Measuring and Understanding the Relationship between Air Service and Regional Economic Development

CONTRACTOR'S TECHNICAL REPORT

Prepared for
Airport Cooperative Research Board
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Summary

This Technical Report accompanies *ACRP Web-Only Document 53: Measuring and Understanding the Relationship Between Air Service and Regional Economic Activity* (the guide). The guide and *ACRP WebResource 12: Air Service Development and Regional Economic Activity* are to serve as practical tools for airport officials so that they can better understand how air service contributes to business activity in the airport's catchment areas. The guide offers suggestions on how better to explain and communicate that contribution to different community audiences. By better understanding the nexus between the two concepts, airport officials and regional economic interests can assist each other in contributing to a region's vitality.

The project relied upon case studies to illustrate differences in how air service contributed to regional economic activity. Those case studies were selected to highlight airports of different sizes and service patterns, and regional economies that differed in structure and economic strength.

This Technical Report focuses on the mechanics of how the research was completed. It includes a detailed description of the approach and methodology applied in the project, the high-level findings from that project, a discussion of the applicability of the research to airports of differing sizes and competitive positions, limitations to the research, and potential avenues for future research.

The project represents an important step in helping the airport community better understand and communicate to regional stakeholders the underlying value of commercial air service to regional economies. Doing so better enables airports and regional stakeholder organizations concerned with business interests and economic development to work together toward common goals that will benefit the community to the greatest extent possible.

Audience for the Technical Report

This Technical Report is intended for use by airports of all sizes and types with varying levels of resource availability that are interested in gaining an understanding of how air service contributes to economic activity "outside the fence" – that is, in industry sectors that are not immediately tied to airport and airline operations. Traditional economic impact studies that describe the contributions of airports to local economies do not typically incorporate employment effects that occur within the region, except to the extent that air service supports tourism and hospitality. That air service is a critical intermediate component of business operations in other industry sectors (such as information technology, finance and insurance, wholesaling, or advanced manufacturing) is not usually incorporated into these analyses.

This Technical Report is also suitable for researchers interested in understanding the approach and methodology applied to the project, particularly that used for developing the typology of airports, along with the summaries of information developed through the case studies.

In addition to this report and the guide, the research yielded other products that are available to interested readers and users. They are a website (*ACRP WebResource 12*) that airports and regional stakeholders can use as an alternative to the guide that includes the case studies developed. An appendix to the guide includes condensed versions of the case studies. *ACRP WebResource 12* includes the condensed case studies and

provides downloadable pdfs of the "long version" case studies. The separate compilation includes the long versions only.

Organization of the Technical Report

This Technical Report is organized into four chapters, along with a list of references and bibliography.

Chapter 1 provides essential background to the issue. It includes a summary of the literature review that underpinned the study, along with the objectives and scope of the completed research.

Chapter 2 summarizes the approach and methodology used in the project.

Chapter 3 presents an expansion of the summary results of the study's analyses with high-level tables and figures and narrative. The project relied upon 14 case studies to illustrate how different airports and the regions they serve measure and communicate changes in air service and regional economic activity. The results of the individual case studies are not appropriate for summing, so readers are cautioned against generalizing based on those results. The chapter also includes a discussion of the applicability of the research to airports of different sizes and competitive positions, along with the limitations to the research and its application.

Chapter 4 includes the Conclusions and Suggested Research. The conclusions should emphasize the most important findings and may extend the findings beyond conditions specific to the project. Successful applied research will produce results that should facilitate application of the findings and should be accompanied by information on potential benefits that can be expected from using the research products. A plan for implementing the research products should be provided. If the project findings have revealed specific areas where further research would be valuable, these areas should be described in this chapter.

Appendix I includes a summary of the research that served as the intellectual foundation for the project. **Appendix II** lists the references for the academic and industry research used.

CHAPTER 1

Background

That air service is a fundamental contributor to regional and national economic development is now a commonly accepted truth. For over a decade, the U.S. Federal Aviation Administration (FAA) has issued reports that have estimated the total economic impact of civil aviation on the nation. In 2020, FAA reported that civil aviation – including commercial airlines, general aviation, civil aviation and avionics manufacturing, related research and development, non-military airports, and visitor spending – supported 10.9 million jobs that paid nearly $490 billion, $1.8 trillion in total economic activity, and 5.2 percent of U.S. gross domestic product (GDP).

> Civil aviation provides the means of transporting millions of passengers and tons of freight to all corners of the globe each and every day. Consumers rely on this physical connectivity to improve their quality of life and businesses depend on it to facilitate transactions, both of which are key to increasing a nation's economic productivity and prosperity. (FAA January 2020, p. 4)

Trade associations publish economic impact studies to help convey to lawmakers and other stakeholders the value that their members contribute to national and state economies. In 2018, Airports Council International – North America (ACI-NA) reported that airport operations, capital development, and visitor spending at 430 commercial U.S. airports supported 11.5 million jobs with a payroll of nearly $430 billion and total economic output of $1.4 trillion.

The Airport Cooperative Research Program (ACRP) has funded multiple reports that examined the relationship between airport activities and economic activity. Notably, in 2015, ACRP released *The Role of U.S. Airports in the National Economy*. (*ACRP Report 132*). The economic analysis included documentation of the existing contributions of 3,300 airports in the U.S. National Plan of Integrated Airport Systems (NPIAS) with an impact of changes in airport connectivity, air cargo, and airfares. The report established a statistical relationship between the national aviation system and the overall economy. It also highlighted the critical value that airports provide to local economic activity:

Commercial air service to cities and regions across the United States and the world is viewed as a critical resource by local economic development officials. Specifically, economic development officials use a region's access to reliable and affordable air service as a selling point to potential businesses looking to relocate to an area. In an increasingly interconnected world, access to a large network of destinations has become a significant factor for large corporations in deciding where to expand business operations. Access to commercial air service helps connect existing businesses and community members with economic opportunities around the globe through enterprises such as tourism and the just-in-time delivery industry. (*ACRP Report 142*, p. 32)

Within the past decade, new research has better linked the role that commercial and civil aviation play with local and regional economic development. More than simply correlating total population or employment in a region to the amount of air service (however defined) at a local airport, researchers have

begun to identify and understand the demand for air service by particular types of business, by industrial sector.

For airport management and regional economic development officials, it will be increasingly important for air service initiatives at airports to retain and enhance their current levels of service and to improve that service as a means of preserving and increasing regional economic activity. And they will need to be able to convey these complex impacts to local audiences.

Traditionally, airports have measured their contributions to the local economy via economic impact assessments. These analyses typically measure an airport's economic impact based on activities that occur on airport property or that are tied directly to airport operations (e.g., off-site parking, hotels that accommodate airline crew who overnight in a location). Most also incorporate an assessment of the economic impact attributable to visitors who arrive in the area by air and spend money in the region's hospitality sectors. Those assessments are valuable but suffer from a critical shortcoming: They do not capture how air service facilitates economic activity "beyond the fence." That is, they do not capture how air service supports business and employment throughout the region. Consequently, traditional airport economic impact assessments tell only a portion of the story. And as a result, community stakeholders and audiences do not attach or recognize the same importance to the airport's economic impact reports, because they fail to capture the greater value that air service provides to the region.

This report is intended to help airports and key stakeholders in the regions served by those airports better understand the connection between commercial air service and regional economic activity -- employment in the area that is not immediately tied to an airport's operations. Many sectors of a regional economy depend on air service as a critical element of their operations, so changes in air service can help or hinder those businesses. By better understanding the nexus between the two, both airport officials and regional economic interests can assist each other in contributing to a region's vitality.

Project Objectives and Scope

As stated in the original Request for Proposal, the objective of this research was to develop a guide and tools (e.g., flowcharts, decision trees, narrative templates, spreadsheets) to help airports and their communities understand, measure, and address the relationship between air service and economic development. The guide should include:

- Primer describing air service trends and general relationships between air service and regional economic development;
- Overview of data collection sources and methods;
- Guidelines for selecting and using the tools to meet user requirements, including:
    - Selecting appropriate economic metrics (e.g., gross domestic product, job creation and talent retention, payroll, capital
    - investment, foreign direct investment, tax base, per capita income); and
    - Selecting appropriate air service metrics (e.g., up-gauging, seats, frequency, routes, total travel time, airfares, cargo volume and value);
- Methods for communicating results to stakeholders;

- Case studies representing an array of common community sizes, airport activity levels, and air service characteristics for both passenger and cargo service;
- Glossary of terms; and
- Listing of additional research and information on economic and air service development.

The tools should be designed to allow airports and communities to:

- Use a variety of metrics to measure how economic and air service changes could impact their community based on their unique air service and community characteristics;
- Identify which economic sectors (e.g., manufacturing, tourism) are most impacted by air service changes; and
- Consider qualitative impacts (e.g., quality of life, image enhancement, competitiveness).

The project team proposed an approach and methodology designed to meet those objectives, with certain exceptions; the approach is discussed in greater detail in Chapter 2. Broadly speaking, the approach began with a thorough review of academic and industry literature on the issue of air service and regional employment. Because the project as outlined was to rely on case studies, it required developing an "airport-region" typology that would allow the team to identify a spectrum of air service and regional economic activity categories, from which the airports community could find examples most comparable to their operations or economic situation. Those case studies, including impacts of changes in passenger and air cargo/freight service, were completed, and general observations were drawn.

The project team eventually modified the scope with the concurrence of the Review Panel. Those changes included:

- Excluding certain categories of airports:
  - those below a certain enplanement threshold (nonhub nonprimary airports),
  - those receiving air service supported by the Essential Air Service (EAS) program,
  - those in Alaska, Hawaii, and U.S. territories.
- Excluding any analysis of tourism industries from economic sectors most impacted by air service changes

In addition, with the agreement of the Review Panel, the project restricted the analysis of changes over time to the period 2008-2019. Three years were selected for which changes in air service and socio-economic activity would be measured: 2008, 2015, and 2019. Those dates were selected because they represent the beginning of the Great Recession, the point at which national-level data indicated that air travel had fully recovered from the Great Recession, and the most recent year for which data was available (and prior to the collapse brought on by the COVID pandemic). With the three years identified, the team analyzed changes in each of the variables for three intervals:

- Entire study period 2008-2019
- Recovery from the Great Recession 2008-2015
- Stable growth during 2015-2019

CHAPTER 2

Research Approach

The project team applied an interdisciplinary and structured approach to the core research issue. The team examined available air service and regional economic data, available models of the relationship between the two, and propose a data collection and analysis plan that will culminate with detailed case studies. The case studies were designed to explore in more detail the relationship between air service and economic activity in specific regions, seeking insight into the extent to which – if any – the relationships are evident and can be clearly communicated to a range of stakeholders. The case studies' regions/airports varied so that airports of different sizes, service patterns, and regional economies would find relevant examples to illustrate how air service and different regional economies influence each other.

As an overview, the team conducted this project in six basic stages:

Background research. The team analyzed a wide range of information concerning the impact of air service on local and regional economies and how best to communicate economic concepts to the public. The team reviewed academic and industry reports, including relevant ACRP reports. We believe the issue of how best to communicate results to the public is often overlooked by economists, who too often expect non-economists to understand. In addition, regional economic development professionals rely on other metrics to measure an area's strength and competitiveness. This means that airport staff, economists, and economic development professionals do not tend to speak the same language.

Overview of available air service metrics and economic data. The team analyzed major air service metrics for each airport that had commercial service during the study period. We will simultaneously gather and analyze relevant time series economic data for metropolitan areas that are served by those airports. These tasks broadly examine the issues of what air service and regional economic data are available to measure regions' economic strength and vitality, how they have changed over time, and how the local economy depends on air transport. The team also tests the applicability of other economics-related data and software to the task. At the end of this stage, the team prepared a data analysis plan, which it reviewed with the project's Review Panel.

Analysis of changes in air service and economic activity. With a finalized and approved data analysis plan, the team completed its analysis of air service and socio-economic data, producing a typology of airports and regions. That typology or categorization was used to identify potential airport regions for case studies, ensuring the widest possible variety so that all U.S. airports could draw lessons from similarly situated facilities. Based on the categorization developed, the team proposed regions and airports for case studies. Those recommendations were considered and revised by the Review Panel.

Case studies. The team conducted in-depth case studies to determine the extent to which changes in air service have affected the local economy or vice versa. The case studies incorporated the views of the key regional stakeholders on how air transport can best enhance their region's vitality. Qualitative analyses of stakeholder perspectives will add depth to each region's story. Based on the results of the case studies, the team drew a set of general observations about how changes in air service have contributed to the regional

economies, how airports interacted with regional stakeholders, and how the effects of air service on regional employment were communicated to different regional audiences.

Development and testing of a tool for airports' use. Drawing on lessons from the product developed by ACRP 03-31, which created an online tool for airports to use in better understanding their fit into the local and regional economy and on the research completed for this project, the team developed an online a website (*ACRP WebResource 12*) that airports and regional stakeholders could use as a *substitute for* the guide. It is not a word-for-word replication of the guide. Rather, it captures the key information offered there in a casual, conversational tone in an effort to keep users interested and engaged. *ACRP WebResource 12* includes links to this Technical Report.

The following sections describe each of those steps in greater detail.

Background Research

The team conducted a thorough review of the literature available on two central topics: (1) the relationship between air service and economic development and (2) how best to communicate complex economic topics to non-economists. The former helped create the foundation for the data analysis and case studies, and the latter was used to inform the development of the tool and communications strategies for airports. The literature review included peer-reviewed academic studies along with papers published by government and industry groups such as the FAA, the International Air Transport Association (IATA) and the Air Transport Action Group (ATAG). The appendix includes a list of the academic and industry publications reviewed in the project.

Overview of Available Air Service Metrics and Socio-economic Data

Based on a review of the models applied by the academic and industry researchers, the project team turned to the issue of which airline/airport and socio-economic data were most relevant to an analysis of changes in air service and regional economic development. Because so much data are available in both fields, the team focused on those of the greatest relevance only.

Major Air Service Metrics and Sources

There are a large number of datasets available covering air service, although not all are necessarily relevant for capturing economic activity in the region. For example, "enplanements" is one of the most common measures of passenger traffic and one that the FAA uses to categorize airports by hub size. However, for airports that serve as connection points or hubs for legacy network carriers, enplanements are a less effective measure of the amount of local demand generated within the region or for travel to the region.

Key air service variables

- Origin & destination traffic
- Capacity measures
  - Available seats by airline type
  - Flight frequency
- Nonstop destinations served
  - Domestic
  - International

The academic literature on air service and regional economic activity focuses on the major variables that capture the most important considerations of demand and supply. These are measures of O&D traffic, capacity provided, and destinations served. Table 1 summarizes the most important data elements for passenger service.

Table 1: Basic Air Service Metrics and Definitions

Basic Data Element: Passenger Service	General Definition
Origin & Destination (O&D) traffic	O&D refers to the market of travel between two points measured by the volume of passengers who fly between a point of origin (O) and a point of destination (D). The "O&D record or routing" reflects the full itinerary that a passenger flies and may contain one or more segments or flights. O&D routings with one segment are called nonstop. The volume of O&D traffic in a city-pair market is a measure of the total demand for air travel between the two locations.
Passengers Per Day Each Way (PDEW)	A common measure of demand that reflects the volume of O&D passengers that fly one-way per day.
Flight frequency or number of departures	Number of departures, commonly measured in the average number per day. This measure typically reflects scheduled operations, as opposed to operations performed. (The two may differ for multiple reasons, but most commonly because of cancellations due to weather or other airline operational issues.)
Capacity	A measure of total seats operated by an airline or multiple airlines between two nonstop segments
Air service	Because airlines may launch or end operations at different times within a year, and because some airlines may operate only occasional (or seasonal) flights, to sustain or facilitate economic activity between two points, some minimum number of flights (departures) is often set as defining "service." The analysis in this report uses 50 flights per year.
Domestic destinations served	The number of airports served with nonstop flights within the U.S.
International destinations served	The number of airports served with nonstop flights outside of the U.S.

In developing the categorization of airports and economic regions, the team also took into account the service patterns provided by different types of airlines. These are:

- Legacy Network Carrier (LNCs): Generally speaking, these are the airlines that operated interstate service since prior to deregulation in 1978. They are American Airlines, Delta Air Lines, and United Airlines. Alaska Airlines is also usually included within the category. LNCs also have contractual agreements with regional airlines to operate flights using regional aircraft (generally, those operated by regional airlines with 76 seats or fewer). Although *operated* by the regional airline, those flights are *marketed* as being made by the LNC and often connect smaller communities to the LNCs hub airports.
- Low cost carriers (LCCs): Also called low-cost or budget, these are airlines that operate with an emphasis on minimizing operating costs and without some of the traditional services and amenities, resulting in lower fares. The carriers most often considered LCCs are Southwest Airlines and JetBlue.
- Ultra Low Cost Carriers (ULCCs): Most notably defined as a carrier offering very low fares, these airlines are characterized by networks that fly to leisure destinations and charge additional fees for unbundled amenities (e.g., bags, seat selection, drinks and snacks). The carriers most often considered ULCCs are Allegiant, Spirit, Frontier, and Sun Country.

