Causal Effect of Airport Hubs on Urban Growth

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November 8, 2015

Abstract

This paper considers the marginal effect of an airport hub on a metropolitan area's economy. Specifically, it considers the effect of an airport being designated as a "hub" by an airline on its cities economic fortunes. This is estimated relative to cities that have airports, but not hub airports. Using panel regression methods and event study techniques, I find that while hub airports do not significantly affect city employment levels overall, hubs do contribute an effect of 1-2 percent on personal income to their respective cities, as well as establishment growth of 1-2 percent. I find the effects of hubs on employment to be most salient in the air transportation and hotel industries, as well as overall closest to the airport; however, the same is not necessarily true for other sectors where tourism might affect employment. This implies that the effects of hub airports, in most cases, likely operate through their ability to facilitate 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. With recent changes to the system, cities such as St. Louis, Memphis, Cleveland, and to a lesser extent, Cincinnati, all have experienced hub closures as a result of merger reorganizations. While the popular press has made much of the potential harm these losses might cause on their local communities, to date little empirical research has been conducted to substantiate those claims. The purpose of this paper is to fill that void, and, by extension, use these semi-exogenous changes to service to examine the effect that hub airports have on their economies, over and above those of a typical non-hub airport.

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 – for example, there were seven hubs from seven hubs in 1979 and 14 hubs in 2012. However, in peak-hub

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

periods, there were 24 hubs in 1988 and an average of 22 hubs through the 1980s and 1990s.

Using panel regression and event-study techniques, I show that airline hub airports do have a causal effect on city economic outcomes. Namely, I show that hubs increase personal income and establishment counts by 2 to 3 percent, with virtually all of the growth in establishments in the non-traded sector. I also show that positive employment outcomes are limited mostly to related industries, such as air travel and hotels and lodging. The effect of hubs on a city's employment is estimated to be practically zero. However, hub airports do create spillovers on employment overall within a 3 to 7 mile radius of the hub. These effects operate through the changes in air traffic, especially through a variety of frequent flights offered, many non-stop.

The rest of this paper proceeds as follows: Section 2 reviews the literature on air hubs and provides some background. Section 3 presents a basic model of hub formation. Section 4 presents case studies to illustrate how a hub might affect a local economy in practice. Section 5 provides information about the data, section 6 presents the results and discussion, and section 7 concludes.

2 Background

Airports in general have been shown to be important contributors to the health of their local economies. As I showed in Chapter 1, cities with airports grew, on average, 0.5 percent per year more since 1950 than cities without one. 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. However, this finding relies on 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 documentation, an airline considers a particular airport to be a hub in a particular year, then it will count as a hub for the purposes of this paper. This paper will utilize the salient features of a hub - large, located primarily based on airline sunk costs and operational needs, and operated for the sake of maximizing airport profit, not local city outcomes - to study the effect of hub closings and openings on economic development in hub cities. This

[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 help to provide credible causal evidence on the relationship between an airport hub and local economic development.

3 Conceptual Framework

To better understand the effect that a hub may have on a local economy, and to clarify the mechanisms through which those effects might occur, I adapt a model of hub location from Redding et al. (2011), and modify it to account for two distinct types of travelers: connecting passengers and terminating passengers.

As in Redding et al. (2011), consider a model with three locations or cities. A monopoly airline would have the choice to fly point-to-point (bi-directional flights from point A to B, B to C, and C to A), or to offer flights with a hub. For example if C becomes the hub, then there would be flights from A to C and B to C. Passengers who wanted to travel between A and B would have to connect at point C. Intuitively, the airline now requires one fewer set of flights to serve all its customers, but would have to incur the fixed costs F of establishing and maintaining a hub. Additionally, there would be inconvenience to passengers traveling between points A and C relative to the point-to-point system, meaning that discounts would be offered on connecting itineraries to compensate them for their inconvenience. Profitability would determine the airline's choice; that is if $\pi_H = R-(F+D) > \pi_{PP}$, where π_H is the airline's profit under the hub system, R is revenue generated, and π_{PP} is that under the point-to-point system, then the airline will choose the hub system.

Suppose an airline now has to choose between various locations for a hub. In this setup, the choice of city A, B, or C is purely due to factors that comprise F and D. Given the demand for travel, airlines face a downward sloping demand curve for travel between each pair of cities. As shown in Redding et al. (2010), this demand is a function of opportunities for passengers to consume nontraded goods in the destination city, say, for example, by renting a hotel room or performing business transactions over a meeting, or a visit to a tourist destination and travel costs. The airline's goal in hub placement, however, is not to necessarily place the hub in the most desirable locations from a passenger's perspective. Of course, an airline will do so if profits are maximized in such a setup, but in general it is most profitable to establish hubs in a variety of cities, that based on characteristics of the airline's network, will minimize F and D. Hence, hub location is not a function of local demand factors, but rather, network-wide cost minimization properties.

Now suppose there are two airlines - West and East. Both are monopoly airlines that have located their hubs in such a way as to minimize cost. The airlines decide to merge (or, without loss of generality, one buys the other). Due to newly realized network synergies, certain hubs will no longer be required. Hence, it will be profitable for the airline to close certain hubs. The loss of the hub, in this model, is entirely due to airline profitability and not to local labor market conditions. Will this loss affect the local economy? Not necessarily. Spillovers from the hub depend on both aggregate passenger traffic levels and the percentage of passengers whose final destination is the hub airport city. The first type would affect air travel employment, and potentially, hotels and lodging employment, if such a hub requires itineraries with layovers. Thus, the expectation is that employment in those sectors would correlate most strongly with the increased passenger traffic that hubs bring. Other jobs within close vicinity of the airport would also follow the same pattern.

The hub's effect on the local economy, however, is an entirely different story. If passengers are connecting, then they do not consume any nontraded goods in the connecting city. In fact, only the share of destination passengers, α, would be relevant. Empirical estimates of connecting passengers $(1 - \alpha)$ range from a low of 10 percent to a high of 80 percent, with a median of around 60 percent in 2000 (Lee and Luengo-Prado, 2005). For reference, roughly 10 percent of passengers traveling through a non-hub airport connect. It is thus entirely possible that, depending on the actual traffic levels, a city may benefit more from a non-hub airport than a hub airport, or that the relative benefits would be roughly equalized. Which of these ultimately is the case is an entirely empirical question, and is the subject of the analysis to follow.

4 Case Studies

This section presents four case studies of hub airports and their effects on their local economies: St. Louis, Cincinnati, Charlotte, and Dayton. The four airports were selected to illustrate the diversity of mechanisms through which a hub may influence local economic activity.

4.1 Lambert-St. Louis Airport (STL)

Since the late 1920's, Transcontinental and Western Airlines (TWA) was associated with the St. Louis airport (STL) in some capacity. Ozark Airlines, a rising regional player, began serving St. Louis in 1950. The Airline Deregulation Act of 1978 gave TWA power to expand, and its ties with STL for over 50 years led the airline to establish St. Louis as its main hub. With a duopoly at St. Louis with more than 80 percent of its traffic, TWA and Ozark Airlines, a regional airline operating out of STL, merged in 1986 – a year after Southwest entered the market. During the 1990s, TWA's financial situation worsened, leading it to file for bankruptcy three times: 1993, 1995, and 2001, when American Airlines purchased it. By 2003, American had halved more than 400 of STL's daily flights, and gradually reduced flights until it retired the hub in 2010. Once the prominent name in American aviation history, STL was turned into a regional airport dominated by Southwest almost as fast as it became hub (Harty, 2014). By 2010, non-stop market access had been halved.

Figure 1 provides information on employment in the St. Louis metropolitan area. The first signs of trouble began to appear around 1999, when rumors of the TWA and American merger began circulating. Interestingly, this anticipatory decline in employment was most noticeable within a 10-mile radius of the airport. There was virtually no effect on metropolitan area employment. Aviation sector employment decreased, but the hotel industry boomed until 2004. Moreover, only a couple Fortune 500 firms left the area as a result. In all cases, the declines in employment were small. While the metropolitan area emerged relatively unscathed, jobs were lost in the immediate vicinity of the airport. Within 5 miles of the airport, the second significant drop in employment rate started around 2007, as American gradually downsized St. Louis. By 2010, the job losses would continue, but at a much slower rate. In all cases, it appears the adjustment process was rapid; there is little evidence of a lag between the loss of hub traffic and employment levels.

4.2 Cincinnati/N. Kentucky International Airport (CVG)

Trends in aviation changed the airline industry in many ways after the events of September 11th. As passenger traffic was down overall, Delta made the decision to downsize Cincinnati/Northern Kentucky International Airport (CVG). By the end of 2005, CVG had lost 30 percent of its flights, half its passenger traffic and one third of its jobs (Pilcher, 2010). After Delta's merger with Northwest Airlines in 2008, the situation became more dire. Officially, Cincinnati still remains a Delta hub, but in practical terms it has essentially been de-hubbed.[3]

Turning to Figure 2, it becomes clear that passenger traffic has been steadily increasing, while flight traffic peaked in the late 1990s. Much of that peak was due to increased service for the Summer Olympics, which took place in Atlanta in 1996.[4] The 2005 downsizing resulted in a sizable decrease in market access, with a 40 percent reduction in non-stop destination access. While there were some decreases in employment near the airport, those were in the 5 to 10 percent range. Metropolitan area employment dropped from its peak but by no more than 10 percent, and even rebounded after the first round of service cuts, until the Great Recession occurred in 2008. There was a marked decline in air travel sector employment. Additionally, up to four Fortune 1000 firms had closed their headquarters by 2014, though those firms had headquarters located more than 20 miles from the airport. Compared to St. Louis, which lost its hub status and subsequently rebounded, it does not appear that CVG's continued designation as a "hub" will be as beneficial to the fortunes of Cincinnati as might otherwise be believed.

[3]To be clear, however, for this analysis, CVG is still considered an open hub as of 2012.
[4]Atlanta is Delta's largest hub. Connecting traffic accounted for the increase in CVG's traffic.

Figure 1: Case Study: St. Louis Area Airport Employment

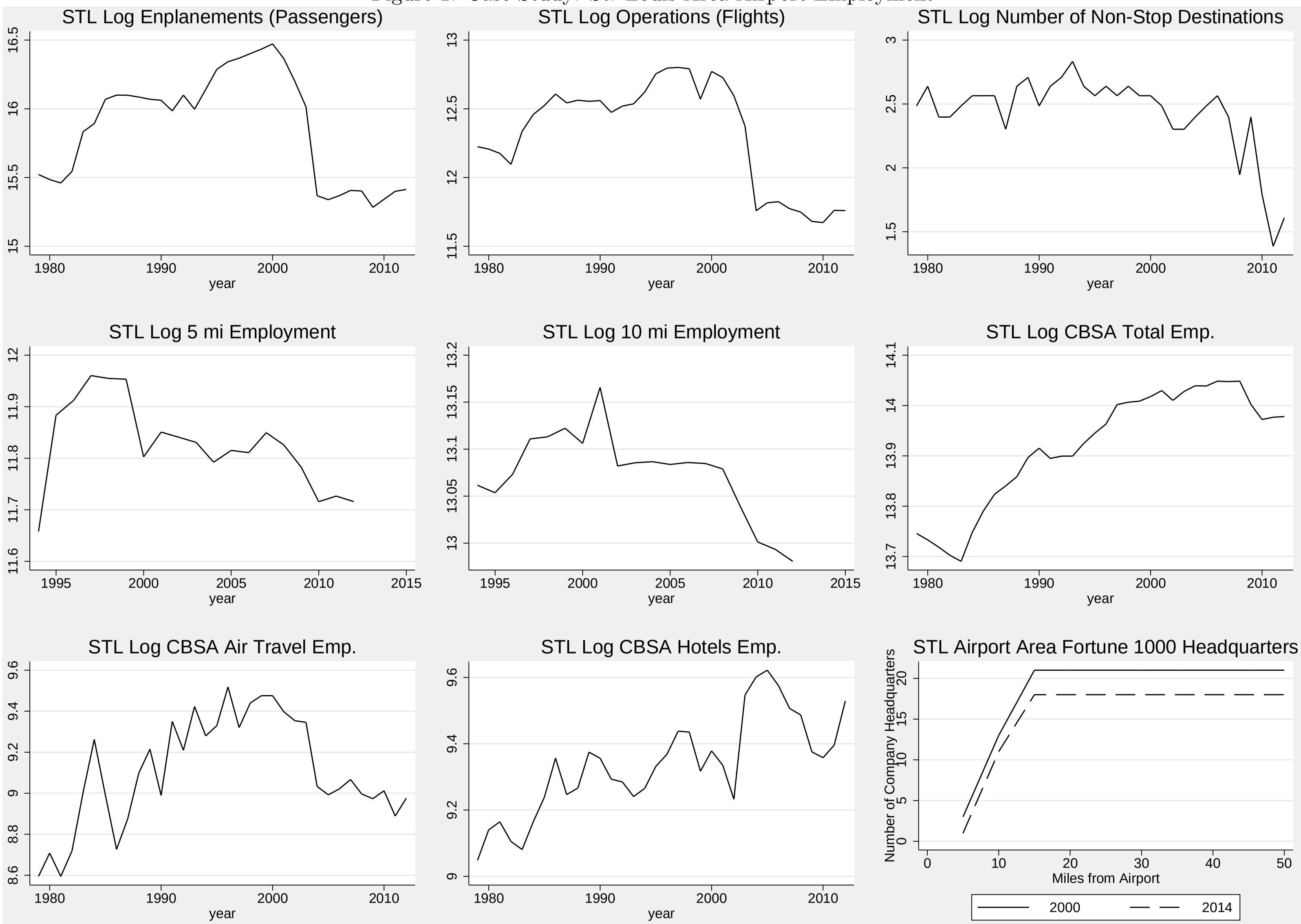
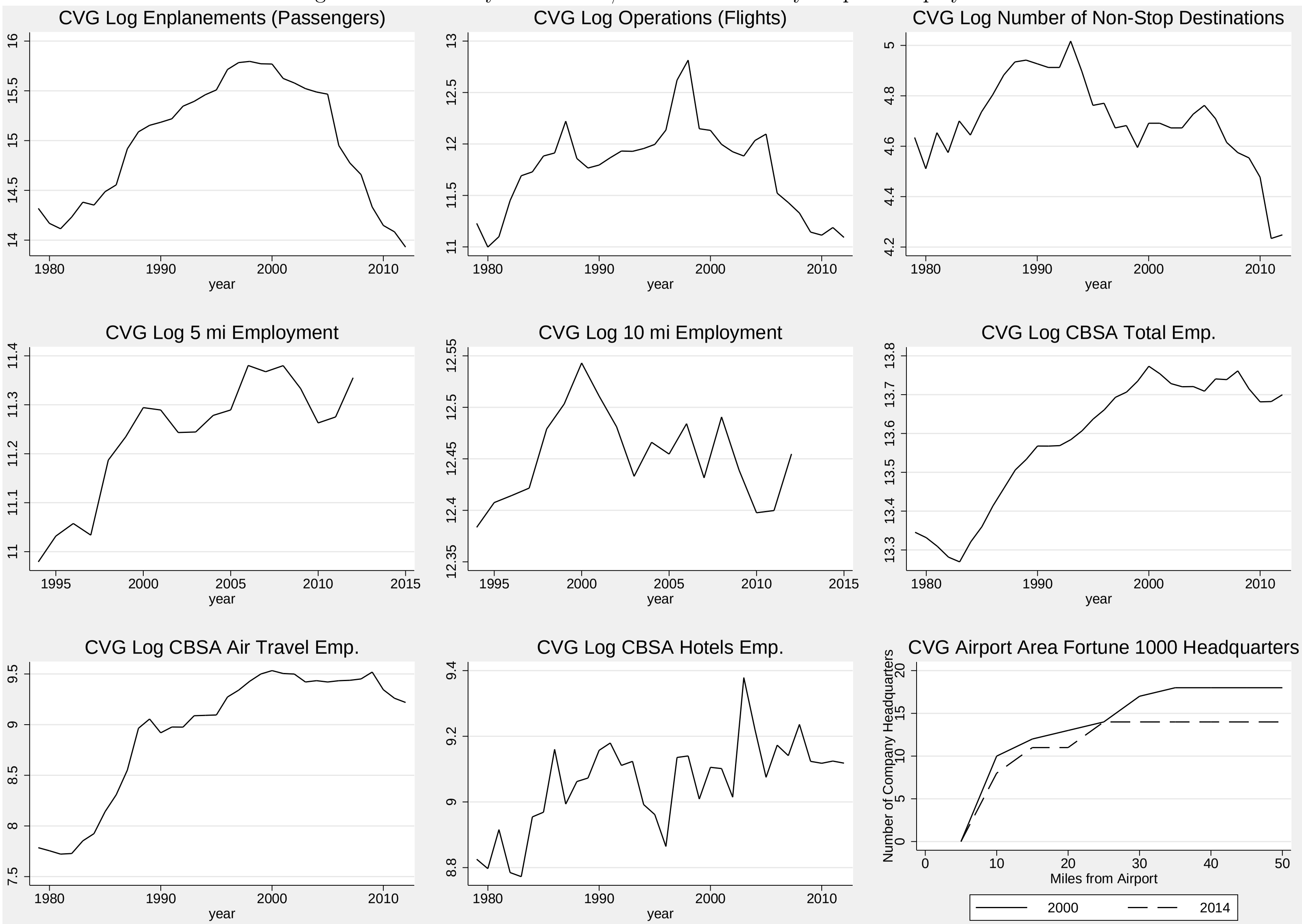


