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Air service and urban growth: Evidence from a quasi-natural policy experiment ☆

Bruce A. Blonigen [a,b,1], Anca D. Cristea [a,*]

[a] University of Oregon, USA
[b] NBER, USA

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ABSTRACT

While significant work has been done to examine the determinants of regional development, there is little evidence on the role of air services. This paper exploits the large and swift changes to air traffic induced by the 1978 Airline Deregulation Act to identify the link between air traffic and local economic growth. Using data for 263 Metropolitan Statistical Areas (MSAs) over a two-decade time period, we estimate the effects of airline traffic on local population, income, and employment growth. Our most conservative estimates suggest that a 50-percent increase in an average city's air traffic growth rate generates an additional stream of income over a 20-year period equal to 7.4 percent of real GDP, the equivalent of $523.3 million in 1978 dollars.

1. Introduction

Almost since the invention of the airplane, policymakers at all levels of government have spent considerable resources to promote air services for their constituents. Currently in the United States, local airports and communities are quite active in providing subsidies and pledging future travel tickets in order to encourage airlines to add new routes for their region (e.g., Tampa[2]), or to deter them from terminating strategic routes (e.g., Portland[3]), or from downgrading a city from its hub status (e.g., Cleveland[4]). A 2009 survey by Airports Council International North America found that of the 52 responding airports, 33 had incentive agreements involving domestic air service, and 23 airports had incentive agreements for international air service.[5]

The universal justification for these government policies is the stated belief that air services are crucial for regional economic growth. In support of this belief there is anecdotal evidence suggesting that air transport improves business operations by providing quick access to input supplies, it stimulates innovation by facilitating face-to-face meetings, and overall it represents an essential input to the activity of many industries. However, it is not clear how much local economies significantly rely on air services, nor the extent to which other modes of transportation and communication can be easily used as substitute. In the end, a positive correlation between air services and economic growth may make policymakers erroneously believe that there is a causal

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* Corresponding author at: Department of Economics, 1285 University of Oregon, Eugene, OR 97403, USA.

E-mail addresses: bruceb@uoregon.edu (B.A. Blonigen), cristea@uoregon.edu (A.D. Cristea).

[1] Department of Economics, 1285 University of Oregon, Eugene, OR 97403, USA.

[2] See "Intense competition boosts airport incentives to airlines" at: http://www.tampabay.com/news/business/airlines/intense-competition-boosts-airport-incentives-to-airlines/1042035.

[3] See "Port's gamble on Delta pays off" from 06/11/2010 on www.oregonlive.com.

[4] See "Pittsburgh could foreshadow future of Cleveland Hopkins International Airport" from 11/22/2009 on www.cleveland.com.

[5] McAllister, Brad, "Regaining stability," Airport Business Magazine, September 15, 2011 at: http://www.airportbusiness.com/print/Airport-Business-Magazine/Regaining-stability/137314.

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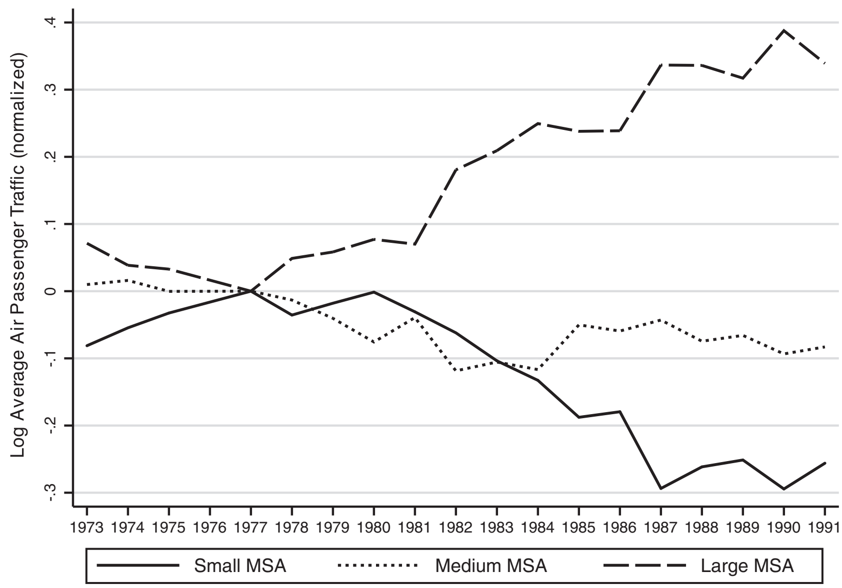

Source: Authors' Calculations

Fig. 1. Trends in air passengers by city size category. *Note*: The series represent the average (log) number of air passengers by year and city size category. To remove level differences in air traffic and facilitate relative comparisons between city size categories, each series has been adjusted by its average value for year 1977. The small, medium and large city categories are defined by splitting the sample distribution of MSA population levels in three equal parts, based on city size information at the beginning of the sample period.

relationship that they can affect, when other factors out of their control could be driving the positive correlation.

Estimating the economic benefits of transportation projects in general, and of air services in particular, is difficult because there is a strong interdependence between the provision of such services and regional growth. Communities that benefit from more rapid economic growth tend to also invest more in infrastructure, and in the provision of transportation services. In turn, the availability of reliable transportation services further stimulates regional development.

Perhaps due to the difficulty of identification, there are only a couple prior studies examining the effect of air service on regional growth. Brueckner (2003) estimates the effect of airline traffic on employment using cross-sectional data at the Metropolitan Statistical Area (MSA) level, and finds that a 10 percent increase in passenger enplanements leads to an approximately 1 percent increase in MSA employment, with service sectors responsible for most of the effect. Brueckner (2003) uses hub status of an airport, the MSA's centrality within the U.S., and its proximity to the nearest large metropolitan area to instrument for the endogeneity of the level of air transport services. However, hub status may be endogenous with current and expected growth of an MSA, while geographic factors may affect general economic growth of a region just as much as air services.[6] Green (2007) estimates the effect of air transport on regional growth. Using information on 83 MSAs, he regresses air passenger traffic levels in 1990 on subsequent decennial population and employment growth, and finds that a 10 percent increase in boardings per capita generates a 3.9 percent higher population growth and 2.8 percent higher employment growth for the period 1990–2000. However, economic outcomes such as population, employment, and even air services are persistent processes. This too makes identification difficult in the absence of a major exogenous and long-lasting shock to the airline service.

In this paper we present an alternative way to identify the relationship between air services and regional economic growth, which relies on time series variation. We exploit a quasi-natural experiment that stems from the dramatic changes in the aviation industry following the 1978 U.S. Airline Deregulation Act.[7] In just a few years following the legislation, the industry was rapidly deregulated, transitioning from an environment of tight policy restrictions to free market. This transformation was accompanied by large changes in air services across cities to unwind the artificial constraints imposed under regulation. These constraints included a regulatory regime that had stopped approving new routes since the early 1970s, and that had explicitly subsidized air service to small and medium communities in the U.S. at the expense of larger cities.[8] To illustrate the relevance and impact of the policy, Fig. 1 illustrates the relative changes in air services across city size groups in the wake of deregulation around the phase-in years 1977–1983. The simple snapshot of the raw data suggests that the 1978 aviation deregulation led to sizable, long-lasting and heterogeneous effects on the provision of aviation services across urban locations.

Using historical data on economic and aviation indicators for 263 MSAs spanning the period 1969–1991, we exploit the significant changes in passenger aviation triggered by industry deregulation in order to infer the effect of air services on regional growth.[9] We

[6] There is a significant economic geography literature showing how spatial location influences regional development and income growth via market access effects. See, for example, Redding and Venables (2004) for a cross-country analysis, or Hanson (2005) and Head and Mayer (2006) for a regional analysis.

[7] Using the German division and reunification as a natural experiment, Redding et al. (2011) provide interesting evidence for how persistent the shocks to the aviation network can be, in large part due to the presence of sunk costs and network externalities.

[8] The only major form of regulation in the industry that remained was the Essential Air Service program, which mandated service to very small communities. This program has been quite limited in the communities it covers, and currently provides services to approximately 3000 passengers a day.

[9] Technically, the unit of observation in our dataset is a Core Based Statistical Area (CBSA), which includes both micropolitan and metropolitan statistical areas. However, since 75 percent of the cities in our sample are metropolitan statistical areas, throughout the paper we will be using the abbreviation MSA to refer to cities in our sample.

take advantage of the variation in the growth of air traffic before versus after the policy change, and employ a difference-in-differences framework. Given the artificial distortions swiftly unwound by deregulation, it is plausible that these deviations in air passenger changes over time were unrelated to urban growth patterns. If so, then an OLS estimation methodology would be sufficient to causally identify the effect of air passenger service on regional growth.

However, we take a number of additional measures to purge our results of any remaining endogeneity concerns. First, we estimate our difference-in-differences framework on already differenced data (i.e., variables expressed as average annual growth rates), so that we identify our effects from deviations in growth paths.[10] Second, we control for location-specific secular trends, as well as for joint determinants of air traffic and urban growth via city fixed effects and control variables for initial period economic conditions. Third, we are only identifying our effects from changes in air passenger traffic that occurred in a relatively short time window following deregulation (i.e., 1977–1983). Longer time frames would mix these one-time deregulatory changes with ongoing air passenger changes that are made in response to current and expected future regional growth trends.

While we believe that these strategies largely eliminate endogeneity concerns, we also employ instrumental variables methods in tandem with our difference-in-differences framework. We explore a number of alternative instruments to isolate the exogenous component of the change in the growth of air traffic that occurred in the wake of deregulation. First, we instrument the deviation in a city's air traffic growth with the average deviation in air traffic growth among cities within the same size category as the city in question. Second, we use information only on "neighboring" cities to construct the average change in air traffic growth triggered by deregulation, and explore a number of alternative definitions of what constitutes a neighboring city.

Our analysis provides evidence for a direct effect of air services on regional development that is robust to these many strategies for identifying this relationship. We find statistically significant and positive estimates across the OLS and across the IV estimates. For a given city, a 50 percent increase in the growth rate of air passenger traffic (a relatively small change in our sample[11]) leads, on average, to an increase in the annual population growth rate ranging between 1.55 and 4.2 percent. To put this result in perspective, this corresponds to an additional 0.42–1.14 percent increase in the population level of the average city after a 20-year period. In the same manner, we find that a 50 percent increase in a city's air traffic growth rate leads to between 1.65 and 3.45 percent increase in the annual income growth rate (which corresponds to an additional 0.6–1.20 percent increase in the level of per-capita income after a 20-year period), and to 2.7–4.7 percent increase in the annual employment growth rate (which corresponds to an additional 1.6–5.7 percent increase in total employment after a two-decade period) on average. When estimating the employment effects by sector, we find that services and retail industries are the ones experiencing significant growth. These effects are comparable in magnitude to similar studies in the literature.[12]

Our paper contributes to the broader literature on the determinants of urban growth, among which transportation infrastructure is one. In two related papers, Glaeser et al. (1992) and Glaeser et al. (1995) provide a framework for analyzing the determinants of urban growth. While they employ their set-up to examine the effect of agglomeration economies and human capital on urban growth, we focus on the role of air services. A study closer to ours is Duranton and Turner (2012), which examines the causal relation between road transportation and city growth. The study finds large and significant effects of highway kilometers on employment and population growth, focusing particularly on intra-city transportation investments as the main determinants of growth. Using historical data on U.S. railroad construction, Donaldson and Hornbeck (2013) assess the importance of railroads to the national economy by quantifying the changes in the agricultural land values resulting from improvements in market access at county level. Banerjee et al. (2012) and Faber (2013) focus on a rapidly growing developing country such as China, and investigate empirically how access to transport infrastructure (e.g., railroads, highways) affects regional economic growth. They find mixed results regarding the local benefits of transport infrastructure investments.

Our paper also complements an expanding literature evaluating other economic consequences of transport infrastructure projects. A prior line of research has examined the aggregate relationship between public spending and economic growth finding mixed results.[13] The availability of historical data on road or railroad construction at detailed geographical level has spurred a number of new studies on the impact of infrastructure, though most of these papers focus on how infrastructure affects trade between regions rather than regional growth.[14]

The remainder of our paper proceeds as follows. The next section describes the context and consequences of the Airline Deregulation Act of 1978. Section 3 lays out the empirical model and discusses the estimation methodology. The data sources are presented in Section 4, while Section 5 describes the estimation results. Finally, Section 6 concludes.

2. The 1978 aviation deregulation and its appropriateness as a quasi-natural experiment

2.1. Institutional background

The 1978 Aviation Deregulation Act (ADA) in the United States was a significant policy change that led to swift and dramatic transformations in the aviation industry. Important for our purposes, the evidence suggests that it had a number of features that make it an appropriate quasi-natural experiment.

First, the regulatory regime had clearly and systematically distorted air service patterns from what one would see in the free

[10] This strategy follows the "difference of differences" approach pursued by Trefler (2004).