Data on air cargo and freight are also important reflections of airport activity and regional economic activity. Air carriers providing commercial air service in the U.S. are also required to report data to DOT/BTS on these operations. The 2014 ACRP report on the economic impacts of air cargo on the regional economy noted the difficulty of quantifying the economic effects of air cargo in the regional economy. However, it is generally agreed that industries are concentrated within regions with direct access to air cargo operations. Table 2 summarizes the most important data elements for air cargo and freight service.

Table 2: Basic Air Cargo/Freight Metrics and Definitions

Basic Data Element: Air Cargo / Freight	General Definition
All-Cargo Carrier	Air carrier operating only freighter aircraft exclusively for the purpose of transporting cargo
Express Freight Carrier (Integrated Carrier)	A carrier handling all aspects of the supply chain for freight, including the pre-shipment, shipment, and post-shipment transportation processes (examples include FedEx, UPS, and DHL)
Air Freight	Property, other than express freight and passenger baggage being transported by air
Express Freight	Property, other than passenger baggage, that charges a premium over standard freight prices for faster delivery
Commodity	The type of products that are shipped, which are categorized using the harmonized categorization system to varying levels of specificity.
Tons Shipped	Total weight of an entire shipment, reported in pounds; pounds are then converted to short-tons (2,000 pounds) and displayed in thousands
Value of Shipment	The dollar value of the entire shipment, excluding taxes or fees and expressed in millions of dollars
Air Imports	Total physical movement of merchandise into the U.S. from foreign countries by air, recorded by weight and value.
Air Exports	Total physical movement of merchandise out of the U.S. to foreign countries by air, recorded by weight and value

Major Relevant Socio-economic Data

Again, drawing upon the academic literature on air service and regional economic activity, the project team identified the most commonly applied economic measures, which are summarized in Table 3.

Table 3: Summary of Major Economic Metrics

Indicator	Description
Employment	The number of jobs or employees (or some other measure of labor such as Full Time Equivalent) associated with the activity that is being examined. Employment is a common indicator measured in economic impact analysis of airports as it is easily understood by broad audiences in terms of giving a sense of scale about an activity or operation.
Employee Earnings	The wages, salaries, and benefits earned by employees
Gross Domestic Product (GDP) or Gross Regional Product (GRP)	GDP is a measure of the dollar value of final goods and services produced locally as a result of economic activity. This measure is *net of* the value of intermediate goods and services used up to produce the final goods and services. GRP is the comparable measure applied to a regional economy rather than a state or nation.
Economic Output (or Economic Activity)	The dollar value of the production of new goods and services *including* intermediate goods and services. It is a broader measure of the economy than GDP. Gross output can also be measured as the sum of an industry's value added (similar to GDP) and intermediate inputs.
Personal Income	Personal income is the income received by, or on behalf of, all persons from all sources: from participation as laborers in production, from owning a home or business, from the ownership of financial assets, and from government and business in the form of transfers. It does not include realized or unrealized capital gains or losses.
Per capita income	Per capita income is the mean income computed for every man, woman, and child in a particular group including those living in group quarters. It is derived by dividing the aggregate income of a particular group by the total population in that group.
Disposable personal income	Disposable personal income is the income available to persons for spending or saving. It is equal to personal income less personal current taxes.

The more recent academic research highlights the relationship between commercial air service and particular industry sectors, such as Information; Management of Companies; Finance and Insurance; and Professional, Scientific, and Technical Services (PST). Employment in these classifications is quantified via the North American Industry Classification System (NAICS), which is explained and discussed in detail in the guide.

The academic and industry literature also used different measures of a region's economic strength and capabilities. These included Location Quotients and Economic Clusters, which are defined in detail in the guide.

Location quotient (LQ): An LQ is a measure of the relative strength of the local or regional economy compared to the national average. It is calculated by comparing an industry's share of local employment with its share of national employment.

Economic clusters. An economic cluster can be defined as a geographic concentration of interrelated, competitive firms and related institutions that are of sufficient scale to generate external economies that are not typically found in regions lacking such concentrations. Clusters consist of companies, suppliers, and

service providers, as well as government agencies and other institutions that provide specialized training and education, information, research, and technical support. Clusters can enhance productivity and spur innovation.

Other Measures of Regional Activity and Competitiveness

Beyond the traditional metrics of air service and socio-economic activity are other indicators that attempt to quantify other aspects of life in different areas. Such indicators can provide information about an area's environment, society, and culture. For example, the number of patent applications or patents granted in a particular industry or jurisdiction is sometimes used to measure the degree of "inventiveness." Indicators may be topical or comprehensive. Topical indicators are those pertaining to a related set of issues, such as health, water quality, education, science, technology, or transportation. Comprehensive indicators aggregate key economic, environmental, and social and cultural indicators into a single system.

The project team researched some of these considerations and focused on two: Quality of Life and the diversity of the regional economy (a complement to regional economic strength and economic clusters, but one that relates to support for the regional tax base). Both concepts are discussed in greater detail in the guide but summarized below.

Quality of Life

Quality of life (QOL) is a concept that has long been discussed as an alternative to measures of economic activity or consumption. There does not appear to be a universally-accepted definition of how QOL is measured. The issues that most concern people can vary significantly over time and from place to place. For example, one early report on variations in the quality of life among U.S. metropolitan areas from 1975 noted that the issues of most concern (based on public opinion surveys) changed notably from 1959 (when the top issues identified involved individual health, standards of living, concerns about children, and housing) to 1973 (when the top concerns reported involved inflation, a lack of integrity in the government, and crime).

Based on a review of more recent literature, a society's QOL measures can include, but are not limited to, multiple major components:

- Health and Education
- Environmental
- Economic
- Social

Each major component includes multiple indicators. The economic component, for example, may include multiple measures of income, housing costs and quality, transportation costs and accessibility, and highway congestion.

ACRP Research Report 221: Measuring Quality of Life in Communities Surrounding Airports includes an overview of selected QOL studies and research. The report notes the connection between QOL and sustainability. The traditional definition of sustainability considers the intersection of environment, economics, and social factors (the "triple bottom line"). The airport industry developed a modified version that includes economic viability, operational efficiency, natural resource conservation, and social responsibility. QOL concepts also relate to international frameworks and measures of sustainability. Especially relevant to the aviation industry are the United Nation's Sustainable Development Goals (SDGs)

related to improving industry, innovation, and infrastructure, in addition to promoting sustainable cities and communities, responsible consumption and production, and climate action. The Air Transport Action Group found that the aviation industry plays an important role in supporting 15 of the 17 SDGs. (ACRP 221 pp. 6-7).

With the current project, the research team could find no published reports that specifically, directly, and positively incorporate the extent of an airport's service patterns (i.e., number of nonstop destinations served) or connectivity to a region's QOL. That the two concepts should be connected may seem like a reasonable hypothesis for those who work in and around the commercial aviation industry, this team was not able to locate any such research.

Diversity of the Regional Economy and Effects on the Local Tax Base

The strength, stability, and diversity of a metropolitan region's economy and the associated effects on the local tax base is another issue of concern. Broadly speaking, this issue concerns a central tension between whether a more diverse regional economy is better able to develop over time – and weather an economic downturn – than one that tends to specialize to take advantage of linkages among related industries and labor. In this context, "economic diversification" refers to the extent to which employment and economic activity are concentrated or dispersed among industry sectors.

Data Analysis and Development of the Airport Region Typology

To select the case studies needed to represent the broadest array of airports and regional economies, the project team needed to generate a categorization of U.S. airports and the economic regions ("airport regions"). This section summarizes the analysis of air service and regional socio-economic data completed to develop that typology or categorization. It explains the processes through which the team analyzed the large amount of data for the airport regions. It also describes some of the issues that the team confronted during the analysis and how they were addressed. The section then describes the final categories of air service and economic activity that represent a spectrum of differences among airport regions and the 14 regions selected.

The Airport Region Universe

The project is restricted to airports that the FAA defines as primary service airports: those that receive scheduled commercial passenger service and more than 10,000 passenger boardings each year. For 2019 (the latest data available from the FAA at the time of the analysis and notably pre-COVID), this included 403 total airports, as summarized in Table 4.

Table 4: FAA-Defined Primary Hubs, 2019

Category	Number
Large hub	30
Medium hub	32
Small hub	74
Non-hub	267
Total	**403**

Source: FAA Preliminary 2019 Enplanement Data

The project team made two adjustments to the universe of airports. First, the team excluded airports where air service was provided only because of the Essential Air Service (EAS) program. By definition, the EAS program subsidizes air service to regions where commercial service would not otherwise be provided. Because economy activity in those regions is inadequate to support unsubsidized commercial service and because the carriers providing the EAS service are unable to adjust their routes and capacity without governmental approval, they are not included. As of Feb. 2020, there were 165 EAS airports in the contiguous states, Hawaii, Alaska, and Puerto Rico, but the FAA classifies only 63 as primary service airports, which the team now excluded. Second, the team also excluded airports in the U.S. territories: Puerto Rico, Guam, the U.S. Virgin Islands, American Samoa, Saipan, and the Northern Marianas Islands. These airport regions were considered to be exceptionally unique in terms of the economies that they serve, in part because they serve island economies.

The project team then matched airports with Metropolitan Statistical Areas (MSAs), based on the counties where the airports are located and the county-based definitions of the MSAs. This is a convention used by academic researchers. Standard federal statistical areas like MSAs were used because socio-economic data are reported on that basis. Individual airports' air service development programs might adopt more sophisticated analyses of their unique catchment areas – for example, based on drive time relative to other nearby airports. For purposes of this task, such an approach was deemed too complex and costly. The challenge that this revealed was that an unexpectedly large number of MSAs did not include an airport within their geographic boundaries. Notable examples are the Durham-Chapel Hill, NC MSA and Boulder, CO MSA. Raleigh-Durham International Airport is in Wake County, NC (the Raleigh MSA) which abuts and obviously serves Durham County. Denver International Airport (DEN) is in Denver County, which abuts and obviously serves Boulder County.

To address that challenge, the team adopted a larger statistical area to link airports to economic regions. Combined Statistical Areas (CSAs) "represent larger regions that reflect broader social and economic interactions" and complement MSAs. Examples of CSAs include not just the mega-urban centers of the northeast like greater Boston (the CSA incorporates Worcester and Providence) or greater New York City (which stretches from Connecticut to Pennsylvania), but also other multi-airport regions like Phoenix-Mesa and Norfolk-Virginia Beach. In addition, in many areas, using CSAs provided a better linkage between the airports and the regions they serve. The MSAs in densely populated areas are quite small and the catchments of airports are considerably larger. Combining airports with MSAs and CSAs largely eliminated the issue of MSAs not being tied to a primary service airport, as summarized in Table 5. Table ES-6 summarizes the CSAs/MSAs and shows the number of airports associated.

Table 5: Airport – CSA/MSA Summary: Airports within Major Statistical Areas

Total Primary Service Airports	403
EAS Airports	63
Subtotal – Non-EAS Airports	340
Airports within a CSA	193
Airports outside a CSA but inside an MSA	86
Airports outside either a CSA or MSA	61
Airports within a MicroSA	*26*
Airports outside of an MSA or MicroSA	*35*

Note: MicroSAs (Micropolitan Statistical Areas) are similar to MSAs but smaller. MicroSAs have at least one urban cluster of at least 10,000 but less than 50,000 population, plus adjacent territory that has a high degree of social and economic integration with the core as measured by commuting ties.

Table 6: Airport – CSA/MSA Summary Counts

Category	Count of CSAs/MSAs	Number of Primary Service Airports
CSAs with 1 airport	101	101
CSAs with >1 airport	32	92
MSAs outside of CSAs but with 1 airport	75	75
MSAs outside of CSAs but with >1 airport	5	11
Total	**213**	**279**

Not surprisingly, single and multi-airport regions differ vastly in terms of the populations served. In general, multi-airport regions tend to have much larger populations than single-airport regions. The estimated population of the median multi-airport region in 2019 was over seven (7) times larger than that of the median single airport region: 2.9 million (St. Louis-St. Charles-Farmington MO-IL) vs. 400,000 (Peoria, IL). By multiple metrics, ranging from employment growth to available airline seat capacity and passenger traffic, multi-airport regions also grew faster.

The project team thus focused the analysis on those 213 statistical regions served by those 279 primary service airports. This excluded 61 airports from the analysis – those 26 outside a CSA or MSA but located within a MicroSA and the other 35 outside those areas. This includes several airports in remote parts of Alaska and the U.S. Territories.

Time Period of Analysis

The project team examined the air service and economic data for three years: 2008, 2015, and 2019. Those dates were selected because they represent the beginning of the Great Recession, the point at which national-level data had fully recovered from the downturn, and the most recent year for which data was available (and prior to the collapse brought on by the COVID pandemic). The Great Recession began in December 2007 and ended in June 2009, which made it the longest recession since World War II. Beyond its duration, the Great Recession was notably severe in several respects. Real gross domestic product (GDP) fell 4.3 percent, the largest decline in the postwar era (based on data as of October 2013). The unemployment rate, which was 5 percent in December 2007, peaked at 10 percent in October 2009.

With the three years identified, the team analyzed changes in each of the variables for three intervals:

- Entire study period 2008-2019
- Recovery from the Great Recession 2008-2015
- Stable growth during 2015-2019

Summary: Air Service and Socio-Economic Data Used for Analysis

In general, the key airport and air service variables were:

- Hub sizes
- Whether airports were part of a multi-airport system that served a geography or a smaller airport "in the shadow" (i.e., within a relatively short drive) of a larger facility
- Whether airports provided service to international destinations or only domestic locations
- Capacity offered (airline seats available for purchase)
- Origin and destination traffic

- Cargo (various measures)

The key economic data analyzed were:

- Employment
- LQs
- Employment in selected industry sectors (e.g., by NAICS codes -- manufacturing; information technology; finance and real estate; professional, scientific, and technical services; management of companies)
- Selected economic clusters

Generating the Typology of Airport Regions

The project team focused first on changes in available seat capacity and O&D traffic and changes in regional employment for each of the three time periods. These data were selected because they most immediately reflect the issues that are central to the project. The project team noted that capacity and passenger traffic grew increasingly correlated during the period, as industry-wide domestic load factors rose from 79 percent in 2008 to 85 percent in 2019.

Separate analyses were conducted on the 176 "single airport" CSA/MSA regions and the 37 "multi-airport" CSA/MSA regions. In general, while recognizing the fundamental underlying differences between single- and multi-airport regions in terms of average population, employment, and key aviation metrics (e.g., capacity offered), the team found little significant difference in the relationship between capacity or passenger traffic and employment between the two groups of regions. That is, for both types of airport regions, the relationship was positive – that as one variable (employment) increases so does the other (capacity).

Analysis of changes in economic activity and air service in the multi-airport regions was exceptionally difficult because changes in economic activity within the broader region could not readily be associated with or disaggregated from air service at any one airport. Distinguishing the impacts of separate airports on a large metropolitan region would require extensive detailed information on air service options at all airports within the region (e.g., carriers serving each airport, nonstop domestic and international destinations, flight frequencies, aircraft types, airline strategies or business models, etc.), the locations of residential and business centers relative to each airport, barriers to movement within the region that can affect drive times to the airport (e.g., traffic, bridges), the economic structure of the region, and scores of other factors.

Because of the complexity, for purposes of creating categories of airport regions, the project team opted to aggregate the air service metrics for all airports serving the region and compare the totals against the economic variables.

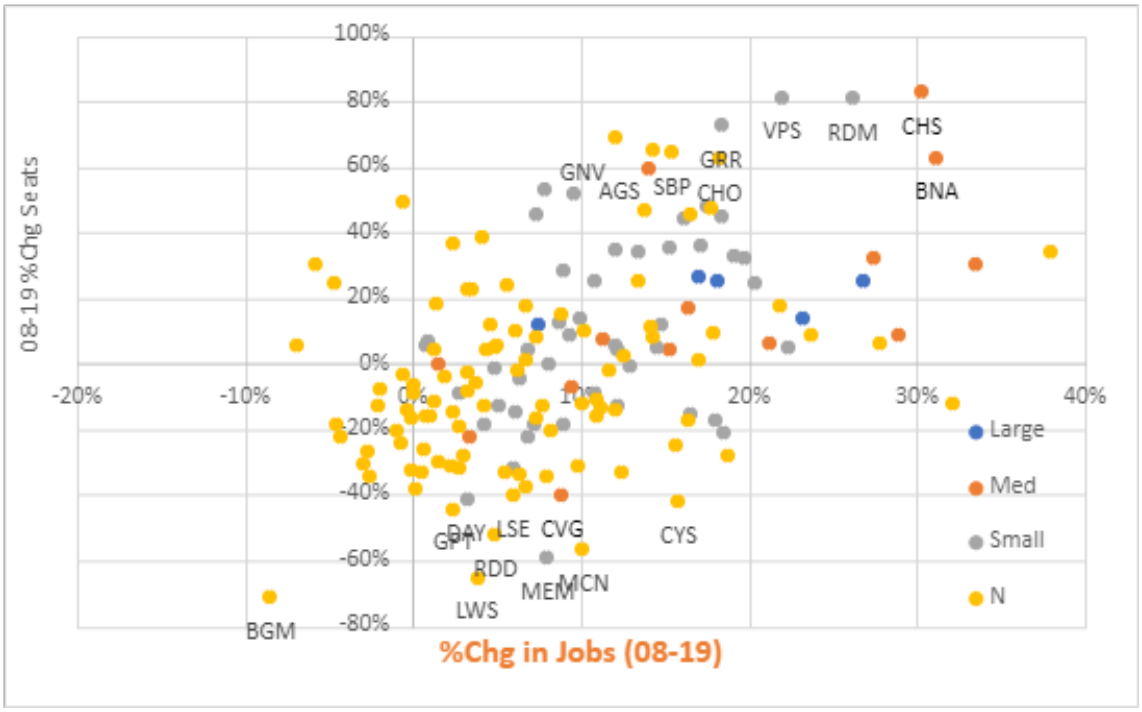
To provide some background to the changes in the regional economies that occurred during the 2008-2019 period, the team first examined changes in total employment. The data were organized into quintiles (five groups of equal numbers of regions ranging from those with the lowest absolute change in employment – the bottom 20% -- up to those with the highest absolute change in employment – the top 20%). Table 7 shows the results for the single-airport regions for the entire study period 2008-2019. The bottom quintile is characterized by regions that experienced job losses.

