993	0.993
Log Air Travel Payroll	0.752****	0.428****	0.432****	0.295***	0.234**	0.478****
	(0.152)	(0.083)	(0.087)	(0.099)	(0.107)	(0.108)
R^2	0.658	0.857	0.861	0.894	0.893	0.893
Log Hotels and Lodging Payroll	0.425**	0.137*	0.140*	0.121***	0.072*	0.102*
	(0.177)	(0.070)	(0.072)	(0.036)	(0.037)	(0.059)
R^2	0.678	0.951	0.953	0.972	0.972	0.972
Log Amusements and Recreation Payroll	0.359	-0.051	-0.016	-0.067*	-0.090**	-0.145**
	(0.239)	(0.044)	(0.050)	(0.035)	(0.035)	(0.065)
R^2	0.460	0.948	0.954	0.977	0.977	0.977
n	1680	1680	1680	1680	1680	1680
CZ (Airport) Fixed Effects	Y	Y	Y	Y	Y	Y
Time Trend (Linear and Quadratic)	N	Y	N	Y	Y	Y
Year FE	N	N	Y	N	N	N
City-Specific Trends	N	N	N	Y	Y	Y

Cluster robust standard errors in parentheses, clustered at the commuting zone (airport) level.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

This table presents results from various specifications of OLS regressions run on the panel dataset, specifically, the estimated effect of having a hub on the dependent variable shown within a given sample group of hub airports. Specifications 1-4 present results for the entire sample considered in the analysis. Specification (1) includes only commuting zone (CZ)/airport level fixed effects. Specification (2) adds a time trend. Specification (3) substitutes a year fixed effect for the time trend. While year fixed effects would be preferable in the final specification (4), limitations on the degrees of freedom make this impossible. Hence, Specification (4), the preferred specification, accounts for CZ/airport fixed effects, time trends, and city-specific time trends. The reader may compare the results in specifications (2) and (3) to confirm the reasonableness of this choice. Specification (5) repeats specification (4), but restricted to the sample of hub airports that were served by an airline which would eventually be folded into a "major" airline family (American, Delta, or United). Specification (6) repeats specification (4), but for a specially selected set of five airports: Dayton (DAY), Syracuse (SYR), San Jose (SJC), Reno (RNO), and San Diego (SAN). This "M&A" sample consists of the airport hub closures that could be definitively said to have occurred solely a result of M&A activity. All samples include "airport potential" airports which do not affect estimation of the coefficient on the dependent variable, but (may) improve efficiency. Tradable sector payroll is defined as the sum of mining, manufacturing, and wholesale trade payroll. Non-tradable sector payroll is defined as the sum of construction, retail trade, finance, insurance and real estate, and services payroll. All standard errors clustered at the CZ level.

Table A.10: Results - Panel Regressions - Sectoral Payroll

	All Hubs (n = 26)				Major Airline (n =22)	M&A (n = 5)
Dependent Variable/Sample:	(1)	(2)	(3)	(4)	(5)	(6)
Log Manufacturing Payroll	0.272***	0.043	0.040	0.035	0.031	-0.017
	(0.085)	(0.052)	(0.054)	(0.029)	(0.025)	(0.027)
n	1632	1632	1632	1632	1632	1632
R^2	0.888	0.957	0.959	0.988	0.988	0.988
Log Wholesale Trade Payroll	0.307*	0.019	0.019	0.034**	0.025	0.020*
	(0.158)	(0.062)	(0.064)	(0.017)	(0.025)	(0.012)
n	1680	1680	1680	1680	1680	1680
R^2	0.675	0.957	0.958	0.990	0.990	0.990
Log Retail Trade Payroll	0.290**	0.029	0.028	0.014	0.030	0.004
	(0.130)	(0.031)	(0.032)	(0.016)	(0.018)	(0.034)
n	1680	1680	1680	1680	1680	1680
R^2	0.619	0.977	0.978	0.995	0.995	0.995
Log Finance/Insurance/Real Estate Payroll	0.406**	0.063	0.070	0.001	-0.024	0.014
	(0.196)	(0.044)	(0.042)	(0.036)	(0.046)	(0.056)
n	1680	1680	1680	1680	1680	1680
R^2	0.566	0.969	0.972	0.981	0.981	0.981
Log Services Payroll	0.455**	0.011	0.012	-0.001	0.008	-0.018
	(0.217)	(0.031)	(0.031)	(0.012)	(0.011)	(0.018)
n	1680	1680	1680	1680	1680	1680
R^2	0.450	0.988	0.988	0.998	0.998	0.998
CZ (Airport) Fixed Effects	Y	Y	Y	Y	Y	Y
Time Trend (Linear and Quadratic)	N	Y	N	Y	Y	Y
Year FE	N	N	Y	N	N	N
City-Specific Trends	N	N	N	Y	Y	Y

Cluster robust standard errors in parentheses, clustered at the commuting zone (airport) level.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

This table presents results from various specifications of OLS regressions run on the panel dataset, specifically, the estimated effect of having a hub on the dependent variable shown within a given sample group of hub airports. Specifications 1-4 present results for the entire sample considered in the analysis. Specification (1) includes only commuting zone (CZ)/airport level fixed effects. Specification (2) adds a time trend. Specification (3) substitutes a year fixed effect for the time trend. While year fixed effects would be preferable in the final specification (4), limitations on the degrees of freedom make this impossible. Hence, Specification (4), the preferred specification, accounts for CZ/airport fixed effects, time trends, and city-specific time trends. The reader may compare the results in specifications (2) and (3) to confirm the reasonableness of this choice. Specification (5) repeats specification (4), but restricted to the sample of hub airports that were served by an airline which would eventually be folded into a "major" airline family (American, Delta, or United). Specification (6) repeats specification (4), but for a specially selected set of five airports: Dayton (DAY), Syracuse (SYR), San Jose (SJC), Reno (RNO), and San Diego (SAN). This "M&A" sample consists of the airport hub closures that could be definitively said to have occurred solely a result of M&A activity. All samples include "airport potential" airports which do not affect estimation of the coefficient on the dependent variable, but (may) improve efficiency. All standard errors clustered at the CZ level.

