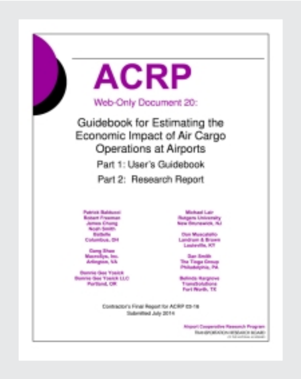
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Guidebook for Estimating the Economic Impact of Air Cargo Operations at Airports

Part 1: User's Guidebook

Part 2: Research Report

Estimating the Economic Impact of Air Cargo Operations at Airports, Part 1: User's Guidebook and Part 2: Research Report

DETAILS

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1 SECTION I – INTRODUCTION AND PURPOSE

1.1 Introduction

Air cargo services occupy a special place in modern supply chains, carrying the most valuable, most perishable, and most urgent shipments across the nation and the world. From necessities such as pharmaceuticals to luxuries such as exotic flowers, air cargo services shrink time and space to link customers to distance sources quickly, efficiently, and reliably. Air cargo keeps assembly lines rolling and remote communities connected. At the same time, air cargo service enables U.S. businesses large and small to communicate and compete in global markets.

Air cargo facilities and operations likewise occupy a special niche in the communities they serve. International airports are large, costly facilities with a major presence in a metropolitan area. Even smaller regional airports are prominent fixtures in their markets. The air cargo niche reaches beyond airport boundaries to include integrated carriers, air freight forwarders, air freight truckers, ground handlers, and their customers. These stakeholders together constitute an industry that, unlike highway trucking or freight railroads, are largely behind the scenes.

Despite its essential nature, air cargo service and the facilities it needs may be undervalued by the public sector. The general public is typically aware of integrated carriers such as FedEx and UPS, but lacks familiarity with the more complex interaction between air cargo carriers and the local economy. Airline passengers have little awareness of what goods are travelling beneath them as “belly cargo”, or of what round-the-clock activities are necessary to support those shipments.

Airport authorities and air cargo stakeholders have periodic needs to demonstrate the public value of their activities and facilities. In this era of limited resources, public planners, elected officials, and legislators are forced to choose among competing transportation investment proposals, and need help in making good decisions. Complexity, specialization, and public unfamiliarity can place the air cargo industry at a disadvantage compared to more familiar transport modes. In one sense everyone who sends an overnight package is an air cargo shipper. Yet conventional approaches to air cargo data and analysis have underestimated the value of air cargo shipments and the economic importance of the air cargo industry.

Regional planners and state transportation officials likewise have goods movement responsibilities that span air cargo service and facilities, but may have little experience in the field and no time to learn it in the face of looming deadlines. Approaches that work well when applied to passenger modes or other freight modes may yield misleading results when applied to air cargo.

Logistics factors, including access to air cargo service, are increasingly prominent in industrial and commercial location decisions. As economic development agencies strive to attract and retain employers to their cities and regions, they have a concomitant need to understand the impact of air cargo service on regional competiveness.

This Guidebook and the companion project report were therefore commissioned by the Airport Cooperative Reproach Program to fill the need for economic impact estimation tools that public and private practitioners can apply to the air cargo industry.

1.2 Purpose of This Guidebook

This Guidebook was developed to assist airport authorities, air cargo operators, and public sector planners in establishing the value of air cargo facilities and operations to their communities and regions. The primary metric of this value is economic impact: the direct, indirect, and induced income and employment generated by the industry. The primary tools are economic impact models that use available data to answer the questions posed by practitioners.

The Guidebook addresses several dimensions of economic impact and value creation:

- The structure of the air cargo industry and its role in the supply chain.
- The size of air cargo facilities and operations relative to the region and market they serve.
- The nature of air cargo services, and their linkage to local industry and economic activity.
- Air cargo industry response to changing economic conditions, particularly the price of fuel and evolving security requirements.
- The relative cost and service characteristics of alternate shipping modes (e.g. truck).

Airports and air cargo services differ widely, so the tools and techniques presented in this Guidebook are flexible in their application. The basic tools offered include:

- A discussion of economic impact models and their application to the air cargo industry.
- A discussion of data collection and survey techniques to support the impact analysis.
- Demand elasticity models for fuel cost impacts and security screening impacts
- A simplified model for estimating economic impact.

The Guidebook also presents selected case studies involving air cargo economic impact assessments for five airports. These case studies have been chosen to illustrate the application of analytic tools for airports that vary in size, air cargo volumes, and regional context.

1.3 The Air Cargo Industry and Its Role in the Supply Chain

The air cargo industry has become an increasingly important sector in the transportation service industry. Indeed, it plays a key role in the globalization and evolution of supply chains and has enabled supply chain managers to shrink their firms' "time-space continuum." That is, geographically dispersed and distant markets are being served in ever-less time, overcoming such obstacles as perishability, inventory requirements, stringent order and replenishment lead times, and high inventory-carrying costs. Firms are thereby able to cover wider markets both nationally and internationally because air cargo makes it possible for them to quickly fulfill the needs of their customers in a cost-effective manner.

Part of the air cargo industry's success can be attributed to the growth of internet and web applications, which have driven supply chains to new levels of efficiency. This is not only due to the speed of communication, but also to more efficient inventory management and lower net production and delivery costs. The use of air cargo also enables efficient supply-chain strategies—such as just-in-time (J-I-T) and postponement—by reducing carrying costs through lower inventory requirements. It further enables sellers to take advantage of both lower-cost labor markets and economies of scale in production, since they are now able to produce farther from their markets. Thus, air freight's more responsive service justifies higher costs for many commodities. It has also enabled the growth of value-added services offered by third-party logistics (3PLs) providers and integrators.

Visible examples illustrating contributions of the air cargo industry in the global supply chain include:

- Helping to speed time-sensitive products to market
- Improving the reliability of assembly lines by enabling rapid, JIT delivery of parts for processing machinery as well as production inputs.
- Delivering quick-order, bio-medical products and equipment to hospital emergency wards and operating rooms
- Deploying large project equipment to remote airfields
- Enabling small businesses across America to compete in major foreign markets
- Enabling remote communities and installations without surface transportation to timely access supplies and life safety products necessary for productive and healthy lives.

Participants of the Air Cargo Industry

Air cargo services are provided to customers in a highly complex and competitive environment to producers. Many parties are involved to ensure air cargo is shipped on time and safely from one place to another, either domestically or internationally. Parties such as freight forwarders, 3PLs, airlines, airports, ground handlers, and truckers are responsible for packing and transporting commodities to and from airports, or on and off aircraft. Below are brief descriptions of the services provided by each of the key industry participants:

- Airports—offer infrastructure and services to air carriers for transporting and sorting commodities; such as runways/taxiways, aircraft parking, cargo handling land and facilities, roads and utilities, cargo security, aircraft maintenance, and other support.

- Airlines—provide airport-to-airport freight services either via lower deck space on passenger aircraft or via all-cargo freighter space using both scheduled and supplemental or charter services; provide pickup and delivery services in airport regions or to more distant markets.

- Air cargo terminals—process air cargo and mail that is transferred between air carriers, trucks, trains, and marine vessels. The terminals may be operated by airports, air carriers, surface transportation carriers, or third parties.

- Air freight forwarders and 3PLs—provide consignment, transportation handling, documentation services to shippers and consigners, as well as value-added logistics, transportation, and trade services. The largest are global companies that also offer truck, maritime steamship, barge, and rail services.

- General sales agents—sell air freight capacity on behalf of airlines.

- Integrators—offer direct selling of door-to-door services to businesses and individuals based on time-definite products handling shipment sizes from letters to heavy cargo that are comprised of a mix of air, truck and intermodal. Integrators typically own and operate aircraft or lease on a dedicated basis.

- Consolidators—work with or may function as a freight forwarder providing assembly points for cargo prior to its delivery to a carrier on the airport.

- Container freight stations—are typically located off-airport and handle the breakdown of inbound international freight. Their function is similar to a consolidator (see above) in that they provide space for short-term storage and redistribution to a number of clients.

- Ground handlers—provide aircraft loading/unloading, short-term freight storage, fueling, technical maintenance, deicing, crew support, and liaison with support parties.

- Air cargo truckers—specialize in road transportation services for air freight shipments, typically requiring specialized roller-bed equipment.

- Brokers—buy capacity from airlines and sell it to small- and medium-sized forwarders.

- Customs brokers—assist importers and exporters in meeting federal requirements governing imports and exports.

Trends in the Air Cargo Industry

The U.S. air cargo industry handles 32.7 percent of exports and 27.6 percent of imports by value, and 0.5 percent of exports and 0.7 percent by weight of the nation's freight transportation, according to data reported by the Freight Analysis Framework (FAF). Comparatively, trucking represented the largest mode by both weight (61.6 percent) and by value (54.7 percent). The percentage of U.S. commodity value, including import and export, shipping by air freight grew from 6.5 percent in 2007 to 7.3 percent in 2011, and is forecast to reach 12.8 percent by 2040 (US DOT 2012).

When benchmarking against other modes, a commodity's value/weight ratio is clearly a key indicator of its propensity to be shipped by air. The higher relative value of air cargo supports the premise that air freight's benefit of reliable, quick service justifies its higher cost.

This justification is especially poignant for overseas trade where the only alternative mode of freight shipment is water transportation, which is the most inexpensive and slowest freight transport mode.

When compared to exports and domestic activities, exports represent the highest share of air cargo activity. Exports held a 32.7 percent share by value in 2011, which was a higher share relative to imports (27.6 percent) and domestic (1.2 percent) cargo shipping. While the domestic market is dominated by a few integrators, international traffic has many more airlines involved. The decision criteria for domestic and import traffic, which is discussed in a later section, are quite different.

In terms of annual growth rates, U.S. air cargo grew 3.1 percent by value and 7.5 percent by weight from 2007 to 2011. The annual growth rates for air cargo are higher than the growth rates in the same period for total U.S. freight transported, which are 0.2 percent by value and -1.7 percent by weight. Also, the annual growth rates for air cargo are higher than the growth rates of freight transported by trucks, which declined in terms of both weight and value. During this period, an economic recession resulted in the slowing of economic forces that generate demand for shipping. A number of factors caused a more significant growth in air cargo relative to other modes. Whether that will be a short- or long-term phenomenon remains to be seen; however, Freight Analysis Framework (FAF) forecasts suggest the trends is expected to continue, though at a slower pace, through 2040.

Air Cargo Success Factors

As the industry undergoes major changes, the basic ingredients of an airport's successful air cargo operation have remained essentially intact. These factors have played major roles in the success of gateways to date. However, as airports mature, regional growth and evolving goods movement dynamics may negatively impact the airport's ability to meet the needs of the air cargo industry, and eventually force shifts in operations to alternate facilities. In looking at these factors, there are indications that growing challenges develop as airports mature. The challenges create opportunities to be explored regarding more efficient utilization of existing airport assets as well as development of new facilities and infrastructure.

Substantial passenger market – both Origin & Destination and transfers: Despite their interest in air cargo, the gateways all stress that one of their top priorities is maintaining a preeminent position in passenger traffic. To grow this segment of the business will require an airport to accommodate substantial amounts of belly cargo and, in the instances of carriers that fly both passenger and freighter aircraft, provide adequate aircraft apron for the freighter component of the business. Given the existing high levels of passenger activity, and the projected growth for the industry, most of the national gateways are well positioned to achieve this goal and have the physical capacity to address physical constraints.

Large regional consuming and producing marketplace: The large and growing population of a gateway city and the surrounding region, along with the city's interest in the promotion of logistics and the related jobs generates substantial volumes of both inbound and outbound freight. Trade flows to Europe and to Asia typically favor exports and imports respectively as a result of international monetary standards. This creates shortfalls in outbound shipments to Asia and inbound product from Europe. A balance is critical to the financial success of a cargo operation. The flow of cargo to and from certain global regions will vary based on economic trends. In the event the economics substantially decrease in either direction, there is a strong probability that cargo in general and freighter traffic in particular will be reduced accordingly. The challenge for a region is to create an operating environment with sufficient financial benefits to attract products from the surrounding region. Air cargo business reacts to economies of scale; large volumes enable all parties to reduce costs and potentially pass on savings to customers.

Substantial lift to a large number of markets: A substantial number of operations to global markets and sufficient volumes of cargo to each destination enables shippers to consolidate shipments thus reducing overall shipping rates. Gateways have a large and diverse user universe that enables efficient interlining between passenger and freighter aircraft with a resultant global outreach. Forwarders are attracted to larger facilities because of the ability to backstop flights with other options in the event the targeted flight is missed. The other major element of this factor is that the amount of lifts and the competition helps control costs.

Supporting business infrastructure of freight forwarders, customs brokers, and trucking: While integrated carriers control the vast majority of domestic cargo shipments, freight forwarders and customs brokers control the majority of the international market. Although this split has remained fairly consistent, the role of forwarders in domestic shipping continues to shrink and the integrators are pursuing a larger share of the international business as well. Typically, these segments of the industry cluster on or near the transportation facility they wish to utilize. The result is the existence in the areas immediately surrounding the airport of substantial square footage of logistics facilities. Many gateways also have expanded supporting business infrastructure reflecting related ocean-borne shipping that is served by regional customs brokers and freight forwarders. In an ideal environment many of these supporting businesses would prefer to locate on-airport (space permitting) to help reduce operating costs. Historically, the biggest issues are the inability of an airport to sell property and the comparative high leasing costs of on- versus off-airport property.

Roadway infrastructure providing ready access to the airport and to an effective highway distribution system: One of the side effects of air cargo growth is a corresponding increase in trucking traffic and its impact on regional traffic patterns and flows. An original determinant of air cargo success at the larger airports was the regional roadway infrastructure and the links it provided between the airport and a highway distribution system. The growth in passengers and cargo, as well as overall regional growth, can cause congestion making effective access and efficient rates of travel increasingly problematic. The resultant shipping inefficiencies and higher costs can place the more mature regions at a disadvantage. The traffic is an issue at the larger airports. Nevertheless, the other advantages of the major gateways continue to offset most traffic concerns.

Physical capacity to accommodate growth: The most obvious criterion for the future success of an air cargo program is the physical capacity to accommodate the airside and landside requirements of both tenants and users. This includes aeronautical infrastructure, physical facilities, landside parking and queuing, and roadway geometry. The latter two elements are important to ensure that the airport functions efficiently as an intermodal facility. While the cargo operations continue to experience solid growth, there are some very real constraints facing airports as buildings age and carrier requirements change.

Geographic positioning to serve effectively as a major cargo center with clear advantages over potential competitors: Historically, the gateways were coastal airports best-positioned for international cargo growth. Inland airports such as Dallas, Houston and Chicago are in a sense better positioned for overall growth because of the greater catchment areas (the areas around the airport to and from which cargo is typically shipped, which is typically considered the market that can be reached within a day's drive).

Bilateral and Open Skies Agreements: The use of U.S. airports by foreign flag carriers is based on international trade agreements which formally grant nations and carriers access and are discussed at greater length later in this section. The gateways are usually the first markets to which international carriers seek, and are granted access.

Critical Cargo Variables

The goods movement industry continues to experience dramatic changes. Factors such as consolidations, rising fuel costs, changing distribution patterns, increased reliance on speed, e-commerce, and high-speed logistics will require that individual airports re-examine their business goals, market priorities, physical capacity, and the compatibility of these three criteria in meeting the challenges of accelerating growth. The remainder of this section outlines several critical variables driving goods movement by air. All of these variables impact air cargo operations to some degree. Although some of the variables are not air cargo specific, they reflect changes that will eventually affect air cargo volumes at the airports and their long-term compatibility with industry needs.

One of the most difficult variables to evaluate in air cargo is the truck substitution component. Many air cargo facilities are operating to a great extent as truck terminals, yet requirements to report truck-to-truck traffic are scarce. Airports cannot realistically evaluate comprehensive space demands, effectively plan for and phase new development, or fully capture business opportunities without careful consideration of the truck substitution component. Additionally, as truck substitution continues to play a greater role, airports must address the fact that an air cargo facility is an inter-modal facility, and must be designed to accommodate trucks as well as aircraft. Critical elements include roadway access and truck parking, as well as queuing, maneuvering, and docking challenges. Truck substitution has been accelerated by the new security screening requirements which, because of the associated increases on air shipping costs, have pushed modal diversion. When combined with passenger growth, the constraints of the land envelope warrant business strategies, lease management practices, and physical planning that will optimize airport property and its ability to serve customers.

1.4 The Economic Impact of Air Cargo

The economies involved with air cargo operations, not unlike any facility, industry, or event can affect the local economy in many ways. The most common measures of "economic impact" are the jobs created, the total revenues brought to local businesses, and contributions to the gross domestic product ("GDP") of an area. So in turn, the economic effect of an airport's cargo operations, whatever their form, can reach the community through four principal channels.

1. There are the effects of the activities taking place at the airport. These could include the loading and unloading of cargo, work related to leasing and security, and cargo handling in the warehouse.

2. The activities that occur off - airport. These activities can include a wide range of functions including the work of freight forwarders and customs brokers, trucking, and a number of other diverse supporting firms.

3. The effects that arise from the expenditures by the recipients of direct and indirect wages and salaries. Wage earners spend a portion of their income on goods and services, thereby creating employment for additional persons.

4. The catalytic affects resulting from the structural changes a facility such as an airport makes in the business environment of a region. An airport may lower the cost of doing business in a region, or increase the quality of life sufficiently to attract new firms. A firm that establishes a warehouse near an airport to capitalize on the air cargo services would also generate such an effect.

Economic impact models measure changes in the regional economy resulting from a change in activity relative to a baseline representation of the economy. The sources of the activity being measured vary, but typically involve changes in production or consumption activities, government policies, infrastructure, or changes in costs or technology. For any change in economic activity, the impacts on the economy can be reported on one of three levels:

- **Direct** impacts represent the initial change in final demand for the industry sector(s) in question.

- **Indirect** impacts represent the response as supplying industries increase output to accommodate the initial change in final demand. These indirect beneficiaries spend money for supplies and services, which results in another round of indirect spending, and so on. Indirect impacts are often referred to as "supply-chain" impacts.

- **Induced** impacts are generated by the spending of households who benefit from the additional wages and income they earn through direct and indirect economic activity. The increase in income, in effect, increases the purchasing power of households. Induced impacts are also described as "consumption-driven" effects.

This cycle of direct, indirect, and induced spending does not go on forever. It continues until the spending eventually leaks out of the economy as a result of taxes, savings, or purchases of non-locally produced goods and services or "imports".

While the modeling tools are well known, the approaches used to evaluate the economic impact of air cargo operations has historically varied significantly between studies. Some studies use gross measures of economic output of the air cargo industry to determine total cargo revenue. Input-output models are then employed to determine overall regional economic impacts, including indirect and induced effects. For example, the 2013 economic impact analysis of Detroit Metropolitan County Airport estimated cargo yields of 36 cents per ton-mile for international shipments and 74.9 cents per ton-mile for domestic shipments to estimate a direct economic impact of $92 million per year (Detroit Metro Willow Run Wayne County Airport Authority and the University of Michigan-Dearborn School of Business 2014). In a study conducted for the Memphis International Airport, the product of the total pounds of air cargo enplaned (4.4 billion in fiscal year 2007) in Memphis and the average revenue per pound ($2.92 taken from the FedEx Express Corporation's Financial Highlights for 2007) were used to estimate total cargo revenue ($12.8 billion annually). The multiplier effects were, in turn, determined through input-output models and total economic output resulting from air cargo operations was estimated at $27.1 billion annually (University of Memphis 2009).

Other studies evaluating the economic impacts of air cargo operations employ more complex approaches similar to those used in the case studies (Section III, below). These studies attempt to characterize the regional air cargo industry or air cargo operations at the regional airport. Typical types of air cargo oriented businesses targeted in these studies include: airlines, freight forwarders, cargo handlers, integrated couriers, customs brokers, trucking firms, and warehousers. These assessments are, in turn, used to determine the number of direct jobs tied to the region's aviation industry and direct wages. For example, the Port Authority of New York and New Jersey (PANYNJ) estimated that air cargo operations serving the region's three major airports accounted for 40,280 jobs and $2.4 billion in direct wages. When indirect and induced effects were included, the number of jobs rose to 79,650 and total wages exceeded $4 billion.

1.5 Guidebook Organization

Section II of this Guidebook begins with an overview of the estimation and modeling approach, and of economic impact concepts as applied to air cargo. The main body of Section II is devoted to coverage of:

- Economic Impact Models
- Survey Techniques
- Demand Elasticity of Fuel Cost Impacts
- Demand Elasticity of Security Screening Impacts
- The Simplified Estimation Model

The final component of the Guidebook, Section III presents case studies for five selected airports: Kansas City International Airport (MCI), Louisville International Airport (SDF), George Bush Intercontinental Airport (IAH), JFK International Airport (JFK), and Reno-Tahoe International Airport (RNO).

2 SECTION II – ASSESSING THE ECONOMIC IMPACT OF AIR CARGO

2.1 Introduction

The key participants in the air cargo industry include air carriers, airports, and freight forwarders or third-party logistics providers (3PLs). The three types of air carriers involved in air cargo shipment are: passenger airlines carrying cargo in the "belly" of aircraft, all-cargo carriers, and integrators – combining all-cargo air service with ground transportation. Passenger and all-cargo airlines may only provide airport-to-airport shipment, while integrators such as FedEx and UPS offer door-to-door delivery services.

Despite high shipping costs relative to other modes, air cargo is frequently selected for delivering commodities with high value with tight time-definite delivery windows. Additionally, air freighters often handle perishable goods and emergency deliveries for unexpected shortages. Growing openness in international trade has stretched the "just-in-time" business model, and air freight has played a key role by enabling quick, regular access to an increasing array of geographic areas on different continents. It also has expanded the types of commodities shipped and types of supply chains served by air cargo.

Similar to other industries, the air cargo industry is sensitive to the conditions of the U.S. and world economies. The global economic recession experienced in recent years has added negative pressure on the air cargo industry. The International Air Transport Association (IATA) reported that "in just one year international air cargo traffic fell 23 percent." International air cargo has stabilized in recent years, but the impact of the recession was significant. In addition to economic conditions, the air cargo industry is sensitive to other factors such as changes in fuel prices, aircraft design, regulation, security regulations, and shifts between air and other transportation modes logistical dynamics.

To examine the economic impact of air cargo, it is necessary to articulate the magnitude and nature of the air cargo business itself and to describe its potential effects on the complicated economic systems that it generates. The analysis of the air cargo industry, involves all the linkages in the supply chain as it pertains to air cargo economic impact. This section addresses the models, tools and information required to evaluate the economic impacts of air cargo, along with the related impacts of demand elasticity with fuel costs and security screening. Finally, this section provides a simplified estimation model to help airport authorities, planners and public officials to more effectively gauge the impacts of this industry for their respective airports.

2.2 Economic Impact Models

In the United States, most airports are owned and operated by local government or quasi-government agencies, which need to provide convincing evidence of the economic significance of airports. These impacts are provided to the public and stakeholders for the purpose of competing for public funding. Economic impact studies utilizing models to support data findings commonly help achieve that purpose. Model studies report the number of jobs and economic activities (state and/or local) generated by airports and civil aviation. Although the economic impact study differs from a financial feasibility study, which focuses on return of public investment, some results of economic impact studies feed readily into such financial feasibility analyses and typically are more readily understood and communicated to the public. One of the examples of the economic impact study is the contribution of civil aviation made to the U.S. economy. As estimated by FAA, civil aviation contributed 11 million jobs and $1.2 trillion in economic activities in 2006 (FAA 2008).

To effectively communicate with the public and stakeholders, it is important to understand what an economic impact study covers. The coverage of an economic impact study typically includes two fundamental elements: types of activities and the depth of economic activities. Types of activities can also be referred to as the parties to be included in the study. An FAA guideline report indicates that types of activities in an economic impact study for airports should include airport employees, employees of an aviation manufacturing plant if the plant locates on or near the airport site, and visitor spending. Based on the guideline report, numerous airport economic studies have been conducted to demonstrate the significant economic value that an airport contributes to its local and regional economies.

Economic Impact Model Preparation

The preparation of economic tools/models includes defining regions to be covered by the models, as well as renting/purchasing the models selected for use. The I-O models can be built for any regions composed of counties, and requires users to specify the regions of analysis before renting/purchasing. So, the first action is to define the regions, which can be a single county or a combination of counties to be covered by the models. Once the regions are defined, the model vendors need to be contacted for renting/purchasing the models.

Before using with economic impact analysis, economic tools and models must be tested for several reasons. First, bugs can turn up in the models. They tend to be produced in low-volume with somewhat frequent updates. Testing it will ensure the selected model has the capabilities promised. Second, users can make sure they fully understand how to use the model and interpret its results when they are not under the pressure of project deadlines. Third, the data related to the direct impact such as the opportunity costs need to feed in and run through the models to test the validity of the models. Fourth, tests can reveal whether additional data are needed for a complete economic impact analysis.

Economic Tools for Economic Impact Analysis

I-O Model. The most popular tool for evaluating an airport's economic impact is the regional input-output model. Input-output (I-O) models are built around a matrix that describes how sectors of an economy interact with one another. That is, for a given industry, it shows the "production recipe" for the goods and/or services that it sells as well as the shares of its revenues that are consumed by other industries in the economy. Such models provide multiplier effects (indirect and induced impacts) that attenuate to a specific geography and are typically calibrated using economic data for a local economy.

The advantages of using an input-output model are:

(1) Its structure is relatively straightforward
(2) Provides extraordinary sectoral detail (400-500 industries), which enables refined estimates of multiplier effects
(3) It can measure the results of economic changes in terms of jobs, labor compensation, GDP, industry receipts (often the value of shipments), and even local, state, and federal tax revenues
(4) Compared to other economic models its cost of use is low.

Although popular, the input-output model has some shortcomings. Primarily those weaknesses are:

(1) It lacks an ability to measure an economy's response to price changes
(2) It also lacks the ability to show how an economy's response is likely to be changed over time

As a result of these weaknesses there will then be certain cases where the needs of modeling exercises do not match up well against I-O's capabilities. Of course, other economic models can be used to measure multiplier effects at the regional or national level.

SETS Model. One of the most established tools is structural econometric time-series (SETS) models. For states, the model is composed of a system of as many as 300 equations, each of which is based on historical data for that state and the nation. Further, such models are tailor-made for an economy. Typically established national forecasts of employment, wages, GDP, and prices drive the model's state or local forecasts. The key focus of SETS models is employment since these data are generally the most current. Equations in SETS models must be updated on a monthly, quarterly, or annual basis to keep them current.

Major strengths of SETS models are:

(1) They produce results that are dynamic (laid out in time schedule)
(2) They can simulate the effects of price changes
(3) They have great sensitivity to historical trends in the local economy.

Of course, this strength of their entrenchment in historical trends is also a prime weakness. That is, the past cannot always inform us about how major economic events or activities will affect an economy in the future. Other limitations with the SETS model include

(1) Full historical data by industrial sectors for employment and gross product are available at the three-digit NAICS level or less, depending on the sector. That is, they lack the articulation of multiplier effects that is available in I-O models.
(2) Perhaps the most significant limitation is the extreme cost in terms of time and labor required to construct and maintain SETS models.

CGE Model. Computable General Equilibrium (CGE) models are another set of models frequently used in a variety of economic impact analyses. CGE models assume optimal decisions by consumers and producers in response to markets and prices subject to labor, resource, and capital constraints. CGE models, in essence, have blocks of equations that represent key actors in the economy (e.g., consumers, producers, government) and equations that make sure that the different blocks are consistent. The heart of the model is usually a modified I-O model—a so-called “social accounts matrix” (SAM). The models can be built to explicitly consider sectoral resilience and substitution across industries in the equation structure. In short, the factors of economic elasticity, which are simply the measure of how responsive one economic variable is to a change in other – if the price goes up, how will it affect sales? This element of the CGE Model offers a major advantage, if, the elasticities in the models realistically reflect resilience, commodity substitution, and other built-in changes.

A chief criticism leveled at CGE models is their reliance on external sources for some of the elasticity values required during their calibration. This is especially the case for region-specific models where studies that derive the elasticities are scant. As a result, regional CGE models tend to rely upon elasticities from national or international studies, which are likely not to be comparable. In some cases this may not be a serious fault if the analyst can perform sensitivity analyses on various values of certain key elasticities. But in some cases, particularly for dynamic CGE models the data are lacking to econometrically estimate some key components equations. Additionally, the costs in terms of time and labor required to produce such a model are likely not much less than those of a SETS model.

Other economic models exist and have been or could be used to model the economic impacts of airports. One option is a model that conjoins I-O and SETS models, which maintains the best of both models but is greater in cost than a SETS model alone for obvious reasons. Other proprietary models implemented for airport economic impact analysis utilize a structure which offers a cross between an input-output model and a SETS model. These are predicated on a panel of data across U.S. states, although as in the case of I-O models its relationships are extrapolated for use for any aggregates of counties. Although, like SETS models, this type of modeling overcomes most shortcomings of the I-O models. The costs of such proprietary models prohibits many users from selecting them for their studies (Lynch 2000). Still, they can prove to be a less costly alternative than building either the CGE or SETS models. Another disadvantage compared to I-O models is the degree of sophistication that is required of the model user and would often require extensive training prior to application.

Economic Tools for Supply Chain Analysis

A supply chain is defined as an integrated process involving various organizations, people, technology, activities, information, and resources for transforming raw materials to a product and transporting from suppliers to end users or customers. Obviously, the air cargo industry is a major supply chain component for a numerous industries with shipping demands fulfilled by these services. The complicated structure of most supply chains calls for a powerful and easy-to-understand economic tool for analyzing its component activities. On-going research focuses on the use of input-output models to describe and examine effects of supply chain on specific industries or regional economies because these models are ideal for supply chain analysis. This results since the I-O models reveal average direct and indirect relationships among industrial sectors. The model begins with an account of economic transactions—a matrix with purchases of materials made by each sector from all other sectors involved in their production processes. By normalizing on the columns of the transactions matrix, one can depict the intensity of the dependency between any pair of industries, for example, the auto-producing industry and the primary metals sector.

Beyond the direct production relationship, the model can also capture additional indirect relationships existing in supply chain. For instance, in responding to the demand from the auto-producing industry, the primary metals sector will call suppliers from its supply chain. Production by the auto-producing industry is labeled by the model as a "first round" response, while actions taken by the primary metals sector is a "second round" response. The effects from one round to other rounds of responses decline since demand shares diminish as the production extends to other "rounds" or pushing output further and further backward. The I-O model captures the round-by-round effects that inevitably occur in supply chains of an economic system. Indeed, this analytical approach has been implemented in analyzing supply chain for numerous industries, to include transportation sectors and the performance and sustainability of their supply chains.

2.3 Data Collection and Survey Techniques

The first and most obvious source of airport-related economic impacts is the employees who work there. Those associated with air cargo include airlines handling cargo, third-party cargo-handling companies, customs agents, TSA, customs brokers, container freight stations, freight forwarders, trucking companies, and other cargo-related services. Airports' employment data can be obtained through the airport authority based on the number of employees with security badges. Additional data are then supplemented through the project surveys of air carriers and third-party cargo-handling companies. These combined data yield cargo-related employment estimates.

More difficult to quantify is the contribution of air cargo to the regional economy. However, it is generally agreed that industries are concentrated within regions with direct access to air cargo operations. In the absence of this access, companies that rely on these services would likely re-locate to other regions with such access.

Several publicly available freight datasets provide freight shipment data by transportation mode, weight, value of commodities, commodity, or region. Some of these datasets provide estimates of air cargo data, which are valuable for the economic impact analysis of air cargo at airports. A recently compiled dataset, the Freight Analysis Framework (FAF) from the Federal Highway Administration (FHWA), has overcome some shortcomings in older datasets which have attained a relatively long history of data collection. There are still data gaps so this Guidebook offers other data sources that could be used to partially address these data gaps, along with the use of surveys to a attain a relatively more accurate data representation of air cargo related activities.

Given the lack of data, one approach is to utilize the linkage of interdependence between businesses, industries and clusters. One tool common with cluster analysis is to study the Location Quotient (LQ), which measures industry concentration in a regional economy. It does so by comparing the ratio of employment in a certain sector of a local economy to the same ratio in a comparison economy, identifying specializations in the local economy. An LQ value of 1.0 indicates that employment in an industry in the regional economy is exactly the same proportion as the national average, while an LQ value greater than 1.0 indicates that employment in that industry has a higher concentration than that of the reference economy.

2.3.1 Air Cargo Data

In working economic impact analysis the air cargo data for an airport reveals the amount of commodities, express packages, and mail shipped by air. In and outbound air shipment data are useful for analyzing industrial activities near and around airports that have an impact on the overall cargo operations. In and outbound domestic and international air shipment data are useful information for directing specific analysis to examine related economic impacts, such as assessing opportunity costs under a scenario of closing an airport. At a national or regional level, air cargo data measured by weight and by value of shipment can be used for comparative analysis between air transportation and other modes.

Through continuous efforts, federal government agencies collect and compile aviation-related cargo flow data. Four major publicly available data sources related to air cargo are as follows:

- The Commodity Flow Survey (CFS) from the Bureau of Transportation Statistics (BTS), an establishment-based survey, is conducted every five years as part of the Economic Census. Conducted in 1993, 1997, 2002, 2007 and most recently in 2012, the CFS provides a modal picture of national freight flows.