Table 7: Quintiles of Single Airport Regions by Changes in Employment - 2008-2019

2008-19 Job Quintiles	Low	High	Median	Median Airport
Quintile 1	-16,584	2,590	-29	TXK - Texarkana
Quintile 2	2,623	10,606	6,607	LAN – Lansing
Quintile 3	11,028	28,007	19,834	FAY – Fayetteville NC
Quintile 4	28,469	55,247	39,529	CLL – College Station TX
Quintile 5	56,294	837,619	118,360	CVG - Cincinnati

With those changes in employment understood, the team added in the air service variable (e.g., capacity). The team analyzed changes in employment against changes in capacity. Broadly speaking, whether a region is served by one or more airports, the relationship was positive: as employment grew, so did capacity and traffic (and vice versa). See for example Figure 1, which shows the data for single-airport regions only, with those airports serving the regions with the highest and lowest percentage changes in capacity identified with the airports' 3-letter designator code.

Figure 1: Changes in Available Capacity and Employment, Single-Airport Regions 2008-2019, by Hub Size



Note: Data not available for 6 regions. N = nonhub.

The figure highlights the generally positive relationship between the two variables: In general, as employment increased so did available airline capacity (or vice versa). Of the 169 single-airport regions shown, 88 (52 percent) saw increases in capacity, even though four of those regions (non-hubs BGR, ELM, PIA, and RFD) experienced a loss of employment.

Yet a large number of single-airport regions experienced a loss of capacity from 2008 to 2019 even if employment increased. Of the airports shown, 81 (48%) lost capacity, and 67 of those regions had increased employment. For example, the Macon GA (MCN) region gained 10 percent in employment between 2008 and 2019 but lost over 50 percent of its available capacity. Employment in the Dubuque, Iowa (DBQ) area also increased by 10 percent, but capacity fell by 33 percent.

Another way to summarize those results is to divide them into quadrants based on changes in both variables – employment and capacity. Table 8 summarizes the figure above.

Table 8: Major Categories of Change in Seats and Employment 2008-2019

Employment and Capacity Quadrant	Number of Airport Regions	Examples by hub size			
		L	M	S	Non
Jobs down, seats down	14	none	none	none	BGM, FSM
Jobs down, seats up	4	none	none	none	RFD, ELM
Jobs up, seats down	67	none	CVG, MCI	COS, ELP	BFL, CYS
Jobs up, seats up	84	DEN, SAN	IND, OMA	MAF, RDM	SGU, LCH

Approximately 89 percent of the regions experienced job growth between 2008 and 2019, and of those, 56 percent also saw increases in air capacity.

Shadow Airports. Shadow airports are Small or Non-hubs within 125 miles of a larger airport (either a Medium or Large hub). Examples include Toledo, Ohio (TOL -- 68 miles south of Detroit Wayne County International, DTW) and Greensboro-High Point (GSO), 100 miles northwest of Charlotte Douglas International (CLT) and 80 miles west of Raleigh-Durham International Airport (RDU). There are 95 shadow airports – 30 small hub and 65 non-hubs. If the mileage limit is relaxed slightly to 160 miles, the number of shadow airports rises to 106 (33 small hubs and 73 non-hubs). Shadow airports include not just smaller facilities that serve their own MSAs, but also those within multi-airport regions (e.g., Concord-Padgett Regional Airport 21 miles from Charlotte Douglas International Airport).

For the shadow airports with employment and capacity data for 2008 and 2019, about as many experienced increases in capacity as decreases, even though only six experienced losses of employment. Non-hub shadow airports were more likely to have lost capacity:

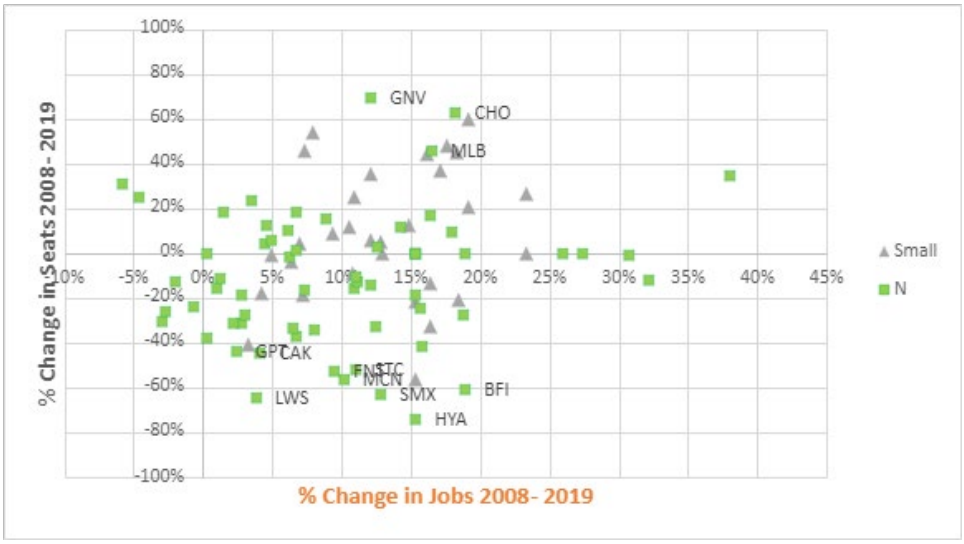
- Of the 33 Small hubs, capacity increased at 21 (64 percent), was unchanged at one, and dropped at 12 (36 percent)

- Of the 73 nonhubs, capacity increased at 30 (41 percent) was unchanged at 7 (10 percent) and dropped at 36 (49 percent).

For the shadow airports, Figure 2 shows the distribution of percentage changes in seats and jobs for the period in single-airport regions only. Of the 69 single-airport regions, 36 (52 percent) lost capacity. Non-hub shadow airports were more likely to have lost capacity, even if employment increased. Of the 48 single-airport non-hubs, 28 (58 percent) lost capacity. Of the 21 single-airport Small hubs, 8 (38 percent) lost capacity.

Table 9 summarizes the data from Figure 2 in the jobs/capacity quadrants for all shadow airports where data were available. For those 98 areas, capacity rose at 50 (51 percent) and dropped at 48 (49 percent).

Figure 2: Shadow Airports' Changes in Capacity and Employment 2008-2019 (Single-Airport Regions Only)



Note: The figure excludes 14 airports where the percentage change in seats exceeded 100 (often due to the entry of a ULCC). Those included Trenton, NJ (TTN), Santa Fe, NM (SAF), Portsmouth, NH (PSM), and Hagerstown, MD (HGR) – all of which had at least a 1700% increase in capacity. N = nonhub

Table 9: Major Categories of Change in Shadow Airports' Employment and Capacity, 2008-2019

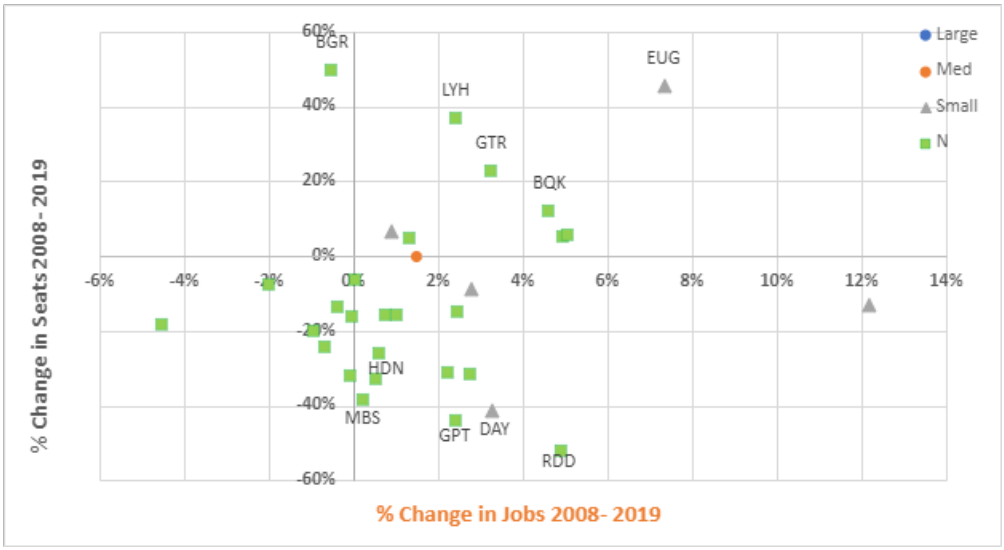
Employment and Capacity Quadrant	Number of Airport Regions	Examples by hub size	
		Small	Non
Jobs down, seats down	4	none	BMI, ERI
Jobs down, seats up	2	none	RFD, ELM
Jobs up, seats down	44	ALB, CAE	ACT, AZO
Jobs up, seats up	48	PIE, SFB	HGR, MLB

In multi-airport regions, of the 36 Shadow Airports, 14 (about 40 percent) had more than half of their available capacity provided by ULCCs such as Allegiant or Frontier. For those 14, capacity dropped at only two: St. Cloud, MN (STC) and Santa Maria, CA (SMX). In both cases, legacy network airlines discontinued service that they were operating in 2008, leaving the airports to be served only by ULCCs.

Rebound regions. Single-airport regions that experienced job losses during the 2008-2015 period but recovered (in whole or in part) in the subsequent 2015-2019 period were labeled "rebound" regions. Of the 31 regions that met those conditions, 25 were non-hubs, 5 were small hubs, and one was a medium hub (Bradley International Airport in Hartford, CT -- BDL).

Figure 3 shows the relationship between changes in jobs and capacity over the entire period for the rebound airports. What is immediately apparent is that despite the gains in employment, the majority of regions (21 out of 31) lost capacity over the period, and about half of those lost at least 20 percent of their 2008 capacity. This may be due to the airlines' emphasis on capacity control and the effect of mergers.

Figure 3: Rebound Regions: Changes in Capacity and Employment 2008-2019



Note: Not shown is one non-hub airport that had service in 2008 and 2015 but then lost all service, although employment in the area increased. N = nonhub

These summaries raised the questions of whether and how to consider the impact that ULCCs exert. During the study period, ULCCs such as Allegiant greatly expanded the number of airports served. For example, airports served by Allegiant rose from 72 in 2008 to 126 in 2019, many of which are small or non-hubs. In 2019, almost 20 Shadow Airports were "ULCC-heavy" – that is, over half of their capacity was attributable to ULCC service. From the perspective of the airport operator, the increase in activity associated with ULCCs can be a highly positive development. Although the economic impact at the destination points like Punta Gorda, Florida is unquestionably clear and notable, the economic benefits for many origin points are not.

Simply put, the impact on either the origin or destination for economic activity beyond the tourism and hospitality sector is not well understood. A commonly-held perception is that ULCCs' patterns of flight operations are inconsistent with business travel as ULCCs often operate less than daily service from a point of origin to a given destination, and rarely offer multiple daily frequencies. (Flights are often only three or four times weekly in a given airport-pair.) Those flight frequencies may be acceptable for leisure travelers but not for business passengers who demand greater frequencies and flight options – usually at least two or three flights each day.

The project team discussed the issue with the Review Panel and ultimately determined to exclude from the research those airports that were "ULCC-heavy." This is an issue for future consideration.

Other Results: Selected Industry Sectors

Drawing on the background research that revealed relationships between commercial air service and particular industries, the team examined changes in regions characterized by particularly strong economic employment activity in the following broad industry groupings, which have relatively greater reliance or dependence on air transport as an intermediate factor of production. :

- Manufacturing (NAICS categories 31-33)

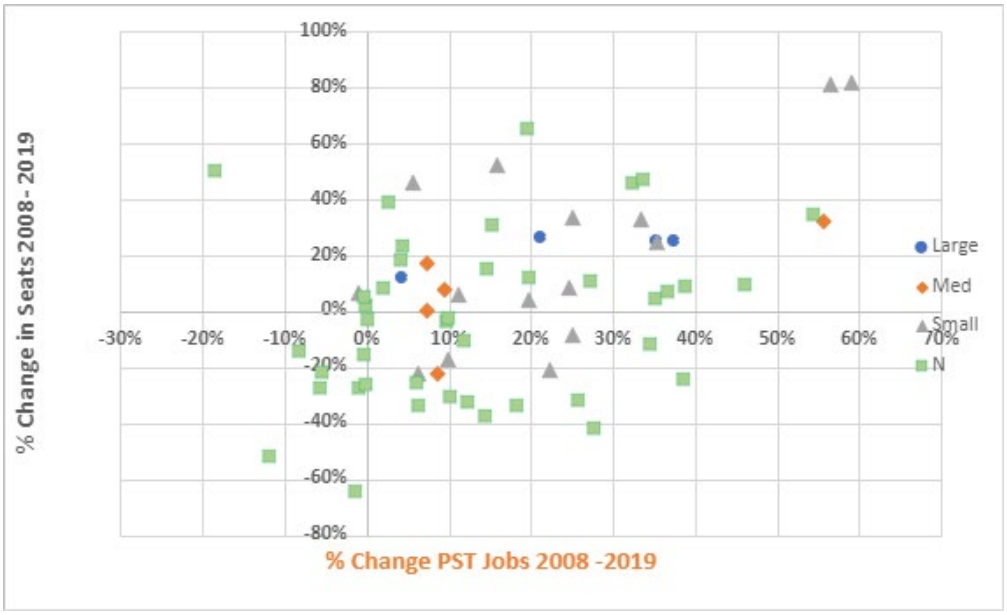
- Information (NAICS 51)
- Professional, Scientific, and Technical (PST) Services (NAICS 54)
- Management of Companies (NAICS 55)
- Information Technology (NAICS
- Finance and insurance (NAICS 52)
- Administrative and Support and Waste Management and Remediation Services (NAICS 56)

The Manufacturing NAICS sector is included because of the reliance on air transportation for key subsectors, such as Computer and Electronic Product Manufacturing; Electrical Equipment, Appliance, and Component Manufacturing; and Pharmaceutical Preparation Manufacturing.

To determine if a region had a strength in a particular industry, the team analyzed each in terms of changes in total absolute employment by NAICS sector and LQ. These analyses revealed locations that had strong and increasing amounts of economic activity in those sectors. They revealed locations by hub size that represented both average and exemplary situations of changes in employment and air service activity. They did NOT however reveal unambiguous relationships between employment and capacity.

For example, academic research has demonstrated that the PST sector is a significant consumer of commercial air transportation. Figure 4 shows the relationship between changes in PST employment and capacity in single-airport regions. Although it broadly suggests a positive relationship between the two, it also shows that increases in PST employment in and of itself is insufficient to support increases in capacity. More factors must be influencing air service in those regions.

Figure 4: Changes in PST jobs and Capacity 2008-2019



Of the total 69 single-airport regions for which data on changes in PST employment and capacity were available, PST employment increased in 58 and fell in 11. However, for the regions where the employment grew, available air capacity nevertheless decreased in 20 – over one-third of the regions with increases in PST employment. Of the 11 areas where PST jobs fell, seven also lost capacity and four did not.

To focus in more on regions where the NAICS industries were particularly strong, the team then analyzed the single-airport regions to identify those that met more than one of the following conditions:

- Being within the top 20 percent of regions with employment in the sector
- Having LQs greater than 1.0 (indicating a higher-than-average share of sector employment in that region)
- Having experienced the greatest amount of growth in the absolute number of jobs in the sector.

Few met all three for any one of the NAICS industry sectors. Table 10 summarizes the number of airport regions that met all three conditions and lists those that did. Four airport regions -- DEN, PDX, RDU, and SDF – meet all three conditions in more than one industry sector.

