Air Passenger Demand and Skilled Labor Markets by U.S. Metropolitan Area

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Abstract:

This paper examines the relationships that exist between skilled labor markets and air transportation by US metropolitan area. The goal is to enhance the current literature by conducting a more specific investigation of the links that exist between air passenger demand and employment levels within metropolitan economies focusing especially on employment patterns and the number of establishments for both the professional, scientific, and technical (PST) services sector and the high-technology sector. The results suggest that employment opportunities and the number of establishments in both sectors are systematically linked to the geography of air passenger demand.

Keywords: economic development | metropolitan areas | technical services | air passenger demand | skilled labor markets | air transportation industry

Article:

1. Introduction

The role that air transportation plays in shaping growth and economic development patterns are still the subject of debate. It is not fully understood how dynamic metropolitan economies impact individual airline route networks and the geography of air passenger demand. That said, air transportation has been, and will continue to be, an important factor in the growth and economic development of urban areas (Goetz, 1992).

A considerable proportion of airline passengers in the US travel for business purposes suggesting that a close relationship exists between business activity on the ground and airline networks in the skies. Even with recent technological innovations that minimize the need for direct face-to-face contact, many economic sectors still rely heavily on direct contact with colleagues, suppliers, customers, and other key employees (Debbage and Delk, 2001 p. 159).

The aim here is to examine the relationships that exist between skilled labor markets and air transportation by US metropolitan area. More specifically, we investigate the potential linkages that exist between both the professional, scientific, and technical (PST) services sector and the high-technology sector with air passenger demand by metropolitan area focusing especially on employment patterns and the number of establishments. Providing answers to these questions is crucial because US air passenger volume totaled 571.6 million enplaned passengers in 1997 (US Federal Aviation Administration, 1997) and the PST services sector generated 5.2 million jobs for the same year while the high-technology sector generated nearly 3 million jobs and $114.8 billion in salaries (US Economic Census, 2004).

2. Background

Smith and Timberlake (2001) argue that a key player in facilitating network connectivity between major cities is the airline route network and that a substantial demand still exists for face-to-face business relations despite radical improvements in global telecommunication technology. Button and Taylor (2000) suggest that the liberalization of international air transportation has generated significant economic benefits including the generation of additional employment in the 'new economy'. They found that "new economy" workers in fields such as information technology, electronics and management services, "fly over 1.6 times as much as those in traditional industries" (p. 213).

Bell and Feitelson (1991) argue that the increased emphasis on just-in-time services and the rapid shipment of smaller and lighter high-value products suggests that metropolitan economies well served by well-organized air transportation nodes will sustain more significant employment growth over other places. In addition, they argued that post-industrial cities that have experienced a rapid growth in information-intensive producer services (e.g., legal services, banking, insurance) will require more efficient air transport links due to the increased demand for face-to-face contact. The suggestion is that metropolitan areas with significant concentrations of these sorts of highly skilled workers are more likely to have a high demand for travel by air.

Brueckner (2003) found that when air traffic increases 10%, workers in service-related industries will grow by 1.1%. However, he also found no significant link between the number of air passengers and the number of workers in goods-related industries (e.g. manufacturing and construction activities) partly because of their decreased dependence on face-to-face interaction.

Ivy et al. (1995) examined changes in air service connectivity levels and their impact on administrative and auxiliary employment levels (e.g., research laboratories and financial services) by metropolitan area for the period between 1978 and 1988. Generally, they found a statistically significant positive link and that “changes in air services connectivity had a greater effect on administration and auxiliary employment than a percentage change in administrative and auxiliary employment had on connectivity over the period examined”. Unlike Ivy et al. who examined route connectivity levels, Debbage and Delk (2001) used enplanements to investigate how air transportation can influence local employment patterns and found that metropolitan areas experiencing a significant increase in air service passenger volume generated higher levels of administration and auxiliary employment, thus confirming Ivy et al.'s findings. What is less clear is how airline services influence more specific sectors of the metropolitan economy, especially industries highly sensitive to changes in air passenger demand—such as the PST services sector and the high-technology sector—that are often involved in shared research and development activities that require frequent face-to-face interactions.

3. Data and methods

The main purpose here is to determine whether the geography of air transport demand (as measured by US air passenger enplanements by metropolitan area) is systematically related to employment share and the number of establishments in PST services, and computer and electronic product manufacturing/computer systems design and related services. It is hypothesized that as air passenger demand increases, the employment share and the number of establishments in the PST service sector and the high-technology sector will increase in a similar fashion.

Only those metropolitan areas that the Federal Aviation Administration (FAA) (1997) defined as air traffic hubs in 1997 are examined. The FAA designates hubs “as geographic areas based on the percentage of total passengers enplaned in that area.” This should not be confused with how airlines define a hub when describing their hub-and-spoke route structures, that usually refers to a single airport operation. The definition includes data for the entire metropolitan area and in some instances includes data for more than one airport. The data set includes most of the large, medium, and small air traffic hubs:

- Large air traffic hubs: >1% of total US enplaned passengers.
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Medium air traffic hubs: 0.25–0.99% of total US enplaned passengers.