- The T100 and T100f airline data from the BTS, Office of Airline Information (OAI) contains Air Carrier Traffic and Capacity data. This data collection includes two data reports: the Non-Stop Flight Segment; and On-Flight Market data. The T100 covers all U.S.-certified air carriers and commuter air carriers; the T100f contains information for all foreign air carriers operating in the United States.

- The Import/Export data on Merchandise Trade from the U.S. Census Bureau contains data collected by the U.S. Customs and Border Protection for all goods that pass through U.S. Customs other than low-value items and some intergovernmental shipments. The data are broken out by foreign country, U.S. customs district, commodity, value, and mode of transportation.

- The FAF, which covers freight transportation from all modes to include air freight. This analysis estimates commodity flows and related freight transportation by mode and between regions, and flow through major international gateways in the United States. The FAF integrates data from several sources, to include the CFS, T100, and Import/Export data described above.

2.3.2 Air Cargo Data Bases

This section focuses on the data coverage and recognized data gaps of four publicly available air cargo datasets, including the CFS, T100, Merchandise Imports/Exports, and FAF. It further provides a description of the coverage and gaps for these datasets that may impact and assessment. Additionally, it provides how the FAF combines these and other sources to close some, but not all, of the data gaps. Table 1 (below) presents the coverage and key characteristics for each of these datasets. All of the four datasets would be useful to minimize gaps that exist in air cargo data in structuring an economic impact model.

The CFS Dataset

The CFS is the first major dataset that laid the foundation for air cargo data. Major advantages of the CFS include its basis in formal survey techniques, multimodality, capture of "door-to-door" shipments, and coverage of weights and values by commodity shipped. However, gaps in the coverage of the CFS must be recognized and those include:

- Imports are not covered since the CFS surveys U.S. establishments.
- There is evidence that exports in the CFS are underrepresented.
- A limited number of geographic regions are covered by the CFS, which has 114 domestic regions.
- Intermodal connections may be underrepresented because shippers do not know modal changes in shipping routes.
- The commodities reported by the CFS at a region-to-region level are limited to commodities classified at 2-digit of the Standard Classification of Traded Goods (SCTG).
- Industries outside of CFS's survey scope may account for as much as 25 percent of U.S. freight

In addition to those commonly mentioned gaps in the CFS, some issues with respect to air express are particularly relevant to air cargo:

- Parcels or packages shipped by the U.S. Postal Service (USPS) or other couriers by air are either missing or lumped into the much smaller other data category such as "other multi-modal."

- Air express packages classified under the category of administrative/mail/business documents are explicitly excluded from statistics.

This final shortfall is significant since the integrators' rapid expansion in the shipping business has raised the importance of air express. According to T100 data, the top five integrated carriers account for over 51 percent of U.S. air freight enplaned. Federal Express (FedEx) and United Parcel Service (UPS) alone account for almost 47 percent of U.S. air cargo.

Table 1. Characteristics of the CFS, T100, Import/Export, and FAF Datasets

Main Category	Detailed Category	CFS	T100	Import/Export	FAF
Air cargo data	Weight	Yes	Yes	Yes	Yes
	Value	Yes	No	Yes	Yes
	Detailed commodity	2 digit	No	10-digit harmonized system	Same as CFS
	Low-value/ weight goods	<100 lbs. included in the box-type of parcels	Yes	Imports <$2,000 and exports <$2,500 are excluded	Same as CFS
	Box-type of parcels shipped by air	Yes, but lumped with other intermodal	Yes	No	Same as CFS
	Letter-type of packages shipped by air	No, excluded from surveys	Yes	No	Same as CFS
Industry coverage	Surveyed by CFS	Manufacturing, mining, wholesale, selected retails, and publishing (except 2002)	Yes	Yes	Same as CFS
	Not surveyed by CFS	Most services, publishing (2002), petroleum, government, and households	Yes	Yes, except intra-governmental	Expanded coverage from CFS for trucks, but little expansion for domestic air and parcel shipments
International trade	Imports	No	Yes	Yes	Yes, expanded by combining the T100 and Import data to account for inbound shipments
	Exports	Yes, but underrepresented	Yes	Yes	Yes; expanded by combining the T100 and Export data to account for outbound shipments

The Merchandise Import/Export Dataset

Census Bureau's Merchandise Import/Export dataset contains information that can be used to fill the first two gaps in the CFS related to international trade. The air cargo data available from the Import/Export dataset include values and weights of the international shipments at the detailed 10-digit commodity level. However, there are at least two shortcomings in the Import/Export dataset:

- Data are reported on customs districts for entry/routes rather than on the actual entry and origin-destination points.

- Low-value shipments, parcel, and mail for all modes are excluded, but those shipments could be significant for air cargo.

The T100 Dataset

The T100 (and T100f) dataset is collected from air carriers according to regulatory requirements. The T100 dataset contains monthly air cargo weight data summarized by carrier-origin-destination airports for all U.S. and foreign carriers operating a flight with at least one takeoff/ landing in the United States. The T100 dataset includes two reports, the Non-Stop Segment and On-Flight Market data. In short, the segment data covers air cargo transported between nonstop segments, while the market data contain information of air cargo between airports where it is enplaned and where it is "deplaned."

A caveat to the Market data is that in addition to actual unloading, cargo is also counted as deplaned when there is a change in flight number. From a technical point of view, the T100 data should provide a breakout of shipments between mail and commodities. However, in reality, integrators such as FedEx are less willing to break out mail due to concerns that it would reveal proprietary information regarding its contract with the USPS. The T100 dataset's shortcomings include a lack of information on detailed commodities shipped, first origin/ultimate destination routes, and value. However, the T100 dataset provides a valuable contribution with its complete coverage of inter-airport cargo weight data.

The FAF Dataset

Using the CFS as a base and supplemented by the Import/Export and T100 datasets, the FAF is able to close or reduce the gaps with respect to international air shipments, and with air shipments missed by the surveys in the CFS. The estimated results of international air freight in the FAF include international shipments in terms of the CFS's O-D as well as weights and values at the 2-digit commodity level. The use of the T100 and Import/Export data also eliminates the data gap existing in the CFS for those industries not covered in the survey for international shipments. Since neither the T100 nor Import/Export data are subject to the same restrictions of data collection as CFS, including the results is an approximately 50 percent increase in the coverage of air freight. Furthermore, the T100 dataset provides actual entry/exit points as opposed to customs districts.

The FAF dataset has made significant improvement in data coverage for air cargo and overcomes shortcomings reported in the other three datasets. Nevertheless, data gaps still exist in the FAF as part of inheritance from the CFS, and some of the data gaps—especially in the coverage of air express data—have impacts on air cargo. The major data gaps related to air cargo in the FAF are listed below:

- Box-type of packages – These are parcels or packages weighing less than 100 lbs. They are often shipped by integrators, USPS, or other couriers and are lumped together with other modes such as "other intermodal." As a result, the air express of these shipments is combined with shipments that were ground only or used other modes in the FAF.

- Letter-type packages – Similar to the CFS, any letter-type of air express packages that fall into the category of Administrative/Mail/Business documents are excluded in the FAF.

Although the coverage of air cargo was increased by 50 percent with the FAF over the CFS with the inclusion of Import/Export information, the domestic shipments by industrial establishments not covered in the CFS are still missing. Similar to the CFS, the FAF has limited coverage for commodities and geographic areas. The number of commodities covered by the FAF is limited at the 2-digit commodity level, while the total number of geographic regions covered is still limited to 114 regions and 17 gateways in the United States.

Other Air Cargo Data Sources

Beyond these four publically available datasets there are other data sources for air cargo provided either by a government agency or private entities. A new data source, the Freight Assessment System has been compiled by the Transportation Security Administration (TSA) as a result of implementing the regulation of screening cargo on passenger aircraft. Other data sources compiled by private entities that include air cargo-related data include: IHS Global Insight's Transearch database; Colography, and the Official Airline Guide (OAG).

The TSA Dataset. The TSA collects information on all air cargo shipments within the United States as part of its aviation risk analysis system. The resultant database is being developed as the Freight Assessment System (FAS), which is described as follows:

> The FAS will screen all air cargo to identify elevated-risk shipments for aircraft operator inspection prior to flight. Data on shippers, agents, IACs, air carriers, consignees, contents of the shipment, and threat information will be incorporated into the risk assessment at a transactional level for domestic and international shipments.

As a virtual census of all commodities shipped by air, the FAS might be a valuable source of information on air cargo flows. In particular, the FAS data may be supplemental to shipments missed in the CFS surveys. However, the TSA has treated the FAS data as sensitive security information. At present, little information is available on how the data are collected, the coverage of data, and whether it will be released for public use.

The Transearch Dataset. The Transearch dataset is a database that provides Origin-Destination flows for truck, rail, water and air. This is based on a combination of a shipper's survey conducted by Global Insight and publicly available data such as the CFS. Shipment data in the Transearch dataset are available by commodity and value at the county/state level. The major advantage of the Transearch data is the use of private information from the Motor Carrier Data Exchange, which may be of limited advantage for the analysis of air cargo. The Transearch data has a relatively high purchasing cost as well as a methodology for estimating shipment data that is proprietary.

The Official Airline Guide (OAG) Dataset. The OAG is a leading publisher of worldwide airline flight schedules and also provides data on air freight rates. The schedule information could be used to validate routes obtained for air cargo shipments under the estimation procedure above, as well as provide useful information on time of day/day of the week. This dataset also has a relatively high purchasing cost of this product relative to its targeted use is its primary shortcoming.

Colography Group's Dataset. The Colography Group conducts annual shipper surveys and compiles transportation databases based on the data collected. The products do not include specific information on air cargo, Origin-Destination information, or inbound shipment data. Therefore, the Colography's dataset would not add significant value to what is available from public sources.

In sum, each of the above data sources cannot be used as the only data source on air cargo flows and related air cargo studies. The TSA dataset is restricted and at this time cannot be released to the public, and the other three datasets provided by private entities either lack specific data required for the economic impact analysis, lack an available explanation for their methodologies, or bear relatively high purchasing costs.

2.3.3 Survey Techniques

It is recommended that any air cargo research involving the use of surveys use the principles provided in the *ACRP Report 26 Guidebook for Conducing Airport User Surveys* to gather the information for economic analyses of air cargo.(This Guidebook can be found at: http://onlinepubs.trb.org/onlinepubs/acrp/acrp_rpt_026.pdf)

Of importance for applied surveys the following points are drawn from Report 26:

- "Surveys of air cargo activities and operations at an airport represent a particularly challenging type of survey, because information on shipment characteristics and detailed cargo flows is typically regarded as highly proprietary."

- "Surveys of air cargo carriers, freight forwarders, or selected shippers will typically take the form of an in-person interview. Respondents may be able to provide useful information in general terms, even if they are not willing to provide detailed data on individual shipments."

- "There is little experience to draw upon, and therefore virtually no standard practices that can be applied, or modified, for a particular airport. Any survey designed to capture air cargo data is likely breaking new ground."

- "To date, the most common survey method for air cargo is similar to stakeholder interviews. Although shippers and forwarders may be reluctant to release detailed information on air cargo shipments or cargo activity at their facility, it is possible to construct a survey in the form of an interview. Using the survey purpose as a base, a series of questions can be constructed to form a structured interview to be conducted with all, or selected, air cargo operators at the airport" (Biggs et al. 2009).

A recommended representation of airport and air cargo personnel to be considered for a survey would include:

- Airport representative
- Air carriers
- Freight forwarders and air transportation service providers
- Shippers – Single stand-alone businesses; warehouses; distribution centers

In general, the surveys should request information on the air cargo volumes (dollar value and/or weight) by type (or commodity code) as well as numbers of employees. Follow-up interviews may also prove helpful in answering any questions the respondent might have on specific survey questions. If you chose to complete surveys in-person, ensure you have plenty of time to complete the survey. Due to varied amount of information being requested the commitment of time is usually longer than expected.

Given the breadth of the information which needs to be covered, most individuals would need to conduct some research in order to complete the surveys. In many situations, various data points may be kept in a variety of locations such as, the Office of Public Relations having landing data, while the Air Operations Office may have data on actual cargo movements on the air field. Recognize that data from each source may not match exactly, but can be cross-referenced and reconciled to determine which data is most robust and accurate.

Due to the proprietary nature of the cargo market, individual companies will need assurance that their individual data will be kept confidential. Be prepared to discuss issues such as how business/competition sensitive corporate data will be used, stored, protected, presented, and published (or not) in a private or public forum.

Some airports with large numbers of carriers and large volumes of cargo have local air cargo associations and annual (or more frequent) cargo conferences. Requesting the assistance of the local industry groups or associations may help identify professionals in the field that can assist with survey efforts. However, keep in mind many organizations keep their membership lists private. To gain the support of the members, it may be most effective to write a formal request for assistance to be introduced at a regular business meeting and/or request a speaking role at one of their meetings. These associations and events provide excellent opportunities to introduce the purpose of an impact analysis, the importance of the survey information, along with networking to meet individuals who will assist in providing the necessary data.

Small incentives, such as coffee shop gift cards or airport club passes, may encourage survey responses from private industry participants. However, air cargo revenues provide small margins to freight forwarders, and even incentives for survey completion may not easily offset the time spent completing a survey, to working on their standard business items or selling a cargo shipment. It is recommended to identify one or more key individuals at each airport who are knowledgeable about the local air cargo industry; their contacts assist with gathering necessary information and they often can provide estimates if actual detailed information cannot be obtained.

Finally, surveys assessing economic impact may be more effective if they include questions related to elasticity of the market (e.g., How the market would reduce cargo shipments if the price increases and/or air cargo was not available at the specific airport). Of course, these types of questions greatly increased the survey length and likely the time required to complete the survey. In addition, many individuals are uncomfortable answering such subjective questions and may not want their responses perceived as responses from their whole organization. If elasticity questions hinder the number of desired responses, then these questions may have to be removed to increase overall participation and survey response. In summary, only build into the survey the necessary pieces of information to gain the data required in the most succinct manner to enhance participation.

Considering the four suggested representatives, examples of the types of information to request and the people to engage with for a survey are provided by position with the following information.

Airport Representative

An airport focused survey primarily requests information the authorities have readily available, including:

- Total numbers of airport employees
- Number of employees performing air cargo-related operations (airport employees and tenants) by industry sector
- Annual cargo volume by:
    - Inbound/outbound
    - Domestic/international
    - Weight and/or monetary value
    - Airline
- Commodity code
- Passenger, express and all-cargo airlines serving the airport
- Forecasted air cargo growth rates

While the airport likely has the information readily available, it may reside with different offices or departments. Employment for tenants may be estimated from security badging counts, which can be obtained from the airport security manager. Access control records may provide estimates of cargo vehicle movements. In general, airport staff are able to provide all the information requested and may even assist in identifying others to survey. A further action may be to have the airport manager or cargo manager can send introductory email to air carriers, third-party ground handlers, and freight forwarders to facilitate their understanding of the overall project and encourage their participation.

Suggested survey reach out list:

- Airport Manager
- Staff person responsible for Air Cargo at that airport
- Security officer (badging or access control office) can help with on-airport employment estimates
- Public Relations (usually has the basic, distilled information)
- FAA Airports All Cargo data: http://www.faa.gov/airports/planning_capacity/passenger_allcargo_stats/passenger/.

Air Carriers

Both commercial passenger airlines (accepting cargo as belly freight) and commercial cargo airlines need to be included in the survey. The airports have information on cargo volume by carrier, so some of the survey questions may be redundant, but the surveys can also serve to gather more detailed information from the specific airlines. The air carrier surveys may also include requesting information on the costs for accommodating the Transportation Security Administration (TSA) requirements to screen 100 percent of all air cargo.

Specifically, the air carrier survey should primarily requests information on the following:

- Total numbers of employees on-airport and off-airport, full-time and part-time
- Annual cargo volume by weight and/or monetary value
- Top ten commodity codes
- Forecasted air cargo growth rates
- Estimates of customer reactions (change in volume) to price increases
- Cost implications of TSA screening requirements.

In cases where the airport provides information about cargo volume by carrier, then focusing questions with the group of the providers who process the largest amounts of cargo will maximize the overall percentage of cargo volume represented by completed surveys. Recognize also local station managers or sales managers may have authorization to provide only basic information on volumes and employment, but not any speculative information (e.g., forecasts, how the cargo might be transported if this airport could not accommodate the volumes, or how the cargo volumes might change due to price increases). The carriers' corporate headquarters often must be consulted to request the data and/or grant permission to discuss the information with their local personnel on-site at the airports. Each business has their own procedures regarding participation in surveys and/or releasing company data. Most carriers will consider all information provided as Business Sensitive and/or Confidential. Be prepared to discuss how you will use and protect the data, especially from their competitors.

At airports where individual carriers have small numbers of flights and/or cargo volume, the airlines often contract with third-party ground handlers to process the cargo. It is important to capture their employment numbers, since in many cases the third parties will have many more employees than the individual carriers. The airport will have a list of third-party ground handlers and cargo terminal operators since they operate on the airfield.

Suggested survey reach out list:

- Commercial passenger &/or cargo airline station managers
- Cargo Airline Sales Managers
- Third-party ground handlers
- Air Cargo Associations:
    - Regional: http://www.raccaonline.org/
    - International: http://www.tiaca.org

Freight Forwarders

Freight forwarders are an important element in the air cargo system. Freight forwarders are third-party logistics providers who contract with originators of shipments (manufacturers, etc.) and with the carriers to deliver items from the shipper's site to the final destination. Most airports have a list of known freight forwarders who work with cargo at their airport, but there may still be additional forwarders in the area that should be surveyed.

The initial survey questions for forwarders should include the following:

- Total numbers of employees in the specific economic region, on-airport and off-airport, full-time and part-time
- Annual air cargo volume handled in area, by:
    - Weight and/or monetary value
    - Cargo-only airlines vs passenger belly cargo
    - Inbound/outbound
    - Domestic/international
- Air cargo value as percent of total cargo value handled in area
- Top ten commodity codes
- Estimates of customer reactions (change in volume) to price increases for:
    - Cargo-only air cargo
    - Belly air cargo
    - Other modes
- Estimates of customer reactions (change in volume) to reduction of belly cargo capacity
- Estimates of how air cargo would move to other modes if air cargo services were discontinued
- Cost implications of TSA screening requirements.

The freight forwarders could also be asked to rank why their customers choose air transportation rather than other modes to ship cargo. This may include survey decision parameters such as time to market, frequency of service, reliability of service, value of time relative to other modes, security, ability to track/trace air shipments.

The freight forwarder surveys may be quite extensive, asking several more items than the air carrier survey. Due to the length potential length of the survey and time required to answer all the questions for this group it may be more difficult to gain responses from freight forwarders. Again, freight forwarders' profit margins are thin, so requesting their time for an economic survey simply takes away more time from their business than they may be willing to spend. If information is limited, relying on employment estimates based on information from the Airforwarders Association, local brokers/freight forwarders organizations, and/or local chambers of commerce may help in filling this information gap.

Suggested Survey reach out list with information sites:

- Freight forwarders: http://airforwarders.org/
- Third Party Logistics (3PL) association: http://www.iwla.com/why/members.aspx
- National Customs Brokers and Forwarders Association of America: http://www.ncbfaa.org

Shippers

Shippers may be any type of business/organization, including manufacturers, office/professional businesses, warehouses, distribution centers, or consolidation centers. Requesting the assistance of the local industry groups, chambers of commerce, economic development councils or associations may help identify appropriate businesses to survey. Recognize, however, these only represent cargo shipments that originate locally, not inbound shipments or connecting cargo at each airport. *ACRP Report 26* states, "surveys of area businesses and other organizations are perhaps the most difficult of all airport user surveys to perform in a way that gives results that accurately reflect the characteristics and views of the targeted population" and "non-response can be a significant problem with surveys of area businesses."

The initial survey questions for shippers should include the following:

- Total numbers of employees within the specific economic region
- Company/industry NAICS code
- Annual air cargo handled in area, by:
  - Weight and/or monetary value
  - Cargo-only airlines vs. passenger belly cargo
  - Inbound/outbound
  - Domestic/international
- Air cargo value as percent of total cargo value handled in area
- Top five commodity codes shipped by their business
- Estimates of company shipping reactions (change in volume) to price increases for:
  - Cargo-only air cargo
  - Belly air cargo
  - Other modes
- Estimates of company shipping reactions (change in volume) to reduction of belly cargo capacity
- Estimates of how air cargo would move to other modes if air cargo services were discontinued
- Annual spending by company on all air transport services, and proportion to air cargo vs air passenger transport
- Value assigned to a one-hour delay in shipment

The survey could also include asking shippers to rank why they choose air transportation rather than other modes to ship cargo. This should include decision parameters such as: time to market; frequency of service; reliability of service; value of time relative to other modes; security; and the ability to track/trace air shipments.

Similar to the questions asked of freight forwarders, shippers should also be asked how their air cargo volumes would respond to changes in market prices, capacity, and overall availability of air cargo at this specific airport. Again gathering the requested data and gaining the level of responses desired will be difficult, so overall employment numbers may be the most relevant data for local businesses/shippers.

<u>Suggested survey reach out list:</u>

- Local/regional chambers of commerce
- Local economic development agencies or city/county departments for economic development

2.4 Estimating Demand Elasticity – Security Screening and Fuel Cost Impacts

The role of air cargo in the nation's supply chain has continued to expand in recent years, with system revenue freight ton miles expanding from 7.0 billion in 1996 to nearly 29 billion in 2011 (BTS 2011). The nation's growing reliance on air cargo, however, does not come without some uncertainty. Two issues that have raised concern within the industry in recent years are the implementation of the Transportation Security Administration's 100 percent air cargo screening rule (TSA 100) and jet fuel price volatility.

2.4.1 Demand Elasticity Models for Security Screening Impacts

In estimating the economic impact of the TSA 100 percent screening rule – requiring security screening of all cargo transported in the belly of passenger aircraft, the following five-step approach will guide the assessment. The five-step approach is outlined in the step descriptions below and supported by the graphic to the right. As each step is addressed, the corresponding step in the graphic will be shown in black with white text. The five-step approach is as follows:

Step 1. Develop a statistical price elasticity model relating the quantity of air cargo services demanded to certain economic variables, including shipping prices, to model the potential impacts of the TSA 100 percent screening rule, as well as those associated with other future regulations.

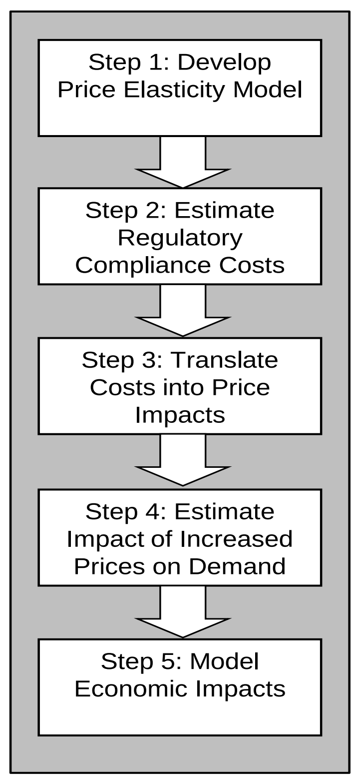
Step 2. Develop an approach for estimating the costs associated with the 100 percent screening rule.

Step 3. Translate these costs into price impacts.

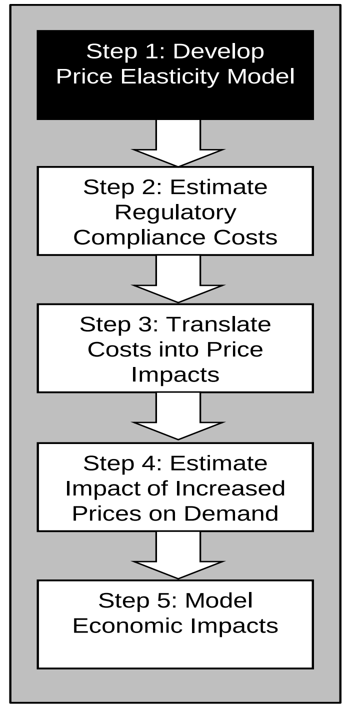
Step 4. Using the price elasticity model, estimate the impact of the upward price pressure on the demand for air cargo.

Step 5. Model the economic impacts of the reduced demand for air cargo, increased shipping prices, and increased use of air transportation support industries using the input-output (I-O) models The I-O models will aid determining the direct, indirect, and induced economic effects of the 100 percent screening rule as these associated costs ripple through the local economies.

This approach is supported by examples from five airport test cases. An additional model, also used in these test cases, provides airport staffs the means to better understand the demand and economic impacts associated with fuel price volatility.



Air Cargo Price Elasticity of Demand Model



Data collected in support of the air cargo price elasticity of demand model will capture numerous variables, utilizing data obtained from a number of sources. Leading data sources which should be used include: the Bureau of Economic Analysis (BEA); Energy Information Administration (EIA); Bureau of Transportation Statistics (BTS); Bureau of Labor Statistics (BLS); and Association of American Railroads (AAR). Broadly described common variables will fall into the following categories:

- Economic indicators including gross domestic product (GDP) and national income
- Price data including jet fuel prices, consumer price index (CPI), and price/revenue per ton-mile of air freight
- Price data from competing modes including the general freight trucking producer price index (PPI)
- Quality of service variables including flight stage length.

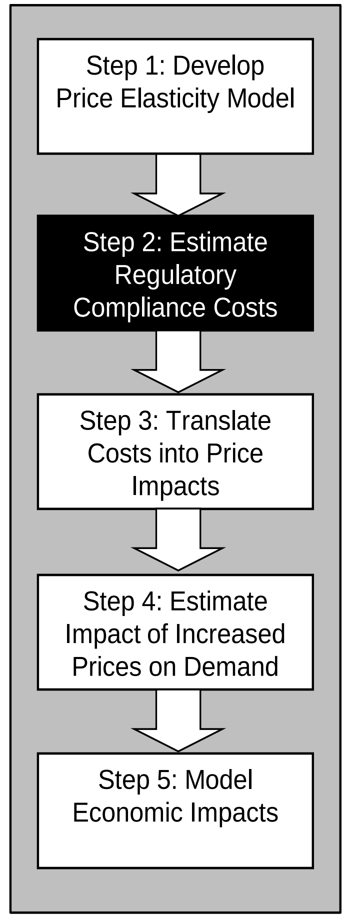
The dependent variable used in the model is the sum of international and domestic freight enplaned as measured in pounds. A thorough exploration of the data would be of great help estimating the price elasticity to find any data anomalies with determined variables. This will uncover changes in reporting, changes in data requirements or inaccurate data reporting that must be accounted. Even with the rich data available, some derivations of simple data transformations may be necessary.

Many candidate models can be tested that utilize variable permutations or incorporate different statistical techniques. With all models or approaches some exploratory data analysis should be performed to tease out variables which accomplish two primary objectives:

1) Finding variables that have practical and reasonable interpretability
2) Identifying variables contributing to the best-fitting model possible given the data.

A suggested model would use the real air cargo operating revenue per ton-mile (essentially real air cargo price) as an independent variable. This real air cargo operating revenue per ton-mile variable is of significance because its coefficient will determine, at the national level, the elasticity (or relationship) between the price and demand of air cargo.

Estimating the Compliance Costs Associated with the TSA 100 Percent Screening Rule



To determine the economic impacts of reduced air cargo operations on local regions, it is necessary to determine the screening costs associated with the 100 percent screening rule. Two sources of information are useful in assessing these costs: the regulatory evaluation of the 100 screening rule carried out by the Transportation Security Administration (TSA); and data collected from third-party entities.

The Air Cargo Screening Initial Regulatory Evaluation carried out by the TSA presents a methodology for assigning costs to the 100 percent air cargo screening rule. These costs include those associated with the:

- certification of shippers
- indirect air carriers (IACs)
- logistics companies and other companies with Certified Cargo Screening Facilities (CCSFs) for screening air cargo off-airport

Additional costs included in the evaluation involve expenses to support: training requirements; the adoption and assessment of security programs; labor costs associated with screening air cargo; equipment costs; and the costs associated with delays (TSA 2009).

The cost framework developed by TSA in its regulatory evaluation was subsequently used to estimate the costs of the 100 percent screening rule on the operations of commercial airline facilities at a small number of airports across the country. The estimated screening cost per pound varied significantly from as low as 1 cent per pound to as high as 57 cents per pound. The results demonstrated that due to the significant fixed costs associated with the upfront purchase of equipment and associated facility design and construction, costs per pound declined significantly as the number of parcels passing through the facility grew. This point is demonstrated in Figure 1, which compares the screening price per pound to the annual number of parcels expected to be screened at each facility. When the results for each facility are weighted based on the expected number of parcels screened annually, the estimated weighted average cost per pound is 4.8 cents.

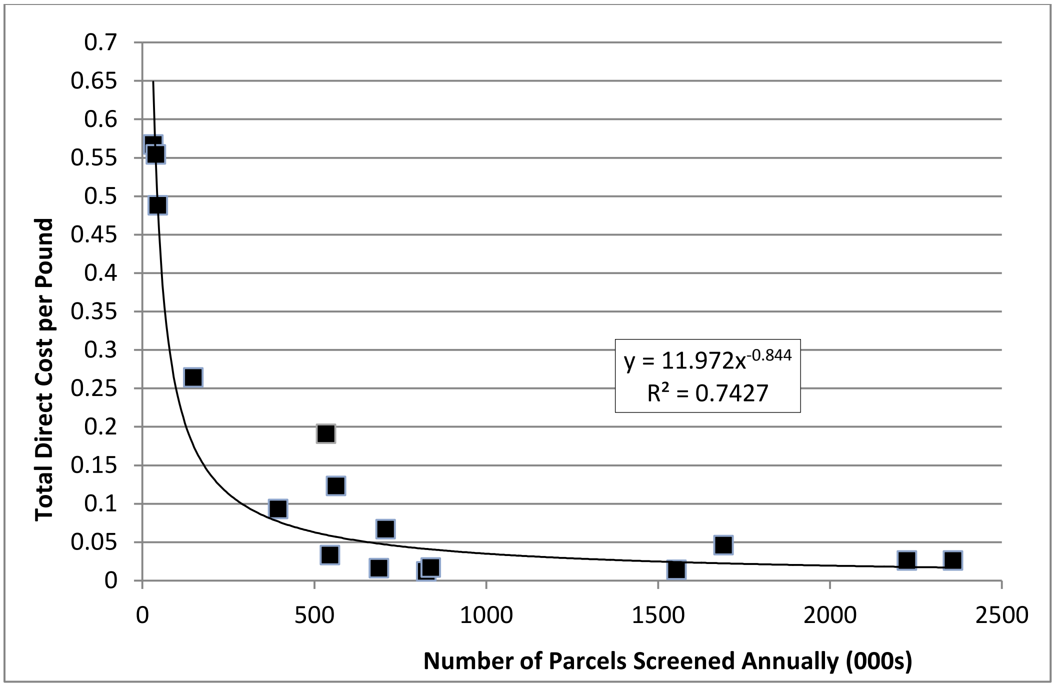
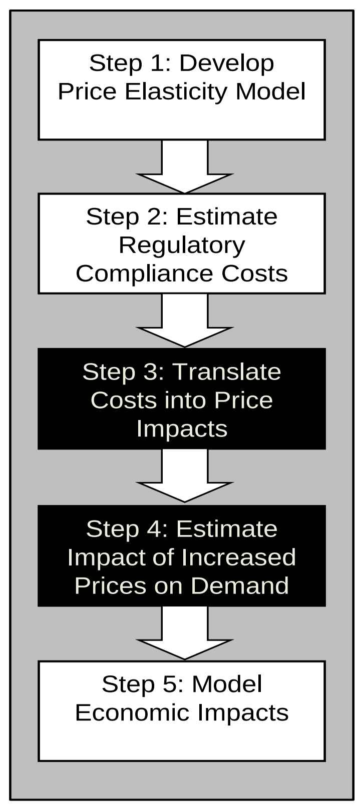


Figure 1. TSA Estimated Total Costs of Complying with the 100 Percent Screening Rule

The results of this graph suggest strong incentives for airlines with small cargo operations to seek third-party screeners who can take advantage of economies of scale to reduce the screening price.

Translate Costs into Price Impacts/ Estimate Impact of Increased Prices on Demand



To determine the economic impact of the 100 percent screening rule, the costs presented in the previous section must be translated into price impacts in percentage terms. Using the outlined approach, price impacts are translated into demand impacts, which are then fed into the input-output models (e.g., IMPLAN, RIMS II) to determine regional economic impacts.

To determine the price effects of the screening costs, the BEA's input-output (I-O) accounts were used to apply an industry overhead charge to the screening costs. This overhead charge was set equal to the gross operating surplus for the air transportation industry. Between 2008 and 2012, gross operating surplus added an average of 8.4 percent to total output in the air transportation industry. Applying this 1.084 industry markup to the screening costs resulted in a final screening price impact of 5.7-7.4 cents per pound (Bureau of Economic Analysis 2011).

To determine the percentage increase in air cargo prices resulting from the added screening costs, the average revenue per pound of air freight in the US was calculated using financial data and traffic statistics published by the BTS. Using freight weight and revenue data the average revenue per pound of air cargo transported by U.S. carriers was estimated at 86.2 cents. To calculate this value, freight data for specific carriers were obtained from the T-100 Market (US Carriers) BTS data file and compared with revenues from the P-1.2 data file. The price impacts associated with the 100 percent screening rule must be translated into percentage terms to apply the price elasticity model. The TSA100 percent screening rule was estimated to increase the overall price of air cargo transported on-board passenger aircraft by 6.0-8.6 percent.