Table 10: Summary of Airport Regions with Strong NAICS Industry Presences

Industry Sector	Airport Regions	Airports
PST	4	PDX, SAN, DEN, RDU
Management of Companies	2	BDL, MKE
Information Technology	3	RDU, MSN, DEN
Finance	8	SDF, BHM, SAT, OMA, AUS, RSW, JAX, ALB
Manufacturing	9	PDX, SDF, TOL, GRR, GSP, TYS, TUL, FWA, SBN
Total ***unique*** regions	***22***	

Note: Airport regions listed more than once are DEN, PDX, RDU, and SDF.

Significantly more airport regions met two conditions. Those may include, for example, being counted within the top 20 percent of regions with employment in that industry AND having an LQ of more than 1.0, but NOT having experienced the greatest amount of absolute growth in jobs. As an illustration, in the Finance sector, 20 regions met two conditions. Examples are:

- Hartford, CT: Top 20% of regions with employment in finance AND location quotient above 1.0
- Grand Rapids, MI: Top 20% of regions with employment in finance AND top quintile in finance job growth
- Cedar Rapids, IA: Location quotient above 1.0 AND top quintile in finance job growth

Note on Tourism/Hospitality

Travel and tourism are unquestionably a major part of many regions' economic bases. The impact of COVID on this industry (and on local economies) has been pronounced. In January 2021, the U.S. Department of Labor reported that while total employment in the U.S. decreased by 140,000 in December,

> "…employment in leisure and hospitality declined by 498,000, with three-quarters of the decrease in food services and drinking places (-372,000). Employment also fell in the amusements, gambling, and recreation industry (-92,000) and in the accommodation industry (-24,000). ***Since February (2020), employment in leisure and hospitality is down by 3.9 million, or 23.2 percent."*** (***emphasis added***)(BLS press release)

Hospitality and tourism are umbrella terms for a wide range of commercial activities. For example, the hospitality industry consists of lodging, food services in restaurants, planes and cruise ships, clubs, cafeterias, hospitals, etc.; and recreational facilities ranging from casinos to resorts. The tourism industry supports a traveler's need for transportation, food, lodging, amusement, and entertainment. It involves tour operators, rental cars, hotels, bars, gasoline stations, theme parks, and attractions.

Because economic activities that comprise hospitality and tourism are spread among multiple sectors (e.g., transportation, retail, accommodation, and food service), the activity is not defined as a separate industry within the NAICS system, but instead as a "satellite account." Thus, it is not possible to readily analyze changes in air service and employment in this "sector." In addition, although there may be significant amounts of employment associated with travel and tourism, the overall economic impact may be relatively modest because of limited "ripple" effects tied to the modest wages generated.

The project team recommended – and the Review Panel concurred – that effects of changes in air service and tourism/hospitality would be excluded from the project.

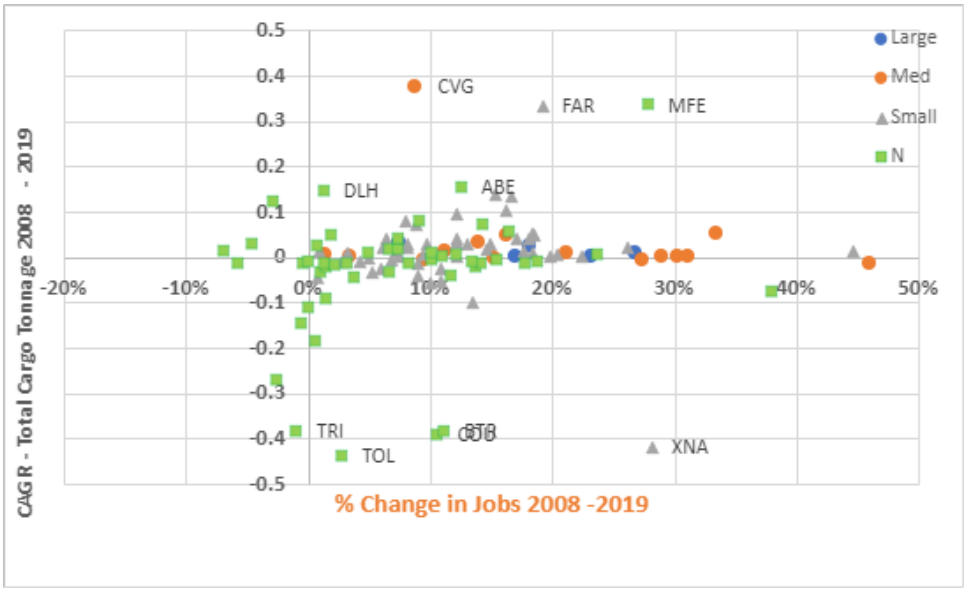
Cargo and Economic Activity

Similar to the analyses of changes in economic activity and air service metrics, the team analyzed changes in the same economic variables against measures of cargo activity at airports. Those included total cargo tonnage and separate measures of activity and tonnage by integrators (e.g., FedEx), pure or "dedicated" freight operators (e.g., Atlas Air), cargo carried in the belly of passenger airlines, and Amazon Air.

Not surprisingly, the airport regions that ship the greatest tonnage of cargo/freight are the larger metropolitan areas, which also tend to have more international operations than smaller airport regions. Many airports have relatively incidental volumes of cargo during any given year. For example, of the 176 single-airport regions, 56 had less than 100 tons in 2019 (an average of less than 550 lbs. per day) and 67 flew less than 1 ton per day. To better focus the analysis on airport regions where cargo activity was more likely to contribute to meaningful economic activity, the project team screened those airports out.

Figure 5 and 6 shows the changes in the compound average rate of growth for total cargo tonnage from 2008-2019 at both groups of airports plotted against the percentage change in employment. Most airport regions exhibited little or no change in cargo tonnage (being clustered on the 0 axis with less than about 15% change in employment). Of the 117 single-airport regions for which data were plotted, at 85 (73 percent), the CAGR for total cargo tonnage was +/- 3 percent. Only 9 had compound annual growth rates (CAGR) of 10 percent or more. Ten lost tonnage at a CAGR of -10 percent or more.

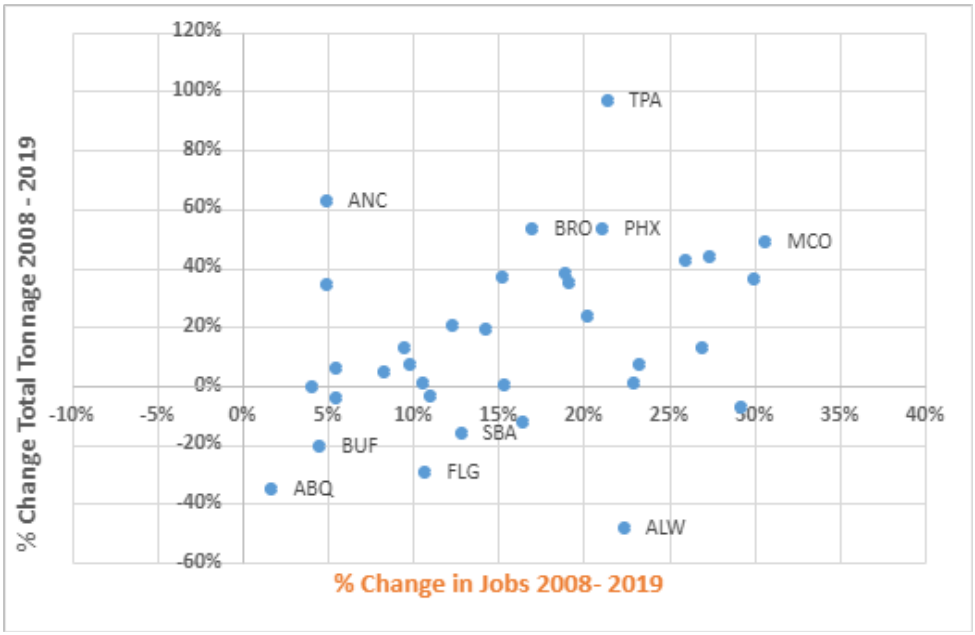
Figure 5: Single-Airport Regions: Changes in Employment vs. Total Cargo Tonnage 2008-2019



Note: 11 airports that had cargo tonnage in 2008 reported 0 tonnage in 2019 and are not shown. Another 19 had 0 tonnage in 2008.

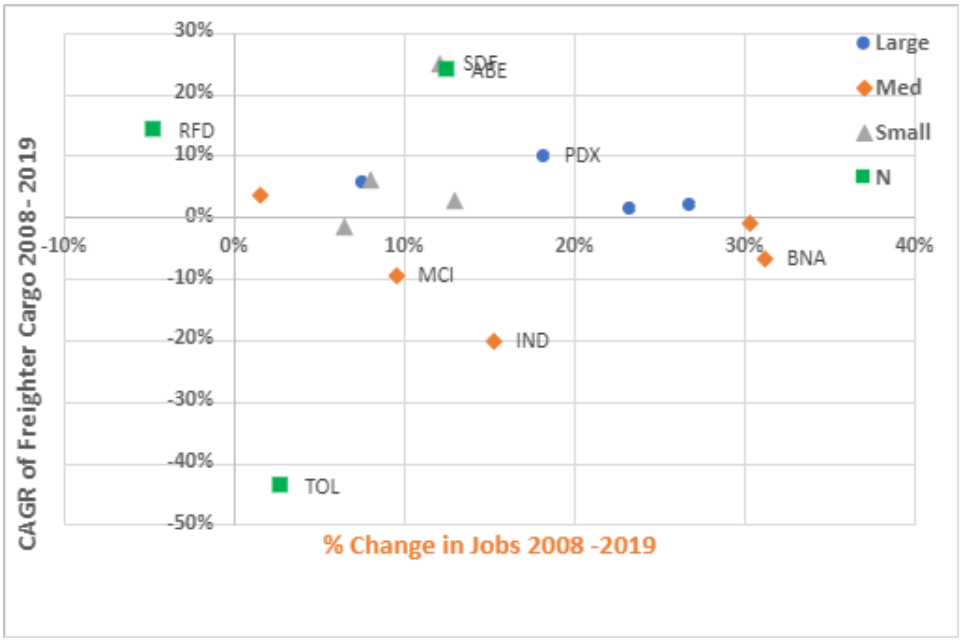
Of the 35 multi-airport regions with data, only 10 experienced losses in tonnage over the period. On average, tonnage increased in these regions by almost 20 percent.

Figure 6: Multi-Airport Regions – Changes in Employment vs. Total Cargo Tonnage 2008-2019



Even fewer airport regions have significant volumes of cargo that are shipped on dedicated freighters. In 2019, of the single-airport regions, 91 (53%) had 10 tons or less of cargo shipped on dedicated freighters. On the other hand, only 42 (less than 25%) shipped an average of 1000 tons or more and only 18 shipped an average of more than 10,000 tons. Figure 7 shows the changes in freighter tonnage and employment over the period 2008-2019 for single airport regions with a minimum of 1,000 tons in either 2008 or 2019. More many airports experienced decreases in freighter tonnage (n=39) as increases (n=22).

Figure 7: Change in Freighter Volumes and Employment, Selected Single-Airport Regions



Note: The figure suppresses data points indicating the 11 airports that had over 1,000 tons of cargo shipped on freighters in 2008 that lost all of that tonnage and the one airport whose CAGR increase approached 100%.

Several airports are now locations that support "electronic commerce" (e-commerce), defined as the commercial transaction of money, funds, data, and buying and selling of goods, products, or services via the internet. These include not only major large hub airports but smaller facilities too (e.g., Denver and Allentown, PA).

- Integrated carriers. Total tonnage shipped on integrated carriers increased by 20% over the study period, and larger numbers of airport regions experienced notable growth. The number of airport regions that handled over 10,000 tons rose from 56 to 65. Beyond the carriers' major hubs in Memphis, Louisville, and Cincinnati, large numbers experienced significant amounts of growth, including Small hubs (e.g., GSO, CID) and non-hubs (e.g., CPR, FWA).

- Amazon Air. Beginning in 2015, Amazon launched its own airline (Amazon Air) to move products to distribution hubs rather than relying on the integrators. Cincinnati serves as its primary hub, although several other locations now operate as important focus cities, including non-hub locations ABE and RFD.

Airport Categories and Case Study Airport Regions

The Project Team revisited the original objective of the project – to help airports and their communities understand, measure, and address the relationship between air service and economic development. The Project Team felt that the state of the national economy and commercial air service sector could not be ignored. Many airports and communities have been severely and adversely affected by the downturn in travel. As a result, the team suggested that one or more case studies should include examples of airport regions that experienced significant or varying degrees of downturn following the Great Recession. The team suggested that the major categories of airport regions would be those characterized by:

- Changes in employment and capacity 2008-2019 and in capacity, by hub size
  - Changes (positive or negative) in employment and capacity 2008-2015. (Negative changes may be reflective of what many airports may experience in the post-pandemic era.)
  - Growth in employment and capacity 2008-2019 (capturing recovery from Great Recession)
- Shadow airports (non- or small hub)
  - Growth in employment
  - Loss of employment?
- Strong NAICS employment (without regard for hub size)(mostly outbound markets?)
  - PST
  - Finance & insurance
  - Management of businesses
  - Transportation / Logistics
- Multi-Airport Regions
  - Anchored by hub with international service
- Regions with cargo airports with focus on different types of operations
  - Freighter
  - Amazon Air

An important consideration for the research revolved around the question of whether to select the "typical" airport that met the category (for example, the "median" airport in each grouping) or "exemplars" (for example, airports that were at or near to top in each grouping). On the one hand, because the team felt that the case studies and end products should be informative to as wide of a spectrum of airports as possible, that argued for nominating "typical" airports. On the other hand, because those airports' experiences may not clearly indicate the best possible nexus between air service and economic development, that argued for selecting exemplar airports. Ultimately, the team nominated airport regions that are likely to illustrate more clearly the relationship between the economic activity and air service, and selected airport regions where preliminary analysis suggested a stronger connection ("exemplar regions").

The team discussed the airport categorization and nominated airport regions with the Review Panel. The Review Panel concurred that the categorization was reasonable. It offered some suggestions for different airports so that the final list of case study facilities reflected greater geographic dispersion and more emphasis on small communities (small and nonhub airports). The Panel also agreed that the team should use "exemplar" regions.

The project team contacted all the recommended airports to obtain their consent and willingness to participate in the project. One of the prerequisites for participating was that the airport must be willing to allow the project team to contact regional stakeholder organizations (e.g., local Chambers of Commerce or Economic Development Authorities) to obtain their perspectives on how commercial air service contributes

to local economic development. One nominated airport did not accept that condition. Another airport declined without specifying a particular reason. A third airport (one that was selected because of its cargo and freight operations) agreed to participate but then failed to do so.

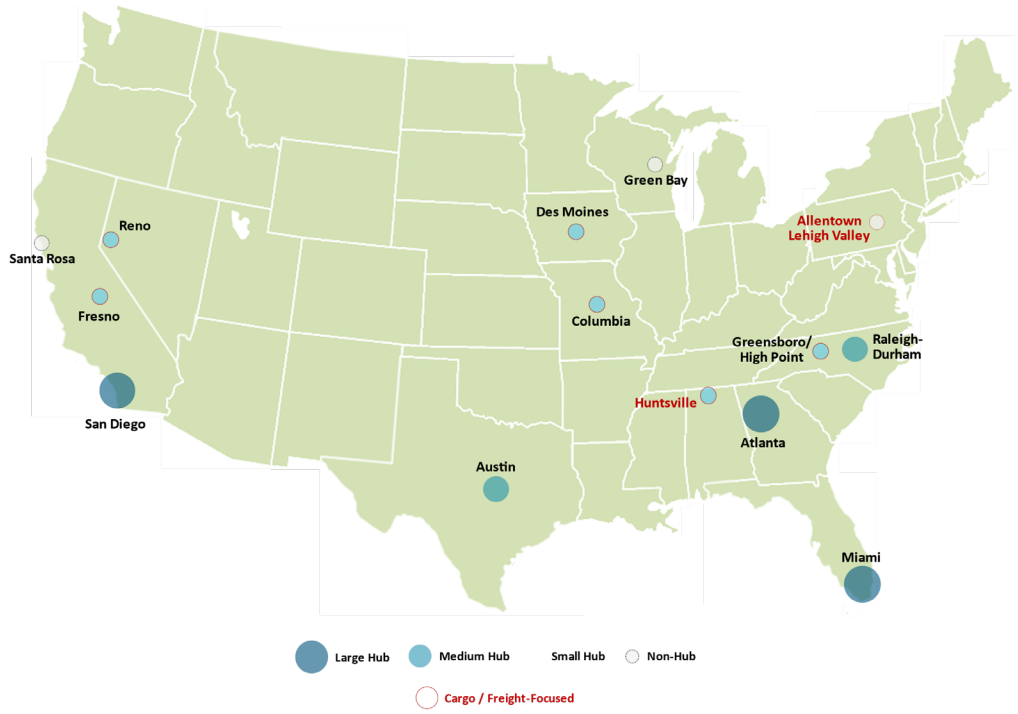
Table 11 summarizes the case study airport regions that participated in the project by hub size and characteristics of the region's air service and/or regional economy. In some cases, an airport may illustrate more than one aspect of air service or changes in the economy. Figure 8 maps the location of the case study airports, showing their geographic dispersion, hub size, and passenger or cargo focus.