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Small air traffic hubs: 0.05–0.24% of total US enplaned passengers.

In 1997, there were 118 FAA-defined air traffic hubs, although not all are used due to the lack of data on the PST services sector and high-technology sector in the 1997 US economic census. The focus is thus on the 98 metropolitan areas that had complete data; they accounted for 94.9% of all enplaned passenger volume.

The North American Standard Industrial Classification System (NAICS) is used by the US Federal Government to define industries. NAICS 54 represents the PST services industry. According to the US Economic Census (2004), NAICS 54 includes activities that require a high degree of expertise and training. Activities performed included: legal advice and representation; accounting, book-keeping, and payroll services; architectural, engineering, and specialized design services; computer services; consulting services; research services; advertising services; photographic services; translation and interpretation services; veterinary services; and other PST services. The sector excludes establishments primarily engaged in providing a range of day-to-day office administrative services, such as financial planning, billing and record keeping, personnel, and physical distribution and logistics.

High-technology industries are selected based on the perceived level of technical sophistication of the product produced and include both NAICS 334 (computer and electronic product manufacturing) and NAICS 5415 (computer systems design and related services). The former includes establishments that manufacture computers, computer peripherals, communications equipment, and similar electronic products, and establishments that manufacture components for these products. NAICS 5415 comprises establishments primarily engaged in providing expertise in the field of information technologies through one or more of the following: writing, modifying, testing, and supporting software to meet the needs of a particular customer; planning and designing computer systems that integrate computer hardware, software, and communication technologies; on-site management and operation of a clients' computer systems and/or data processing facilities; and other professional and technical computer-related advice and services.

4. Findings

4.1. The spatial distribution of enplaned passengers by metropolitan area

Although the metropolitan areas include the FAA defined hub classes, the enplaned passenger volume is further refined using modified natural breaks in Fig. 1 and thus the classification of areas does not completely match the FAA definitions allowing attention to focus on the handful of major metropolitan areas that essentially control the national air transportation system. The large FAA hubs are sub-classified using natural breaks to distinguish class 1 (>3.18%), class 2 (2.05–3.18%), and class 3 (1–2.05%) large hubs. These large hub areas accounted for 79.6% of US passenger volume.

Fig. 1. Spatial distribution of airport passenger enplanements (%) by metropolitan area, 1997. Source: US Federal Aviation Administration (1997).

Fig. 1 illustrates the spatial distribution of enplaned passengers. The Class 1 Large hubs ranged in size from 35 to 26 million passengers and included Chicago, New York, Atlanta, Los Angeles, Dallas, and San Francisco. These metropolitan areas functioned as primarily airline-based hub and spoke network centers (i.e. Chicago, Atlanta, and Dallas) or as substantive international gateways to overseas markets (i.e. New York, Los Angeles, and San Francisco). Chicago, Atlanta, and Dallas all operated traditional hub and spoke operations for United, Delta, and

American Airlines, respectively, and are located in relatively central locations allowing the connecting flights needed to sustain major hub operations. The primary airport for each of these areas was dominant although Chicago (Midway) and Dallas (Love Field) have significant alternative airports. By contrast, the international gateway nodes in New York, Los Angeles, and San Francisco operated more sophisticated and complex systems with multiple airports. Some airports in these more sophisticated metropolitan areas functioned as traditional airline-based hubs while others simultaneously functioned as international gateways. For example, the New York metropolitan area included both domestic hub facilities and a unique international gateway. The John F. Kennedy International Airport functioned primarily as a worldwide gateway with 59% of passengers being international. Newark Airport, however, acted more as a traditional domestic hub for Continental Airlines with domestic passenger accounting for 80.3% of traffic (Airport Traffic Report, 1997).

Many of the Class 2 Large hubs in Fig. 1 emerged during the post-deregulation era as fortress hubs for one or two particular airlines where competition from other carriers was relatively small (e.g., Minneapolis and Northwest Airlines, Houston and Continental Airlines, and Detroit and Northwest Airlines). This lack of competition allowed the dominant carriers to raise fares. Another example of a Class 2 Large hub is the Miami metropolitan area that attracted 17.5 million enplanements in 1997. The substantial passenger volume through this gateway is partly explained by the rapid expansion in international traffic to Latin American destinations. Delta was the leading airline at Fort Lauderdale-Hollywood International Airport with a 28% market share, while American Airlines dominated Miami International Airport controlling 66.7% of passengers (US Federal Aviation Administration, 1997).

Many of the metropolitan areas with smaller traffic volumes tend to function as spoke airports to nearby large cities (Fig. 1). Examples include the numerous medium and small markets clustered around the Dallas and Houston metropolitan areas where American Airlines and Continental airlines are the major carriers.

4.2. Spatial distribution of skilled labor markets by metropolitan area

4.2.1. The geography of PST establishments

Fig. 2 illustrates the geographic distribution of PST establishments by metropolitan area. Substantial agglomerations of these firms appeared in a small number of urban regions. Examples of PST service clusters included the Bowash megalopolis from Boston to Washington DC, as well as Chicago, San Francisco, and Los Angeles. New York stands out as a major center with 63,083 PST establishments compared to an average of 4925 establishments per metropolitan area.