[11] There is a lot of variation across communities in the change in air traffic growth rates pre- versus post-deregulation. Rather than rely on the large sample deviation to interpret the coefficients, we chose instead to use a more moderate value of a 50 percent change in the air traffic growth rate. There are only 42 communities (16%) in our sample whose air traffic growth rate changed by 50 percent or less. While this may not be a very large number, we think this conservative scenario is more representative for out-of-sample periods. The kind of changes in air traffic growth rates that happened around the deregulation period are probably much larger than what we tend to observe today. In fact, the change in air traffic growth rate at the national level between 2011–2012 and 2012–2013 is 43 percent (source: Department of Transportation).

[12] For example, Duranton and Turner (2012) find that a 10 percent increase in a city's stock of highways leads to 1.5 percent increase in local employment over a 20-year period.

[13] See Aschauer (1989), Munnell (1992), Holtz-Eakin (1994), Evans and Karras (1994), and Shirley and Winston (2004). Fernald (1999) and Chandra and Thompson (2000) provide insights into the heterogeneous effect of transportation infrastructure across industries and counties, which may explain the mixed findings.

[14] Michaels (2008) provides evidence that rural counties with access to interstate highways experience an increase in trade-related activities such as trucking and retail sales. Duranton et al. (2014) bring additional evidence for the role of interstate highways in determining the specialization of urban locations in sectors producing and trading heavy goods. Sheard (2012) uses the 1944 Civil Aeronautics Administration national airport plan as an instrument for current day airport sizes to examine their impact on the composition of industrial activity. Donaldson (2010) examines how the introduction of railroads in India differentially affected incomes and prices across regions.

market following the industry deregulation. Before 1978, the development and activity of the airline industry was closely overseen by the Civil Aeronautic Board (CAB). The CAB was in charge of certifying and approving new entrant carriers, and assigning them precise point-to-point routes that they had to operate at predetermined airfares. Except for aircraft capacity and flight frequency, all operation decisions, such as entry and exit, route allocations, intensity of market competition, and price levels, were centrally determined by the CAB (Morrison and Winston, 1986). Entry was tightly controlled, certification being awarded on a per-case basis and only for operations on specified routes (Bailey et al., 1985). Rather than aim for industry efficiency, CAB regulations strived to protect the well-being of all existing airlines. It achieved this by suppressing market competition and favoring cross-route subsidization (Dempsey, 1987; GAO, 1996).[15] At the peak of the government intervention, in the early 1970s, CAB ceased to certify new carriers entirely, and even rejected requests by existing carriers to enter new city-pair routes (Borenstein, 1992).

A second important feature of the deregulation was the fast rate at which significant transformations were taking place, as "policy changes followed one another with dazzling rapidity" (Bailey et al., 1985, p. 37). Facing an economic recession, the Ford administration had an economic summit in 1974, where a consensus was reached to tackle federal deregulation. The CAB became an immediate focus and a Senate hearing in 1975 brought much economic evidence to bear that regulation had restricted pricing and entry to the detriment of consumers. When the Carter administration came in 1976 supporting deregulation, there was virtually full political support and the ADA was passed in 1978. In fact, the CAB began significant reforms already by 1977, allowing "pro forma approval of discount fares" and granting "permissive route authority, which would allow a carrier to enter and exit from a route without CAB intervention" (Bailey et al., 1985, p. 33). The ADA specified full deregulation by January 1, 1983, but the CAB already had granted airlines complete route flexibility within a year of the act and new airlines were entering the market.

A third important feature is that the ultimate effects of the aviation deregulation were uncertain and the industry responded in a number of unexpected ways. The rapidity of the deregulation process, as described above, made the effects unlikely to be anticipated. The expectation was that the aviation industry would become much more competitive after deregulation, leading to greater efficiencies and lower prices for air travel. The contestable market theory, combined with the lack of evidence in support of economies of scale in the aviation industry, diminished any concerns about anti-competitive effects in markets dominated by single carriers (Borenstein, 1992). While there is significant evidence of lower general prices and increased competition, in many ways, the actual transformations that swept the aviation industry since deregulation had been surprising due to "mistaken expectation and unforeseen outcomes" (Kahn, 1988). Perhaps one of the most significant yet totally unanticipated responses from air carriers was the switch from operating point-to-point service to a hub-and-spoke network. This transformation increased industry efficiency through better capacity utilization, as captured by higher load factors per flights (Borenstein and Rose, 2011). It also allowed for more frequent departures and more flexibility in flight schedules from hub airports, but at the cost of an increase in the average number of connections and travel distances for itineraries originating in smaller airports. The restructuring of non-stop destinations by airport size implied a decrease in the number of non-stop destinations at small and some medium size communities (Dempsey, 1987; GAO, 1996), and a much larger increase in air services in big cities, many of which had been selected as hub locations.[16]

A final feature of aviation deregulation that is fundamental to our identification strategy consists of the systematic heterogeneity in the policy-induced shock to air services across locations. The CAB undertook many efforts to ensure service to smaller communities under regulation. In fact, the CAB deliberately set fares above cost in city-pair markets located more than 400 miles apart (typically large, dense markets), and set fares less than the costs in shorter city-pair markets (Bailey et al., 1985, p. 20). The loss of this cross-market subsidization was a primary concern of legislators when considering deregulation, as there were real fears that many small (and even medium-sized) communities would face substantial loss of air service. Ultimately, arguments that commuter air services would likely take the place of traditional airline services in these communities, as well as the institution of the Essential Air Service program to directly subsidize air service at the smallest communities, allowed legislators to back deregulation.[17]

In summary, it was well known that the price levels and route allocations set by the CAB favored small communities. The reverse was true for large urban areas, where high fares and the suppressed competition hindered the growth and development of air transport services. As a result, the regulatory environment led to large and systematic deviations from market forces.

2.2. Descriptive evidence

The evidence for the systematic distortions in air traffic patterns across city sizes is noticeable in the data. Fig. 1 depicts the average number of air passengers per city by size category in the years before and after the aviation deregulation, relative to the national trends.[18] The data representation shows that prior to 1978 small communities witnessed the largest increase in air traffic – evidence that the CAB strategies of route cross-subsidization had been effective at stimulating air service in small locations at the expense of large communities.[19] Following the Airline Deregulation Act in 1978, large urban areas benefited from a relative increase in the rate of air passenger growth, while small communities suffered a negative shock to the provision of air services. These trend reversals triggered by the regime switch are consistent with the changes in air traffic expected from the removal of capacity restrictions and price setting schemes imposed by the CAB prior to 1978.

Going beyond average tendencies in air passenger flows by city size group, Fig. 2 documents the differences in air traffic growth rates between the regulated and deregulated periods. The scatterplots bring further support to how large and persistent was the

[15] In documenting the cross-subsidization practice of the CAB Eads (1972, pp. 205–206) states that: "the more recent attempt by the Board to internalize the local service subsidy (by giving carriers routes on which it hoped substantial profits could be made) required that entry controls be continued. It also meant that the Board, in deciding which carrier to favor with route awards, had to continue to base its choice in large part on the need of local service carriers for profit and not on the more desirable criterion of which carrier would provide the service at the least cost."

[16] The evidence on the decrease in the number of non-stop destinations at small cities as a consequence of the aviation deregulation is mixed. While many small communities indeed suffered a net loss in non-stop destinations reached, Morrison and Winston (1986) find that other factors specific to the post-deregulation period are responsible for these service losses, such as increased fuel prices, higher returns to aircraft equipment elsewhere, or cyclical macroeconomic conditions.

[17] Several very small communities did lose air traffic entirely after deregulation. However, the Essential Air Service (EAS) program allowed many others to keep air connectivity with the nearest hub airport. For more information on costs and benefits of the EAS Program, see the General Accounting Office report (GAO, 2000), among others.

[18] For ease of representation, each time series has been rescaled by the average level of air traffic in 1977.

[19] The small, medium and large city categories are defined by splitting the sample distribution of MSA population levels in three equal parts, based on city size information at the beginning of the sample period.

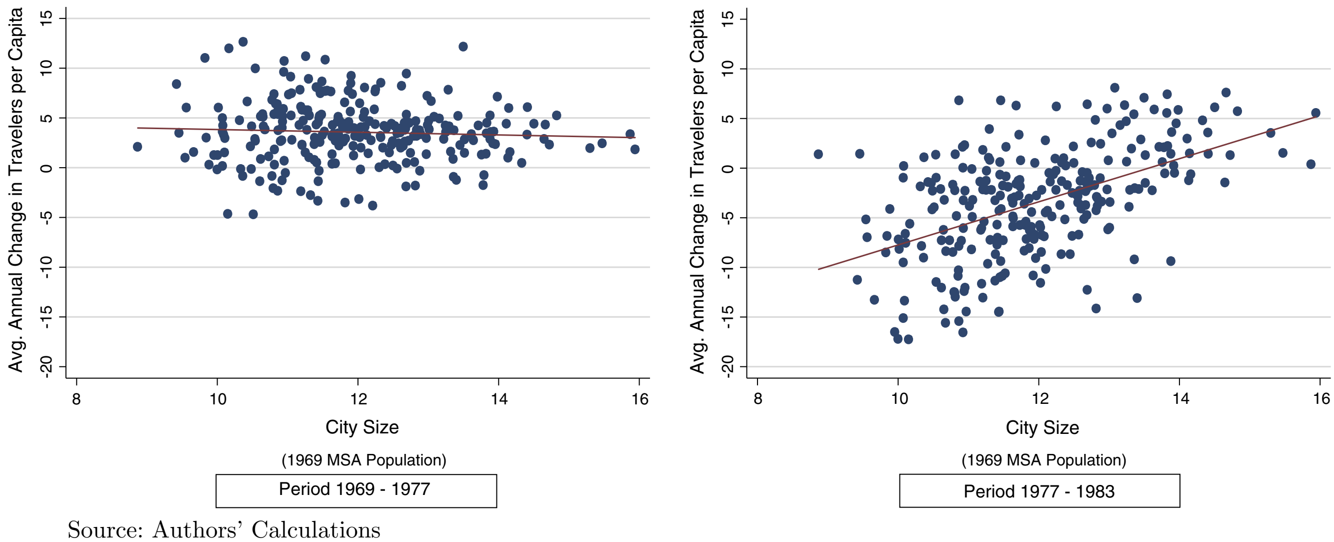

Fig. 2. City-level changes in air traffic per capita during regulation and deregulation. *Note*: The *y*-axis of each scatterplot represents the average annual percentage change in air passengers per capita at city level. The average percentage change is calculated over two distinct periods: 1969–1977, which denotes the pre-deregulation period; and 1977–1983, which corresponds to the aftermath of the aviation deregulation. The pattern of changes in air traffic per capita differs quite substantially across the two time periods, suggestive of the major shock to the aviation industry induced by the policy change. The fact that differences in air traffic changes display significant variation both within and across city size groups can be indicative of the heterogeneous effect of deregulation across locations.

impact of the policy change. They also illustrate the heterogeneity across cities in air traffic changes over time. Even though, on average, small and medium size cities have witnessed a larger negative shock to air traffic growth than large cities, when looking within a given city size, there is still quite a bit of variation in the magnitude of the policy-induced shock. This aspect is going to play a crucial role in the analysis, as our estimation will exploit both within city size and across city size variation in air traffic changes over time.

Besides the large data variation that it generates, identification from a quasi-natural experiment requires that there are no other confounding events that also affect urban growth. There are two major events that took place around the same time as the deregulation of the aviation industry, which could potentially affect our ability to identify the effects induced by the airline deregulation on regional growth.

The first event is the 1979 oil price shock, which occurred in the aftermath of the aviation deregulation. The surge in fuel costs and energy prices in the early 1980s presumably impacted not only the growth and development of the aviation industry, but also the economy as a whole. To the extent that these shocks affected economic growth differentially across cities of different sizes, then part of this variation may be spuriously picked up in our estimation. However, we think this issue is less problematic for our data exercises because our variables of interest are long-run growth rates computed over a period of time (i.e., 1977–1991) whose start and end dates are distant from the oil crisis and its aftermath.[20]

A second series of events that may be of concern for our estimation strategy is the full or partial deregulation occurring during the same time period in other industries – most notably in the trucking and railroad industries.[21] However, unlike the airline industry, we are not aware of any evidence to suggest that these deregulation events led to systematic heterogeneous changes in the economic activity across regions. While increased competition and improved cost efficiency in the absence of regulation have favored industry expansion and a rapid output growth, these trends have been observed nationwide. This implies that any systematic deviations from national trends in local economic growth rates that we identify across different-sized communities pre- versus post- the 1978 aviation deregulation cannot be attributed to regulatory initiatives happening simultaneously in other sectors.