Table 11: Categories of Airport Regions and Airports Selected as Case Studies

	Characteristic of airport or region								
						Regional Economic Strength			
Hub size	Sustained growth	Economic rebound	Multi-airport region	Cargo / freight	International service	PST	Information Technology	Finance and Real Estate	Transportation and Logistics
Large			SAN		MIA	SAN	ATL		ATL
Medium	AUS, RDU					RDU	AUS		
Small	FAT	RNO	GSO	HSV				DSM	GSO
Non	COU		COU, GRB, STS	ABE					

ABE = Lehigh Valley International Airport, Allentown, PA
ATL = Hartsfield-Jackson Atlanta International Airport, Atlanta, GA
AUS = Austin Bergstrom International Airport, Austin, TX
COU = Columbia Regional Airport, Columbia, MO
DSM = Des Moines International Airport, Des Moines, IA
FAT = Fresno Yosemite International Airport, Fresno, CA
GRB = Green Bay Austin Straubel International Airport, Green Bay, WI
GSO = Piedmont Triad International Airport, Greensboro, NC
HSV = Huntsville International Airport, Huntsville, AL
MIA = Miami International Airport, Miami, FL
RDU = Raleigh-Durham International Airport, Morrisville, NC
RNO = Reno-Tahoe International Airport, Reno, NV
SAN = San Diego International Airport, San Diego, CA
STS = Charles M. Schulz Sonoma County Airport, Santa Rosa, CA

Figure 8: Case Study Airport Locations, Sizes, and Nature of Operations Examined



Case Studies

For each case study airport region, the team examined changes in all relevant air service and socio-economic variables for each of the three time periods. The team analyzed changes in capacity and O&D traffic against total employment in the region and the sum of a subset of employment for only those sectors identified in the prior research as being "aviation-reliant" (e.g., Finance and Insurance, PST). In addition, for those airport regions that were selected based on economic strengths (e.g., RDU and PST employment), the team analyzed changes in air service against changes in employment specific to those industry sectors.

For most case study regions, employment data for certain industry sectors, often including several or all the "aviation-dependent" sectors, were not available from the BEA for the period 2008-2012. BEA suppressed those data to avoid disclosure of confidential information. Consequently, analyses of changes in employment in those sectors against changes in air traffic were restricted to the period 2013 through 2019.

The team included analyses of the changes in the number of business establishments along with other economic variables. Those data were from the Census Bureau's County Business Patterns.

The Team contacted the airport manager or CEO and interviewed them or delegated staff. The interviews covered multiple topics, such as if and how the airport's air service development efforts were integrated with the business community, how changing economic activity and business patterns were communicated to the airports, and how the airport communicated its impact on the local economy to different audiences. The interviews also inquired about their connections to local stakeholder organizations that were focused

on business concerns, job growth, economic development, and related issues. The team asked the airport to identify what regional stakeholder organizations it coordinated with (if any), and which ones would be candidates for the team to interview.

Based on that information, the team contacted those regional stakeholder organizations to obtain their perspectives on the extent to which air service contributes to regional economic development. The team asked for specific examples of how changes in air service affected business activity and employment. The team asked how the connection between air service and economic activity was discussed or reported, along with what goals or metrics the stakeholder organization used to measure its performance.

Development of Online Tool

The project team began development of the Online Tool for Airports (website) after drafting the Interim Report, which summarized the results of the work through the case studies. This portion of the work relied heavily upon one of the subcontractors, as the project team's principals had little or no experience in website design and construction.

The major steps involved in this task were:

- Based on the Interim Report, identify key research and data elements to be included on website and develop an outline (sitemap)
- In MS Word, develop substantive material for each major element shown on the sitemap, using research completed and prior (intermediate deliverable) reports on the project's progress (e.g., review of literature, survey of air service and socio-economic data). This includes figures, tables, maps, pictures, infographics, and any other type of graphic.
- Migrate substantive content onto website using ACRP template. Identify issues for discussion with ACRP/TRB/NAS staff (e.g., plug-ins needed or requested, formatting, etc.). Revisions to that material to meet various presentation considerations (discussed below).
- Internal reviews to check for website navigation concerns; content accuracy; and any needs to clarify, add, or eliminate content.
- Test with external parties (airports and stakeholders who participated in the case studies) to obtain feedback on the site's navigability and content.
- Revisions based on feedback and submission to ACRP and Review Panel for review.

The project team adopted a general framework that was built around a core concept accessible from the homepage:

- Getting Started (overview and quick links)
- Understand (background information on the topics, including information that ties air service and regional economic activity together, along with other major topics such as connectivity)
- Measure (major data elements, assessing changes over time in air service and economic activity)
- Communicate (identifying different audiences for the information, suggestions on how to present different types of information, and a general outline or template on the information that could be included)

The project team was challenged by the issue of adopting an appropriate "tone" or "voice" for the website. After reviewing other websites and in discussion with the subcontractor with expertise in website design, the project team came to understand that the "tone" and "voice" of the website narrative should NOT be the same as that required for traditional formal "white paper" reports. The site needs to convey content in a professional and competent manner without sounding overly formal or pedagogical. Because so much of the content is specific to the fields of economics, air service, and development, creating language that would be understandable to wider, possibly nontechnical audiences was challenging.

Website navigation was a particular concern, as the team was guided by the idea that many readers or users would not want to proceed "linearly" through the site like readers might with a traditional research report. The team re-imagined how some of the material could or should be presented, so that readers could move between topics freely without necessarily needing to read in an A -> B -> C -> D sequence, as in a white paper report. This required including multiple means by which users could skip to different topics to meet their interests and needs.

The team revised its approach to website graphics considering limits on the plug-ins that ACRP/TRB/NAS could accommodate. For example, the team's original desire to incorporate Tableau graphics and data were dropped when it learned that needed plug-ins would require annual licenses that neither party were able to fund and maintain. This required re-thinking how certain graphics and other types of information would be presented.

Another complication that the team confronted was how to segment and present information concisely. For example, the team was guided by a principle that web pages are better received if they do not require users to scroll down much. This meant that the team needed to ensure that each page or "visible block" of information was concise. Further, to assist with keeping users engaged, the team wanted to include photos or graphics so that readers are not numbed with text.

Along the lines of keeping material concise, the project team considered how to present the case studies and results. Because the comprehensive case studies for each region averaged about 15 pages in length, the team prepared condensed (2-3 page) summaries of each to allow readers to see the key points associated with each airport region. The users/readers can select studies via a "selection matrix" by clicking on airport codes (i.e., by hub size and characteristic of changes in air service or the regional economies). Doing so will open the condensed version of the case study. Each condensed version also included a link to the comprehensive (full) case study.

Testing Website with Users

The team contacted all of the officials with airports and regional stakeholder groups who participated in the case studies and asked that they test the website and offer comments and suggestions. To guide those testers, the project team developed a short survey so that the team could assess the extent to which the website was functioning as intended. The topics covered:

- Clarity of website objectives on the homepage
- Does the homepage make clear that the website is not a source for all the data and models possibly needed to estimate the economic effect of air service in your region?
- Does the "Getting Started" page give enough information to begin navigating through the material?
- From the "Understand" and "Measure" pages, is it clear what are the major subjects or topics included?

- Does the overview of changes in air service and regional economies cover the topics and data items that you expected?
- Are the expected measures of air service included, or should other data be shown?
- Are the expected data relevant to understanding the structure and strength of a regional economy included?

- Case studies: Were users able to select case studies from the matrix, open different case studies, and download condensed or full versions of case studies?
- From the "Communicate" page, is the material shown logical, clear, and helpful?
- General Impressions on
  - Navigating the website:
    - Was it clear and logical?
    - Was it intuitive?
  - The tone of the language or narrative used:
    - Did it make the website easy to understand?
    - Was it *too academic?* Or *too casual or conversational?*
  - The website's use of graphics (maps, tables, photographs).
  - The ease with which users could locate and download case studies of interest.

The team received comments from half of the case study airports and a few stakeholders. The team also asked for comments and suggestions from the team members (i.e., the subcontractors) along with some of InterVISTAS's economists and air service development staff who were not working on the project. Tables 12 and 13 summarize the responses from the website testers on the close-ended questions. As shown, for most questions, testers found the preliminary website logical, and they found material that they expected to see. The responses also indicated some areas that needed attention, such as the need to provide more introductory language for one section. Testers also noted the need for more prominent links to the full guide and Technical Report.

Table 12: Responses from Testers on "Yes/No" Questions

Webpage	Question	% Yes	% No
Homepage	Are the objectives clear to you	100%	0%
	Does the page make clear that the website is not a source for all of the data and models possibly needed to estimate the economic effect of air service in your region?	90%	10%
Getting Started	Does this page give you enough information to begin navigating through the material	100%	0%
	Is it clear what are the major subjects or topics included?	100%	0%
Basic Metrics of Air Service	Does the page cover the data items that you expected?	80%	20%
Understanding the Regional Economy	Does the page cover the topics and data items that you expected?	90%	14%
	Does this page need introductory language to guide readers?	80%	20%
How Has Air Service Changed Over Time	Does the page cover the topics and data items that you expected?	90%	10%
How Has Regional Economic Activity Changed Over Time	Does the page cover the topics and data items that you expected?	90%	10%
Case Studies	Were you able to locate, open, and download a case study?	100%	0%
	Are the topics shown logical?	90%	10%
Illustrating the Concepts	Is the material shown logical?	100%	0%
	Are the graphics clear and helpful?	100%	0%
Telling Your Story	Is the material shown logical?	100%	0%
	Would it be more helpful if the website had a checklist?	60%	40%
Links to Technical Report	Did you see several locations where links to that report were provided?	70%	30%

As shown in Table 13, testers were positive about the preliminary website's clarity, logical flow, and ease of use. They agreed that the use of graphics was good. However, testers were split about whether the tone of the website was "too academic" or "too casual or conversational." Perhaps most importantly, testers felt that the website would be useful to them to better understand the relationship between air service and regional economic activity, and that it would be useful to airports of all sizes.

Table 13: Considering Issues of Navigating the Website, Extent to Which Testers Agreed with the Following Considerations (average scores, where 1 = Totally Disagree and 5 = Totally Agree)

Consideration	Average Score
It was clear and logical.	4.4
It was intuitive.	4.3
The tone of the language or narrative used made the website easy to understand.	4.6
The tone of the language or narrative used wastoo academic.	2.4
The tone of the language or narrative used wastoo casual or conversational.	2.2
The website made good use of graphics (maps, tables, photographs).	4.3
I was able to locate and download case studies of interest easily.	4.5
The information provided will be useful to me or others I work with in better understanding the relationship between air service and regional economic activity.	4.3
The website will be useful for airports and regions of all sizes	4.5

The survey asked testers to add comments in situations where they answered "no" to a question and in a final "other comments" field. In general, the comments from the airport community and stakeholders were positive. No airport or stakeholder organization was critical about the website's content or navigability. Some suggestions were offered to add further content and to clarify some concepts. These included adding more discussion about:

- EAS carriers that serve many airports;
- e-commerce and the impact on air cargo operations;
- the distinction between current and constant dollars, the Consumer Price Index, and the overall concept of price inflation; and
- how migration patterns affect air service, both domestically and internationally. A city where many Germans historically settled will likely attract German companies, new people, and therefore flights. Same for a region where people migrated north, but still have family in the south. It's an indirect point, but it does have an influence that many in the aviation sector neglect or are unaware of.

The project team incorporated the comments as appropriate and submitted the website, guide, and compilation of case studies along with this Technical Report to ACRP and the Review Panel for review, comment, and revision.

CHAPTER 3

Findings and Applications

The previous chapter explained in detail the approach used to create a categorization of airport regions from which the case studies could be selected. That categorization was intended to be reflective of the broad range of airport types and regional economies in the U.S. To the extent that the categorization accurately reflected that reality, airports of all sizes and economic conditions should be able to find case studies that are similar to their own situations.

Naturally, it is difficult if not inappropriate to try to summarize the results of case studies. Airport and economic experiences in different regions cannot be added up to produce a result. However, it is possible to draw some general conclusions or observations from the case studies where common themes arose. This chapter summarizes some observations from the 14 case studies, including how the airports and regional stakeholders recognized and communicated how the air service and regional economic activity were connected.

Summary Observations from the Case Studies

Relationships between Air Traffic and Regional Economic Activity

At all airport regions except one, the amount of O&D traffic and regional employment is highly correlated. Clearly, there is an interrelationship between air traffic and total regional employment: As one increases so does the other. When the relationship is limited to industry sectors that tend to be more highly dependent on aviation (Information; Finance and Insurance; Real Estate; Professional, Scientific, and Technical Services; Management of Companies; and Administrative and support and waste management and remediation services), the correlation remains very high. Table 14 summarizes the correlation coefficients between O&D traffic and total regional employment and employment in "aviation reliant" sectors for the case study airports. Figures 9 and 10 illustrate the relationship graphically; the upward-sloping trend lines indicate that the relationship is positive: as one variable increases so does the other one. Figure 9 illustrates the relationship between total O&D traffic and regional employment in the greater Fresno, California region. Figure 10 focuses the analysis onto changes in total O&D traffic and employment in "aviation-dependent" industry sectors in the Greater Des Moines region.

Table 14: Summary of Correlation Coefficients from Case Study Airports

Airport	Total O&D and Total Employment	Total O&D and Aviation-Reliant Sector Employment
ATL	0.9307	0.9833
AUS	0.9872	N/A
COU	0.8885	0.9563
DSM	0.9721	0.9662
FAT	0.9564	0.9797
GRB	0.0504	N/A
GSO *	0.8078	0.9913
MIA	0.9820	0.9786
RDU	0.9524	0.9851
RNO	0.8369	0.9617
SAN	0.9669	0.9715
STS **	0.9702	0.9423

* excludes 2008

** excludes 2008-13 before runway lengthened

N/A = not available

The correlation coefficient is a statistical measure of the strength of the relationship between changes in two variables. Positive numbers indicate that as one variable changes, the second also changes in the same direction. A value of exactly 1.0 means there is a perfect relationship between the two variables; a change of one unit in one variable is tied to a change of one unit in the other variable. A correlation coefficient with a value of 0.9 or greater represents a very strong relationship.

Caveat: Correlation does not establish causation. That is, it is not evident whether rising total employment levels lead to more air traffic, or whether more air traffic leads to more total employment.