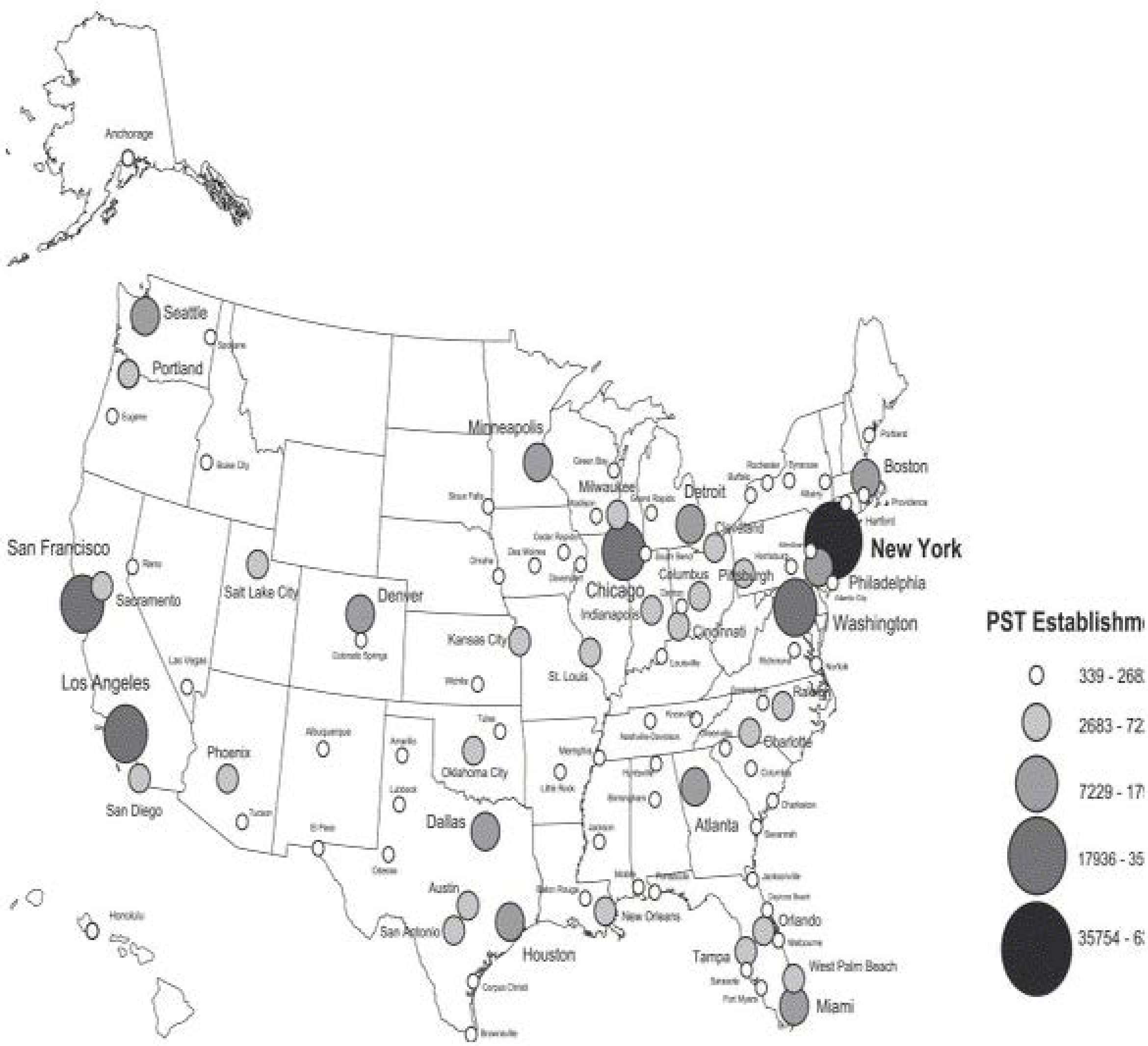

Fig. 2. Spatial distribution of professional, scientific, and technical services sector establishments by metropolitan area, 1997. Source: US Economic Census (2004).

4.2.2. The geography of high-technology establishments

Fig. 3 illustrates the geographic distribution of high-technology firms by metropolitan area and comparing it to Fig. 2 suggests that the geography of PST establishments and high-technology establishments by metropolitan area are comparable. The leading high-technology centers in terms of establishments in electronic product manufacturing and computer systems design services includes New York, San Francisco, Los Angeles, Washington DC, Chicago, and Boston. It is often argued that activities of these establishments require high levels of face-to-face contact suggesting that associated metropolitan areas should have a significant amount of originating traffic to accommodate the needs of the high-technology workers.

Fig. 3. Spatial distribution of high-tech sector establishments by metropolitan area, 1997. Source: US Economic Census (2004).

