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It has been suggested that successful economies and convenient access to air transportation are correlated and that centrality in the high-tech business network is a precursor to a robust economy. It is hypothesized in this thesis that a significant positive relationship exists between air passenger enplanements by core urban area and selected labor markets with particular attention focused on Professional, Scientific, and Technical Services (PST)(NAICS 54) and Management Services (NAICS 55). The data for this analysis was collected from the Federal Aviation Administration and the US Bureau of Labor Statistics for years 2009 and 2012. It was determined that the most accurate predictors of the geography of air passenger enplanements included PST employment, airline hubs and management service total wages. This thesis also found that these trends do not extend to service-providing industries in the aggregate, suggesting that high-tech and management workers more likely than other service workers to fly and contribute to their regional economy in times of economic growth and recession.

THE GEOGRAPHY OF AIR PASSENGERS AND EMPLOYMENT PATTERNS BY US CORE URBAN AREA FOLLOWING THE GREAT RECESSION: 2009-2012

by

Anna Caroline Levi

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Approved by

_____
Committee Chair

APPROVAL PAGE

This thesis written by Anna Caroline Levi has been approved by the following committee of the Faculty of The Graduate School at The University of North Carolina at Greensboro.

Committee Chair _____

Committee Members_____

_____

_____
Date of Acceptance by Committee

_____
Date of Final Oral Examination

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CHAPTER I

INTRODUCTION

Developing a better understanding of how local employment patterns shape air transportation networks is critical because the dominant form of long-distance passenger transportation in the US is air transportation. Even with technological innovations that minimize the need for direct face-to-face contact, many economic sectors still rely on direct contact with colleagues, suppliers and customers. Irwin and Kasarda (1991, p. 535) claim that "…the rise of aviation and changes in the airline network have been important factors reorganizing metropolitan economies and creating competitive advantages for employment growth for areas centrally located in the airline network." They go on to say, "because of aviation, the structure of economic interdependence owes less to geographic proximity and more to position in the airline network" (Irwin and Kasarda, 1991, p. 535).

Though face-to-face interactions are increasingly unnecessary due to various technological advancements, many firms still require intimate business collaborations with diverse partners to trade ideas and facilitate innovation. Firms that require extensive face-to-face business interactions have tended to gravitate towards core urban areas because these areas generally contain skilled labor forces that are essential to the development of producer services (Ivy et. al, 1995). Although the land is more expensive and tax rates are higher, core urban areas are

attractive to firms because they offer centrality and connectivity within a business network that can provide easier access to resources and human capital (Liu et. al, 2013; Neal, 2011). Many airline hubs are located in these core urban areas, so it is not surprising that the connections that exist between airline centrality and local employment patterns have been positive. Goetz (1992) found that growth in the population and employment levels of metropolitan areas partly explained increased levels of air passengers per capita. In a study of hi-tech employment, Button et. al (1999) found that airlines do not select cities for hubs because they are already economically diverse but rather, that hubs create employment that can then lead to more economically diverse areas. Ivy et. al (1995) found that changes in air service connectivity can lead to corresponding changes in administrative employment levels, while Debbage (1999) confirmed these trends with respect to the geography of air passenger enplanements. Green (2007) has argued that a significant relationship exists between airports and economic development by testing whether airport activity levels could predict employment and population growth. He found that a significant correlation existed between passenger airport activity and both employment and population growth, and that a one standard deviation increase in air passenger boardings would result in a roughly 8% increase in employment growth and population growth.

It has been suggested that successful economies and air transportation are correlated and that centrality in the business airline network is a precursor to a robust economy (Neal, 2011). Significant correlations have also been shown to exist

between enplaned passengers and administrative and auxiliary employment and the professional, scientific, and technical services sector (Debbage and Delk, 2001; Alkaabi and Debbage, 2007). These studies indicate that service sectors with high salaries, and thus a high propensity to fly, directly generate enplaned passenger demand and ultimately economic growth and development. Yet presently no research exists that evaluates if these relationships have changed post 2008 recession. If the relationship between key service sector jobs appear to be linked to air passenger demand since the Great Recession, the resilience of those jobs in the face of economic downturn will be made more evident. As such, core urban areas could economically benefit by attracting those key service sector jobs to their area. The following research tests whether the relationship between air passenger enplanements and labor sector data has changed since the Great Recession of the late 2000's.

This thesis will investigate spatially connections between air traffic by airport and economic activity on the ground. Specifically, I hypothesize that, following the Great Recession, a significant positive relationship remains between air passenger enplanements by core urban area and selected labor markets with particular attention focused on Professional, Scientific, and Technical Services and Management Services. It is expected that robust employment in these specified service sectors are tied to greater number of enplanements within a core urban area. The goal of this thesis will be to attempt to contribute to the existing literature

by emphasizing how key employment patterns generate air traffic and, ultimately, long term economic growth.

CHAPTER II

REVIEW OF THE LITERATURE

2.0 The Relationship Between Airports, Employment Growth and Economic Development

In recent decades, air transportation has become increasingly more fundamental to the functionality of economic development. Face to face interactions among businesspeople and between firms creates an environment in which collaboration allows knowledge and capital to flow. Intercity agglomerations have emerged as business clusters that share resources, human capital, and innovation through connected airline networks. Geographical centrality within those business networks has emerged as an important aspect of the economic equation. It is necessary, then, to understand the relationship that exists between air transportation and economic development because the ability to recognize their mutual effects will aid in long-term regional economic development.

The advancement in communication technology in recent years has created an environment in which physical interactions are no longer required. There is, to a lesser extent, a need to conduct business, in person, when other modes of communication, like international conference calling, can be used instead. Though face-to-face interactions are frequently unnecessary, they are still widely used and are valuable to certain economic sectors, such as business and producer services,

which are hereafter referred to interchangeably. Many firms still require intimate business collaboration with partners outside their city or region to trade ideas and facilitate cash flow. In these instances, communication technology has only opened up new possibilities for widespread collaboration and business partners who wish to meet must frequently use air transportation to do so (Ivy, Fik, and Malecki 1995).

Firms that necessitate face-to-face business interactions have gravitated towards metropolitan areas because those areas generally contain a skilled labor force that is essential to producer service. Metropolitan areas are also increasingly important because they provide communication channels from corporate headquarters to headquarters in other cities and to R&D and manufacturing that have moved outside of the central business district (CBD) to cheaper, peripheral areas. Although the land is more expensive and taxes rates are higher (Ivy, Fik, and Malecki 1995), metropolitan areas are attractive to firms because they offer centrality and connectivity within a business network that provides easier access to resources and human capital (Neal 2011). Intercity agglomeration economies have emerged between metropolitan areas that are central in the airline network. It becomes necessary, then, for those metropolitan areas to maintain quality airports as a means to facilitate the business interactions that will stimulate economic growth (Bruckner 2003).

The positive correlation between economic productivity and business network centrality has long been evident in cities like New York. However, these global cities, along with Denver and San Francisco also share the largest losses in

business air passengers from 1993 to 2008. In fact, the Rust Belt region is beginning to lose its economic dominance to southern and western cities like Atlanta, GA; Charlotte, NC; and Dallas, TX who are among the five cities who increased their shares of business air passengers the most in this time period (Neal 2011). Irwin and Kasarda (1991) reaffirm the transition from north to south and west by finding that no relationship exists between thriving producer services and densely populated older metropolitan areas such as New York and Chicago. They postulate that the aging infrastructure of historic metropolitan areas may be responsible for the transition.

In addition, the deregulation of the airline industry in 1978 is, perhaps, the most important contributor to shifting centrality. Under deregulation, airlines were able to thrive, or fail as many smaller airlines did, along with market demand. Increased competition during this era led to reduced ticket prices and increased air enplanements, or total number of boarding passengers (Ivy, Fik, and Malecki 1995). The surge in air transportation led to the decentralization of the intercity business network. As previously mentioned, throughout the 1990s, economic dominance began to migrate from Rust Belt cities towards Sun Belt cities, like Atlanta, and centrally located cities like Dallas (Neal 2011). This has been particularly evident in Dallas, which, since 1970 when construction on Dallas/Fort Worth International Airport began, saw the number of jobs in the four-county region increase by 148 percent (Green 2007). Dallas's growth was substantive when considering that job

growth for the nation, as a whole, over the same period grew just 67 percent (Green 2007).