Figure 9: Scatterplot of Total O&D Traffic and Total Regional Employment, Fresno Area

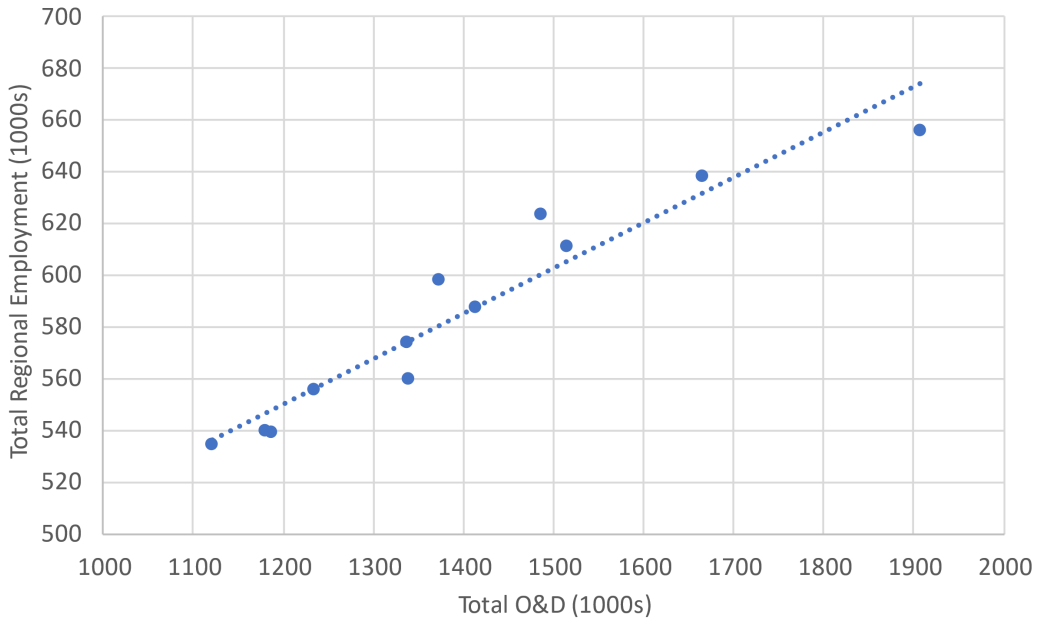
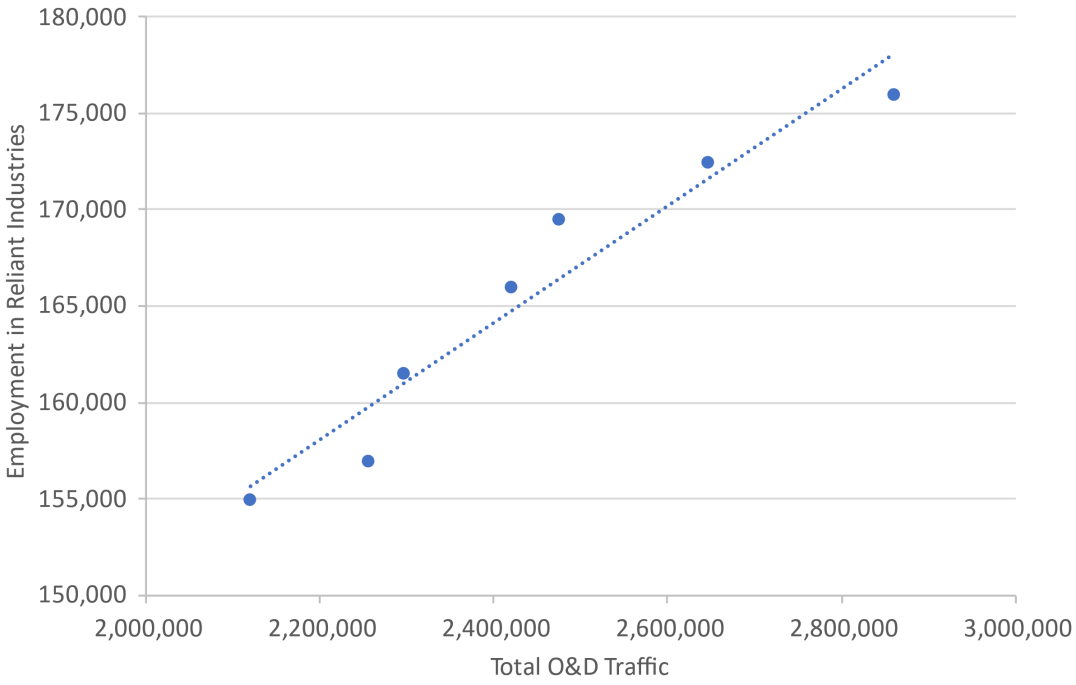


Figure 10: Scatterplot of Total O&D Traffic and Employment in Aviation-Reliant Industry Sectors, Greater Des Moines



Regions served by airports with international air service had evidence of increasing foreign investment and job growth. Increases in those types of economic activity were especially clear in the regions served by AUS, SAN, and RDU, where new nonstop service to Europe contributed to new foreign investment by European-based firms.

Engagement with Regional Stakeholder Organizations

All the case study airports engaged with one or more regional economic stakeholders for purposes of air service development. Stakeholder organizations can include those that represent local or regional business interests (such as the chamber of commerce), regional economic development councils or authorities, other public organizations such as local public universities, and other groups. Those stakeholders can be knowledgeable about emerging business activities and needs, which is important for the aviation community to understand and support. The extent of the engagement varied significantly.

In several case studies, regional stakeholder organizations were active members of committees with airport officials working to enhance air service. This helped ensure that the interests of the business community were clearly communicated to airport staff. The airports also participate with stakeholder committees to convey a consistent message to the organizations' memberships. In some airports, the need for air service to new markets originates with the business community, which pushes the airport to pursue those opportunities.

Some airports reach directly to major employers in the region to better understand how they travel and what their air service needs might be. This can include private businesses and public organizations, such as universities.

Regional economic development groups may target selected industry sectors that have been identified as "high wage" and "high growth" industries for the area. Because these often include sectors with a high reliance on aviation, there is a natural connection between the stakeholders and airports.

Some airports' strategic goals incorporate regional economic development goals, "mindfully developing the airport in ways that support its role as an economic driver for the region."

However, among the case study regions, most stakeholder organizations did not have standing committees or structures that addressed commercial air service issues. Many organizations supported efforts to improve transportation matters generally, although those tended to focus on highway considerations or deficiencies.

Several case study airports – especially smaller facilities that are owned and operated by municipal governments – are connected to the municipal economic development authorities. In cases like these, the stakeholder organizations' interests may be focused on "Main Street" issues of filling vacant downtown storefronts with retail, highway improvements, and business retention rather than air service and business activities that are dependent on aviation.

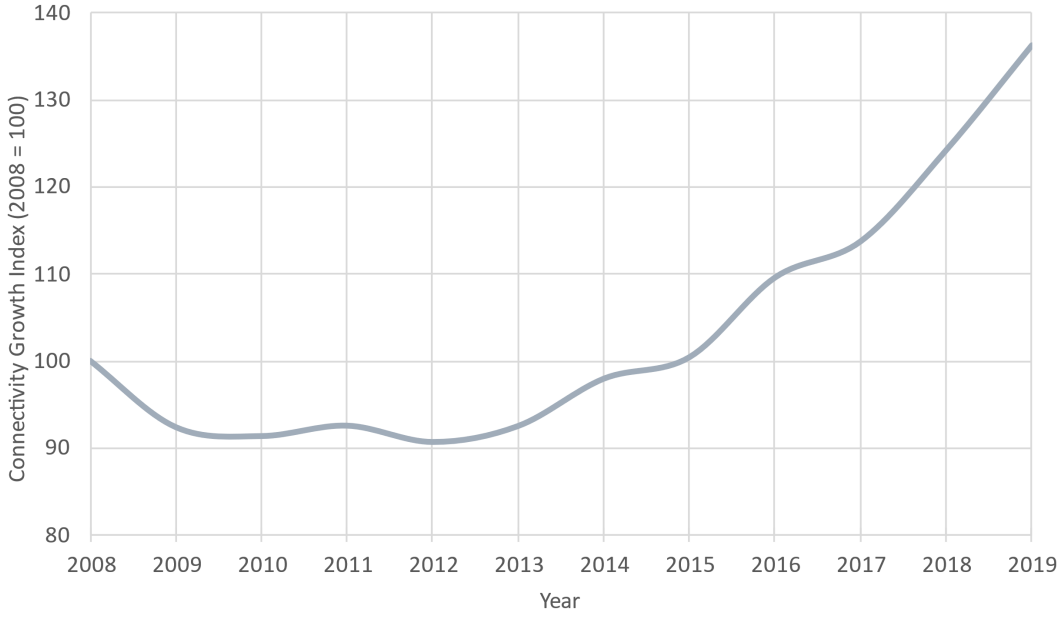
These can be challenging situations, but airports and the business community can make a compelling story that better clarifies the connection between air service and employment, especially in those industry sectors that are reliant on aviation.

The case studies include examples of airports and regional stakeholders working toward economic development and air service goals that tie the two together. There are examples where air service improvement is specifically listed as a key strategy for community development. Beyond "big business" development, the airport's priorities around balanced air service options and comprehensive connectivity are designed to support and attract small businesses and to serve the community at large. In this manner, the value of air service is not simply about making it easier for corporate executives to visit the region but also contributing toward a standard of living that will attract the businesses and residents who want to see the community thrive.

Quantifying Changes in Connectivity

For most case study region airports, connectivity declined following the Great Recession but then improved as the airline industry and national economy recovered. Figure 11 summarizes how connectivity (as measured using the IATA connectivity index) changed from 2008 to 2019 at Raleigh-Durham International Airport (RDU). Connectivity there declined after 2008 and did not recover until 2015. It then grew by 36 percent between 2015 and 2019. This growth was driven by expanded service to Denver, Los Angeles, San Francisco, and Seattle, as well as the introduction of service to Paris and Montreal in 2016 and 2019, respectively.

Figure 11: Changes in Connectivity at RDU



Source: InterVISTAS analysis of schedule data using the IATA methodology.

There is appreciation among airports and stakeholders of the value of improving connectivity, especially where new service to a hub would reduce circuity and improve accessibility to international markets. Many stakeholders would like to see increases in the number of markets served, often for improving business accessibility.

A stronger story can be told when linkages and insights from the business community are uncovered. Even a single business that gained access to new markets for its products or improved access for intermediate products can make a powerful anecdote.

Accessibility can attract new and more diverse businesses into a region, particularly from industry sectors that are more reliant on air service which tend to support higher paying job opportunities. In this manner, air service facilitates not only economic growth but a high quality of growth that supports a higher standard of living and a more resilient economy.

Conveying Economic Impact and How Air Service Supports Regional Economic Activity

Airports and stakeholders tended to focus mostly on airport economic impact assessments rather than evaluations of how changes in air service contribute to broader regional economic development.

- Most of the case study airports offer little if any information on their websites on either economic impact or how air service supports regional economic activity. Those that do only include summary information from an economic impact study of the airport.

- Some regions recognize that the airport plays a pivotal role in contributing to regional economic development. Commercial air service is an important consideration for site selectors and business decisions on where to expand or locate.

- Regional stakeholder organizations use their own metrics to gauge performance. These do not generally tie to measures that airports typically report, although some are often used in airport economic impacts, such as jobs supported.
- The result is that the metrics used by airports to tout their economic contributions do not connect or resonate with regional stakeholder groups.

Several stakeholders noted the challenges of conveying economic concepts to the public.

- Some suggested using individual stories to personalize how an individual's employment or business is tied to the airport or airlines.
- Concise messaging and context play a role in delivering research findings to key stakeholders, including local elected officials and the general public. Large impact numbers cannot necessarily convey a message on their own and should be accompanied with benchmarks, comparisons, graphics, or some additional context that helps an audience quickly and accurately interpret the results.
- Standard marketing strategies can have a role in generating awareness for the airport as a driver of economic growth. Local advertisements that showcase key air service development successes or at the airport can help generate support from the community for future initiatives.

Application to Airports

The results of the research should be applicable to commercial airports of all hub sizes, with the caveat that those served by EAS carriers only were not included in the research. Because of the inherent nature of EAS service at those locations, altering service patterns is difficult but not impossible. For airports with other competitive positions, the case studies make clear that changes in air service can contribute to changes in regional economic activity. For those facilities that could support nonstop international service, the case studies suggest that new international service can directly lead to additional business investment and activity.

Limitations

There were two significant limitations that the team encountered in the project design. The first concerned the research at regions served by more than one commercial airport and how changes in economic activity can separately be attributed to service at those airports. For example, of the ten largest U.S. urban areas in 2021 by population, seven – New York, Los Angeles, Chicago, Houston, Dallas, Miami, and Washington, DC – are served by more than one large airport. The team was unable to determine how to segregate or attribute changes in regional business and economic activity to changes in air service at the different airports. Consequently, the team made the simplifying assumption that changes in regional economic activity were associated with total regional changes in air service rather than changes in service at one airport or another.

A similar type of conceptual hurdle applied to regions with a "shadow airport," especially if the shadow airport was near a large hub, especially if the large hub also serves as an airline hub. Among the case study airports, this situation arose with Piedmont Triad Airport (GSO) in North Carolina, Charles M. Schulz

Sonoma County Airport (STS) in Santa Rosa, California. Many other airports in the U.S. likely experience the same sorts of effects of changes in regional activity being associated with changes in air service at both the shadow and hub facilities. Possible examples include Columbia (SC) Metropolitan Airport (CAE) with its proximity to CLT, Worchester Regional Airport (ORH) near Boston Logan International, and Toledo Express Airport (TOL) near Detroit Wayne County International Airport.

CHAPTER 4

Conclusions and Suggested Research

The conclusions from this project are based on the research that led to the creation of the airport region typology, the research during the 14 case studies, and observations taken from those case studies. As such, readers are cautioned about applying the conclusions to the airport community at large.

Conclusions

It is the conclusion of the research team that:

1. Airports can do better at understanding how air service and regional economic activity/employment are interrelated. Airport officials generally report having a "gut feeling" or basic understanding about which industries in the region rely on air service to reach clients and to connect to suppliers. Some airports' staff who specialize in air service development may be aware of some employers in the region – especially the largest area employers – that have employees that travel extensively. But their understanding beyond those large employers may be limited. But the depth and extent of this understanding could be expanded, and the ability of the airports' executives and board can be advanced.

2. Once the airport community recognizes that the connection between air service and regional economic activity can and should be assessed, it can be communicated to the community at large. Doing so will better enable the public and elected officials to understand the breadth and value that air service brings to the region beyond employment at the airport or related to tourism and hospitality industries. Such an understanding would be an important factor for communities to consider when they undertake the mental calculus about the overall costs and benefits of airports and air service, especially as part of an equation often dominated by concerns about noise and environmental impacts.

3. The project team found no case study airport that publicly reports on how air service at its location supports business activity in the region *except* via airport economic impact assessments. But those economic impact studies focus on activity that occurs on airport properties or is directly tied to commercial air service. Consequently, how air service supports other industry sectors in the region is not known, understood, or communicated.

4. Further, because airport economic impact assessments tend to be inwardly focused, the results reported do not connect or resonate with regional stakeholders concerned with business and economic development. Similarly, results of economic impact studies do not integrate with industries that are somewhat reliant on air service.

5. Based on the interviews with case study airport staff, several airports have little if any connections to some of the regional stakeholders that work on matters relating to business and economic development. This may be a missed opportunity to better understand the nature of the underlying

regional demand for air service and build relationships with what could be valuable community partners. The partnerships could be a powerful unified voice to educate public officials about the synergies between business and air service.

6. It is an exception to the rule that those stakeholder organizations work closely with the airport to identify air-reliant target industries and emerging air service needs. But in those situations where it occurs, both the airports and regional businesses appear to have benefitted significantly.

7. Smaller airports may be challenged to coordinate more closely with these stakeholders, if for no other reason than that resources are constrained. Where the number and/or expertise of staff are limited, taking the time to develop and nurture relationships with regional stakeholders becomes a practical challenge.

8. Some airports are under pressure from the community to bring ULCC operations to the region for the sake of "lower air fares," particularly to leisure destinations. This is understandable, but the community needs to better understand that such service will not necessarily provide meaningful assistance to the business community, since the nature of ULCC operations (typically less-than daily service to a limited number of destinations) does not tend to facilitate business travel.

9. The case studies suggested great strength in the relationship between flights to international business destinations and facilitating foreign investment in the regional economy. This is distinct from international flights to vacation destinations like the Caribbean or Latin America. But this conclusion may be dependent on the particular case studies selected in this project.

Suggestions for Further Research

The Review Panel and the RFP asked that the research incorporate a consideration of not only how air service contributes to the major metrics of regional economic activity but to some related issues such as Quality of Life (QOL). It may seem intuitive that having access to a larger number of nonstop destinations may be more desirable from a QOL perspective, but the project team was unable to uncover research that included that metric as a specific contributor to a higher regional QOL in the U.S. or Europe. To the extent that air service is tied to QOL in industry publications, it is framed in terms of basic connectivity in less-developed areas. Further, in interviews with airport officials and regional stakeholders, none were able to state that the region's QOL was affected – positively or negatively – by changes in air service. The team found multiple instances in which regional stakeholder organizations' annual reports or strategic plans included QOL considerations, but none of those related to air transport.

Despite these findings, to the extent that air service contributes to a region's economic viability and sustainability, it seems to be a reasonable assumption. However, the project team believes that the issue could be explored in a more structured manner to investigate whether and to what extent communities might value air connectivity to a number of domestic and international destinations as a contributor to the region's QOL or desirability.

A second area of possible further research concerns the regional economic impact of ULCC service, especially as a point of origin. That ULCCs bring visitors to some (typically leisure) regions is widely recognized, and the effect on those economies of additional tourism spending is relatively well understood. However, the effect that ULCC service may have on those flights' points of origin is less well known. The assumption is that the majority of travelers on those flights are leisure-oriented. It is a commonly-held perception that ULCCs' patterns of flight operations are inconsistent with business travel, since ULCCs often operate less than daily service from points of origin to a given destination, and rarely offer multiple daily frequencies. Those flight frequencies may be acceptable for leisure travelers but not for business

passengers who demand greater frequencies. Thus, the question arises as to the contribution that the ULCCs make to the points of origin, whether for the local economy, the QOL and desirability of that region, and for airports' finances.

Third, for metropolitan areas served by multiple large airports (such as New York, Chicago, Los Angeles, Dallas, Houston, and Baltimore-Washington), the project team was unable to parse the effects of changes in air service at individual airports to changes in service at the individual airports serving those regions. Distinguishing the impacts of separate airports on a large metropolitan region would require extensive detailed information on air service options at all airports within the region (e.g., carriers serving each airport, nonstop domestic and international destinations, flight frequencies, aircraft types, airline strategies or business models, etc.), the locations of residential and business centers relative to each airport, barriers to movement within the region that can affect drive times to the airport (e.g., traffic, bridges), the economic structure of the region, and scores of other factors. This would be an exceptionally challenging modeling exercise, but one that would be of interest to many researchers, airports, and business interests.

Related to this would be an exploration of whether changes in international air service contributed to changes in foreign direct investment. If the above question was restricted to international service, the project would be more workable.