4.2.3. The geography of PST employment

The employment levels in PST and high-technology industries by metropolitan area largely replicate the national establishment hierarchies. However, the geography of PST by employment share is quite different to the geography of PST establishments by metropolitan area. Although a large number of these establishments are clustered in a small number of metropolitan markets (Fig. 2), a significant number of metropolitan areas generate considerable amounts of PST employment as a percentage of overall employment (Fig. 4). On average, each metropolitan area generates a mean market share of 3.5% with the highest percentage of employees in New York (11.8%), and the lowest proportion of PST jobs in Brownsville, Texas (1.8%). The geography of PST employment mimics the broader population hierarchy with a few notable exceptions including Huntsville, Albuquerque, and Melbourne.

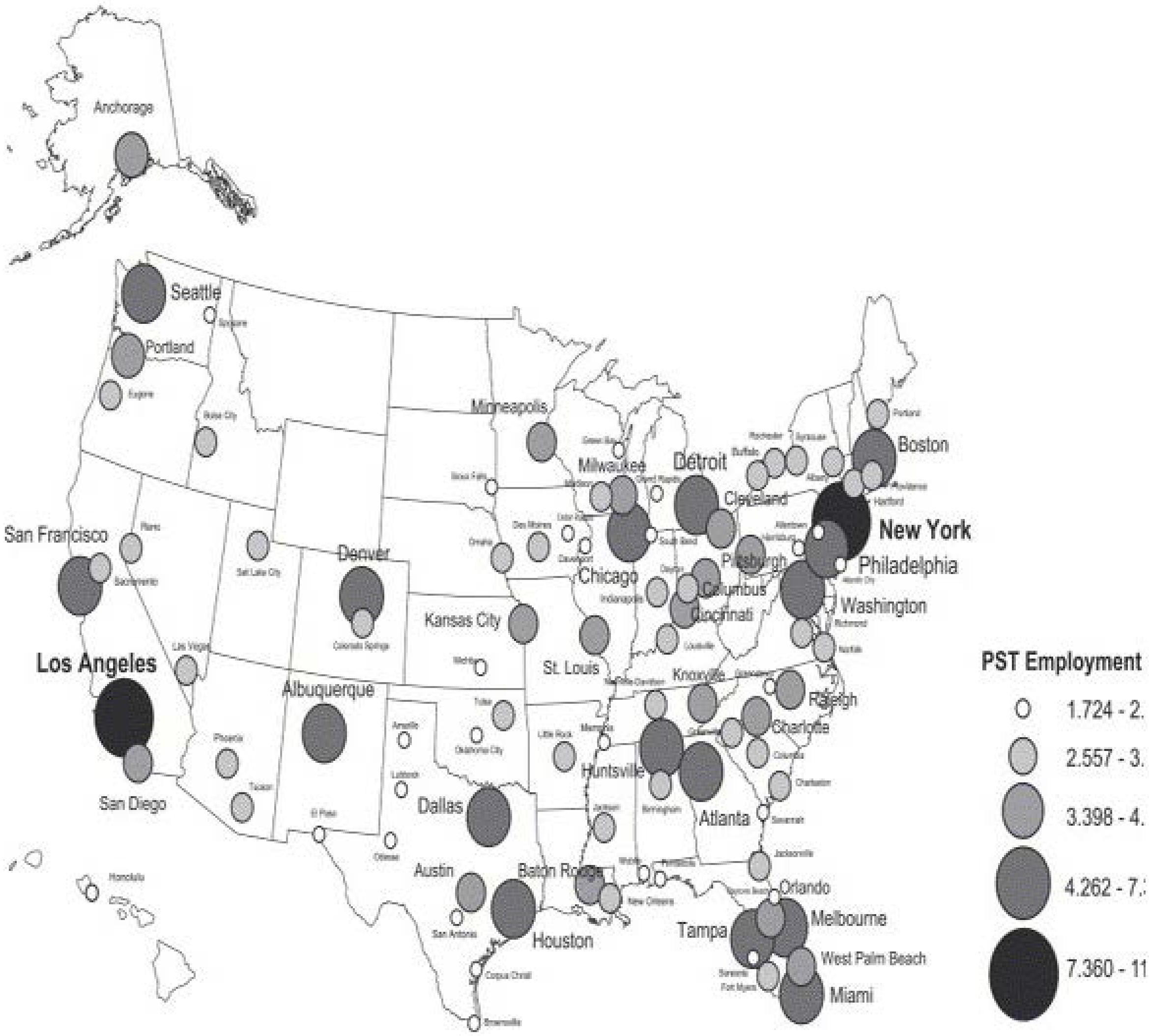

Fig. 4. Spatial distribution of professional, scientific, and technical services sector employment (%) by metropolitan area, 1997. Sources: US Bureau of Economic Analysis (2003), and US Economic Census (2004).

4.2.4. The geography of high-technology employment

The geography of high-technology by employment share (Fig. 5) is different to the geography of high-technology establishments by metropolitan area. Although a considerable number of high-technology establishments are clustered in relatively few markets (e.g., New York and Los Angeles), just as for PST, a large number of metropolitan areas have successfully generated a considerable high-technology employment as a percentage of total employment. The mean number of high-technology workers by metropolitan area was 21,300 and the mean percent of high-technology workers by metropolitan area was 1.75%. Although the San Francisco metropolitan area generated the largest absolute number of high-technology workers (nearly 260,000), the highest percentage of high-technology workers was in the Cedar Rapids metropolitan area (13.4%) with the lowest in Amarillo, Texas (0.08%). Thus although it is often suggested that high-technology companies tend to seek out large, urban agglomerations, a significant number of smaller metropolitan areas generated a very high percentage of high-technology workers including Cedar Rapids, Huntsville, Boise City, Melbourne, and Austin.