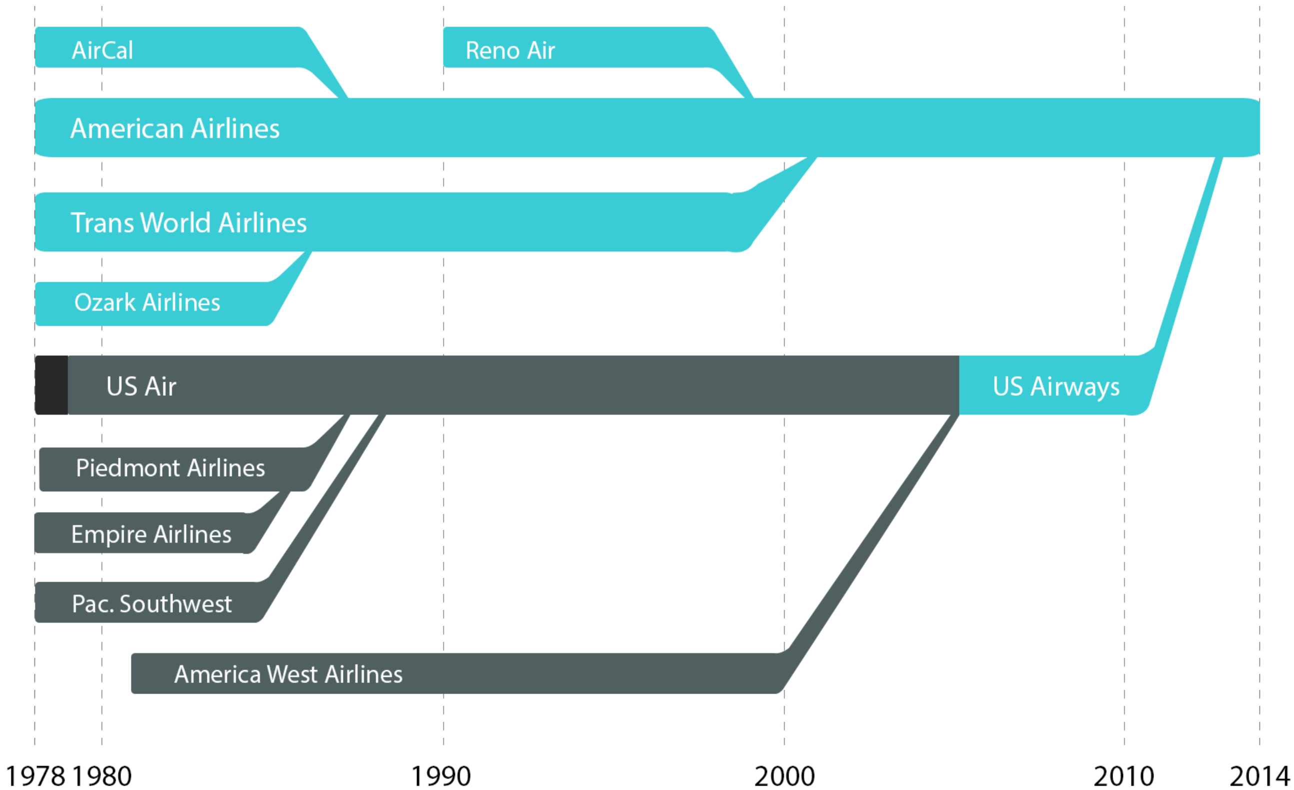
Table A.11: Results - Panel Regressions - Employment Shares and Affected Industry Wages Per Worker

	All Hubs (n = 26)				Major Airline (n =22)	M&A (n = 5)
Dependent Variable/Sample:	(1)	(2)	(3)	(4)	(5)	(6)
Log Share Tradable Employment	-0.122*	-0.038	-0.003	-0.044	-0.084**	-0.091
	(0.063)	(0.032)	(0.021)	(0.035)	(0.036)	(0.059)
n	1680	1680	1680	1680	1680	1680
R^2	0.375	0.667	0.950	0.691	0.692	0.691
Log Share Nontradable Employment	0.038*	-0.007	-0.009	-0.002	0.008	0.003
	(0.021)	(0.008)	(0.008)	(0.005)	(0.005)	(0.008)
n	1680	1680	1680	1680	1680	1680
R^2	0.479	0.903	0.913	0.970	0.970	0.970
Log Payroll Per Worker - Air Travel Sector	0.090	0.070*	0.052	0.063	0.053	0.143***
	(0.061)	(0.038)	(0.038)	(0.043)	(0.045)	(0.045)
n	1678	1678	1678	1678	1678	1678
R^2	0.130	0.326	0.364	0.398	0.398	0.399
Log Payroll Per Worker - Hotels and Lodging	0.228*	0.041**	0.044**	0.028*	-0.008	0.043***
	(0.115)	(0.019)	(0.019)	(0.014)	(0.016)	(0.011)
n	1680	1680	1680	1680	1680	1680
R^2	0.138	0.914	0.920	0.930	0.930	0.930
CZ (Airport) Fixed Effects	Y	Y	Y	Y	Y	Y
Time Trend (Linear and Quadratic)	N	Y	N	Y	Y	Y
Year FE	N	N	Y	N	N	N
City-Specific Trends	N	N	N	Y	Y	Y