An important product of deregulation and decentralization has been the implementation of hub-and-spoke networks that most major airline carriers have since adopted. These networks consist of hubs, which are centrally located airports, through which a carrier can funnel a majority of its air traffic to spokes, or connected airports in other cities, via connecting flights. The implication of the development of hub-and-spoke networks is increased connectivity and airflow efficiency for cities within the network. Subsequently, hub cities offer many non-stop destination routes and generate very large amounts of air traffic (Ivy, Fik, and Malecki 1995). Given the idea that economic activity and quality airport connectivity are correlated, it is no wonder that hub cities, like Atlanta, are emerging as economic powerhouses. Compared to citied like Los Angeles and Chicago in terms of regional functionality, Atlanta is situated at the top of the southern urban hierarchy with several fortune 500 firms headquartered there and a population of nearly one million as of 2013 (Hartshorn 1997; United States Census Bureau 2013).

Furthermore, the ability for peripheral cities, as Atlanta once was, to become national and international economic competitors insinuates that centrality in the airline network does indeed go hand in hand with economic development. Firms in peripheral regions have benefited from increased connectivity because they have acquired access to intercity partnerships and a broader labor pool, both of which

increase competitiveness and are essential to economic development (Mukkala and Tervo 2012).

Economic development is often facilitated by employment growth. Green (2007) successfully sought to uncover whether or not a relationship existed between airports and economic development by testing whether airport activity could predict employment and population growth. After controlling for other variables that may impact economic growth, like tax variables, climate variables, and human capital variables, Green (2007) found a significant correlation existed between passenger airport activity and both employment and population growth. In fact, his research showed that, for a metropolitan region, a one standard deviation increase in boardings, or originations per capita, would result in a roughly 8 percent increase in employment growth and population growth. It is important here to note the difference between boarding passengers and originating passengers. Passenger originations account for the number of passengers that are initiating their trip in an economic market, while boarding passengers which are synonymous with enplanements, refers to the total number of passengers boarding an airplane at a given airport, encompassing both originating passengers and, crucially, connecting air traffic.

Green's findings, that there is a statistically significant tie between air traffic and economic growth, are important. Previous literature on the subject has been limited. He has demonstrated that access to an airport is an important factor when considering the economic wellbeing of a metropolitan area. However, another

problem emerges. While it is evident that face-to-face interactions are important economic tools in agglomeration economies, it remains to be seen whether cities become centrally located within the business network because of their substantial economic activity or whether cities experience economic growth because of their central position (Neal 2011). The quandary directly relates to metropolitan airports. Is access to an airport the means to a healthy economy or does a healthy economy yield employees who need and utilize an airport?

2.1 Causality

Previous literature has shown that high quality, well-connected airports are, indeed, related to economic growth. Neal (2011) points out that cities with larger air traffic volumes tend to have more jobs. However, the question remains, is the airport a function or a cause of said growth? It is a 'chicken or the egg' argument that has often been cited yet rarely measured.

A study by Irwin and Kasarda (1991) attempted to determine the direction of the causality between air passenger linkages and economic growth. By analyzing the levels of airline centrality and change in employment for a thirty-year period, they found that for manufacturing and producer services, the change in air network centrality had significant positive effects on employment. Their study was one of the first to show causality, although Brueckner (2003) later argued that manufacturing was much less affected by changing network centrality because manufacturing

industries require little face-to-face interaction and so use air transportation infrequently.

A study by Neal (2011) also sought to test the causal relationship between airline networks and employment. He presented two theoretical models that represented the possible direction that the relationship might take, including the Flow Generation Hypothesis and the Structural Advantage Hypothesis. The models were offered in his research as attempts to define the causality of the relationship between business network centrality and employment.

The Flow Generation Hypothesis is a demand-based theory that suggested that cities with robust economies and high employment levels create demand for business creation and intercity interactions, thus propelling those cities towards centrality. The Structural Advantage Hypothesis, on the other hand, is a supply-based theory. It argues that strategic resources found within cities, such as human capital, are in the greatest supply within metropolitan regions that are located within the business network. According to this theory, cities that are already located within the network are more competitive and benefit economically because convenient access to and from the region provides opportunities for increased access to information, business expansion, and economic stimulation. The Structural Advantage Hypothesis, favored by Neal, also points out that a centrally located city controls the flow of information within its region, just as an airline hub controls access to the hub city. Ideally, a centrally located city would funnel business

travelers through its network and would, in a sense, act as a gatekeeper for the information carried by the business travelers (Neal 2011).

Neal goes on to define both the Flow Generation and the Structural Advantage hypothesis as being driven by business travelers rather than leisure travelers. He compares the two types of travelers with the analogy that business travelers are to venture capital funds as leisure travelers are to spending money. The difference between the two types of travelers allows for profitable leisure travel industry found in many cities, while maintaining that economies fueled by business travel are more lucrative and often more stable. He identified business travelers as those passengers who are traveling alone and who paid significantly more for their ticket than the average passenger who traveled the same route in the same quarter. Using "willingness to pay more" as a measure of a business traveler, Neal is able to account for business passengers traveling coach as well as business class or first class travelers. However, his classification does exclude leisure travelers who bring work with them and passengers who find bargains or use frequent flier miles on their plane ticket (Neal 2011).

According to the regression analyses performed by Neal for the Flow Generation and Structural Advantage Hypotheses, evidence that a causal relationship exists between employment and business networks can be defined and better articulated. His analysis shows that, in accordance with the Structural Advantage Hypothesis, historic business centrality was indicative of robust employment levels. In other words, urban areas that had a history of being centrally

located within the business network had higher rates of job growth. There does appear to be room for outliers in Neal's Structural Advantage Hypothesis model, however. There were several cities that did not fit within the parameters of the model. For example, Detroit, MI and Pittsburg, PA both had fewer jobs than the model would predict, given their central location within the business network. Similarly, Phoenix, AZ and Riverside, CA had more jobs. This suggests that regional differences and industrial specialization play an important role in determining whether a city might benefit from network centrality or not (Neal 2011).

In a follow-up study, Neal conducted a similar causality analysis on the relationships that might exist between creative employment and the flow of airline passengers. He reasoned that, since many city leaders have adopted a 'creative city' approach to economic development, it might be useful to determine whether those jobs follow network centrality or whether centrality in the network produces creative jobs (Neal 2012). Michigan's Cool Cities Initiative aspires to revitalize declining cities like Detroit "by applying the new economy paradigm where creative place making and talent matter" (Neal 2012, 2693) meaning that by promoting artists and performers, Michigan hopes to attract other economic business that is interested in existing within a "Cool City." From an economic perspective, it is unlikely that a region like Detroit would choose to support creative jobs simply to support artists. However, it is entirely plausible that firms may choose to locate within a creative class in order to have access to both entertainment and an innovative pool of workers. Knudsen et al (2008) pointed to agglomeration

economies like that of the Hollywood film industry that have developed a robust economy around creative employment.

Neal (2012) expected that the number of originating air passengers would determine the flow of creative employment according to the Structural Advantage Hypothesis. He defined creative jobs as those that are in the "Arts, design, entertainment, sports, and media occupations" (Neal 2012, 2697), as defined by the US Department of Labor's *Occupational employment statistics survey.* Again, Neal chose to eliminate connecting passengers from his study but unlike in his previous study, he included both business passengers and leisure passengers as they both consume creative products. Whereas Neal's study of the causality between employment and business network centrality provided statistically significant evidence that business follows network centrality (Neal 2011), the causality between creative employment and air traffic is less clear.

Like Neal, Irwin and Kasarda (1991) attempted to look at the causality between airline flows and positioning in the business network and employment growth. They looked at producer service sector, including FIRE industries, and the manufacturing sector and came to the conclusion that changes in the airline centrality network effect employment and not the reverse. They found this to be true for both producer services and manufacturing. However, Bruecker (2003) argued that airline traffic actually has no effect on manufacturing employment since those jobs require little face-to-face interaction with businesses located in other regions. While the study found producer service employment to be affected by

changes in the airline centrality network, it also found that cities with a history of strong producer services have a negative effect on airline centrality. This means that cities like New York and Chicago, that have long been economically robust in the producer sector, have declining centrality in the airline network (Irwin and Kasarda 1991).

This can, perhaps, be best explained by the advent of the hub-and-spoke network and the migration of talent from the Rust Belt towards southern and western regions (Neal 2011). By comparison, the rapid growth of cities like Atlanta and Dallas make Chicago and New York appear to be losing centrality, but they are actually still quite strong. The existing presence of a healthy producer services sector should not frighten regional leaders into believing that a decline in centrality was inevitable since it has been shown that past employment is a weak indicator of present centrality (Neal 2012). Quite the opposite, since workers in producer sectors have a high propensity to fly, those jobs would create the necessary passenger demand that has been shown to bolster employment and stimulate economic growth.