[20] There is no evidence in our sample that economic growth rates differ across MSA size categories once controlling for initial conditions, industrial composition and lagged urban growth rates. Estimates are available upon request.

[21] Winston (1993) provides a comprehensive survey of the regulatory reforms implemented in the U.S. at the end of 1970s and beginning of 1980s, including the deregulation of the transport sector.

3. Empirical strategy

3.1. Basic framework

In this paper, we take the view that aviation services are part of the local fundamentals characterizing an urban community. As such, they contribute to enhancing local productivity levels while, at the same time, being a valuable city amenity that enhances the quality of life.[22] In a Web Appendix,[23] we build these assumptions into a simple model of urban growth to formally derive a direct relationship between changes in air traffic at the community level, and subsequent changes in population, labor force and per-capita income. Using the notation $\dot{K}_{iT} \equiv \frac{lnK_{iT_1} - lnK_{iT_0}}{T_1 - T_0}$ to denote the (log) average annual change of variable K in city i over the time period

[22] Several channels have been suggested for the productivity effect of air transport services. First, air travel facilitates face-to-face communication, which is essential for innovation, technology diffusion, and for coordination and efficient allocation of resources (see, among others, Gaspar and Glaeser, 1998; Audretsch and Feldman, 1996; Hovhannisyan and Keller, 2011; Giroud, 2013). Second, the availability of air services reduces transaction costs, increasing the openness of a region to trade (Poole, 2010; Cristea, 2011). This in turn fosters labor and industrial specialization at the micro level, as well as product diversification at the regional level, leading to increased aggregate productivity (Glaeser et al., 1992; Feenstra and Kee, 2008). Finally, air traffic could raise regional productivity via agglomeration effects and the associated positive externalities (see, among others, Stuart and Strange, 2004). The location decision of exporters and multinational firm headquarters is influenced by the quality of air services (Lovely et al., 2005; Bel and Fageda, 2008). At the same time, both types of firms are shown to exert positive spillovers on local businesses, further affecting productivity (Blomstrom and Kokko, 1998; Arnold et al., 2011). Our intention in this study is to identify an aggregate net effect of air traffic on urban development, working in part through any of these productivity effects.

[23] Web Appendix URL: <http://pages.uoregon.edu/cristea/Research_files/WebAppendix_urban.pdf>.

$T = [T_0, T_1]$, the resulting estimation equation can be written as follows:

$$\dot{Y}_{iT} = \beta\dot{A}_{iT} + X_{iT_0}{}'\gamma + \alpha_i + \alpha_T + \varepsilon_{iT} \tag{1}$$

where Y_i stands for population, employment or per-capita income in city $i; A_i$ denotes the level of air services in city i, as measured by the total number of enplaned passengers; the vector X_{iT_0} captures location-specific control variables that are observable at the beginning of the time period T and that affect urban growth. Finally, α_i and α_T stand for location and time period fixed effects, and ε_{iT} denotes the error term.

Our interest lies in estimating the effect of air services on regional growth. We expect the coefficient of interest β to be positive and significant.[24] A challenge in identifying β comes from the interdependency between the provision of air services and regional growth, which raises endogeneity concerns. To address this, we take advantage of the exogenous data variation generated by the dismantling of aviation regulations. Before analyzing the approaches we take to isolate the exogenous variation in air traffic from any endogenous responses to the policy change, it is worth discussing some key aspects related to the specification in Eq. (1).

First, the outcome variables of interest – population, per-capita income or employment – change slowly over time. As a result, long run growth rates may be better suited for capturing regional development. Unlike year-on-year changes, long differences of the data are more appropriate for correctly identifying any persistent relation between the variables of interest in the presence of significant autocorrelation (Bertrand and Duflo, 2004). For this reason, in our estimation we consider two long-run subsample periods: one that defines an interval of time before the aviation deregulation, and one that defines an interval of time following the policy change. We let the time indicator T index the two time periods, with $T = 0$ denoting the pre-deregulation period 1966–1977, and $T = 1$ denoting the post-deregulation period 1977–1991.[25] We choose the year 1977 as the cutoff point rather than 1978, which is the year when the Airline Deregulation Act entered into effect, because we want to calculate post-deregulation long-run changes in air traffic starting from a reference period that pre-dates and thus is unaffected by any major changes in routes or price levels triggered by the policy change.

Second, the period fixed effect α_T is important for model identification as it accounts for any period-specific macroeconomic factors that may influence regional growth. However, given the long-run time horizon being considered, it is possible for cities to go through structural changes in their urban growth paths. These changes may differ systematically across cities depending on geographic location, economic size or industrial specialization. To account for this in our regression model, we control for economic conditions at the beginning of each time period T. We specify the vector X_{iT_0} to include information on population size, per-capita income, factor endowments, and industrial composition at the MSA level for the base year of each long-term period. This allows us to implicitly control for things like changes in labor productivity and skill premium across both periods, as well as across cities of different sizes.

Finally, to account for location-specific determinants of urban growth that may be difficult to measure, we employ city fixed effects, α_i. These control for factors such as economic fundamentals, geographical location, land area, climate, natural resource endowments, and any persistent socio-cultural characteristics that may affect the economic growth of a city. Adding city fixed effects to the regression Eq. (1) allows us to remove location-specific secular trends. A direct implication is that the model coefficients are identified from the comparison of urban growth rates before versus after the aviation deregulation.[26]

This estimation approach is very demanding of the data. If the policy shock under consideration is not large enough to generate substantial variation in the variables of interest, or if the time period is not long enough for the economic outcomes to fully adjust to their new equilibrium levels, then differencing the data by constructing long-run annual growth rates, and removing location-specific trends by adding city fixed effects are going to sweep away any useful information. Fortunately for our identification strategy, Figs. 1 and 2 provide suggestive evidence of substantial variation in air passenger traffic before versus after deregulation.

3.2. Estimation methodology

Estimating Eq. (1) requires a careful consideration of the data generating process underlying the changes in air traffic, $\dot{A}_{iT}$, in order to understand the main sources of variation and to isolate the exogenous component. We proceed by discussing first the lengths we can go to fully exploit the quasi-natural policy experiment to identify the effects of air service on regional growth within an OLS framework. We then describe a number of instrumental variables strategies that we use to pin down the exogenous portion of air passenger growth, thus allaying any remaining concerns about endogeneity.

Given the regression specification, the variation exploited for model identification consists of the *deviation* in air traffic changes between the regulation ($T = 0$) and post-deregulation ($T = 1$) periods, i.e., $\Delta\dot{A}_{iT} \equiv \dot{A}_{i1} - \dot{A}_{i0}$. To formally derive it, we begin by defining the level of air traffic in city i at time t. We assume that the CAB rules imposed during the regulatory period distorted air traffic by affecting both its level and its rate of adjustment to local economic conditions. Thus, air traffic in city i at time t can be defined as:

$$lnA_{it} = \begin{cases} \alpha_i + \delta lnZ_{it} + \alpha_t, & \text{if deregulation (free market)} \\ (\alpha_i + \widetilde{\alpha}_i) + (\delta + \widetilde{\delta}) lnZ_{it} + \alpha_t, & \text{if regulation} \end{cases} \tag{2}$$

where $\widetilde{\alpha}_i, \widetilde{\delta}$ denote the policy-induced distortions to air traffic, which can be location-specific; and Z_{it} represents any city characteristics that explain the level of air traffic in city i, including city size or income level (which are elements of Y_{it} in Eq. (1)).

From Eq. (2), using the notation $\dot{K}_{iT} \equiv \frac{lnK_{iT_1} - lnK_{iT_0}}{T_1 - T_0}$, we can write the average annual change in air traffic during the regulatory period as:

$$\dot{A}_{i0} = \dot{\alpha}_0 + (\delta + \widetilde{\delta})\dot{Z}_{i0} \tag{3}$$

where the subscript "0" indexes pre-deregulation period variables.

Similarly, we can express the average annual change in air traffic post-deregulation as:

$$\dot{A}_{i1} = \dot{\alpha}_1 - \widetilde{\alpha}_i + \delta\dot{Z}_{i1} - \widetilde{\delta} lnZ_{i1,T_0} \tag{4}$$

where the subscript "1" indexes post-deregulation period variables, and T_0 denotes the initial year of the post-deregulation period. Note

[24] The coefficients β, γ are reduced-form parameters whose structure is derived in the Web Appendix from the proposed urban growth model.

[25] The chosen time periods are determined by the data availability on air services, and by the timing of deregulation. In particular, year 1969 is the first year when air passenger traffic was collected and reported at city level, while year 1991 is the earliest year that such records have become available electronically. In the empirical analysis, we provide evidence for the robustness of our results to perturbations in these time windows.

[26] Given that the estimation sample includes two long-run periods, i.e., $T \in \{0, 1\}$, the city fixed effects model in Eq. (1) delivers identical estimates as a differenced model of urban growth rates between the two time periods (Wooldridge, 2002, p. 284).

that since the initial year of the post-deregulation period coincides with the last year of the regulatory period (i.e., year 1977 in the data), in deriving Eq. (4) we use policy-distorted levels of air traffic for the base year T_0 of the post-deregulation period "1".

The variation exploited for identifying the coefficient of interest β in Eq. (1) is then given by the deviation in air traffic growth rates between pre- and post-deregulation periods. From Eqs. (3) and (4), we can derive this differential change as:

$$\Delta\dot{A}_i \equiv \dot{A}_{i1} - \dot{A}_{i0} = \Delta\dot{\alpha} - \widetilde{\alpha}_i + \delta\Delta\dot{Z}_i - \widetilde{\delta}(\dot{Z}_{i0} + lnZ_{i1,T_0}) \quad (5)$$

The constant term $\Delta\dot{\alpha} \equiv \dot{\delta}_1 - \dot{\delta}_0$ captures the change in air traffic growth rates between the pre- and post-deregulation periods that is uniform across all cities in the sample. The term $\Delta\dot{Z}_i$ captures over time changes in the growth rate of location specific determinants of air traffic. Note that $\Delta\dot{Z}_i$ is different from zero only for those city characteristics that witness systematic changes in their long-run growth rates at the time of the aviation deregulation. This is important for model identification as many unobservable factors that jointly determine air traffic and urban growth are potentially evolving at a constant rate over the two periods of interest $T \in \{0, 1\}$.

Key for our purposes, Eq. (5) identifies the conditions under which the variation in air traffic changes over time, i.e., $\Delta\dot{A}_i$, can be taken as exogenous with respect to the unobserved determinants of urban growth (i.e., the residual variation in Eq. (1)). It also formalizes the channels through which endogeneity may operate. The regulatory distortions rapidly unwound by deregulation, as captured by $\widetilde{\alpha}_i$ and $\widetilde{\delta}$, add unique variation to city-level changes in air traffic. This is the exogenous variation generated by the quasi-natural experiment that we want to exploit in our estimation. However, city size or per-capita income – the dependent variables in our baseline model – are likely part of the vector Z_i. This creates an endogeneity problem. Note that the sources of endogeneity in $\Delta\dot{A}_i$ lie both in the levels (Z_{i1,T_0}) and per-period growth rates ($\dot{Z}_{i0}, \dot{Z}_{i1}$) of urban growth determinants. To the extent that we can isolate the exogenous component of the variation in $\Delta\dot{A}_i$ once conditioning on city characteristics, the OLS estimation methods should be appropriate to use in estimating Eq. (1). Otherwise, we need to refer to instrumental variable methods.

At this point, before discussing each estimation method, it is useful to take a preliminary look at the data and examine raw correlations between the variables in Eq. (5). Table 1 provides some interesting statistics, with Panel A reporting the correlation between city-level changes in air traffic and urban growth rates pre- versus post-deregulation (i.e., $corr(\Delta\dot{A}_i, \Delta\dot{Z}_i)$). In general, the growth rate changes are not highly correlated among the variables of interest, reducing concerns about simultaneity or spurious correlation. This is in contrast to the correlation coefficients between the level of these variables – observed in Panel B of Table 1 – where the scale differences across cities make the volume of air traffic highly correlated with the population size and with total employment.[27] Based on this, we can reasonably argue that many of the factors that simultaneously determine air travel and regional economic development are eliminated by double differencing the data.

Additional descriptive evidence is provided in Panel C of Table 1, which illustrates the relatively weak correlation between the variables' growth rates in the regulation period (i.e., ΔZ_{i0}) and the air traffic growth rate in the post-deregulation period (i.e., ΔA_{i1}). For example, the correlation coefficient between population growth in the regulation period and passenger growth post-deregulation is 0.37, absent any city level controls. Similarly, the correlation between the air traffic growth rates pre- and post- deregulation is 0.33, a value that is suggestive of some consistency in the evolution of air traffic over time, but also of significant shocks to its growth trajectory at city level. Finally, the last row in Panel C reports the correlations between city-level changes in air traffic growth ($\Delta\dot{A}_i$) and pre-deregulation urban growth rates (i.e., ΔZ_{i0}). Again, we find little to no evidence of systematic relationships – suggestive that endogeneity concerns may be limited.