Figure 2: Case Study: Cincinnati/Northern Kentucky Airport Employment



4.3 Charlotte-Douglas International Airport (CLT)

While the CVG case indicated that simply labeling an airport a "hub" will not improve an economy's fortunes, especially in the absence of the necessary service, the Charlotte case illustrates that becoming a hub can, in some cases, be transformative. Just after deregulation, Piedmont Airlines needed a hub to expand its network, and the prospering city of Charlotte was its first choice. Dubbed "the city deregulation built", usage of Charlotte's airport facilities went from 7 percent to 79 percent within six years (Eller, 2008).

In 1989, Piedmont Airlines merged with US Air. US Air would continue to grow the hub. CLT survived and thrived, even after American West Airlines acquired US Airways in 2005. Five years later, CLT was US Airways' largest hub.[5] The most recent merger in Charlotte Douglas' history was in 2013 between American Airlines and US Airways (McLaughlin and Zajac, 2014). For now, CLT remains a major hub in the American air transportation industry. On all metrics considered in Figure 3, it is clear that CLT has had a large impact on its local economy. Of the case studies considered so far, it has retained much of its non-stop market access, and clearly has retained virtually all its passenger traffic. It is also the only case considered thus far that has gained Fortune 1000 company headquarters between 2000 and 2014. The lesson here is that for some cities, hubs can be a transformative force.

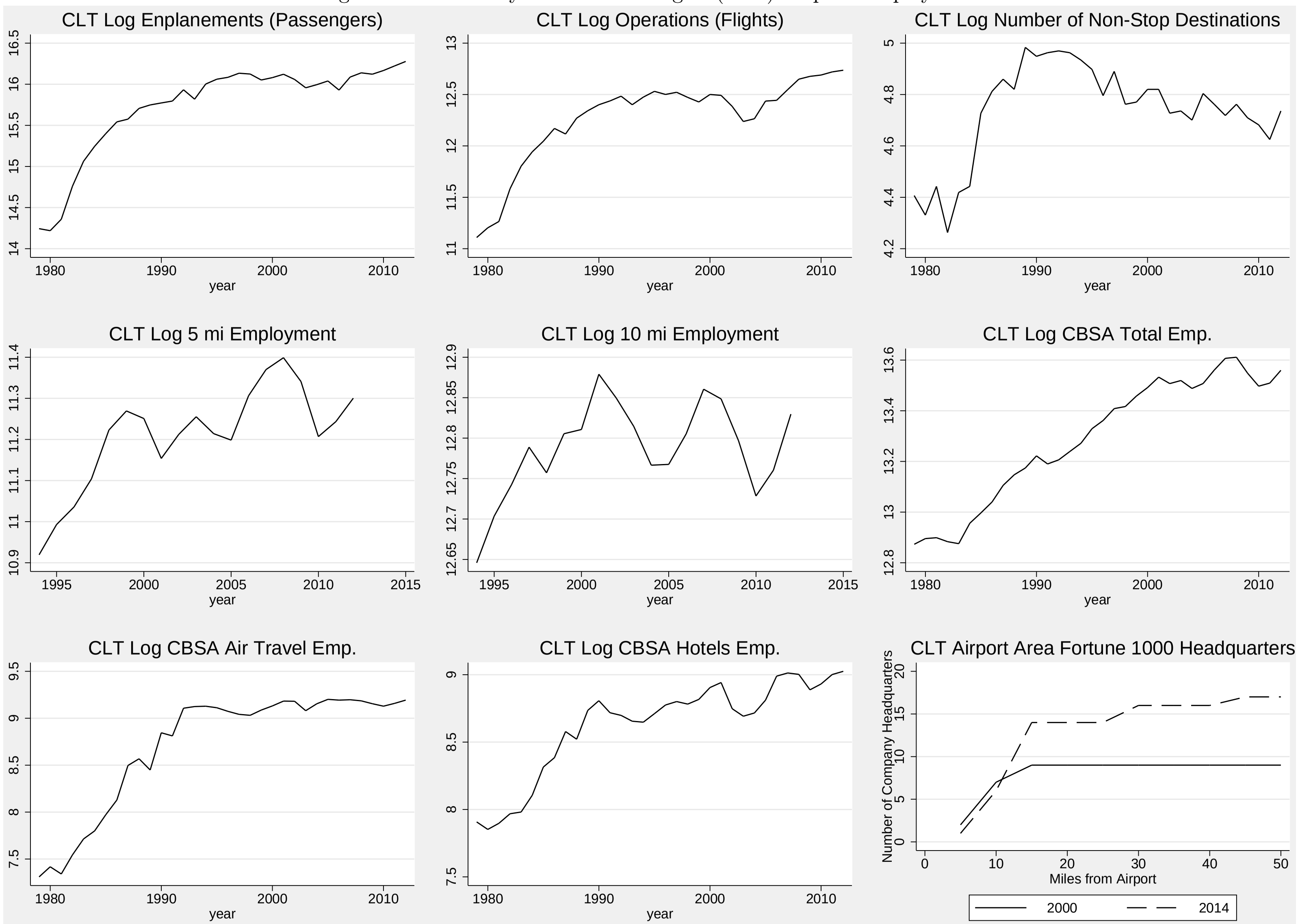
4.4 Dayton, Ohio (DAY)

Finally, consider an early case in hub closings: that of Dayton, Ohio (DAY). In 1982, after its success with the hub at Charlotte, Piedmont Airlines turned Dayton into its Midwest hub. The following decade saw another of Piedmont's success of building and maintaining a hub, as Dayton was crucial in connecting major western cities such as San Francisco and Los Angeles to the Midwest and the East Coast . However, Dayton's success was short lived. After its merger with Piedmont Airlines, US Air had an abundance of hubs. Dayton's proximity to Pittsburgh meant that US Air was also hurting that hub as well. As a result of those financial issues, Dayton was closed as a hub in 1993.

While the Charlotte hub continued to prosper (see section 3), Dayton suffered. As shown in Figure 4, employment declines began in the 1990s and continued through the present. Metropolitan area employment did not immediately decline, however. For a time, it actually continued to increase. Perhaps most interestingly is that within the air travel industry, the effect of the hub closing in the early 1990's was not accompanied by a corresponding decrease in sector employment until post-2000. Ultimately, the combined effects of the hub loss and industry changes post-September-11th led to the region's ultimate decline. Still, considering solely the isolated effect of the hub loss itself, as in the other cases considered, we see that did not in and of

[5] US Airways Chronology:
http://www.usairways.com/en-US/aboutus/pressroom/history/chronology.html

Figure 3: Case Study: Charlotte-Douglas (CLT) Airport Employment



itself lead to immediate declines in employment except within the immediate area of the airport.

Taken together with previous case studies, the graphs of employment in Dayton after US Air closed the hub seem to reiterate the general finding that hub losses do not appear to have dramatic effects on the local economy.

5 Data and Methods

The analysis in this project is based on a panel data set that was constructed 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*.[6] 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.[7] This yields a sample of 51 airports - 29 that were 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.

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.[8] 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 - the number of cities one can travel to or from an airport without any stops, and the number of cities that can be reached with no more than one connection. I also use this to generate a measure of one-way fares by originating airport.[9]

Primary data on city employment outcomes are derived from the County Business Patterns.[10] 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 the data for establishments by sector, and total payroll. I use the Standard Industrial Classification (SIC)

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

[7]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 1977 traffic levels of 0.2 percent. 1977 was chosen as this was just prior to deregulation in 1978.

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

[9]I am grateful to Severin Borenstein for providing this data. https://sites.google.com/site/borenstein/airdata

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

Figure 4: Case Study: Dayton, OH (DAY) Airport Employment

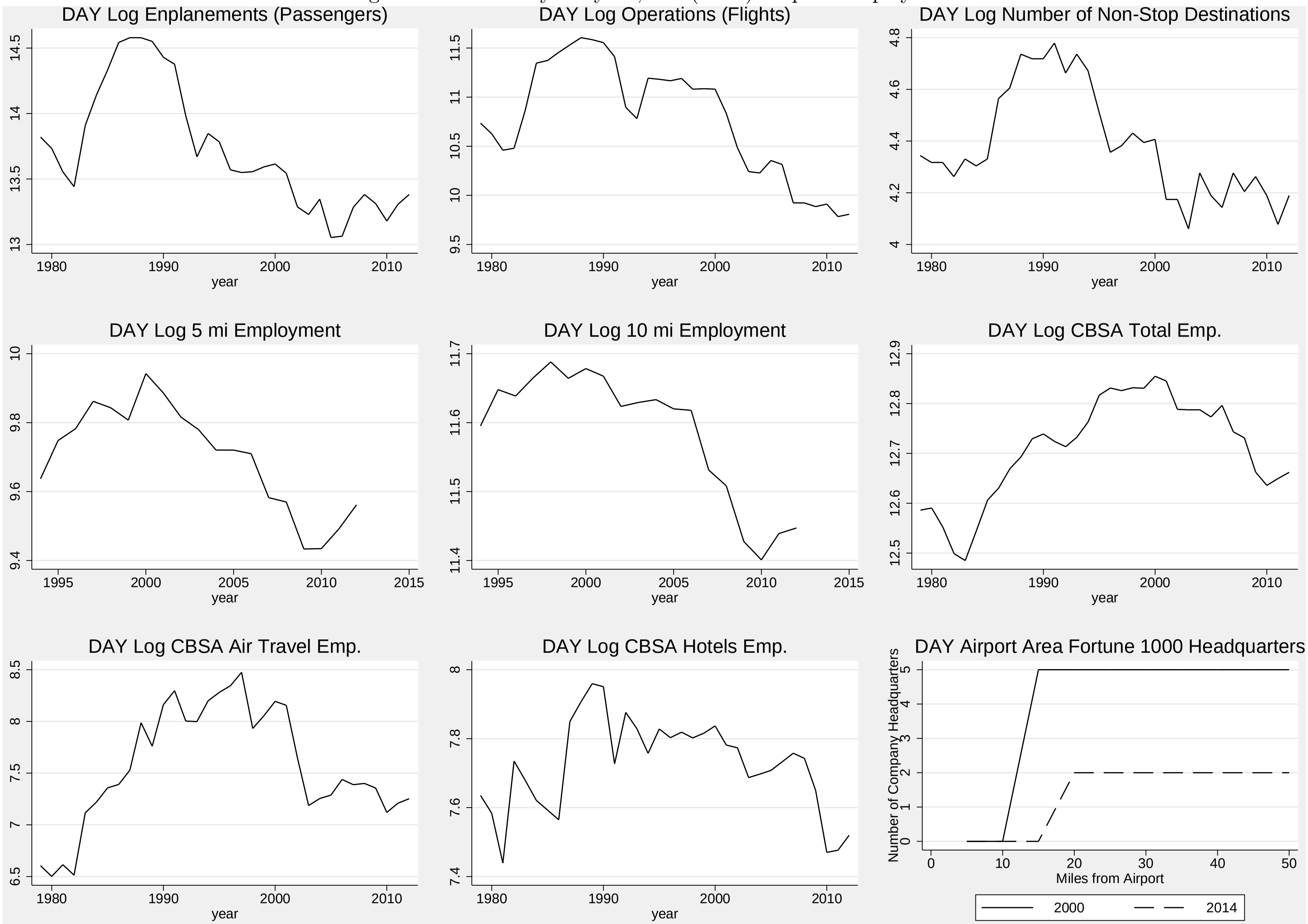
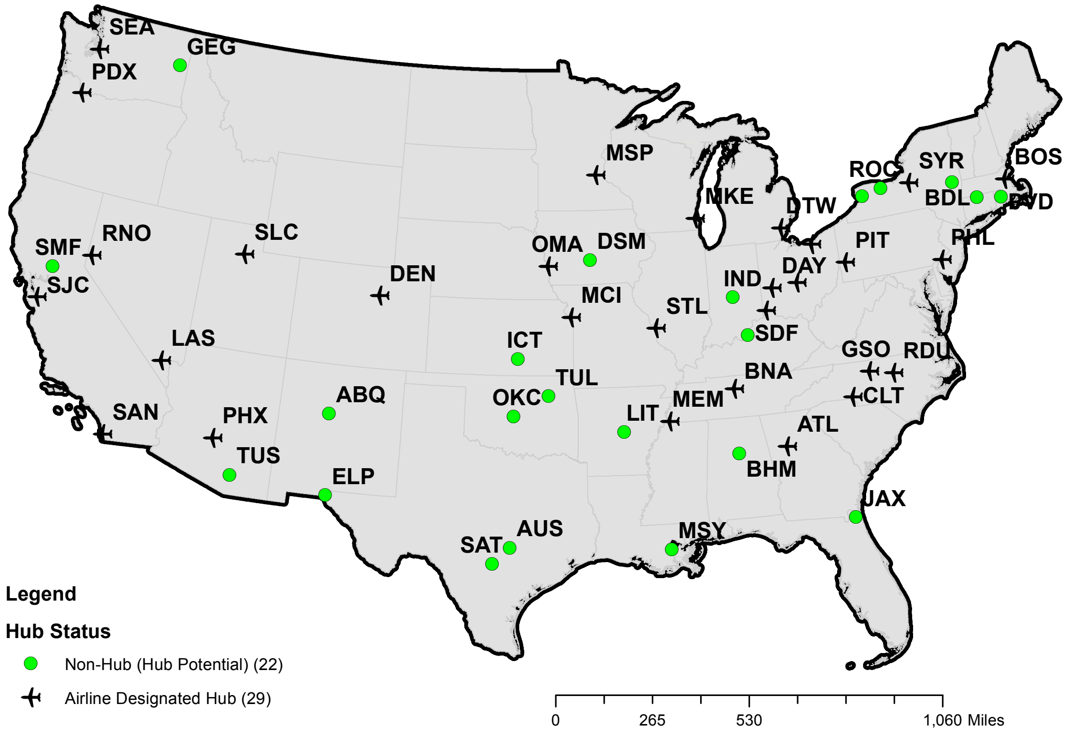