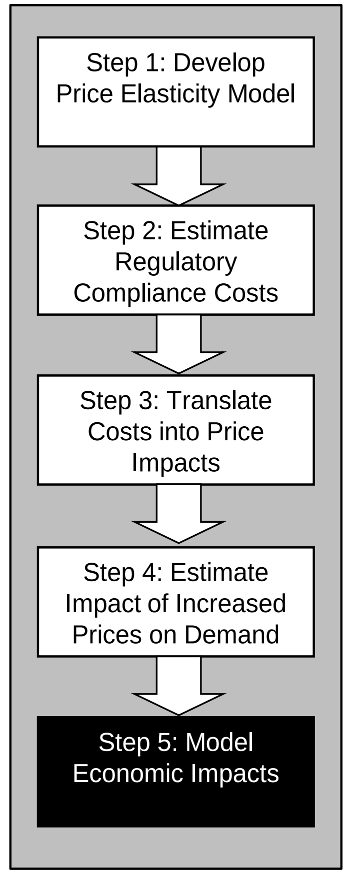
Table 2 provides examples of impact analysis using the outlined approach applied to the five case study airports. The table presents the estimated reduction in freight on-board aircraft using the suggested approach and then translates those reductions into overall reductions in freight. For each airport, BTS data were used to determine the share of total freight comprised of air cargo transported on-board passenger aircraft. At airports with the largest share of freight comprised of cargo transported on-board passenger aircraft (e.g., JFK), impacts were the most significant. At airports dominated by air cargo operations (e.g., SDF), demand reductions were estimated to be relatively less significant.

Table 2. Estimated Impact of Increased Prices on Air Cargo Demand – Case Study Airports

Airport	Reduction in Freight On-board Passenger Aircraft		Air Cargo On-board Passenger Aircraft as Share of Total Freight	Reductions in Total Freight	
	TSA Analysis	Industry Estimates		TSA Analysis	Industry Estimates
IAH	-1.4%	-2.0%	47.1%	-0.6%	-0.9%
JFK	-5.7%	-8.2%	46.1%	-2.7%	-3.8%
MCI	-6.1%	-8.7%	6.8%	-0.4%	-0.6%
RNO*	-3.0%	-4.3%	3.3%	-0.1%	-0.1%
SDF	-6.9%	-9.8%	0.1%	0.0%	0.0%

*The national model was used as a default for estimating the price elasticity of air cargo demand in Reno due to the inadequate results generated using local data.

Estimate Regional Economic Impacts



From an economic perspective, there are three effects that will be captured in the I-O models applied to airport studies:

- The reduced demand for air cargo reveals a contraction in the industries engaged in air cargo operations
- Increased output by air transportation operations engaged in air cargo screening activities
- Increased output for air transportation companies due to overhead expenses applied to air cargo screening costs (this third impact may serve to counterbalance the first effect)

Table 3, presents the air cargo inputs required for the I-O models to effectively assess impacts. The reduction in freight presented in this table represents the percentage reduction in total (cargo-only and cargo transported on-board passenger airplanes) cargo. The impacts vary depending on the price elasticity modeled at each airport and the scale of air cargo transported on-board passenger aircraft. Of course, the screening rule does not affect cargo-only aircraft. So economic impacts are isolated to only cargo transported on-board passenger aircraft.

The negative economic effects reduce the economic output of the industry. Since the impact of the TSA 100 percent screening rule applies to all air cargo transported on-board passenger aircraft, it is expected to impact both enplaned and deplaned cargo volumes. Since it does not impact cargo-only aircraft, the overall reductions in freight are less than the impacts on cargo on-board passenger aircraft. The cargo screening costs and industry markup attached to those costs reflect the price increase that is passed on to the customer. These values reflect increased revenue/output to the air transportation and supporting industries.

Table 3. Air Cargo Screening Inputs for I-O Models – Case Study Airports

Airport	Reductions in Freight		Cargo Screening Costs		Gross Industry Surplus on Cargo Screening Costs	
	TSA Analysis	Industry Estimates	TSA Analysis	Industry Estimate	TSA Analysis	Industry Estimate
IAH	-0.6%	-0.9%	$8,944,118	$12,775,705	$751,501	$1,073,438
JFK	-2.7%	-3.8%	$25,241,205	$36,054,330	$2,120,813	$3,029,352
MCI	-0.4%	-0.6%	$247,949	$354,169	$20,833	$29,758
RNO*	-0.1%	-0.1%	$71,619	$102,300	$6,018	$8,595
SDF	0.0%	0.0%	$101,236	$144,605	$8,506	$12,150

2.4.2 Demand Elasticity Models for Fuel Cost Impacts

To model the price elasticity of air cargo demand with respect to jet fuel prices a stepwise regression approach should be used to target variables that had a statistically significant impact on air cargo demand.

The use of this approach is effective since you have a choice of predictive variables (e.g. cost to demand) which can be carried out by a selective procedure. So for example, one variable, log-GDP, can be manually entered into the model. An example of the variable selection process used with this approach is reviewed in Table 4, where besides the five flag variables there are three other selected inputs: log-GDP (real); log-Jet Fuel Price (real), and domestic passengers enplaned.

Table 4. Summary of Stepwise Regression

Step	Variable Entered	Variable Removed	Partial R-Square	Model R-Square	F Value	Pr>F
1	post_flag		0.0472	0.9322	56.44	<.0001
2	anom_flag		0.0210	0.9533	36.01	<.0001
3	pasenplanedd		0.0091	0.9624	19.16	<.0001
4	Lrailrev		0.0025	0.9649	5.65	0.0199
5	q3_flag		0.0016	0.9666	3.80	0.0550
6	q2_flag		0.0036	0.9701	9.03	0.0036
7		Lrailrev	0.0009	0.9693	2.21	0.1412
8	Lrealjetfuel		0.0014	0.9706	3.59	0.0619
9	q1_flag		0.0012	0.9719	3.30	0.0733

Results of a jet fuel price elasticity model are summarized in Table 5. The model fits the data well with an R-Squared and an adjusted R-Squared of approximately 0.97. The overall model is highly significant with a p-value less than 0.001.

Table 5. Jet Fuel Price Elasticity Model – Analysis of Variance

Source	Degrees of Freedom (DF)	Sum of Squares	Mean Square	F Value	Pr > F
Model	8	20.00432	2.50054	324.07	<.0001
Error	75	0.570	0.00772		
Corrected Total	83	20.58302			
Root MSE	0.08784	R-Square	0.9719		
Dependent Mean	22.44098	Adj R-Square	0.9689		
Coeff Var	0.39143				

An inspection of the parameter estimates table in Table 6 reveals much about the observed relationship between air cargo demand and the selected explanatory variables. As important as the magnitude of the parameter estimates is the arithmetic sign. Of the eight inputs (not counting the intercept), four are positive and four are negative in sign indicating a positive or negative correlation, respectively, with air cargo demand. Of the three non-flag variables, only the jet fuel variable was negative in sign as expected. Two of the flag variables helped the model better fit the aforementioned data anomaly, and the other three were quarterly flags. These latter variables were all negative in sign – indicating a steady quarterly decrease in Air Cargo shipments culminating in an offsetting increase in the 4th quarter. The parameter estimate for the real jet fuel price variable is -.07537 indicating that for every 10 percent increase in jet fuel prices, air cargo demand would be expected to drop by 0.75 percent.

Table 6. Jet Fuel Price Elasticity Parameter Estimates

Variable	Parameter Estimate	T Value	Pr > |t|
Intercept	2.50542	0.49	0.6286
lgdp05	0.62514	3.54	0.0007
q1_flag	-0.04974	-1.82	0.0733
q2_flag	-0.12919	-4.22	<.0001
q3_flag	-0.13259	-4.24	<.0001
anom_flag	0.45435	8.84	<.0001
post_flag	0.56740	12.18	<.0001
lrealjetfuel	-0.07539	-2.06	0.0433
pasenplanedd	7.313436E-9	6.32	<.0001

Table 7 presents the impacts of a 10, 20, and 30 percent increase in jet fuel prices on demand for air cargo at each of the five case study airports. As shown, the impacts range from less than 1 million pounds for RNO under the 10 percent jet fuel price increase scenario to over 100 million pounds for SDF under the 30 percent price increase scenario. For every 10 percent increase in jet fuel prices, air cargo demand is estimated to decline by 0.7 percent.

Table 7. Impacts of Jet Fuel Price Increases (10, 20, and 30 percent) on Demand for Air Cargo

	Impacts of Jet Fuel Prices Increases on Demand for Air Cargo		
Airport	10%	20%	30%
IAH	(6,368,857)	(12,737,715)	(19,106,572)
JFK	(21,150,552)	(42,301,105)	(63,451,657)
MCI	(1,354,130)	(2,708,260)	(4,062,390)
RNO	(781,291)	(1,562,582)	(2,343,873)
SDF	(33,956,926)	(67,913,853)	(101,870,779)
Reduction in Air Cargo	-0.7%	-1.5%	-2.2%

The five-step approach outlined previously for the TSA 100 percent air cargo screening can be applied to jet fuel costs. (Note that Steps 2 and 3 – in estimating regulatory compliance costs and translate cost into price impacts are not required for this analysis because there are no overhead costs associated with constant price fluctuations in jet fuel). Thus, the output of the model can be applied directly to freight totals to estimate reductions in air cargo demand. In terms of applying these results at the local level, reduced demand for air cargo would be modeled as a contraction in the industries engaged in air cargo operations. For every 10 percent increase in price, air cargo operations would be expected to contract by 0.7 percent.

2.5 Simplified Economic Impact Analysis Model

To determine the contribution of additional air cargo freight activity at a given airport on the total economic output in the market area influenced by that airport, there are several decisions must be make in structuring a model. Decisions will involve several characteristics of the air cargo's potential economic impact on final demand. Final demand is an economic term defining the total amount of economic activity for a defined region. Final demand would include the direct impacts of expanding air cargo freight capacity at the airport, plus the additional economic activity generated by these direct changes. These indirect and induced effects are why the additional impacts are often called multipliers.

2.5.1 Instructions for a Simple Estimation Model

To determine the relationship between freight and economic output key questions about changes to the status quo must be addressed. The following provides those questions supported by specific guidance for finding the answers to support inputs for a simplified model.

1. How much additional economic activity would be generated?
   - The following are the key data items that are needed to evaluate additional economic activity:
   a. Jobs and wage related to air cargo services from the participants of the air cargo industry such as freight forwarders/3PLs, airports, airlines, and others at the selected airport
   b. Air cargo shipments in tons handled by the industry participants such as freight `forwarders/3PLs
   c. Commodities shipped by air and other modes
   d. Revenue related to air cargo business from the industry participants such as airports and freight forwarders/3PLs
   e. Industry concentrations within the defined study region. (See page 72 of the main report)

2. What industries would be most affected by such changes?
   a. Inspection of the BEA RIMS II 471 industry types would suggest which detailed industries would best match to the main industries needing the support of air cargo operations
   b. Stakeholders and their respective survey response would also provide extra data and information in answering this question
3. What area (economic region) would the changes effect?
   a. In determining a study region, most cases should begin with the counties within the Metropolitan Statistical Area (MSA) where each airport is located.
   b. The study region is defined at the county level because the datasets underlying each of the I-O models reside at that level

Simple Step Process to Construct a Simple Economic Estimating Model:

- After considering the three key questions above, the first action is to define the regions, which can be a single county or a combination of counties that that will be

covered by the impacts generated by air cargo freight capacity changes within an airport market area.
- Once the regions are defined, the Bureau of Economic Analysis (BEA) should be contacted for renting/purchasing the needed models.
- Select our construct the simple model
- Fill in the data and factor your estimated outcomes

Supporting Information
The BEA has developed input-output (I-O) models for any United States regions composed of counties, and requires users to specify the regions of analysis before renting/purchasing. This I-O model from BEA is called RIMS II.

- The URL to purchase RIMS II multipliers is: https://bea.gov/regional/rims/rimsii/
- Multipliers may be ordered for any region that consists of one or more contiguous counties at a cost of $275 per region.
- For each region ordered includes Type I and Type II (detailed below) final-demand and direct-effect multipliers for all the RIMS II industries in the region.
    - Note: Multipliers for each county or state within the region will not be provided.
    - Type II multipliers should be used as it includes both inter-industry and household spending of a final demand changes. Type I multipliers only account for the inter-industry effect, which is not the full impact being sought with a regional air cargo estimate.

In addition, BEA has published two useful reference documents. The first is a RIMS II user guide, which can be found at the URL:
http://www.bea.gov/regional/pdf/rims/RIMSII_User_Guide.pdf

- While the BEA guide is useful material, the streamlined model offered here is intended to further simplify a description of the use of RIM II multipliers.

The second suggested resource is entitled, *Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System* (Third Edition, 1997), found at the URL: http://www.bea.gov/scb/pdf/regional/perinc/meth/rims2.pdf.

- This document provides appendices which will guide you to choose the appropriate industries whose multipliers would be most affected by air cargo freight expansion.

In estimating economic impact this simplified approach uses economic output measures combined with basic input-output account data to formulate direct, indirect, and induced effects. This can be accomplished by first executing the various data collection and survey techniques discussed in this Guidebook. Information can be generated on basic economic measures such as employment (number of jobs and earnings) value and value-added output (expressed in dollars). This gives the analyst the basic information on changes in economic activity to which economic multipliers will be applied.

Reviewing the *Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II)*, will reveal massive tables of multipliers. Additionally, for 38 industry aggregations, and 471 detailed industries, four tables of multipliers exist. Rather than discuss in detail each of these options, we recommend using a table of total final-demand multipliers for output, earnings, employment (Labeled Table 1.4). Since the air cargo industry is limited in the types of industries that use its services, it would be best to select from the more detailed 471 industry multipliers rather than the 38 industry aggregation.

As offered with Table 8, a simple table can be developed to total these full impacts. In the first column, list all the detailed industries that would be impacted by the expansion of air cargo capacity. In the second column, list the direct impact to the column 1 industry either as dollars for most items or the number of jobs for the additional employment provided. There would then be up to three columns (3, 4, and 5, below) listing the final demand multipliers. These multipliers would be provided by BEA in accordance with what the analyst ordered from them for the modeled region. The final set of columns (6, 7, and 8) would then be the final demand multiplier columns (3, 4, and 5) times the second column displaying the resulting full impact on the defined region. The last three columns would be added up for all the industries listed to determine the estimated final full impact.

Table 8. Simplified Economic Impact Estimation Model

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
			Final Demand Multiplier			Full Impact	
Industry 1	Direct impact ($ or employ)	Output ($)	Earnings ($)	Employment (jobs)	Output ($)	Earnings ($)	Employmen t (jobs)
					Col. 2X3	Col. 2x4	Col. 2x5
Industry 2							
Industry 3, etc.							
					Total	Total	Total

3 SECTION III – CASE STUDIES FOR FIVE SELECTED AIRPORTS

In 2012, U.S. airports served 807.1 million passengers and handled 57.3 billion pounds of freight (Bureau of Transportation Statistics 2012). Most of the air service (83.2 percent of passengers and 88.5 percent of the cargo) was provided by the nation's top 50 airports (ACI 2012). Although the air services supplied by airports were highly concentrated in the nation's largest airports, small and medium airports also were involved and generated substantial economic effects for their local economies.

In selecting a sample of five airports for the case studies, it is certainly critical to understand that air freight and passenger services are dominated by a small number of large airports. Still, it is important to capture the perspective of airports with differing characteristics, since the models presented with this Guidebook must be useful for various types of airports. The selection criteria for sample airports included:

- Geographic dispersion
- Airport characteristics
    - Major passenger and air freight hub
    - Specialized airport
    - Major regional airport.

Based on the criteria set up for selecting sample airports for case studies, the following five airports were selected:

- JFK in New York, NY
- RNO in Reno, NV
- IAH in Houston, TX
- SDF in Louisville, KY
- MCI in Kansas City, MO

These airports represent a sample of major hubs, special types of large airports, and major regional airports in diversified regions. Each airport has its characteristics and specialties, which are summarized in Table 9.

Table 9. Characteristics of Airports Selected for Case Studies

Airport Code	City, State	Selection Criterion	Region	Freight Shipment (million lbs.)	# of Passengers Enplaned (thousands)	% of Outbound
JFK	New York, NY	Hub	NE	2,824.2	23,663.0	44.3
SDF	Louisville, KY	Integrator	S	4,640.0	1,647.5	51.6
MCI	Kansas City, MO	Regional	MW	182.7	5,007.3	50.2
IAH	Houston, TX	Regional	S	919.2	19,303.1	50.4
RNO	Reno, NV	Regional	W	109.3	1,8178.0	59.3

Source: Bureau of Transportation Statistics (2012).

3.1 Case Studies

Case Study 1 – Kansas City International Airport, Kansas City, MO

MCI has served the needs of travelers to the Midwest for over 25 years. Opening in 1972, the airport is owned and operated by the city of Kansas City, Missouri. The airport is located approximately 15 miles from the center of the city. Its 10,000-plus acres of airfield make it physically one of the largest airports in the U.S., and its three runways can accommodate up to 139 aircraft operations per hour. There are currently ten major airlines that operate out of the three passenger terminals at MCI, which saw an increase in passenger traffic in 2010 of 1.3 percent from the previous year, despite a decrease in total aircraft movements of 2.5 percent over 2009 (Kansas City Aviation Department 2012).

The airport is well positioned in the United States for air cargo and distribution development. It must, however, compete with larger gateways where the ability to consolidate freight is a substantial advantage. In 2010, total cargo handling saw a decrease of 1.8 percent from the previous year due to a shift in domestic freight to trucking and total airmail operations. However, international freight saw a substantial 41.3 percent increase from the previous year (from a relatively small base) due mainly to increased charter activity (Kansas City Aviation Department 2012). The airport has a surplus of existing cargo capacity and enough land to expand if needed. The cargo area is comprised of four commercial cargo terminals with airside access. The cargo facilities contain an expansive cargo-handling infrastructure, on-site Foreign Trade Zone, and Enhanced Enterprise Zone tax initiatives. The city is also known for having the nation's second largest rail center, which contributes to the efficiency of the region's overall logistics system.

More than 95 percent of the cargo moving through MCI is processed by the integrators (Kansas City Aviation Department 2012). FedEx and United Parcel Service (UPS) control 73 percent and 25 percent of the cargo moving through the airport, respectively (Kansas City Aviation Department 2012). Since the early 1990's, much of the international origin-and-destination cargo from the Kansas City area has been trucked to international hubs such as Chicago and Dallas/Ft. Worth due to the lack of wide-body passenger aircraft at MCI. In 2011, passenger carriers accounted for less than 6.2 percent of the total freight carried at the airport and this percentage has diminished (Bureau of Transportation Statistics 2012). Trans-Pacific and trans-Atlantic air cargo markets may have some future potential if congestion builds at other established gateways. Domestic growth in the cargo industry is expected to increase in the future for integrated carriers, which could potentially have an impact on future cargo operations at MCI. It is likely that growth in the air cargo industry will also require leading carriers such as FedEx and UPS to adjust and update aircraft to accommodate the growing market, potentially affecting cargo operations at MCI.

This case study describes the structure of the Kansas City regional economy, and the method for estimating the economic impact of air cargo through MCI airport. These estimates are presented at the scale of the 15-county Kansas City, MO-KS Metropolitan Statistical Area, consistent with the 2009 Office of Management and Budget (OMB) regional definition and comprised of the following counties:

- Franklin County, KS
- Johnson County, KS
- Leavenworth County, KS
- Linn County, KS
- Miami County, KS
- Wyandotte County, KS
- Bates County, MO
- Caldwell County, MO
- Cass County, MO
- Clay County, MO
- Clinton County, MO
- Jackson County, MO
- Lafayette County, MO
- Platte County, MO
- Ray County, MO

Airports play an essential role in supporting the growth of a metropolitan economy like the Kansas City region. They directly employ hundreds of workers and provide millions of dollars in direct economy activity and taxes and other revenues to local government. They also support the growth of the regional economy by moving people, goods, and services that originate in, or are transported through the region, in response to its market opportunities. Airports and related aviation facilities become structurally integrated into a region's economy and provide it with competitive advantages. Airports enable industries that either depend on, or learn to take advantage of, efficient air transportation to access domestic and international markets. In the Kansas City region, MCI plays this vital role.

The airport accommodated over 10 million passengers and nearly 86,000 metric tons of cargo in 2011, making it the 36th busiest passenger airport and 45th busiest cargo airport in North America according to ACI's 2011 report.

The primary objective of this case study was to estimate the current economic impacts associated with the air cargo movement, estimating the economic output, employment, personal income, of that activity, and to document the analysis so as to make it easily replicable for other airports in other regions.

The analysis is based on RIMS-II multipliers. The RIMS-II multipliers are regional input-output multipliers developed and provided by the Bureau of Economic Analysis (BEA). These multipliers allow the user to estimate the economic impact of a change in final demand,[1] in earnings, or in employment on a region's economy.

The multipliers are used to estimate changes in the regional economy that result from a change in activity relative to a baseline representation of the economy. The sources of the activity being measured vary, but typically involve changes in production or consumption

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[1] Also referred to as "change in output delivered to final users."

activities, government policies, infrastructure, or changes in costs or technology. For any change in economic activity, the impacts on the economy are typically reported on one of three levels:

- Direct impacts represent the initial change in final demand for the industry sector(s) in question. For this analysis, we are estimating the economic activity associated with air cargo in Kansas City.

- Indirect impacts represent the response as supplying industries increase output to accommodate the initial change in final demand. These indirect beneficiaries spend money for supplies and services, which results in another round of indirect spending, and so on. Indirect impacts are often referred to as "supply-chain" impacts.

- Induced impacts are generated by the spending of households that benefit from the additional wages and income earned through direct and indirect economic activity. The increase in income, in effect, increases the purchasing power of households. Induced impacts are also described as "consumption-driven" effects.

This cycle of direct, indirect, and induced spending does not go on forever. It continues until the spending eventually leaks out of the economy as a result of taxes, savings, or purchases of non-locally produced goods and services or "imports."

The RIMS-II multipliers are provided for Type I and Type II impacts. Type I multipliers account for the direct and indirect impacts based on the supply of goods and services in the region. Type II multipliers account for these same direct and indirect impacts, and for induced impacts, associated with the purchases made by employees. Both types of multipliers include the initial change.

Kansas City Regional Economy

Kansas City is one of 422 Metropolitan Statistical Areas (MSA) in the United States. Based on its 2009 population estimate of 2,067,585, it is ranked 29th in size in the United States. Its per-capita personal income is about 102 percent of the national average.

The scale of economic activity occurring in the Kansas City region would not have been possible without development of the water, rail, highway, and airport infrastructure that enables businesses to take maximum advantage of the region's location.

The economic multiplier effect generated by air cargo activities depends on the geographic boundary or defined "region of analysis." A dollar spent in the City of Kansas City has a smaller impact on the city alone than it would have on the 15-county region. When selecting the region of analysis, the goal is to balance selecting an area that is large enough to capture a substantial portion of the economic multiplier effect and an area that is small enough to be relevant for the regional analysis.

Estimating MCI's Air Cargo Contribution to the Regional Economy

This section summarizes the methods used to estimate MCI's current contribution to the regional economy. This effort quantifies the impact the air cargo through the airport has on the economy at a particular moment in time, using input-output modeling and analysis recommended by the FAA.

Measuring the economic impact of the cargo activity at the airport involves tracing the linkages between the airport's cargo activity level, expressed in terms of airport operations and air cargo volumes, and the sectors of the economy that interact with them. These linkages produce the "direct," or initial round of economic impact. Direct impacts, in turn, stimulate "indirect" impacts, from the supply of goods and services to businesses at the airport or production of goods for shipment by air. A third round of economic impacts, called "induced" impacts, results from the spending of income earned by direct and indirect employees. The sum of indirect and induced impacts is often referred to as the "multiplier effect" on direct impacts. Total economic impact is the sum of the direct, indirect, and induced impacts.

The first and perhaps most obvious source of MCI-related economic impact is the employees who work there. Though many are present to support the air passengers (such as passenger and visitor service providers), many are associated with airport operations and air cargo, including cargo-handling companies, customs agents, TSA, customs brokers, container freight stations, freight forwarders, trucking companies, and other cargo-related services.

A second important impact related to airport economic activity is the passenger impact, including expenditures for lodging, food, retail purchases, entertainment, transportation services and parking, among others. Again, the scope of this effort is focused on air cargo, rather than on passengers.

The final category of impact is the contribution of air cargo to the regional economy. The analysis of economic impacts of air cargo shipments is part of a developing area of economic research that is still limited by two key factors: 1) the lack of a complete and workable theory of the role of air cargo in economic development; and 2) the lack of data describing the quantity and value of exported goods at any level of specificity. We will explore these limitations and some analytic approaches to them in the next section.

Airport Operations

As noted earlier, the first and most obvious source of MCI-related economic impact is the employees who work there. Those associated with air cargo include airlines handling cargo, other cargo-handling companies, customs agents, TSA, customs brokers, container freight stations, freight forwarders, trucking companies, and other cargo-related services.

Employment data were provided by the airport authority and supplemented by the project surveys of air carriers. These combined data yielded the cargo-related employment estimates presented in the remainder of this section.

Cargo-related employment for airlines and forwarders were estimated from survey responses, employment data from the airport, and analyses of other similar airports.

Despite repeated attempts to gather employment data for several of the cargo-related categories listed above (customs agents, customs brokers, TSA, etc.), we were unable to secure such data. Therefore, it is likely that some of the categories are underrepresented in this analysis.

Information received on Kansas City airport cargo operations includes limited employment information from the airport and information from the survey of airlines. Given the information available, the figures for employment and employment categories were estimated from the information provided by the airport, and are shown in Table 10.

Table 10. Estimated Employment by Industry Group, MCI, 2010

	Number of Jobs (a)
Air Transport	27
Transportation Support Activities	380
Couriers and Messengers	55
Total	462

Source: Employer surveys and MCI Airport Authority.

Resulting output was estimated from these employment figures and the RIMS-II multipliers. Using the RIMS-II multipliers, we can determine the average number of direct jobs per million dollars change in final demand, as shown in Table 11.

Table 11. Using the Multipliers and an Estimate of the Number of Jobs the Final-demand Industry to Calculate Final-demand*

Industry	Final-demand Multiplier				Direct-effect Multiplier		Direct jobs per $1m change in final-demand (col. c ÷ col. f)
	Output (total industry output per $1 change in final-demand)	Earnings (total household earnings per $1 in final-demand)	Employment (total jobs per $1m change in final-demand)	Value-added (total value-added per $1 change in final-demand)	Earnings (total household earnings per $1 change of household earnings in the final-demand industry)	Employment (total jobs per 1 job change in the final-demand industry)	
	(a)	(b)	(c)	(d)	(e)	(f)	(g)
Air transportation	2.20	0.71	17.82	1.15	2.02	2.68	6.66
Support activities for transportation	2.44	0.87	22.41	1.42	2.07	2.79	8.04
Couriers and messengers	2.09	0.63	22.27	1.24	2.15	1.91	11.65

**Multipliers for the final-demand industry are used to calculate the final-demand change. The change in earnings in the final-demand industry is often referred to as the direct or initial earnings. Similarly, the change in jobs in the final-demand industry is often referred to as the direct or initial jobs.*

Source: BEA 2011.

From there, the number of direct jobs is divided by the direct jobs per $1 million in final demand to arrive at an estimated final demand, as shown in Table 12.

Table 12. Estimated Final Demand from Multipliers and Estimate of Jobs

	Direct Employment	Direct jobs per $1m change in final-demand (col. H from Table 2)	Estimated final-demand based on RIMS II assumptions and estimated new jobs in the final-demand industry (millions of dollars) (col. a / col. b)
	(a)	(b)	(c)
Air transportation	27	6.66	4.06
Support activities for transportation	380	8.04	47.25
Couriers and messengers	55	11.65	4.72

Source: BEA 2011.

For most types of goods-producing industries, the resulting estimated output would be adjusted for regional purchases in purchasers' prices, adjusting for transport costs and wholesale and retail margins. However, according to the I-O commodity composition of NIPA (BEA's National Income and Product Accounts) final use by exports of goods and services, the purchaser value is equivalent to the producer value for these industry categories, therefore, margining for producer prices does not apply.

These 462 direct jobs have an estimated output value of over $56 million as shown in Table 13. In addition to the direct impacts, they would have an additional total impact estimated of over $134 million in output, over $47 million in aggregated earnings, and over 1,230 total jobs, as shown in Table 13.

Table 13. Estimated Economic Impact, Air Cargo Operations, MCI

		Final Demand Multiplier			Impact		
	Regional Purchases (millions of dollars)	**Output (millions of dollars)**	**Earnings (millions of dollars)**	**Employment (number of jobs)**	**Output (millions of dollars)** (col a * col b)	**Earnings (dollars)** (col a * col c)	**Employment (number of jobs)** (col a* col d)
	(a)	(b)	(c)	(d)	(e)	(f)	(g)
Air transportation	$4.06	$2.20	$0.71	17.82	$8.92	$2.87	72
Support activities for transportation	$47.25	$2.44	$0.87	22.41	$115.48	$41.31	1,059
Couriers and messengers	$4.72	$2.09	$0.63	22.27	$9.85	$2.99	105
Total	$56.02				$134.25	$47.18	1,236

Source: BEA 2011.

Air Cargo Impacts to Regional Economy

More difficult to quantify is the contribution of air cargo to the regional economy. However, it is generally agreed industries are concentrated within regions with direct access to air cargo operations. In the absence of this access, companies that rely on these services would likely re-locate to other regions with such access.

As noted earlier, the analysis of economic impacts of air cargo shipments is part of a developing area of economic research that is still limited by two key factors: 1) the lack of a complete and workable theory of the role of air cargo in economic development; and 2) the lack of data describing the quantity and value of exported goods at any level of specificity.

In the first category, one important issue that remains unanswered is the potential for shippers to utilize other airports in the region to export goods in the presence of air cargo supply constraints. For example, there are other airports within the trade area of MCI. This factor is important for modeling MCI's contribution to the regional economy. It would be unreasonable, for example, to simply subtract the entire value of goods exported by air, because this subtraction would grossly overstate the economic impacts of air cargo (i.e., the value of the goods shipped by air).

In the second category are severe air cargo limitations. There are few systematic sources of air cargo data. One is the US Department of Commerce import and export trade statistics and a second is the Commodity Flow Survey (CFS) undertaken every five years by a partnership between the Bureau of Transportation Statistics and the Census Bureau. Data are available for 89 National Transportation Analysis Regions (NTARs). The challenge is that these NTARs are generally larger in geographic area than the metropolitan regions being analyzed. (There are only 89 NTARs in the United States, compared to 422 Metropolitan Statistical Areas. As such, the NTARs are generally much larger than the metropolitan areas, making the cargo volumes for NTARs generally higher than those for the metropolitan areas.)

The Freight Analysis Framework (FAF) integrates data from a variety of sources to create a comprehensive picture of freight movement among states and major metropolitan areas by all modes of transportation. With data from the 2007 Commodity Flow Survey and additional sources FAF version 3 (FAF^3) provides estimates for tonnage and value by origin, destination, commodity, and mode for 2007, the most recent year, and forecasts through 2040.

According to the FAF, over 8 million tons of goods were shipped from the Kansas City Metropolitan area. Of that, nearly 1,040 tons were shipped via air (including truck and air).[2] The largest proportion of goods shipped by air is machinery by weight, comprising just under 15 percent of the weight of commodities shipped by air. In terms of value, transportation equipment is higher in value terms, nearly 47 percent of the value of goods shipped by air but just over 7 percent of the weight of goods shipped by air in 2007. Other major commodities shipped via air include electronics and precision equipment, as shown in Table 14.

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[2] The modes tracked by the Commodity Flow Survey are: For-hire truck, Private truck, Rail, Air, Shallow draft vessel, Deep draft vessel, Pipeline, Parcel/U.S. Postal Service/courier, Other, and Unknown.

Table 14. Shipment Characteristics by Commodity for Air Transportation (including Truck and Air) for Kansas City Metropolitan Area of Origin: 2007

Commodity	Value		Weight	
	Million $ in 2007	Percent of Total Value	KTons in 2007	Percent of Total Weight
Animal feed	0.0062	0.0%	0.0065	0.6%
Articles-base metal	1.3462	1.4%	0.0895	8.6%
Base metals	0.4849	0.5%	0.0524	5.1%
Basic chemicals	1.1997	1.2%	0.0697	6.7%
Cereal grains	0.005	0.0%	0.0038	0.4%
Chemical prods.	1.3744	1.4%	0.0421	4.1%
Coal-n.e.c.	0.0203	0.0%	0.0056	0.5%
Electronics	15.668	16.0%	0.1081	10.4%
Furniture	0.3874	0.4%	0.0122	1.2%
Live animals/fish	0.0372	0.0%	0.0005	0.0%
Machinery	12.9457	13.2%	0.1498	14.5%
Meat/seafood	0.0118	0.0%	0.0037	0.4%
Metallic ores	0.0025	0.0%	0.0075	0.7%
Milled grain prods.	0.0043	0.0%	0.0189	1.8%
Misc. mfg. prods.	0.3542	0.4%	0.0084	0.8%
Mixed freight	0.6968	0.7%	0.0116	1.1%
Motorized vehicles	0.2932	0.3%	0.0235	2.3%
Nonmetal min. prods.	0.6282	0.6%	0.0753	7.3%
Nonmetallic minerals	0	0.0%	0	0.0%
Other ag prods.	0.0054	0.0%	0.0005	0.0%
Other foodstuffs	0.1913	0.2%	0.0608	5.9%
Paper articles	0.1672	0.2%	0.0198	1.9%
Pharmaceuticals	3.2331	3.3%	0.0475	4.6%
Plastics/rubber	0.8406	0.9%	0.0478	4.6%
Precision instruments	11.0804	11.3%	0.0281	2.7%
Printed prods.	1.0938	1.1%	0.0349	3.4%
Textiles/leather	0.2452	0.2%	0.0117	1.1%
Transport equip.	45.8372	46.7%	0.0756	7.3%
Wood prods.	0.0088	0.0%	0.0206	2.0%
Grand Total	98.169	100.0%	1.0364	100.0%

Source: BTS 2009.