Cluster robust standard errors in parentheses, clustered at the commuting zone (airport) level.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

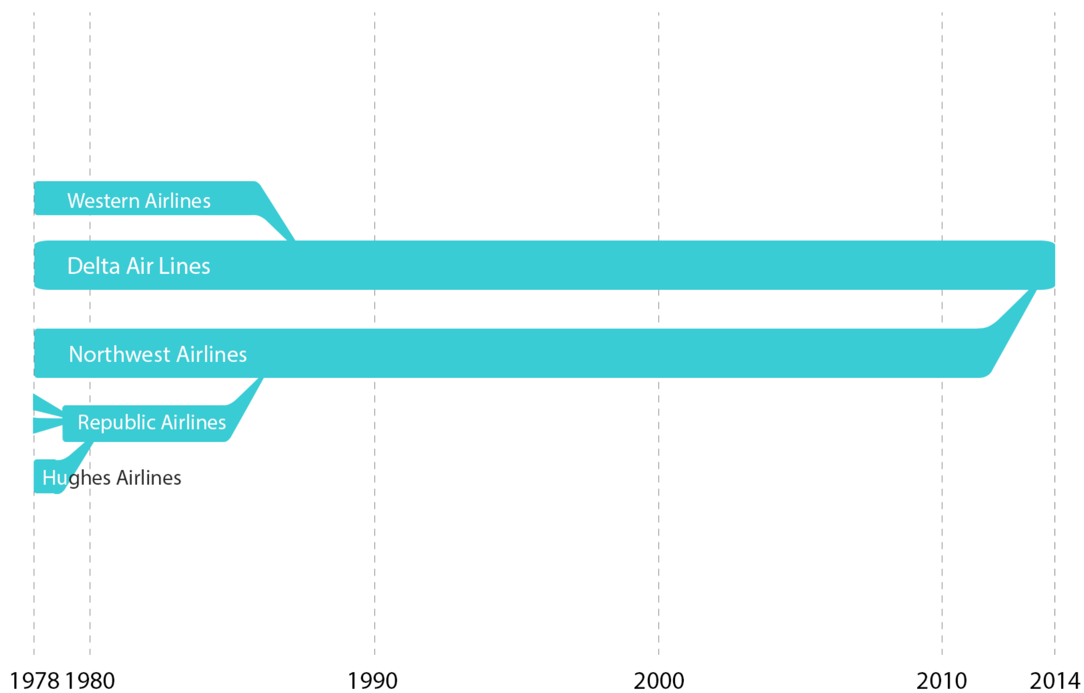
This table presents results from various specifications of OLS regressions run on the panel dataset, specifically, the estimated effect of having a hub on the dependent variable shown within a given sample group of hub airports. Specifications 1-4 present results for the entire sample considered in the analysis. Specification (1) includes only commuting zone (CZ)/airport level fixed effects. Specification (2) adds a time trend. Specification (3) substitutes a year fixed effect for the time trend. While year fixed effects would be preferable in the final specification (4), limitations on the degrees of freedom make this impossible. Hence, Specification (4), the preferred specification, accounts for CZ/airport fixed effects, time trends, and city-specific time trends. The reader may compare the results in specifications (2) and (3) to confirm the reasonableness of this choice. Specification (5) repeats specification (4), but restricted to the sample of hub airports that were served by an airline which would eventually be folded into a "major" airline family (American, Delta, or United). Specification (6) repeats specification (4), but for a specially selected set of five airports: Dayton (DAY), Syracuse (SYR), San Jose (SJC), Reno (RNO), and San Diego (SAN). This "M&A" sample consists of the airport hub closures that could be definitively said to have occurred solely a result of M&A activity. All samples include "airport potential" airports which do not affect estimation of the coefficient on the dependent variable, but (may) improve efficiency. All standard errors clustered at the CZ level.

Figure A.2: Airline Genealogy: American



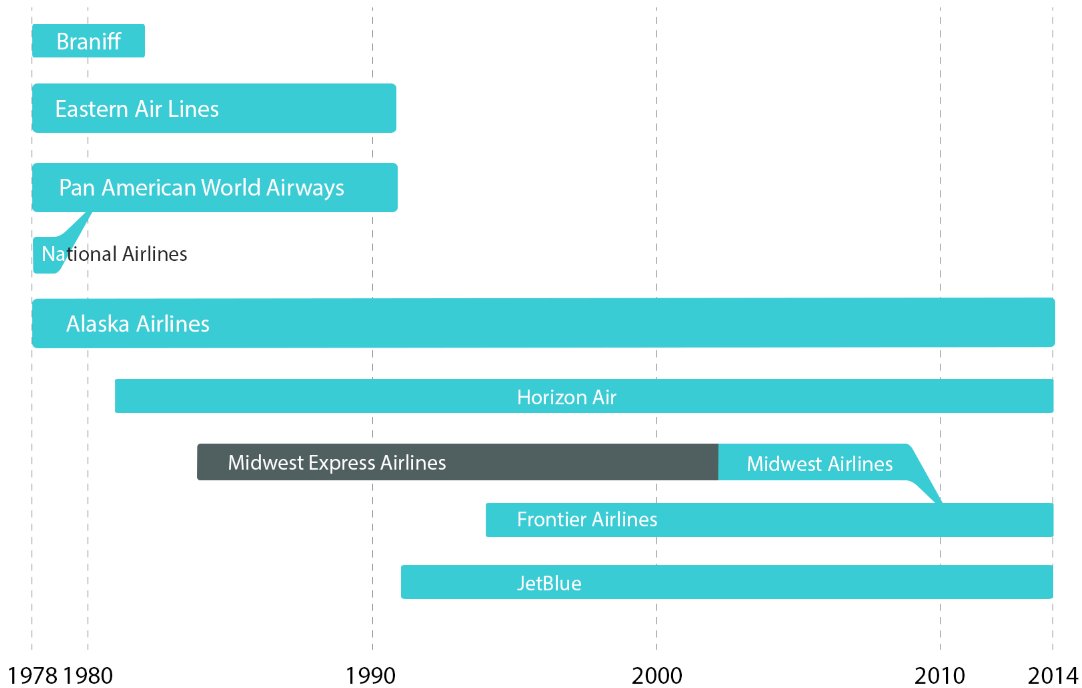
Shading corresponds to the eventual airline predecessor airlines would merge into.