Figure 5: Map of Hub and Hub Potential Airports in Study



categories as a baseline.[11] Where necessary, data were converted from NAICS groups to SIC groups.[12][13] Finally, all county-level data was aggregated to the Census Based Statistical Area (CBSA) metropolitan area level.[14]

Data on population and personal income are obtained from the U.S. Bureau of Economic Analysis.[15] for each of the industries listed above, at the metropolitan area level.[16] I also obtain this data for personal income, earnings, earnings per worker and per-capita personal income.[17]

Finally, to assess whether hub airports might have any local spillover effects on the economy, I use Zip Code Business Patterns (ZBP) data from the U.S. Census Bureau.[18] This data is available from 1994 to 2012.

[11] 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), 58 (Eating and Drinking Places), 60-67 (Finance, Insurance and Real Estate), 70-89 (Services), 71 (Hotels and Lodging), 79 (Amusement & Recreation Services), 84 (Museums, Botanical, Zoological Gardens). 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.

[12] 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

[13] 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.

[14] As a robustness check, I repeated the analysis at the Commuting Zone and County levels, and found the results to be virtually indistinguishable.

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

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

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

[18] https://www.census.gov/econ/cbp/historical.htm

Using zip code centroids and GIS software, I compute the distance from the airport's FAA-computed latitude and longitude to each centroid. This enables me to examine employment outcomes within various radii of the airport, and also to verify how much (if any) information is lost in standard metropolitan-area level analyses of airports and employment. The ZBP data provides total employment and payroll, establishment counts for each industry, and indicators for the number of establishments within an employment size class. I use the midpoint of these employment size classes, multiplied by the number of establishments in each class, to generate estimates of industry-specific employment. As most of the establishments are relatively small, the employment estimates should be fairly accurate on an aggregated level.

5.1 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 benefits, e.g. mergers, bankruptcies, and acquisitions, I use the list compiled by Airlines for America, the aviation industry trade group.[19] Relevant events (post-1978, affecting a major U.S. hub airport) were compiled into a timeline shown in Figure 6. The timing of resulting hub openings and closings is summarized in Appendix Table A.1.

Identification is based on the assumption that hub closures were due to plausibly exogenous changes in the network structure resulting from industrial organization-related activity. Hub closures and downsizings that were made for other reasons (such as the reduction in size of the Cincinnati hub considered in Section 4.2) 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:

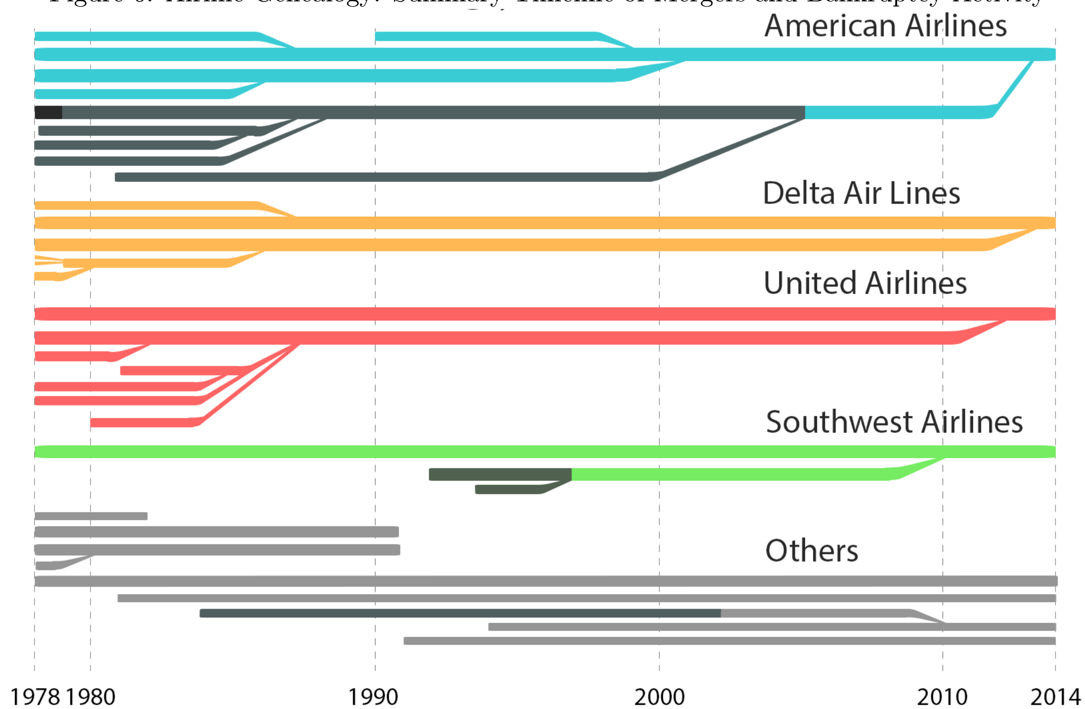
$$Y_{it} = \alpha + \beta(H = 1) + \kappa \boldsymbol{X} + \gamma_i + \tau_t + \epsilon_{it} \tag{1}$$

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 metropolitan area, also referred to as a Census Based Statistical Area (CBSA). In the specifications that follow, controls that may be included in the vector of 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 CBSA (airport) level.

As a check on the values given by equation 1, I also use an event-study methodology. After normalizing

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

Figure 6: Airline Genealogy: Summary Timeline of Mergers and Bankruptcy Activity



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

the data to the time of airport opening or closing, I run the following event-time specification:

$$Y_{it} = \alpha + \gamma_i + \tau_t + \sum_{k=-4}^{4} \beta_{k,it} + \epsilon_{it} \quad (2)$$

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 $k_{min} = -4$ and $k_{max} = 4$, respectively. The omitted category is the last year prior to the hub opening or closing. Cluster-robust standard errors are estimated, clustered at the CBSA (airport) level. In both cases, city-specific trends are accounted for in the final specifications.

6 Results and Discussion

6.1 Panel Evidence (Entire Sample)

First, to ensure that the measure of hub openings and closings I consider here captures changes in the aviation system as expected, Table 1 provides information on how airport hubs affect air service. In Panel A, I consider passenger boardings/enplanements. Specification 1 includes only airport (city) fixed effects, and gives a value

Table 1: Results: Panel Regressions - Air Access Factors

	(1)	(2)	(3)	(4)
Panel A				
Log Boardings	0.486****	0.304****	0.305****	0.247****
	(0.083)	(0.083)	(0.086)	(0.048)
N	1734	1734	1734	1734
R-Sq	0.885	0.917	0.922	0.968
Panel B				
Log Flights	0.374****	0.267***	0.262***	0.207****
	(0.079)	(0.082)	(0.084)	(0.042)
N	1734	1734	1734	1734
R-Sq	0.898	0.911	0.916	0.962
Panel C				
Log Non-Stop Destinations	0.110**	0.073**	0.038	0.058
	(0.051)	(0.030)	(0.028)	(0.037)
N	1724	1724	1724	1724
R-Sq	0.946	0.963	0.975	0.970
Panel D				
Log One-Stop Destinations	-0.005	0.020	0.022	0.018
	(0.029)	(0.020)	(0.021)	(0.014)
N	1734	1734	1734	1734
R-Sq	0.986	0.993	0.994	0.995
Panel E				
Log Average One-Way Ticket Price	0.070	0.016	0.004	-0.002
	(0.043)	(0.033)	(0.031)	(0.039)
N	1734	1734	1734	1734
R-Sq	0.441	0.727	0.797	0.764
City (Airport) FE	Y	Y	Y	Y
Time Trend (Linear and Quadratic)	N	Y	N	Y
Year FE	N	N	Y	N
City-Specific Trends	N	N	N	Y

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

of 0.486. Adding a linear and quadratic time trend reduces this value to 0.304 in specification 2. Swapping out the time trends for year fixed effects does not change the estimation much, giving an estimate of 0.305 in specification 3. After controlling for city-specific trends in specification 4, my preferred specification, we see that hubs increase air passengers by approximately 25 percent.[20] Similarly, after accounting for trends, hubs have roughly 21 percent more flights, but do not necessarily allow access to significantly more destinations non-stop. The same is true for destinations reachable with one connection, and ticket prices. In fact, Panel E provides absolutely no evidence that hubs lead to airline monopoly pricing power.

Table 2 considers population and wage measures. In Panel A, it is clear that hubs have effectively a zero

[20]I include the comparison between Specification 2 and 3 to assess the amount of variation there might be between including year fixed effects (preferred) and a linear and quadratic time trend. While I would prefer to include city by year fixed effects in the final model, this is impractical given the number of regressors that would ultimately be required, hence I opted not to include year effects in the final, preferred specification.

effect on population. It also appears that hub airports do not substantially increase payroll, either overall or on a per-worker basis. Yet, measures of personal income, which essentially proxy for a city's gross domestic product and output, are significant, both on an aggregate and per-worker basis, as shown in Panels B and C. In Table 3, I find that, as expected, employment increases in the air travel sector by roughly 20 percent as a result of hub airports. However, there is no corresponding increase in wholesale trade employment or eating and drinking places. However, in Panel D, we see that hotel employment increases substantially, by roughly 8 percent. Is this increase due to tourism? Panels E and F suggest otherwise. Hubs actually appear to decrease amusements and recreation sector employment.[21] In contrast, while noise in the data precludes any judgment of significance, the coefficients on all four specifications of Panel F (Museums, Zoos, and Botanical Gardens) are substantial relative to those of the other employment categories.

Turning to Table 4, I find no significant effects on total employment (in fact, just as noted by Sheard (2014), it is practically zero). I also find no significant employment effects on the aggregate groups of tradable and non-tradable employment, services, finance, insurance and real estate, or retail trade. In Table 5, we see that there are no significant effects of hubs on the classes of aviation-related employment sectors considered earlier, including Hotels, Amusements and Recreation, and Museums, Zoos, and Botanical Gardens. The small coefficients on the coefficients in Panels E and F relative to their counterparts in Table 3 suggest that tourism-related employment is likely not responsible for the employment increase in hotel employment. Table 6, on the other hand, shows an overall 1.4 - 2 percent increase in establishments, with all of the increase coming from the nontraded sector. Coupled with the finding of virtually zero change in employment, this implies that the number of workers per establishment is smaller in cities with airport hubs, which based on previous research (see, for example, Chatterji et al. (2013)) could indicate higher levels of entrepreneurial activity which is also correlated with city growth. This finding also corroborates with the work of Button, Lall, Stough and Trice (1999) who find that hub airports have a causal positive effect on employment in presumably more innovative high-technology industries.

I also find evidence that (log) employment shares increase by 20 percent in airport employment, by 7 percent in hotel employment, but decrease by up to 8 percent in amusements and recreation employment, consistent with the employment findings above. I find no additional significant effects on employment shares. Additionally, using industry payroll data from the Bureau of Economic Analysis, I find evidence (at the 10 percent level) of a 4 percent increase in income for eating and drinking places, but otherwise no significant effects on industry-level payroll.

[21]It is difficult to measure tourism-related employment. SIC 79, Amusements and Recreation, is likely not the best measure of the tourism sector's activity, as it includes employment in categories such as dance studios, theatrical services, bowling centers, commercial sport franchises, physical fitness facilities, and amusement parks. Many of these types of establishments would exist even without an airport in the city.