Employment growth and economic development are directly affected by air traffic and a city's positioning within the business network. Previous literature has shown correlation and causality exists between them. However, the argument for causality, though convincing, will be difficult to truly test. Airports are preexisting entities and it would be difficult to measure the hypothetical economic development

of a given region without its airport. It would be equally difficult to build an airport and measure the economic success of the same city with and without the airport.

2.2 Predictors for Successful Economics

It has been indicated that successful economies and air transportation are indeed correlated and, as suggested by Neal (2011), centrality in the business network is a precursor to a robust economy. If that were true then, presumably, all regions with centrally located airports would have successful economies. We know that that cannot be true however, since centrally located cities like Detroit and Pittsburgh are underperforming in job creation (Neal 2011). So then the question becomes; what are the key predictors for successful economies?

One predictor for successful economies is the presence of an airline hub. Since centrality in the airline network has been directly linked to economic success, its stands to reason that hub cities, which control the flow of air traffic and information within their region, would thrive economically (Neal 2011). This appears to be the case. Green (2007) found that from 1990 to 2000, the population in hub cities grew between 9 and 16 percent faster than non-hub cities. Similarly, he found that hub cities see employment growth between 8.4 and 13.2 percent faster than non-hub cities.

Button et al (1999) suggested that the quality of airport service is not so much responsible for increased air passengers as is the establishment of an airline hub. They indicate that hub airports offer wider selections of destinations and lower

fares, among other benefits, that non-hub airports cannot offer. For this reason, they argue that business travelers are frequently more likely to utilize hub airports and invest their money into those economies that house a hub airport. A leading example is Cincinnati, OH. George Mason University's Aviation Policy Program, as cited by Green in 2007, found that from 1989 to 1996, the number of high-tech jobs within the Cincinnati metropolitan region had increased by 15,000 jobs. The presence of a hub airport and the connectivity it facilitated was credited as a major factor in the regional economic development that came from the high-tech employment growth (Green 2007).

Similarly, from 1978 to 1988, Charlotte, NC demonstrated growth in employment, air service connectivity, and total boarding passengers. This suggested that its central location and hub status has bolstered its economy (Ivy, Fik, and Malecki 1995). However, there is the chance that the numbers reported by hub cities are inflated since they funnel connecting flights from a hub to a spoke at another destination. The economic success of a hub city should not be attributed to its air traffic centrality solely on the grounds that it had a large number of enplanements. In such instances it could be that the high air traffic volume was coincidental and the economic success should be attributed elsewhere. However, it is widely understood that hub cities do elevate ease of access and intercity connectivity and that connectivity is often a catalyst for economic expansion.

Another indicator of successful economies is a large share of workers who have a high propensity to fly. Workers who require face-to-face interaction with

partners in other cities frequently use air travel to realize that close proximity. Brueckner (2003) argued that service related businesses require such interaction more frequently than do manufacturing and goods-related businesses. Through regression analysis, he found that by increasing air passenger enplanements by 10 percent, service related employment would rise by, roughly, one percent for a metropolitan area. He went on to argue that the quality of transportation was influential in business travel and, ultimately, in the economic development of the host region. He claimed "it is alleged that poor service inhibits local employment growth by limiting the attractiveness of the city as a location for new businesses and by reducing the viability of existing firms." (page 1455)

Although unanimity throughout the literature has not been achieved in pointing to a single business sector as being most responsible for economic growth, the literature is conclusive in the respect that most of the authors did cite certain business services sectors as key predictors when associated with air travel. These include sectors like producer services (Irwin and Kasarda 1991) and a strong general service sector (Brueckner 2003). Irwin and Kasarda (1991) made the argument that the change in airline connectivity was a significant driver of producer services job stimulation. Button et al (1999) have indicated that workers in high technology jobs frequently are more likely to fly than workers in more traditional jobs. Particular high-tech jobs within the service sector have also been shown to be especially indicative of increasing air traffic due to their high propensity to fly. Workers in the administrative and auxiliary services sector and the professional,

scientific, and technical services sector are examples of such workers (Ivy, Fik, and Malecki 1995; Debbage 1999; Debbage and Delk 2001; Cidell 2014).

In a study by Debbage and Delk, (2001) enplaned air passengers and administrative and auxiliary services employment for 50 metropolitan regions were analyzed. A significant positive relationship was shown to exist between enplanements and key service workers due to the fact that those workers required face-to-face business interactions and had a higher propensity to fly than other sectors. The implications of which suggest a link between air passengers and economic development for metropolitan areas that invest in those job sectors. Likewise, Debbage (1999) also found that metropolitan areas in the US Carolinas that experienced significant gains in air traffic had comparable gains in employment in the administrative and auxiliary services sector.

A study by Alkaabi and Debbage (2007) found a link existed between air passenger enplanements and the number of workers in the professional, scientific, and technical services sector, as well as a link between enplaned air passengers and the high-technology sector, suggesting that attracting high-tech service jobs could generate additional air traffic and increase economic growth. Liu, Debbage, and Blackburn (2006) reaffirm these findings in research that compared major and minor air passenger markets. They found that major air passenger markets had significantly higher proportions of workers in the professional, scientific, and technical services sector, as well as in the management services sector and in FIRE

industries. Their research found that PST workers were most highly indicative of propensity to fly.

In similar research, Button and Taylor (2000) also found that workers in "new economy" jobs (ie biotechnology, management and services, various computer programming and design…etc), who conduct activities that engage an extensive number of contacts, fly 1.6 times as often as other, traditional, workers. According to them, these contacts can only be maintained through high quality transportation. They go on to argue that a strong tie exists regarding connectivity between both US and EU markets and "new economy" jobs within a region. They theorized that an additional EU destination would yield an additional 40,000 air passengers and an additional 1150 new economy jobs. Assuming each job was worth $55,000 per year, a region could increase their tax base by $160 million per year- a significant impact on a regional economy. Furthermore, Alkaabi and Debbage (2007) found that metropolitan areas that hosted international gateway airline hubs, like New York and Los Angeles, were more likely to attract additional professional, scientific, and technical/high-technology workers than metropolitan areas without gateway hubs.

The literature on the relationship between air traffic and employment growth yields important information about the effect that administrative and auxiliary service and professional, scientific, and technology services employment has on the economy. Workers in these sectors exibit a higher propensity to fly and thus are important human capital within a region. What remains to be seen is whether these jobs have proven themselves resilient following the Great Recession.

Pierce (2012) has shown significant improvement in the airline industry since the low point of the recession in 2009. He specifically points to resurgence in airline freight and business travel. The following research will attempt to uncover whether the same is true for business travel within the professional, scientific, and technical services sector (PST) and the management services sectors.

CHAPTER III

RESEARCH DESIGN

Previous literature illustrated that a relationship between enplaned air passengers and regional economic wealth exists. The purpose of this thesis is to establish which underlying employment patterns best explain spatial variations in passenger enplanements. Building on the work of Irwin and Kasarda (1991); Brueckner (2003); and Alkaabi and Debbage (2007) I hypothesize that:

- H1- The Professional, Scientific and Technical services sector is positively related to total air passenger enplanements.
- H2- The Management Services sector is positively related to total air passenger enplanements.
- H3- The Service industry, in general, has no relationship to total air passenger enplanements.

Air-transportation data will be collected for the total number of enplaned passengers for large, medium, and small hub airports in 2009 and 2012, based on the Federal Aviation Administration's (FAA) hub classification system for the 124 urban airports that fall into those categories for 2009 and 2012 (Table 3.0.1). Non-hub airports will not be used in this thesis' data set. From 2009 to 2012, seven airports fell from small hub status to non-hub status and were not included in the

data set for 2012. Likewise, eight airports rose from non-hub to small hub status from 2009 to 2012 and were only included in the 2012 data set. Total enplaned air passengers will represent the dependent variable. The difference between FAA hubs and airline hubs is important to note. FAA hubs are simply measures of total US air traffic while airline-based hubs (i.e. Delta's hub at Hartsfield-Jackson International Airport in Atlanta GA) are centrally located airports that specific airline carriers use as a gateway to other locations via the hub-and-spoke system.

Table 3.0.1. Federal Aviation Administration Hub Definitions

Large Hub	1% or More of Total Air Traffic in U.S.
Medium Hub	At least 0.25% but less than 1% of Total Air Traffic in U.S.
Small Hub	At least 0.05% but less than .025% of Total Air Traffic in U.S
Non Hub	Less than 0.05% of Total Air Traffic in U.S.

Total county employment and wages data were collected from the US Bureau of Labor Statistics' *Quarterly Census of Employment and Wages* for the 124 core urban areas, where each host-county will include at least one airport. In the instance of multiple airports within an urban-core area, employment and wage data from all selected airports and urban-core counties are aggregated. For example, the New York City urban-core area included JFK, LaGuardia, and Newark Liberty

International Airport and also New York, Queens, and Essex Counties. For a full list of combined core urban areas, refer to table 3.0.2.