Cargo Screening and Jet Fuel Elasticity Modeling

The effects of the 100-percent cargo screening rule and volatility in jet-fuel prices were analyzed and described in a separate chapter, with price models developed to estimate the elasticity of demand upon price changes from the increased costs of the additional cargo screening and the increase in the price of air cargo due to increases in jet-fuel prices.

Cargo Screening Impacts

The elasticity analysis noted that the cargo screening includes three effects to be captured in the I-O models applied at the case-study airports:

- The reduced demand for air cargo modeled as a contraction in the industries engaged in air cargo operations
- Increased output by air transportation engaged in air cargo screening activities
- Increased output for air transportation companies due to overhead applied to air cargo screening costs (this third impact serves to counterbalance the first effect)

Table 15 presents the air cargo the inputs required for the I-O models. The reduction in freight presented in this table represents the percentage reduction in total (cargo-only and cargo transported on-board passenger airplanes) cargo. The impacts vary depending on the price elasticity modeled at each airport and the scale of air cargo transported on-board passenger aircraft. The screening rule does not affect cargo-only aircraft. The negative economic effects reduce the economic output of the industry. The cargo screening costs and industry markup attached to those costs reflect the price increase that is passed on to the customer. These values reflect increased revenue/output to the air transportation and supporting industries.

Table 15. Air Cargo Screening Inputs for I-O Models

Airport	Reductions in Freight		Cargo Screening Costs		Gross Industry Surplus on Cargo Screening Costs	
	TSA Analysis	Industry Estimates	TSA Analysis	Industry Estimate	TSA Analysis	Industry Estimate
IAH	-0.6%	-0.9%	$8,944,118	$12,775,705	$751,501	$1,073,438
JFK	-2.7%	-3.8%	$25,241,205	$36,054,330	$2,120,813	$3,029,352
MCI	-0.4%	-0.6%	$247,949	$354,169	$20,833	$29,758
RNO*	-0.1%	-0.1%	$71,619	$102,300	$6,018	$8,595
SDF	0.0%	0.0%	$101,236	$144,605	$8,506	$12,150

For Kansas City, the reductions in freight and counterbalancing increases in cargo screening impacts results in the following direct impacts:

Table 16. Air Cargo Screening Inputs for MCI I-O Modeling

Grand Total Changes	Lower Estimate	Upper Estimate
Air Transport	($15,854)	($24,390)
Transportation Support Activities	($182,264)	($280,645)
Couriers/messengers	($28,320)	($42,480)
Total Changes	($226,438)	($347,515)

According to the RIMS-II multipliers, these direct impacts of between $226,400 and $348,000 would result in between $539,400 and $828,600 in total impact, as shown in Table 17 below.

Table 17. Economic Impact Associated with Cargo Screening

	Regional Purchases (dollars)	Output (dollars)	Earnings (dollars)	Employment (number of jobs)	Value-added (dollars)
Cargo Screening- lower estimate					
Transport by air	($15,854)	($34,865)	($11,234)	(0.28)	($18,181)
Sup't activities/ air transport	($182,264)	($445,490)	($159,372)	(4.08)	($258,742)
Couriers/messengers	($28,320)	($59,078)	($17,963)	(0.63)	($35,049)
Total Impact	($226,438)	($539,433)	($188,569)	(5.00)	($311,972)
Cargo Screening- upper estimate					
Transport by air	($24,390)	($53,636)	($17,283)	(0.43)	($27,970)
Sup't activities/ air transport	($280,645)	($685,953)	($245,396)	(6.29)	($398,404)
Couriers/messengers	($42,480)	($88,618)	($26,945)	(0.95)	($52,573)
Total Impact	($347,515)	($828,206)	($289,624)	(7.67)	($478,947)

Impacts of Jet Fuel Price Fluctuations

The second elasticity model developed examines the impacts of jet-fuel price increases on air cargo demand. It examined the impacts associated with 10 to 30 percent increases in jet-fuel prices, using a stepwise regression approach.

Table 18 presents the impacts of a 10, 20, and 30 percent increase in jet fuel prices on demand for air cargo at each of the five case study airports. For every 10 percent increase in jet-fuel prices, air cargo demand is estimated to decline by 0.7 percent.

Table 18. Impacts of Jet Fuel Price Increases (10, 20, and 30 percent) on Demand for Air Cargo

	Impacts of Jet Fuel Prices Increases on Demand for Air Cargo		
Airport	**10%**	**20%**	**30%**
IAH	(6,368,857)	(12,737,715)	(19,106,572)
JFK	(21,150,552)	(42,301,105)	(63,451,657)
MCI	(1,354,130)	(2,708,260)	(4,062,390)
RNO	(781,291)	(1,562,582)	(2,343,873)
SDF	(33,956,926)	(67,913,853)	(101,870,779)
Reduction in Air Cargo	**-0.7%**	**-1.5%**	**-2.2%**

Applying these values to the on-airport operations yields the following results for the 10, 20, and 30-percent increases in jet-fuel prices. As shown in Table 19, the reduction in output ranges from $939.7 thousand to $2.8 million for 10 percent and 30 percent increases in jet fuel prices, respectively.

Table 19. Economic Impacts of Jet Fuel Price Increases (10, 20, and 30 percent)

	Regional Purchases (dollars)	Output (dollars)	Earnings (dollars)	Employment (number of jobs)	Value-added (dollars)
10% increase in fuel price					
.7% decrease in cargo volume					
Transport by air	($28,399)	($62,453)	($20,124)	(0.5)	($32,568)
Sup't activities/ air transport	($330,721)	($808,348)	($289,182)	(7.4)	($469,492)
Couriers/messengers	($33,035)	($68,915)	($20,954)	(0.7)	($40,885)
Total Impact	($392,156)	($939,717)	($330,261)	(8.7)	($542,945)
20% increase in fuel price					
1.5% decrease in cargo volume					
Transport by air	($60,856)	($133,828)	($43,122)	(1.1)	($69,789)
Sup't activities/ air transport	($708,688)	($1,732,175)	($619,677)	(15.9)	($1,006,053)
Couriers/messengers	($70,790)	($147,675)	($44,902)	(1.6)	($87,610)
Total Impact	($840,334)	($2,013,678)	($707,701)	(18.5)	($1,163,453)
20% increase in fuel price					
1.5% decrease in cargo volume					
Transport by air	($85,198)	($187,359)	($60,371)	(1.5)	($97,705)
Sup't activities/ air transport	($992,163)	($2,425,045)	($867,547)	(22.2)	($1,408,475)
Couriers/messengers	($99,106)	($206,746)	($62,863)	(2.2)	($122,654)
Total Impact	($1,176,467)	($2,819,150)	($990,782)	(26.0)	($1,628,834)

Case Study 2 – Louisville International Airport, Louisville, KY

Louisville International Airport (SDF), located just 10 minutes from downtown Louisville, Kentucky was originally established by the U.S. Army Corp of Engineers in 1941. The airport efficiently operates with two parallel runways and one crosswind runway and more than 62,000 linear feet of Taxiways. In 2011, the Airport recorded 152,998 operations (take offs and landings). Situated on 1,200 acres, the airport contains a centralized terminal facility with 23 passenger gates. In 2010, the airport served more than 3.3 million passengers. This represented an increase of 2.6 percent over 2009 traffic volumes (Louisville Regional Airport Authority 2012). Currently, 8 major commercial passenger airlines operate out of SDF. These carriers mainly serve the Midwest and east coast, however, there are a few western destinations including Las Vegas, Nevada and Denver, Colorado. Most of the operations are with narrow-body aircraft or regional jets that provide very limited belly capacity for cargo. SDF is also home to the 123rd Wing of the Kentucky Air National Guard, as well as one of the top air cargo facilities in the world.

SDF is ranked 10th among the top air cargo airports in the world and ranks 3rd domestically behind Memphis, Tennessee and Anchorage, Alaska (which is essentially a transfer facility and fuel stop for transpacific traffic). SDF processed over 2.3 million tons of total cargo in 2010 - up 11.2 percent from the previous year (Louisville Regional Airport Authority 2012). In 2011, the Airport's cargo volumes were flat due to recent economic stagnation.

Cargo is the fortress hub of United Parcel Service (UPS) and its massive Worldport facility. This substantial operation connects Louisville to 220 countries and territories and process 416,000 packages per hour. In addition to their Worldport facility, UPS added a heavy airfreight hub in 2005 that provides an additional 686,000 square feet of space for operations (United Parcel Service 2011). The Worldport facility occupies approximately 5.2 million square feet of space. The second UPS Worldport expansion was completed in 2010 increasing the facilities sorting capacity by 37 percent. The operation, which is dominated by an extremely sophisticated material handling system, is nevertheless extremely labor intensive.

This section describes the structure of the Louisville regional economy, and the method for estimating the economic impact of air cargo through SDF airport. These estimates are presented at the scale of the eight-county region, comprised of Bullitt, Jefferson, Oldham, and Shelby counties in Kentucky, and Clark, Floyd, Harrison, and Scott counties in Indiana.

Airports play an essential role in supporting the growth of a metropolitan economy like the Louisville region. They directly employ hundreds of workers and provide millions of dollars in direct economic activity and taxes and other revenues to local government. They also support the growth of the regional economy by moving people, goods, and services that originate in, or are transported through, the region. Airports and related aviation facilities become structurally integrated into a region's economy and provide it with competitive advantages. Airports enable industries that either depend on, or learn to take advantage of, efficient air transportation to access domestic and international markets. In the Louisville region, SDF plays this vital role.

Because the purpose of this project is to develop a Guidebook for quantifying the economic impacts of air cargo, this analysis focuses on the cargo volumes through SDF, with limited analysis of passengers and airline operations. The primary objective of this analysis is to estimate the current economic impacts associated with the air cargo movement, estimating the economic output, employment, personal income, of that activity, and to document the analysis so as to make it easily replicable for other airports in other regions.

This memo first describes the structure of the Louisville metropolitan economy in 2009, using a Louisville region-specific version of the IMPLAN impact analysis software.[3] It then presents the methods used to estimate the air cargo contribution to the economy, and finally presents estimates of economic impact of that air cargo movement.

The model is used to measure changes in the regional economy that result from a change in activity relative to a baseline representation of the economy. The sources of the activity being measured vary, but typically involve changes in production or consumption activities, government policies, infrastructure, or changes in costs or technology. For any change in economic activity, the impacts on the economy can be reported on one of three levels:

- **Direct** impacts represent the initial change in final demand for the industry sector(s) in question. For this analysis, we are estimating the economic activity associated with air cargo in Louisville.

- **Indirect** impacts represent the response as supplying industries increase output to accommodate the initial change in final demand. These indirect beneficiaries spend money for supplies and services, which results in another round of indirect spending, and so on. Indirect impacts are often referred to as "supply-chain" impacts.

- **Induced** impacts are generated by the spending of households who benefit from the additional wages and income they earn through direct and indirect economic activity. The increase in income, in effect, increases the purchasing power of households. Induced impacts are also described as "consumption-driven" effects.

This cycle of direct, indirect, and induced spending does not go on forever. It continues until the spending eventually leaks out of the economy as a result of taxes, savings, or purchases of non-locally produced goods and services or "imports".

Louisville Regional Economy

This section summarizes the Louisville economy, and presents an economic portrait of the region's economy in terms of employment and output by industry for the base year of 2009.

Louisville is one of 422 MSAs in the United States. Based on its 2009 population estimate of 1.14 million, it is ranked 42nd in size in the United States. Its per-capita personal income is about 95 percent of the national average. There are an estimated 726,742 jobs across 356 industries in the region. The top industries by employment are presented in Table 20.

[3] The IMPLAN model is based on an input-output modeling framework, and uses secondary source data and proprietary analytic methods to estimate empirical input-output relationships from a combination of national technological relationships and county-level measures of economic activity.

Table 20. Top Ten Industries, Ranked by Employment
Louisville Region, 2009

Code	Description	Employment	Labor Income	Output
413	Food services and drinking places	49,539	$1,022,839,000	$2,829,005,000
438	State & local govt, education	44,401	$2,489,589,000	$2,828,209,000
360	Real estate establishments	30,527	$285,869,900	$2,811,924,000
319	Wholesale trade businesses	27,909	$2,034,809,000	$5,337,690,000
394	Offices of physicians, dentists, and other health practitioners	22,438	$1,658,313,000	$2,806,253,000
397	Private hospitals	21,994	$1,353,499,000	$2,895,250,000
382	Employment services	20,393	$410,902,500	$599,624,600
339	Couriers and messengers	17,650	$1,341,379,000	$3,645,585,000
357	Insurance carriers	17,154	$1,308,918,000	$5,289,567,000
437	State & local govt, non-education	14,988	$776,938,200	$882,612,900

Source: MIG 2011a.

The top industries ranked by output are presented in Table 21.

Table 21. Top Ten Industries, Ranked by Output
Louisville Region, 2009

Code	Description	Employment	Labor Income	Output
277	Light truck and utility vehicle manufacturing	3,314	$349,197,500	$5,516,958,000
319	Wholesale trade businesses	27,909	$2,034,809,000	$5,337,690,000
357	Insurance carriers	17,154	$1,308,918,000	$5,289,567,000
361	Imputed rental activity for owner-occupied dwellings	0	$0	$4,360,240,000
339	Couriers and messengers	17,650	$1,341,379,000	$3,645,585,000
397	Private hospitals	21,994	$1,353,499,000	$2,895,250,000
413	Food services and drinking places	49,539	$1,022,839,000	$2,829,005,000
438	State & local govt, education	44,401	$2,489,589,000	$2,828,209,000
360	Real estate establishments	30,527	$285,869,900	$2,811,924,000
394	Offices of physicians, dentists, and other health practitioners	22,438	$1,658,313,000	$2,806,253,000

Source: MIG 2011a.

The scale of economic activity occurring in the Louisville region would not have been possible without development of the water, rail, highway, and airport infrastructure that enables businesses to take maximum advantage of the region's strategic location at the midpoint of key North American trade routes. Today, the region is a major hub of express freight, with over 20,000 UPS employees based in the Louisville region. Though UPS had a hub in Louisville since 1980, it was in 2002 that the company made its first $1 billion expansion, establishing Louisville as "Worldport", the company's worldwide air hub. A second $1 billion expansion was completed in April 2010, bringing its facility to 5,200,000 square feet, with capacity to handle 416,000 packages per hour (United Parcel Service 2011).

The regional economic impacts of air cargo through SDF are directly related to the scale and composition of the air cargo forecasts (i.e., international versus domestic, and belly cargo versus all-cargo freighters).

Estimating SDF's Air Cargo Contribution to the Regional Economy

This section summarizes the methods used to estimate SDF's current contribution to the regional economy. This effort quantifies the impact the air cargo through the airport has on the economy at a particular moment in time, using input-output modeling and analysis recommended by the FAA (Butler and Kiernan 1992).

Measuring the economic impact of the cargo activity at the airport involves tracing the linkages between the airport's cargo activity level, expressed in terms of airport operations and air cargo volumes, and the sectors of the economy that interact with them. These linkages produce the "direct," or initial round of economic impact. Direct impacts, in turn, stimulate "indirect" impacts, from the supply of goods and services to businesses at the airport or production of goods for shipment by air. A third round of economic impacts, called "induced" impacts, results from the spending of income earned by direct and indirect employees. The sum of indirect and induced impacts is often referred to as the "multiplier effect" on direct impacts. Total economic impact is the sum of the direct, indirect, and induced impacts.

The first and perhaps most obvious source of SDF-related economic impact is the employees who work there. Though many are present to support the air passengers (such as passenger and visitor service providers), many are associated with airport operations and air cargo, including cargo-handling companies, customs agents, TSA, customs brokers, container freight stations, freight forwarders, trucking companies, and other cargo-related services.

A second important impact related to airport economic activity is the passenger impact, including expenditures for lodging, food, retail purchases, entertainment, transportation services and parking, among others. Again, the scope of this effort is focused on air cargo rather than on passengers.

The final category of impact is the contribution of air cargo to the regional economy. The analysis of economic impacts of air cargo shipments is part of a developing area of economic research that is still limited by two key factors: 1) the lack of a complete and workable theory of the role of air cargo in economic development; and 2) the lack of data describing the quantity and value of exported goods at any level of specificity. We will explore these limitations and some analytic approaches to them in the next section.

Airport Operations

As noted earlier, the first and most obvious source of SDF-related economic impact is the employees who work there. Those associated with air cargo include airlines handling cargo, other cargo-handling companies, customs agents, TSA, customs brokers, container freight stations, freight forwarders, trucking companies, and other cargo-related services.

Employment data were provided by the airport authority and supplemented by the project surveys of air carriers. These combined data yielded the cargo-related employment estimates presented in the remainder of this section.

Cargo-related employment for airlines and forwarders were estimated from survey responses, employment data from the airport, and analyses of other similar airports.

Despite repeated attempts to gather employment data for several of the cargo-related categories listed above (customs agents, customs brokers, TSA, etc.), we were unable to secure such data. Therefore, it is likely that some of the categories are underrepresented in this analysis. Employment with other air freight companies was extrapolated using cargo volumes reported by the airport and UPS' employment in their air business unit.

Of UPS' 20,288 Louisville employees, 13,934 work in the air business unit. Using the employment in the air business unit and the airport-reported air cargo volume for UPS of 2.396 billion enplaned pounds and 2.280 billion deplaned pounds yields an average of about 167.8 tons of air cargo volume per employee. There are shortcomings to this approach given UPS' atypical operations. However, other freight-handling companies operating in this area need to do so in a way which effectively competes with UPS, supporting the application of UPS' business model to ratios of other freight-handling companies. Applying that UPS average to the volume of air cargo reported by other air freight carriers to the airport suggests air cargo related employment in the Louisville region of 243 employees with other air freight employers (Table 22).

Table 22. Estimated Employment by Industry Group, SDF, 2010

Industry	Estimated Employment
Airlines	40
Freight forwarders	45
Other express package companies	243
UPS	20,288
Total	20,616

Source: Employer surveys, Louisville Regional Airport Authority.

These 20,616 direct jobs have an estimated aggregated labor income of $1.6 billion, and estimated output value of nearly $4.6 billion. In addition to these direct impacts, they would have an additional indirect impact of an estimate 9,200 indirect with nearly $413 million in labor in come and over $1 billion in output, and an additional 16,200 induced jobs with nearly $624 million in labor in come and over $1.8 billion in output, as shown in Table 23.

Table 23. Estimated Economic Impact, Air Cargo Operations, SDF

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	20,616.0	$1,628,987,781	$3,003,199,929	$4,582,713,114
Indirect Effect	9,241.3	$412,823,692	$630,001,968	$1,035,052,465
Induced Effect	16,227.4	$623,604,815	$1,114,000,105	$1,853,075,695
Total Effect	46,084.7	$2,665,416,288	$4,747,202,002	$7,470,841,275

Source: MIG 2011a.

Air Cargo Impacts to Regional Economy

More difficult to quantify is the contribution of air cargo to the regional economy. However, it is generally agreed that industries are concentrated within regions with direct access to air cargo operations. In the absence of this access, companies that rely on these services would likely re-locate to other regions with such access.

As noted earlier, the analysis of economic impacts of air cargo shipments is part of a developing area of economic research that is still limited by two key factors: 1) the lack of a complete and workable theory of the role of air cargo in economic development; and 2) the lack of data describing the quantity and value of exported goods at any level of specificity.

In the first category, one important issue that remains unanswered is the potential for shippers to utilize other airports in the region to export goods in the presence of air cargo supply constraints. For example, there are other airports within the trade area of SDF. This factor is important for modeling SDF's contribution to the regional economy. It would be unreasonable, for example, to simply subtract the entire value of goods exported by air, because this subtraction would grossly overstate the economic impacts of air cargo (i.e., the value of the goods shipped by air).

In the second category are severe air cargo data limitations. There are few systematic sources of air cargo data. One is the US Department of Commerce import and export trade statistics and a second is the CFS undertaken every five years by a partnership between the BTS and the Census Bureau. Data are available for 89 NTARs. The challenge is that these NTARs are generally larger in geographic area than the metropolitan regions being analyzed. (There are only 89 NTARs in the United States, compared to 422 MSAs. As such, the NTARs are generally much larger than the metropolitan areas, making the cargo volumes for NTARs generally higher than those for the metropolitan areas.)

According to the CFS, over 52 million tons of goods were shipped from the Kentucky part of the Louisville/Jefferson County-Elizabethtown-Scottsburg Metropolitan area. Of that, 11,000 tons were shipped via air (including truck and air).[4] The largest proportion of goods shipped by air is machinery by both weight and value terms, comprising 40 percent of the value of goods shipped by air and over 36 percent of the weight of goods shipped by air in 2007. Other major commodities shipped via air include electronics, printed products, pharmaceutical products, miscellaneous manufactured products, and articles of base metal. Unfortunately, the data for many of the commodities are suppressed for confidentiality, as shown in Table 24.

[4] The modes tracked by the Commodity Flow Survey are: For-hire truck, Private truck, Rail, Air, Shallow draft vessel, Deep draft vessel, Pipeline, Parcel/U.S. Postal Service/courier, Other, and Unknown.

Table 24. Shipment Characteristics by Two-Digit Commodity and Mode of Transportation for Metropolitan Area of Origin: 2007
Louisville/Jefferson County-Elizabethtown-Scottsburg, KY-IN (KY part)

		Value	Tons
SCTG (2) Code	Commodity Description	2007 (million $)	2007 (thousands)
07	Other prepared foodstuffs and fats and oils	S	S
08	Alcoholic beverages	S	S
20	Basic chemicals	S	S
21	Pharmaceutical products	3	-
23	Chemical products and preparations, nec	S	S
24	Plastics and rubber	S	S
28	Paper or paperboard articles	S	S
29	Printed products	2	1
30	Textiles, leather, and articles of textiles or leather	S	S
31	Nonmetallic mineral products	-	-
32	Base metal in prim. or semifin. forms & in finished basic shapes	S	S
33	Articles of base metal	4	-
34	Machinery	176	4
35	Electronic & other electrical equip & components & office equip	45	S
36	Motorized and other vehicles (including parts)	S	S
38	Precision instruments and apparatus	S	S
40	Miscellaneous manufactured products	4	S
43	Mixed freight	S	S
00	**All Commodities (5)**	**440**	**11**

S = Estimate does not meet publication standards because of high sampling variability or poor response quality. - = Zero or Less than half the unit shown; thus, it has been rounded to zero.

Notes: (1) Commodity Flow Survey (CFS) geographic areas were drawn from a subset of Combined Statistical Areas (CSAs) and Metropolitan Statistical Areas (MeSAs) as defined by the Office of Management and Budget (OMB). However, CFS metropolitan areas are divided into their state parts when they include more than one state. In addition, the CFS also utilizes a unique geography referred to as, "remainder of state," to represent those areas of a state not contained within a separately published metropolitan area for the CFS (as opposed to not part of any Core-Based Statistical Area (CBSA) as defined by OMB). Because of the differences in the CFS geography, as compared to OMB defined geography, caution should be exercised when comparing CFS estimates to other estimates of similar geography.

(2) Standard Classification of Transported Goods.

(6) "Truck" as a single mode includes any shipment that was made by private truck only, by for-hire truck only, or by a combination of private and for-hire truck.

Source: BTS 2009.

Given the lack of data, one approach is to utilize the linkage or interdependence between businesses, industries and clusters. One tool common with cluster analysis is to study the Location Quotient (LQ)[5], which measures industry concentration in a regional economy. It does so by comparing the ratio of employment in a certain sector of a local economy to the same ratio in a comparison economy, identifying specializations in the local economy. An LQ value of 1.0 indicates that employment in an industry in the regional economy is in exactly the same proportion as the national average, an LQ value greater than 1.0 indicates that employment in the industry has a higher concentration that of the reference economy, and—similarly—an LQ value lower than 1.0 indicates a lower employment concentration in the industry than that of the reference economy.

This analysis uses the BLS' Location Quotient Calculator of the 2010 Quarterly Census of Employment and Wages (QCEW) data (Bureau of Labor Statistics 2011). It uses the Louisville MSA as the analysis area and the U.S. total as the reference area. Concentrations or specialties in the regional economy emerge at the two-digit NAICS level, as shown in Table 25.

[5] Location Quotient: Ratio of analysis-industry employment in the analysis area to base-industry employment in the analysis area divided by the ratio of analysis-industry employment in the base area to base-industry employment in the base area.

Table 25. Location Quotients Calculated from Quarterly Census of Employment and Wages Data, 2010

Industry	Louisville, KY-IN MSA
Base Industry: Total, all industries	1
NAICS 11 Agriculture, forestry, fishing and hunting	0.14
NAICS 21 Mining, quarrying, and oil and gas extraction	ND
NAICS 22 Utilities	0.68
NAICS 23 Construction	0.99
NAICS 31-33 Manufacturing	ND
NAICS 42 Wholesale trade	1.02
NAICS 44-45 Retail trade	0.91
NAICS 48-49 Transportation and warehousing	2.06
NAICS 51 Information	0.74
NAICS 61 Educational services	ND
NAICS 62 Health care and social assistance	0.98
NAICS 71 Arts, entertainment, and recreation	0.95
NAICS 52 Finance and insurance	1.31
NAICS 53 Real estate and rental and leasing	0.79
NAICS 54 Professional and technical services	0.79
NAICS 55 Management of companies and enterprises	ND
NAICS 56 Administrative and waste services	ND
NAICS 72 Accommodation and food services	0.98
NAICS 81 Other services, except public administration	ND
NAICS 99 Unclassified	0.1

Footnotes:
(ND) Not Disclosable
Source: BLS 2011.

Compared to the U.S. average, the Louisville region has relatively lower concentrations of most industry groupings (or LQs) for most industry groups, with exceptions in Wholesale Trade, and Transportation and Warehousing, most likely due to the role of UPS' regional operations and related industries. The relatively high LQ in the Finance and Insurance industry group is likely due to the presence of key Bank of America and Citicorp operations in the Louisville region.

Though some of the data are suppressed for confidentiality reasons, we can explore the employment concentrations at the three-digit level for some codes, including NAICS codes 481 through 493, as shown in Table 26.

**Table 26. Location Quotients Calculated from Quarterly Census of Employment and Wages Data, 2010
NAICS Codes 481 through 493 Only**

Industry	Louisville, KY-IN MSA
Base Industry: Total, all industries	1
NAICS 481 Air transportation	0.25
NAICS 482 Rail transportation	ND
NAICS 483 Water transportation	ND
NAICS 484 Truck transportation	1.47
NAICS 485 Transit and ground passenger transportation	0.46
NAICS 486 Pipeline transportation	ND
NAICS 487 Scenic and sightseeing transportation	ND
NAICS 488 Support activities for transportation	0.9
NAICS 491 Postal service	1.08
NAICS 492 Couriers and messengers	7.29
NAICS 493 Warehousing and storage	2.25

(ND) Not Disclosable
Source: BLS 2011.

At the three-digit level, it is evident that the higher LQs in the transportation and warehousing are related to the very high LQ of NAICS code 492 (couriers and messengers)—most likely attributable to the presence of UPS. At 7.29, the courier and messenger industry is over seven times as concentrated in the Louisville region than in the U.S. national average overall. Warehousing and storage is also very concentrated—more than twice as concentrated as the U.S. national average, likely made possible by the concentration of courier and messenger services. It is interesting to note that these concentrations are present in spite of the fact that truck transportation is just slightly higher than the national average and air transportation actually has a very low LQ—one-quarter the concentration of the U.S. national average.

One way to approach the LQ to estimate the impact of air cargo in the region is to quantify the economic impact of the air cargo on the regional economy is model the portion of the high LQ industries. For example, with the truck transportation LQ at 1.47 and warehousing and storage at 2.25, it is likely that 32 percent of truck transportation (the “extra 0.47”) and 55.6 percent of warehousing and storage (the “extra 1.25”) are due to the presence of UPS’ Worldport operations (Table 27).

Table 27. Estimation of Economic Activity Attributable to Presence of UPS' Worldport Operations

	LQ	Percentage over Base	Total Industry Employment	"Extra" Employment due to presence of UPS' Worldport
NAICS 484 Truck transportation	1.47	32.0%	10,741	3,434
NAICS 493 Warehousing and storage	2.25	55.6%	6,022	3,346

Source: Bureau of Labor Statistics 2011and MIG 2011a.

Using total industry employment in each of those industries, we are able to calculate the additional employment in the industry due to the presence of UPS' Worldport operations and to estimate the economic impacts associated with those activities.

As one indicator, the warehousing and storage industry in the Louisville metropolitan region has over 6,000 employees in aggregate. According to the shippers' survey, many of the shippers in this region fall into this warehousing and storage category, and many of them state explicitly that they chose to locate in this region largely due to the presence of UPS' Worldport operations. For example, some of the key shippers engaged in this activity include the employers outlined in Table 28.

Table 28. Key Shippers Attributable to Presence of UPS' Worldport Operations

Employer	Number of Employees
Alliance Entertainment LLC	300
Best Buy Co Inc DC #1376	100
Gilt Group	180
GSI Commerce Solutions Inc	325
JOM Pharmaceutical Services Inc	43
Medline Industries Inc	47
Zappos Fulfillment Centers Inc	971
Total	**1,966**

Source: Kentucky Cabinet for Economic Development 2011.

Industries with high LQs built into our estimates (e.g., trucking and warehousing operations) are included because Worldport offers such a strong competitive advantage that it can be argued to be the dominant attractor to those industries. The economic impacts of the companies highlighted in our analysis (and listed in Table 28) were characterized as warehousing operations and are thus included in the trucking/warehousing employment estimates. These 1,966 direct jobs have an estimated aggregated labor income of $86.4 million, and estimated output value of over $180 million.

Using the increased employment of 6,780 for the truck transportation and warehousing and storage industries from the LQ analysis, the impact of these economic activities includes a total impact of 13,345 jobs, with a total of over $595 million in labor income and total output of over $1.5 billion (Table 29).

Table 29. Estimated Economic Impact, Enhanced Truck Transportation and Warehousing and Storage Industries

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	6,780.0	$327,398,501	$420,554,676	$806,524,806
Indirect Effect	2,918.2	$127,869,435	$201,068,011	$326,858,325
Induced Effect	3,646.5	$139,986,987	$250,213,553	$416,130,791
Total Effect	13,344.7	$595,254,923	$871,836,241	$1,549,513,922

Source: MIG 2011a.

The competitive advantage offered by Worldport could be argued to extend to other industries with a heavy reliance on air cargo (such as machinery or electronics); however, because of a lack of data to link these industries empirically to air cargo, any attempt to include them would be speculative and unsupportable. Thus, the economic activity associated with these industries was not included in our estimates.

Cargo Screening and Jet Fuel Elasticity Modeling

The effects of the 100-percent cargo screening rule and volatility in jet-fuel prices were analyzed and described in a separate chapter, with price models developed to estimate the elasticity of demand upon price changes from the increased costs of the additional cargo screening and the increase in the price of air cargo due to increases in jet-fuel prices.

Cargo Screening Impacts

The elasticity analysis noted that the cargo screening includes three effects to be captured in the I-O models applied at the case-study airports:

- The reduced demand for air cargo modeled as a contraction in the industries engaged in air cargo operations
- Increased output by air transportation support industries engaged in air cargo screening activities
- Increased output for air transportation companies due to overhead applied to air cargo screening costs (this third impact serves to counterbalance the first effect)

Table 30 presents the air cargo inputs required for the I-O models. The reduction in freight presented in this table represents the percentage reduction in total (cargo-only and cargo transported on-board passenger airplanes) cargo. The impacts vary depending on the price elasticity modeled at each airport and the scale of air cargo transported on-board passenger aircraft. As noted previously in this report, the screening rule does not affect cargo-only aircraft.

The negative economic effects reduce the economic output of the industry. The cargo screening costs and industry markup attached to those costs reflect the price increase that is passed on to the customer. These values reflect increased revenue/output to the air transportation and supporting industries.

Table 30. Air Cargo Screening Inputs for I-O Models

Airport	Reductions in Freight		Cargo Screening Costs		Gross Industry Surplus on Cargo Screening Costs	
	TSA Analysis	Industry Estimates	TSA Analysis	Industry Estimate	TSA Analysis	Industry Estimate
IAH	-0.6%	-0.9%	$8,944,118	$12,775,705	$751,501	$1,073,438
JFK	-2.7%	-3.8%	$25,241,205	$36,054,330	$2,120,813	$3,029,352
MCI	-0.4%	-0.6%	$247,949	$354,169	$20,833	$29,758
RNO*	-0.1%	-0.1%	$71,619	$102,300	$6,018	$8,595
SDF	0.0%	0.0%	$101,236	$144,605	$8,506	$12,150

For Louisville, the reductions in freight and counterbalancing increases in cargo screening impacts results in the direct impacts presented in Table 31.