Figure A.3: Airline Genealogy: Delta



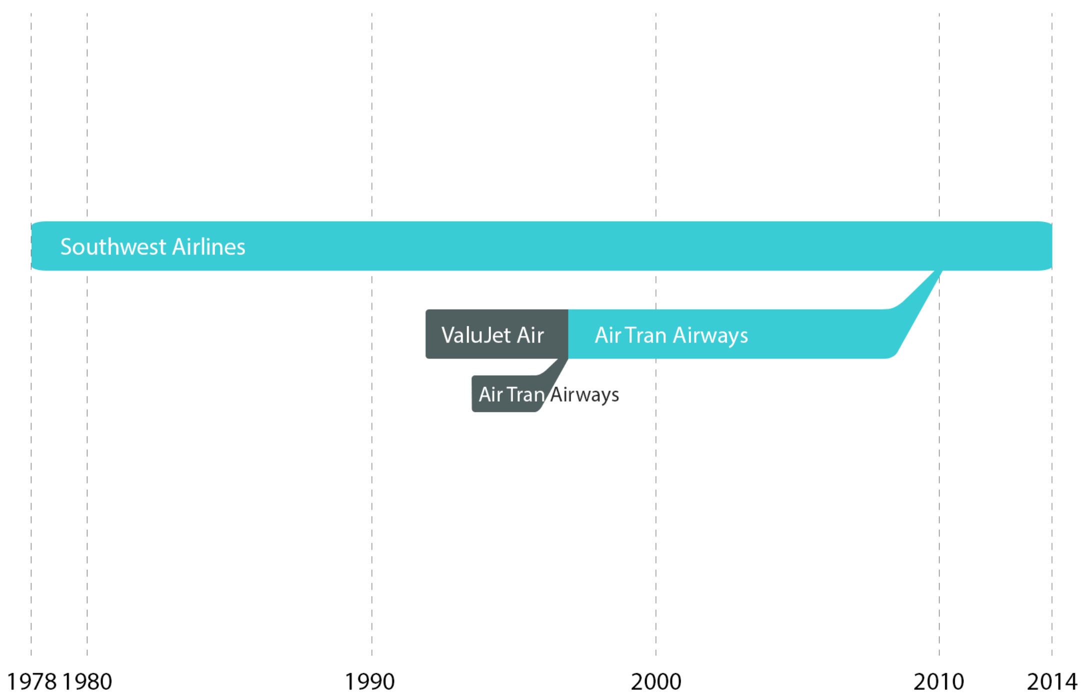
Shading corresponds to the eventual airline predecessor airlines would merge into.

Figure A.4: Airline Genealogy: Other Airlines



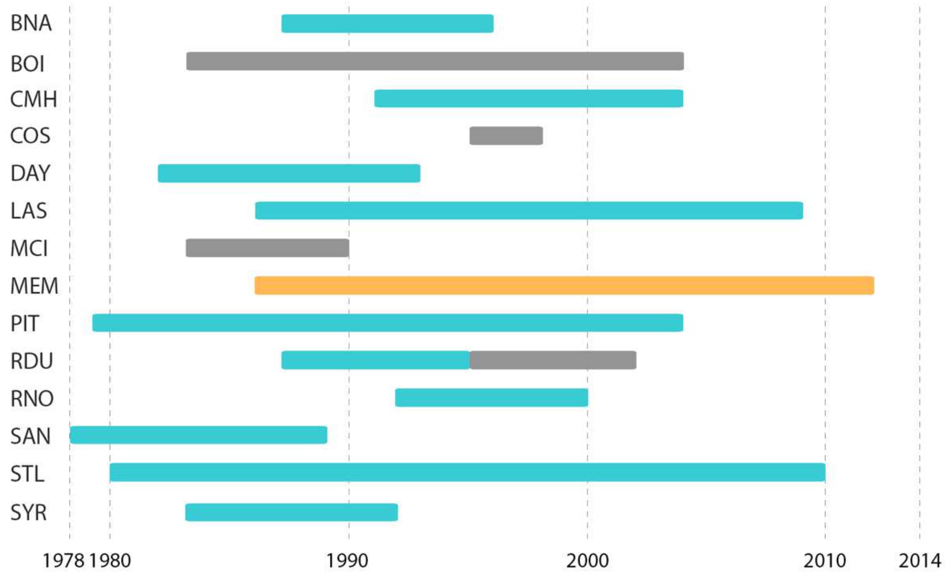
Shading correstponds to the eventual airline individual airports would merge into.