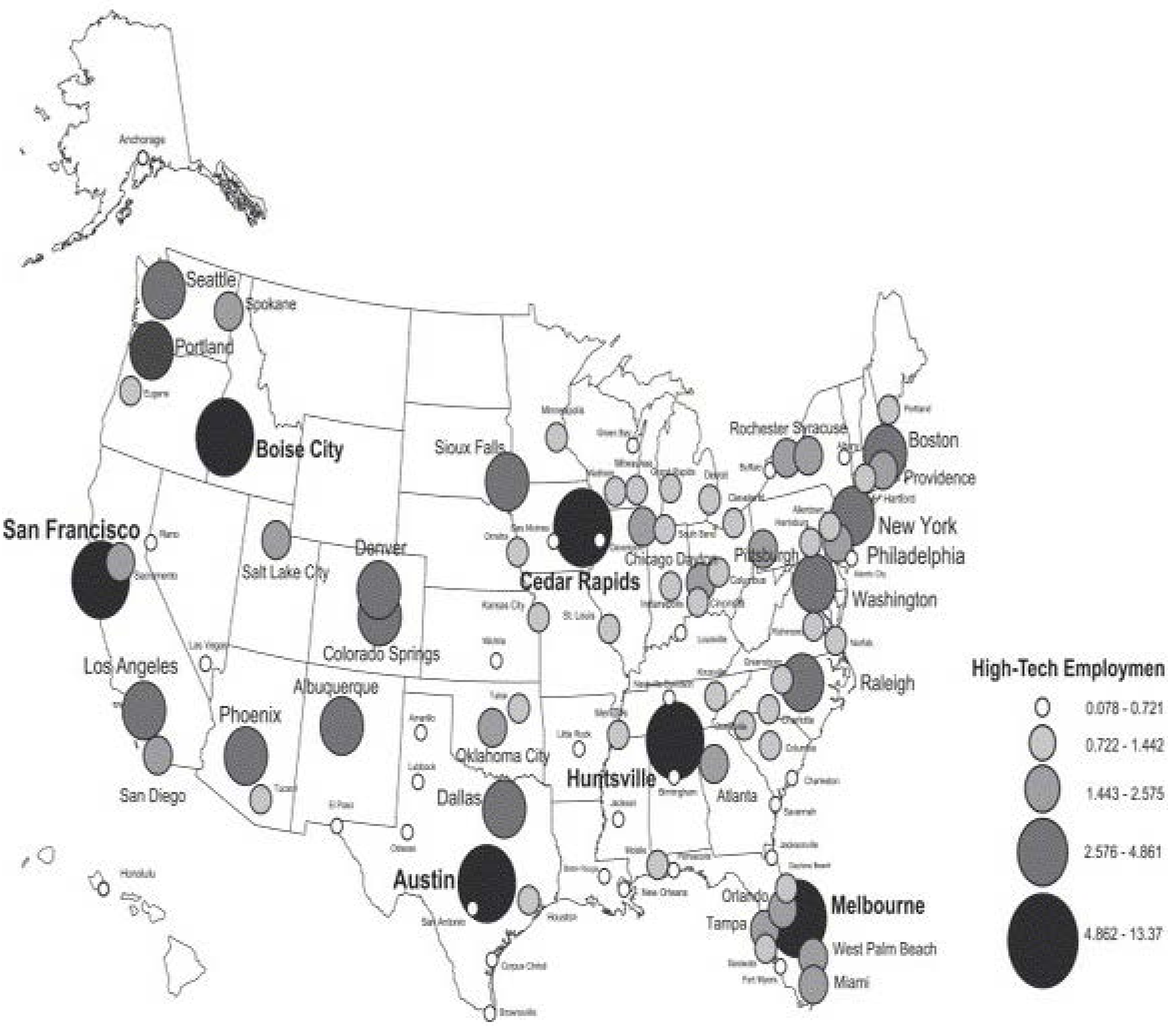

Fig. 5. Spatial distribution of high-tech sector employment (%) by metropolitan area, 1997. Sources: US Bureau of Economic Analysis (2003) and US Economic Census (2004).

4.2.5. Air passengers and PST/high-technology

The scatter diagram in Fig. 6 suggests that metropolitan areas with a low percentage of enplaned passengers tend to have a low number of PST establishments, while metropolitan areas with a higher percentage of enplaned passengers have a greater number of PST establishments. A visual inspection of the scatter diagram line-of-best-fit suggests that Los Angeles and San Francisco closely approximate the linear relationship.