Table 31. Air Cargo Screening Inputs for SDF I-O Modeling

Grand Total Changes	Lower Estimate	Upper Estimate
Transport by air	($51,508.67)	($77,872.01)
Support activities/ air transport	$77,377.38	$108,817.06
Couriers/messengers	($27,412,405.25)	($41,118,607.87)
Off-Airport (WorldPort “extra")	*($4,839,148.84)*	*($7,258,723.25)*
Total Changes	($32,225,685.38)	($48,346,386.07)

Due to the size of the Courier/Messenger industry, losses are concentrated in that sector, though they also occur in transport by air and the off-airport traded sectors, in this case study illustrated by the additional truck transportation and warehousing deemed attributable to the presence of UPS’ Worldport facility. Some offsetting gains occur in the support activities for air transportation for the additional screening services required.

According to the IMPLAN model, these direct impacts of between $32.2 million and 48.3 million would result in between $53.6 million and $80.4 million in total impact, as shown in Table 32, below.

Table 32. Economic Impact Associated with Cargo Screening

Impact Type	Employment	Labor Income	Value Added	Output
Lower Estimate				
Direct Effect	-157.2	($11,475,207)	($20,125,328)	($32,225,686)
Indirect Effect	-70.1	($3,179,270)	($4,886,944)	($8,072,442)
Induced Effect	-114.3	($4,481,191)	($8,005,972)	($13,313,055)
Total Effect	-341.5	($19,135,668)	($33,018,244)	($53,611,183)
Upper Estimate				
Direct Effect	-235.8	($17,217,366)	($30,192,855)	($48,346,388)
Indirect Effect	-105.1	($4,769,869)	($7,331,823)	($12,110,970)
Induced Effect	-171.5	($6,723,483)	($12,011,991)	($19,974,624)
Total Effect	-512.5	($28,710,718)	($49,536,669)	($80,431,982)

Impacts of Jet Fuel Price Fluctuations

The second elasticity model developed for this study examines the impacts of jet-fuel price increases on air cargo demand. It examined the impacts associated with 10 to 30 percent increases in jet-fuel prices, using a stepwise regression approach.

Table 33 presents the impacts of a 10, 20, and 30 percent increase in jet fuel prices on demand for air cargo at each of the five case study airports. For every 10 percent increase in jet-fuel prices, air cargo demand is estimated to decline by 0.7 percent.

Table 33. Impacts of Jet Fuel Price Increases (10, 20, and 30 percent) on Demand for Air Cargo

	Impacts of Jet Fuel Prices Increases on Demand for Air Cargo		
Airport	**10%**	**20%**	**30%**
IAH	(6,368,857)	(12,737,715)	(19,106,572)
JFK	(21,150,552)	(42,301,105)	(63,451,657)
MCI	(1,354,130)	(2,708,260)	(4,062,390)
RNO	(781,291)	(1,562,582)	(2,343,873)
SDF	(33,956,926)	(67,913,853)	(101,870,779)
Reduction in Air Cargo	**-0.7%**	**-1.5%**	**-2.2%**

Applying these values to the on-airport operations yields the following results for the 10, 20, and 30-percent increases in jet-fuel prices. As shown in Table 34, the reduction in output ranges from $52.3 million to $156.9 million for 10 percent and 30 percent increases in jet fuel prices, respectively.

Table 34. Economic Impacts of Jet Fuel Price Increases (10, 20, and 30 percent)

Impact Type	Employment	Labor Income	Value Added	Output
10% increase in fuel price .7% decrease in cargo volume				
Direct Effect	-144.3	-$11,402,914	-$21,022,400	-$32,078,992
Indirect Effect	-64.7	-$2,889,766	-$4,410,014	-$7,245,367
Induced Effect	-113.6	-$4,365,234	-$7,798,001	-$12,971,530
Total Effect	-322.6	-$18,657,914	-$33,230,414	-$52,295,889
20% increase in fuel price 1.5% decrease in cargo volume				
Direct Effect	-309.2	-$24,434,817	-$45,047,999	-$68,740,697
Indirect Effect	-138.6	-$6,192,355	-$9,450,030	-$15,525,787
Induced Effect	-243.4	-$9,354,072	-$16,710,002	-$27,796,135
Total Effect	-691.3	-$39,981,244	-$71,208,030	-$112,062,619
20% increase in fuel price 1.5% decrease in cargo volume				
Direct Effect	-432.9	-$34,208,743	-$63,067,199	-$96,236,975
Indirect Effect	-194.1	-$8,669,298	-$13,230,041	-$21,736,102
Induced Effect	-340.8	-$13,095,701	-$23,394,002	-$38,914,590
Total Effect	-967.8	-$55,973,742	-$99,691,242	-$156,887,667

Applying the same reductions to the off-airport traded sector results in additional reductions in output ranging from $10.8 million to $32.5 million for 10 percent and 30 percent increases in jet fuel prices, respectively.

Table 35. Output impacts of Jet Fuel Price Increases (10, 20, and 30 percent)

Impact Type	Employment	Labor Income	Value Added	Output
10% increase in fuel price 0.7% decrease in cargo volume				
Direct Effect	-47.5	-$2,291,790	-$2,943,883	-$5,645,674
Indirect Effect	-20.4	-$895,086	-$1,407,476	-$2,288,008
Induced Effect	-25.5	-$979,909	-$1,751,495	-$2,912,916
Total Effect	-93.4	-$4,166,784	-$6,102,854	-$10,846,597
20% increase in fuel price 1.5% decrease in cargo volume				
Direct Effect	-101.7	-$4,910,978	-$6,308,320	-$12,097,872
Indirect Effect	-43.8	-$1,918,042	-$3,016,020	-$4,902,875
Induced Effect	-54.7	-$2,099,805	-$3,753,203	-$6,241,962
Total Effect	-200.2	-$8,928,824	-$13,077,544	-$23,242,709
30% increase in fuel price 2.1% decrease in cargo volume				
Direct Effect	-142.4	-$6,875,369	-$8,831,648	-$16,937,021
Indirect Effect	-61.3	-$2,685,258	-$4,222,428	-$6,864,025
Induced Effect	-76.6	-$2,939,727	-$5,254,485	-$8,738,747
Total Effect	-280.2	-$12,500,353	-$18,308,561	-$32,539,792

The sheer volume of the courier and messenger activity at SDF yields far greater impacts on that than other off-airport operations when applying a similar percentage decline.

Case Study 3 – George Bush Intercontinental Airport, Houston, TX

George Bush Intercontinental Airport (IAH), Houston's largest airport is located just 23 miles north of downtown Houston. Officially opening in the summer of 1969, the Airport is owned and operated by the Houston Airport System which is a self-supporting system generating revenue through user fees and lease agreements. The Airport is the 7th busiest U.S. airport for both total traffic and international passenger traffic and utilizes 5 runways on 11,000 acres of land. The Airport currently offers nonstop service to over 110 destination in the U.S. and 70 destinations worldwide.

IAH ranks in the top 25 airports worldwide for total passengers. In 2010 the airport's five terminals handled 40.5 million passengers, which represented a small 1.2 percent increase from 2009. Similar to most other airports, IAH saw a decrease in the number of total aircraft movements – down 1.3 percent from the previous year (Houston Airport System 2012).

As the 16th largest U.S. air cargo hub, IAH is an ideal consolidation and distribution point. It currently hosts 880,000 square feet of cargo area with a capacity to handle up to 1,450,000 tons of cargo which includes the newly expanded IAH CargoCenter.

The annual amount of cargo handled in 2010 also increased by 13.6 percent. International cargo increased by approximately 20 percent with most of the volume carried in wide-body passenger aircraft. At the same time, domestic cargo increased by 11.5 (Houston Airport System 2012). The industry trend to minimize freighter use was reflected in a one percent decrease in all-cargo movements. Overall, IAH was ranked 7th in the top ten airports in North America by the ACI World Airport Traffic Report in 2010.

IAH has an aggressive marketing program strongly emphasizing Transpacific and Latin American traffic.

This section describes the structure of the Houston regional economy in 2009, and the method for estimating the economic impact of air cargo through IAH airport. These estimates are presented at the scale of the ten-county region, comprised of Austin, Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, San Jacinto, and Waller counties.

Airports play an essential role in supporting the growth of a metropolitan economy like the Houston region. They directly employ hundreds of workers and provide millions of dollars in direct economy activity and taxes and other revenues to local government. They also support the growth of the regional economy by moving people, goods, and services that originate in, or are transported through, the region. Airports and related aviation facilities become structurally integrated into a region's economy and provide it with competitive advantages. Airports enable industries that either depend on, or learn to take advantage of, efficient air transportation to access domestic and international markets. In the Houston region, IAH and the region's smaller airports play this vital role.

The primary objective of this analysis is to estimate the current economic impacts associated with the air cargo movement, estimating the economic output, employment, personal income, of that activity, and to document the analysis so as to make it easily replicable for other airports in other regions.

This section describes the structure of the Houston Metropolitan economy in 2009, using a Houston region-specific version of the IMPLAN impact analysis software.[6] It then presents the methods used to estimate the air cargo contribution to the economy, and finally presents estimates of economic impact of that air cargo movement.

The model is used to measure changes in the regional economy that result from a change in activity relative to a baseline representation of the economy. The sources of the activity being measured vary, but typically involve changes in production or consumption activities, government policies, infrastructure, or changes in costs or technology. For any change in economic activity, the impacts on the economy can be reported on one of three levels:

- **Direct** impacts represent the initial change in final demand for the industry sector(s) in question. For this analysis, we are estimating the economic activity associated with air cargo in Houston.

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[6] The IMPLAN model is based on an input-output modeling framework, and uses secondary source data and proprietary analytic methods to estimate empirical input-output relationships from a combination of national technological relationships and county-level measures of economic activity.

- **Indirect** impacts represent the response as supplying industries increase output to accommodate the initial change in final demand. These indirect beneficiaries spend money for supplies and services, which results in another round of indirect spending, and so on. Indirect impacts are often referred to as "supply-chain" impacts.

- **Induced** impacts are generated by the spending of households who benefit from the additional wages and income they earn through direct and indirect economic activity. The increase in income, in effect, increases the purchasing power of households. Induced impacts are also described as "consumption-driven" effects.

This cycle of direct, indirect, and induced spending does not go on forever. It continues until the spending eventually leaks out of the economy as a result of taxes, savings, or purchases of non-locally produced goods and services or "imports".

Houston Regional Economy

This section summarizes the Houston economy, and presents an economic portrait of the region's economy in terms of employment and output by industry for the base year of 2009.

According to the BEA, Houston is one of 366 MSAs in the United States. Based on its 2009 population estimate of 5,867,489, it is ranked 6th in size in the United States. Its per-capita personal income is about 17 percent higher than the national average. According to IMPLAN, there are an estimated 3.5 million jobs across 410 industries in the region. The top industries by employment are presented in Table 36. Houston's top industries ranked by output are presented in Table 37.

Table 36. Top Ten Industries, Ranked by Employment
Houston Region, 2009

Code	Description	Employment	Labor Income	Output
438	State & local govt, education	206,200	$12,000,810,000	$13,633,090,000
413	Food services and drinking places	204,124	$4,454,105,000	$12,042,710,000
319	Wholesale trade businesses	155,329	$13,753,630,000	$35,985,460,000
360	Real estate establishments	144,085	$2,651,987,000	$26,323,530,000
20	Extraction of oil and natural gas	111,311	$20,697,070,000	$78,225,240,000
36	Construction of other new nonresidential structures	105,933	$5,846,335,000	$13,298,820,000
369	Architectural, engineering, and related services	105,312	$9,217,233,000	$15,180,520,000
382	Employment services	98,694	$3,023,581,000	$4,415,131,000
437	State & local govt, non-education	98,470	$5,406,622,000	$6,142,000,000
394	Offices of physicians, dentists, and other health practitioners	73,271	$6,001,712,000	$9,886,075,000

Source: MIG 2011b.

Table 37. Top Ten Industries, Ranked by Output
Houston Region, 2009

Code	Description	Employment	Labor Income	Output
115	Petroleum refineries	12,319	$5,855,176,000	$131,604,200,000
20	Extraction of oil and natural gas	111,311	$20,697,070,000	$78,225,240,000
120	Petrochemical manufacturing	12,394	$1,932,184,000	$69,195,790,000
319	Wholesale trade businesses	155,329	$13,753,630,000	$35,985,460,000
361	Imputed rental activity for owner-occupied dwellings	0	$0	$26,463,550,000
360	Real estate establishments	144,085	$2,651,987,000	$26,323,530,000
28	Drilling oil and gas wells	16,519	$2,320,788,000	$21,301,580,000
31	Electric power generation, transmission, and distribution	14,795	$3,296,287,000	$16,581,100,000
206	Mining and oil and gas field machinery manufacturing	28,454	$3,101,443,000	$15,422,700,000
369	Architectural, engineering, and related services	105,312	$9,217,233,000	$15,180,520,000

Source: MIG 2011b.

The scale of economic activity occurring in the Houston region would not have been possible without development of the water, rail, highway, and airport infrastructure that enables businesses to take maximum advantage of the region's location in the central US.

The regional economic impacts of air cargo through IAH are directly related to the scale and composition of the air cargo forecasts (i.e., international versus domestic, and belly cargo versus all-cargo freighters).

Estimating IAH Air Cargo Contribution to the Regional Economy

This section summarizes the methods used to estimate IAH's current contribution to the regional economy. This effort quantifies the impact the air cargo through the airport has on the economy at a particular moment in time, using input-output modeling and analysis recommended by the FAA (Butler and Kiernan 1992).

Measuring the economic impact of the cargo activity at the airport involves tracing the linkages between the airport's cargo activity level, expressed in terms of airport operations and air cargo volumes, and the sectors of the economy that interact with them. These linkages produce the "direct," or initial round of economic impact. Direct impacts, in turn, stimulate "indirect" impacts, from the supply of goods and services to businesses at the airport or production of goods for shipment by air. A third round of economic impacts, called "induced" impacts, results from the spending of income earned by direct and indirect employees. The sum of indirect and induced impacts is often referred to as the "multiplier effect" on direct impacts. Total economic impact is the sum of the direct, indirect, and induced impacts.

As noted in the introduction, the first and perhaps most obvious source of IAH-related economic impact is the employees who work there. Though many are present to support the air passengers (such as passenger and visitor service providers), many are associated with airport operations and air cargo, including cargo-handling companies, customs agents, TSA, customs brokers, container freight stations, freight forwarders, trucking companies, and other cargo-related services.

A second important impact related to airport economic activity is the passenger impact, including expenditures for lodging, food, retail purchases, entertainment, transportation services and parking, among others. Again, the scope of this effort is focused on air cargo, rather than on passengers.

The final category of impact is the contribution of air cargo to the regional economy. The presence of a well-functioning air cargo system is what allows a region to export goods and services and develop traded-sector industries for the purposes of export. While every region has some need for local-serving goods and services (haircuts, restaurant meals, etc.), a region's ability to export additional goods and services increases its economic potential. While the concept is simple, the analysis of economic impacts of air cargo shipments is part of a developing area of economic research that is still limited. We will explore these limitations and some analytic approaches to them in this section.

Airport Operations

As noted earlier, the first and most obvious source of IAH-related economic impact is the employees who work there. Those associated with air cargo include airlines handling cargo, third-party cargo-handling companies, customs agents, TSA, customs brokers, container freight stations, freight forwarders, trucking companies, and other cargo-related services.

Employment data were provided by the airport authority for the number of employees with security badges. These data were supplemented by the project surveys of air carriers and third-party cargo-handling companies. These combined data yielded the cargo-related employment estimates presented in the remainder of this section.

Table 38. Estimated Employment by Industry Group, IAH, 2010

Industry	Estimated Employment
Transport by Air	726
Support Activities for Air Transportation	439
Couriers and messengers	686
Total	1,851

Source: IAH Airport, Employer surveys, and estimates by TransSolutions (IAH study 2010).

Running the resulting number of direct jobs through the IMPLAN model generates the direct, indirect, and induced jobs, output, labor income, and value added of this activity (movement of air cargo). These 1,851 direct jobs have an estimated aggregated labor income of over $116 million, or an average per-job compensation of $62,850. The estimated output value generated from those jobs is over $338 million, as shown in Table 39.

Table 39. Estimated Economic Impact, Air Cargo Operations, IAH

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	1,851.0	$116,340,215	$166,346,325	$338,456,519
Indirect Effect	654.9	$40,051,279	$72,684,391	$148,621,695
Induced Effect	925.0	$42,122,921	$79,801,351	$130,628,887
Total Effect	3,430.9	$198,514,416	$318,832,067	$617,707,100

Source: MIG 2011b.

In addition to the direct impacts, these 1,851 jobs would have an additional indirect impact of an estimate nearly 655 indirect jobs with over $40 million in labor income and over $148 million in output, and an additional 925 induced jobs with $42 million in labor income and $130 million in output, as shown in Table 39.

Air Cargo Impacts to Regional Economy

More difficult to quantify is the contribution of air cargo to the regional economy. However, it is generally agreed that export industries are concentrated in regions with direct and efficient access to air cargo operations. In the absence of this access, companies that rely on these services would likely re-locate to other regions with such access.

As noted earlier, the analysis of economic impacts of air cargo shipments is part of a developing area of economic research. One important issue that remains unanswered is the potential for shippers to utilize other airports in the region to export goods in the presence of air cargo supply constraints. For example, there are other airports within the trade area of IAH. This factor is important for modeling IAH's contribution to the regional economy. It would be unreasonable, for example, to simply subtract the entire value of goods exported by air, because this subtraction would grossly overstate the economic impacts of air cargo (i.e., the value of the goods shipped by air).

Another issue is the few systematic sources of air cargo data. ACI-NA collects annual data on-airport operations, passengers and weight of air cargo, principally to evaluate airports and rank them by size. For the value of shipments, however, one of the only sources is the CFS undertaken every five years by a partnership between the BTS and the Census Bureau.

FAF integrates data from a variety of sources to create a comprehensive picture of freight movement among states and major metropolitan areas by all modes of transportation. With data from the 2007 CFS and additional sources, FAF version 3 (FAF^3) provides estimates for tonnage and value by origin, destination, commodity, and mode for 2007, the most recent year, and forecasts through 2040.

According to the FAF, over 791 million tons of goods were shipped from the Houston Metropolitan area. Of that, nearly 250,000 tons were shipped via air (including truck and air).[7] The largest proportion of goods shipped by air is machinery by weight, comprising 34 percent of

[7] The modes tracked by the Commodity Flow Survey are: For-hire truck, Private truck, Rail, Air (including Truck and Air), Shallow draft vessel, Deep draft vessel, Pipeline, Parcel/U.S. Postal Service/courier, Other, and Unknown.

the weight of commodities shipped by air. In terms of value, electronics is slightly higher in value terms, nearly 39 percent of the value of goods shipped by air but less than 17 percent of the weight of goods shipped by air in 2007, which makes sense as those commodities are often light, but of relatively high value. Other major commodities shipped via air include plastics/rubber, precision instruments, and articles of base metal, as shown in Table 40.

Table 40. Shipment Characteristics by Commodity for Air Transportation (including Truck and Air) for Houston Metropolitan Area of Origin: 2007

	Value		Weight	
	M$	Percent of Total Value	Tons (Thousands)	Percent of Total Weight
Alcoholic beverages	4.33	0.03%	0.61	0.25%
Animal feed	1.31	0.01%	0.11	0.05%
Articles-base metal	432.25	2.57%	22.38	8.96%
Base metals	74.01	0.44%	6.52	2.61%
Basic chemicals	168.13	1.00%	4.43	1.77%
Cereal grains	0.21	0.00%	0.04	0.01%
Chemical prods.	179.59	1.07%	8.68	3.47%
Coal-n.e.c.	2.50	0.01%	1.44	0.58%
Electronics	6,490.16	38.65%	42.25	16.91%
Fertilizers	0.02	0.00%	0.00	0.00%
Furniture	56.13	0.33%	2.03	0.81%
Live animals/fish	22.16	0.13%	2.14	0.86%
Machinery	5,894.25	35.10%	84.33	33.74%
Meat/seafood	1.17	0.01%	0.30	0.12%
Metallic ores	8.61	0.05%	0.36	0.14%
Milled grain prods.	0.68	0.00%	0.30	0.12%
Misc. mfg. prods.	309.02	1.84%	4.98	1.99%
Mixed freight	364.16	2.17%	2.48	0.99%
Motorized vehicles	100.48	0.60%	5.30	2.12%
Newsprint/paper	0.01	0.00%	0.01	0.00%
Nonmetal min. prods.	33.01	0.20%	1.40	0.56%
Nonmetallic minerals	0.55	0.00%	0.66	0.26%
Other ag prods.	18.89	0.11%	1.73	0.69%
Other foodstuffs	5.76	0.03%	1.30	0.52%
Paper articles	5.59	0.03%	1.00	0.40%
Pharmaceuticals	78.86	0.47%	0.56	0.22%
Plastics/rubber	193.35	1.15%	33.53	13.42%
Precision instruments	1,658.07	9.87%	11.91	4.77%
Printed prods.	50.34	0.30%	1.57	0.63%
Textiles/leather	160.44	0.96%	6.22	2.49%
Tobacco prods.	0.92	0.01%	0.03	0.01%
Transport equip.	471.92	2.81%	1.04	0.42%
Wood prods.	3.92	0.02%	0.27	0.11%
Total	16,790.78	100%	249.92	100%

Source: BTS 2009.

Clearly, the presence of the IAH airport and its well-functioning air cargo operations enables the air transport of this nearly $17 billion in exports. However, a portion of these exports would continue to leave the region in the absence of the IAH airport, using other modes, or through a combination of modes to reach an alternative airport.

For an illustration, let us examine the nearly $6.5 billion of electronics exported from the region. The FAF and CFS use Standard Transportation Classification Codes (STCC) whereas IMPLAN uses the IMPLAN industry codes. Unfortunately, international trade in electronics and other commodities not historically carried by railroads is not well-represented in the STCC, and there are several electronics-related manufacturing industries in IMPLAN. To select an appropriate industry, the first thing would be to evaluate total employment and output for a potential industry. For example, in Houston, some of the electronics industries are small, with only a handful of employees, as shown in Table 41.

Table 41. Employment, Output, and Employee Compensation of Industry Codes 234 through 249

Industry Code	Description	Employment	Output	Employee Compensation
234	Electronic computer manufacturing	6,496.00	$8,444,266,496	$929,792,000
235	Computer storage device manufacturing	7.6	$5,813,081	$721,615
236	Computer terminals and other computer peripheral equipment manufacturing	358	$161,496,688	$31,774,904
237	Telephone apparatus manufacturing	69.1	$35,220,008	$5,740,229
238	Broadcast and wireless communications equipment manufacturing	79.4	$41,965,576	$6,862,952
239	Other communications equipment manufacturing	167	$56,209,872	$10,589,846
240	Audio and video equipment manufacturing	111.1	$64,382,104	$6,929,096
241	Electron tube manufacturing	0	$0	$0
242	Bare printed circuit board manufacturing	501.5	$102,211,008	$30,264,414
243	Semiconductor and related device manufacturing	1,087.40	$745,661,568	$158,196,944
244	Electronic capacitor, resistor, coil, transformer, and other inductor manufacturing	306	$53,095,824	$16,604,259
245	Electronic connector manufacturing	81.9	$17,726,202	$3,631,496
246	Printed circuit assembly (electronic assembly) manufacturing	622.6	$227,634,032	$52,766,300
247	Other electronic component manufacturing	1,158.70	$267,425,664	$99,531,240
248	Electromedical and electrotherapeutic apparatus manufacturing	745.7	$345,771,392	$64,623,396
249	Search, detection, and navigation instruments manufacturing	346.1	$123,891,152	$23,133,980

Source: MIG 2011b.

The largest is the electronic computer manufacturing industry, with 6,496 employees and $8.4 billion in output. It is likely that the $6.5 billion of exported electronics are commodities produced by a combination of industries, including electronic computer manufacturing. To select the industries for the modeling and to avoid over- or under-stating the impacts, the analyst would want to review the levels of output per worker and compensation-per-worker for the range of industries, as shown in Table 42.

Table 42. Per-worker Output and Employee Compensation of Industry Codes 234 through 249

Industry Code	Description	Employment	Output per Worker	Compensation-per-Worker
234	Electronic computer manufacturing	6,496.00	$1,299,917.87	$143,133.00
235	Computer storage device manufacturing	7.6	$764,879.08	$94,949.34
236	Computer terminals and other computer peripheral equipment manufacturing	358	$451,108.07	$88,756.72
237	Telephone apparatus manufacturing	69.1	$509,696.21	$83,071.33
238	Broadcast and wireless communications equipment manufacturing	79.4	$528,533.70	$86,435.16
239	Other communications equipment manufacturing	167	$336,586.06	$63,412.25
240	Audio and video equipment manufacturing	111.1	$579,496.89	$62,368.10
241	Electron tube manufacturing	0	NA	NA
242	Bare printed circuit board manufacturing	501.5	$203,810.58	$60,347.78
243	Semiconductor and related device manufacturing	1,087.40	$685,728.87	$145,481.83
244	Electronic capacitor, resistor, coil, transformer, and other inductor manufacturing	306	$173,515.76	$54,262.28
245	Electronic connector manufacturing	81.9	$216,437.14	$44,340.61
246	Printed circuit assembly (electronic assembly) manufacturing	622.6	$365,618.43	$84,751.53
247	Other electronic component manufacturing	1,158.70	$230,798.02	$85,899.06
248	Electromedical and electrotherapeutic apparatus manufacturing	745.7	$463,686.99	$86,661.39
249	Search, detection, and navigation instruments manufacturing	346.1	$357,963.46	$66,841.90

Source: MIG 2011b.

For the most part, the electronics-related industries have similar levels of output-per-worker and employee compensation-per-worker; however, levels for the electronic computer manufacturing industry are among the highest (at nearly $1.3 million average per-worker output and over $143,000 in average per-worker compensation). As such, to avoid overstating the impacts, it is reasonable to model the impacts using a combination of this largest industry and another representative industry whose output-per-worker and compensation-per-worker fall more in the middle of the range, such as other electronic component manufacturing (Industry Code 247) with per-worker output averaging $230,800 and per-worker compensation averaging $84,750 (Minnesota IMPLAN Group, 2011b.)

According to the Houston Airport System, there was an aggregated total value of $7.2 billion in exported goods shipped through the Houston airport in 2009. Of that, $3.1 billion was classified as industrial equipment and computers, as shown in Table 43. These values are roughly half those reported from the FAF whose “air” category includes truck and air, and therefore, may include goods shipped from other airports.

Table 43. Top Exports by Weight and their Estimated Value, Houston

2009 Rank	Top Commodities	Air Cargo Exports Weight (KG)	Air Cargo Exports Value ($)
1	Industrial Equipment and Computers	44,840,986	3,127,150,859
2	Articles of Iron or Steel	13,297,438	122,924,227
3	Electrical Machinery, Equipment and Parts	11,397,772	1,178,203,472
4	Optic, Photographic, Medical, Surgical Instruments	7,578,404	1,093,271,364
5	Iron and Steel	4,266,317	9,265,833
6	Plastics and Plastic Articles	3,733,719	66,945,591
7	Metal Tools, Cutlery, Etc.	2,350,414	291,425,435
8	Miscellaneous Chemical Products	1,822,211	59,458,838
9	Aircraft, Spacecraft and Parts Thereof	1,371,784	750,409,353
10	Inorganic Chemicals	1,362,419	37,969,218
	Totals (includes commodities not shown above)	**110,731,668**	**7,230,003,104**

Source: Houston Airport System, Houston and the World, 2012 International Air Cargo Data.

To complete the illustration, evaluating the impacts of $3.1 billion in exported electronics might involve modeling the impacts associated with $1.6 billion electronic computer manufacturing and $1.5 billion in electronic component manufacturing as shown in Table 44.

Table 44. Economic Impact of $3.1 Billion in Electronic Manufacturing

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	10,739.4	$1,123,202,763	$1,785,063,755	$3,100,000,063
Indirect Effect	6,140.0	$437,344,449	$727,238,123	$1,215,059,723
Induced Effect	9,240.2	$421,212,476	$797,820,446	$1,306,313,610
Total Effect	26,119.6	$1,981,759,687	$3,310,122,324	$5,621,373,395

Source: MIG 2011b.

The $1.6 billion in electronic computer manufacturing and $1.5 billion in electronic component manufacturing have direct employment of over 10,700 employees, with over $1.1 billion in employee compensation and nearly $1.8 billion in value added, plus an additional 6,140 indirect employees, and another 9,240 induced employees.

This $3.1 billion modeled in this example is but a portion of the nearly $17 billion in value of commodities exported from the Houston region, according to the FAF, and the over $7.2 billion in value of commodities exported from the Houston Airport, according to the Houston Airport System.

Cargo Screening and Jet Fuel Elasticity Modeling

The effects of the 100-percent cargo screening rule and volatility in jet-fuel prices were analyzed and described in a separate section of this report, with price models developed to estimate the elasticity of demand upon price changes from the increased costs of the additional cargo screening and the increase in the price of air cargo due to increases in jet-fuel prices.

Cargo Screening Impacts

The elasticity analysis noted that the cargo screening includes three effects to be captured in the I-O models applied at the case-study airports:

- The reduced demand for air cargo modeled as a contraction in the industries engaged in air cargo operations
- Increased output by air transportation engaged in air cargo screening activities
- Increased output for air transportation companies due to overhead applied to air cargo screening costs (this third impact serves to counterbalance the first effect)

Table 45 presents the air cargo inputs required for the I-O models. The reduction in freight presented in this table represents the percentage reduction in total (cargo-only and cargo transported on-board passenger airplanes) cargo. The impacts vary depending on the price elasticity modeled at each airport and the scale of air cargo transported on-board passenger aircraft. As noted previously in this report, the screening rule does not affect cargo-only aircraft. The negative economic effects reduce the economic output of the industry. The cargo screening costs and industry markup attached to those costs reflect the price increase that is passed on to the customer. These values reflect increased revenue/output to the air transportation and supporting industries.

Table 45. Air Cargo Screening Inputs for I-O Models

Airport	Reductions in Freight		Cargo Screening Costs		Gross Industry Surplus on Cargo Screening Costs	
	TSA Analysis	Industry Estimates	TSA Analysis	Industry Estimate	TSA Analysis	Industry Estimate
IAH	-0.6%	-0.9%	$8,944,118	$12,775,705	$751,501	$1,073,438
JFK	-2.7%	-3.8%	$25,241,205	$36,054,330	$2,120,813	$3,029,352
MCI	-0.4%	-0.6%	$247,949	$354,169	$20,833	$29,758
RNO*	-0.1%	-0.1%	$71,619	$102,300	$6,018	$8,595
SDF	0.0%	0.0%	$101,236	$144,605	$8,506	$12,150

For Houston, the reductions in freight and counterbalancing increases in cargo screening impacts results in the direct impacts identified in Table 46. Though there are losses in the Transport by Air and Courier/Messenger industries, losses are concentrated in the off-airport traded sectors, in this case study illustrated by the electronics industry. Some offsetting gains occur in the support activities for air transportation for the additional screening services required. For air transport support activities, the increase in output associated with screening activities more than offsets the losses resulting from reductions in freight due to the inelastic demand measure (0.23) calculated for IAH.

Table 46. Air Cargo Screening Inputs for IAH I-O Modeling

Grand Total Changes	Lower Estimate	Upper Estimate
Transport by air	($696,799.06)	($1,099,012.10)
Support activities/ air transport	$8,617,331.34	$12,285,525.00
Couriers/messengers	($255,652.37)	($383,478.55)
Off-Airport example (electronics)	($18,600,000.00)	($27,900,000.00)
Total Changes	**($10,935,120.10)**	**($17,096,965.64)**

According to the IMPLAN model, these direct impacts of between nearly $11 and $17 million would result in between $19 and $30 million in total impact. As noted earlier, the losses occur mostly in the traded-sector industries, illustrated in this case study by the electronics industry. These industries tend to have high wages and high output per worker, while gains occur in support activities for air transportation, an industry with relatively lower output per worker. As such, employment impacts seem low relative to the output impacts, as shown in Table 47 below.

Table 47. Economic Impact Associated with Cargo Screening

Impact Type	Employment	Labor Income	Value Added	Output
Lower Estimate				
Direct Effect	-1.2	($1,416,321)	($5,248,857)	($10,935,010)
Indirect Effect	-20.0	($1,840,594)	($3,228,926)	($5,451,864)
Induced Effect	-19.4	($888,585)	($1,681,356)	($2,756,602)
Total Effect	-40.6	($4,145,501)	($10,159,139)	($19,143,475)
Upper Estimate				
Direct Effect	-7.1	($2,555,684)	($8,335,944)	($17,096,965)
Indirect Effect	-31.5	($2,834,219)	($4,955,888)	($8,373,362)
Induced Effect	-32.1	($1,468,339)	($2,778,740)	($4,554,947)
Total Effect	-70.7	($6,858,241)	($16,070,571)	($30,025,274)

Impacts of Jet Fuel Fluctuations

The second elasticity model developed examines the impacts of jet fuel price increases on air cargo demand. It examined the impacts associated with 10-30 percent increases in jet fuel prices, using a stepwise regression approach.