3.2.1. OLS approach

We propose several model refinements to restrict the variation in air traffic growth to only capture the exogenous policy-induced shocks triggered by the dismantling of aviation regulation.

Short post-deregulation time window. We shorten the time horizon over which air traffic changes are measured during the post-deregulation period as a way to mitigate the impact of reverse causality. Referring to Eq. (4), by limiting the time frame for $T = 1$, we force the vector of city characteristics $\dot{Z}_{iT}$ that affects $\dot{A}_{i1}$ to only vary due to immediate or short run changes. To the extent that such changes are not much different from the changes observed the previous period – e.g., sluggish adjustments – this reduces the reverse causality problem, increasing the chances that $\Delta\dot{Z}_i = 0$ in Eq. (5).

In the empirical analysis, we restrict our attention to the time window 1977–1983 to define $\dot{A}_{i1}$, as this period captures the aftermath of deregulation, when the large unexpected changes in air traffic occurred. We choose 1983 as the end-year, first, because this is when the CAB was fully dissolved – suggestive that the industry had reached a stable equilibrium and required no more oversight; and second, because year 1983 was relatively uneventful at a macroeconomic level, reducing the potential for other market distortions to affect the calculated average annual changes in air traffic.

Observed and anticipated urban growth. As Eq. (5) shows, the variation in air traffic changes depends on urban growth determinants (both levels and changes). To mitigate endogeneity concerns, we control for these directly in our regression model. Eq. (1) already accounts for per-period initial economic conditions (lnZ_{i1,T_0}), so what still needs to be controlled for are the observed ($\dot{Z}_{i0}$) and anticipated ($\dot{Z}_{i1}$) rates of urban growth. For that, we rely on cities' historical population sizes. Thus, we expand our regression model by including as additional control variables: (1) decade-long lags of city population (i.e., L_{i,T_0-j} for $j > 0$); (2) per-period base year city characteristics; and, as a distinct element of the vector of initial conditions, (3) the level of air passengers per capita at the beginning of each period (i.e., A_{iT_0}/L_{iT_0}), as a way to account for any systematic variation in $\dot{A}_{iT}$ across cities. The estimating Eq. (1) now becomes:

$$\dot{Y}_{iT} = \beta\dot{A}_{iT} + X_{iT_0}{}'\gamma + \theta ln\left(\frac{A_{iT_0}}{L_{iT_0}}\right) + \sum_{j=0}^{L}\tilde{\gamma}_j L_{i,T_0-j} + \alpha_i + \alpha_T + \varepsilon_{iT} \quad (6)$$

with Y standing for population, employment or per-capita income in city i.

Eq. (6) can achieve proper identification by OLS methods if the remaining residual variation in $\dot{A}_{iT}$ coming from the unwinding of policy distortions is exogenous.

3.2.2. Instrumental variables (2SLS) approach

Differencing the data, and adding control variables and fixed effects to the regression model may be sufficient measures to eliminate any correlation between our variable of interest and the error term. However, in the event of remaining endogeneity concerns, we also estimate our model using instrumental variables. For this purpose, we exploit the differential impact that the ADA had on cities of different sizes. We instrument for the change in air traffic growth in city i using the average change in air traffic growth over time

[27] While the reported correlation coefficients are calculated based on data for year 1969, this pattern is found for all other years in the sample.

Table 1
Correlation coefficients.

Panel A: Correlation coefficients between changes in variables' growth rates

	Δ Passenger growth	Δ Population growth	Δ Income growth	Δ Employment growth
Δ Passenger growth (log)	1.00			
Δ Population growth (log)	0.23	1.00		
Δ Income growth (log)	0.40	0.16	1.00	0
Δ Employment growth (log)	0.29	0.49	0.59	1.00

Panel B: Correlation coefficients between (log) base year variables

	Passengers 1969	Population 1969	Income 1969	Employment 1969
Passengers 1969	1.00			
Population 1969	0.88	1.00		
Income 1969	0.50	0.48	1.00	
Employment 1969	0.87	0.98	0.51	1.00

Panel C: Correlation coefficients between variables' growth rates across periods

	Passenger growth 69–77	Population growth 69–77	Income growth 69–77	Employment growth 69–77	Passenger growth 77–83	Population growth 77–91	Income growth 77–91	Employment growth 77–91
Passenger growth 69–77	1.00							
Population growth 69–77	0.50	1.00						
Income growth 69–77	0.16	0.01	1.00					
Employment growth 69–77	0.44	0.72	0.36	1.00				
Passenger growth 77–83	0.33	0.37	−0.20	0.21	1.00			
Population growth 77–91	0.39	0.75	−0.13	0.55	0.46	1.00		
Income growth 77–91	0.04	0.16	−0.30	−0.01	0.37	0.20	1.00	
Employment growth 77–91	0.35	0.66	−0.16	0.52	0.49	0.85	0.47	1.00
Δ Passenger growth (91–77)–(77–69)	−0.23	0.09	−0.30	−0.03	0.84	0.27	0.36	0.30

Note: Each variable measuring a change in growth rates is constructed at MSA *i* level as follows: $\Delta y_i = \frac{1}{14} log\left(\frac{y_{i,1991}}{y_{i,1977}}\right) - \frac{1}{8} log\left(\frac{y_{i,1977}}{y_{i,1969}}\right)$, with $y \in$ {passengers; per capita income; employment}.

observed across the MSAs in the same size category as city *i*. Specifically, we use the interaction term between the time period indicator *T* and each of the three MSA size category indicators to predict $\dot{A}_{iT}$. [28]

Exploiting information pertaining to many cities of similar size as city *i* has several advantages. It significantly reduces reverse causality concerns, since much of the data variation contained in the excluded instrument comes from sources external to city *i*. It also mitigates the concern of weak instruments, as we have already documented the common patterns among cities of similar size in their policy-induced distortions.

We also experiment with two related versions of the proposed instrument. First, within each MSA size category, we calculate the average deviation in air traffic changes among cities *other* than the particular city of focus, city *i*. By construction, this instrument is now purged of any economic growth determinants specific to city *i*. Second, rather than rely on the simple average of air traffic changes for cities $j \neq i$, we compute instead a weighted average using the inverse of the geographic distance between cities *i* and *j* as weights. That is, we instrument for $\dot{A}_{iT}$ using the weighted average: $\frac{1}{N}\sum_{j\neq i}\dot{A}_{jT}/Dist_{ij}$, with city *j* belonging to the same MSA size category as city *i*. The main benefit of using spatial weights is to place greater importance on cities that are in proximity of city *i*. To the extent that the regulatory distortions had regional components, then such a geography-weighted instrument may have a stronger predictive power.

Besides their benefits, a potential drawback of these instruments is that, by construction, they may capture more than just the exogenous changes in air traffic growth induced by the airline deregulation. For instance, unobserved factors that affect both air traffic and urban growth, and that change simultaneously with the change in policy are going to load onto the first stage estimator. To understand how large is this concern, as a preliminary data check, we inspect for structural breaks in the MSAs' growth path around the time of the ADA.[29] The results of this exercise, relegated to the Appendix Table A1, suggest that once accounting for city and time fixed effects, the average annual growth rate of population, employment or per-capita income during the period 1977–1983 does not differ from the pre-deregulation period in a way that is systematically related to the size category of the cities in the sample.

4. Data

The data used in this study correspond to years 1969, 1977 and 1991 (and 1983 for air traffic), and are collected from various sources. The beginning and end years of the sample period are dictated by data availability, as well as the distance in time away from the policy shock represented by the 1978 ADA. The data are collected at the city or county level for the 48 contiguous U.S. states, and aggregated to the level of metropolitan (or, in some cases micropolitan) statistical areas.[30] This seems the most appropriate spatial unit for evaluating the economic impact of an airport's air transport services.

[28] We are grateful to Jan Brueckner for suggesting these instruments.

[29] To do so, we include the instruments as explanatory variables in a fully specified regression model of urban growth, where the growth rate of each economic indicator used as dependent variable is calculated over the same post-deregulation time window as the growth rate of air traffic, i.e., 1977–1983.

[30] We use the current mapping of counties into the core based statistical areas (the majority of which are MSAs) available from the U.S. Census through their U.S Gazetteer Place data from 2006. Even if the current delineation does not correspond to the one implemented several decades ago, its application throughout the entire sample period ensures the consistency of statistical areas throughout the panel period.

Table 2
Summary statistics.

Variable (log)	Obs.	Mean	Std. dev.	Min.	Max.
Growth rates: total sample					
Passenger growth	526	0.012	0.061	−0.185	0.150
Population growth	526	0.012	0.012	−0.014	0.060
Income growth	526	0.017	0.011	−0.010	0.051
Employment growth	526	0.028	0.018	−0.033	0.080
Growth rates: pre-deregulation period					
Passenger growth '69–'77	263	0.049	0.034	−0.040	0.150
Population growth '69–'77	263	0.015	0.012	−0.005	0.053
Income growth '69–'77	263	0.025	0.008	0.000	0.051
Employment growth '69–'77	263	0.031	0.020	−0.033	0.080
Growth rates: post-deregulation period					
Passenger growth '77–'83	263	−0.025	0.060	−0.185	0.108
Population growth '77–'91	263	0.009	0.011	−0.014	0.060
Income growth '77–'91	263	0.010	0.006	−0.010	0.029
Employment growth '77–'91	263	0.025	0.015	−0.014	0.074
Base year variables (per long-run period)[a]					
Passengers per-capita	526	−0.713	0.937	−3.456	2.036
Population	526	12.034	1.273	9.273	16.020
Income per-capita	526	9.220	0.184	8.478	9.746
Employment	526	10.687	1.390	7.745	14.990
Share manufacturing	526	−1.430	0.604	−3.870	−0.350
Share services	526	−1.632	0.270	−2.722	−0.646
Share wholesale	526	−2.731	0.366	−5.573	−1.675
Share retail	526	−1.482	0.227	−2.341	−0.862
Share transport/utilities	526	−2.793	0.320	−3.799	−1.397
Share construction	524	−2.800	0.359	−3.878	−1.266
Population $\text{Lag}_{(T_0-10)}$[b]	526	11.933	1.254	8.870	15.940
Population $\text{Lag}_{(T_0-20)}$[b]	526	11.795	1.222	8.648	15.764
Population $\text{Lag}_{(T_0-30)}$[b]	526	11.609	1.211	8.665	15.567

[a] Initial conditions refer to economic indicators from year 1969 for the pre-deregulation period, 1969–1977, and from year 1977 for the post-deregulation period 1977–1991.
[b] For the pre-deregulation period, the three lags of population levels correspond to years 1960, 1950 and 1940. For the post-deregulation period, the three lags of population levels correspond to years 1969, 1960 and 1950.

The air passenger transport data are provided by the Department of Transportation (DOT) and the Federal Aviation Administration (FAA). We collect the data from the *Airport Activity Statistics of Certificated Route Air Carriers*, which cover the activity of large air carriers certified to operate aircraft with capacity of 60 seats or more. We augment this data with air traffic information from the Small Air Carriers Database (Form 298C Schedule T1) provided by the DOT. We restrict attention to domestic scheduled air services and for each city or airport in the U.S. record the total annual number of enplaned passengers. We map all U.S. airports or city locations available in our dataset into the corresponding counties using information from the FAA, and then map counties into MSAs based on the concordance available from the U.S. Census Bureau.

Data on population and per-capita income is provided by the Bureau of Economic Analysis at the county level, which we then aggregate to the MSA level.[31] Employment data – total and by major sectors (manufacturing, services, wholesale, retail, construction, transportation and utilities) – are available from the *County Business Patterns* (CBP) provided by the U.S. Census.[32]

After combining all sources of data over the three selected years 1969, 1977 and 1991 (1983 for air traffic), and after screening the resulting sample for potential outliers, we end up with a set of 263 urban centers.[33] Each of these remaining MSAs hosts at least one airport that has been active in every one of the three years spanning the 23-year period. The summary statistics on the variables of interest, including the constructed annual growth rates for the periods 1969–1977 and 1977–1991 (respectively, 1977–1983 for air traffic), are reported in Table 2. An important thing to notice is the substantial variation in growth rates over the two sample periods, especially for air passenger traffic.

5. Estimation results

5.1. OLS approach

Table 3 reports the results from estimating Eq. (6) with population growth as the local economic outcome of interest. The first column includes city-level changes in air traffic, in addition to a minimum set of control variables: time fixed effect and initial period conditions. Population levels at the start of each time period account for differences across cities in population growth rates, while the time fixed effect captures any post-deregulation macroeconomic shocks that may affect the rate of population growth nationwide.