Table 2: Panel Regression Results: Population, Output and Wage Measures

	(1)	(2)	(3)	(4)
Panel A				
Log Population	0.053	0.014	0.016	-0.002
	(0.033)	(0.031)	(0.032)	(0.007)
N	1734	1734	1734	1734
R-Sq	0.935	0.972	0.972	0.999
Panel B				
Log Personal Income	0.270*	0.038	0.039	0.024**
	(0.146)	(0.031)	(0.031)	(0.011)
N	1734	1734	1734	1734
R-Sq	0.584	0.984	0.985	0.998
Panel C				
Log Per-Capita Personal Income	0.217*	0.024**	0.023**	0.026**
	(0.123)	(0.011)	(0.010)	(0.011)
N	1734	1734	1734	1734
R-Sq	0.077	0.990	0.992	0.993
Panel D				
Log Earnings Per Worker	0.168	0.011	0.014	0.005
	(0.105)	(0.012)	(0.011)	(0.007)
N	1734	1734	1734	1734
R-Sq	0.072	0.987	0.989	0.994
Panel E				
Log Payroll	0.277*	0.039	0.047	0.014
	(0.145)	(0.036)	(0.036)	(0.015)
N	1734	1734	1734	1734
R-Sq	0.640	0.978	0.979	0.996
Panel F				
Log Payroll Per Worker	0.153	0.016	0.016	0.006
	(0.098)	(0.014)	(0.013)	(0.008)
N	1734	1734	1734	1734
R-Sq	0.107	0.980	0.984	0.992
City (Airport) FE	Y	Y	Y	Y
Time Trend (Linear and Quadratic)	N	Y	N	Y
Year FE	N	N	Y	N
City-Specific Trends	N	N	N	Y

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

Table 3: Panel Results: Sectoral Employment (1)

	(1)	(2)	(3)	(4)
Panel A				
Air Travel Employment	0.534****	0.280***	0.298***	0.208***
	(0.101)	(0.091)	(0.092)	(0.077)
N	1734	1734	1734	1734
R-Sq	0.796	0.897	0.901	0.940
Panel B				
Wholesale Trade Employment	0.103**	0.014	0.019	0.027
	(0.049)	(0.040)	(0.042)	(0.018)
N	1734	1734	1734	1734
R-Sq	0.941	0.961	0.963	0.991
Panel C				
Eating and Drinking Places	0.119*	0.002	-0.002	0.006
	(0.065)	(0.024)	(0.026)	(0.012)
N	1734	1734	1734	1734
R-Sq	0.828	0.973	0.974	0.994
Panel D				
Hotels and Lodging	0.179***	0.094*	0.093*	0.080**
	(0.066)	(0.050)	(0.052)	(0.031)
N	1734	1734	1734	1734
R-Sq	0.926	0.959	0.961	0.979
Panel E				
Amusements and Recreation	0.121	-0.062*	-0.026	-0.068**
	(0.140)	(0.033)	(0.037)	(0.030)
N	1734	1734	1734	1734
R-Sq	0.622	0.936	0.947	0.972
Panel F				
Museums, Zoos, Parks	0.373*	0.065	0.077	0.089
	(0.216)	(0.106)	(0.107)	(0.092)
N	1729	1729	1729	1729
R-Sq	0.662	0.881	0.887	0.933
City (Airport) FE	Y	Y	Y	Y
Time Trend (Linear and Quadratic)	N	Y	N	Y
Year FE	N	N	Y	N
City-Specific Trends	N	N	N	Y

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

Table 4: Panel Results: Sectoral Employment (2)

	(1)	(2)	(3)	(4)
Panel A				
Total Employment	0.125**	0.023	0.032	0.009
	(0.053)	(0.028)	(0.029)	(0.013)
N	1734	1734	1734	1734
R-Sq	0.902	0.972	0.975	0.995
Panel B				
Tradables	0.018	-0.015	0.029	-0.035
	(0.052)	(0.048)	(0.042)	(0.038)
N	1734	1734	1734	1734
R-Sq	0.880	0.885	0.962	0.913
Panel C				
Nontradables	0.154**	0.014	0.020	0.007
	(0.068)	(0.023)	(0.025)	(0.012)
N	1734	1734	1734	1734
R-Sq	0.846	0.979	0.980	0.995
Panel D				
Services	0.190**	-0.004	0.002	-0.002
	(0.090)	(0.023)	(0.025)	(0.012)
N	1734	1734	1734	1734
R-Sq	0.773	0.980	0.981	0.996
Panel E				
Finance, Insurance, Real Estate	0.141**	0.036	0.043	-0.012
	(0.055)	(0.032)	(0.031)	(0.021)
N	1734	1734	1734	1734
R-Sq	0.905	0.971	0.974	0.991
Panel F				
Retail Trade	0.109**	0.016	0.015	0.013
	(0.045)	(0.023)	(0.025)	(0.012)
N	1734	1734	1734	1734
R-Sq	0.903	0.973	0.974	0.995
City (Airport) FE	Y	Y	Y	Y
Time Trend (Linear and Quadratic)	N	Y	N	Y
Year FE	N	N	Y	N
City-Specific Trends	N	N	N	Y

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

Table 5: Panel Results: Sectoral Establishment Counts (1)

	(1)	(2)	(3)	(4)
Panel A				
Air Travel Establishments	0.234**	0.058	0.060*	0.055
	(0.092)	(0.035)	(0.035)	(0.034)
N	1734	1734	1734	1734
R-Sq	0.713	0.936	0.937	0.959
Panel B				
Wholesale Trade	0.111**	0.005	0.003	0.018
	(0.047)	(0.038)	(0.039)	(0.014)
N	1734	1734	1734	1734
R-Sq	0.949	0.970	0.973	0.994
Panel C				
Eating and Drinking Places	0.119**	0.009	0.000	0.006
	(0.054)	(0.030)	(0.031)	(0.009)
N	1734	1734	1734	1734
R-Sq	0.860	0.974	0.976	0.996
Panel D				
Hotels and Lodging	0.091**	0.027	0.028	0.017
	(0.039)	(0.033)	(0.033)	(0.020)
N	1734	1734	1734	1734
R-Sq	0.875	0.953	0.956	0.985
Panel E				
Amusements and Recreation	0.174**	0.007	0.012	0.001
	(0.082)	(0.031)	(0.032)	(0.013)
N	1734	1734	1734	1734
R-Sq	0.762	0.973	0.975	0.994
Panel F				
Museums, Zoos, Parks	0.146	-0.053	-0.039	-0.050
	(0.139)	(0.055)	(0.057)	(0.059)
N	1701	1701	1701	1701
R-Sq	0.589	0.920	0.926	0.953
City (Airport) FE	Y	Y	Y	Y
Time Trend (Linear and Quadratic)	N	Y	N	Y
Year FE	N	N	Y	N
City-Specific Trends	N	N	N	Y

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

Table 6: Panel Results: Sectoral Establishment Counts (2)

	(1)	(2)	(3)	(4)
Panel A				
Total Establishments	0.128***	0.024	0.019	0.018**
	(0.044)	(0.025)	(0.025)	(0.008)
N	1734	1734	1734	1734
R-Sq	0.910	0.978	0.980	0.997
Panel B				
Tradables	0.086*	-0.011	0.000	-0.001
	(0.045)	(0.036)	(0.035)	(0.018)
N	1734	1734	1734	1734
R-Sq	0.942	0.959	0.976	0.980
Panel C				
Nontradables	0.139***	0.022	0.020	0.012*
	(0.051)	(0.024)	(0.025)	(0.006)
N	1734	1734	1734	1734
R-Sq	0.883	0.979	0.980	0.998
Panel D				
Services	0.169**	0.015	0.009	0.010
	(0.067)	(0.024)	(0.025)	(0.008)
N	1734	1734	1734	1734
R-Sq	0.836	0.980	0.981	0.998
Panel E				
Finance, Insurance, Real Estate	0.132*	0.023	0.035	-0.003
	(0.067)	(0.028)	(0.028)	(0.014)
N	1734	1734	1734	1734
R-Sq	0.818	0.972	0.976	0.992
Panel F				
Retail Trade	0.085***	0.021	0.012	0.014*
	(0.028)	(0.025)	(0.025)	(0.007)
N	1734	1734	1734	1734
R-Sq	0.954	0.978	0.979	0.997
City (Airport) FE	Y	Y	Y	Y
Time Trend (Linear and Quadratic)	N	Y	N	Y
Year FE	N	N	Y	N
City-Specific Trends	N	N	N	Y

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

6.2 Extensions: Zip Code Business Patterns

Given the findings above, it is interesting to explore how airports might generate spillover effects, and, more importantly, how the magnitude of these employment effects might change with distance from the airport. It is important to bear in mind that ZBP data is only available from 1994 on, so these estimates differ from those presented in Section 6.1 above. In Figure 7, I consider nine outcomes: total employment, total establishments, total payroll, airport employment, hotels employment, amusement and recreation employment, museums and botanical gardens, wholesale trade, and services.[22] For virtually all the industries affected by airports, the size of the effect peaks between 3 and 7 miles away from the airport, and subsequently decreases from there. These effects for total employment, air travel, amusements and recreation, museums, wholesale trade, and service sector employment are significant at the 10 percent level for at least one point within that range. We see, however that virtually all the effects, save for the hotel sector, shrink in size and become non-significant past the 15 mile mark. Given that the average area of a metropolitan area is 5,390 miles (corresponding to an average radius of 37 miles from an airport), it could simply be the case that some effects of the hub were too small to be detected at the level of the CBSA, but could be detected closer to the airport. As a robustness check, I repeated the analysis presented in Section 6.1 and found nearly identical results to those presented here.

6.3 Event Study

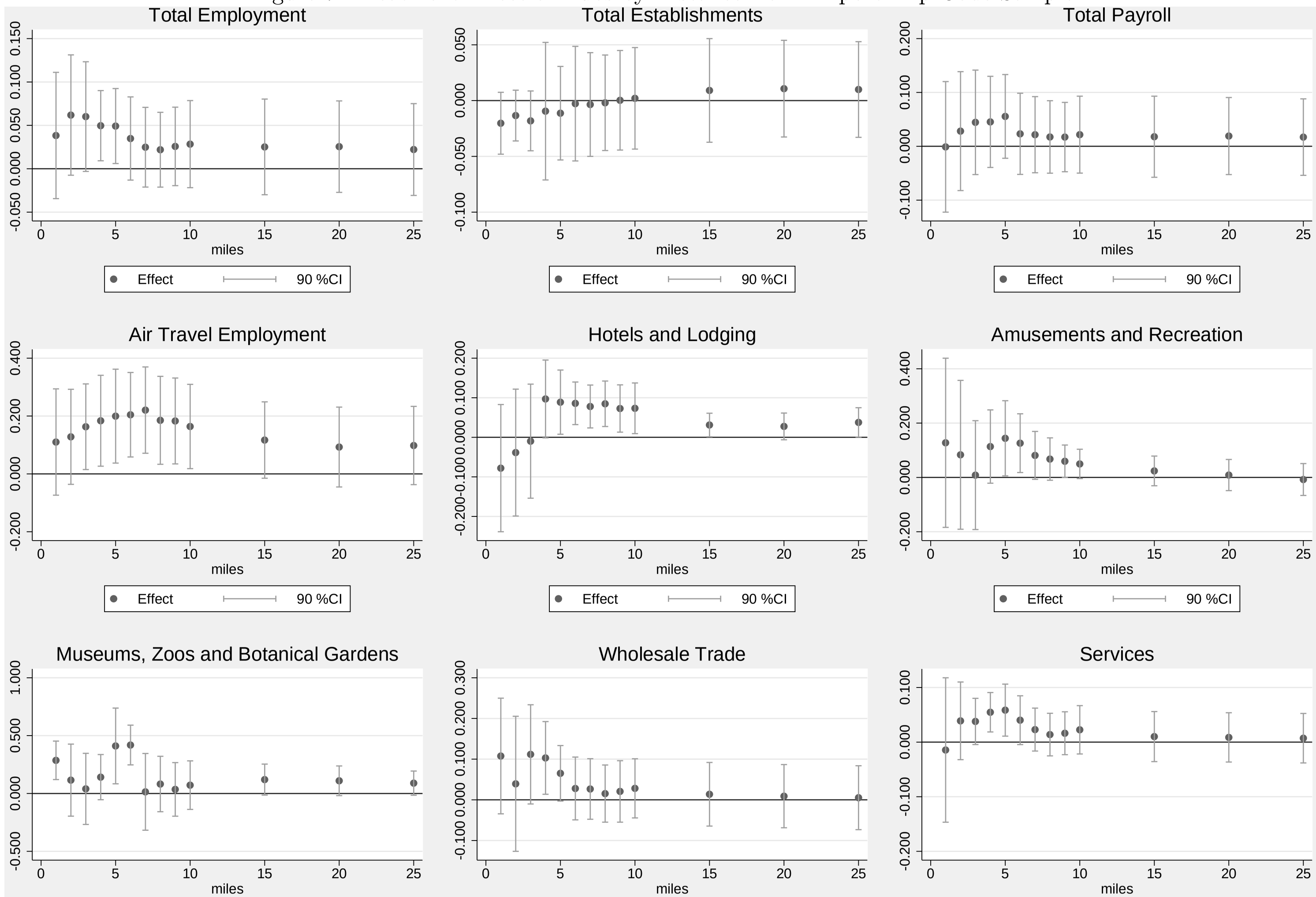
As a check on the primary findings, I also use an event-study design to separately estimate the effects of hub openings and hub closings on the local economy. In each specification, I control for four years prior to and after hub opening (three years in the case of more limited Zip Code Business Patterns (ZBP) data). 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. I focus on nine measures of the local economy: total employment, total establishments, per capita personal income, air travel employment, hotels employment, amusements and recreation employment, museums, zoo and botanical garden employment, wholesale trade employment, and service sector employment.

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 to this day. This is to reduce the potential of contaminating the estimates of hub openings via hub closings, though downsized hubs might still pose an issue for identification.[23] Similarly,

[22] ZBP employment for industries estimated - see Section 5.

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

Figure 7: Treatment Effect of Hubs by Distance from Airport- Zip Code Sample



Figures generated using Zip Code Business Patterns data. Each data point plots the coefficient of interest (indicator variable for having a hub) for a fixed-effects regression which includes airport (city) and year fixed effects, city-specific trends, similar to Specification (4) of the regressions presented previously.. Standard errors clustered at the city level. 90 percent (not 95 percent) confidence intervals shown. Miles represent cumulative distance from airport - for example, 5 miles out includes employment between 0-5 miles from the airport.

hub closing events were included only if prior to 2004, to ensure that event studies of at least 4 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. It is important to note that given the event studies are working with fewer data points than the panel regressions, these results may be biased.

To establish a baseline for the CBSA-level effects, Figure 8 shows the result of the event study for hub openings on four air travel characteristics: boardings, flights, non-stop destinations, and average ticket prices. While the estimator shows an increase in passenger boardings, it fails to show a significant increase in flights. This is troubling, as it is clear from the previous section that boardings and flights must move together. In terms of non-stop market access, this provides evidence that easier access to markets may not be the primary driver of any observed employment effects. Rather, it may be the frequency of flights that drives their effects on employment. Estimates of the employment, establishment and income outcomes considered in Figure 9 do change as expected. The estimates are noisy, and few are significant for even a single year at the 5 percent significance level. The only exception is the estimates for hotels and lodging, which increase as expected. These estimates could be as they are simply because hub openings are additions to existing airports, which may have already been large enough to impact their local economies before their labeling as airline hubs.