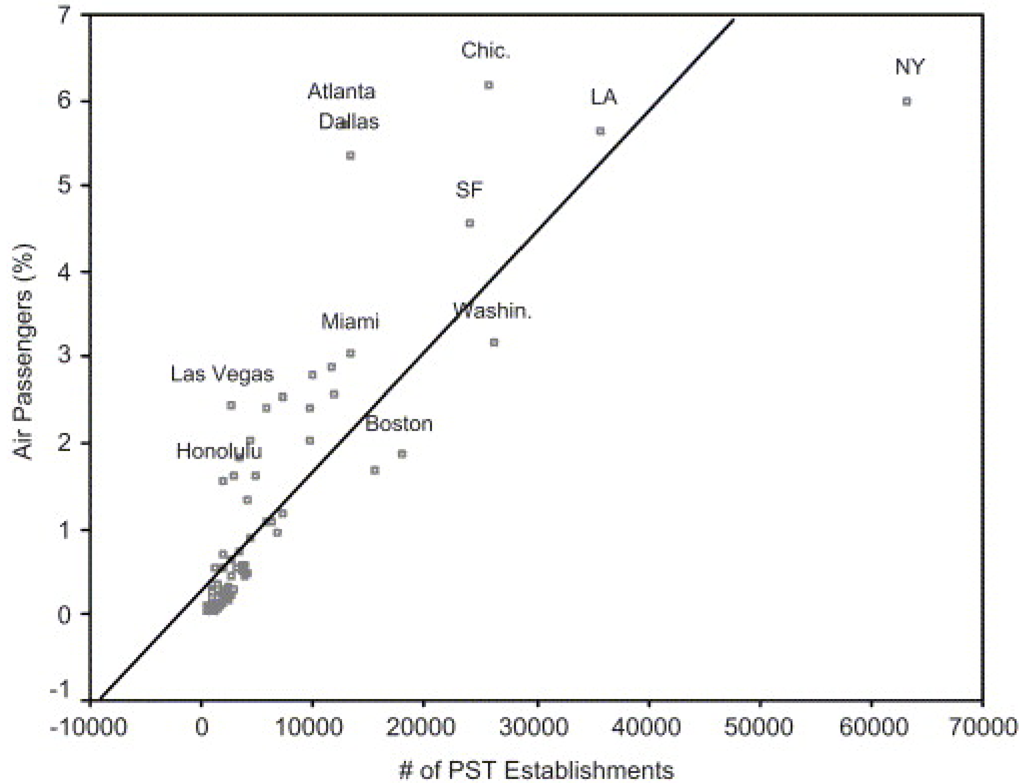

Fig. 6. Air passenger demand (%) and professional, scientific, and technical services sector establishments by metropolitan area, 1997.

Based on a visual inspection of the univariate histograms and a box-plot analysis of the percentage of enplaned passengers and the number of PST establishments, it appears that the distribution of the data is not normal. In the case of the percentage of enplaned passengers, the histogram suggests some degree of skew and kurtosis with several potential outliers or anomalies including Chicago, New York, Atlanta, and Dallas. Because of the problems with skew/kurtosis and a Shapiro–Wilk normality test of significance suggesting that the percentage of enplaned passengers and the number of PST establishments are not normally distributed, the Spearman's rank correlation coefficient (rs) is estimated. A high and positive correlation coefficient suggests that a strong linear relationship exists between air passenger volume and the number of PST establishments.1

Atlanta and Dallas stand out as anomalies because they are unable to generate the number of PST establishments at the rate expected for the percentage of air passengers generated by Atlanta's Hartsfield International, Dallas-Fort Worth and Love Field airports. A large part of Atlanta's and Dallas's traffic is connecting traffic suggesting that a high percentage of air passengers do not necessarily guarantee that the economy will spawn a large number of PST firms. By contrast, New York appears to generate more PST firms than predicted by the line-of-best-fit, in part because of the Manhattan effect leading to an intense concentration of legal, management and consulting, and accounting firms at the city's core. Despite the high proportion of originating air traffic in New York and its key role as an international gateway for air passengers, the line of best fit over-predicts enplaned passengers suggesting that the passenger demand-PST establishment relationship is not always straightforward.

Fig. 7 implies a similarly positive relationship between the percentage of enplaned passengers and the number of high-technology establishments by metropolitan area. Washington, DC and San Francisco straddle the line-of-best-fit and the same anomalies seen in Fig. 6 are repeated. The rs (0.84) for the percentage of enplaned passengers and the number of high-technology establishments suggests a strong linear relationship exists between air passenger volume and the number of high-technology establishments.