Air traffic growth has a positive effect on the rate of population growth. While significant, this result does not take into account the possibility that prior and anticipated future city growth are not only correlated with actual urban growth rates, but they also determine the growth rate of air traffic post-deregulation. To remove this source of endogeneity, in column 2 we include three decadal lags of population, in levels. The effect of air service on population growth decreases in magnitude but remains positive and significant.

[31] Nominal per-capita income rates are converted into real values using the consumer price index (CPI) series provided by the Federal Reserve Bank of St. Louis.
[32] For the years prior to 1986, the CBP files are not available electronically from the U.S. Census, so we use the Inter-University Consortium for Political and Social Research (ICPSR) as our data source.
[33] In obtaining the estimation sample, we have dropped the top and bottom 5 percent of cities based on (per-period) passenger growth rates in order to remove any outliers.

Table 3
OLS effect of air travel changes on population growth.

	Dependent variable: population growth rate$_{iT}$				
	Basic (1)	Population lags (2)	Industrial composition (3)	MSA fixed effects (4)	No hubs (5)
Passenger growth rate$_{iT}$	0.108***	0.084***	0.066***	0.031***	0.026***
	[0.010]	[0.010]	[0.009]	[0.007]	[0.007]
Passenger per capita$_{T_0}$	0.002**	0.001	−0.001	0.005***	0.004***
	[0.001]	[0.001]	[0.001]	[0.002]	[0.001]
Population$_{T_0}$	−0.002***	0.015**	0.009	−0.053***	−0.053***
	[0.000]	[0.007]	[0.006]	[0.007]	[0.007]
Population lag$_{T_0-10}$		−0.007	−0.008	0.002	0.001
		[0.006]	[0.005]	[0.003]	[0.003]
Population lag$_{T_0-20}$		0.003	−0.005	0.004	0.004
		[0.005]	[0.004]	[0.003]	[0.003]
Population lag$_{T_0-30}$		−0.014***	−0.010***	0.011***	0.010**
		[0.003]	[0.002]	[0.004]	[0.004]
Income per capita$_{T_0}$			−0.021***	−0.012	−0.010
			[0.004]	[0.008]	[0.008]
Employment$_{T_0}$			0.013***	0.001	0.001
			[0.003]	[0.005]	[0.005]
Share manufacturing$_{T_0}$			0.000	0.002	0.002
			[0.001]	[0.002]	[0.002]
Share services$_{T_0}$			0.004	0.003	0.003
			[0.003]	[0.004]	[0.004]
Share retail$_{T_0}$			0.008**	−0.001	−0.001
			[0.004]	[0.005]	[0.005]
Share wholesale$_{T_0}$			−0.001	0.002**	0.002**
			[0.001]	[0.001]	[0.001]
Share transport/utilities$_{T_0}$			0.002	−0.004**	−0.005**
			[0.001]	[0.002]	[0.002]
Share construction$_{T_0}$			0.005***	0.001	0.001
			[0.001]	[0.001]	[0.002]
Time fixed effect	Yes	Yes	Yes	Yes	Yes
MSA fixed effects	No	No	No	Yes	Yes
Large hubs included?	Yes	Yes	Yes	Yes	No
Observations	526	526	524	524	486
R-squared	0.301	0.479	0.577	0.673	0.693

Robust standard errors clustered at MSA level in brackets.
Notes: The reported results correspond to the baseline regression Eq. (6). The data panel includes two long-run time periods, 1969–1977 and 1977–1991, defined around the year of the aviation deregulation. The dependent variable, i.e., annual population growth, is calculated at MSA level over each time period. The main variable of interest, i.e., air passenger annual growth rate, is calculated over a shorter post-deregulation period (1977–1983) to better isolate the exogenous variation induced by the policy shock. The decennial population lags control for previous and anticipated city growth rates. The period-specific initial economic conditions help to mitigate endogeneity. The time period and city level fixed effects account for both macroeconomic and for location-specific secular growth trends. The large city hubs (dropped in the last column) are identified based on a classification provided by the Federal Aviation Administration.
* $p < 0.1$.
** $p < 0.05$
*** $p < 0.01$.

Next, we add to the estimation model regional indicators to account for differences in economic conditions at city level at the start of each time period. In particular, the industrial composition of a city's activities has been shown to be a significant determinant of urban growth.[34] Therefore, we allow the rate of urban growth to vary over time according to the sectoral composition of cities in the initial period. The estimates are reported in column 3. As expected, differences across cities in industrial structure influence both urban growth, as well as the growth of air services. Once conditioning on such linkages, the impact of air traffic changes on population growth decreases in magnitude, but remains positive and highly significant.

Finally, there are several other location specific characteristics that need to be considered but may be difficult to measure. Some of these characteristics are time invariant, like geographic location, natural resources, or climate. Other factors, even if location-specific, may evolve at a constant rate over time. To account for such factors that simultaneously determine air travel and urban growth rates, we rely on city fixed effects as solution. Column 4 of Table 3 reports the results from such a fully specified regression model. This is our preferred specification. The coefficient on the variable of interest remains positive and significant, with a 50 percent increase in the annual air traffic growth rate leading to a 1.55 percent increase in the annual population growth rate, on average.[35] Cumulating the resulting change in population over time, this

[34] Glaeser et al. (1992) provides evidence that inter-industry knowledge spillovers, which are facilitated by a diverse industrial base, explain economic agglomerations. At the same time, the industrial composition of a region also determines its average level of human capital, influencing income levels and consumption. More importantly, Brueckner (2003) provides evidence from a cross-section of MSAs that services benefit more than manufacturing activities from the availability and quality of air services.

[35] There is a lot of variation across communities in the change in air traffic growth rates between the pre- and post-deregulation periods. The median city in the sample witnessed an average −1.9 percent annual growth rate in air passenger traffic in the time period following the deregulation, and this represents a negative 123 percent change relative to the average annual growth rate observed in the regulation period. To interpret our estimation coefficients, rather than rely on the large sample deviation, we chose to use a more moderate value of a 50 percent change in the air traffic growth rate. In the sample, there are 42 (16%) communities whose air traffic growth rate changed by up to 50 percent. While this may not be a very large number, we think this conservative scenario is more representative for out-of-sample periods. The kind of changes in air traffic growth rates that happened around the aviation deregulation period are probably much larger than what we tend to observe today.

Table 4
OLS effect of air travel changes on local per-capita income growth and on employment growth.

	Dependent variable: annual growth rate$_{iT}$ for…					
	Per capita income			Employment		
	Industrial composition (1)	MSA fixed effects (2)	No hubs (3)	Industrial composition (4)	MSA fixed effects (5)	No hubs (6)
Passenger growth rate$_{iT}$	0.039***	0.033***	0.034***	0.100***	0.054***	0.050***
	[0.007]	[0.008]	[0.009]	[0.014]	[0.013]	[0.014]
Passenger per capita$_{T_0}$	−0.000	0.003*	0.003*	−0.000	0.007**	0.006**
	[0.000]	[0.002]	[0.002]	[0.001]	[0.003]	[0.003]
Income per capita$_{T_0}$	−0.023***	−0.143***	−0.144***	−0.030***	−0.034***	−0.030**
	[0.004]	[0.007]	[0.008]	[0.006]	[0.013]	[0.012]
Population$_{T_0}$	−0.005	0.014	0.013	0.010**	0.064***	0.065***
	[0.004]	[0.009]	[0.009]	[0.004]	[0.012]	[0.013]
Population lag$_{T_0-10}$	0.006	−0.001	−0.001	−0.001	0.005	0.004
	[0.005]	[0.002]	[0.003]	[0.004]	[0.005]	[0.004]
Population lag$_{T_0-20}$	−0.004	−0.003	−0.003	−0.014**	−0.000	−0.001
	[0.005]	[0.003]	[0.003]	[0.006]	[0.004]	[0.004]
Population lag$_{T_0-30}$	0.002	−0.004	−0.003	−0.006	0.006	0.004
	[0.003]	[0.003]	[0.004]	[0.004]	[0.005]	[0.005]
Employment$_{T_0}$	0.001	−0.000	0.000	0.009**	−0.106***	−0.106***
	[0.002]	[0.007]	[0.007]	[0.004]	[0.010]	[0.010]
Share manufacturing$_{T_0}$	−0.001	0.000	0.001	0.000	−0.004	−0.003
	[0.001]	[0.002]	[0.002]	[0.002]	[0.003]	[0.003]
Share services$_{T_0}$	0.002	−0.000	−0.000	0.012***	−0.007	−0.007
	[0.002]	[0.004]	[0.004]	[0.003]	[0.010]	[0.010]
Share retail$_{T_0}$	−0.002	0.002	0.003	0.026***	0.005	0.006
	[0.003]	[0.006]	[0.006]	[0.005]	[0.008]	[0.008]
Share wholesale$_{T_0}$	−0.000	0.002	0.002	0.002	0.004**	0.004**
	[0.001]	[0.001]	[0.001]	[0.002]	[0.002]	[0.002]
Share transport/utilities$_{T_0}$	0.001	−0.000	−0.000	0.002	−0.007**	−0.007**
	[0.001]	[0.002]	[0.002]	[0.002]	[0.003]	[0.003]
Share construction$_{T_0}$	−0.000	−0.006***	−0.005***	0.003*	−0.004	−0.003
	[0.001]	[0.002]	[0.002]	[0.002]	[0.003]	[0.003]
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
MSA fixed effects	No	Yes	Yes	No	Yes	Yes
Large hubs included?	Yes	Yes	No	Yes	Yes	No
Observations	524	524	486	524	524	486
R-squared	0.628	0.918	0.920	0.586	0.755	0.763

Robust standard errors clustered at MSA level in brackets.
Notes: The reported results correspond to the baseline regression Eq. (6). The data panel includes two long-run time periods, 1969–1977 and 1977–1991, defined around the year of the aviation deregulation. The dependent variable, i.e., annual per-capita income growth, is calculated at MSA level over each time period. The main variable of interest, i.e., air passenger annual growth rate, is calculated over a shorter post-deregulation period (1977–1983) to better isolate the exogenous variation induced by the policy shock. The decennial population lags control for previous and anticipated city growth rates. The period-specific initial economic conditions help to mitigate endogeneity. The time period and city level fixed effects account for both macroeconomic and for location-specific secular growth trends. The large city hubs (dropped in the last column) are identified based on a classification provided by the Federal Aviation Administration.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

corresponds to a 0.42 percent additional increase in the population of the average city after a 20-year period.[36]

We further examine the sensitivity of our results to sample composition by verifying whether our estimates are driven by a subset of cities, in particular, by large hub airports. We identify the MSAs that host the largest airport hubs based on the airport classification compiled by the Federal Aviation Administration (FAA). Column 5 reports the results from a fully specified model estimated on a subsample that excludes large hub cities. While the effect of air traffic on urban growth decreases in magnitude, it remains positive and significant. This provides evidence that our finding is not a local result, driven by a particular subset of urban centers in our sample.

Overall, the estimates in Table 3 provide robust evidence that urban growth, as measured by population size, is directly affected by the provision of air services. Next, we investigate whether per-capita income responds in a similar manner. If air services are an important factor into productivity changes, then a standard model of urban growth predicts that they should directly affect changes in per-capita income as well.

Table 4 reports the estimation results following the same model specifications as in columns 3–5 of Table 3. In all of the estimated regressions, the impact of air traffic on per-capita income growth is positive and significant. The magnitude of the effects decreases as we control for omitted variable bias by gradually accounting in our estimation for city characteristics that simultaneously affect air traffic and urban growth rates. Based on the preferred specification reported in column 2, a 50 percent increase in the air passenger growth rate leads to a 1.65 percent increase in the annual growth rate of per-capita income, on average. To put results in perspective, the annual income growth rate calculated over the sample period is 1.76 percent for the average city. Cumulating the resulting change in per-capita income over a 20-year period, this corresponds to a 0.57 percent additional increase in the level of

[36] To arrive at this number, we take the annual population growth rate of an average city in the sample, computed over the period 1969–1991, which is equal to 1.365 per year. Then, a 50 percent increase in the air traffic growth rate predicts an annual growth rate of population of: $g_{pop}^{predict} = (1 + 0.0155)1.365 = 1.386$. We then apply the following calculation: $\frac{Pop_{t+20}^{predict}}{Pop_{t+20}^{actual}} = \frac{(1+1.386/100)^{20} * Pop_t}{(1+1.365/100)^{20} * Pop_t} = 1.0042$ or 0.42 percent.

per-capita income for the average city. These effects are almost identical when we eliminate the large hub cities from the sample (see column 3).

While there are several reasons why population growth may be preferred to employment as an indicator of regional growth, it is customary in the urban economics literature to investigate the effects of air traffic on regional employment. Research work has shown that agglomerations, through the positive externalities they provide, represent a strong force of attraction for future businesses. Furthermore, the effect of air passenger services on employment growth may operate not only through productivity effects, but also through quality of life considerations (i.e., urban amenities).