On the other hand, CBSA level effects for hub closings do show the expected effects. Figure 10 presents the results of the event studies for hub closings. We see a significant decline in boardings and flights, with the effect on boardings greater than that on flights. In contrast to the estimates of Figure 11, the hub closing employment results parallel much of what was seen in the panel regression analysis: a small decline in total employment; a slightly more pronounced decline in total establishments; a borderline-significant decline in per-capita personal income; a decline in air travel employment; and a decline in wholesale trade employment. There are no significant changes in hotels and lodging employment or in other related sectors. These findings corroborate somewhat with the estimates shown in Tables 3 - 6. Moreover, they offer some indication that the negative values observed in Panel E of Table 3, are not robust, but it also offers evidence that tourism is likely not the cause of most of the observed effects. That is, there appears to be no reason to expect that hub airports lead to a decline in sectors such as amusement and recreation, but there is no evidence that hubs boost employment in these sectors either. If nothing else, the implication is that tourist destinations may have the potential to turn a destination airport into a hub (though it is unlikely), but that hub airports alone should not be viewed as catalysts for tourism on their own.

As a final method of assessing the effects of hubs on cities, I consider the role distance may play in the occurrence of those effects. That is, are there additional effects of hubs occurring closer to the airport that may be lost at the CBSA level? Since the ZBP data is only available from 1994 to 2012, only hub closings

Figure 8: Hub Opening Event Study: CBSA - Air Travel Indicators

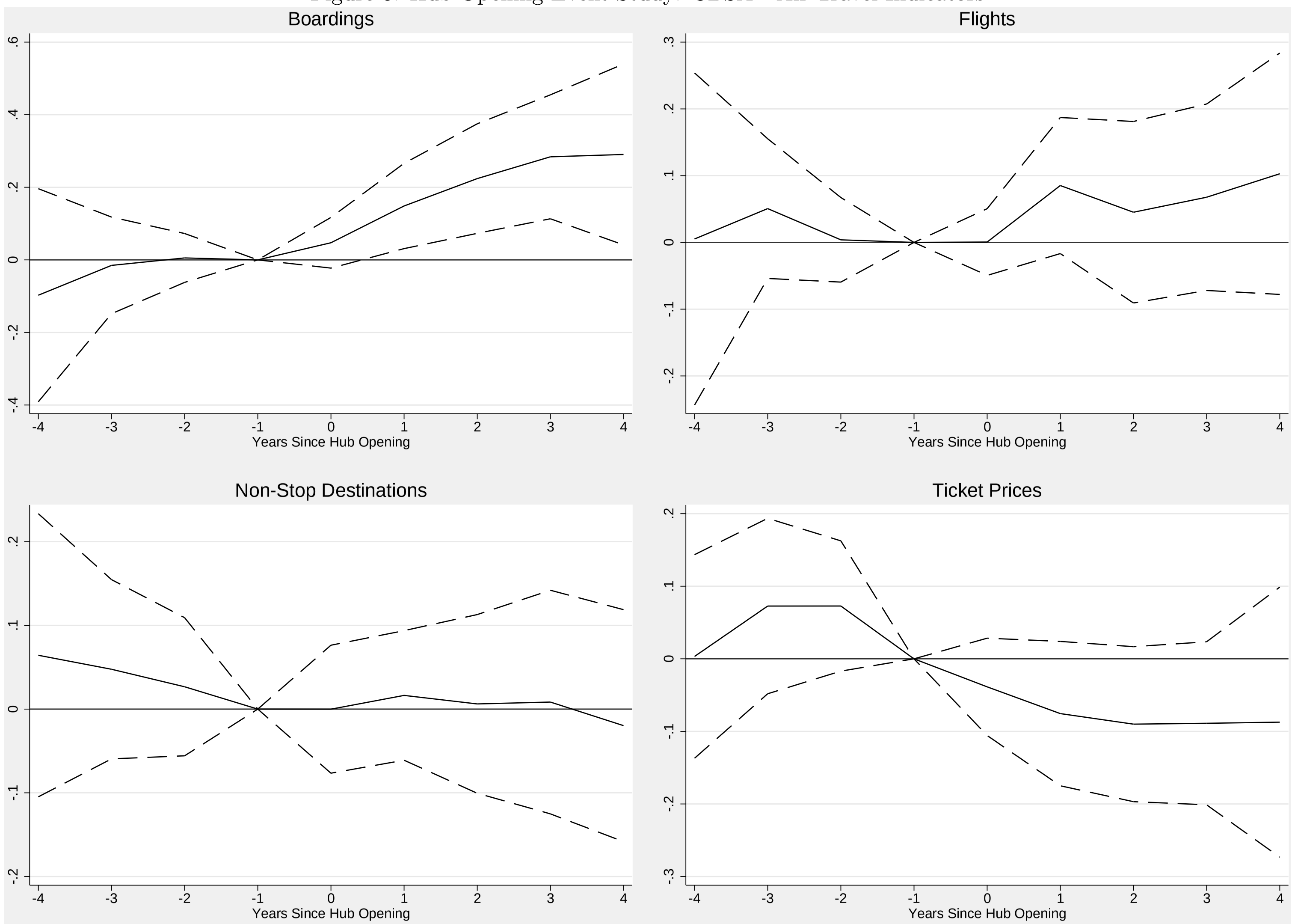


Figure shows event study outcomes on the quantities indicated above. Event studies include airport (city) and year fixed effects, as well as city specific trends. Standard errors are clustered at the city level. Dotted lines indicate 95 percent confidence intervals.

Figure 9: Hub Opening Event Study: CBSA - Local Economy Indicators

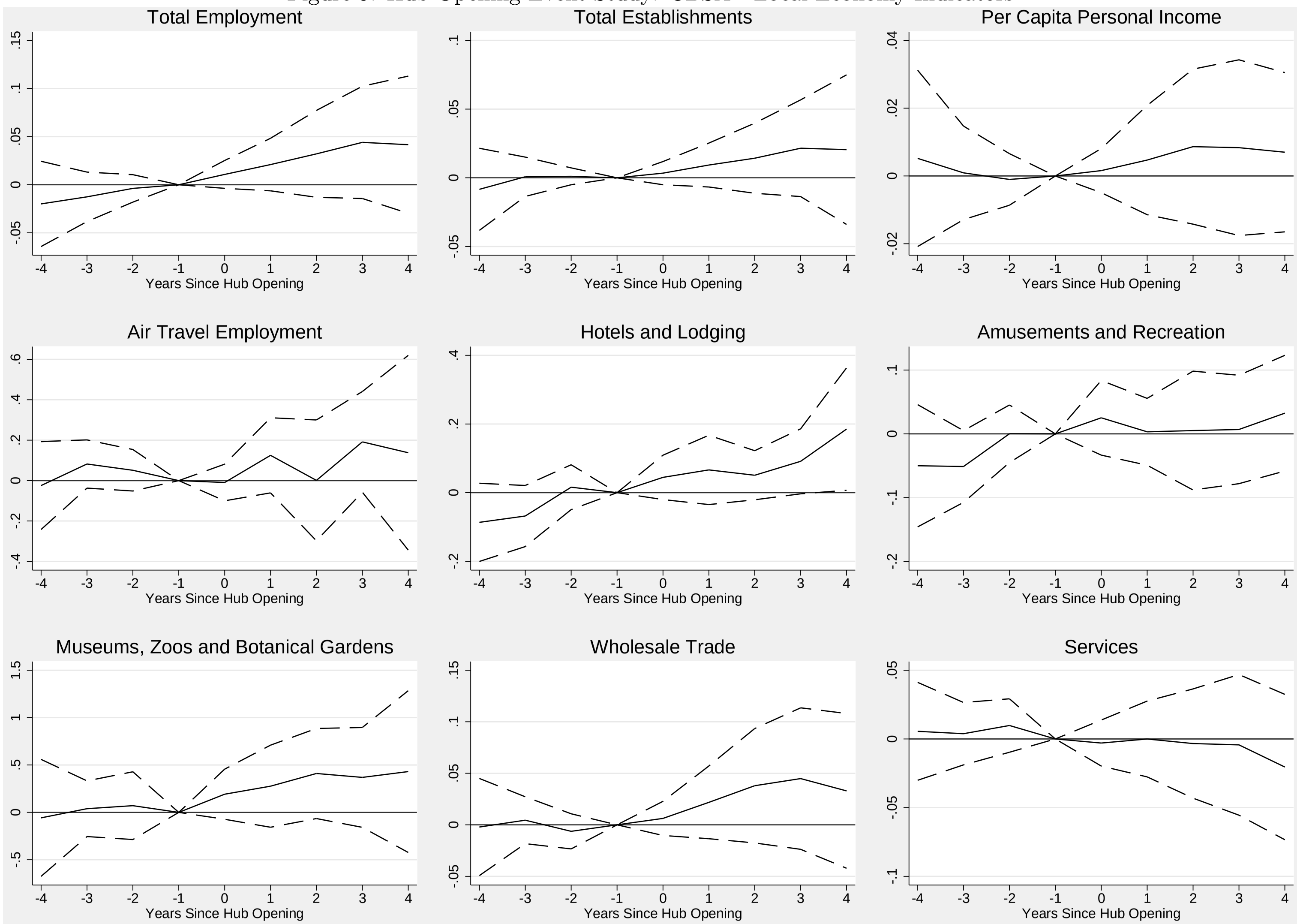


Figure shows event study outcomes on the quantities indicated above. Event studies include airport (city) and year fixed effects, as well as city specific trends. Standard errors are clustered at the city level. Dotted lines indicate 95 percent confidence intervals.

Figure 10: Hub Closing Event Study: CBSA - Air Travel Indicators

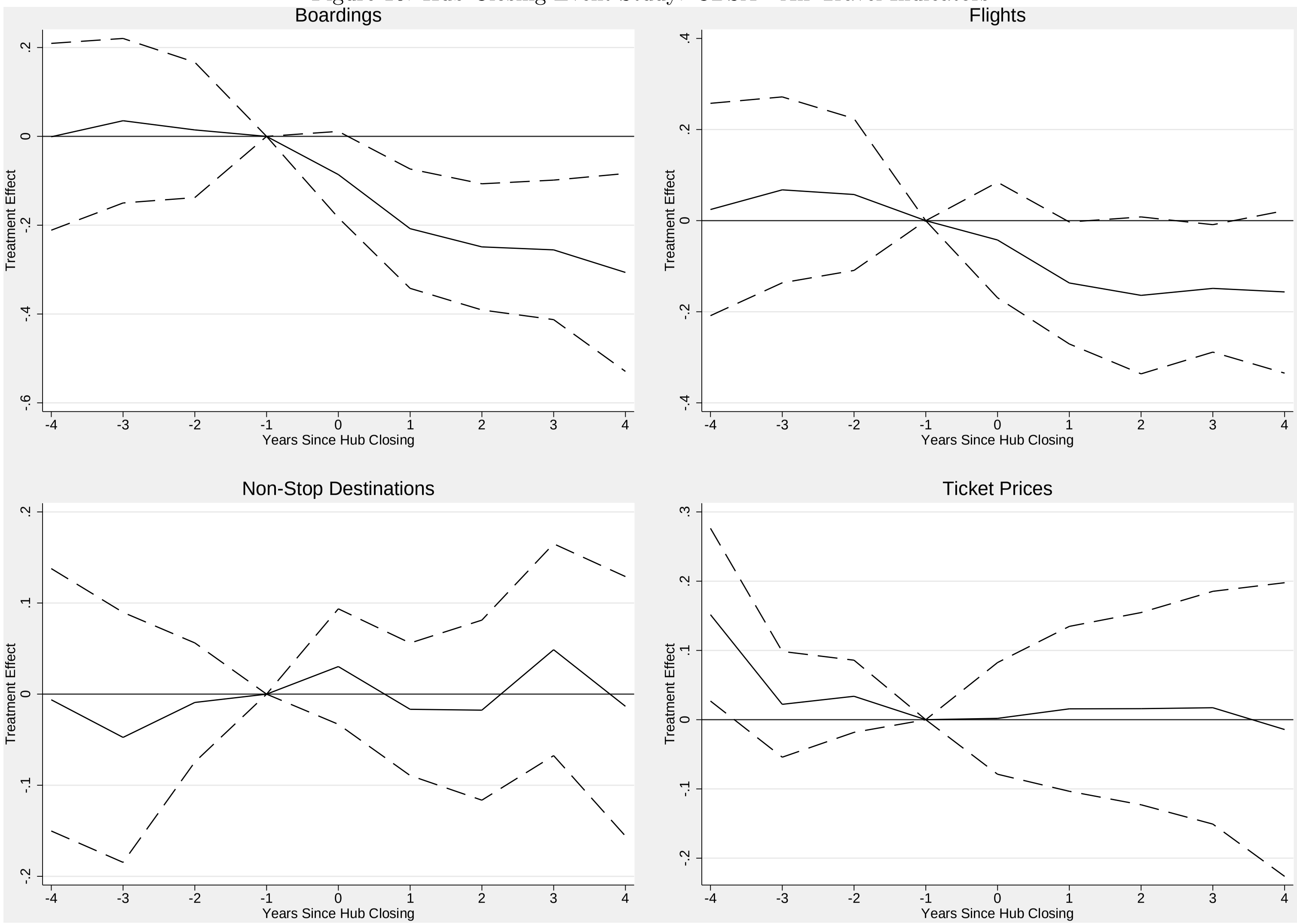


Figure shows event study outcomes on the quantities indicated above. Event studies include airport (city) and year fixed effects, as well as city specific trends. Standard errors are clustered at the city level. Dotted lines indicate 95 percent confidence intervals.