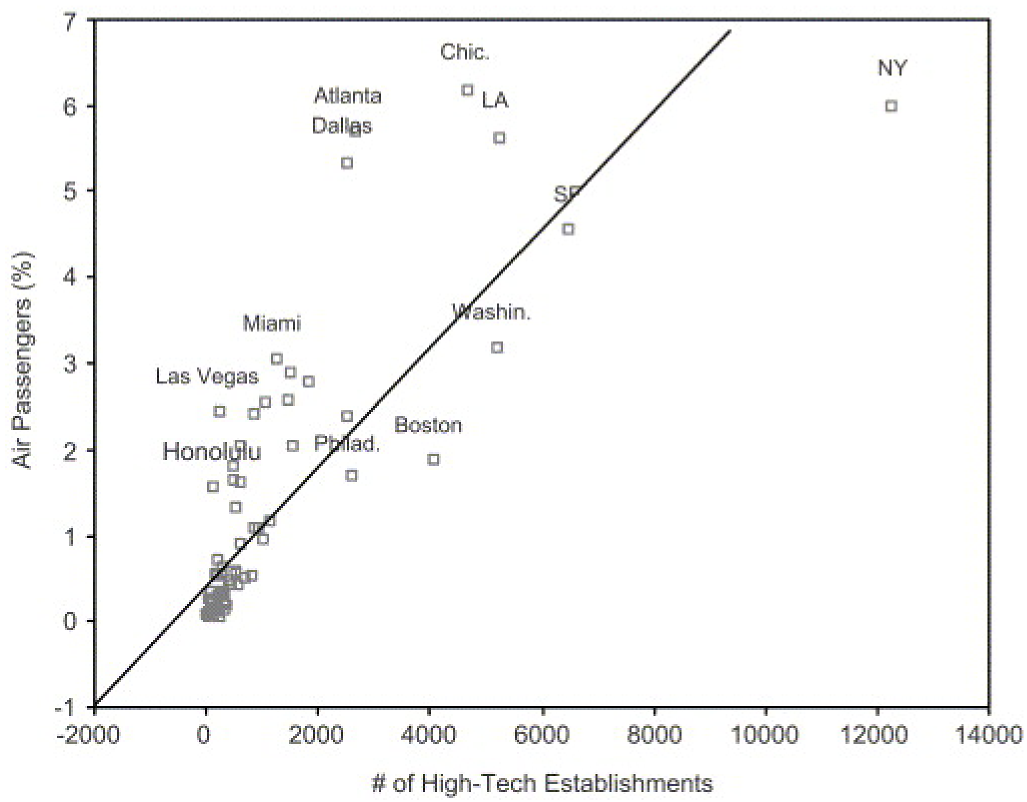

Fig. 7. Air passenger demand (%) and high-tech establishments by metropolitan area, 1997.

The scatter diagram in Fig. 8 suggests that those metropolitan areas with a low percentage of enplaned passengers tended to experience a low percentage of PST employment, while metropolitan areas with a higher percentage of enplaned passengers experienced a higher percentage of PST employment. Fig. 8 also illustrates the dominant role of international gateways like New York and Los Angeles. By contrast, major connecting hubs like Atlanta, Chicago and Dallas generated a smaller percent share of PST jobs based on the level of air passenger demand generated at these hubs. It is less clear why San Francisco generated such a low percentage of PST employment given the substantial air passenger volume. Huntsville, Albuquerque, and Melbourne stand out as slight anomalies because they generated a strong base of PST workers even though air passenger demand in all three metropolitan areas was well below average. All these anomalies demonstrate that the relationship between PST employment generation and air passenger demand can be complex. Despite this, the rs for the percentage of enplaned passengers and the percentage of PST employment was 0.68 at the 1% level. The high and positive correlation coefficient suggests that a strong linear relationship exists between air passenger demand and the percent PST employment.

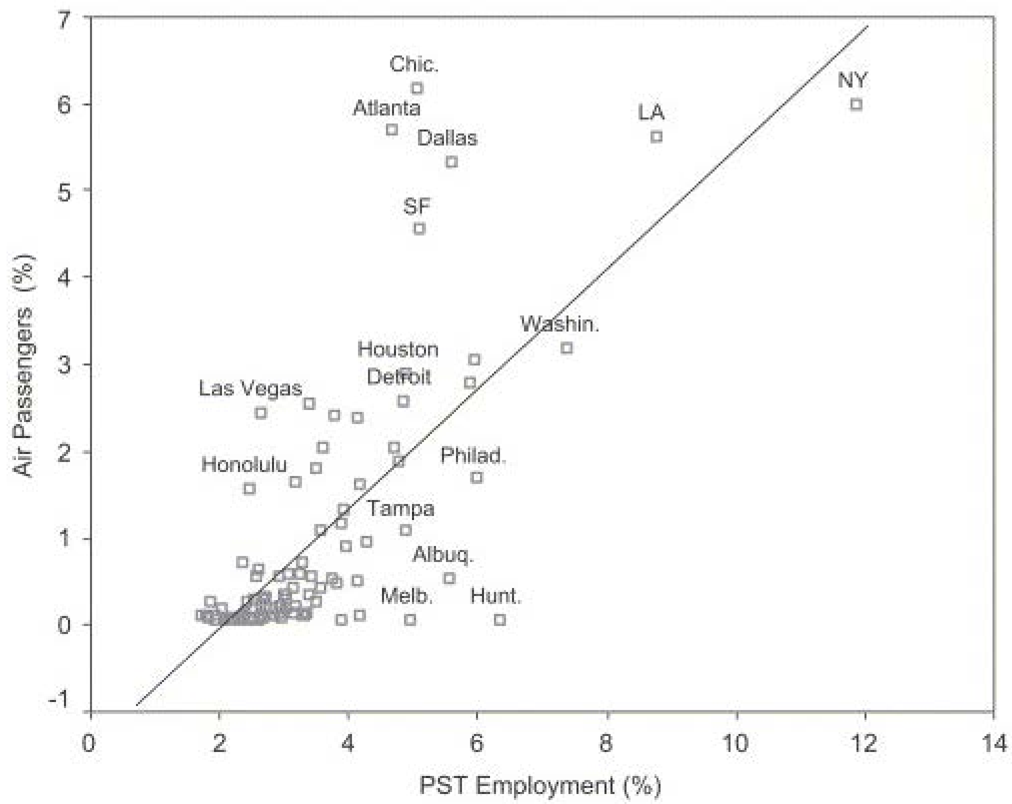

Fig. 8. Air passenger demand (%) and the % of professional, scientific, and technical services sector employment by metropolitan area, 1997.