Finally, the team believes that more in-depth research about how changes in air service support new business activity, especially in aviation-reliant industries would be a valuable contribution to understanding aspects of business-oriented travel in certain industries. This may be especially relevant in a post-COVID travel world, when so much business activity has been handled virtually (i.e., by video conference).

Implementation Plan

This section summarizes the tactics that the project team proposes to facilitate implementation of the research results, describes the major institutions and organizations that will be important partners in that strategy, identifies potential impediments to the spread of information, and suggests some possible metrics by which the implementation can be assessed.

Recommended Tactics to Facilitate Implementation

The project team has developed a strategic roadmap (or flight plan) to promote the research to the airports, airlines, and regional development community. This follows ACRP's suggested 5-A structure:

- Awareness: How the project team will raise awareness to practitioners of the product as a reliable source of information.
- Availability: How the project team will help ensure that the research findings are readily available in a timely manner.
- Access: How practitioners will be able to find and access the information.
- Alignment: How to help practitioners understand that the research results align with their goals and objectives.
- Ability: How the project team assesses practitioners' abilities to use the information presented.

Awareness. The project team envisions a multi-stage effort, undertaken in cooperation with ACRP/TRB, to raise awareness of the research. This will involve announcements made through ACRP's regular press releases and weekly newsletters, along with announcements of upcoming webinars. The project team will

independently make announcements on the prime contractor's corporate website and via social media (such as LinkedIn). In addition, the project team will undertake a strategy of outreach to industry trade associations and other relevant groups (see section below on possible institutions/partners) to inform key staff and request opportunities to make presentations (either via webinars or in-person) at conferences or workshops. This will ensure that the widest audience of airport, airline, and regional economic development officials can be reached.

Availability and Access: The project's multiple deliverables (traditional ACRP report AND website) extend the availability of the products to a wide range of possible audiences, better ensuring that the information is readily available through different channels. So that different search engines might quickly identify the research, key search terms could be added to all product lines.

Alignment: Airports increasingly need to build alliances with community stakeholders to generate a wider base of support for various initiatives, including risk-sharing for new route development. Traditional airport-centric economic impact analyses fail to capture the benefits that commercial aviation brings to the community at large. This product's research and tools will serve as an important stepping stone to show airports how to develop the information and communicate it with those critical regional stakeholder organizations about the value of aviation.

The fact remains however that the analyses will likely not be something that airports themselves can undertake or complete. Each airport's regions of service will have geographic elements or characteristics that present unique analytic challenges. Many or most airports will need external assistance from universities or consulting firms.

Developing an online tool that would integrate the key air service and socio-economic data onto a single platform that any and all airports could use would seem to be a Herculean task of questionable cost-benefit. As an alternative measure, to the extent that the airport community can more widely understand and accept the value of an analysis that incorporates air service with regional business and economic activity, they will better facilitate widespread community support for the airport and air services. Developing more of a commonly-accepted template or approach to such an analysis would be an important step.

Ability: The project's key deliverable – the guide for airports – includes a primer on the topic, lists of key data and definitions of terms, case studies that serve as examples of the analysis of changes in air service and regional economic development, and suggestions for helping airports communicate the results of the analyses. Nevertheless, many airports may lack the human resources to undertake such analyses themselves, and some will also lack a financial ability to arrange for consultancies to assist. The airport community could consider engaging with local public universities and their faculty and graduate students to undertake the work as an applied research effort.

Possible Institutions/Partners and Their Implementation Role

The key institutions and partners include those tied to airports, airlines, and business/economic interests. This section offers an overview of their roles.

First, the major airport trade organizations – Airports Council International/North America and the American Association of Airports Executives – will likely be the greatest allies in promoting the research and urging their members to take account of the research. Both ACI-NA and AAAE hold regular conferences and workshops at which the research could be promoted. The project team would work closely with both associations to secure speaking roles on panels to review the project. Particular workshops and conferences of interest include:

- ACI-NA Marketing and Communications, National Conference,
- ACI-NA / AAAE Boards and Commissioners Conference,
- Regional AAAE conferences that emphasize air service development.

In addition, the airline trade associations (Airlines for America, the Regional Airline Association, and the National Air Carrier Association) may be interested in the research because it helps airports and regional economic development organizations better appreciate the value of air service. The firm will meet with officials at these associations to discuss the research and possible implications for their members. This could include participating on sponsored webinars and at annual meetings.

The National Association of State Aviation Officials (NASAO) is another important trade group that will be interested in the research. Because NASAO members are also officials with state governments, there is a natural symbiosis with the states' interests in economic development. The project team has delivered online webinars and in-person presentations at NASAO events and will seek to identify opportunities to use those platforms to reach state government audiences.

Finally, the project team believes that major business and economic development organizations will be interested, to the extent that air service can exert a catalytic impact on regional employment. The National Association of Development Organizations (NADO) provides advocacy, education, research, and training for the nation's regional development organizations. The association and its members promote regional strategies, partnerships, and solutions to strengthen the economic competitiveness and quality of life across America's local communities. The project team would reach out to NADO to explore opportunities to share the research with them, to spur interest and actions from this side of the equation.

Potential Impediments to Implementation

The project's key deliverable – the guide – includes a primer on the topic, lists of key data and definitions of terms, case studies that serve as examples of the analysis of changes in air service and regional economic development, and suggestions for helping airports communicate the results of the analyses. Nevertheless, many airports may not have the human resources to undertake such analyses themselves, and some will also not have the financial ability to arrange for consultancies to assist. The airport community could consider engaging with local public universities and their faculty and graduate students to undertake the work as an applied research effort.

Other possible impediments include trade associations not providing opportunities for making presentations on the research. The project team recognizes that there will be "first-mover" advantages for the associations or groups first willing to host a presentation and declining interest levels over time. However, because the membership of the associations – airports v. airlines v. regional development organizations – differs, there should be a large section of the potential audiences that were not yet aware of the research, meaning that the material will remain "fresh" for some time.

A related potential impediment to widespread implementation is that many commercial service airports – especially those serving small communities (small and nonhub airports) – rely only on statewide airport/aviation economic impact studies to gather information on and analyze the effect of their facilities. Those statewide efforts occur only every few years. As a result, because the large majority of commercial service airports in the U.S. are small and nonhub facilities, it will be years before they are potential targets of analysis. Then, only if the project scope includes a specific requirement that the regional impact of air service on aviation-reliant industries will these assessments be conducted for those facilities.

Metrics to measure extent of product use and benefit

The project team suggests the following as initial measures of the extent of project use:

- Download counts
- Physical copy requests
- Counts of online tool (website) hits and downloads

Project team members and the prime contractor can also record the number of related phone calls, hits on the website, and email requests related to the research.

Ultimately, the adoption of the broader research in airports' economic impact assessments is expected to be incremental. As the research indicated, most airports do not publicize their existing economic impact studies, and those studies now being conducted generally fail to incorporate considerations o regional economic impact. It will likely be several years before statewide and local airports' economic studies begin to more widely bring these considerations into their scope.

APPENDIX I

Summary of Background Research

Summary of Background Research

Early Research on Air Service and Employment

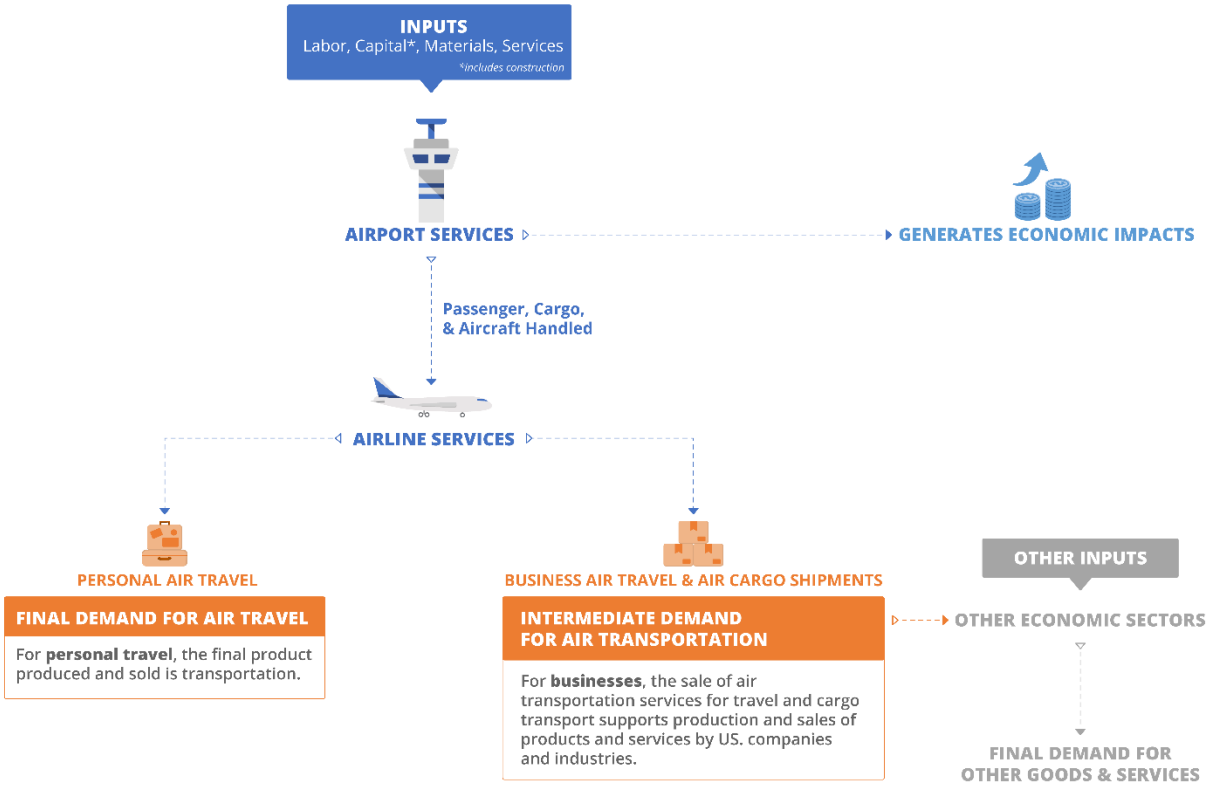
Many academic researchers have written about the relationships between air service and economic activity. For example, Bruekner (2003) found a correlation between air service and total employment in metropolitan areas, reporting that a 10 percent increase in passenger traffic raises total employment by 0.9 percent and service employment (defined as those wholesale and retail trade; finance, insurance; and real estate; services; government transportation; and public utilities employment) by 1.1 percent suggesting employment gains far beyond the airport.

McGraw (2015) examined the effects of commercial airports on local economies for the 60-year period 1950–2010. Focused on airports in midsized and smaller cities, the analysis found that the presence of airports in these communities contributed to an average of 3.9 percent growth in total employment (and 3.4 percent growth in population) per decade. Effects on wages and job creation in airport cities were also observed, on the order of 1 to 3 percent per decade. That the conclusion concerns airports serving areas that are not major metropolitan regions is also generally consistent with an earlier finding from Button, Doh, and Yuan (2010), who reported that for a sample of 66 small airports in Virginia, doubling passenger traffic produced up to a 4 percent increase in per capita income.

Bilotkach (2015), examining 17 years of data on air service and U.S. MSAs, found that the number of destinations served by non-stop flights has robust positive impact on the total number of jobs, number of business establishments, and average wages. Further, adding flights to a new destination generated more economic effects than adding capacity to an existing destination. At the sample median, connecting an MSA with an extra destination, keeping everything else constant, created 223 jobs and 15 new business establishments.

ACRP Report 132 examined how air service improvements between regions and selected international markets could benefit the U.S. economy. Figure A-1 illustrates the role of airports in the national economy. Airports facilitate services to businesses and personal travelers by providing passenger transportation and rapid long distance cargo movement. For businesses, passenger and cargo transportation services are intermediate purchases used to facilitate production or sales. For example, a company may acquire an electronic component that is part of a larger product. After production, that product may be sent by air to a customer. For personal travel, however, the final product that is being purchased is air transportation.

Figure A-1: Airports' Role in the U.S. Economy



Source: Adapted from *ACRP Report 132*

Air Service and Employment in Specific Industry Sectors

Building on the initial studies that linked air service and regional economic development, researchers began to refine the analyses to link air transport and particular sectors of the economy. Certain industry sectors have a relatively great reliance on air transport as a part of their business.

Over 20 years ago, Button and Taylor (2000) found a nexus between air service and economic development. Examining changes in international air service associated with Open Skies agreements and employment in areas around U.S. airports that were served with nonstop flights to European Union markets. Regions that had those flights attracted, retained or generated more "new economy" employment than those without such flight services. 'New economy' employment was defined to include industrial categories where there are location choices (e.g., not extractive industries) that could potentially be influenced by the quality of local transportation services. Both the number of international destinations served and the quality of service had impacts on employment.

Others have argued that post-industrial cities that have experienced a rapid growth in information-intensive producer services like information technology (IT), professional, scientific and technical (PST)

activities, and finance, insurance and real estate (FIRE) will require more efficient air transport links due to the increased demand for face-to-face contact. An early study from Debbage and Delk (2001) investigated the relationship between air service and total employment in "administrative and auxiliary" fields (i.e., workers engaged in activities such as management, research and development, financial services and supporting services such as accounting and data processing).

Alkaabi and Debbage (2007) analyzed the links between passenger enplanements and employment and the number of firms in certain specific sectors: PST; computer and electronic product manufacturing; and computer systems design and related services. They reported a strong linear relationship between air passenger demand and the percent of an MSA's PST employment, but less clear relationships with employment in the other sectors. This study did not include FAA-defined nonhub airports, and it did not address the question of causality.

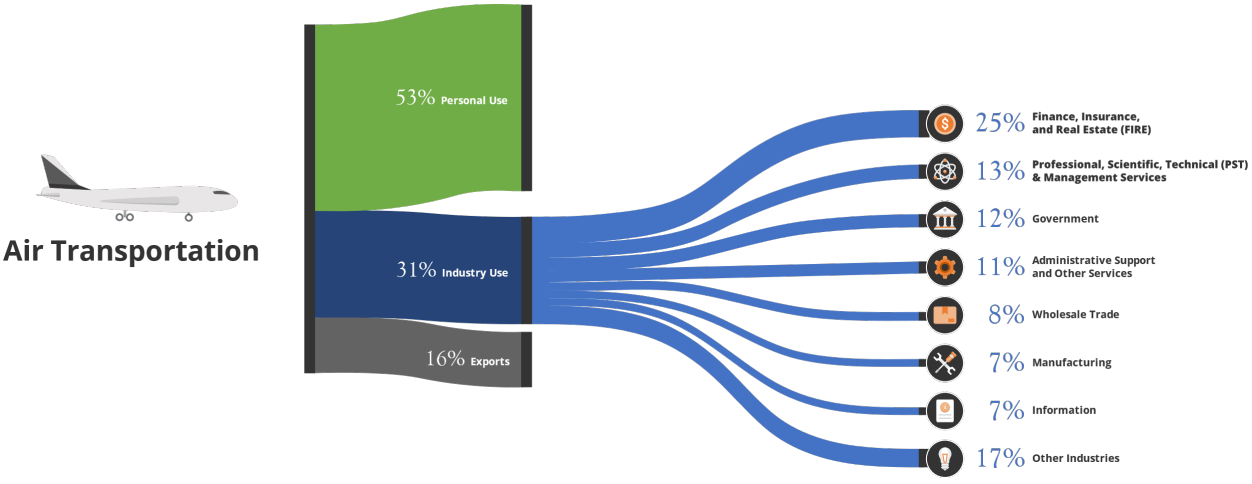
Bloningen and Cristea (2012) found significant relationships between air service and employment growth in service and trade-related industries. Using data for 263 MSAs over two decades, they estimated the effects of airline traffic on local population, income, and employment growth. Their findings suggested that increases in air service led to statistically and economically significant increases in regional growth. They reported that a 50 percent increase in the air passenger growth rate leads to a 3.2 percent increase in the annual rate of per-capita income growth, on average. The results are statistically significant regardless of hub size. Air traffic changes also have a positive and significant effect on the growth in the number of local businesses. A 50 percent increase in the air passenger growth rate leads to a 5.5 percent increase in the annual rate of employment, on average. Increases in the air traffic growth rate can also lead to an increase in the growth of the number of firms.

Sheard (2014) extended the analysis to cover the relationship between air service and "tradeable services" (i.e., services that could be produced locally but consumed outside the area, such as insurance, financial services; or professional, scientific, and technical services). The author found that airport size had a positive effect on the employment share of tradable services, controlling for overall local employment. A 10 percent increase in air traffic would generate 1,650 additional service jobs in MSA with 1 million residents or more but found no measurable effect on employment in manufacturing or most non-tradable services. The effect of airport size on overall local employment is practically zero, suggesting that airports lead to specialization but not growth at the metropolitan scale.

Even with the pandemic and recent technological innovations (e.g., Zoom) that may minimize the need for direct face-to-face contact, economic sectors like IT, PST and FIRE will still rely heavily on direct contact long-term with colleagues, suppliers, and other key employees. Furthermore, cities that have many point-to-point routes on different carriers and have local economies that have labor pools with a high propensity to fly tend to be good candidates for air service market growth (Liu et al., 2006).