Figure 11: Hub Closing Event Study: CBSA - Local Economy Indicators

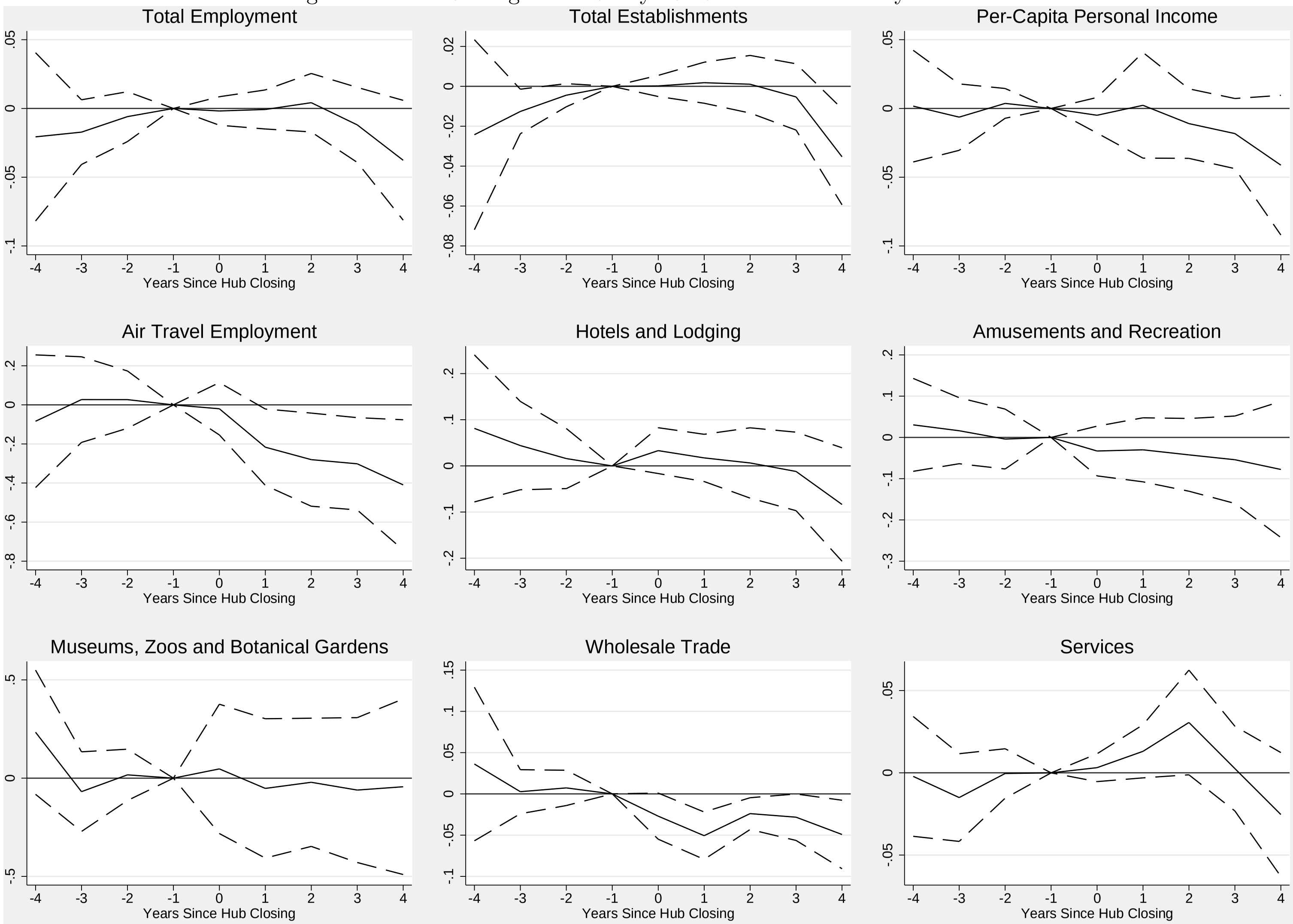


Figure shows event study outcomes on the quantities indicated above. Event studies include airport (city) and year fixed effects, as well as city specific trends. Standard errors are clustered at the city level. Dotted lines indicate 95 percent confidence intervals.

could be considered. Given the need for sufficient years of prior data, the sample of hubs included was restricted to those that closed in year 2000 or after. I present the ZBP outcomes for employment outcomes 5 miles and 10 miles away from the airport.

First, I consider the effects of hubs on air travel factors. Changes in boardings, flights, and average ticket prices are not significant, as shown in Figure 12. Changes in non-stop destinations are negative and significant. This indicates that any changes we find in employment could potentially be driven more by market access factors than traffic. Figure 13 considers effects at five miles. We see a decline in total employment, and to a lesser extent, payroll. There is a significant decline in air travel employment, amusements and recreation, museums, zoos, and botanical gardens, and service sector employment. There is no significant change in hotels and lodging employment or wholesale trade employment. This indicates that, perhaps a hub airport may not be a huge driver of employment for a city as a whole, but hub airports do generate localized spillovers, especially in some of the more tourist-oriented sectors. Moving to 10 miles out, as shown in Figure 14, the negative effect on hotels becomes more pronounced, but the effects on all other outcomes becomes flat.

6.4 Mergers and Acquisitions - Robustness

So far, the effects considered have involved all hub openings and hub closings that occurred in aviation history. The majority of these 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 M&A 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.

In general, specifications (1) - (3) differ greatly from the final specification in which city-specific trends are accounted for. As the number of hubs is small, I consider specification 4 as my preferred specification.

Figure 12: Hub Closing Event Study: Zip Code Level - Air Travel Indicators

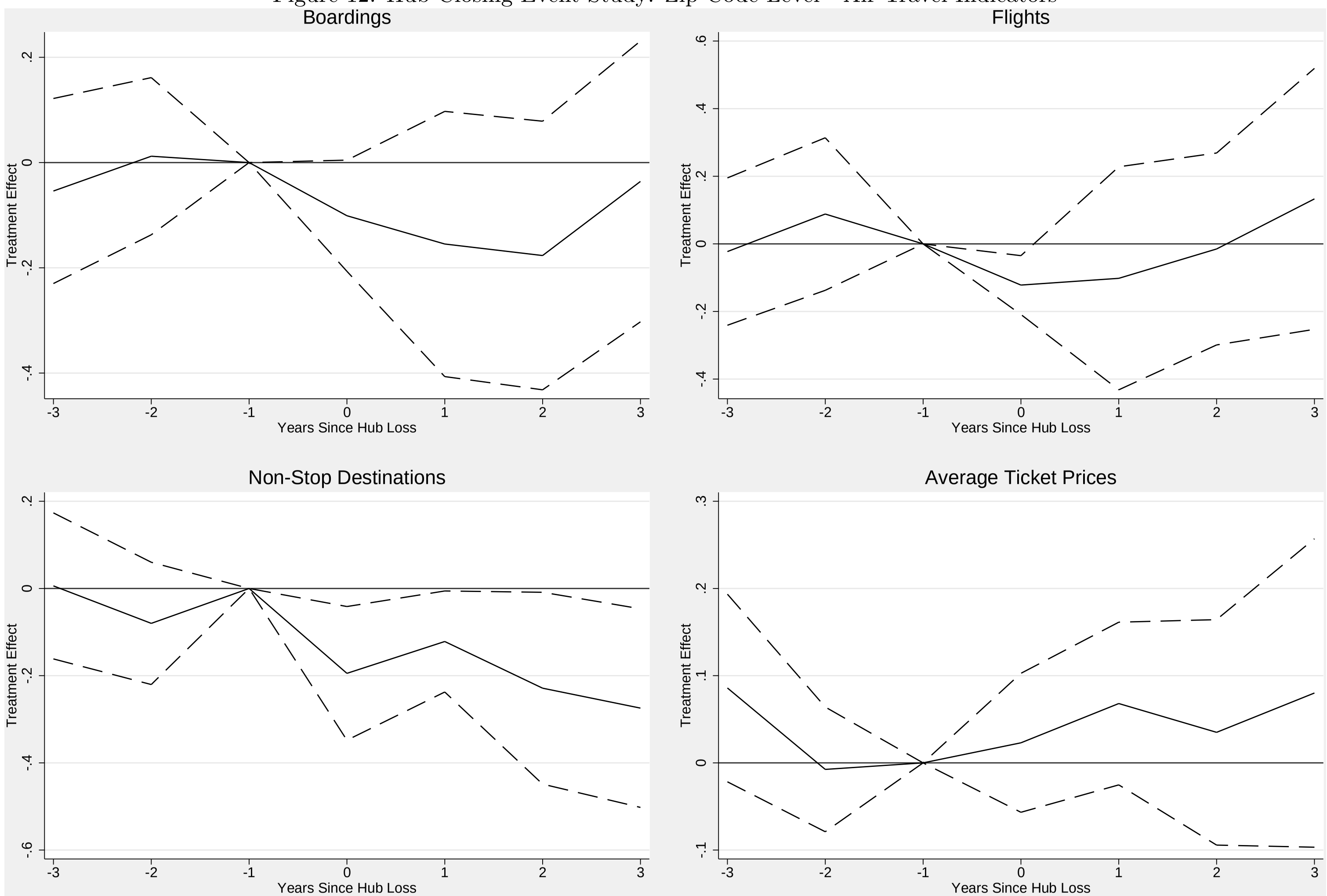


Figure shows event study outcomes on the quantities indicated above. Event studies include airport (city) and year fixed effects, as well as city specific trends. Standard errors are clustered at the city level. Dotted lines indicate 95 percent confidence intervals.

Figure 13: Hub Closing Event Study: Local Economy Indicators at 5mi from Airport

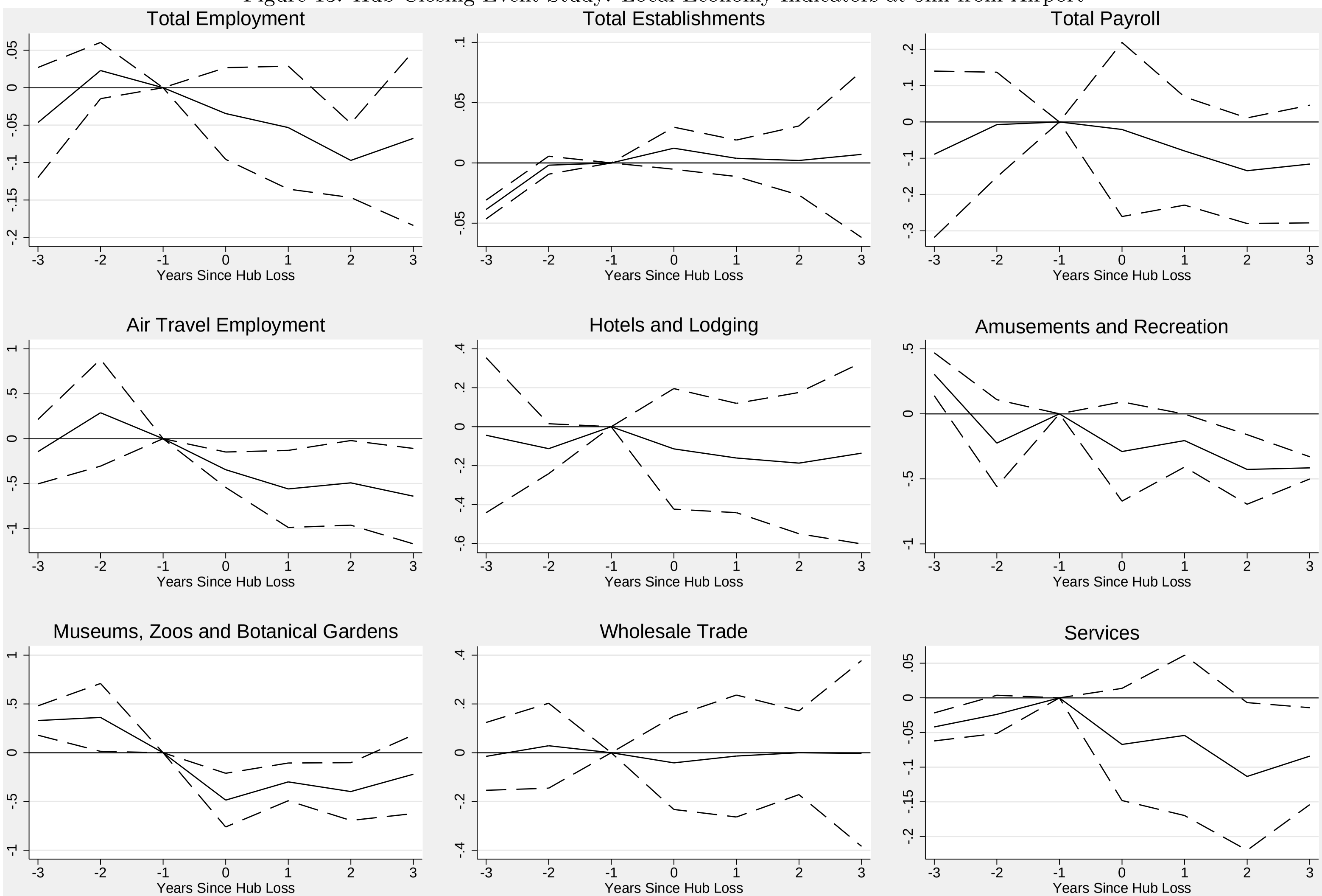


Figure shows event study outcomes on the quantities indicated above. Event studies include airport (city) and year fixed effects, as well as city specific trends. Standard errors are clustered at the city level. Dotted lines indicate 95 percent confidence intervals.