The results explaining the growth in employment are provided in columns 4–6 of Table 4. Again, the columns report the estimates from specifications that gradually incorporate an increasing set of control variables to explain the differences in employment growth across communities (following the same pattern as columns 1–3 of the same table). Focusing on the most complete specification reported in column 5, we find that a 50 percent increase in the rate of regional air traffic growth leads to a 2.7 percent increase in annual employment growth, on average. The coefficient is larger in magnitude than the effect of traffic growth on population, suggestive of additional channels through which air services affect employment growth that operate independently from population growth determinants. To put results in perspective, the annual employment growth rate calculated over the sample period is 3 percent for the average city. Cumulating the resulting change in employment over a 20-year period, this leads to an additional increase in total employment of 1.6 percent for the average city. By dropping the large hub cities from our sample, the magnitude of the main coefficient of interest decreases slightly but remains highly significant (column 6). This reveals that the estimated average employment effects are not driven by a particular subgroup of cities, but are in fact representative for the entire sample of urban centers.

5.2. Instrumental variables (2SLS) approach

To address any remaining endogeneity concerns, we experiment with two sets of excluded instruments. We exploit information on the differences in regulatory distortions across cities based on their size. Table 5 reports the 2SLS estimation results for each of the three urban growth indicators as dependent variable. For conciseness, we only report the coefficients for the variable of interest, however the estimated model includes the complete set of controls and fixed effects used in prior estimations.

Columns 1–4 of Table 5 include the 2SLS estimates for the specification explaining urban population growth. We first instrument for the difference in the growth rate of air traffic over time using the average air traffic change observed across cities within the same size category. That is, we use the interaction terms between the post-deregulation time indicator and city size indicators, distinguishing between small, medium or large cities. The results are reported in column 1. In the subsequent columns, we experiment with variants of the proposed instrument. In column 2 we use as instrument the average air traffic change observed in *other* cities within the same size category as the city in question. In column 3 we use proximity as criteria to weight the other cities whose air traffic changes are used in predicting a city's response to deregulation. If regulatory distortions have regional-specific components, we are able to exploit that additional source of exogenous variation with this location-specific instrument. In column 4, we combine the predictive power of the last two instruments by using them together in the same regression.

Across all four 2SLS specifications, the effect of air traffic on population growth remains positive and statistically significant. Using the coefficient from column 1, a 50 percent increase in the air passenger growth rate leads to a 4.15 percent increase in the annual rate of population growth, on average. Comparing columns 1–4, there are no notable differences between the estimated coefficient of interest. However, the IV estimates are larger in magnitude when compared to the OLS results from column 4 in Table 3. While this direction of change may seem contrary to the expected positive correlation between air traffic and population growth rates, this outcome is not new to the literature (e.g., Duranton and Turner, 2012; Duranton et al., 2014). Like others have pointed out, transportation infrastructure might get allocated disproportionately to cities that are less productive, poorer and that grow slower, which explains the underlying negative correlation. Put differently, unobservable factors causing urban growth during the regulation period may have determined the CAB to inefficiently allocate air services across communities, oversupplying the cities witnessing slower growth at the expense of rapidly growing areas. In addition, much of the positive correlation between air traffic and urban growth is already accounted for by the control variables and the regression fixed effects. Lastly, it is also possible that air traffic changes are measured or recorded with error at city level, inducing attenuation bias in the OLS estimates.

Two conditions are necessary for these proposed variables to qualify as valid instruments. First, the excluded instruments need to be correlated with city level changes in air traffic growth, conditional on all the right-hand side regression variables. In that respect, both the anecdotal evidence and the data representation in Fig. 2 seem to give support to this condition. Second, the excluded instruments must not be correlated with the residual from the urban growth regression. Here, it is important to emphasize that the model specification directly controls for the city size at the beginning of each period, as well as for the city's history of economic growth, in addition to accounting for secular trends using city fixed effects. This removes concerns about omitted variable bias, minimizing the ways in which the excluded instruments could be correlated with the urban growth residual.

Formal tests for the validity of the excluded instruments are reported at the bottom of Table 5. From the first stage coefficients, it appears that the excluded instruments are jointly significant in explaining changes over time in air traffic growth. The reported F-statistic and the partial R-squared are large, being well above the conventional critical levels. Furthermore, the overidentification test for the exogeneity of the excluded instruments also provides support for their choice. Based on the reported Hansen J-statistic, the test fails to reject the hypothesis that the instruments are uncorrelated with the residual from the population growth regression (once conditioning on all the control variables and fixed effects).

Moving to the specifications explaining per-capita income growth, we report the corresponding 2SLS estimates in columns 5–8 of Table 5. We exploit the same set of excluded instruments as before (in columns 1–4), and we find a similar pattern of results. The effect of air traffic on per-capita income growth is positive and significant in all of the 2SLS estimations, and the magnitude of the coefficient is almost double in size compared to the OLS result (reported in Table 4). Based on the estimate from column 5, a 50 percent increase in the air passenger growth rate leads to a 3.2 percent increase in the annual rate of per-capita income growth, on average. Since the estimated regression model is no different from the one explaining population growth, the first stage coefficients reported at the bottom of columns 5–8 are identical to the ones in columns 1–4. Only the test of overidentifying restrictions provides different statistics due to a change in the dependent variable. Judging from the reported Hansen J statistic, the chosen instruments are exogenous to the regression model, being orthogonal to the residual income growth rates.

Table 5
Instrumental variables estimates for the effect of air travel on urban growth.

	Dependent variable: annual growth rate$_{iT}$											
	Population				Income				Employment			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Passenger growth rate$_{iT}$	0.083***	0.086***	0.081***	0.084***	0.064***	0.066***	0.072***	0.069***	0.101***	0.104***	0.079**	0.094***
	[0.017]	[0.018]	[0.021]	[0.017]	[0.017]	[0.018]	[0.020]	[0.016]	[0.025]	[0.027]	[0.031]	[0.025]
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
MSA fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Initial economic conditions$_{(T_0)}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pop. lags$_{(T_0-10,T_0-20,T_0-30)}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sectoral composition	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	520	520	520	520	520	520	520	520	520	520	520	520
R-sq	0.602	0.593	0.608	0.599	0.912	0.911	0.908	0.910	0.740	0.738	0.750	0.744
Excluded instruments:												
Post-deregulation period × medium city	0.014*				0.014*				0.014*			
	[0.008]				[0.008]				[0.008]			
Post-deregulation period × large city	0.058***				0.058***				0.058***			
	[0.009]				[0.009]				[0.009]			
Avg. passenger growth in *other* cities by size		0.832***		0.577***		0.832***		0.577***		0.832***		0.577***
		[0.115]		[0.160]		[0.115]		[0.160]		[0.115]		[0.160]
Avg. passenger growth in *other* cities by location & size			6.315***	3.349**			6.315***	3.349**			6.315***	3.349**
			[1.028]	[1.359]			[1.028]	[1.359]			[1.028]	[1.359]
First stage statistics:												
F-statistic	30.11	52.39	37.75	33.47	30.11	52.39	37.75	33.47	30.11	52.39	37.75	33.47
Partial R-squared	0.173	0.156	0.133	0.179	0.173	0.156	0.133	0.179	0.173	0.156	0.133	0.179
Hansen J statistic	0.092	n.a.	n.a.	0.081	2.403	n.a.	n.a.	0.092	1.084	n.a.	n.a.	0.867
Hansen J *p*-value	0.762	n.a.	n.a.	0.777	0.121	n.a.	n.a.	0.762	0.298	n.a.	n.a.	0.352

Robust standard errors clustered at MSA level in brackets.

Notes: The reported results correspond to the regression Eq. (6) estimated by instrumental variables methods (2SLS). We instrument for the variable of interest – air passenger annual growth rate – using the following excluded instruments: (1) a time dummy for the post-deregulation period, allowed to vary by city size category (this measure corresponds to the deviation in air traffic changes over time observed among cities within the same size groups); (2) the average air traffic growth rate of *other* cities within the same size category; (3) the average air traffic growth rate of *other* cities within the same size category, weighted by distance. Because of the presence of city fixed effects, the variation exploited by the last two instruments also consists of deviations in air traffic changes over time. The complete list of the controls and fixed effects from prior estimations are included in all the reported specifications.

* $p < 0.1$.

** $p < 0.05$.

*** $p < 0.01$.

Table 6
Effect of air travel changes on local employment growth by sector.

	Dependent variable: sector employment growth rate$_{iT}$											
	Manufacturing			Services			Wholesale			Retail		
	(1) OLS	(2) 2SLS	(3) 2SLS	(4) OLS	(5) 2SLS	(6) 2SLS	(7) OLS	(8) 2SLS	(9) 2SLS	(10) OLS	(11) 2SLS	(12) 2SLS
Passenger growth rate$_{iT}$	−0.011	−0.049	−0.092	0.071***	0.203***	0.212***	0.011	0.087*	0.065	0.040***	0.080***	0.078***
	[0.027]	[0.055]	[0.059]	[0.017]	[0.038]	[0.038]	[0.024]	[0.050]	[0.053]	[0.011]	[0.025]	[0.025]
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
MSA fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Initial economic conditions$_{(T_0)}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pop. lags$_{(T_0-10,T_0-20,T_0-30)}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sectoral composition	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	519	512	512	524	520	520	523	520	520	524	520	520
R-squared	0.789	0.788	0.781	0.702	0.620	0.608	0.902	0.897	0.899	0.812	0.801	0.802
Excluded instruments:												
Post-deregulation period × medium city		Yes			Yes			Yes			Yes	
Post-deregulation period × large city		Yes			Yes			Yes			Yes	
Pax growth in *other* cities by size			Yes			Yes			Yes			Yes
Pax growth in *other* cities by loc. and size			Yes			Yes			Yes			Yes
First stage statsistics:												
F-stat		28.64	31.46		30.11	33.47		30.11	33.47		30.11	33.47
Hansen J stat		0.140	2.014		7.658	0.018		0.001	1.601		1.074	0.327
Hansen J p-val		0.709	0.156		0.006	0.894		0.985	0.206		0.300	0.568

Robust standard errors clustered at MSA level in brackets.

Notes: The reported results correspond to the baseline regression Eq. (6), with the modification that sector level employment growth rates are used as dependent variables. The data panel includes two long-run time periods, 1969–1977 and 1977–1991, defined around the year of the aviation deregulation. The dependent variable, i.e., annual growth in sector level employment, is calculated at MSA level over each time period. The main variable of interest, i.e., air passenger annual growth rate, is calculated over the shorter post-deregulation period (1977–1983) to better isolate the exogenous variation induced by the policy shock. To remove endogeneity concerns, in the reported 2SLS estimates in columns 2, 5, 8 and 11, the growth rate of air traffic is instrumented by the same excluded variables as those reported in column 1 of Table 5. Further, in the reported 2SLS in columns 3, 6, 9 and 12, the growth rate of air traffic is instrumented by the same excluded variables as those reported in column 4 of Table 5. The first stage regression leads to the same estimates as previously reported. The complete list of the controls and fixed effects from prior estimations are included in all the reported specifications.

* $p < 0.1$.

** $p < 0.05$.

*** $p < 0.01$.

Table 7
Effect of air travel changes on the number of local businesses.

	Dependent variable: growth rate in number of firms$_{iT}$			
	OLS Basic (1)	OLS No hubs (2)	2SLS City category (3)	2SLS City category (4)
Passenger growth rate$_{iT}$	0.039***	0.035***	0.123***	0.135***
	[0.010]	[0.011]	[0.032]	[0.033]
Large hubs included?	Yes	No	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes
MSA fixed effects	Yes	Yes	Yes	Yes
Initial economic conditions$_{(T_0)}$	Yes	Yes	Yes	Yes
Pop. lags$_{(T_0-10,T_0-20,T_0-30)}$	Yes	Yes	Yes	Yes
Sectoral composition	Yes	Yes	Yes	Yes
Observations	524	486	520	520
R-squared	0.832	0.841	0.769	0.750
Excluded instruments:				
Post-deregulation period × medium city			0.013*	
			[0.008]	
Post-deregulation period × large city			0.046***	
			[0.009]	
Avg. passenger growth in *other* cities by size				0.444***
				[0.156]
Avg. passenger growth in *other* cities by location and size				2.628*
				[1.347]
First stage statistics:				
F-statistic			16.59	17.80
Partial R-squared			0.100	0.103
Hansen J statistic			0.034	0.114
Hansen J p-value			0.854	0.736

Robust standard errors clustered at MSA level in brackets.
Notes: The reported results correspond to the baseline regression Eq. (6). The data panel includes two long-run time periods, 1969–1977 and 1977–1991, defined around the year of the aviation deregulation. The dependent variable, i.e., average annual change in the number of firms, is calculated at MSA level over each time period. The main variable of interest, i.e., air passenger annual growth rate, is calculated over the shorter post-deregulation period (1977–1983) to better isolate the exogenous variation induced by the policy shock. The decennial population lags control for previous and anticipated city growth rates. The period-specific initial economic conditions help to mitigate endogeneity. The time period and city fixed effects account for both macroeconomic and location-specific secular growth trends. The large city hubs (dropped in the last column) are identified based on a classification provided by the Federal Aviation Administration.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

Finally, columns 9–12 of Table 5 report the 2SLS estimates for total employment as measure of urban growth. The pattern of results observed so far applies to this specification as well. Again, we find that the 2SLS estimates for the effect of air traffic growth are positive and significant, with a magnitude that is almost twice the size of the corresponding OLS coefficient from column 5 in Table 4. The same reasoning for this finding that we provided earlier applies here as well. Based on the estimate reported in column 9, a 50 percent increase in the air passenger growth rate leads to a 5.5 percent increase in the annual rate of employment, on average. The reported tests of overidentifying restrictions validate once again the excluded instruments' exogeneity.