Table 3.0.2. List of Core Urban Areas that Consist of More Than One County, Parish, or City.

Core Urban Area	Counties/Parishes/Independent Cities Included	Airports Included
Los Angeles CA	Los Angeles County	LAX, BUR, LGB
Tampa FL	Hillsborough and Pinellas Counties	TPA, PIE
Chicago IL	Cook County	ORD, MDW
Greater Cincinnati	Hamilton County OH and Boone County KY	CVG
New Orleans LA	Jefferson Parish and Orleans Parish	MSY
Baltimore MD	Baltimore County and Baltimore City	BWI
Minneapolis MN	Hennepin County and Ramsey County	MSP
St Louis MO	St Louis County and St Louis City	STL
New York	New York County NY, Queens County NY, Essex County NJ	JFK, LGA, EWR
Dallas-Fort Worth TX	Dallas County and Tarrant County	DAL, DFW
Houston TX	Harris County	IAH, HOU
Greer SC	Greeneville County and Spartanburg County	GSP
Washington DC	District of Columbia, Fairfax County VA, Loudoun County VA, Arlington County VA	DCA, IAD
Richmond VA	Henrico County and Richmond City	RIC

Employment and total-wage data from 2009 and 2012 will be collected for each urban-core area based on the North American Industry Classification System that will include: Professional, Scientific, and Technical Services (PST) (NAICS 54) and Management of Companies and Enterprises (NAICS 55). PST jobs frequently require advanced degrees and specialization expertise, and training. Common PST activities include legal representation; architectural, engineering, and design services; and computer and research services; among others. The management services sector typically includes non-governmental establishments that manage, administer, and oversee other companies or enterprises.

Mean annual pay will be determined by dividing total wages by total employment for each core urban area. The percent of the labor force in all service providing activities, in the aggregate, by core urban area, will also be included in the analysis as a control variable to capture broader economic shifts in the service economy. Among the pairs of independent variables that demonstrate co-linearity, the variable with the least amount of correlation with the dependent variable will be excluded. Table 3.0.3 lists all variables to be used in the analysis and their respective sources. Each variable listed in the table will be collected for years 2009 and 2012 for each core urban area.

Table 3.0.3. All Variables for Years 2009 and 2012 for Each Core Urban Area

Variable	Sourced From
Enplanements by airport	Federal Aviation Administration
Hub Type	Federal Aviation Administration
Per capita income	United States Census Bureau
Percent of population age 25+ with a 4 year degree	United States Census Bureau
Professional, Scientific, and Technical Services (NAICS 54) • Employment • Percent Employment • Total Wages • Average Annual Pay	United States Bureau of Labor Statistics
Management Services (NAICS 55) • Employment • Percent Employment • Total Wages • Average Annual Pay	United States Bureau of Labor Statistics
Three Year Employment Growth • 2006-2009 • 2009-2012	United States Bureau of Labor Statistics
Three Year Population Growth • 2006-2009 • 2009-2012	United States Bureau of Labor Statistics
All Service Related Employment • 2009 • 2012	United States Bureau of Labor Statistics
All Services as a Percent of Total Employment	United States Bureau of Labor Statistics

CHAPTER IV

FINDINGS

4.0 Enplanements

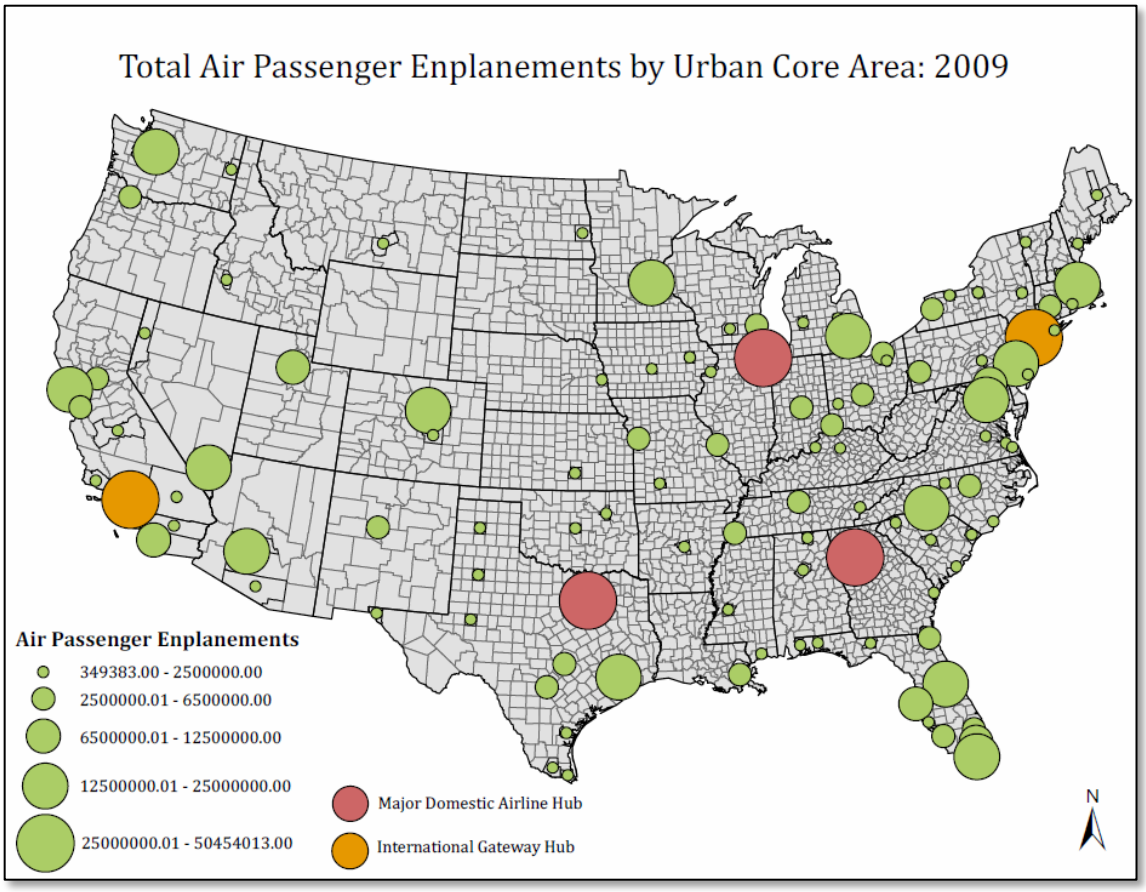
Air passenger enplanements are representative of any person boarding a plane and takes into account all travelers, both originating and connecting. This variable illustrates the level of connectivity between a core urban area and others by way of their airports. In 2009, the New York core urban area, consisting of JFK, LGA, and EWR had nearly 50.5 million enplaned passengers, the largest number of enplaned passengers in the US that year. It was followed by Atlanta, GA's Hartsfield-Jackson International Airport with over 42 million enplanements. Conversely, Corpus Christi, TX had the fewest at just 350,000. By 2012, the number of enplaned passengers for the NY core urban area had grown to over 54 million, which remained the highest in the nation. Atlanta also remained in the second spot with almost 46 million enplanements. Contrastingly, Fargo, ND had the fewest enplaned passengers in 2012 with 370,000 passengers. Table 4.0.1 lists the ten core urban areas with the highest enplanements for 2012. The core areas marked with an asterisk indicate that the core hosts a major domestic airline hub.

Table 4.0.1. Top Ten Core Urban Areas with the Highest Enplanements in 2012. Asterisks Denote a Major Domestic Airline Hub.

Core Urban Area	Total Air Passenger Enplanements
1. New York, NY*	54395691
2. Atlanta, GA*	45798928
3. Chicago, IL*	41608182
4. Los Angeles, CA	34908317
5. Dallas-Forth Worth, TX*	31925532
6. Denver, CO*	25799841
7. Houston, TX*	24082737
8. San Francisco, CA	21284236
9. Washington, DC	20278447
10. Charlotte, NC*	20033816

Figure 4.0.1 illustrates the largest urban airport complexes for 2009. A few select areas captured a disproportionate share of air passenger enplanements. As highlighted in red in Figure 4.0.1, the three largest domestic airport operations included Atlanta's Hartsfield-Jackson International Airport (Delta), Chicago O'Hare (United Airlines), and Dallas-Forth-Worth's DFW International Airport (American Airlines). By contrast, New York and Los Angeles (highlighted in green) acted as international global gateways with both domestic and international air traffic.