Figure A-2 summarizes the end users of commercial air services. Most users are individuals traveling for personal (leisure) purposes; 53 percent of travel purchases are for personal reasons. Another 16 percent is exported (need to define). And the remaining 31 percent are used by industry as an input to the development of their goods or services. It is this 31 percent that is associated with regional economic activity outside of the tourism and hospitality sectors.

Figure A-2: The End Users of Commercial Air Transport



Quantifying the Value of Connectivity

Similarly, a study on the economic impact of aviation connectivity published by the United Kingdom's Airports Commission of the United Kingdom (2013) reported positive benefits of enhanced international connectivity, especially for economic clusters considered "high value." International connectivity is important in attracting international business headquarters and foreign investment into the U.K. London's connectivity helps sustain and attract employment in the "high-value" clusters including the finance, legal, information technology consulting, business management and chemical sectors. "[G]ood aviation links facilitate trade and investment, enhances communications and business interactions and improve efficiency through time savings, reduced costs and better reliability" (pp. 12-13).

In 2013, researchers at the Massachusetts Institute of Technology (MIT) created an index of connectivity -- the Airport Connectivity Quality Index (ACQI) – that computed airport connectivity as a function of the frequency of available scheduled flights, the quantity and quality of destinations served, and the quantity and quality of connecting destinations. This model considers connecting opportunities from a given airport as well as the quality of destinations served, such that an additional flight to a large city or a major connecting hub is more valuable than an additional flight to a smaller community with limited connecting options.

In 2015, Allroggen, Wittman, and Malina created a measure of connectivity – the Global Connectivity Index (GCI) – that takes into account the "quality" and interaction potential of both the point of connection and destination. The quality of a connecting point depends on the frequency of flights from the point of origin to the connecting point and the length of time that a passenger must wait until the next flight departs. The quality of the destination reflects the potential for economic interactions at that location. "[A]nalyses of the economic growth and employment effects of aviation would benefit from incorporating a connectivity metric, since the metric reflects the degree of access to other regions facilitated through air transport services." (p. 45)

Similar findings have been reported in other studies of connectivity. A study from the consulting firm PriceWaterhouseCoopers (2017) reported on the importance of connectivity to unlocking a country's economic growth potential, in part because it enables the country to attract business investment and human

capital. Improving air connectivity also supports additional tourism, which is vital to many countries' economic prosperity. This report also acknowledged other indices of connectivity beyond IATA's, most of which emphasize the capacity to nonstop destinations and the number of onward connections to points beyond the hub. For example, the York Aviation Business Connectivity Index (BCI) captures the economic importance of destinations and measures value of connectivity to businesses. The BCI considers the value of each destination city in an airport's route network in terms of the city's economic status, as defined by its ranking in the Globalization and World Cities (GaWC) Research Network ranking of "world cities," and the ease with which it can be reached in terms of frequency. The GaWC list of 314 world cities includes 39 U.S. and seven Canadian cities, which largely correspond with the largest airports.

APPENDIX II

References

Academic

Albayrak, M.B.K., Ozcan, I.C., Can, R. & F. Dobruszkes. 2020. "The Determinants of Air Passenger Traffic at Turkish Airports." *Journal of Air Transport Management*, Vol. 86, https://doi.org/10.1016/j.jairtraman.2020.101818.

Alkaabi, K.A. & K.G. Debbage. 2013. "The Promise of the Aerotropolis Model in the United Arab Emirates: The Role of Spatial Proximity and Global Connectivity." *The Arab World Geographer* Vol. 16, No. 3, pp. 289-312. https://doi.org/10.5555/arwg.16.3.g61n13n43m1p365q.

Alkaabi, K.A. & K. Debbage. 2011. "The Geography of Air Freight: Connections to U.S. Metropolitan Economies." *Journal of Air Transport Geography*, Vol. 19, pp. 1517-1529. https://doi.org/10.1016/j.jtrangeo.2011.04.004.

Alkaabi K.A. & K. Debbage. 2007. "Air Passenger Demand and Skilled Labor Markets by U.S. Metropolitan Area." *Journal of Air Transport Management*, Vol. 13, pp. 121-130. https://doi.org/10.1016/j.jairtraman.2006.11.006.

Audretsch, D. B., Dohse, D., & Niebuhr, A. (2010). "Cultural diversity and entrepreneurship: A Regional Analysis for Germany," *Annals of Regional Science*, Vol 45, 55–85.

Azadian, F. 2020. "Assessing the Effects of Urban Socioeconomic Factors and the Financial Crisis of 2008 on Domestic Air Cargo Traffic in Florida." *Transportation*, Vol. 47, pp. 223-241. https://doi.org/10.1007/s11116-018-9872-9.

Blonigen, B.A. & A.D.Cristea. 2012. "Airports and Urban Growth: Evidence from a Quasi-Natural Policy Experiment." *National Bureau of Economic Research*, Working Paper 18278, Cambridge: Mass. https://www.nber.org/system/files/working_papers/w18278/w18278.pdf.

Brueckner, J.K. 2003. "Airline Traffic and Urban Economic Development." *Urban Studies* Vol. 40, No. 8, pp. 1455-1469. https://www.jstor.org/stable/43100460.

Button, K., Lall, S., Stough, R. & M. Trice. 1999. "High-technology Employment and Hub Airports." *Journal of Air Transport Management*, Vol. 5, pp. 53-59. https://doi.org/10.1016/S0969-6997(98)00038-6.

Button, K. & J. Yuan. 2013. "Air Freight Transport and Economic Development: An Examination of Causality." *Urban Studies*, Vol. 50, No. 2, pp. 329-340. https://doi.org/10.1177/0042098012446999.

Cidell, J. 2015. "The Role of Major Infrastructure in Sub-Regional Economic Development: An Empirical Study of Airports and Cities." *Journal of Economic Geography*, Vol. 15, pp. 1125-1144. https://doi.org/10.1093/jeg/lbu029.

Conventz, S., Derudder, B., Thierstein, A. & F. Witlox. *Hub Cities in the Knowledge Economy: Seaports, Airports, Brainport*. Routledge, London, England. https://doi.org/10.4324/9781315587264.

Cotti, C. & Johnson, M. 2012 "Teaching Economics Using Historical Novels: Jonathan Harr's The Lost Painting ". T*he Journal of Economic Education,* Vol.43, No.3, pp.269-281. https://doi.org/10.1080/00220485.2012.686391.

Debbage, K. 1999. "Air Transportation and Urban-Economic Restructuring: Competitive Advantage in the U.S. Carolinas." *Journal of Air Transport Management*, Vol. 5, pp. 211-221. https://doi.org/10.1016/S0969-6997(99)00015-0.

Debbage, K. & D. Drake. 2001. "The Geography of Air Passenger Volume and Local Employment Patterns by U.S. Metropolitan Area." *Journal of Air Transport Management*, Vol. 7, No. 3, pp. 159-167. https://doi.org/10.1016/S0969-6997(00)00045-4.

Derudder, B., Van de Vijver, E. & F. Witlox. 2016. "Knowledge Flows and Connectivity in the Global Economy: An Exploration of the Related Geographies of Producer Services and Air Passenger Markets."

Dobrusczkes, F., Lennert, M. & G. Van Hamme. 2011. "An Analysis of the Determinants of Air Traffic Volume for European Metropolitan Areas." *Journal of Transport Geography*, Vol. 19, pp. 755-762. https://doi.org/10.1016/j.jtrangeo.2010.09.003.

Dobrusczkes, F. and G. Van Hamme. 2011. "The Impact of the Current Economic Crisis on the Geography of Air Traffic Volumes: An Empirical Analysis." *Journal of Transport Geography*, Vol. 19, pp. 1387-1398. https://doi.org/10.1016/j.jtrangeo.2011.07.015.

Florida, R. (2002). The Rise of the Creative Class. New York: Basic Books.

Florida, R., Mellander, C., & Stolarick, K. (2008). "Inside the Black Box of Regional Development—Human Capital, The Creative Class and Tolerance," *Journal of Economic Geography*, Vol. 8, 615–649.

Florida, R., Mellander, C. & T. Holgersson. 2014. "Up in the Air: The Role of Airports for Regional Economic Development." *The Annals of Regional Science*, Vol. 54, pp. 197-214. https://doi.org/10.1007/s00168-014-0651-z.

Green, R.K. 2007. "Airports and Economic Development." *Real Estate Economics*, Vol. 1, pp. 91-112. https://doi.org/10.1111/j.1540-6229.2007.00183.x.

Grubesic, T.H. 2010. "Spatial Variations in Broadband and Air Passenger Service in the United States." *Geojournal*, Vol. 75, pp. 57-77. https://www.jstor.org/stable/i40050926.

Ho, D. & Niah, S. 2017. " Effectiveness of Audio-Visual Aids in Teaching Lower Secondary Science in a Rural Secondary School ". *Asia-Pacific Journal of Educators and Education*, Vol.32, pp. 91-106. https://doi.org/10.21315/apjee2017.32.7.

Ivy, R.L., Fik, T.J. & E.J. Malecki. 1995. "Changes in Air Service Connectivity and Employment." *Environment and Planning A*, Vol. 27, pp. 165-179. https://doi.org/10.1068/a270165.

Krugman, Paul et al. (2005). *Microeconomics, Canadian Edition*. New York, United States. Worth Publishing.

Lakew, P.A. 2015. "Airport Traffic and Metropolitan Economies: Determinants of Passenger and Cargo Traffic." *Transportation Research Record: Journal of the Transportation Research Board*, No. 2471, pp. 58-72. https://doi.org/10.3141/2471-08.

Lakew, P.A. & Y.C.A.Tok. 2015. "Determinants of Air Cargo Traffic in California." *Transportation Research Part A: Policy and Practice*, Vol. 80, pp. 134-150. https://doi.org/10.1016/j.tra.2015.07.005.

Liu, Z.J., Debbage, K. & B. Blackburn. 2006. "Locational Determinants of Major U.S. Major Air Passenger Markets by Metropolitan Area." *Journal of Air Transport Management*, Vol. 12, pp. 331-341. https://doi.org/10.1016/j.jairtraman.2006.08.001.

Mathew, G. N., et al. 2013. "A Study on the Usefulness of Audio-Visual Aids in EFL Classroom: Implications for Effective Instruction". *Journal of Higher Education*, Vol.2, No.2, pp. 86-92.

Moryl, R., et al. 2020. " Podcasts as a Tool for Teaching Economics". Journal of Economic Education, Vol.45, No. 2, pp. 284-285. Accessed via: https://www.abacademies.org/articles/jeeervol17no12016.pdf.

Mosbah, S. & M.S. Ryerson. 2016. "Can U.S. Metropolitan Areas Use Large Commercial Airports as Tools to Bolster Regional Economic Growth." *Journal of Planning Literature*, Vol. 31, No. 3, pp. 317-333. https://doi.org/10.1177/0885412216653100.

Neal, Z.P. 2011. "The Causal Relationship Between Employment and Business Networks in U.S. Cities." *Journal of Urban Affairs*, Vol. 33, No. 2, pp. 167-184. https://doi.org/10.1111/j.1467-9906.2010.00538.x.

Neal, Z. 2012. "Creative Employment and Jet Set Cities: Disentangling Causal Effects." *Urban Studies*, Vol. 49, No. 12, pp. 2693-2709. https://doi.org/10.1177/0042098011431282.

Ozcan, I.C. 2014. "Economic Contribution of Essential Air Service Flights on Small and Remote Communities." *Journal of Air Transport Management*, Vol. 34, pp. 24-29. https://doi.org/10.1016/j.jairtraman.2013.07.005.

Shabiralyani, G., et al. 2015. "Impact of Visual Aids in Enhancing the Learning Process". *Journal of Education and Practice*, Vol.6, No.19, pp. 226-233.

Sheard, N. 2014. "Airports and Urban Sectoral Employment." *Journal of Urban Economics*, Vol. 80, pp. 133-152. https://doi.org/10.1016/j.jue.2014.01.002.

Storper, M., & Scott, A. J. (2009). "Rethinking Human Capital, Creativity and Urban Growth," *Journal of Economic Geography*, Vol. 9, 147–167.

Van de Vijver, E., DeRudder, B. & F. Witlox. 2016. "Air Passenger Transport and Regional Development: Cause and Effect in Europe." *Traffic and Transportation*, Vol. 28, pp. 143-154. https://doi.org/10.7307/ptt.v28i2.1756.

Watts, M. and Christopher, C. 2012. "Using Art (Paintings, Drawings and Engravings) To Teach Economics". *The Journal of Economic Education, vol.43, no.4, pp.408-422.* https://doi.org/10.1080/00220485.2012.714317.

Wooten, J., et al. 2020. "Economics within ABC's Modern Family". *Journal of Economic Education*, Vol.51, No. 2.

Industry and Government

Airports Commission of the United Kingdom. 2013. *Aviation Connectivity and the Economy*. Government of the United Kingdom.

Caribbean Development Bank. 2018. *Air Transport Competitiveness and Connectivity*. Caribbean Development Bank. https://www.caribank.org/publications-and-resources/resource-library/working-papers/air-transport-competitiveness-and-connectivity-caribbean.

Cooper, A. and Smith, P. 2002. *The Economic Catalytic Effects of Air Transport in Europe*. EUROCONTROL Experimental Centre.

Federal Aviation Administration. The Economic Impact of Civil Aviation on the U.S. Economy, (multiple years).

Federal Reserve Bank of Minneapolis. 1998. *Why it's important to Understand Economics*. Accessed at: https://www.minneapolisfed.org/article/1998/why-its-important-to-understand-economics

International Air Transportation Authority. 2006. *Airline Network Benefits*.

International Air Transportation Authority. 2007. Aviation Economic Benefits, IATA Economics Briefing No. 8, Measuring the economic rate of return on investment in the aviation industry. https://www.iata.org/en/iata-repository/publications/economic-reports/aviation-economic-benefits/.

International Civil Aviation Organization, Industry High Level Group, *Aviation Benefits Report 2019*. **https://www.icao.int/sustainability/Documents/AVIATION-BENEFITS-2019-web.pdf**

National Academies of Sciences, Engineering, and Medicine 2013. *Understanding Airline and Passenger Choice in Multi-Airport Regions*. Washington, DC: The National Academies Press. https://doi.org/10.17226/22443.

National Academies of Sciences, Engineering, and Medicine. 2014. *Estimating the Economic Impact of Air Cargo Operations at Airports, Part 1: User's Guidebook and Part 2: Research Report.* Washington, DC: The National Academies Press. https://doi.org/10.17226/22235.

National Academies of Sciences, Engineering, and Medicine. 2015. *Effects of Airline Industry Changes on Small- and Non-Hub Airports.* Washington, DC: The National Academies Press. https://doi.org/10.17226/21909.

National Academies of Sciences, Engineering, and Medicine. 2015a. *Guidebook for Air Cargo Facility Planning and Development.* Washington, DC: The National Academies Press. https://doi.org/10.17226/21906.

National Academies of Sciences, Engineering, and Medicine. 2015b. *The Role of U.S. Airports in the National Economy.* Washington, DC: The National Academies Press. https://doi.org/10.17226/22146.

NERA Economic Consulting. 2008 *The Impact of International Air Transport Liberalisation on Employment.* https://www.iata.org/en/iata-repository/publications/economic-reports/liberalization-and-employment/.

Oxford Economics. 2015. *Impacts of the UK Economy Through the Provision of International Connectivity.* https://www.gihub.org/resources/publications/impacts-on-the-uk-economy-through-the-provision-of-international-connectivity/.

Oxford Economics. 2003. *The Contribution of Air Transport to Sustainable Development in Africa*. https://www.icao.int/Meetings/wrdss2011/Documents/JointWorkshop2005/ATAG_AfricaStudy1.pdf.

PriceWaterhouseCoopers. 2017. *Connectivity and Growth 2017 Edition*. https://www.pwc.com/gx/en/industries/assets/connectivity-and-growth-2017-edition.pdf.

Purdue University. 2018, February. *Using Art to Teach Economics: Introduction.* PowerPoint slides]. Retrieved July 28, 2020, from: https://intra.krannert.purdue.edu/sites/econandart/_layouts/15/WopiFrame.aspx?sourcedoc=/sites/econandart/Documents/Slideshows/Introduction.pptx&action=default.

SEO Economics. 2016. *Economic Benefits of European Airspace Modernization*. https://www.iata.org/contentassets/66e31e4aa82e4741b23f85e3c866836d/european-airspace-modernization.pdf.

Sparks Bureau of Business and Economic Research. 2017. *An Economic Assessment of the Impact of the Memphis International Airport.* Fogelman College of Business & Economics, University of Memphis. https://flymemphis.com/wp-content/uploads/2019/11/2017-Economic-Impact-Report.pdf.

The White House, Office of Management and Budget, Statistical Programs and Standards (https://www.whitehouse.gov/omb/information-regulatory-affairs/statistical-programs-standards/).