Table 48 presents the impacts of a 10, 20, and 30 percent increase in jet fuel prices on demand for air cargo at each of the five case study airports. For every 10 percent increase in jet fuel prices, air cargo demand is estimated to decline by 0.7 percent.

Table 48. Impacts of Jet Fuel Price Increases (10, 20, and 30 percent) on Demand for Air Cargo

	Impacts of Jet Fuel Prices Increases on Demand for Air Cargo		
Airport	**10%**	**20%**	**30%**
IAH	(6,368,857)	(12,737,715)	(19,106,572)
JFK	(21,150,552)	(42,301,105)	(63,451,657)
MCI	(1,354,130)	(2,708,260)	(4,062,390)
RNO	(781,291)	(1,562,582)	(2,343,873)
SDF	(33,956,926)	(67,913,853)	(101,870,779)
Reduction in Air Cargo	**-0.7%**	**-1.5%**	**-2.2%**

Applying these values to the on-airport operations yields the results for the 10, 20, and 30-percent increases in jet-fuel prices presented in Table 49.

Table 49. Economic Impacts of Jet Fuel Price Inreases (10, 20, and 30 percent) on Airport Operations

Impact Type	Employment	Labor Income	Value Added	Output
10% increase in fuel price .7% decrease in cargo volume				
Direct Effect	(12.96)	($814,382)	($1,164,424)	($2,369,196)
Indirect Effect	(4.58)	($280,359)	($508,791)	($1,040,352)
Induced Effect	(6.48)	($294,860)	($558,609)	($914,402)
Total Effect	(24.02)	($1,389,601)	($2,231,824)	($4,323,950)
20% increase in fuel price 1.5% decrease in cargo volume				
Direct Effect	(27.77)	($1,745,103)	($2,495,195)	($5,076,848)
Indirect Effect	(9.82)	($600,769)	($1,090,266)	($2,229,325)
Induced Effect	(13.88)	($631,844)	($1,197,020)	($1,959,433)
Total Effect	(51.46)	($2,977,716)	($4,782,481)	($9,265,607)
20% increase in fuel price 1.5% decrease in cargo volume				
Direct Effect	(38.87)	($2,443,145)	($3,493,273)	($7,107,587)
Indirect Effect	(13.75)	($841,077)	($1,526,372)	($3,121,056)
Induced Effect	(19.43)	($884,581)	($1,675,828)	($2,743,207)
Total Effect	(72.05)	($4,168,803)	($6,695,473)	($12,971,849)

Applying the same reductions to the off-airport traded sector, results in the economic impacts estimated presented in Table 50.

Table 50. Economic Impacts of Jet Fuel Price Increases (10, 20, and 30 percent) on Off-Airport Activities

Impact Type	Employment	Labor Income	Value Added	Output
10% increase in fuel price *0.7% decrease in cargo volume*				
Direct Effect	(75.2)	($7,862,419)	($12,495,446)	($21,700,000)
Indirect Effect	(43.0)	($3,061,411)	($5,090,667)	($8,505,418)
Induced Effect	(64.7)	($2,948,487)	($5,584,743)	($9,144,195)
Total Effect	(182.8)	($13,872,318)	($23,170,856)	($39,349,614)
20% increase in fuel price *1.5% decrease in cargo volume*				
Direct Effect	(161.1)	($16,848,041)	($26,775,956)	($46,500,001)
Indirect Effect	(92.1)	($6,560,167)	($10,908,572)	($18,225,896)
Induced Effect	(138.6)	($6,318,187)	($11,967,307)	($19,594,704)
Total Effect	(391.8)	($29,726,395)	($49,651,835)	($84,320,601)
30% increase in fuel price *2.1% decrease in cargo volume*				
Direct Effect	(225.5)	($23,587,258)	($37,486,339)	($65,100,001)
Indirect Effect	(128.9)	($9,184,233)	($15,272,001)	($25,516,254)
Induced Effect	(194.0)	($8,845,462)	($16,754,229)	($27,432,586)
Total Effect	(548.5)	($41,616,953)	($69,512,569)	($118,048,841)

The sheer volume of the off-airport impacts yields far greater impacts than on-airport operations when applying a similar percentage decline. These results show the importance and far-ranging effects of an efficient air transportation system on a healthy regional economy.

Case Study 4 – John F. Kennedy International Airport, New York, NY

John F. Kennedy International Airport (JFK), originally known as Idlewild Airport, was established in 1942 and is owned and operated by the Port Authority of New York and New Jersey (PANYNJ). The airport is approximately 15 miles from midtown Manhattan. Today, JFK functions as one of America's leading international gateway airports, with more than 80 airlines operating from its gates. JFK sits on 4,930 acres of land and currently contains seven operational passenger terminals that contain more than 150 gates.

JFK is one of the world's leading international air cargo centers with more than six million square feet of office and warehouse space spread out over four cargo areas. The entire area comprising the cargo operation at JFK is designated as a Foreign Trade Zone. A total of 1,700 acres dedicated to air cargo activities is divided into Cargo Areas A, B, C, and D. JFK currently has approximately 500 cargo companies based on or around the airport. The carriers are served by ten ground handling services and by hundreds of long and short haul trucking companies. JFK is also home to the northeast region's U.S. Customs headquarters.

JFK was ranked 19th in the world for total cargo handling in 2010. Cargo volumes increased by 17.5 percent from 2009 but the total of 1.3 million tons was well below the 2000 peak of 1.9 million. International freight was up by 23 percent in 2010 placing JFK 15th worldwide. Passenger traffic was relatively flat, and aircraft movements at JFK dropped 4.2 percent in 2010 compared to the previous year. However, both domestic and international passenger traffic has grown over the last decade with domestic traffic growing almost 64 percent since 2000. This is due in large part to the growth of JetBlue operations at JFK which has very little cargo capacity (Port Authority New York New Jersey 2012).

Currently, transatlantic freight makes up the largest market share for freight at JFK topping out at 45 percent of the market with transpacific freight making up 31 percent of the market. In total, international freight comprises 82 percent of the cargo being processed at JFK while domestic freight represents the remaining 18 percent of the market (Port Authority New York New Jersey 2012). JFK is expected to pursue South and Latin American, African and Eastern European markets over the next 20 years as the European market reaches maturity (Port Authority New York New Jersey 2012).

New York-Northern New Jersey-Long Island, NY-NJ-PA MSA (NY Portion) Economic Profile

While the overall impact analysis that follows relates to the entire metropolitan area, the market analysis, which focuses on the disposition of exports, necessarily focuses on the New York State portion of the MSA, which hosts JFK International. The assumption is that air freight traffic emanating west of the Hudson River is largely in the market area of Newark Liberty International Airport. The New York state area includes 10 of 23 counties that comprise the entire MSA: the five counties of New York City proper (Bronx, Kings, New York, Queens, and Richmond), the two counties that comprise the western portion of Long Island (Nassau and Suffolk), and three suburban counties on “mainland” New York (Putnam, Rockland, and Westchester.

The 23-county New York-Northern New Jersey-Long Island, NY-NJ-PA (NYC) MSA is the most populous metropolitan area in the United States with 18,897,109 inhabitants as of 2010.[8] That year it also had nation’s largest metropolitan economy with a total GDP of $1.28 trillion dollars.[9] It may come as no surprise then that the composition of the regional economy is more diversified and complex than most other regional economies in the U.S.

Major Industries in the New York Portion of the NYC MSA

As shown in Table 51, the largest sectors of the regional economy (as ranked by payroll-based location quotient) are in the professional service occupations. Number one on the list is the Finance and Insurance sector, with total employment of 360,885 and total annual wages of $84,646,337,886, for an average annual wage per employee of over $230,000. Real estate rental and leasing is next on the list, with total employment of 142,915 earning an aggregate $8,499,094,293 for an average annual salary of approximately $60,000. Commodity-producing

[8] Census 2010
[9] BEA 2010

sectors such as Manufacturing and Agricultural and Mining come in the bottom three positions. This suggests that large volumes of goods required of New York area residents and firms are not produced in the region. Likewise, the sector Transportation and Warehousing ranks low, suggesting that local distributing agents do not play a dominating role in supplying the region with goods that the region demands. Instead, agents from outside of the area do so.

Table 51. Sector Payroll Location Quotient, Employment, and Payroll for NY MSA (New York Portion), 2010

NAICS	Description	LQ	Jobs	Payroll ($1,000)	Average Payroll
11	Agriculture, Forestry, Fishing and Hunting	0.11	5,995	$212,852	$35,505
21	Mining, Quarrying, and Oil and Gas Extraction	0.09	3,403	$339,537	$99,776
22	Utilities	0.57	13,612	$1,798,700	$132,141
23	Construction	0.71	192,510	$12,732,695	$66,140
31	Manufacturing	0.41	256,521	$17,814,825	$69,448
42	Wholesale Trade	0.69	208,714	$15,885,152	$76,110
44	Retail	0.67	517,434	$17,115,621	$33,078
48	Transportation and Warehousing	0.59	143,073	$6,778,352	$47,377
51	Information	1.43	181,055	$18,914,665	$104,469
52	Finance and Insurance	2.77	360,885	$84,646,338	$234,552
53	Real Estate and Rental and Leasing	1.54	142,915	$8,499,094	$59,470
54	Professional, Scientific, and Technical Services	1.09	411,584	$41,572,278	$101,006
55	Management of Companies and Enterprises	1.25	87,489	$15,014,586	$171,617
56	Administrative and Support, Waste Management, & Remediation Services	0.78	270,152	$12,607,593	$46,669
61	Educational Services	1.36	191,278	$9,420,094	$49,248
62	Health Care and Social Assistance	0.81	805,756	$38,036,297	$47,206
71	Arts, Entertainment, and Recreation	1.22	97,168	$4,928,580	$50,722
72	Accommodation and Food Services	0.76	361,040	$9,564,573	$26,492
81	Other Services (except Public Administration)	1.01	214,021	$8,489,208	$39,665
99	Unclassified	1.48	19,112	$751,489	$39,320
	Total		4,483,717	$325,122,529	$72,512

At the finer level of three-digit NAICS codes (Table 52), white-collar professions continue to dominate. A notable exception is Apparel Manufacture, which employed a total of 18,259 people earning an aggregate $965,840,676 for an average annual salary of $52,897.

Table 52. Top Ten Industries by Three-Digit NAICS Code, 2010

3-Digit NAICS	Description	LQ	Employment	Payroll	Average Payroll
523	Securities, Commodity Contracts, and Other Financial Investments and Related Activities	5.95	173,765	$61,693,480,861	$355,040
515	Broadcasting (except Internet)	2.89	32,160	$3,920,802,704	$121,916
315	Apparel Manufacturing	2.61	18,259	$965,840,676	$52,897
485	Transit and Ground Passenger Transportation	2.45	47,909	$1,733,842,960	$36,190
512	Motion Picture and Sound Recording Industries	2.42	36,873	$3,541,451,716	$96,045
519	Other Information Services	2.19	19,628	$2,003,248,633	$102,061
712	Museums, Historical Sites, and Similar Institutions	2.17	11,320	$555,762,884	$49,096
525	Funds, Trusts, and Other Financial Vehicles	2.04	7,022	$1,108,889,832	$157,917
531	Real Estate	1.90	128,657	$7,636,604,091	$59,356
533	Lessors of Nonfinancial Intangible Assets (except Copyrighted Works)	1.79	2,274	$250,744,139	$110,266

By drilling down to the finest level of detail, six-digit NAICS, it is evident that the region is a significant exporter of some specific products (Table 53). Average payroll in these sectors are above average for manufacturing, suggesting that the goods produced are likely of high value, and high value-to-weight items are the most likely to be shipped by air. The top 20 list is comprised almost exclusively of apparel items, including women’s dresses, men’s neckware, fur and leather, and apparel for infants. Other manufactured goods include beet sugar, cane sugar, and electronic coils.

Table 53. Top 20 Manufacturing Sectors in New York Portion of NYC MSA by Six-digit NAICS

6-Digit NAICS	Description	LQ	Employment	Payroll	Average Payroll
315231	Women's and Girls' Cut and Sew Lingerie, Loungewear, and Nightwear Manufacturing	7.56	595	$45,065,064	$75,740
315233	Women's and Girls' Cut and Sew Dress Manufacturing	7.42	2,598	$207,840,150	$80,000
315234	Women's and Girls' Cut and Sew Suit, Coat, Tailored Jacket, and Skirt Manufacturing	5.75	584	$52,955,634	$90,677
315993	Men's and Boys' Neckwear Manufacturing	5.46	245	$17,725,458	$72,349
339913	Jewelers' Material and Lapidary Work Manufacturing	4.29	739	$25,007,623	$33,840
315239	Women's and Girls' Cut and Sew Other Outerwear Manufacturing	4.22	2,059	$201,246,500	$97,740
339911	Jewelry (except Costume) Manufacturing	3.94	4,360	$246,165,170	$56,460
315292	Fur and Leather Apparel Manufacturing	3.67	231	$10,121,252	$43,815
315291	Infants' Cut and Sew Apparel Manufacturing	3.49	73	$3,677,728	$50,380
312221	Cigarette Manufacturing	3.19	152	$216,354,787	$1,423,387
315991	Hat, Cap, and Millinery Manufacturing	3.08	574	$28,628,882	$49,876
311313	Beet Sugar Manufacturing	3.05	912	$58,492,605	$64,137
316110	Leather and Hide Tanning and Finishing	2.94	628	$32,607,895	$51,923
316211	Rubber and Plastics Footwear Manufacturing	2.73	244	$17,439,782	$71,475
315212	Women's, Girls', and Infants' Cut and Sew Apparel Contractors	2.72	7,006	$188,334,484	$26,882
315232	Women's and Girls' Cut and Sew Blouse and Shirt Manufacturing	2.28	370	$43,644,231	$117,957
334518	Watch, Clock, and Part Manufacturing	2.14	567	$31,090,410	$54,833
315221	Men's and Boys' Cut and Sew Underwear and Nightwear Manufacturing	2.14	73	$3,460,867	$47,409
311312	Cane Sugar Refining	2.09	258	$33,680,445	$130,544
334416	Electronic Coil, Transformer, and Other Inductor Manufacturing	2.03	754	$47,571,197	$63,092

New York City Area Freight (NY Portion) Freight Movements

New York City MSA (NY Portion) Air Exports

Results from a direct survey data of air freight carriers provided somewhat fragmentary information. This was undoubtedly due to the lack of official PANYNJ support for the endeavor. Clearly, past work was done on the topic for JFK: the objective of this study, however, was to perform an independent assessment in as uniform a manner across airports as possible.

It was therefore clear that the analysis needed to lean on secondary data for air shipments. The best and most complete publicly available data on trade for subregions of U.S. states are widely known to be Version 3 of the Freight Analysis Framework (FAF^3) Origin-Destination Data, which are available online from the U.S. Department of Transportation.[10] Table 54 shows the total weight and value of goods shipped by air from the New York portion of the NYC MSA.

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[10] Last accessed in June 2012 at http://www.ops.fhwa.dot.gov/freight/freight_analysis/faf/. For details on how the FAF^3 data are estimated see Southworth et al. (2010) at http://faf.ornl.gov/fafweb/Data/FAF3ODCMOverview.pdf.

Table 54. Total Air Exports from NY Portion of NYC MSA, 2007

SCTG	Total Out Air	Total Tons in 2007 (Thousands)	Total M$ in 2007	Air Share (Value)
1	Live animals/fish	11.3	$176	68.8%
2	Cereal grains	0.0	$0	0.0%
3	Other ag prods.	5.1	$47	0.5%
4	Animal feed	1.6	$18	2.5%
5	Meat/seafood	1.0	$8	0.1%
6	Milled grain prods.	0.5	$1	0.0%
7	Other foodstuffs	10.5	$45	0.3%
8	Alcoholic beverages	1.7	$17	0.2%
9	Tobacco prods.	1.0	$6	0.2%
13	Nonmetallic minerals	2.2	$4	1.6%
14	Metallic ores	0.9	$21	58.8%
19	Coal-n.e.c.	1.9	$4	0.1%
20	Basic chemicals	16.0	$822	30.0%
21	Pharmaceuticals	12.5	$2,383	7.9%
23	Chemical prods.	49.5	$1,314	16.2%
24	Plastics/rubber	27.5	$689	6.2%
26	Wood prods.	1.9	$10	0.2%
27	Newsprint/paper	0.7	$1	0.1%
28	Paper articles	13.7	$68	2.5%
29	Printed prods.	19.1	$452	4.4%
30	Textiles/leather	24.8	$890	2.2%
31	Nonmetal min. prods.	9.4	$214	7.1%
32	Base metals	33.5	$323	5.7%
33	Articles-base metal	37.3	$677	5.5%
34	Machinery	79.4	$9,470	20.7%
35	Electronics	51.9	$8,225	26.7%
36	Motorized vehicles	8.5	$252	1.4%
37	Transport equip.	7.0	$3,511	75.2%
38	Precision instruments	31.6	$6,017	34.0%
39	Furniture	2.6	$82	1.4%
40	Misc. mfg. prods.	17.0	$24,364	41.0%
43	Mixed freight	1.9	$199	1.2%
	Total	483.7	$60,310	14.5%

To meaningfully employ the FAF3 data, Quarterly Census of Employment and Wages (QCEW) were matched to Standard Classification of Transported Goods (SCTG) categories used by FAF[3] (Appendix A provides a NAICS to SCTG crosswalk). Table 55 resulted. Note that less than 6 percent of all employment and payroll reported in Table 55 for the New York portion of the New York City MSA is in sectors producing those commodities.

Table 55. Employment and Payroll of Commodity-producing Industries by Commodity, New York State Portion of NYC Metropolitan Area, 2007

SCTG	Description	LQ	Emp.	Payroll
1	Live animals/fish	0.21	1,489	$67,459,095
2	Cereal grains	0.01	9	$313,142
3	Other ag prods.	0.09	3,518	$114,126,711
4	Animal feed	0.18	569	$40,136,638
5	Meat/seafood	0.15	3,498	$175,169,538
6	Milled grain prods.	0.22	2,922	$104,804,942
7	Other foodstuffs	0.44	16,088	$904,859,929
8	Alcoholic beverages	0.39	1,386	$99,556,465
9	Tobacco prods.	2.28	156	$216,797,013
10	Building stone	0.40	709	$36,701,908
11	Natural sands	0.12	349	$25,576,641
12	Gravel	0.44	272	$12,390,538
13	Nonmetallic minerals	0.06	49	$4,374,383
14	Metallic ores	1.23	2,543	$270,136,299
15	Coal	0.00	0	$0
16	Crude petroleum	0.01	377	$36,284,079
17	Gasoline	0.00	22	$1,913,800
18	Fuel oils	0.00	0	$0
19	Coal-n.e.c.	0.34	931	$111,528,579
20	Basic chemicals	0.21	1,433	$119,152,224
21	Pharmaceuticals	0.67	15,693	$1,247,241,929
22	Fertilizers	0.05	110	$5,279,624
23	Chemical prods.	0.41	6,012	$466,855,355
24	Plastics/rubber	0.28	9,567	$645,602,769
25	Logs	0.01	55	$2,208,505
26	Wood prods.	0.20	4,482	$205,309,182
27	Newsprint/paper	0.34	3,016	$267,105,167
28	Paper articles	0.43	5,153	$312,156,461
29	Printed prods.	0.47	11,680	$615,971,776
30	Textiles/leather	1.39	26,189	$1,408,427,481
31	Nonmetal min. prods.	0.38	4,541	$324,702,646
32	Base metals	0.39	5,765	$542,462,439
33	Articles-base metal	0.31	21,694	$1,216,749,349
34	Machinery	0.28	13,278	$1,037,817,034
35	Electronics	0.44	25,338	$2,375,145,863
36	Motorized vehicles	0.26	9,550	$719,227,279
37	Transport equip.	0.48	12,881	$1,535,496,275
38	Precision instruments	0.38	17,234	$1,396,006,181
39	Furniture	0.48	8,221	$386,109,983
40	Misc. mfg. prods.	0.81	14,610	$804,782,303
41	Waste/scrap	0.00	0	$0
43	Mixed freight	0.25	147	$6,510,656
	Total		251,536	$17,862,450,181

Table 56 reveals most of the industries have payroll location quotients substantially lower than 1.0, the threshold typically used to identify industries that export. As with RNO, the list of exported commodities does not appear to be closely connected to production of the local economy, suggesting again many goods exiting JFK have their origins outside the study region.

Table 56 shows payroll of the production sectors that we have identified as producing goods for export via air freight. As described above, these are aggregate QCEW sectors related to the commodities shipped that have a location quotient greater than 0.3. The "air base payroll" is calculated by taking the portion of the total sector payroll beyond the 0.3 threshold and then the percentage of that commodity that is shipped by air. A threshold of 0.3 has been identified by Stevens, Treyz, and Lahr (1989) as the norm for interstate shipment of commodities.

Table 56. Portion of Commodity-producing Industries Directly Related to Air Freight, New York Portion of NYC MSA

SCTG	Description	M$07 Air	Air Share $$	LQ	Air Base Payroll
7	Other foodstuffs	$44.8	0.3%	0.44	$1,040,526
8	Alcoholic beverages	$17.3	0.2%	0.39	$74,492
9	Tobacco prods.	$6.2	0.2%	2.28	$310,873
14	Metallic ores	$21.5	59%	1.23	$127,847,192
19	Coal-n.e.c.	$4.2	0.1%	0.34	$31,426
21	Pharmaceuticals	$2,382.6	7.9%	0.67	$59,613,934
23	Chemical prods.	$1,314.0	16.2%	0.41	$40,355,620
27	Newsprint/paper	$0.7	0.1%	0.34	$87,850
28	Paper articles	$67.8	2.5%	0.43	$2,049,620
29	Printed prods.	$452.2	4.4%	0.47	$11,048,581
30	Textiles/leather	$889.6	2.2%	1.39	$24,547,022
31	Nonmetal min. prods.	$214.2	7.1%	0.38	$8,583,580
32	Base metals	$323.5	5.7%	0.39	$14,115,803
33	Articles-base metal	$676.7	5.5%	0.31	$12,371,578
35	Electronics	$8,224.6	26.7%	0.44	$259,300,819
37	Transport equip.	$3,511.0	75.2%	0.48	$647,811,775
38	Precision instruments	$6,016.6	34.0%	0.38	$173,109,521
39	Furniture	$82.4	1.4%	0.48	$2,398,472
40	Misc. mfg. prods.	$24,363.6	41.0%	0.81	$171,630,950
	Total				$1,556,329,635

Table 57 presents the total economic impacts of JFK air cargo outflows on the entire New York metropolitan area. As can be observed from Section II, Line 1 of the table, the $1.543 billion in payroll required to produce the $6.31 billion in goods shipped out of JFK translates to 22,506 jobs (annual average pay per job of $68,560) and more than $2.4 billion is state GDP for New York. Further Section II, Line 2 shows that this direct economic effect of the goods shipped out of JFK is supported by 23,085 jobs with a combined payroll of nearly $1.74 billion ($75,530 per job) and $3.15 billion in state GDP. In this vein, the lower-paying jobs of the air cargo-producing industries of the region are supported by higher-paying jobs in Finance, Health, and other assorted service industries (see Section I of Table 57).

Section IV of Table 57 shows estimates of the total tax revenues that state and local governments receive annually due to the existence of outgoing cargo shipments from JFK. About $619.0 million (44.6 percent) of the $1.39 billion in tax revenues generated are estimated as indirect business taxes. By level of government 50.5 percent of all tax revenues are estimated to be federal tax revenues, 20.8 percent as state revenues, and 21.2 percent as local tax revenues.

Note that the gap between state and local tax revenues is generated largely via indirect business taxes.

Table 57. Total Economic Impacts of JFK Air Cargo Outflows on the New York Metropolitan Area

		Output ($Thousands)	Employment (jobs)	Compensation ($Thousands)	GDP ($Thousands)
I. Total Effects (Direct + Indirect/Induced)					
1.	Agriculture, Forestry, Fishing, and Hunting	33,060.7	129	4,957.4	11,727.2
2.	Mining	829,675.7	2,173	140,103.7	388,381.2
3.	Utilities	161,757.5	105	24,701.1	91,278.9
4.	Construction	8,782.9	32	2,852.4	3,942.8
5.	Manufacturing	6,790,085.3	24,310	1,701,870.9	2,387,718.9
6.	Wholesale Trade	596,631.7	2,246	198,673.4	382,679.9
7.	Retail Trade	280,675.0	2,472	98,890.8	165,895.7
8.	Transportation and Warehousing	166,544.3	816	57,211.5	79,643.0
9.	Information	286,988.2	441	55,466.0	158,637.1
10.	Finance, Insurance, Real Estate, Rental, and Leasing	1,159,148.1	1,118	178,962.2	738,157.3
11.	Professional and Business Services	910,323.8	4,032	421,571.3	642,594.9
12.	Educational Services, Health Care, and Social Assistance	556,962.3	4,395	273,070.7	338,308.6
13.	Arts, Entertainment, Recreation, Accommodation, and Food Services	248,019.0	2,380	80,235.8	134,346.3
14.	Other Services (except Government)	115,499.5	943	48,076.2	64,907.8
	Total Effects	12,144,153.9	45,591	3,286,643.2	5,588,219.7
II. Distribution of Effects and Multipliers					
1.	Direct Effects	6,305,048.5	22,506	1,543,002.9	2,435,910.7
2.	Indirect/Induced Effects	5,839,105.5	23,085	1,743,640.3	3,152,309.0
3.	Total Effects	12,144,153.9	45,591	3,286,643.2	5,588,219.7
4.	Multipliers (= 3 / 1)	1.926	2.03	2.130	2.294
III. Composition of GDP					
1.	Compensation (Net of Taxes)				3,286,643.2
2.	Taxes				618,976.2
	a. Local				148,538.6
	b. State				251,407.2
	c. Federal				219,030.4
3.	Profits, Dividends, Rents, and Other				1,682,600.3
4.	Total GDP (= 1 + 2 + 3)				5,588,219.7
IV. Tax Accounts					
			Business	**Household**	**Total**
1.	Earnings (Net of Taxes)		3,286,643.2	3,155,177.4	----------------
2.	Taxes		618,976.2	769,589.9	1,388,566.1
	a. Local		148,538.6	146,126.8	294,665.5
	b. State		251,407.2	140,720.9	392,128.1
	c. Federal		219,030.4	482,742.1	701,772.5

New York City MSA (NY Portion) Air Imports

Table 58 shows the total weight and value of goods shipped by air from the New York portion of the NYC MSA. All of these shipments were assumed to be distributed by wholesalers within the region.

Table 58. Total Air Imports to NY Portion of NYC MSA

SCTG	AIR	Total KTons in 2007	Total M$ in 2007	AirShare of $
1	Live animals/fish	23.3	$318	52.4%
2	Cereal grains	0.1	$0	0.0%
3	Other ag prods.	25.8	$248	3.5%
4	Animal feed	2.1	$121	12.4%
5	Meat/seafood	2.7	$44	0.3%
6	Milled grain prods.	0.6	$3	0.1%
7	Other foodstuffs	5.7	$74	0.5%
8	Alcoholic beverages	3.0	$30	0.3%
9	Tobacco prods.	0.2	$5	0.1%
13	Nonmetallic minerals	1.3	$2	0.5%
14	Metallic ores	0.2	$7	8.9%
19	Coal-n.e.c.	1.1	$1	0.0%
20	Basic chemicals	9.8	$2,725	56.6%
21	Pharmaceuticals	19.0	$5,329	24.9%
22	Fertilizers	0.0	$0	0.0%
23	Chemical prods.	18.3	$823	8.8%
24	Plastics/rubber	22.0	$447	5.0%
26	Wood prods.	2.8	$22	0.4%
27	Newsprint/paper	0.0	$1	0.0%
28	Paper articles	4.7	$50	1.5%
29	Printed prods.	10.3	$205	1.6%
30	Textiles/leather	170.8	$6,174	23.6%
31	Nonmetal min. prods.	12.9	$185	3.5%
32	Base metals	13.4	$141	2.2%
33	Articles-base metal	15.4	$535	4.1%
34	Machinery	83.1	$7,325	15.6%
35	Electronics	64.9	$6,507	18.4%
36	Motorized vehicles	18.4	$356	1.6%
37	Transport equip.	2.6	$1,081	34.6%
38	Precision instruments	33.2	$4,767	36.9%
39	Furniture	6.9	$150	2.0%
40	Misc. mfg. prods.	30.7	$24,396	53.5%
43	Mixed freight	13.7	$2,749	6.8%
	Total	618.7	$64,820	15.1%

As noted in the sector detail by two-digit NAICS, the local wholesale sector employs 208,714 workers with an aggregate payroll of $15.8 billion. By applying national wholesale margins to the value of the imported commodities as well as applying labor compensation's share of the margin at the national level, about 2.0 percent of all wholesale trade production in the region is estimated to be generated by incoming JFK air freight. This amounts to 3,505 jobs and $310.0 million in payroll in the region's wholesale industry.

Freight-Related Airport Operations and Shipping Industry

Usably complete responses were received from 17 freight forwarders, 22 air carriers, the airport, and 2 shippers. Where data on payroll for an organization was missing, we used industry-average pay levels and the number of jobs reported by the survey respondent to estimate the payroll. When jobs were not reported but payroll levels were, industry-average wage levels were used to estimate the number of jobs. Table 59 summarizes the results of the survey data and the aforementioned estimation procedure for the total population of organizations involved in airport freight-related operations, such as freight forwarders and shippers, at JFK. The figures listed below are the total employees and payroll that are directly related to air cargo freight activities.

Table 59. Summary of Survey of JFK Airport Freight Operations and Related Activity

Summary	Total Employment	Total Pay
FF Air Service	249	$10,636,571
Air Carrier	2,571	$101,705,988
Airport	24,700	$1,354,194,478
Shipper	172	$6,392,000
Total	27,692	$1,472,929,037

One point of comparison for this survey is the 2010 QCEW for Scheduled Freight Air Transportation (NAICS 481112) and the Air Carrier information in Table 59 above. The QCEW data reveal that officially, according to the US Bureau of Labor Statistics, 1,067 jobs with a payroll of $120,157,858. Thus, the study survey reports 240 percent the QCEW jobs and about 85 percent of its payroll. Clearly, the payroll figure is within reasonable bounds. Of course, LaGuardia Airport is within this region as well; but it has little freight throughput, so its air freight payroll should be negligible. The employment differential is more of a quandary since with the exception of three smaller firms, the 22 carriers tended to report that their employees in air freight worked full-time. In any event, rather than follow jobs numbers from the survey we held by the payroll numbers, and assumed that they represented a census of air freight employers at the airport. Later we use industry-average pay levels to estimate the employment levels in the model.

Total Economic Impacts of Freight-related Airport Operations and Warehousing of Inflows

The Rutgers Economic Advisory Service's input-output modeling system (R/ECON I-O) perfectly estimated the jobs affiliated with the payroll for freight forwarders. To effect (mimic) in the modeling exercise the direct of the "airport industry" (as no such industry exists), however, its payroll was equally split between the model's industry representing "Support activities for transportation" and one representing "Office administrative services." As a result, the model's underlying data system estimated that more jobs should exist than suggested by the survey work. Given the already higher average pay of the Office administrative services industry, only the job count related to the Support activities for transportation was ratcheted downward. The job count estimated by the model for Air carriers was lower than derived via the survey. They were respectfully upwardly adjusted to match that obtained via the survey. Such blatant adjustment of known effects from those estimated via economic models is best practice in the field of economic modeling. The rationale behind the adjustment is that the model produces the job estimates using industry-average rates of pay for a specific year. In the case of the R/ECON I-O model used, the underlying regional economic data are for the year 2010.

Table 60 presents the total economic impacts of JFK air cargo inflows (related as direct effects only to the wholesale trade sector) plus those for air freight and related industries on the New York metropolitan area. As can be observed from Section II, Line 1 of the table, the $1.783 billion in payroll at the airport and the wholesale trade facilities affiliated with JFK traffic translates to 17,908 jobs (annual average pay per job of $99,560) and nearly $2.78 billion in state GDP for New York. Further Section II, Line 2 shows that this direct economic effect is supported by 24,181 other jobs with a combined payroll of nearly $1.6 billion ($66,000 per job) and $3.09 billion in state GDP. Thus, higher-paying jobs at or near the airport are supported by lower-paying jobs, largely those in Retail Trade, health Care, and Entertainment industries (see Section I of Table 60), although the supporting jobs are well distributed across a large array of industries.

Section IV of Table 60 shows estimates of the total tax revenues that state and local governments receive annually due to the existence of outgoing cargo shipments from JFK. About $791 million (50.0 percent) of the $1.582 billion in tax revenues generated are estimated as indirect business taxes. By level of government 46.4 percent are estimated to be federal tax revenues, 34.3 percent as state revenues, and 19.3 percent as local tax revenues. State tax revenues from wholesaling activities are assumed to dominate state tax revenues insofar as indirect business taxes are concerned. Of course, all such revenues, and some federal revenues as well, might not accrue due to the extent of traffic that is likely handled at JFK's Free Trade Zone.