Figure 4.0.1. Total Air Passenger Enplanements by Core Urban Area for 2009



The average numbers of enplaned passengers for 2009 and 2012 were 5.6 million and 5.8 million, respectively, which is far fewer than the number of enplanements for core urban areas like New York City and Atlanta. As illustrated by Figure 4.0.1, hub airports boast a disproportionally large share of enplanements. Often, airports that serve as hubs for major domestic airlines have an elevated number of connecting air traffic that invests little into the local economy.

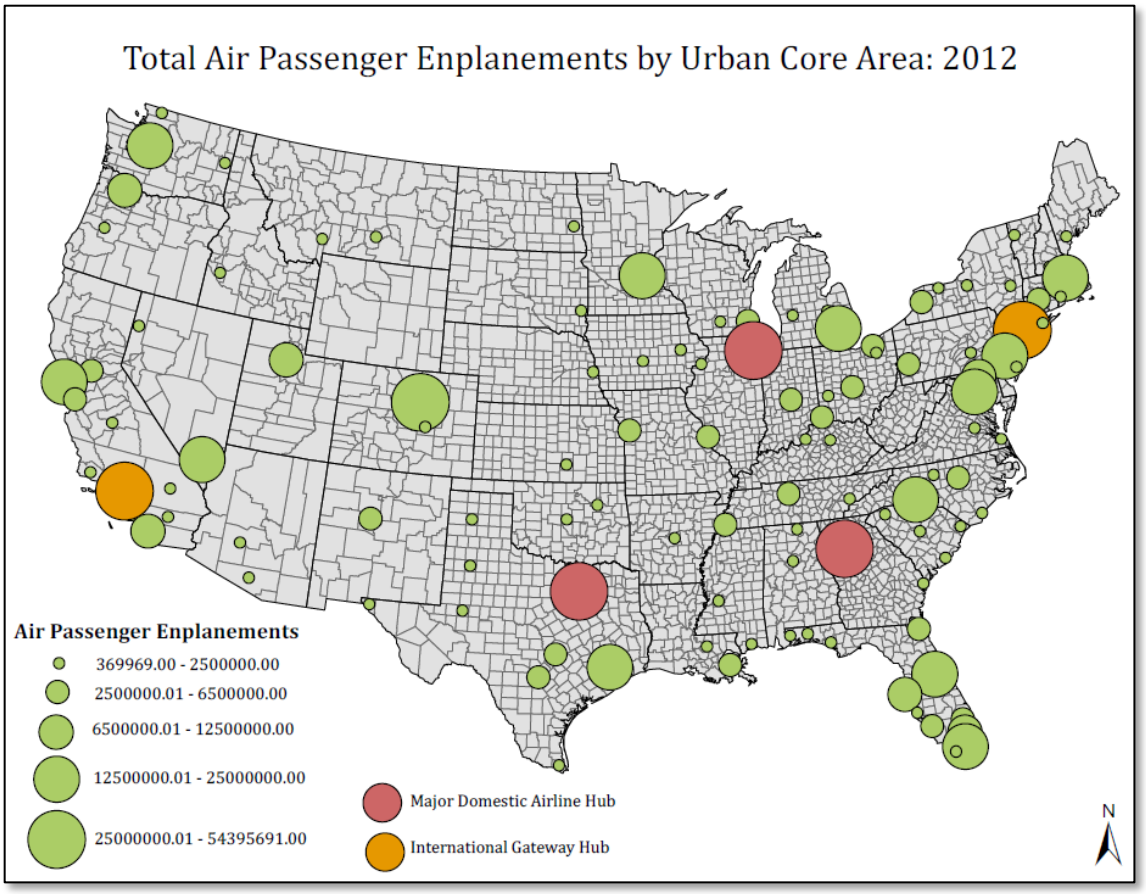
Table 4.0.2. Major Domestic and International Gateway Hubs

Major Domestic Airline Hub	International Gateway Hub
Phoenix AZ PHX • Southwest, US Airways	New York NY JFK
Denver CO DEN • Frontier Airlines, United Airlines	Los Angeles CA LAX
Atlanta GA ATL • Delta Air Lines	
Chicago IL ORD • United Airlines, American Airlines	
Greater Cincinnati OH Area CVG • Delta Air Lines	
Detroit MI DTW • Delta Air Lines	
Minneapolis MN MSP • Delta Air Lines	
Charlotte NC CLT • US Airways	
Cleveland OH CLE (de-hubbed as of 2014) • Continental and United Airlines	
Philadelphia PA PHL • US Airways	
Dallas-Fort Worth TX DFW • American Airlines	
Houston TX IAH • Continental Airlines, United Airlines	
Salt Lake City UT SLC • Delta Air Lines	
Newark NJ (within the NYC CUA) EWR • Continental and United Airlines	

For example, as of January of 2015, United Airlines controlled 78 of Chicago O'Hare's 188 gates, 41 percent (Chicago Department of Aviation 2015). As United Airline's largest hub, a large number of O'Hare's total enplanements are passengers being routed to another destination by way of Chicago. Similarly, in 2014, Delta Airlines passengers comprised 74.15 percent of all enplaned passengers at Atlanta Hartsfield (Department of Aviation, Hartsfield-Jackson International Airport 2014). Table 4.0.2 lists selected major domestic gateway hubs and the hubs that act as international gateways.

Figure 4.0.2 illustrates the number of total enplaned air passengers by core urban area for 2012. This map shows little change from the number of enplanements in 2009. O'Hare, Hartsfield-Jackson, and DFW remain the largest domestic airport hubs, all of whom continue to maintain disproportionally large numbers of enplanements. In fact, in 2012 the Chicago, Atlanta, and Dallas- Fort Worth core urban areas, alone, accounted for 17.5 percent of total US enplanements for all core urban areas within the study. This was slightly higher than in 2009 when the three largest airline hub core urban areas accounted for 17.2 percent. The fact that just three core urban areas possess nearly 20 percent of total enplanements within the US, exemplifies the significant role that major domestic airline hubs play in the facilitation of human and financial capital.

Figure 4.0.2. Total Air Passenger Enplanements by Core Urban Area for 2012



Similarly, New York's JKF airport and LAX in Los Angeles remain international gateway hubs that also have a disproportionally large number of enplanements. The number of enplanements for their combined core urban areas accounted for 12.5 percent and 13 percent of this study's total US enplanements for 2009 and 2012, respectively. Like major domestic airline hubs, international gateway hubs attract large numbers of business travelers into an area. Core urban areas that host international gateway hubs often times benefit financially from the

exchange of people and information from both national and international business travelers.

While international gateway hubs and domestic airline hubs both contribute to large numbers of additional air traffic, it can be argued that domestic airport hubs simply facilitate passengers through a core urban area and do not necessarily retain them. However, core urban areas that are host major domestic airline hubs still frequently attract technical service industry. For example Atlanta, which is home to Delta's largest hub, had the fifth largest percentage (13.5 percent of total county employment) of PST and management services workers from among the selected core urban areas for 2012.

Table 4.0.3. Top Ten Core Urban Areas Ranked by Share of PST and Management Employment for 2012.

Core Urban Area	Total PST and Management Employment (000)	Total County Employment (000)	PST and Management as a Percent of Total Employment
1. Washington DC	353107	1612445	21.8
2. San Francisco, CA	105522	586538	18.0
3. Huntsville, AL	31444	178442	17.6
4. San Jose, CA	127177	903053	14.1
5. Atlanta, GA	97310	721170	13.5
6. Richmond, VA	42897	326498	13.1
7. Cincinnati, OH	73265	565723	13.0
8. Oakland, CA	84241	658708	12.8
9. Minneapolis, MN	145775	1156219	12.6
10. New York, NY	401905	3239494	12.4

As shown on table 4.0.3, only Washington, DC (21.9); San Francisco, CA (18.0); Huntsville, AL (17.6), and San Jose (14.1) had higher percentages of workers from the selected industries than Atlanta. The ten core urban areas listed on table 4.0.3 consistently retained technical service jobs from the low point of the recession in 2009 to 2012. During that time, all ten core urban areas increased the percentage of PST and management workers included in their total county employment with the exception of Huntsville that fell from 17.8 percent in 2009 to 17.6 percent in 2012.

Although not a high-tech cluster in the same sense that San Francisco is, Atlanta's ability to maintain PST and management workers me be, partly, due to the high connectivity options that hub airports offer. This may also be impacted by Atlanta's central position within the Sunbelt industrial region. Known regionally as the "Paris of the South," Atlanta is well connected within the business network and offers many other important amenities that business travelers frequently require. The overlying implication of the mentioned core urban areas maintaining PST and management services jobs throughout the recession implies that these particular industries were and are more resilient in times of economic downturn than other industries. Additionally, in 2012 Washington, DC (60.3 percent), San Francisco (53.6), and Atlanta (49.4) had the highest shares of the population aged 25 or older with a four-year degree, suggesting education is also an important factor in an area's ability to maintain technical workers that have a high propensity to fly.