Figure 14: Hub Closing Event Study: Local Economy Indicators at 10mi from Airport

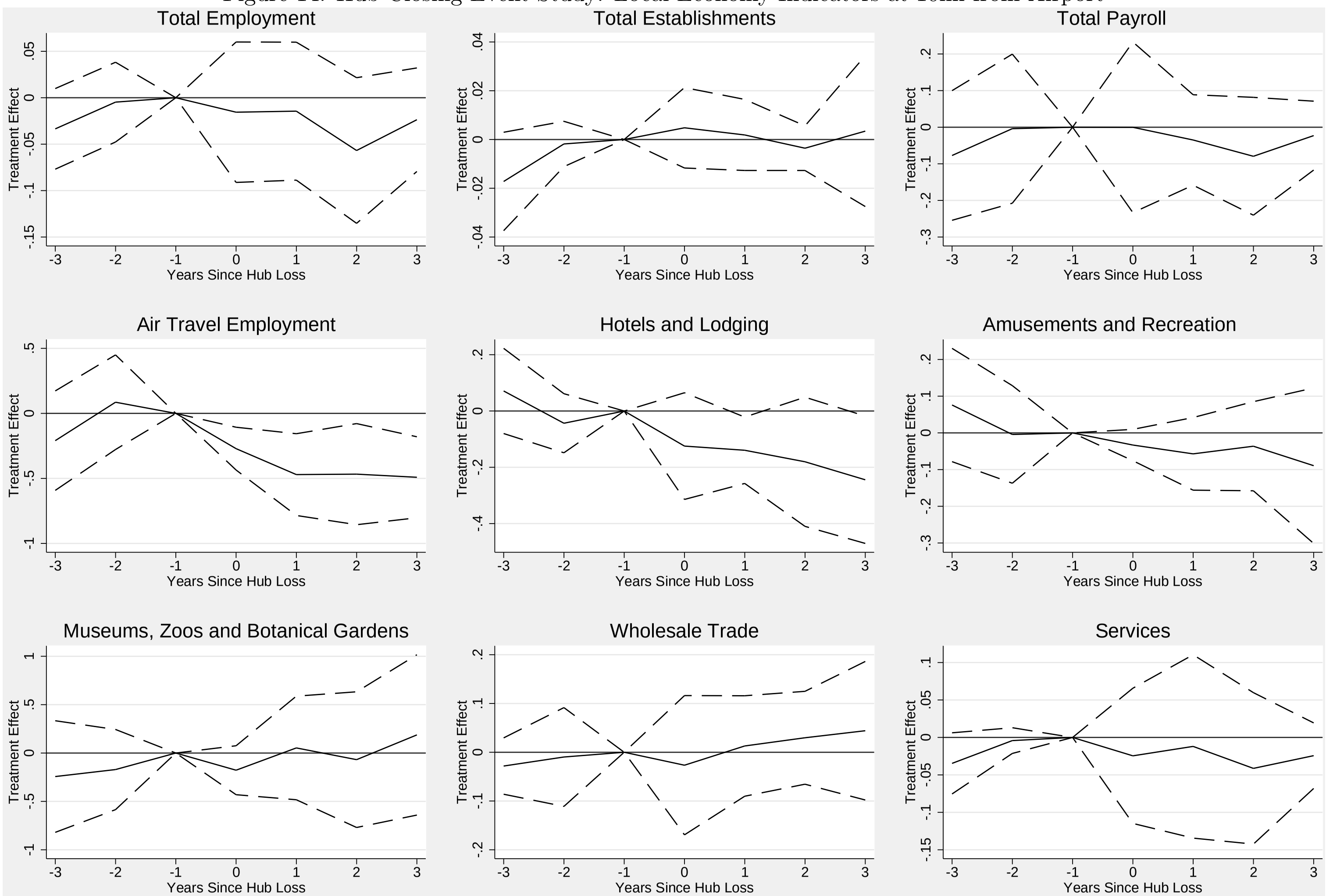


Figure shows event study outcomes on the quantities indicated above. Event studies include airport (city) and year fixed effects, as well as city specific trends. Standard errors are clustered at the city level. Dotted lines indicate 95 percent confidence intervals.

Turning to Table A.3, we see that hubs still lead to increases in boardings and flights. The size of the increase is slightly larger than that shown in the main specifications. As in the main analysis, non-stop market access is no longer significant, and ticket prices fail to significantly change as well. Table A.4 shows no increase in population. However, in contrast to the result in Table 2, personal income and per-capita income increases by 4 to 5 percent, substantially larger than the main effect of roughly 3 percent. Additionally, earnings per worker increases by roughly 3 percent in this model. This confirms the main result, that air hubs lead to personal income growth. As before, payroll remains insignificant, but payroll per worker appears to increase by almost 3 percent. In Table 3, air travel retains its significance, with a magnitude of roughly 50 percent larger than those in the main result. The effect of hotels is indistinguishable from that in the main model. There remains no significant effect on employment by sector as considered in Table 4, except in the case of services. The non-significant coefficient on total employment provides evidence that hub status does not substantially affect total employment. The coefficient of -0.019 implies that the true effect is close to zero, as does the effect of 0.009 estimated in the main table. There are differences in establishment counts: the M&A model shows a roughly 5 perent increase in hotels and amusement and recreation establishments due to hubs. The magnitude of the increases for other establishment outcomes generally mirror those estimated in the main analysis.

In summary, the estimates of this model line up with those shown in Section 6.1. Event studies are also estimated and are shown in Figures A.1 and A.2. However, these models appear suspect, as they fail simple checks in consistency. For example, the effect on boardings and flights should be similar, but are not. Given the small sample of air hubs that are available for this analysis, and the fact that the event study, by design takes into account substantially less information than the panel regressions, these should be viewed with caution, and only for reference.

6.5 Hub Effects: Traffic, Market Access, or Labeling?

The effects estimated here could be due to air traffic, market access as proxied by the number of destinations reachable, or even the hub designation itself. Generally, non-stop destinations does not appear to be driving the observed effects. So, is there a hub premium? I consider this to be a question for further research. One way to disentangle this effect could be to rescale the local traffic from the hub airports (by passengers) to something that is comparable for non-hub airports; for example, a measure of only destination traffic. To do so, I would compute the shares of connecting passengers at each hub, from baseline DOT ticket data, for each year, and then net out those passengers. From there, city-level outcomes can be estimated and compared. I hypothesize that it is less the label and more the market access (number of destinations) driving this outcome. With additional data, it is possible to examine the travel behavior of high-value business travelers and how they respond in the context of a hub system. Another way to examine this effect might be to consider Southwest's service, which I didn't consider here. At this point in their history they have built a robust network of focus cities that mimic hubs in function to some degree, but that do not carry the "hub" designation. If the Southwest focus city hubs are affecting their economies similarly to the legacy hubs, then we can conclude that it is not the label driving this. Again, I leave this for further research.

7 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 city economic outcomes. Namely, I show that hubs increase personal income by at least 2-3 percent, and also increase establishment counts by up to two percent, with virtually all of the growth in establishments in the non-traded sector. I also show that positive employment outcomes are limited mostly to travel related industries, such as air travel and hotels and lodging. The effect of hubs on a city's employment is estimated to be practically zero. However, hub airports do create spillovers on employment overall within a 5 mile radius of the hub. These effects operate through the changes in air traffic, and, to a limited extent, change in access to markets served by non-stop flights.

Considering the evidence presented, a few lessons emerge. (1) Hubs appear to be more important to a city's business climate than its tourism prospects, seconding Neal (2011)'s finding that only destination hubs are able to generate significant outcomes. (2) The effects of hubs appear to operate primarily through their ability to offer a high frequency of flights to a variety of destinations, many direct. (3) Hubs generate spillover effects, which peak somewhere at a radius of between 3 and 7 miles away from the airport. (4) Most of the effects on industries most likely to be linked to tourism are contained to these localized spillovers. (5) Hubs are not bad for cities, either, in that in every model considered, hubs had no significant effect on ticket prices, while improving options for consumers. In summary, having a hub downsized, or losing a hub, will definitely affect some jobs, and will definitely affect the prospect of those employees who work near an airport. However, the effects of losing a hub, outside of the air travel or hotel industries, is quite small, and need not be cause for alarm. Thus, it appears much of the fear surrounding recent hub losses is not necessarily justified. Hub airports do not make or break a city; rather, strong fundamentals such as business climate and, to a lesser extent, tourist attractions, are likely to be more critical.

In future work, I hope to delve into one of the primary questions that I was unable to adequately consider here: namely, has the role of a hub fundamentally changed in the post-September 11th world? Air carriers have changed their strategies from maximizing market share to maximizing profits, and with recent mergers, have consolidated hubs and flight operations. One benefit for the cities that benefit from this would be stronger hubs with increased market access. How will that affect cities that "win" one of these new super-hubs, such as Charlotte or Philadelphia? Additionally, as transportation investments tend to generate jobs in a small radius of the airport as shown, it is interesting to examine the role air hubs play in providing employment for minorities and/or those with limited job prospects. Finally, while the findings of this paper lead to the conclusion that the benefits of air hubs do exist, they are modest. What role do local level subsidies play in determining the success or failure of a hub? What is the optimal role for local government to play in aviation-related affairs?

References

Bowen, John, *The economic geography of air transportation: space, time, and the freedom of the sky* number 81. In 'Routledge studies in the modern world economy.', London ; New York: Routledge, 2010.

Button, Kenneth, "Debunking some common myths about airport hubs," *Journal of Air Transport Management*, May 2002, *8* (3), 177–188.

_ **and Somik Lall**, "The Economics of Being an Airport Hub City," *Research in Transportation Economics*, 1999, *5*, 75–105.

_ **,** _ **, Roger Stough, and Mark Trice**, "High-technology employment and hub airports," *Journal of Air Transport Management*, January 1999, *5* (1), 53–59.

Chatterji, Aaron, Edward L. Glaeser, and William R. Kerr, "Clusters of Entrepreneurship and Innovation," Working Paper 19013, National Bureau of Economic Research May 2013.

Eller, Richard E., *Piedmont Airlines: A Complete History, 1948 - 1989*, Jefferson, North Carolina: McFarland & Company, Inc., Publishers, 2008.

Giroud, Xavier, "Proximity and Investment: Evidence from Plant-Level Data," *The Quarterly Journal of Economics*, May 2013, *128* (2), 861–915.

Harty, Jack, *Weekend Rewind: A Look Back Into The Archive of Airchives Vault Of Aviation History* February 2014.

Jaillet, Patrick, Gao Song, and Gang Yu, *Airline Network Design and Hub Location Problems* 1996.

Lee, Darin and Maria Jose Luengo-Prado, "The Impact of Passenger Mix on Reported Hub Premiums in the US Airline Industry," *Southern Economic Journal*, 2005, *72* (2).

McLaughlin, David and Andrew Zajac, *American Airlines - US Airways Merger Settlement Approved* April 2014.

Neal, Zachary, "Creative Employment and Jet Set Cities: Disentangling Causal Effects," *Urban Studies*, January 2012, p. 0042098011431282.

Neal, Zachary P, "The Causal Relationship Between Employment and Business Networks in U.s. Cities," *Journal of Urban Affairs*, May 2011, *33* (2), 167–184.

_ , "Types of Hub Cities and their Effects on Urban Creative Economies," 2014.

O'Kelly, M. E., "A Geographer's Analysis of Hub-and-Spoke Networks," *Journal of Transport Geography*, 1998, *6* (3), 171–186.

Pilcher, James, *Why CVG Lost Half of All Flights* May 2010.

Redding, Stephen, Daniel M. Sturm, and Nikolaus Wolf, "Web-Based Technical Appendix for History and Industry Location: Evidence from German Airports," 2010.

Redding, Stephen J., Daniel M. Sturm, and Nikolaus Wolf, "History and Industry Location: Evidence from German Airports," *The Review of Economics and Statistics*, 2011, *93* (3), 814–831.

Sheard, Nicholas, "Airports and urban sectoral employment," *Journal of Urban Economics*, March 2014, *80*, 133–152.

A Appendix

This Appendix presents additional information on the hubs used in the study, as well as the historical activities (mergers, acquisitions, bankruptcies) that led to the hub openings and closings reference in the paper.

Below, I present the outcomes of a model estimated only with hubs affected by merger and/or acquisitions. I present both a panel model and event studies. Please see the main text for more details.

Table A.1: Study Hub Airport Characteristics

ID	Name	City	State	NDestNS	Enpl	Avg Tkt	Open	Closed
ATL	Hartsfield - Jackson Atlanta Intl	Atlanta	GA	190	24	163	1978	
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
MCI	Kansas City Intl	Kansas City	MO	66	4	128	1983	1989
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 - Air Access Factors

	(1)	(2)	(3)	(4)
Panel A				
Log Boardings	0.337	0.369	0.389	0.299****
	(0.276)	(0.229)	(0.242)	(0.076)
N	918	918	918	918
R-Sq	0.812	0.857	0.869	0.952
Panel B				
Log Flights	0.374	0.345	0.353	0.281***
	(0.253)	(0.222)	(0.233)	(0.077)
N	918	918	918	918
R-Sq	0.795	0.823	0.835	0.927
Panel C				
Log Non-Stop Destinations	0.295***	0.135*	0.106	0.031
	(0.080)	(0.069)	(0.083)	(0.087)
N	908	908	908	908
R-Sq	0.943	0.958	0.971	0.965
Panel D				
Log One-Stop Destinations	0.132**	0.061	0.072	0.012
	(0.050)	(0.049)	(0.051)	(0.027)
N	918	918	918	918
R-Sq	0.987	0.992	0.993	0.995
Panel E				
Log Average One-Way Ticket Price	-0.146***	0.014	-0.004	-0.010
	(0.042)	(0.071)	(0.077)	(0.096)
N	918	918	918	918
R-Sq	0.470	0.746	0.805	0.786
City (Airport) FE	Y	Y	Y	Y
Time Trend (Linear and Quadratic)	N	Y	N	Y
Year FE	N	N	Y	N
City-Specific Trends	N	N	N	Y

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

Table A.4: Panel Regression Results: Population, Output and Wage Measures

	(1)	(2)	(3)	(4)
Panel A				
Log Population	-0.076	0.041	0.043	-0.012
	(0.063)	(0.048)	(0.051)	(0.015)
N	918	918	918	918
R-Sq	0.926	0.970	0.970	0.998
Panel B				
Log Personal Income	-0.477**	0.085	0.076	0.037**
	(0.194)	(0.057)	(0.057)	(0.015)
N	918	918	918	918
R-Sq	0.487	0.984	0.985	0.997
Panel C				
Log Per-Capita Personal Income	-0.401***	0.044***	0.033****	0.049**
	(0.141)	(0.014)	(0.009)	(0.018)
N	918	918	918	918
R-Sq	0.086	0.990	0.993	0.992
Panel D				
Log Earnings Per Worker	-0.354**	0.028	0.023	0.034****
	(0.129)	(0.024)	(0.024)	(0.009)
N	918	918	918	918
R-Sq	0.066	0.989	0.991	0.993
Panel E				
Log Payroll	-0.471**	0.039	0.041	0.008
	(0.212)	(0.086)	(0.092)	(0.022)
N	918	918	918	918
R-Sq	0.524	0.969	0.970	0.994
Panel F				
Log Payroll Per Worker	-0.335***	0.023	0.010	0.027*
	(0.117)	(0.030)	(0.029)	(0.013)
N	918	918	918	918
R-Sq	0.088	0.981	0.985	0.990
City (Airport) FE	Y	Y	Y	Y
Time Trend (Linear and Quadratic)	N	Y	N	Y
Year FE	N	N	Y	N
City-Specific Trends	N	N	N	Y

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

Table A.5: Panel Results: Sectoral Employment (1)