To summarize the results so far, we have pursued a variety of estimation strategies to identify a causal effect of the growth in air traffic on the economic development and long-run growth of U.S. cities, and found surprisingly consistent and robust evidence for a positive and significant effect.

5.3. Robustness exercises

This section describes additional data exercises that bring support to the results of the paper. The aim here is twofold. First, we want to shed some light on the channels through which air traffic changes affect urban growth. For that reason, we focus attention on employment composition effects, as well as on the expansion in the number of local businesses. Second, we want to verify the robustness of our findings to the choice of time windows, as well as to the use of the quasi-natural experiment as a source of exogenous data variation.

5.3.1. Sectoral decomposition and firm extensive margin

Studies analyzing the impact of road infrastructure find robust evidence that retail and wholesale industries benefit the most from improved market access and lower transportation costs (Michaels, 2008). Similarly, studies focusing on air transport have shown that service sectors have been the most responsive to the availability of air services (Brueckner, 2003). Following this practice, we exploit the sectoral disaggregation available in the city level employment data to investigate the sectors whose labor demand is sensitive to changes in air passenger transport.

The results reported in Table 6 are consistent with the prior literature. It seems that the total employment effects that we documented earlier are mainly driven by employment growth in services and in trade-related industries. This finding is consistent across OLS and 2SLS specifications (where the latter are estimated using average deregulation shocks by city size category as instruments).[37]

A second robustness exercise examines the impact of air traffic changes on the establishment of new businesses in a location.

[37] This finding gives support to early reports by the CAB suggesting that market towns – where trading is the most important occupation – and diversified cities – which have a significant representation of government, finance or professional activities – represent the type of cities that generate the largest demand for air traffic (Sealy, 1968, p. 149; Eads, 1972).

Table 8
Robustness: sensitivity of estimates to redefining the post-deregulation time periods.

	Dependent variable: annual growth rate for...								
	Population			Income			Employment		
	OLS (1)	2SLS (2)	2SLS (3)	OLS (4)	2SLS (5)	2SLS (6)	OLS (7)	2SLS (8)	2SLS (9)
Baseline estimates									
Urban Growth Window = [1977–1991] & *Policy Shock Window* = [1977–1983]	0.031***	0.083***	0.084***	0.033***	0.064***	0.069***	0.054***	0.101***	0.094***
	[0.007]	[0.017]	[0.017]	[0.008]	[0.017]	[0.016]	[0.013]	[0.025]	[0.025]
Sensitivity to long-run window for urban growth									
Urban Growth Window = [1977–**1989**]	0.032***	0.081***	0.083***	0.037***	0.084***	0.089***	0.064***	0.130***	0.137***
	[0.007]	[0.017]	[0.017]	[0.010]	[0.021]	[0.020]	[0.016]	[0.031]	[0.032]
Urban Growth Window = [1977–**1994**]	0.031***	0.076***	0.076***	0.027***	0.055***	0.056***	0.050***	0.071***	0.065***
	[0.007]	[0.016]	[0.016]	[0.007]	[0.015]	[0.014]	[0.011]	[0.022]	[0.021]
Sensitivity to short-run window for air traffic growth									
*Policy Shock Window = [1977–**1982**]*	0.027***	0.078***	0.088***	0.020***	0.056***	0.064***	0.042***	0.091***	0.102***
	[0.007]	[0.017]	[0.018]	[0.007]	[0.018]	[0.018]	[0.012]	[0.027]	[0.027]
*Policy Shock Window = [1977–**1984**]*	0.038***	0.080***	0.081***	0.026***	0.048***	0.052***	0.050***	0.091***	0.087***
	[0.007]	[0.015]	[0.015]	[0.007]	[0.016]	[0.014]	[0.012]	[0.025]	[0.023]
MSA fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Base year controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pop. lags$_{(T_0-10, T_0-20, T_0-30)}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sectoral composition	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Excluded instruments:									
Post-deregulation period × medium city		Yes			Yes			Yes	
Post-deregulation period × large city		Yes			Yes			Yes	
Pax growth in *other* cities by size			Yes			Yes			Yes
Pax growth in *other* cities by loc. and size			Yes			Yes			Yes

Robust standard errors clustered at MSA level in brackets.
Notes: This table verifies the sensitivity of our results to the chosen time window over which growth rates are calculated for the post-deregulation period. The data sample used in all prior estimations spans two long-run time periods, 1969–1977 and 1977–1991, defined around the year of the aviation deregulation. The air traffic growth rate has been calculated over the shorter period 1977–1983 to better isolate the exogenous variation induced by the policy shock. The reported coefficients correspond to the variable of interest, i.e., air traffic growth, and are obtained from the baseline regression Eq. (6). To remove endogeneity concerns, in the reported 2SLS estimates in columns 2, 5, and 8, the growth rate of air traffic is instrumented by the same excluded variables as those reported in column 1 of Table 5. Furthermore, in the reported 2SLS estimates in columns 3, 6, and 9, the growth rate of air traffic is instrumented by the same excluded variables as those reported in column 4 of Table 5. The complete list of the controls and fixed effects from prior estimations are included in all the reported specifications. The unreported number of observations is 524 (520 in 2SLS regressions) and the R-squared varies between 0.548 and 0.929.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

While we found direct evidence of employment growth at city level, it is not clear whether this is caused by production growth among existing firms (i.e., intensive margin effect), or by the entry of new firms (i.e., extensive margin effect). This distinction may be important to policy makers as business agglomerations are known to generate positive spillovers (e.g., Baldwin and Martin, 2004). Using information on the number of businesses operating in a location, which is available from the County Business Patterns database, we estimate the same fully specified regression model as before and report the estimates in Table 7. Columns 1 and 2 provide OLS estimates on a sample with and without large city hubs. Columns 3 and 4 report 2SLS estimates using the average growth in air traffic across cities of similar size category as instruments. Across all estimations, air traffic changes have a positive and significant effect on the growth in the number of local businesses. Depending on specification, a 50 percent increase in the air traffic growth rate leads to an increase in the growth of the number of firms between 2 and 6.75 percent. Once again, we find that the 2SLS estimates are larger in magnitude than the OLS counterparts, which may be the result of either attenuation bias from measurement error in firm count, or, more likely, from a disproportionate allocation of air services to slow growing cities during the CAB regulatory period.

5.3.2. Coefficient sensitivity to variations in time windows

One consideration regarding our econometric strategy is that the time periods over which the growth rates are calculated may have a direct impact on the data variation used for model identification. This is true especially if macroeconomic factors have a differential impact across cities in the years defining the time window under consideration, case in which the time fixed effect is not able to account for this heterogeneity. For instance, in constructing the long-run urban growth rates, we have chosen year 1991 as the end-point of the post-deregulation period. However, year 1991 is a recession year. This could attenuate the long-run growth rates used for model identification, becoming particularly problematic if the recession had a more negative effect on small or medium size cities compared to large cities (potentially leading to spurious correlation).

To assess the robustness of our findings, we evaluate the sensitivity of our estimates to changes in the time window defining the post-deregulation period.[38] Table 8 povides the results, reporting only the coefficient for the air traffic growth rate estimated both by OLS and 2SLS methods. We consider four time periods as alterna-

[38] Since the regression model controls for initial economic conditions (i.e., base year city characteristics), the starting periods are less of a concern for influencing the econometric analysis and the estimates.

Table 9
Placebo test: 1987 as deregulation year over the period 1983–1994.

Dependent variable	Annual growth rate$_{iT}$ for...			Air passenger growth$_{iT}$	
	Population OLS (1)	Income OLS (2)	Employment OLS (3)	1st Stage (4)	1st Stage (5)
Passenger growth rate$_{iT}$	0.009 [0.006]	0.008 [0.005]	0.014 [0.011]		
Excluded instruments:					
Post-deregulation period × medium City				0.012 [0.023]	
Post-deregulation period × large city				0.020 [0.029]	
Avg. passenger growth in *other* cities by size					−0.045 [0.326]
Avg. passenger growth in *other* cities by location and size					−2.495 [2.309]
First stage F-statistic				0.23	1.06
Time fixed effect	Yes	Yes	Yes	Yes	Yes
MSA fixed effects	Yes	Yes	Yes	Yes	Yes
Initial economic conditions$_{(T_0)}$	Yes	Yes	Yes	Yes	Yes
Pop. lags$_{(T_0-10, T_0-20, T_0-30)}$	Yes	Yes	Yes	Yes	Yes
Sectoral composition	Yes	Yes	Yes	Yes	Yes
Observations	503	503	503	500	500
R-squared	0.565	0.891	0.829	0.748	0.750

Robust standard errors clustered at MSA level in brackets.
Notes: The reported results are the outcome of a placebo experiment defined over the period 1983–1994. Year 1987 is set as the time of a hypothetical aviation deregulation episode, such that the period 1983–1987 becomes the "pre-deregulation" period, and 1987–1994 becomes the "post-deregulation" period. We further limit the "post-deregulation" adjustment period for air traffic growth to the time window 1987–1991. The reported estimates in columns 1–3 correspond to the baseline regression Eq. (6), estimated using the redefined pre- versus post-deregulation periods. The reported estimates in columns 4–5 correspond to the first stage estimates for air traffic growth. The set of excluded instruments are the same as reported in column 1, respectively 4 of Table 5. The complete list of the controls and fixed effects from prior estimations are included in all the reported specifications.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

tives to the baseline case, and report the coefficients for each distinct time period by row. The first two alternative time periods correspond to deviations from the end-year 1991 defining the post-deregulation period over which the urban growth indicators are calculated. The next two period redefinitions correspond to deviations from end-year 1983, defining the period over which air traffic growth rates are calculated. Comparing the estimates by column across all rows, it becomes clear that our findings are not sensitive to the time window being considered. All the estimates are positive and significant, being reasonably close in magnitude to our baseline results.

5.3.3. Placebo test

To verify the robustness of our results to the identification mechanism – which exploits the large and permanent policy shock of the 1978 aviation deregulation – we develop a placebo test based on an arbitrary deregulation year. Focusing on a period with no major policy changes affecting air services, such as the post-deregulation period 1983–1994, we select year 1987 as a hypothetical deregulation year and define the time period 1983–1987 as the "regulatory" period, and the time period 1987–1991 as the "aftermath" of the hypothetical policy change. To maintain the same pattern in the construction of the data sample as before, we allow the urban growth rates to be calculated over a longer "post-deregulation" period, i.e., 1987–1994. Using these redefined time windows, which exploit a purely hypothetical policy shock, we estimate the same regression model relating the differential changes in air traffic and urban growth rates, i.e., Eq. (6).

We report the results of our placebo experiment in Table 9. If the identification method correctly isolates the policy-induced variation in air traffic changes across cities, then this method should fail to detect any significant variation using this counterfactual data sample. The estimates reported in Table 9 seem to confirm this intuition. The OLS results from columns 1–3 show that deviations in air traffic changes around year 1987 have no effect on either population, income or employment growth rates. The fact that the placebo test delivers zero coefficients for the variable of interest is informative also because it suggests that our data differencing strategy is able to successfully deal with the simultaneity between air traffic and urban growth.[39] While we cannot implement instrumental variables estimations given the lack of variation in our variable of interest, we can report the coefficients from the first stage regressions. Using the average changes in air traffic across cities within the same size category as excluded instruments, the results reported in columns 4 and 5 suggest that the instruments have no predictive power in explaining a city's air traffic growth rate. Note that these are the same type of instruments that have been successfully used in previous IV estimations, when exploiting actual policy-induced changes in air traffic growth.

6. Conclusion

Public spending on aviation at the federal, state, and local levels have constantly increased since the beginning of commercial aviation, reaching ten percent of total public spending on infrastructure by 2004 (CBO, 2007). To evaluate the benefits of such resource

[39] While air traffic growth should have a direct effect on urban growth and vice versa during the deregulated time period 1983–1994, in the absence of any major policy shocks to air traffic the regression variables loose most of their predictive power when taking a difference in growth rates around the arbitrary year 1978 (especially in the presence of other control variables and fixed effects).