Figures 4.0.1 and 4.0.2 show a spatial clustering of airports within the densely populated BosWash megalopolis region that from Washington, DC to Boston, MA. This region is host to many people and several airports. Among the core urban areas selected in this study, Washington, DC; Baltimore, MD; Philadelphia, PA; New York, NY; and Boston, MA are the five most populous cities within their respective megalopolis with a total population of roughly 10.5 million people. With so many people living within the region, it is expected that business would also locate there in order to have access to the wealth of ideas and knowledge accruing among BosWash inhabitants. For this reason, business air travel is frequent in the region. In 2012 these five core urban areas mentioned previously had over 100 million enplaned air passengers. That translated into 16.2 percent of the national total.

Again, it should be noted that from 2009 to 2012, Washington, DC, the southern anchor of BosWash, maintained its position as having the highest shares of workers from the selected industries. The Washington, DC core urban area increased its share of PST and management services jobs from 27.6 percent to 28.2 percent. Additionally, it is also within the top 10 core urban areas for number of enplanements as well. Like Atlanta, its central location may play a part in its ability to maintain these jobs because of its advantageous proximity to other markets via air travel.

Similarly, the New York City core urban area lies centrally within the BosWash megalopolis region. As previously mentioned, the NYC core urban area is

host to two hub airports, the international gateway hub at JFK and the Continental/United Airlines hub at Newark Liberty International Airport. These two hubs provide access to a multitude of destinations all over the world. Additionally, LaGuardia airport serves as an efficient destination airport into and out of the City itself. In both 2009 and 2012, the New York core urban area had more enplaned air passengers than any other core urban area in this study. This may be, in part, due to its relatively high population. However, New York offers a level of national and international access that cannot be found in most US urban areas, the implications of which has promoted New York as an ideal location for sharing knowledge and capital. For this reason, large quantities of business travelers fly to and from New York with regularity.

It is also interesting to note the enplanement growth in Portland, OR and Denver, CO from 2009 to 2012. The growth can be seen on figures 4.0.1 and 4.0.2. From 2009 to 2012, Denver gained nearly an additional 2 million enplaned passengers. Portland, OR increased their number of enplaned passengers by roughly 10 percent from 2009 to 2012. Portland's "Portlandia" reputation of being a mecca for quirky, educated, creative class workers is creating a draw for the facilitation of people, innovative ideas, and money to and from Portland (Florida 2002). Many of these young, creative Portlanders fall into the PST and Management services sectors and have a high propensity to fly and, thus, may be contributing factors to Portland's sustained enplanement growth throughout the Great Recession.

4.1 Regression Analysis

Regression analysis was performed on the dependent variable (Total Enplanements) for all independent variables for years 2009 and 2012 using IBM SPSS software. The regression analysis allows for the evaluation of the significance of the relationship and correlation of the independent variables upon the dependent variable. Levels of co-linearity between independent variables were analyzed and, among the pairs of independent variables that demonstrated co-linearity, the variable with the least amount of correlation with the dependent variable was excluded. The final model met all assumptions of linearity, normality, and homoscedasticity.

4.2 Regression Model for 2009

Linear regression analysis revealed a model that best describes the relationship between air passenger enplanements and select socio-economic variables by core urban area for 2009. The final model (n=116) has an r^2 of 0.88 and is represented by the following equation:

Enplanements = -28616.0 + 94.3 PST +9678539.0 Hub + 1.2 Management

PST = Professional, Scientific, and Technical Services Total Employment (NAICS 54)

Hub = Domestic Airline Hub

Management = Management Services Total Wages (NAICS 55)

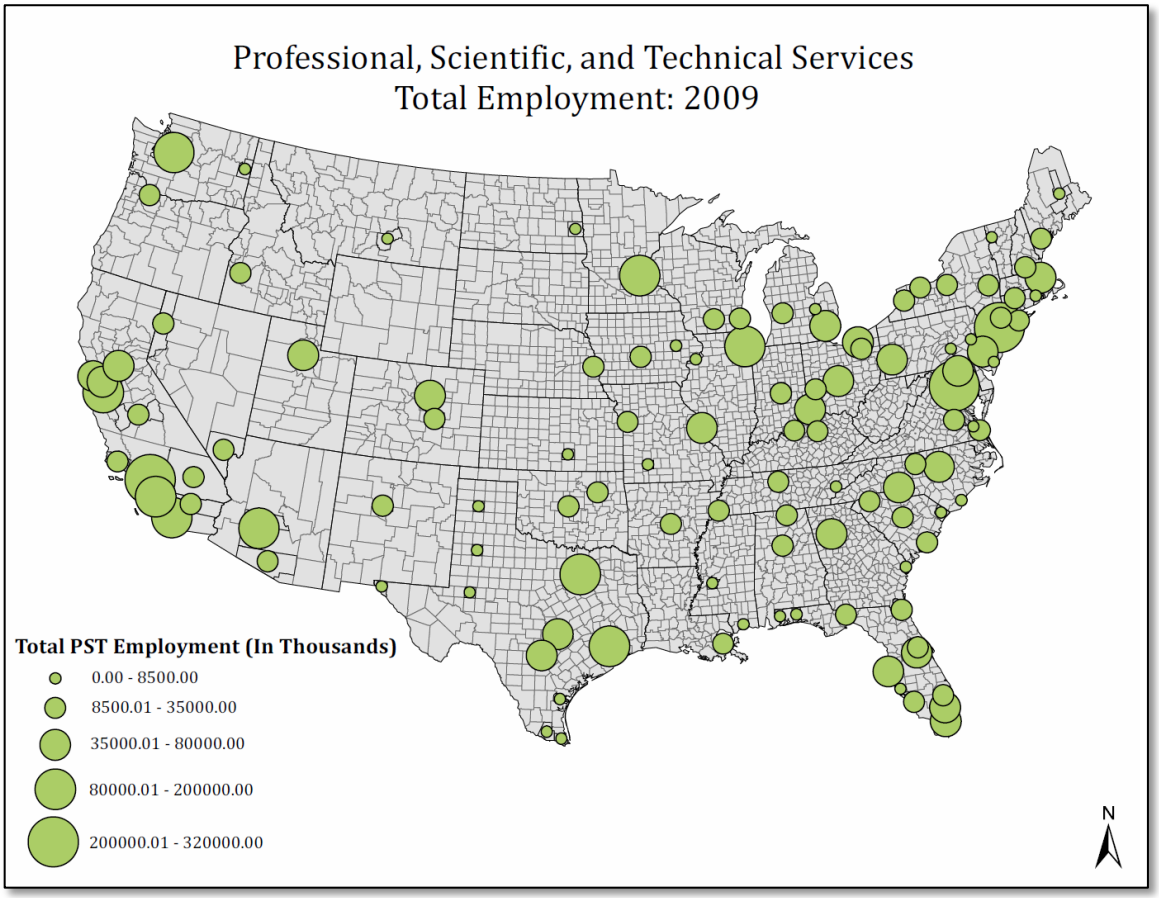
The standard error in the final model for PST total employment is 13.0. The standard error for domestic airline hub is 1365443.0 and the standard error for management services total wages is 0.6. The final model is significant at the .05 level. Multicolinearity between independent variables in the final model is low.

The final model indicates that for every additional 1000 workers employed in PST service jobs, an additional 94 enplaned passengers could be expected. It also points to the importance of airport hub status. Major domestic airline hubs can expect 9.6 million additional enplaned passengers compared to non-hub airports. Likewise, for each additional $1000 dollars earned in management wages, an additional 1.2 enplaned passengers could be expected to fly within the selected core urban area.

The reason that the management services total wage bill appears as only the third variable despite their relatively high income ($84,000 annually in 2009 compared to $66,000 per year for PST workers) could be because the management work sector is a quarter of the absolute size of the PST work sector in terms of jobs. This indicates that, although they have a high propensity to fly and make more money than PST workers, their low absolute numbers may prevent them from being the primary driver of enplanements. That is not to discount management services workers, however. Given the results, for each additional management services worker who earns, on average $80,000 per year, an additional 96 enplaned passengers could be expected. It stands to reason then, that adding these workers

would have a significant impact on the airport and the economic wellbeing of a core urban area.