That said, the relationship between enplaned passengers and percent high-technology employment by metropolitan area is weaker, largely because high-technology employment captured a smaller percentage of the total labor pool than PST employment and is, thus, less able to fundamentally shape the metropolitan economy or overall air transport demand (Fig. 9). The rs for the percentage of enplaned passengers and the percentage of high-technology employees was 0.39 at the 1% level. An important anomaly is Cedar Rapids, which generated a very high percentage of high-technology workers but a very low percentage of enplaned passengers. Cedar

Rapids has a mature and diverse high-technology economy and many highly skilled companies in Cedar Rapids extensively utilize video-conferencing instead of flying to alternative destinations across the country.

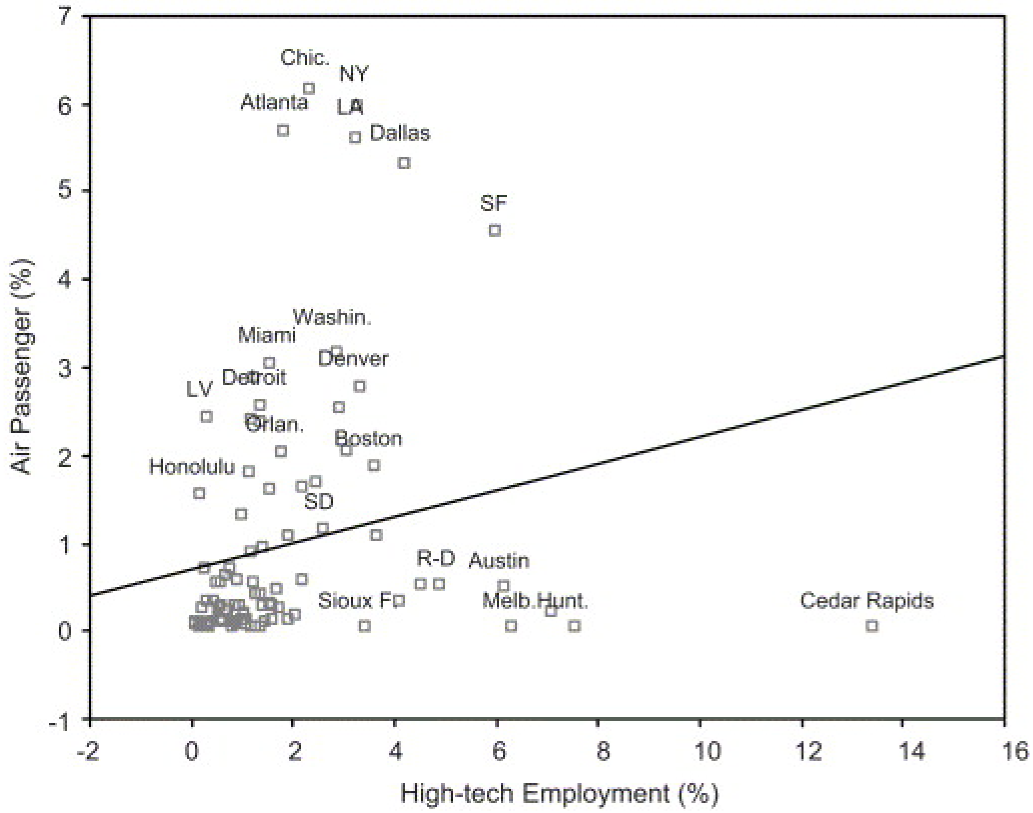

Fig. 9. Air passenger demand (%) and the % of high-tech employment by metropolitan area, 1997.

5. Conclusion

Air transportation emerges as a significant factor in explaining the growth and economic development of metropolitan areas, especially for those with concentrations of industries dependent upon rapid transport of people and products or that require face-to-face interaction. Substantive air traffic generation rates are spatially concentrated in international US gateway cities (e.g., New York, Los Angeles, San Francisco, Washington, and Miami) and intermediate connecting cities (e.g., Chicago, Atlanta, Dallas, Houston, and Denver) located largely in the interior of the country. Significant relationships exist between air transportation and economic development when a region engages in PST employment. Also, these same metropolitan areas are able to generate additional employment in the high-technology sector of the economy where the ability to fly frequently is needed to facilitate face-to-face communications. The relationship between air passenger demand and high-technology employment has limitations partly due to the influence of some anomalous metropolitan areas, such as Cedar Rapids, Huntsville, Boise City, and Melbourne.

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