Table A1
The effect of city size group on short-run urban growth rates.

	Annual growth rate$_{iT}$		
	Population (1)	Income per-capita (2)	Employment (3)
Post-deregulation period × medium city	−0.001	0.002	−0.001
	[0.002]	[0.002]	[0.003]
Post-deregulation period × large city	−0.001	0.001	−0.003
	[0.002]	[0.002]	[0.004]
Passenger growth rate$_{iT}$	0.026*	0.048***	0.097***
	[0.013]	[0.013]	[0.027]
Passenger per capita$_{T_0}$	0.003	0.002	0.008
	[0.002]	[0.003]	[0.005]
Population$_{T_0}$	−0.028**	0.028**	0.119***
	[0.012]	[0.012]	[0.021]
Population lag$_{T_0-10}$	0.001	−0.003	0.003
	[0.002]	[0.004]	[0.004]
Population lag$_{T_0-20}$	0.010**	0.008	0.021**
	[0.005]	[0.005]	[0.010]
Population lag$_{T_0-30}$	0.010**	−0.007	0.004
	[0.004]	[0.005]	[0.008]
Income per capita$_{T_0}$	0.034***	−0.142***	0.019
	[0.011]	[0.014]	[0.022]
Employment$_{T_0}$	−0.004	−0.002	−0.130***
	[0.009]	[0.009]	[0.016]
Share manufacturing$_{T_0}$	0.009***	0.009***	0.010*
	[0.003]	[0.003]	[0.006]
Share services$_{T_0}$	0.007	−0.001	−0.005
	[0.006]	[0.006]	[0.012]
Share retail$_{T_0}$	−0.001	0.002	−0.013
	[0.009]	[0.008]	[0.017]
Share wholesale$_{T_0}$	0.005**	0.002	0.011***
	[0.002]	[0.002]	[0.003]
Share transport/utilities$_{T_0}$	−0.001	0.002	−0.005
	[0.003]	[0.004]	[0.007]
Share construction$_{T_0}$	0.005**	−0.003	−0.002
	[0.002]	[0.003]	[0.005]
Time fixed effect	Yes	Yes	Yes
MSA fixed effects	Yes	Yes	Yes
Observations	524	524	524
R-squared	0.351	0.888	0.583

Robust standard errors clustered at MSA level in brackets.
Notes: The reported results correspond to the baseline regression Eq. (6). The difference from prior estimations is that the two time periods considered here are 1969–1977 and 1977–1983, i.e., the same time periods over which the growth rate in air traffic is constructed. The main goal of these exercises is to see whether there are systematic changes in urban growth rates over the two time periods by city size category, once accounting for all the control variables and fixed effects previously considered. Since the interaction terms between the *Post-Deregulation* dummy and MSA size category indicators are considered as exogenous instruments for the change in the growth rate of air traffic post-deregulation, it is crucial that they are not affecting simultaneously the urban economic growth indicators of interest.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

allocations, it is crucial that we understand the implications of these investments for regional development and economic growth. Surprisingly, this research question has received little attention in the empirical literature, to a large extent because of the difficulty in going beyond correlations to identify actual causation.

This paper exploits the quasi-natural experiment created by the signing of the 1978 Airline Deregulation Act to identify the link between airline traffic and local economic growth. Our findings suggest that exogenous increases in air services lead to statistically and economically significant increases in regional growth. For example, increasing the annual growth rate of air passenger traffic by 50 percent for a given city leads to an increase in the rate of population growth of 1.55 percent (conservative OLS estimates). Cumulating the estimated effect over a 20-year period, this corresponds to an additional 0.42 percent increase in the level of population (we get slightly larger magnitudes with respect to air service effects on per-capita income and employment growth).

From these estimates, one can do simple calculations about how much a region may gain in additional income from increased air service. For example, an average city that witnesses a 50 percent increase in the air traffic growth rate will gain a stream of income over a 20-year period, which in discounted present value terms corresponds to an average 7.4 percent increase in its total real GDP in 1978.[40] This estimate is equivalent to a total discounted present value of 523.3 million dollars in 1978 for the average city.

Our analysis finds only small differences in the main results across communities based on their average size. We also find evidence that shifts in industrial composition are associated with a growth in the aviation networks. When estimating the employment effects by sector, we find that service and retail industries are the ones experiencing the significant growth effects.

These findings are important for better understanding the determinants of regional growth, but also for influencing policies

[40] This estimate corresponds to the stream of income generated over a two decade period, and combines the effects of air service on population growth and per-capita income growth over that same time interval. The calculation is done based on the more conservative OLS estimates.

designed to allocate public infrastructure spending. We note that the identification strategy we use forces us to focus on a period of time when commercial aviation, while it witnessed dramatic growth, might not have been as essential to consumers and businesses as it is today. This suggests that the importance of air service for regional growth may be even greater today than our estimated effects.

Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, athttp://dx.doi.org/10.1016/j.jue.2015.02.001.

References

Arnold, Jens, Javorcik, Beata S., Mattoo, Aaditya, 2011. Does services liberalization benefit manufacturing firms? Evidence from the Czech Republic. Journal of International Economics 85 (1), 136–146.

Aschauer, David, 1989. Is public expenditure productive? Journal of Monetary Economics 23, 177–200.

Audretsch, David B., Feldman, Maryann P., 1996. R&D spillovers and the geography of innovation and production. American Economic Review 86 (3), 630–640.

Bailey, Elizabeth E., Graham, David R., Kaplan, Daniel P., 1985. Deregulating the Airlines. MIT Press, Cambridge, MA.

Baldwin, Richard E., Martin, Philippe, 2004. Agglomeration and regional growth. Handbook of Regional and Urban Economics 4, 2671–2711.

Banerjee, Abhijit, Duflo, Esther, Qian, Nancy, 2012. On the Road: Access to Transportation Infrastructure and Economic Growth in China. NBER Working Paper No. 17897.

Bel, Germa, Fageda, Xavier, 2008. Getting there fast: globalization, intercontinental flights and location of headquarters. Journal of Economic Geography 8, 471–495.

Bertrand, Marianne, Duflo, Esther, 2004. How much should we trust differences-in-differences estimates? Quarterly Journal of Economics 119 (1), 249–275.

Blomstrom, Magnus, Kokko, Ari, 1998. Multinational corporations and spillovers. Journal of Economic Surveys 12 (3), 247–277.

Borenstein, Severin, 1992. The evolution of the U.S. airline competition. Journal of Economic Perspectives 6 (2), 45–73.

Borenstein, Severin, Rose, Nancy, 2011. How airline markets work or do they? regulatory reform in the airline industry. In: Rose, N.L. (Ed.), Economic Regulation and Its Reform: What Have We Learned? University of Chicago Press.

Brueckner, Jan, 2003. Airline traffic and urban economic development. Urban Studies 40 (8), 1455–1469.

Chandra, Amitabh, Thompson, Eric, 2000. Does public infrastructure affect economic activity? evidence from the rural interstate highway system. Regional Science and Urban Economics 30, 457–490.

Congressional Budget Office (CBO), 2007. Trends in Public Spending on Transportation and Water Infrastructure, 1956 to 2004. Available at: <www.cbo.gov/sites/default/files/cbofiles/ftpdocs/85xx/doc8517/08-08-infrastructure.pdf>.

Cristea, Anca, 2011. Buyer-seller relations in international trade: evidence from U.S. states' exports and business-class travel. Journal of International Economics 84 (2), 207–220.

Dempsey, Paul Stephen, 1987. Dark side of deregulation: its impact on small communities. Administrative Law Review 39, 445–465.

Donaldson, Dave, 2010. Railroads of the Raj: Estimating the Impact of Transportation Infrastructure. Massachusetts Institute of Technology, mimeo.

Donaldson, Dave, Hornbeck, Richard, 2013. Railroads and American Economic Growth: A Market Access Approach. NBER Working Paper No. 19213.

Duranton, Gilles, Turner, Matthew, 2012. Urban growth and transportation. Review of Economic Studies 79 (4), 1407–1440.

Duranton, Gilles, Morrow, Peter, Turner, Matthew, 2014. Roads and trade: Evidence from the U.S. Review of Economic Studies 81 (2), 681–724.

Eads, George, 1972. The Local Service Airline Experiment, The Brookings Institution, Washington, D.C.

Evans, Paul, Karras, Georgios, 1994. Are government activities productive? evidence from a panel of U.S. states. The Review of Economics and Statistics 76, 1–11.

Faber, Benjamin, 2013. Trade Integration, Market Size, And Industrialization: Evidence From Chinas National Trunk Highway System. UC Berkley, mimeo.

Feenstra, Robert, Kee, Hiau Looi, 2008. Export variety and country productivity: estimating the monopolistic competition model with endogenous productivity. Journal of International Economics 74 (2), 500–518.

Fernald, John, 1999. Roads to prosperity? assessing the link between public capital and productivity. American Economic Review 89, 619–638.

Gaspar, Jess, Glaeser, Edward L., 1998. Information technology and the future of cities. Journal of Urban Economics 43 (1), 136–156.

General Accounting Office (GAO), 1996. Airline Deregulation: Changes in Airfares, Service, and Safety at Small, Medium-Sized, and Large Communities, GAO/RCED-96-79.

General Accounting Office (GAO), 2000. Essential Air Service: Changes in Subsidy Levels, Air Carrier Costs, and Passenger Traffic, GAO/RCED-00-34.

Giroud, Xavier, 2013. Proximity and investment: evidence from plan level data. The Quarterly Journal of Economics 128 (2), 861–915.

Glaeser, Edward L., Scheinkman, Jose, Schleifer, Andrei, 1995. Economic growth in a cross-section of cities. Journal of Monetary Economics 36, 117–143.

Glaeser, Edward L., Kallal, Heidi, Scheinkman, Jose, Schleifer, Andrei, 1992. Growth in cities. Journal of Political Economy 100 (6), 1126–1152.

Green, Richard K., 2007. Airports and economic development. Real Estate Economics 35, 91–112.

Hanson, Gordon, 2005. Market potential, increasing returns, and geographic concentration. Journal of International Economics 67, 1–24.

Head, Keith, Mayer, Thierry, 2006. Regional wage and employment responses to market potential in the EU. Regional Science and Urban Economics 36, 573–594.

Holtz-Eakin, Douglas, 1994. Public-sector capital and the productivity puzzle. Review of Economics and Statistics 76 (1), 12–21.

Hovhannisyan, Nune, Keller, Wolfgang, 2011. International Business Travel: An Engine of Innovation? NBER Working Paper No. 17100.

Kahn, Alfred E., 1988. Surprises of airline deregulation. American Economic Review Papers and Proceedings, 316–322.

Lovely, Mary E., Rosenthal, Stuart S., Sharma, Shalini, 2005. Information, agglomeration and the headquarters of U.S. exporters. Regional Science and Urban Economics 35, 167–191.

Michaels, Guy, 2008. The effect of trade on the demand for skill: evidence from the interstate highway system. The Review of Economics and Statistics 90 (4), 683–701.

Morrison, S.A., Winston, C., 1986. The Economic Effects of Airline Deregulation. The Brookings Institution, Washington, D.C..

Munnell, Alicia H., 1992. Policy watch: infrastructure investment and economic growth. Journal of Economic Perspectives 6 (4), 189–198.

Poole, Jennifer, 2010. Business Travel as an Input to International Trade. University of California Santa Cruz, mimeo.

Redding, Stephen, Venables, Anthony, 2004. Economic geography and international inequality. Journal of International Economics 62, 53–82.

Redding, Stephen, Sturm, Daniel, Wolf, Nikolaus, 2011. History and industry location: evidence from German airports. The Review of Economics and Statistics 93 (3), 814–831.

Stuart, Rosenthal, Strange, William C., 2004. Evidence on the Nature and Sources of Agglomeration Economies. Handbook of Regional and Urban Economics, vol. 4, pp. 2119–2171.

Sealy, Kenneth R., 1968. The Geography of Air Transport. Aldine Publishing Company, Chicago, IL.

Sheard, Nicholas, 2012. The Effect of Air Transport on the Production of Goods and Services. Stockholm University, mimeo.

Shirley, Chad, Winston, Clifford, 2004. Firm inventory behavior and the returns from highway infrastructure investments. Journal of Urban Economics 55, 398–415.

Trefler, Daniel, 2004. The long and short of the Canada–U.S. free trade agreement. American Economic Review 94 (4), 870–895.

Winston, Clifford, 1993. Economic deregulation: days of reckoning for microeconomists. Journal of Economic Literature 31 (3), 1263–1289.

Wooldridge, Jeffery M., 2002. Econometric Analysis of Cross Section and Panel Data. MIT Press, Cambridge, MA.