Figure A.5: Airline Genealogy: Southwest Airlines



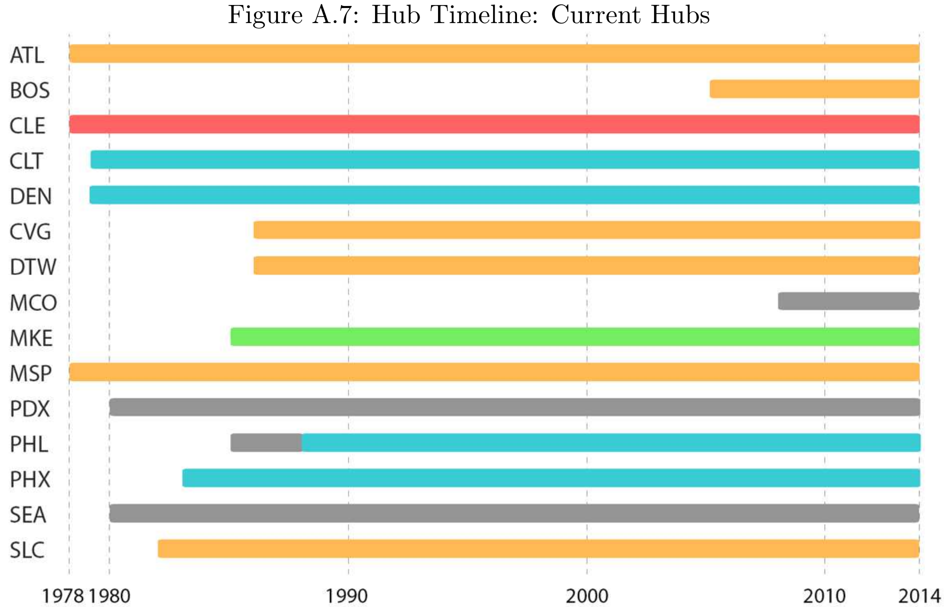
Shading correstponds to the eventual airline individual airports would merge into.

Figure A.6: Hub Timeline: Former Hubs



Orange: Delta | Red: United | Blue: American | Lt. Grey: Other

Figure A.7: Hub Timeline: Current Hubs



Orange: Delta | Red: United | Blue: American | Lt. Grey: Other

Figure A.8: Hub Opening Event Study: Effects on Airport

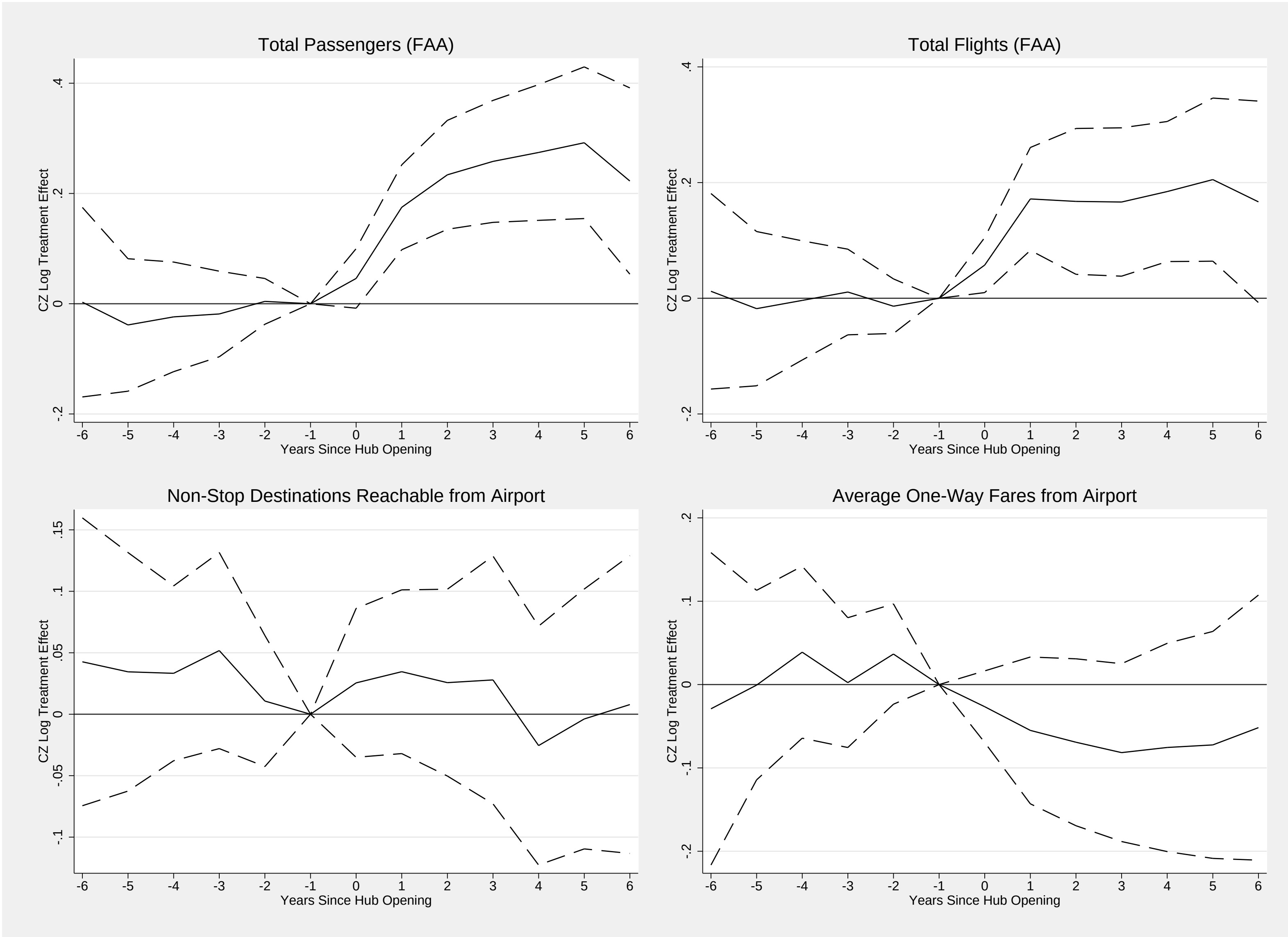


Figure shows event study outcomes on the quantities indicated above. Event studies include airport (city) and year fixed effects, as well as city specific trends. Standard errors are clustered at the city level. Dotted lines indicate 95 percent confidence intervals.