Table 60. Total Economic Impacts of JFK Air Cargo Inflows on the New York Metropolitan Area

		Output ($Thousands)	Employment (jobs)	Compensation ($Thousands)	GDP ($Thousands)
I. Total Effects (Direct + Indirect/Induced)					
1.	Agriculture, Forestry, Fishing, and Hunting	33,523.4	131	5,028.4	11,894.9
2.	Mining	1,910.3	6	506.5	830.2
3.	Utilities	110,758.6	73	16,669.5	61,599.5
4.	Construction	7,942.7	29	2,579.5	3,565.7
5.	Manufacturing	500,347.8	1,482	99,830.9	169,917.9
6.	Wholesale Trade	1,227,761.1	4,622	408,834.3	787,486.5
7.	Retail Trade	290,574.0	2,559	102,378.5	171,746.7
8.	Transportation and Warehousing	3,817,973.2	11,493	908,657.8	1,465,722.6
9.	Information	329,629.1	488	58,264.2	178,625.3
10.	Finance, Insurance, Real Estate, Rental, and Leasing	1,268,925.1	1,201	184,988.2	813,340.5
11.	Professional and Business Services	2,310,792.1	10,846	1,151,977.4	1,605,976.5
12.	Educational Services, Health Care, and Social Assistance	549,589.4	4,338	269,464.9	333,781.2
13.	Arts, Entertainment, Recreation, Accommodation, and Food Services	385,061.1	3,903	123,432.3	204,244.9
14.	Other Services (except Government)	112,339.8	920	46,670.5	62,983.2
	Total Effects	10,947,127.8	42,089	3,379,282.9	5,871,715.5
II. Distribution of Effects and Multipliers					
1.	Direct Effects	5,645,355.7	17,908	1,782,973.9	2,780,068.1
2.	Indirect/Induced Effects	5,301,772.1	24,181	1,596,309.0	3,091,647.4
3.	Total Effects	10,947,127.8	42,089	3,379,282.9	5,871,715.5
4.	Multipliers (= 3 / 1)	1.939	2.35	1.895	2.112
III. Composition of GDP					
1.	Compensation (Net of Taxes)				3,379,282.9
2.	Taxes				790,920.4
	a. Local				155,037.8
	b. State				398,283.4
	c. Federal				237,599.2
3.	Profits, Dividends, Rents, and Other				1,701,512.1
4.	Total GDP (= 1 + 2 + 3)				5,871,715.5
IV. Tax Accounts					
			Business	**Household**	**Total**
1.	Earnings (Net of Taxes)		3,379,282.9	3,244,111.6	----------------
2.	Taxes		790,920.4	791,282.1	1,582,202.5
	a. Local		155,037.8	150,245.6	305,283.5
	b. State		398,283.4	144,687.4	542,970.8
	c. Federal		237,599.2	496,349.1	733,948.3

Case Study 5 – Reno-Tahoe International Airport, Reno, Nevada

Reno-Tahoe International Airport (RNO) originally built in 1929 was named Hubbard Field. It is currently ranked as the 60th busiest commercial airport in the U.S. and sits on 1,450 acres of land. RNO currently serves eight commercial airlines. These carriers operate out of 23 gates at the main terminal, in which Southwest currently makes up 56.4 percent of the market share. The three runways at RNO provide substantial operating capacity and currently accommodate approximately 140 commercial airline operations daily. RNO is also home to the Reno Air National Guard whose base consists of a 60 acre complex on the west side of the airport. The airport served more than 3.8 million passengers in 2010, up 1.8 percent from the previous year. However, total aircraft movements were down 7.3 percent from 2009 (Reno-Tahoe Airport Authority 2012).

Domestic cargo is the only product processed through the airport. Currently, no scheduled international cargo or airmail is handled at the airport. This is due in large measure to the proximity of Reno to large shipping hubs in San Francisco, Los Angeles, and to a lesser extent Seattle and Vancouver. The airport has the potential to grow its domestic cargo market, since it is ideally located to serve numerous West Coast distribution centers, online fulfillment centers, and the Tahoe/Reno Industrial Center, which is being marketed to be the largest industrial park in the world upon completion. Currently, four cargo companies operate out of RNO, including Capital Cargo International, DHL, FedEx and UPS as well as numerous ad-hoc charters throughout the year. In 2010, the Airport handled more than 56,000 tons of cargo; this is approximately a 10 percent increase from 2009 (Reno-Tahoe Airport Authority 2012).

Reno-Sparks Regional Economy

Reno is a city of 213,000[11] located in western Nevada near Lake Tahoe. The area is known for its casinos and associated gambling industries. Unlike Las Vegas, its larger neighbor to the south, the land around Reno can support development without major water-diverting infrastructure. Prior to Nevada's legalization of gambling in 1931, Reno was a regional transportation hub. Located at a crossing of the Truckee River en route to the Donner Pass in the Sierra Nevada Mountains, the city got its start as a railroad town on the Central Pacific Railway.[12] Reno's sister city, Sparks, developed around a switch yard on the Southern Pacific Railroad. With the rise of Las Vegas and the expansion of legalized gambling nationwide, the area declined as a gambling destination; still, gaming and related tourism remain the area's primary industry. Similarly, with rail freight's decline vis-à-vis truck and air freight, the city's fortunes as a transportation hub have also diminished. Still, the area remains home to numerous distribution centers and online fulfillment centers. For its size, Reno-Tahoe International Airport houses an exceptional number of air cargo carriers, including Capital Cargo International, DHL, FedEx Express, and UPS, as well as numerous ad-hoc charters throughout the year. As a result, on average more than 150 tons of cargo arrive/depart daily through the Reno-Tahoe International Airport. Moreover, tonnages shipped through RNO have been rising in recent years (Reno-Tahoe Airport Authority 2012).

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[11] 2005-2009 ACS
[12] http://www.city-data.com/us-cities/The-West/Reno-History.html

The Reno-Sparks Metropolitan Statistical Area includes Washoe County (Reno) and Storey County (Sparks). The 2010 Census counts 421,407 people in Washoe County (with a nonfarm employment of 173,120)[13] and just 4,010 people in Storey County (with a nonfarm employment of 352 in 2009).[14] Carson City, the capital and an independent city, is not part of the MSA, although it is just a 40 minute drive from Reno. Nonetheless, Carson City's 55,274 residents (and 22,258 in nonfarm employment)[15] also depend on the RNO.

Table 61 displays the Reno-Sparks MSA economy by supersector. Reflecting well the economic base of the economy, Accommodation and food services; Transportation and warehousing; Arts, entertainment, and recreation are the only supersectors with payroll locations quotients notably greater than 1.0. Given that payroll figures are better indicators of productivity than are employment numbers or job counts, it is presumed that a payroll location quotient (the industry's share of local activity relative to that share for the industry nationwide) yields a proxy for the supply/demand ratio for the industry. Thus, supersectors with LQs greater than 1.0 should be more than self-sufficient (and abnormally concentrated) in the Reno-Sparks MSA, and clearly forming a substantial portion of the region's export base. In this vein, they are expected to yield net sources of wealth to the region.

Table 61. Employment, Payroll, and Payroll Location Quotients (LQs) by Two-digit NAICS for the Reno-Sparks MSA (2010)

NAICS	Description	LQ	Jobs	Payroll (thousands)	Average Salary
11	Agriculture, Forestry, Fishing and Hunting	0.10	214	$3,973	$18,566
21	Mining, Quarrying, and Oil and Gas Extraction	0.81	548	$62,336	$113,752
22	Utilities	0.93	774	$58,653	$75,779
23	Construction	1.19	8,778	$423,931	$48,295
31-33	Manufacturing	0.72	12,121	$620,010	$51,152
42	Wholesale Trade	1.00	8,346	$455,255	$54,548
44-45	Retail	1.07	20,580	$541,646	$26,319
48-49	Transportation and Warehousing	1.87	10,637	$426,332	$40,080
51	Information	0.49	2,335	$130,075	$55,707
52	Finance and Insurance	0.59	5,628	$361,674	$64,263
53	Real Estate and Rental and Leasing	1.05	3,371	$115,008	$34,117
54	Professional, Scientific, and Technical Services	0.81	9,456	$611,302	$64,647
55	Management of Companies and Enterprises	1.35	3,376	$322,728	$95,595
56	Administrative and Support and Waste Management and Remediation Services	0.95	11,234	$305,799	$27,221
61	Educational Services	0.46	1,828	$62,937	$34,429
62	Health Care and Social Assistance	1.09	19,941	$1,010,593	$50,679
71	Arts, Entertainment, and Recreation	1.48	5,166	$119,226	$23,079
72	Accommodation and Food Services	2.52	28,883	$629,309	$21,788
81	Other Services (except Public Administration)	1.19	5,962	$199,014	$33,380
99	Unclassified	0.70	92	$7,124	$77,437
	Total	0	159,270	$6,466,928	$40,604

Source: R/ECON I-O

[13] http://quickfacts.census.gov/qfd/states/32/32031.html
[14] http://quickfacts.census.gov/qfd/states/32/32029.html
[15] http://quickfacts.census.gov/qfd/states/32/32510.html

Major Industries in Reno-Sparks

With greater sectoral articulation, Table 62 shows, regardless of size, the ten three-digit NAICS industries that are most heavily concentrated in the Reno-Sparks economy. The economic profile for the metropolitan area solidifies. Accommodation (721), largely casino resort hotels around Lake Tahoe, tops the list with a payroll location quotient of 7.29. The subsector supports an annual average of 16,129 employees at an average annual salary of $26,857 dollars (for a total labor income of over $433.2 million). The Warehousing and storage subsector's LQ of 4.69 puts it in the number two spot, with 4,046 employees who earn an average salary of $39,034 (for a total labor income of $157.9 million). Miscellaneous manufacturing occupies the third spot. In that subsector, 2,003 workers are involved in the manufacture of miscellany, bringing home an average salary of $63,471 (for a total labor income of $127.1 million). Curiously, Amusements, gambling, and recreation (713) – the industry to which the number one industry, accommodation, likely owes a great deal, posts a more modest LQ of 2.72. Mining, except oil and gas; Couriers and messengers; Funds, trusts, and other financial vehicles; and Transit and ground passenger transportation; also have payroll location quotients above 2.0.

Table 62. Ten Highest Payroll LQ Industries among Three Digit NAICS for the Reno-Sparks MSA, 2010

NAICS	Description	LQ	Jobs	Payroll (thousands)	Average Salary
721	Accommodation	7.29	16,129	$433,178	$26,857
493	Warehousing and Storage	4.69	4,046	$157,933	$39,034
339	Miscellaneous Manufacturing	3.19	2,003	$127,132	$63,471
713	Amusement, Gambling, and Recreation Industries	2.72	4,578	$97,129	$21,216
212	Mining (except Oil and Gas)	2.26	448	$40,840	$91,160
492	Couriers and Messengers	2.24	1,724	$65,561	$38,028
525	Funds, Trusts, and Other Financial Vehicles	2.16	257	$23,375	$90,952
485	Transit and Ground Passenger Transportation	2.13	819	$29,936	$36,552
451	Sporting Goods, Hobby, Book, and Music Stores	1.87	1,444	$27,774	$19,234
484	Truck Transportation	1.74	2,665	$119,658	$44,900

In drilling even deeper, Table 63 ranks the top 20 manufacturing subsectors with even further refinement (six-digit NAICS) by payroll location quotient. Topping the list is All other miscellaneous manufacturing, which includes "coin-operated amusement machines," "coin-operated gambling devices," and "slot machines" manufacturing. Not surprisingly, International Game Technology (IGT), a Reno-based gaming-machine manufacturer, reported revenues of $1.9 billion in 2010. Clearly, legal gaming and related tourism are core industries of the Reno-Sparks metropolitan area. It is also clear that in Reno-Sparks, local commodity exporting six-digit industries are fairly small in size with the possible exceptions of both All Other Miscellaneous Manufacturing and Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing.

Table 63. The Ten Manufacturing Six-digit NAICS Sectors Most Highly Concentrated in the Reno-Sparks MSA, 2010

NAICS	Description	LQ	Jobs	Payroll (thousands)	Average Salary
339999	All Other Miscellaneous Manufacturing	36.52	1,607	$109,841	$68,352
334418	Printed Circuit Assembly (Electronic Assembly) Manufacturing	6.54	345	$21,201	$61,452
332911	Industrial Valve Manufacturing	5.85	223	$10,785	$48,363
332112	Nonferrous Forging	4.58	40	$2,264	$56,596
314912	Canvas and Related Product Mills	4.51	94	$3,681	$39,165
322215	Nonfolding Sanitary Food Container Manufacturing	4.36	103	$3,030	$29,414
331315	Aluminum Sheet, Plate, and Foil Manufacturing	4.10	103	$5,119	$49,700
331522	Nonferrous (except Aluminum) Die-Casting Foundries	4.10	32	$1,207	$37,713
334511	Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	3.80	945	$70,633	$74,744
337212	Custom Architectural Woodwork and Millwork Manufacturing	3.79	52	$3,450	$66,344
332322	Sheet Metal Work Manufacturing	3.72	499	$20,269	$40,620
322223	Coated Paper Bag and Pouch Manufacturing	3.62	42	$1,650	$39,274
334514	Totalizing Fluid Meter and Counting Device Manufacturing	3.50	68	$2,957	$43,491
322233	Stationery, Tablet, and Related Product Manufacturing	3.34	18	$778	$43,248
334310	Audio and Video Equipment Manufacturing	3.22	98	$6,416	$65,474
326111	Plastics Bag and Pouch Manufacturing	3.18	174	$5,856	$33,658
335129	Other Lighting Equipment Manufacturing	3.12	46	$1,802	$39,181
325910	Printing Ink Manufacturing	3.10	36	$2,382	$66,176
332913	Plumbing Fixture Fitting and Trim Manufacturing	3.07	54	$1,894	$35,069
323119	Other Commercial Printing	3.05	154	$7,132	$46,311

Commodity-producing Industries by SCTG Code

Results from a direct survey of air freight carriers provided fragmentary information at best. The responded population was small, and those who did respond at RNO provided data that were not generally complete. It was therefore clear that the analysis needed to lean on secondary data for air shipments. The best and most complete publicly available data on trade for subregions of U.S. states are widely known to be Version 3 of the Freight Analysis Framework (FAF^3) Origin-Destination Data, which are available online from the U.S. Department of Transportation.[16] To meaningfully employ the FAF3 data, Quarterly Census

[16] Last accessed in June 2012 at http://www.ops.fhwa.dot.gov/freight/freight_analysis/faf/. For details on how the FAF^3 data are estimated see Southworth et al. (2010) at http://faf.ornl.gov/fafweb/Data/FAF3ODCMOverview.pdf.

of Employment and Wages (QCEW) were matched to Standard Classification of Transported Goods (SCTG) categories used by FAF[3] (Appendix A provides a NAICS to SCTG crosswalk). Table 64 resulted. Note that less than 10 percent of all Reno-Sparks employment and just more than 10 percent of its aggregate payroll are engaged in producing the relevant commodities. Moreover, most pertinent industries have LQs substantially lower than 1.0, the threshold generally applied to assume an industry exports.

Table 64. Employment and Payroll by SCTG Category in the Reno-Sparks MSA, 2010

SCTG	Description	Payroll LQ	Jobs	Payroll ($Thousands)
1	Live animals/fish	0.29	66	$1,892
2	Cereal grains	0.00	0	$0
3	Other ag prods.	0.04	40	$933
4	Animal feed	0.28	108	$1,229
5	Meat/seafood	0.28	206	$6,387
6	Milled grain prods.	0.58	138	$5,507
7	Other foodstuffs	0.50	443	$20,499
8	Alcoholic beverages	0.01	1	$45
9	Tobacco prods.	0.00	0	$0
10	Building stone	1.65	87	$2,990
11	Natural sands	0.94	72	$3,900
12	Gravel	0.00	0	$0
13	Nonmetallic minerals	0.48	13	$718
14	Metallic ores	12.26	395	$53,515
15	Coal	0.00	0	$0
16	Crude petroleum	0.06	40	$3,332
17	Gasoline	0.05	6	$585
18	Fuel oils	0.00	0	$0
19	Coal-n.e.c.	0.29	36	$1,887
20	Basic chemicals	0.25	47	$2,881
21	Pharmaceuticals	0.04	39	$1,504
22	Fertilizers	0.12	5	$230
23	Chemical prods.	0.36	123	$8,110
24	Plastics/rubber	0.85	925	$38,667
25	Logs	0.34	36	$1,148
26	Wood prods.	0.81	513	$16,615
27	Newsprint/paper	0.21	76	$3,330
28	Paper articles	1.24	407	$18,014
29	Printed prods.	1.25	751	$32,440
30	Textiles/leather	0.28	229	$5,720
31	Nonmetal min. prods.	0.47	158	$8,008
32	Base metals	0.32	191	$8,977
33	Articles-base metal	1.01	1,839	$79,414
34	Machinery	0.47	705	$34,329
35	Electronics	0.57	1,056	$61,640
36	Motorized vehicles	0.18	212	$9,659
37	Transport equip.	0.39	346	$24,898
38	Precision instruments	1.26	1,348	$92,926
39	Furniture	0.50	177	$8,097
40	Misc. mfg. prods.	5.98	1,798	$118,320
41	Waste/scrap	0.00	0	$0
43	Mixed freight	0.00	0	$0
	Total		12,632	$678,345

Reno Area Air Freight Movements

As was discussed previously, the analysis of air freight necessarily leaned on publically available data from FAF^3. Many (74 to be precise) of FAF^3's 123 regions are metropolitan areas. Unfortunately the Reno-Sparks MA is not one of them. In fact, it lies with the FAF3 region called "Remainder of Nevada." That is, it is all of Nevada excluding both Nye County and Clark County, the latter containing Las Vegas and its suburbs. The "Remainder of Nevada" therefore comprises more than just the Reno-Sparks MSA, and while Reno is undoubtedly the largest city of this geography, it contains less than half of the region's population, which itself comprises about half of the state's total. Indeed, it well may be that RNO services much of this broader region with its air freight needs.

"Remainder of Nevada" Outflows

Table 65 shows air freight export commodities by SCTG code for the year 2007. In total, the Reno-Sparks MSA exported $299.3 million worth of goods by air. Comparing Table 65 to the profile in the previous section, it is evident that air freight exports are not particularly representative of the economy as a whole. This is not surprising given the economy's heavy reliance on casinos and related tourism as well as the geographical mismatch between the MSA and the FAF^3 region represented by Table 65. Still, it certainly makes clear that the economy (from either geographic perspective) also does not depend highly on air freight.

Table 65. Air Freight (including Truck-Air) for the Remainder of Nevada, Total Originating, 2007

SCTG	Description	Kilotons	Air Shipments ($Million)	Air Freight Share ($)
5	Meat/seafood	1.84	$20.1	4.2%
20	Basic chemicals	0.00	$0.8	2.3%
21	Pharmaceuticals	0.03	$90.8	3.0%
23	Chemical prods.	0.34	$2.0	0.1%
24	Plastics/rubber	0.60	$3.0	0.3%
29	Printed prods.	0.77	$4.4	0.6%
30	Textiles/leather	0.33	$26.5	2.2%
31	Nonmetal min. prods.	0.00	$0.2	0.0%
32	Base metals	0.25	$2.0	0.4%
33	Articles-base metal	0.05	$0.6	0.0%
34	Machinery	0.00	$5.6	0.1%
35	Electronics	0.28	$94.4	3.0%
36	Motorized vehicles	0.25	$27.4	1.9%
39	Furniture	0.05	$1.0	0.4%
40	Misc. mfg. prods.	0.00	$1.2	0.1%
43	Mixed freight	1.36	$19.4	0.5%
	Total	6.16	$299.3	

Source: FAF^3 (2007)

Reconciling originating shipments with local MSA production was a challenge. In fact it became immediately apparent since Pharmaceuticals – a top air freight export for the region according to the FAF[3] – does not register as a major production sector in the QCEW data for Reno-Sparks (addressed below). Regardless, $90.8 million worth of pharmaceuticals left RNO by aircraft in 2007. SCTG category 21, Pharmaceutical Products, refers to finished products ready for medical use (and not the raw base chemicals). It also includes bandages, sutures, dental fillings, and other such non-medicinal products. Although Pharmaceuticals loom large as an export from RNO, the largest export sector actually was SCTG Code 35, Electronic and other Electrical Equipment and Components, and Office Equipment. This commodity category includes computer equipment and circuits, audio-video equipment, light bulbs, some (mainly smaller) domestic appliances, electric motors, among other things. In 2007, $94.4 million in electronics were shipped from Reno. Both of these top commodities have high value-to-weight ratios, consistent with expectations for expensive air shipment. The largest next category, Meat, Fish, and Seafood, and their Preparations has a lower value-to-weight ratio, but considerably more urgency since such food goods are typically deemed best when fresh. The category includes meat, poultry, fish fresh, chilled or frozen (or dried, salted, or boiled in the case of some sea foods). About $20.1 million in meat, fish, and seafood and their preparations took flight from RNO in 2007.

Table 66 shows payroll of the Reno-Sparks MSA production sectors that likely produce goods for export by air freight. As described above, these are aggregate QCEW sectors related to the commodities shipped that have a location quotient greater than 0.3. The "air base payroll" is calculated by taking the portion of the total sector payroll beyond the 0.3 threshold and then the percentage of that commodity that is shipped by air. We use a threshold of 0.3 rather than 1.0 here for two reasons (1) because using the more conventional LQ threshold of 1.0 yielded insufficient capacity for a reasonable estimate of air freight from the Reno-Sparks area given its dominance in the "Rest of Nevada" space economy and (2) Stevens, Treyz, and Lahr (1989) found that assuming an LQ threshold of 0.3 was better than using the usual 1.0 threshold when estimating the share of production that is used locally for goods-producing sectors.

Table 66. Air Freight (including Truck-Air) for the Remainder of Nevada, Total Originating from Reno-Sparks MSA, 2007

CTG	Description	Air Shipments ($Million)	Air Share of $s	Payroll LQ	Est. Payroll (Thousands)
23	Chemical prods.	$2.0	0.1%	0.36	$3.1
24	Plastics/rubber	$3.0	0.3%	0.85	$75.3
29	Printed prods.	$4.4	0.6%	1.25	$162.4
31	Nonmetal min. prods.	$0.2	0.0%	0.47	$1.7
32	Base metals	$2.0	0.4%	0.32	$25.8
33	Articles-base metal	$0.6	0.0%	1.01	$23.4
34	Machinery	$5.6	0.1%	0.47	$34.2
35	Electronics	$94.4	3.0%	0.57	$1,205.0
39	Furniture	$1.0	0.4%	0.50	$21.9
40	Misc. mfg. prods.	$1.2	0.1%	5.98	$73.7
	Total	$114.40			$1,626.4

Despite the lower threshold a disjoint clearly exists. After combining data from FAF[3] and on local production capabilities, just $6.87 million of goods that are shipped out of RNO can derive from the Reno-Sparks metropolitan area. As shown in Table 66 this equates to $1.626 million in payroll estimated for the metropolitan area. That is, those commodities shipped from RNO, according to FAF[3], tend not to have a corresponding production presence according to the US Bureau of Labor Statistics. This forces the conclusion that outward-bound goods from RNO's catchment area tend to be produced outside the MSA itself. Still, the MSA benefits from the economic activity, presumably through warehousing and other support services.

Table 67 presents the total economic impacts of RNO air cargo outflows on the Reno-Sparks metropolitan area. As can be observed from Section II, Line 1 of the table, the $1.623 million in payroll required to produce the $6.87 million in goods shipped out of RNO translates to 44 jobs (annual average pay per job of $37,200) and nearly $2.5 million in state GDP for Nevada. Further Section II, Line 2 shows that this direct economic effect of the goods shipped out of RNO is supported by 33 jobs with a combined payroll of nearly $1.70 million ($51,900 per job) and $3.30 million in state GDP. In this vein the lower-paying jobs of the air cargo-producing industries of the region are supported by higher-paying jobs in Finance, Health, and other assorted service industries (see Section I of Table 67).

Section IV of Table 67 shows estimates of the total tax revenues that state and local governments receive annually due to the existence of outgoing cargo shipments from RNO. About $0.67 million (56.8 percent) of the $1.18 million in tax revenues generated are estimated as indirect business taxes. By level of government 61.9 percent are estimated to be federal tax revenues, 22.7 percent as state revenues, and 15.4 percent as local tax revenues. Low local property taxes and a lack of state personal income taxes in Nevada account for this unusually skewed revenue distribution.

Table 67. Total Economic Impacts of RNO Air Cargo Outflows on the Reno-Sparks Metropolitan Area

		Output ($Thousands)	Employment (jobs)	Compensation ($Thousands)	GDP ($Thousands)
I. Total Effects (Direct + Indirect/Induced)					
1.	Agriculture, Forestry, Fishing, and Hunting	$36.2	0	$5.6	$12.6
2.	Mining	$1.3	0	$0.2	$0.7
3.	Utilities	$130.0	0	$16.3	$70.6
4.	Construction	$10.7	0	$3.2	$4.8
5.	Manufacturing	$7,662.1	48	$1,802.0	$2,773.4
6.	Wholesale Trade	$747.2	3	$250.5	$479.2
7.	Retail Trade	$312.7	3	$103.6	$184.8
8.	Transportation and Warehousing	$273.2	2	$88.1	$140.7
9.	Information	$194.6	1	$42.4	$109.0
10.	Finance, Insurance, Real Estate, Rental, and Leasing	$1,146.7	1	$107.9	$738.0
11.	Professional and Business Services	$954.1	7	$441.6	$666.8
12.	Educational Services, Health Care, and Social Assistance	$612.4	6	$312.4	$372.4
13.	Arts, Entertainment, Recreation, Accommodation, and Food Services	$269.4	4	$86.9	$146.5
14.	Other Services (except Government)	$153.0	1	$58.7	$87.3
	Total Effects	$12,503.6	76	$3,319.6	$5,786.8
II. Distribution of Effects and Multipliers					
1.	Direct Effects	$6,874.2	44	$1,623.8	$2,488.9
2.	Indirect/Induced Effects	$5,629.4	33	$1,695.8	$3,297.9
3.	Total Effects	$12,503.6	76	$3,319.6	$5,786.8
4.	Multipliers (= 3 / 1)	1.819	1.75	2.044	2.325
III. Composition of GDP					
1.	Compensation (Net of Taxes)				$3,319.6
2.	Taxes				$671.8
	a. Local				$158.9
	b. State				$268.0
	c. Federal				$244.9
3.	Profits, Dividends, Rents, and Other				$1,795.5
4.	Total GDP (= 1 + 2 + 3)				$5,786.8
IV. Tax Accounts					
			Business	**Household**	**Total**
1.	Earnings (Net of Taxes)		3,319.6	3,186.8	----------------
2.	Taxes		671.8	510.8	1,182.6
	a. Local		158.9	23.3	182.1
	b. State		268.0	0.0	268.0
	c. Federal		244.9	487.6	732.5

Remainder of Nevada Inflows

Table 68 shows air freight inflows by SCTG code for the year 2007. These cargo inflows total $395.8 million. The commodities flown in by air are strikingly similar to the commodities flow outwardly by air. With just only 43 SCTG codes in total, some overlap is inevitable. Interestingly, Pharmaceuticals and Electronics occupy the top two spots on both lists. Both sectors produce highly specialized products, so having a strong local supply does not preclude the need to import like goods.

Table 68. Air Freight (including Truck) to the "Remainder of Nevada," 2007

SCTG	Description	Air Shipments		Air Share (of $)
		Kilotons	$ Millions	
5	Meat/seafood	0.00	$0.0	0.0%
20	Basic chemicals	0.01	$0.3	0.1%
21	Pharmaceuticals	0.41	$96.3	5.5%
23	Chemical prods.	0.81	$10.3	1.0%
27	Newsprint/paper	0.58	$0.6	0.3%
29	Printed prods.	0.02	$6.5	0.9%
30	Textiles/leather	0.05	$0.3	0.0%
33	Articles-base metal	0.00	$3.8	0.3%
34	Machinery	2.49	$25.4	0.6%
35	Electronics	0.35	$116.5	2.2%
36	Motorized vehicles	4.03	$37.4	1.4%
37	Transport equip.	0.00	$9.2	15.5%
38	Precision instruments	0.02	$24.1	1.8%
39	Furniture	0.00	$0.0	0.0%
40	Misc. mfg. prods.	9.02	$64.3	5.0%
43	Mixed freight	0.00	$0.8	0.0%
	Total	17.79	$395.8	

Source: FAF[3] (2007)

A significant import that does not register as an export is SCTG 38, Precision Instruments. In 2007, 24.1 million dollars in precision instruments were flown into the Remainder of Nevada. The precision instruments category includes eyeglasses, photographic equipment, surveying instruments, medical apparatus, and certain items for industrial testing. As evidenced by the high (highest, even) weight-to-value ratio, such pieces can be very expensive, likely rendering their shipping cost comparatively insignificant.

As noted in the sector detail by two-digit NAICS, the local wholesale sector employs 8,346 workers with an aggregate payroll of $455 million. This sector is undoubtedly affected by the incoming air shipments. Hence we applied wholesale margins to all of the incoming air shipments. The average of these margins was around 18 percent or about $7.4 million in net income for the Wholesale Trade sector. This corresponds to about $2.47 million in labor compensation to the industry or about 0.5 percent of the local payroll share.

Freight-related Airport Operations and Shipping Industry

Table 69 summarizes data from a survey of airport freight operations and the related industries, freight forwarders and shippers were included in the population of potential survey respondents. No results were reported for shippers. The table displays the total employees and payroll that are directly related to air cargo freight activities. In total, usably complete responses were received for four freight forwarders, three carriers, and the airport.

Table 69. Air Freight and Related Industries at RNO, 2011

Summary	Jobs	Payroll (Thousands)
Freight forwarding	9	$356.7
Air carrier	13	$554.8
Airport	220	$12,061.7
Shippers	-	$0.0
Total	242	$12,973.2

Total Economic Impacts of Freight-related Airport Operations and Warehousing of Inflows

The Rutgers Economic Advisory Service's input-output modeling system (R/ECON I-O) perfectly estimated the jobs affiliated with the payroll for freight forwarders. To effect (mimic) in the modeling exercise the direct of the "airport industry" (as no such industry exists), however, its payroll was equally split between the model's industry representing "Support activities for transportation" and one representing "Office administrative services." As a result, the model's underlying data system estimated that more jobs than suggested by the survey work. Given the already higher average pay of the Office administrative services industry, only the job count related to the Support activities for transportation was ratcheted downward. The job count estimated by the model for Air carriers was lower than derived via the survey. They were upwardly adjusted to match that obtained via the survey. Such blatant adjustment of known effects from those estimated via economic models is best practice in the field of economic modeling. The rationale behind the adjustment is that the model produces the job estimates using industry-average rates of pay for a specific year. In the case of the R/ECON I-O model used, the underlying regional economic data are for the year 2010.

Table 70 presents the total economic impacts of RNO air cargo inflows (related as direct effects only to the wholesale trade sector) and air freight and related industries on the Reno-Sparks metropolitan area. As can be observed from Section II, Line 1 of the table, the $15.29 million in payroll at airport and the wholesale trade facilities affiliated with RNO traffic translates to 274 jobs (annual average pay per job of $55,800) and nearly $23.4 million in state GDP for Nevada. Further Section II, Line 2 shows that this direct economic effect is supported by 261 other jobs with a combined payroll of nearly $12.1 million ($46,300 per job) and $24.3 million in state GDP. Thus, higher-paying jobs at or near the airport are supported by lower-paying jobs, largely those in Retail Trade and Entertainment industries (see Section I of Table 70), although the supporting jobs are well distributed across a large array of industries.

Section IV of Table 70 shows estimates of the total tax revenues that state and local governments receive annually due to the existence of outgoing cargo shipments from RNO. About $0.67 million (57.4 percent) of the $9.88 million in tax revenues generated are estimated as indirect business taxes. By level of government 56.8 percent are estimated to be federal tax revenues, 28.3 percent as state revenues, and 14.9 percent as local tax revenues. Recall that low local property tax rates and a lack of state personal income taxes in Nevada account for the low tax accumulations for these jurisdictions.

Table 70. Total Economic Impacts of RNO Air Cargo Inflows on the Reno-Sparks Metropolitan Area

		Output ($Thousands)	Employment (jobs)	Compensation ($Thousands)	GDP ($Thousands)
I. Total Effects (Direct + Indirect/Induced)					
1.	Agriculture, Forestry, Fishing, and Hunting	$314.4	2	$48.4	$109.6
2.	Mining	$2.5	0	$0.5	$1.3
3.	Utilities	$882.0	1	$111.7	$483.3
4.	Construction	$84.0	0	$25.0	$37.7
5.	Manufacturing	$3,151.8	18	$672.4	$1,086.6
6.	Wholesale Trade	$9,810.1	43	$3,289.6	$6,292.2
7.	Retail Trade	$2,837.7	26	$940.3	$1,677.3
8.	Transportation and Warehousing	$25,696.4	171	$7,717.0	$12,634.0
9.	Information	$1,873.6	10	$385.1	$1,040.6
10.	Finance, Insurance, Real Estate, Rental, and Leasing	$10,274.9	13	$949.5	$6,614.0
11.	Professional and Business Services	$17,468.9	155	$9,236.2	$12,423.1
12.	Educational Services, Health Care, and Social Assistance	$5,388.5	50	$2,748.6	$3,275.8
13.	Arts, Entertainment, Recreation, Accommodation, and Food Services	$2,394.0	35	$767.0	$1,292.8
14.	Other Services (except Government)	$1,240.2	11	$476.3	$706.0
	Total Effects	$81,418.9	535	$27,367.8	$47,674.4
II. Distribution of Effects and Multipliers					
1.	Direct Effects	$40,714.5	274	$15,287.4	$23,398.9
2.	Indirect/Induced Effects	$40,704.4	261	$12,080.5	$24,275.5
3.	Total Effects	$81,418.9	535	$27,367.8	$47,674.4
4.	Multipliers (= 3 / 1)	$2.000	1.95	$1.790	$2.037
III. Composition of GDP					
1.	Compensation (Net of Taxes)				$27,367.8
2.	Taxes				$5,672.2
	a. Local				$1,281.7
	b. State				$2,795.2
	c. Federal				$1,595.4
3.	Profits, Dividends, Rents, and Other				$14,634.3
4.	Total GDP (= 1 + 2 + 3)				$47,674.4
IV. Tax Accounts					
			Business	**Household**	**Total**
1.	Earnings (Net of Taxes)		$27,367.8	$26,273.1	----------------
2.	Taxes		$5,672.2	$4,211.6	$9,883.8
	a. Local		$1,281.7	$191.8	$1,473.5
	b. State		$2,795.2	$0.0	$2,795.2
	c. Federal		$1,595.4	$4,019.8	$5,615.2

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EXECUTIVE SUMMARY

Air cargo has become an increasingly important sector in the transportation services industry. The air cargo industry and its related support elements play a key role in the globalization of supply chains, enabling logistics and supply managers to shrink the delivery timeline so geographically distant markets are being served in less time. This further serves to overcome obstacles of perishability, inventory requirements, replenishment lead times, and high inventory-carrying costs. This allows manufacturers or distributors in a broad array of economic sectors to cover wider markets since air cargo operations make it possible to quickly and cost-effectively meet the needs of their customers.