	(1)	(2)	(3)	(4)
Panel A				
Air Travel Employment	0.232	0.553****	0.608****	0.327**
	(0.170)	(0.092)	(0.085)	(0.137)
N	918	918	918	918
R-Sq	0.610	0.815	0.826	0.882
Panel B				
Wholesale Trade Employment	-0.091	-0.048	-0.037	-0.011
	(0.133)	(0.102)	(0.109)	(0.013)
N	918	918	918	918
R-Sq	0.901	0.925	0.928	0.981
Panel C				
Eating and Drinking Places	-0.223**	0.032	0.030	-0.007
	(0.085)	(0.038)	(0.038)	(0.023)
N	918	918	918	918
R-Sq	0.793	0.976	0.977	0.992
Panel D				
Hotels and Lodging	-0.063	0.078	0.079	0.087*
	(0.157)	(0.113)	(0.116)	(0.049)
N	918	918	918	918
R-Sq	0.907	0.948	0.949	0.973
Panel E				
Amusements and Recreation	-0.606****	-0.100	-0.059	-0.115**
	(0.135)	(0.068)	(0.079)	(0.044)
N	918	918	918	918
R-Sq	0.541	0.910	0.925	0.961
Panel F				
Museums, Zoos, Parks	-0.498	0.042	0.071	-0.156
	(0.406)	(0.227)	(0.234)	(0.241)
N	917	917	917	917
R-Sq	0.664	0.865	0.871	0.913
City (Airport) FE	Y	Y	Y	Y
Time Trend (Linear and Quadratic)	N	Y	N	Y
Year FE	N	N	Y	N
City-Specific Trends	N	N	N	Y

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

Table A.6: Panel Results: Sectoral Employment (2)

	(1)	(2)	(3)	(4)
Panel A				
Total Employment	-0.136	0.016	0.031	-0.019
	(0.099)	(0.057)	(0.064)	(0.016)
N	918	918	918	918
R-Sq	0.863	0.960	0.963	0.992
Panel B				
Tradables	0.000	-0.061	-0.001	-0.106
	(0.089)	(0.087)	(0.083)	(0.062)
N	918	918	918	918
R-Sq	0.812	0.820	0.940	0.863
Panel C				
Nontradables	-0.209*	0.011	0.022	-0.020
	(0.109)	(0.047)	(0.052)	(0.016)
N	918	918	918	918
R-Sq	0.791	0.974	0.976	0.993
Panel D				
Services	-0.298*	-0.004	0.013	-0.037****
	(0.146)	(0.050)	(0.057)	(0.004)
N	918	918	918	918
R-Sq	0.674	0.971	0.973	0.994
Panel E				
Finance, Insurance, Real Estate	-0.109	0.050	0.048	-0.018
	(0.085)	(0.067)	(0.064)	(0.046)
N	918	918	918	918
R-Sq	0.899	0.967	0.970	0.987
Panel F				
Retail Trade	-0.126	0.026	0.028	-0.012
	(0.074)	(0.042)	(0.043)	(0.023)
N	918	918	918	918
R-Sq	0.879	0.972	0.974	0.992
City (Airport) FE	Y	Y	Y	Y
Time Trend (Linear and Quadratic)	N	Y	N	Y
Year FE	N	N	Y	N
City-Specific Trends	N	N	N	Y

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

Table A.7: Panel Results: Sectoral Establishment Counts (1)

	(1)	(2)	(3)	(4)
Panel A				
Air Travel Establishments	-0.184	0.086*	0.075	0.083
	(0.140)	(0.046)	(0.050)	(0.066)
N	918	918	918	918
R-Sq	0.602	0.903	0.908	0.946
Panel B				
Wholesale Trade	0.014	-0.008	-0.005	-0.006
	(0.141)	(0.108)	(0.112)	(0.027)
N	918	918	918	918
R-Sq	0.915	0.949	0.954	0.991
Panel C				
Eating and Drinking Places	-0.140	0.059	0.043	0.019
	(0.103)	(0.057)	(0.054)	(0.015)
N	918	918	918	918
R-Sq	0.836	0.975	0.979	0.993
Panel D				
Hotels and Lodging	-0.071	0.094**	0.086**	0.050**
	(0.051)	(0.041)	(0.041)	(0.022)
N	918	918	918	918
R-Sq	0.838	0.937	0.940	0.980
Panel E				
Amusements and Recreation	-0.233	0.069	0.068	0.045***
	(0.151)	(0.065)	(0.069)	(0.015)
N	918	918	918	918
R-Sq	0.699	0.965	0.967	0.991
Panel F				
Museums, Zoos, Parks	-0.472***	0.030	0.045	-0.065
	(0.169)	(0.083)	(0.086)	(0.094)
N	901	901	901	901
R-Sq	0.583	0.902	0.909	0.937
City (Airport) FE	Y	Y	Y	Y
Time Trend (Linear and Quadratic)	N	Y	N	Y
Year FE	N	N	Y	N
City-Specific Trends	N	N	N	Y

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

Table A.8: Panel Results: Sectoral Establishment Counts (2)

	(1)	(2)	(3)	(4)
Panel A				
Total Establishments	-0.085	0.048	0.033	0.027
	(0.088)	(0.050)	(0.048)	(0.018)
N	918	918	918	918
R-Sq	0.887	0.976	0.979	0.994
Panel B				
Tradables	-0.019	-0.027	-0.012	-0.032
	(0.124)	(0.092)	(0.091)	(0.044)
N	918	918	918	918
R-Sq	0.910	0.936	0.963	0.967
Panel C				
Nontradables	-0.121	0.048	0.040	0.021
	(0.095)	(0.046)	(0.046)	(0.012)
N	918	918	918	918
R-Sq	0.854	0.979	0.980	0.996
Panel D				
Services	-0.177	0.044	0.033	0.020*
	(0.116)	(0.047)	(0.045)	(0.012)
N	918	918	918	918
R-Sq	0.784	0.980	0.982	0.997
Panel E				
Finance, Insurance, Real Estate	-0.203**	0.057**	0.062**	0.009
	(0.094)	(0.022)	(0.030)	(0.030)
N	918	918	918	918
R-Sq	0.762	0.970	0.976	0.988
Panel F				
Retail Trade	-0.023	0.039	0.024	0.014
	(0.069)	(0.051)	(0.046)	(0.020)
N	918	918	918	918
R-Sq	0.952	0.978	0.982	0.994
City (Airport) FE	Y	Y	Y	Y
Time Trend (Linear and Quadratic)	N	Y	N	Y
Year FE	N	N	Y	N
City-Specific Trends	N	N	N	Y

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

Figure A.1: Hub Closing Event Study - M&A Airports: CBSA - Air Travel Indicators

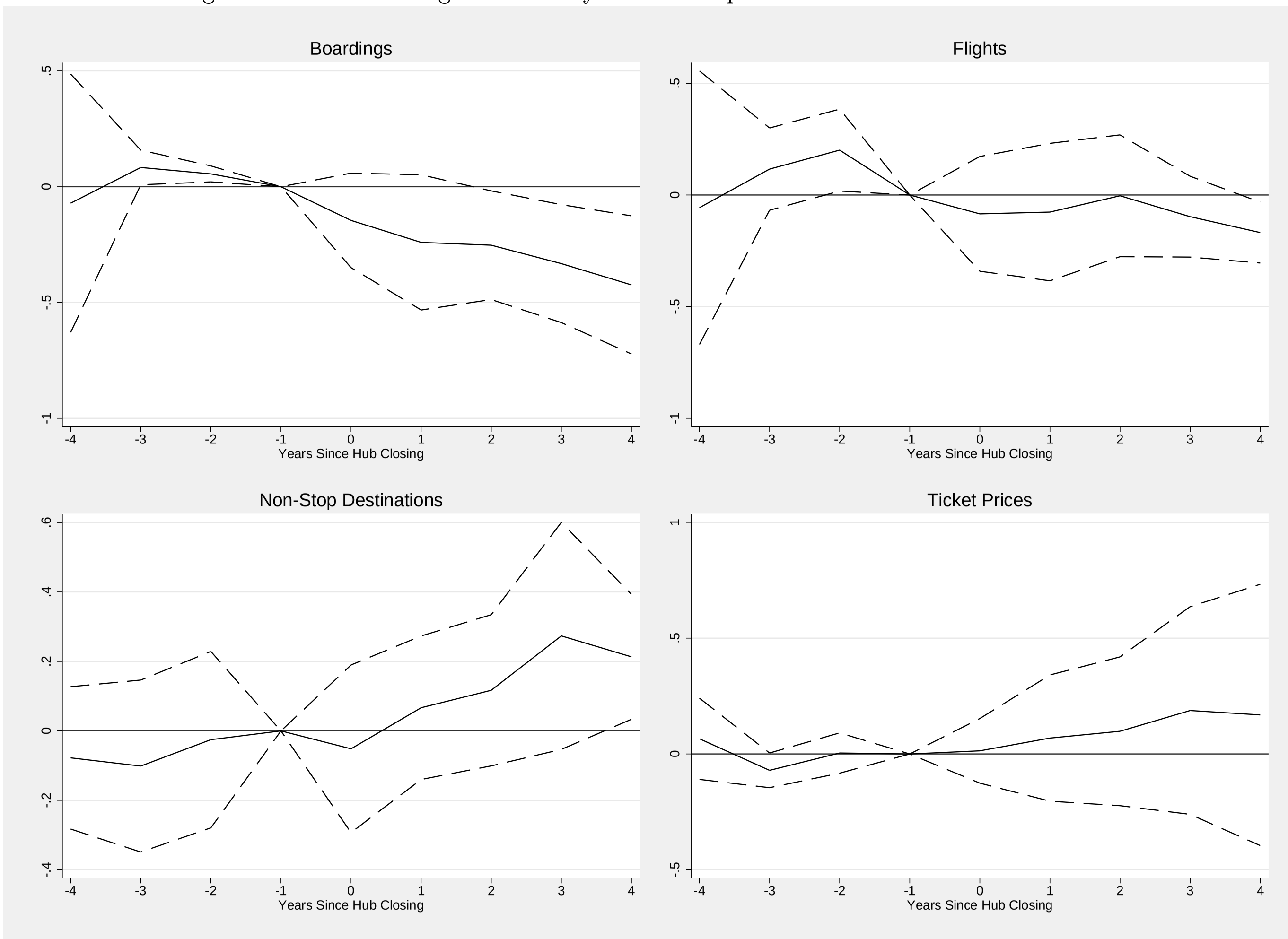


Figure shows event study outcomes on the quantities indicated above. Event studies include airport (city) and year fixed effects, as well as city specific trends. Standard errors are clustered at the city level. Dotted lines indicate 95 percent confidence intervals.

Figure A.2: Hub Closing Event Study - M&A Airports: CBSA - Local Economy Indicators

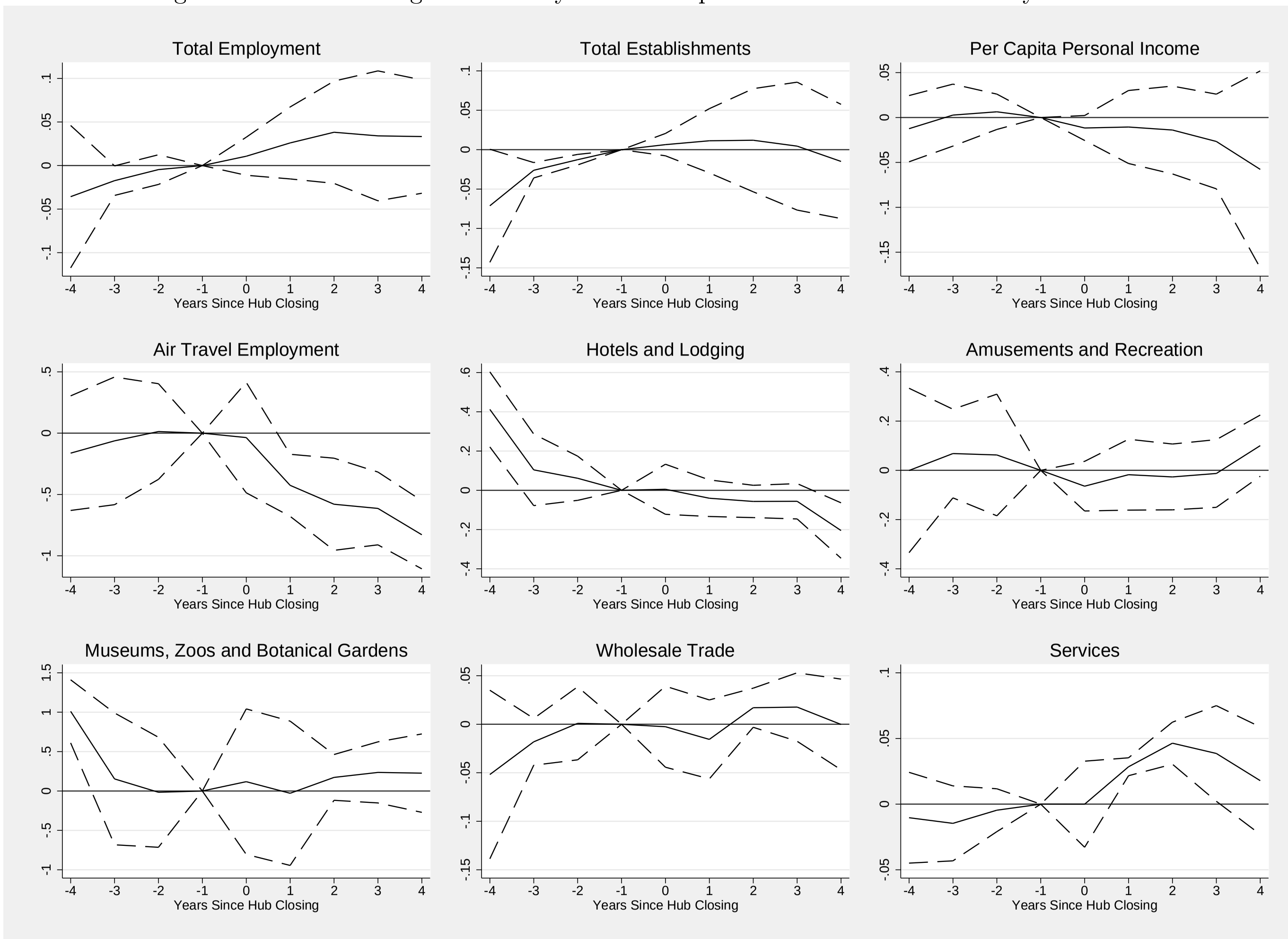


Figure shows event study outcomes on the quantities indicated above. Event studies include airport (city) and year fixed effects, as well as city specific trends. Standard errors are clustered at the city level. Dotted lines indicate 95 percent confidence intervals.