Figure A.9: Hub Opening Event Study: Employment

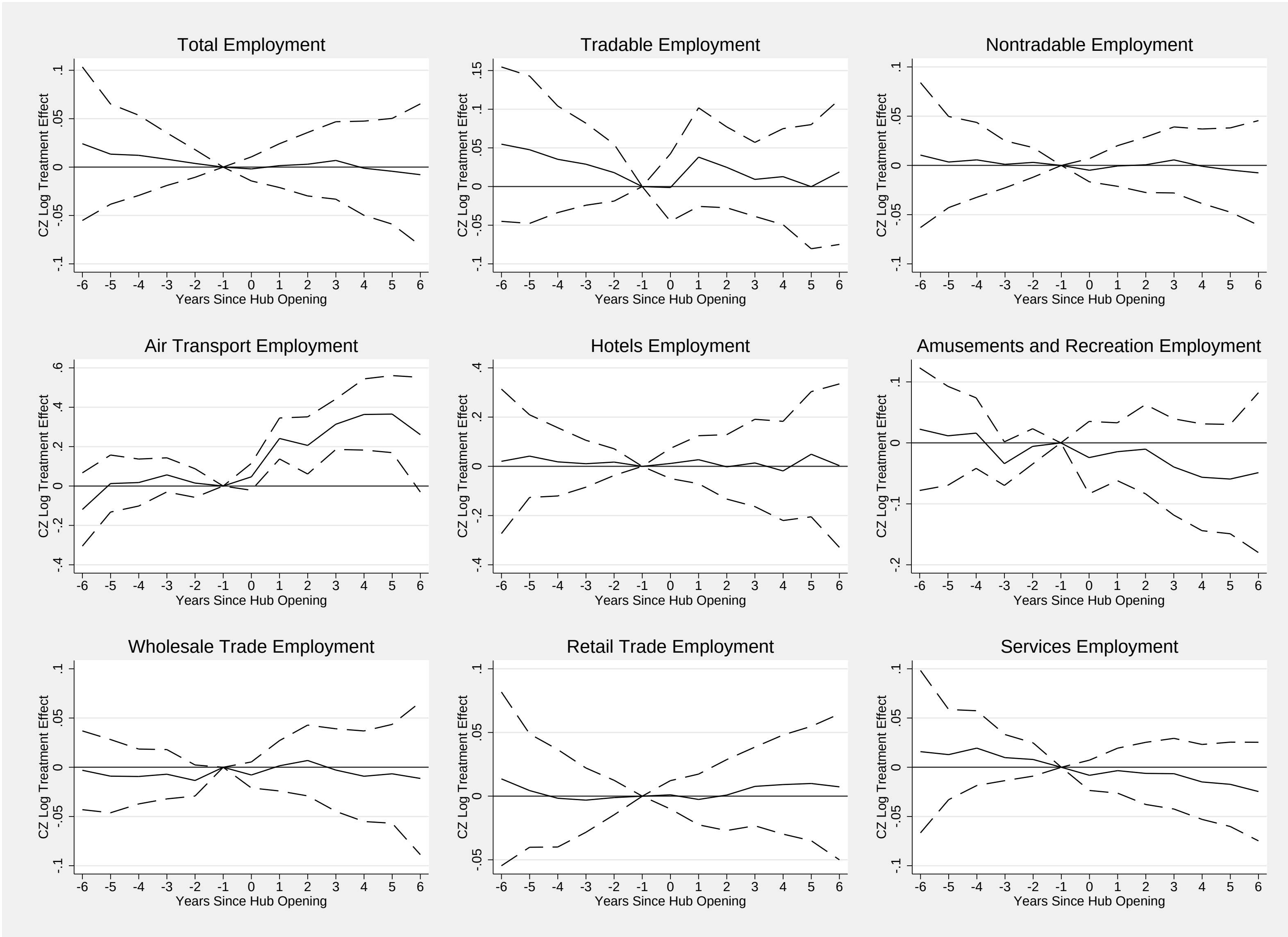


Figure shows event study outcomes on the quantities indicated above. Event studies include airport (city) and year fixed effects, as well as city specific trends. Standard errors are clustered at the city level. Dotted lines indicate 95 percent confidence intervals.