Figure 4.2.0. Professional, Scientific, and Technical Services Total 2009 Employment



Figures 4.2.0 and 4.2.1 show the spatial distribution of 2009 PST employment and 2009 management wages, which are the first and third variables in the final model. The spatial distribution of 2009 PST employment (figure 4.2.0) mirrors the spatial distribution of 2009 enplanements, as illustrated by figure 4.0.1. Large numbers of PST workers can be found in the BosWash megalopolis region, as

well as in the San Francisco, Silicon Valley area and in Los Angeles. Other core urban areas, like Atlanta, do not feature as predominantly on the map of PST employment as they do on the Enplanement map. As home to the major domestic hub for Delta, the Atlanta core area has the second highest number of enplanements in the country and, yet, may appear to be underserved in the total number of PST jobs relative to their high number of enplanements. However, as stated previously, Atlanta ranked fifth among the selected core urban areas in terms of its percent share of PST and management service employment within its total employment base.

The second variable, airline hubs, is indirectly displayed in figure 4.0.1. It is reasonable that airline hubs are weighted heavily in the model since they drive so many additional air passengers. As shown by the model, having status as an airline hub yields an additional nearly 10 million enplaned passengers annually. This applies to the fourteen airports in the study that host a major domestic airline hub. As discussed previously, hub airports have a large degree of connectivity and offer routes to many destinations. This makes core urban areas that host hub airports easy locations for business people to travel to and from. These areas are also convenient locations for firms to locate because of the increased connectivity made available. Millions of additional passengers traveling through a core urban area are the equivalent of millions of additional ideas and dollars being deposited in an area. For this reason, it is clear why airline hubs featured so predominantly in the model. They facilitate additional enplaned passengers and economic growth.

Figure 4.2.1. Management Services Total Wages for 2009

The third variable in the final model, management services total wages, is illustrated in figure 4.2.1. Like that of PST employment, the spatial distribution of management services total wages closely resembles that of the spatial distribution of enplanements. Management wages are heavily distributed in the BosWash megalopolis corridor, as well as in San Francisco and Los Angeles. An interesting wage distribution can be seen in the rust belt region of the country. Management wages are still high in this region and, yet, the number of enplanements is much

lower in many of these core urban areas than elsewhere in the nation. This will likely warrant additional research in the future.

4.3 Regression Model for 2012

Linear regression analysis was also performed for the year 2012, the results of which are similar to those of 2009. However management sector variables did not play into the final model for 2012. The final model (n=117) for 2012 has an r^2 of .863 and is significant at the .01 level. It is represented by the following equation:

Enplanements = -14109.46 + 117.0 PST + 11258215.8 Hub

PST = Professional, Scientific, and Technical Services Total Employment (NAICS 54)
Hub = Domestic Airline Hub

The standard error in the final model for PST total employment is 8.5 and the standard error for domestic airline hub is 1484070.2. The final model has a variance inflation factor of 1.084, which indicates that multicollinearity between the model's variables is low.

The final model shows that for each additional 1000 PST workers, an additional 117 additional enplaned passengers could be expected. Likewise, status as a hub airport yields an additional 11.2 million enplaned passengers. These are the same first two variables that appeared in the final model for 2009. Unlike the 2009 model however, management service variables did not show to be as important to enplanements in 2012.

The models in the two years are quite similar. The r^2 dropped slightly from 2009 to 2012, from 0.88 to 0.863. Even so, they are remarkably constant from one year to the other and may indicate just a small degree of increased variance regarding the cause of additional enplanements. Similarly, the repetition of variables signifies the resilience of these sectors throughout the Great Recession.

Figure 4.3.0. Professional, Scientific, and Technical Services Total 2012 Employment

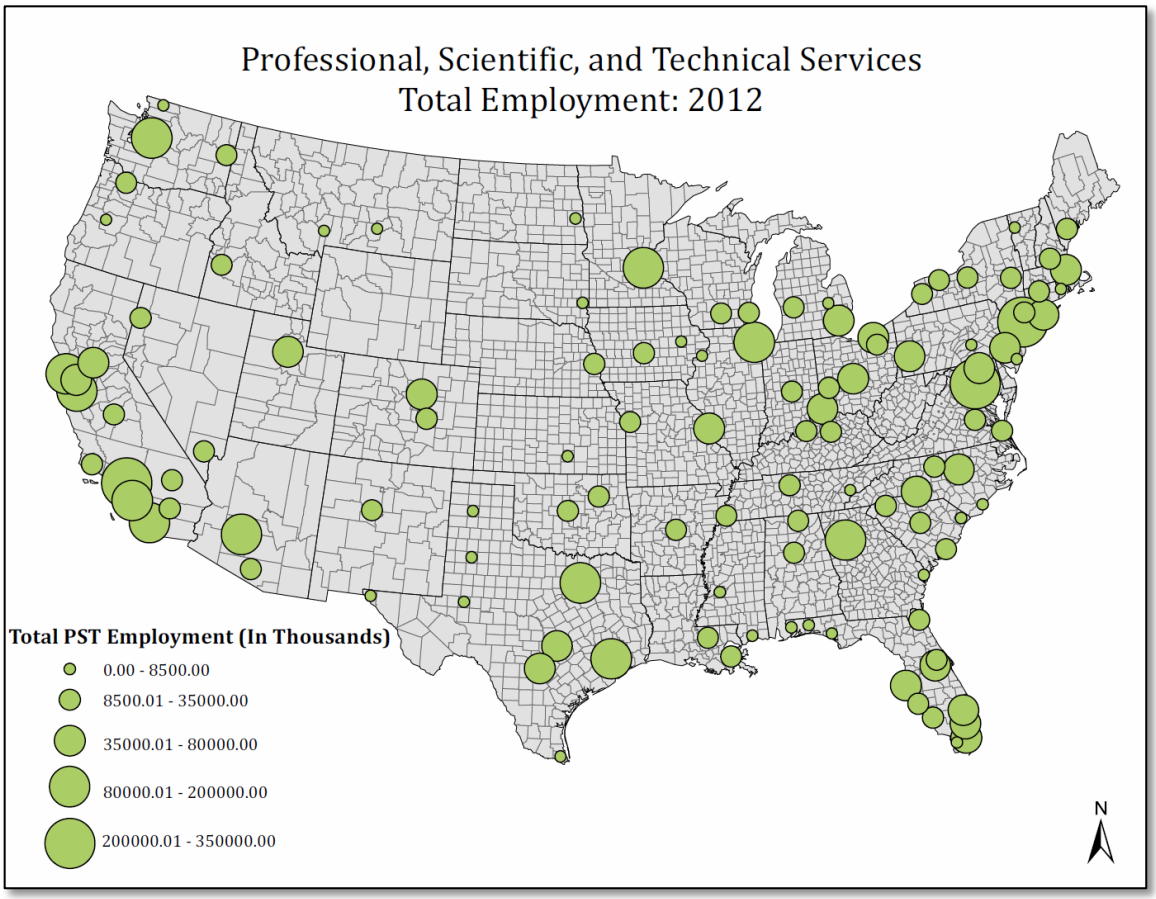


Figure 4.3.0 shows the spatial distribution of total employment for the professional, scientific, and technical services sector for 2012. As is the case for the

2009 final model, this variable appeared as the most important variable for predicting enplanements, followed by the variable airline hubs. Like figure 4.2.0 for 2009 PST employment, the spatial distribution of 2012 PST employment closely resembles the spatial distribution of enplanements. As can be seen in figure 4.3.0, PST workers are found heavily in the BosWash megalopolis region and in the San Francisco and Los Angeles core urban areas.

Overall, the spatial distribution of PST employment did not change dramatically from 2009 to 2012. However, an increase in PST employment can be seen in the San Francisco, Silicon Valley region and in Atlanta. From 2009 to 2012 PST employment grew by nearly 25 percent. During that time the number of enplanements for the San Francisco core urban area also grew by nearly 3 million enplaned passengers per year. In Atlanta, PST employment increased by roughly 10 percent from 2009 to 2012. During that time Atlanta increased their enplanements by 3.5 million passengers per year and maintained their status as having the second largest number of enplaned passengers nationwide, just after the New York core urban area in both years. Atlanta's position as one of the largest airline hubs in the world may have influenced their enplanement growth as the nation emerged from economic recession. However, the simultaneous increase in PST employment signifies that the two are related, as was shown in the models for both years.

San Francisco and the Silicon Valley area, on the other hand, is known worldwide as being one of the most innovative, creative, and profitable regions in the world. It is, consequentially, home to many PST workers. The fact that both San

Francisco and Atlanta increased the size of their PST workforce as well as their number of enplanements from 2009 to 2012 is evidence that these jobs are drivers of air travel and ultimately of economic growth.