Figure A.10: Hub Opening Event Study: Establishments

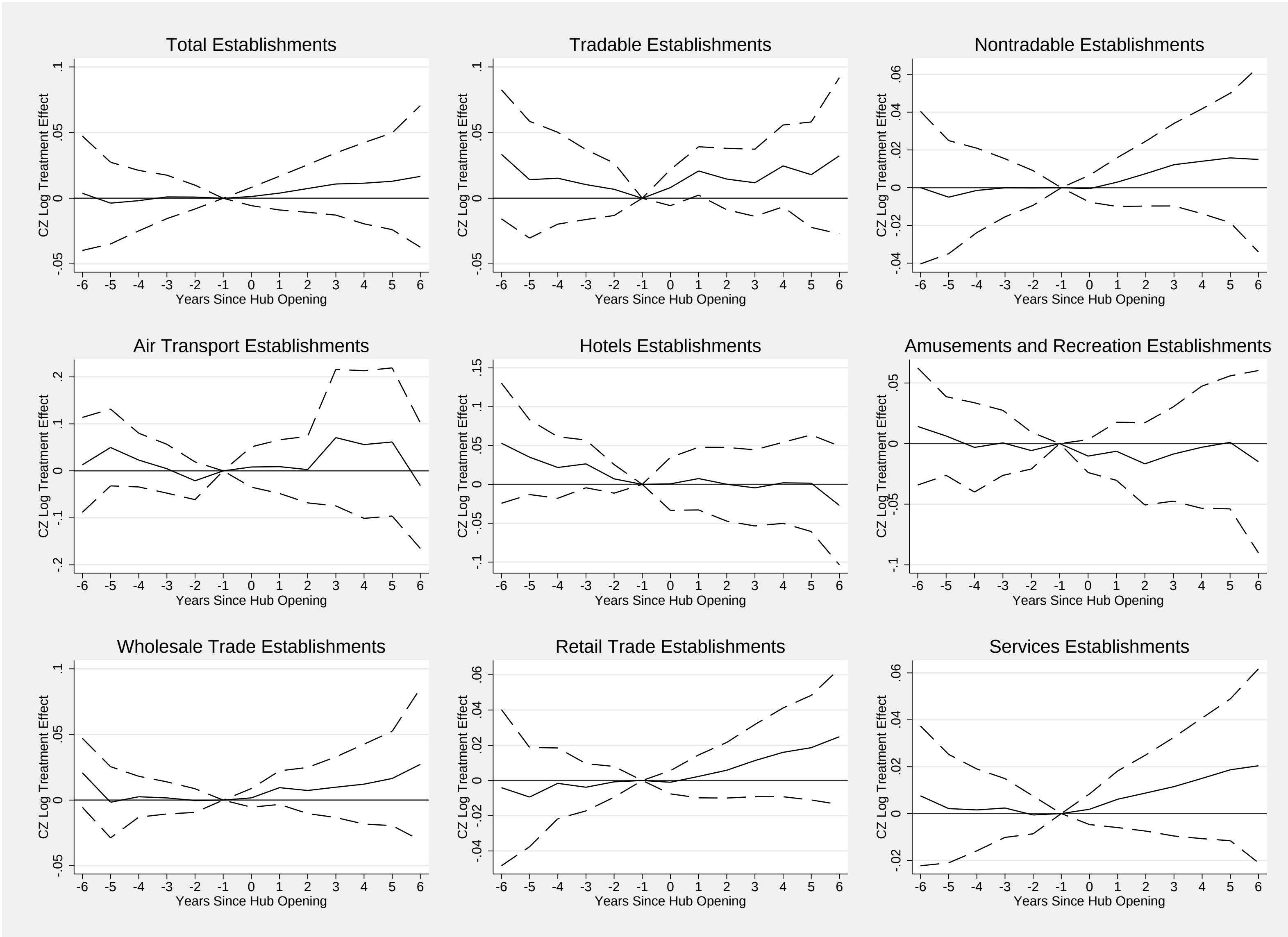


Figure shows event study outcomes on the quantities indicated above. Event studies include airport (city) and year fixed effects, as well as city specific trends. Standard errors are clustered at the city level. Dotted lines indicate 95 percent confidence intervals.

Figure A.11: Hub Opening Event Study: Payroll and Wages

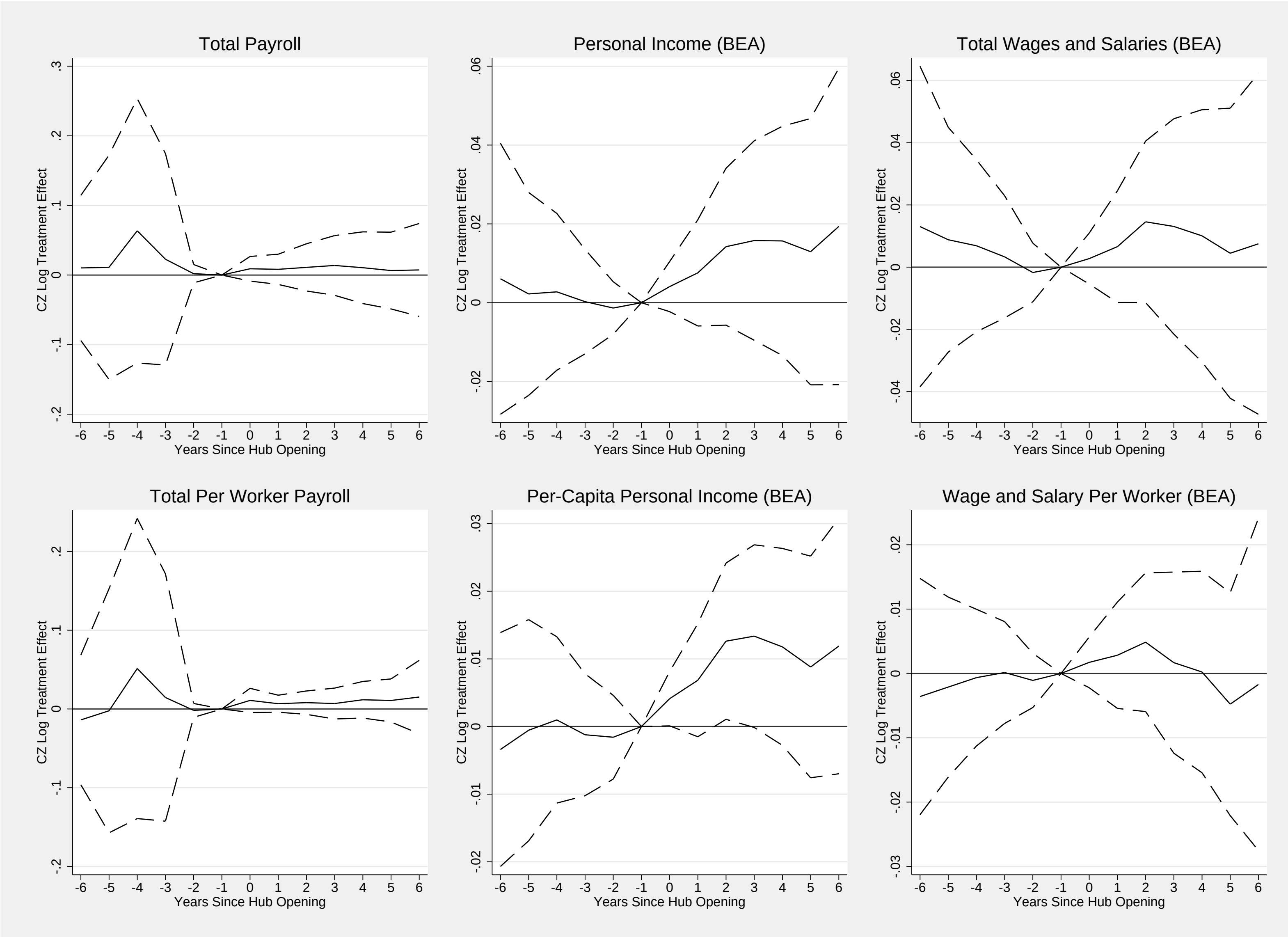


Figure shows event study outcomes on the quantities indicated above. Event studies include airport (city) and year fixed effects, as well as city specific trends. Standard errors are clustered at the city level. Dotted lines indicate 95 percent confidence intervals.

Figure A.12: Hub Closing Event Study: Effects on Airport

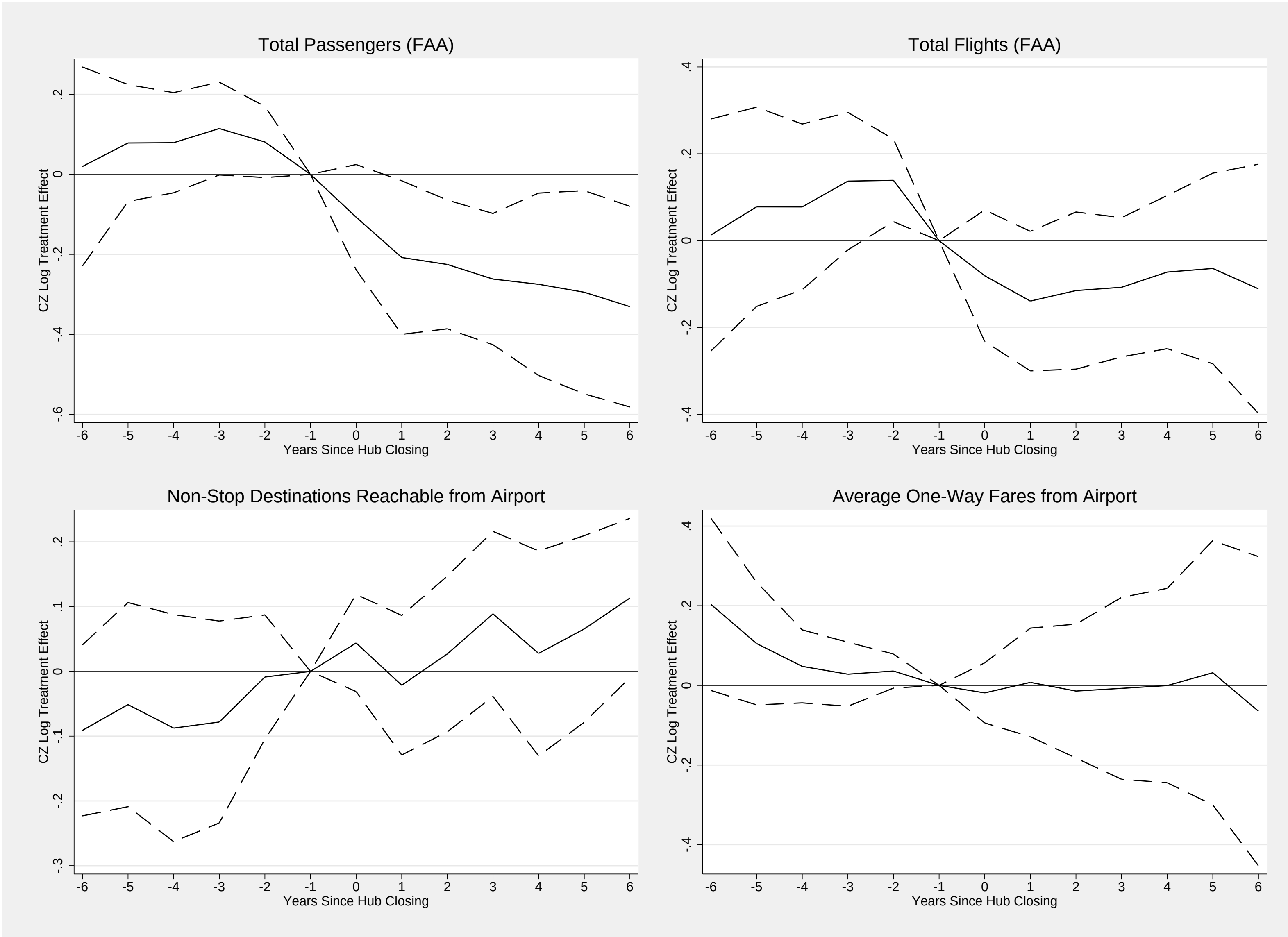


Figure shows event study outcomes on the quantities indicated above. Event studies include airport (city) and year fixed effects, as well as city specific trends. Standard errors are clustered at the city level. Dotted lines indicate 95 percent confidence intervals.