4.4 Results Discussion

The final models for 2009 and 2012 are remarkably similar indicating that PST employment was a resilient workforce, even during economic downturn. Likewise, throughout the recession, airline hubs continue to play dominant roles in the facilitation of human and financial capital from region to region. This indicates that throughout the recession, from the low point in 2009 through the recovery period in 2012, the size of the PST workforce and airline hub status remained drivers of enplanements. Additionally, in 2009, when the recession was at its lowest point, Management services wages also drove the number of enplanements for a core urban area. Previous literature has shown the importance of these sectors prior to the Great Recession. These findings suggest that they are resilient sectors that continue to stimulate enplanements throughout economic downturns.

This analysis measured the impact that specific service sectors on enplanements. While the selected service industries have shown to have a significant relationship, it is not enough to simply say that the relationship exists without comparing it to a control variable. For that reason 'services as a percent of total employment' was included so that a comparison could be made between the

dependent variable and services in general, which encompasses all service related employment.

As indicated in the regression, services as a percent of total employment did not appear to have an impact on the number of enplaned passengers. These findings are significant because they suggest that PST and management service jobs are special in that they create additional enplaned passengers. General service employment does not impact the number of people flying into and out of a core urban area and, as a result, does not impact the economic growth that a region experiences due to growth in enplaned passengers. PST and management services, on the other hand, do contribute economic growth.

The implication of this is that government officials and urban planners would do well to consider these jobs especially when drafting ways to improve the economic health of their core urban area. This thesis demonstrated that PST and management services are resilient industries that continue to thrive during economic downturn. Core urban areas and their airports could benefit greatly if an effort were placed on attracting and maintaining these jobs.

Another interesting finding of this study is not just which variables proved to be significantly related to enplanements, but which variables proved to be unrelated to enplanements. The regression analysis included the macro-demographic variables 'per capita income' and 'percent of the population aged 25+ with a bachelors degree or higher.' Neither of these variables were shown to have an impact on the dependent variable. This implies that enplanements are not driven

solely by high incomes but are driven by particular service industries that have a higher than average propensity to fly- the PST and management services sectors. This is in contrast to previous literature that finds a relationship between services in general and air traffic (Brueckner 2003).

San Jose, CA; White Plains, NY; and Key West, FL are prime examples that illustrate how a high per capita income does not result in large numbers of air passenger enplanements. In 2012, the San Jose core urban area had the fourth highest per capita income ($41,000) among the selected core urban areas. The same year, San Jose was 37th in total enplanements. White Plains, NY also illustrates this point. Just ahead of San Jose, in 2012 White Plains had a per capita income of nearly $55,000 and yet they were 75th in the data set for number of enplanements. However the per capita income for White Plains may be so high because the head quarters for IBM is located just north of White Plains and airports around New York City with greater connectivity are accessible. Furthermore, the most drastic example is Key West, FL. Eighth in the study for per capita income ($36,000 in 2012) and 115th out of 117 for number of enplanements. These examples show that enplanements are not necessarily driven by high per capita income. Some high-income earners frequently travel to larger cities like San Francisco, New York City, and Miami to fly and consequentially contribute to the enplanement numbers and economic growth of other cities.

Furthermore, a highly educated population also has no impact on enplanements. In 2012 Burlington, VT (48.4 percent); Madison, WI (46.1 percent);

and Bozeman, MT (46 percent) all feature in the top 10 core urban areas that have a high percent of the population aged 25+ with a bachelors degree or higher. All three cities rank very low for enplanements; 93rd, 82nd, and 104th, respectively, in the same year. When thinking of highly educated states, Wisconsin and Montana may not come to mind, but these three cities are all home to major universities, which contribute to the high percentage of the population with a bachelor's degree. However, in time with the findings of this research, well educated, university populations do not have a high propensity to fly and, ultimately, do not have an impact on the economic wealth that is gained from increasing air passenger enplanements.

This is not always the case, however. One of the limits of this study is that its unit of analysis is the core urban area, which frequently does not capture all high-tech workers. PST and management jobs are frequently located outside of the core urban area. For example, the Huntsville, AL core urban area has the second highest percentage of PST and management workers in data set and, yet, its airport has a relatively low number of enplanements. The reason for Huntsville's high percentage of high-tech workers is because it is home to NASA's George C. Marshall Space Flight Center. However, Huntsville is located away from a major core urban area and so these workers and their impact on enplanements are not well reflected in this study.

Finally, neither population growth nor employment growth played into the final model. Like the other control variables in the thesis, they did not appear to be as strongly related to enplanements as PST employment and management total

wages. For example, in 2012 the three-year employment growth rate was highest in Midland, TX, which experienced a 10 percent employment growth increase from 2009 to 2012. Midland was followed in employment growth by Fargo, ND (5 percent) and Grand Rapids, MI (4.8 percent). However, none of which experienced a relative increase in enplanements for that time.

Similarly, Midland, TX also had the highest three-year population growth percentage (9.8) in 2012. El Paso also had a high relative three-year population growth (9.6) while remaining in the middle of the pack in terms of total enplaned air passengers who travel through its core area. This is in contrast to Atlanta, GA whose population decreased by 5.7 percent from 2009 to 2012. For the core urban areas analyzed in this thesis, Atlanta's population decrease was smaller only than that of Detroit, MI. Yet, Atlanta, as well as Detroit, remains second and 17th, respectively, in terms of enplanements. This is perhaps because Atlanta and Detroit are both hub airports and because they maintained high levels of PST employees and total management services total wages, as displayed on figures 4.2.1 and 4.3.0.

CHAPTER V

CONCLUSION

In the wake of the Great Recession, many people question, "how can the economic viability of our core urban areas be improved for the long term?" The answer to this question may lie in airports and the jobs that bring business travelers into and through them. Previous literature has showed that airports are directly related to economic growth because they provide routes for communication, innovation, and capital to flow (Brueckner, 2003; Green, 2007; Neal, 2011). Despite advancements in communication technology, many businesspeople continue to rely on face-to-face interaction with national and international partners and clients to complete the mission of their business. However, workers in high-technology service sectors, as well as management service workers, have a higher propensity to fly than many other business people (Irwin and Kasarda, 1991; Button et al, 1999; Debbage and Delk, 2001; Liu, Debbage, and Blackburn, 2006; Alkaabi and Debbage, 2007).

These high-tech and management workers invest into the economy of their core urban area by facilitating additional enplanements, the implication of which is additional capital being distributed into their local economy via business transactions (Ivy, Fik, and Malecki, 1997; Button and Taylor, 2000; Brueckner 2003). This thesis reinforced that information. It finds that PST workers, airline

hubs, and management service worker wages are drivers of additional enplanements, which is a driver of economic growth. Most importantly this thesis built upon previous literature by finding that these variables continue to drive enplanements irrespective of economic recession.

According to the results of this thesis, the addition of 1000 professional, scientific, and technical service workers will result in 94 additional enplaned passengers annually. Likewise, the existence of an airline hub in a core urban area will lead to an additional 10 million enplaned passengers annually. This thesis also found that in 2009, during the low point of the recession, for each additional $1000 earned by management workers an additional enplaned passenger could be expected. These findings were consistent from 2009 to 2012 suggesting that there is stability in these work sectors and in airline hubs that continue to thrive and contribute economically, even in an economic downturn.

Surprisingly however, per capita income, the percent of the population aged 25+ with a bachelor's degree, and population and employment growth did not seem to have an impact on enplanements. This suggests that, while perhaps important, neither income, education, or growth rates necessarily incentivize flying. Furthermore, services in general did not contribute to the number of enplanements for a core urban area. These variables' absence in the final model reinforces the findings that particular high-tech and management service are important drivers of enplanements. This is particularly relevant to urban planners and government officials who, using the results of this study, might choose to attract and maintain

more of these types of workers and should consider incentivizing an airline to utilize their airport as a hub. These planning decisions could lead to additional enplanements, resulting in additional communication lines and an increase in the exchange of knowledge, innovation, and capital.

While this thesis found an important link between PST employment, airline hubs, and management service wages and enplanement, questions remain for future research. From the low point of the Great Recession in 2009 to the recovery period in 2012, these industries appear to be resilient. However, the economic recovery is still taking place. Therefore, similar research should be conducted in the future to see whether PST and management service jobs continue to remain stable, as the US emerges further out of recession. This thesis also does not address the issue of causality. It remains unclear whether additional enplanements lead to additional employment or whether additional employment results in additional enplanements. Lastly, while the results of this thesis are compelling, future analysis should be done on other industries and work sectors to see if stability was widespread throughout the Great Recession or localized to high-tech and management services.

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