These and other factors have led to the expansion of air cargo's role in the supply chain. In 2012, the U.S. air cargo industry handled 7.3 percent of all U.S. freight by value, up from 6.5 percent in 2007. Further, the U.S. air cargo industry handled 32.7 percent of exports and 27.6 percent of all imports by value. U.S. air cargo grew by 3.1 percent by value and 7.5 percent by weight from 2007 to 2012 (US DOT 2012). The role of the air cargo industry is expected to continue in its growth pattern for the foreseeable future. World air cargo is forecast to grow by 4.5-5.6 percent annually over the next 20 years (Boeing 2013). In the U.S., the share of cargo shipped by air is expected to reach 12.8 percent by 2040 (US DOT 2012).

This objective of this report and the companion users' guidebook is to assist airport authorities, air cargo operators, and economic planners with assessing the value of air cargo facilities and operations to their region. This report evaluates the underlying air cargo data to support the primary measures of overall economic impact and its derived valued with direct and related incomes and labor force generated by this industry.

When conducting economic impact analysis (EIA) for air cargo, air cargo data play an important role. The air cargo data for an airport reveal the amount of commodities, express packages, and mail shipped by air. Several publicly available freight datasets provide freight shipment data by transportation mode, weight, value of commodities, commodity, or region. These datasets include the Commodity Flow Survey (CFS) from the Bureau of Transportation Statistics (BTS), the T100 and T100f airline data from the Office of Airline Information at the BTS, and the Import/Export data on Merchandise Trade from the U.S. Census Bureau.
A recently compiled dataset, the Freight Analysis Framework (FAF) from the Federal Highway Administration (FHWA), has overcome many shortcomings compared to other datasets, but the FAF still has data gaps for air cargo.

Table ES-1. Characteristics of the CFS, T100, Import/Export, and FAF Datasets

Main Category	Detailed Category	CFS	T100	Import/Export	FAF
Air cargo data	Weight	Yes	Yes	Yes	Yes
	Value	Yes	No	Yes	Yes
	Detailed commodity	2 digit	No	10-digit harmonized system	Same as CFS
	Low-value/ weight goods	<100 lbs. included in the box-type of parcels	Yes	Imports <$2,000 and exports <$2,500 are excluded	Same as CFS
	Box-type of parcels shipped by air	Yes, but lumped with other intermodal	Yes	No	Same as CFS
	Letter-type of packages shipped by air	No, excluded from surveys	Yes	No	Same as CFS
Industry coverage	Surveyed by CFS	Manufacturing, mining, wholesale, selected retails, and publishing (except 2002)	Yes	Yes	Same as CFS
	Not surveyed by CFS	Most services, publishing (2002), petroleum, government, and households	Yes	Yes, except intragovernmental	Expanded coverage from CFS for trucks, but little expansion for domestic air and parcel shipments
International trade	Imports	No	Yes	Yes	Yes, expanded by combining the T100 and Import data to account for inbound shipments
	Exports	Yes, but underrepresented	Yes	Yes	Yes; expanded by combining the T100 and Export data to account for outbound shipments

Economic impacts of air cargo operations can reach a region through four principal channels. First, there are the effects of the activities that take place on the airport. These could include the loading and unloading of cargo, work related to leasing and security, and cargo handling in the warehouse. Second, there are activities taking place off-airport. These activities can include a wide range of functions including the work of freight forwarders and customs brokers, trucking companies, and other support firms. Third, there are the effects that arise when wage earners who spend a portion of their income on goods and services create output and employment for other local industries. Finally, there are the catalytic impacts that result from structural effects resulting from the presence of a facility such as an airport within the region. An airport may lower the cost of doing business in a region, or increase the quality of life sufficiently to attract new firms.

Economic impact models are used to measure regional economic effects resulting from a change in activity relative to a baseline representation of the economy. The sources of the activity being measured vary, but typically involve changes in production or consumption activities, policies, infrastructure, or changes in costs or technology. For any change in economic activity, the impacts on the economy can be reported on one of three levels:

- **Direct** impacts represent the initial change in final demand for the industry sector(s) in question. For this analysis, we are estimating the economic activity associated with air cargo at an airport.

- **Indirect** impacts represent the response as supplying industries increase output to accommodate the initial change in final demand. These indirect beneficiaries spend money for supplies and services, which results in another round of indirect spending, and so on. Indirect impacts are often referred to as “supply-chain” impacts.

- **Induced** impacts are generated by the spending of households who benefit from the additional wages and income they earn through direct and indirect economic activity. The increase in income, in effect, increases the purchasing power of households. Induced impacts are also described as “consumption-driven” effects.

While the modeling tools are well known, the approaches used to evaluate the economic impact of air cargo operations has historically varied significantly between studies. Some studies use gross measures of economic output of the air cargo industry to determine total cargo revenue. Input-output models are then employed to determine overall regional economic impacts, including indirect and induced effects. Other studies evaluating the economic impacts of air cargo operations employ more complex approaches similar to those used in the case studies highlighted in this report. These assessments are, in turn, used to determine the number of direct jobs and wages tied to the region’s aviation industry.

The primary tools utilized to provide these measures are economic impact models utilizing available data to addresses several dimensions of economic impact and value creation. The research team used a coordinated set of economic variables to establish an approach for separating air cargo related activity from other airport operations to tighten the focus on true air cargo impacts on the economy and relied on three models (IMPLAN, RIMS II, and R/ECON) when applying this approach while estimating the economic impacts of air cargo operations at five airports: Houston, Texas (IAH), New York City, New York (JFK), Kansas City, Missouri (MCI), Reno, Nevada (RNO), and Louisville, Kentucky (SDF).

Table ES-1 present an overview of the analytical framework outlined in this report. This study addresses the economic impacts or demand fluctuation on air cargo due to fuel costs and security screening operations. The research team developed a model to examine impacts of jet fuel price increases on air cargo demand. To model the price elasticity of air cargo demand with respect to jet fuel prices, a stepwise regression approach was employed to target variables that had a statistically significant impact on air cargo demand. The modeled analysis revealed that for every 10 percent increase in jet fuel price, air cargo operations would be expected to contract by 0.7 percent. Demand for air cargo was more sensitive for the overall price per pound for freight shipped by air, with a 10 percent increase in price translating into a 5.0 percent reduction in air cargo demand. With that noted, the modeled elasticities indicate that demand for air cargo is price inelastic.

The rising costs of implementing security checks and the potential delays caused by screening are two key issues that have economic demand implications in the air cargo industry and with airport operations overall. Those two issues will continue to dominate the development of appropriate technologies and efficient but effective methods for screening air cargo. An analysis of Transportation Security Administration (TSA) data and information collected from third-party screening organizations indicate that the final screening price impacts were estimated at 5.7-7.4 cents per pound, which corresponds to an increase in the overall price of air cargo transported on-board passenger aircraft by 6.0-8.6 percent (TSA 2009).

Once these ancillary analyses were complete, EIAs were completed for the case study airports. The first step in estimating the economic impact of air cargo activities was the identification of data needed for the analysis. Following are the key items needed to produce an effective EIA:

- Jobs and wages related to air cargo services from the participants of the air cargo industry such as freight forwarders/3PLs, airports, airlines, and others at the selected airport

- Air cargo shipments in tons handled by the industry participants such as airlines and freight forwarders/3PLs

- Commodities shipped by air and other modes

- Revenue related to air cargo business from the industry participants such as airports and freight forwarders/3PLs

- Industry concentrations within the defined study region.

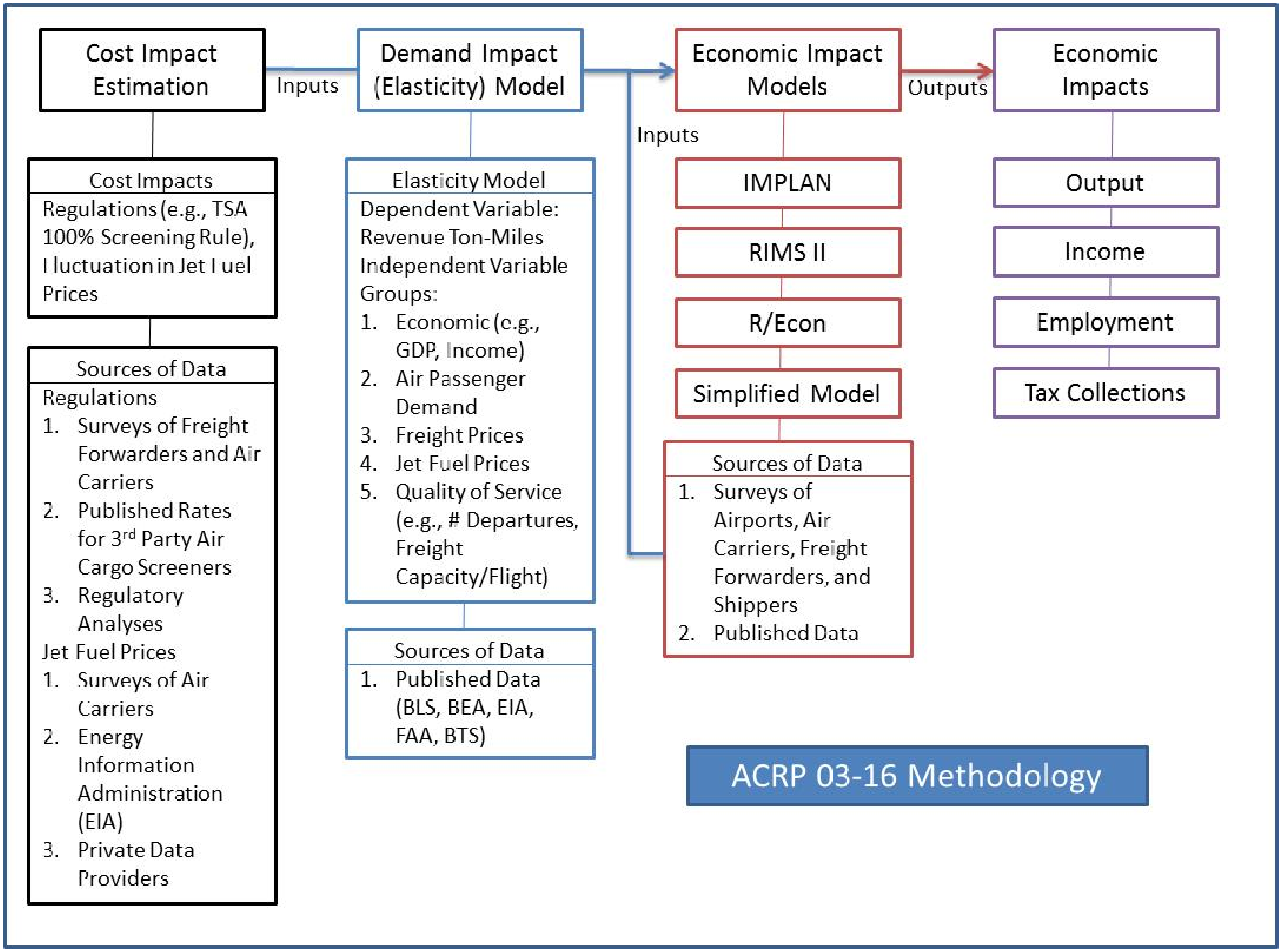


Figure ES-1. ACRP 03-16 Analytical Framework

Data collection consisted of two main activities: a) conducting surveys that includes design of surveys, sample selection, and interviews; and b) gathering data from the previously defined existing data sources. Surveys served as an important tool for collecting missing data. The questionnaires, designed by the team, were used to collect data from airport operators, air carriers, freight forwarders, and shippers. Specific questions were used to gather information related to the following issues: organizations' or associations with and contributions to air cargo at an airport and responses by these organizations if the airport shuts down air cargo services; new and proposed security and other regulations; and changes in fuel prices.

In some cases, data gained from published datasets and the interviews were insufficient to conduct an EIA. In these cases, the research team developed an alternative approach including the use of the Location Quotient (LQ), which measures industry concentration in a regional economy. It does so by comparing the ratio of employment in a certain sector of a local economy to the same ratio in a comparison economy, identifying specializations in the local economy. An LQ value of 1.0 indicates that employment in an industry in the regional economy is exactly the same proportion as the national average, while an LQ value greater than 1.0 indicates employment in an industry has a higher concentration than the reference economy.

One approach used in the study assumed air cargo-dependent industries with LQs in excess of 1.0 were located within the region due to the role of the regional airport, local air cargo operations and related industries. A second approach, based on the findings of Stevens, Treyz, and Lahr (1989), found that portions of industries with LQs in excess of 0.3 should be included in economic impacts since production above that level is typically consumed outside the region.

When using the alternative approach presented by Stevens, Treyz, and Lahr, the first step was to identify total air exports from the region. The best and most complete publicly available data on trade for subregions of U.S. states are widely known to be Version 3 of the Freight Analysis Framework (FAF^3) Origin-Destination Data, which are available online from the U.S. Department of Transportation. To meaningfully employ the FAF3 data, Quarterly Census of Employment and Wages (QCEW) were matched to Standard Classification of Transported Goods (SCTG) categories used by FAF^3 (Appendix D provides a NAICS to SCTG crosswalk). Payrolls of the production sectors were identified as producing goods for export via air freight. The "air base payroll" was calculated by taking the portion of the total sector payroll beyond the 0.3 threshold and then the percentage of that commodity that is shipped by air. The "air base payroll" was a primary input to the economic model for estimating the effects of cargo outflows.

In conducting the case studies, the research team identified several data and modeling gaps. These gaps could be transformed into reach opportunities. The main air cargo–related data gaps in the FAF involve three types of shipments: box-type of packages weighing <100 lbs., letter-type of packages, and domestic shipments by industries not covered in the CFS. These data gaps are defined as follows:

- For box-type of packages, both weight and value data are either intentionally ignored or lumped with other modes.

- For letter-type of packages, there is no coverage for value data in any sources, except that their weight data are included in the T100 data.

- For industries not covered by the CFS, though imports and exports data are available with a better geographic representation and shipment characteristics (commodity, weight, and value), domestic shipments are missing from census surveys.

- An additional limitation of the FAF data is that it is not presented at the desired airport level.

In addition to closing these data gaps, another area of research worthy of consideration is analyzing opportunity costs associated with airport closures. That is, the contribution to the economy made by an airport can be measured by examining a scenario in which the airport is closed. With an airport closure, shippers would face changes in transportation and other costs (i.e., opportunity costs) and these increased costs would be passed on to customers. Finally, while it is generally agreed that industries are concentrated within regions with direct access to air cargo operations, the analysis of these location benefits is part of a developing area of economic research that is still limited by two key factors: 1) the lack of a complete and workable theory of the role of air cargo in economic development; and 2) the lack of data describing the quantity and value of exported goods. This also is an area worthy of future research.

In addition to data collection another means used to expand the data base of information for each airport included surveys. The direct, indirect or induced impact of air cargo service to a region or a city begins with a well-functioning air-cargo system. This allows the local area to export goods and services and develop traded-sector industries for the purposes of export. A region or locations ability to export additional goods and services increases its economic potential. While the concept is simple, the analysis of economic impacts of air cargo shipments is part of a developing area of economic research that is still limited. This study explores these limitations and offers some analytic approaches to them overcome them.

In all, the linkages of economic activities, related services and integrated nature of the air cargo industry does not easily lend itself to a simplified tool for estimating economic impact. But the study offers a shorten and simplified economic impact model to measure to some extent economic activity measures and related direct, indirect and induced effects. This is accomplished with a simple table model to total full demand impacts. This table would include the detailed industries impacted by the expansion of air cargo capacity, along with direct and then final demand multipliers. This model would be constructed utilizing BEA provided multipliers for the given region of study. The combination of final demand multipliers would be combined within the table to determine an estimated final full impact.

Finally, the selected five airport air cargo operations case studies provide the results of the team’s impact studies and analysis. Moreover, they offer the process, tools and evaluation elements planners and airport authorities should consider when seeking to assess economic impacts of air cargo operations.

CHAPTER 1

INTRODUCTION

Air cargo services occupy a special place in modern supply chains, carrying the most valuable, most perishable, and most urgent shipments across the nation and the world. From necessities such as pharmaceuticals to luxuries such as exotic flowers, air cargo services shrink time and space to link customers to distant sources quickly, efficiently, and reliably. Air cargo keeps assembly lines rolling and remote communities connected. At the same time, air cargo service enables U.S. businesses large and small to communicate and compete in global markets.

Likewise, air cargo facilities and operations occupy a special niche in the communities they serve. International airports are large, costly facilities with a major presence in a metropolitan area. Even smaller regional airports are prominent fixtures in their markets. The air cargo community reaches beyond airport boundaries to include integrated carriers, air freight forwarders, air freight truckers, ground handlers, and their customers. These stakeholders together constitute an industry that, unlike highway trucking or freight railroads, is largely unrecognized by the public. Similarly, airline passengers have little awareness of what goods are traveling beneath them as “belly cargo”, or of what round-the-clock activities are necessary to support those shipments.

Airport authorities and air cargo stakeholders need to demonstrate the public value of their activities and facilities. In this era of limited resources, public planners, elected officials, and legislators are forced to choose among competing transportation investment proposals, and need help in making good decisions. Complexity, specialization, and public unfamiliarity can place the air cargo industry at a competitive disadvantage with more familiar transport modes. In one sense everyone who sends an overnight package is an air cargo shipper. Yet conventional approaches to air cargo data and analysis have underestimated the value of air cargo shipments and the economic importance of the air cargo industry.

Logistics factors, including access to air cargo service, are increasingly prominent in industrial and commercial location decisions. As economic development agencies strive to attract and retain employers to their cities and regions, they have a concomitant need to understand the impact of air cargo service on regional competiveness.

This report and the companion guidebook were therefore commissioned by the Airport Cooperative Reproach Program (ACRP) to fill the need for economic impact estimation tools and methods that public and private practitioners can apply to the air cargo industry.

Research Objectives

This report and the companion guidebook were developed to assist airport authorities, air cargo operators, and public sector planners in establishing the value of air cargo facilities and operations to their communities and regions. The primary metric of this value is economic impact: the direct, indirect, and induced income and employment generated by the industry. The primary tools are economic impact models utilizing available data to answer the questions posed by practitioners.

This report addresses several dimensions of economic impact and value creation, including:

- The structure of the air cargo industry and its role in the supply chain.
- The size of air cargo facilities and operations relative to the region and market they serve.
- The nature of air cargo services, and their linkage to local industry and economic activity.
- Air cargo industry sensitivity to changing economic conditions, particularly the price of fuel and evolving security requirements.
- The economic impact of air cargo.

Airports and air cargo services differ widely, so the tools and techniques presented in this report are flexible in their application. The basic tools offered include:

- A discussion of economic impact models and their application to the air cargo industry.
- A discussion of data collection and survey techniques to support the impact analysis.
- Demand elasticity models for fuel cost impacts and security screening impacts.

This report also presents case studies for five airports: JFK in New York, New York; RNO in Reno, Nevada; IAH in Houston, Texas; SDF in Louisville, KY; and MCI in Kansas City, MO. These case studies have been chosen to illustrate the application of analytic tools to airports that vary in size, air cargo volumes, and regional context.

Report Organization

This report is divided into six chapters, including this introduction. The remainder of this report is structured as follows:

- Chapter 2 begins with an overview of the air cargo industry and its role in the supply chain, and evaluates the economic impact of the industry.

- Chapter 3 evaluates key concepts in studying the economic impact of air cargo. This chapter presents an overview of relevant prior research and economic studies, examines the data required to assess the economic impact of air cargo, and evaluates survey techniques.

- Chapter 4 presents an analytical framework for estimating the economic impact of air cargo. This chapter includes an assessment of economic impact concepts, tools and techniques used to assess economic impacts and methods developed for estimating the impact of fluctuations in fuel prices and enhanced screening requirements on the air cargo industry.

- Chapter 5 summarizes the results of the case studies.
- Chapter 6 defines future research opportunities.

In addition to the main body of the report, appendices present an overview of the regions and commodities covered in the Freight Analysis Framework (FAF), the surveys used in the case studies, the detailed case study results, and a crosswalk between Standard Classification of Transported Goods (SCTG) product codes and those found in the North American Industry Classification System (NAICS).

CHAPTER 2

BACKGROUND

The Air Cargo Industry and its Role in the Supply Chain

The air cargo industry plays a key and growing role in the globalization and evolution of supply chains and has enabled supply chain managers to shrink their firms' "time-space continuum." Firms are able to cover wider markets both nationally and internationally since air cargo makes it possible for them to quickly fulfill the needs of their customers in a cost-effective manner. Part of the air cargo industry's growth can be attributed to the growth of internet and web applications, which have driven supply chains to new levels of efficiency. The use of air cargo also enables efficient supply-chain strategies—such as just-in-time (J-I-T) and postponement—by reducing carrying costs through lower inventory requirements. It further enables sellers to take advantage of both lower-cost labor markets and economies of scale in production, since they are now able to produce farther from their markets. Thus, air freight's more responsive service justifies higher costs for many commodities. It has also enabled the growth of value-added services offered by third-party logistics (3PLs) providers and integrators.

Some visible examples illustrating contributions of the air cargo industry in the global supply chain include:

- Helping to speed time-sensitive products to market
- Improving the reliability of assembly lines by enabling rapid, J-I-T delivery of parts for processing machinery as well as production inputs.
- Delivering quick-order, bio-medical products and equipment to hospital emergency wards and operating rooms
- Landing large project equipment at remote airfields
- Enabling businesses across America – small and large – to compete in major foreign markets
- Enabling remote communities and installations without surface transportation to timely access supplies and life safety products for productive and healthy lives.

This chapter is organized as follows:

- Section 2.1 describes the services provided by key participants of the air cargo industry
- Section 2.2 presents an overview of the fundamentals regarding how cargo are shipped
- Section 2.3 discusses trends in the air cargo industry
- Section 2.4 focuses analysis of air cargo usage
- Section 2.5 addresses value-added logistics activities related to air cargo
- Section 2.6 describes key drivers in airport selection
- Section 2.7 discusses the impact of Integrators
- Section 2.8 analyzes the linkage between air cargo and the supply chain
- Section 2.9 examines air cargo success factors.

Participants of the Air Cargo Industry

Air cargo services involve many parties to ensure air cargo is shipped on time and safely from one place to another, either domestically or internationally. Parties such as freight forwarders, 3PLs, airlines, airports, ground handlers, and truckers are responsible for packing and transporting commodities to and from airports, or on and off aircraft. Below are brief descriptions of the services provided by each of the key industry participants:

- Airports—offer infrastructure and services to air carriers for transporting and sorting commodities; such as runways/taxiways, aircraft parking, cargo handling land and facilities, roads and utilities, cargo security, aircraft maintenance, and other support.

- Airlines—provide airport-to-airport freight services either via lower deck space on passenger aircraft or via all-cargo freighter space using both scheduled and supplemental or charter services; provide pickup and delivery services in airport regions or to more distant markets.

- Air cargo terminals—process air cargo and mail that is transferred between air carriers, trucks, trains, and marine vessels. The terminals may be operated by airports, air carriers, surface transportation carriers, or third parties.

- Air freight forwarders and 3PLs—provide consignment, transportation handling, documentation services to shippers and consigners, as well as value-added logistics, transportation, and trade services. The largest are global companies that also offer truck, maritime steamship, barge, and rail services.

- General sales agents—sell air freight capacity on behalf of airlines.

- Integrators—offer direct selling of door-to-door services to businesses and individuals based on time-definite products handling shipment sizes from letters to heavy cargo that are comprised of a mix of air, truck and intermodal. Integrators typically own and operate aircraft or lease on a dedicated basis.

- Consolidators—work with or may function as a freight forwarder providing assembly points for cargo prior to its delivery to a carrier on the airport.

- Container freight stations—are typically located off-airport and handle the breakdown of inbound international freight. Their function is similar to a consolidator (see above) in that they provide space for short-term storage and redistribution to a number of clients.

- Ground handlers—provide aircraft loading/unloading, short-term freight storage, fueling, technical maintenance, deicing, crew support, and liaison with support parties.

- Air cargo truckers—specialize in road transportation services for air freight shipments, typically requiring specialized roller-bed equipment.

- Brokers—buy capacity from airlines and sell it to small- and medium-sized forwarders.

- Customs brokers—assist importers and exporters in meeting federal requirements governing imports and exports.

Understanding Air Cargo

One of the primary challenges for the air cargo industry is the general lack of understanding most people and organizations not involved with goods movement have of the business. It is built around time and cost and offers its constituents an incredible amount of flexibility. Before discussing the trends that affect the industry and resultant economic impacts, it is important to provide some context as to how cargo operates, the major business partners that are involved, and the factors critical to success.

The FAA defines air cargo as freight and mail. It is also typically categorized as either international or domestic. The international and domestic components of air cargo are discussed in the following sections.

International Cargo

Because of their roles as international passenger airports, the bigger commercial airports handle large numbers of international, wide-body aircraft with substantial amounts of belly capacity to transport “belly cargo”. (“Belly cargo” refers to cargo carried in the hold of a passenger aircraft). Many international passenger carriers also operate freighters. This creates an ideal interlining operation (sharing cargo) with the diverse domestic passenger and integrator operations at the airport.

Air cargo shipments begin with the shipper. This can be an individual or a major manufacturer, regardless shippers have the option of taking a product directly to a carrier or alternatively using a third party logistics provider, like a freight forwarder to select the best shipping options and handle all related coordination. There are four principal shipping channels: an integrated express carrier like FedEx; an integrated forwarder like DHL; a non-integrated forwarder like Expeditors; or a carrier.

Forwarders will often work with consolidators to combine shipments to a common destination. By combining the shipments, the cost per pound can be reduced and a savings theoretically passed along to everyone in the shipping chain. Domestic shipments are typically off-loaded at the destination airport and are picked up by, or delivered to, the consignee by truck.

For international shipments, it is necessary for the shipment to be cleared and inspected by the Customs officials of the destination country. Due to this cumbersome process, shippers and forwarders typically work with a Customs Broker (an importer) who works with the government agencies to clear the goods for entry into the country. Once cleared the shipment is picked up by or delivered to the consignee. Subsequently, the shipments are broken down for individual consignees and delivered. .

It is important to remember that virtually all air cargo begins or ends its journey on a truck, making the ground distribution system as critical as the air distribution. The design and location of airports and their cargo facilities must take this into consideration and accommodate growth in the ground component of the operations commensurate with growth on the airside.

To facilitate shipping, freight forwarders have become independent booking links between manufacturers, shippers and logistics operations, and the non-integrated carriers. Typically, to keep costs down, they book blocks of space with carriers in the belly of passenger aircraft. Other shipments are carried by the integrators who will accept shipments directly from shippers and upon occasion will take bookings from a forwarder. On international shipments, integrators may compete directly with airline/forwarder alliances for business, but overnight delivery does not necessarily play as vital a role in international shipping. Forwarders and shippers will also utilize freighters operated either independently or by the passenger carriers. In certain instances, carriers may lease freighter aircraft from a company such as Atlas or other Aircraft, Crew, Maintenance, and Insurance (“ACMI”) carriers, but the numbers of such operations and their impact on airport handling requirements and infrastructure are not typically significant. One of the keys to successful international goods movement is timely inspection and clearance by the federal agencies. If the federal agencies lack the staff to accommodate timely clearance, the best facilities in the world will not move international cargo effectively.

Domestic Cargo

Domestic cargo differs from international since there is no Customs clearance, it is dominated by the integrators, is less influenced by forwarders, has an enormous trucking component, and creates substantial demands on the airport’s aeronautical infrastructure. Integrators (like FedEx and UPS) are the dominant providers of domestic air cargo service.

Competition among the integrated carriers is driven by guaranteed overnight (or other time definite) delivery to almost any location. Integrators operate with tight shipping windows to their mid-west distribution hubs; this creates concentrated ground traffic as trucks bring packages at the last possible minute. Domestic cargo not served by the integrators include large volumes moved as "belly cargo," is not typically as time sensitive, and arrives at cargo facilities in smaller concentrations, at much greater frequency, and with less defined shipping windows.

In August 2001, FedEx was awarded a federal mail contract. Since then, it has become increasingly difficult to track mail volumes since that tonnage has been absorbed in the broader FedEx statistics. The same is true for UPS and to a lesser extent DHL. Non-integrated carriers still report mail and those volumes are anticipated to continue to grow at a very moderate level.

Trends in the Air Cargo Industry

The U.S. air cargo industry handles 32.7 percent of exports and 27.6 percent of imports by value, and 0.5 percent of exports and 0.7 percent by weight of the nation's freight transportation, according to data reported by the Freight Analysis Framework (FAF). Comparatively, trucking represented the largest mode by both weight (61.6 percent) and by value (54.7 percent) as shown in Tables 1 and 2. The percentage of U.S. commodity value, including import and export, shipping by air freight grew from 6.5 percent in 2007 to 7.3 percent in 2011, and is forecast to reach 12.8 percent by 2040 (US DOT 2012).

When benchmarking against other modes, a commodity's value/weight ratio is clearly a key indicator of its propensity to be shipped by air. The higher relative value of air cargo supports the premise that air freight's benefit of reliable, quick service justifies its higher cost. This justification is especially poignant for overseas trade where the only alternative mode of freight shipment is water transportation, which is the most inexpensive and slowest freight transport mode.

When compared to exports and domestic activities, exports represent the highest share of air cargo activity. Exports held a 32.7 percent share by value in 2011, which was a higher share relative to imports (27.6 percent) and domestic (1.2 percent) cargo shipping. In the years reported in Tables 1 and 2, exports represented the higher share. While the domestic market is dominated by a few integrators, international traffic involves many airlines.

In terms of annual growth rates, U.S. air cargo grew 3.1 percent by value and 7.5 percent by weight from 2007 to 2011. The annual growth rates for air cargo are higher than the growth rates in the same period for total U.S. freight transported, which are 0.2 percent by value and -1.7 percent by weight. Also, the annual growth rates for air cargo are higher than the growth rates of freight transported by trucks, which declined in terms of both weight and value. During this period, an economic recession resulted in the slowing of economic forces that generate demand for shipping. A number of factors caused a more significant growth in air cargo relative to other modes. Whether that will be a short- or long-term phenomenon remains to be seen; however, Freight Analysis Framework (FAF) forecasts suggest the trends is expected to continue, though at a slower pace, through 2040.

Table 1. Shares of Shipment by Mode and Value for 2007, 2012, and 2040

Mode \ Shipment	2007[1]				2012				2040[1]			
	Total	Domestic[2]	Exports[2]	Imports	Total	Domestic[2]	Exports[2]	Imports	Total	Domestic[2]	Exports[2]	Imports
Truck	64.7%	76.0%	22.4%	14.4%	62.9%	75.2%	20.7%	16.7%	54.7%	71.2%	18.6%	17.1%
Rail	3.1%	2.8%	3.7%	4.7%	3.1%	2.9%	3.7%	3.8%	2.3%	2.0%	2.8%	2.9%
Water	2.0%	1.2%	1.3%	8.3%	1.7%	1.1%	1.5%	4.7%	0.9%	0.5%	0.9%	2.2%
Air, air & truck	6.5%	1.1%	35.3%	25.3%	7.3%	1.2%	32.7%	27.6%	12.8%	3.1%	37.7%	32.4%
Multiple modes & mail	17.3%	12.2%	33.0%	42.3%	18.4%	12.6%	36.8%	41.7%	25.3%	19.2%	36.0%	41.2%
Pipeline	4.3%	4.9%	0.3%	3.0%	4.6%	5.2%	0.4%	3.5%	2.0%	2.2%	0.3%	2.3%
Other & unknown	2.0%	1.9%	4.0%	2.0%	2.0%	1.8%	4.3%	2.0%	2.1%	1.8%	3.8%	2.0%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: US DOT 2012.
[1]Many 2007 and 2040 numbers in this table were revised as a result of Freight Analysis Framework (FAF) database improvements in FAF version 3.4.
[2]Data do not include imports and exports that pass through the United States from a foreign origin to a foreign destination by any mode

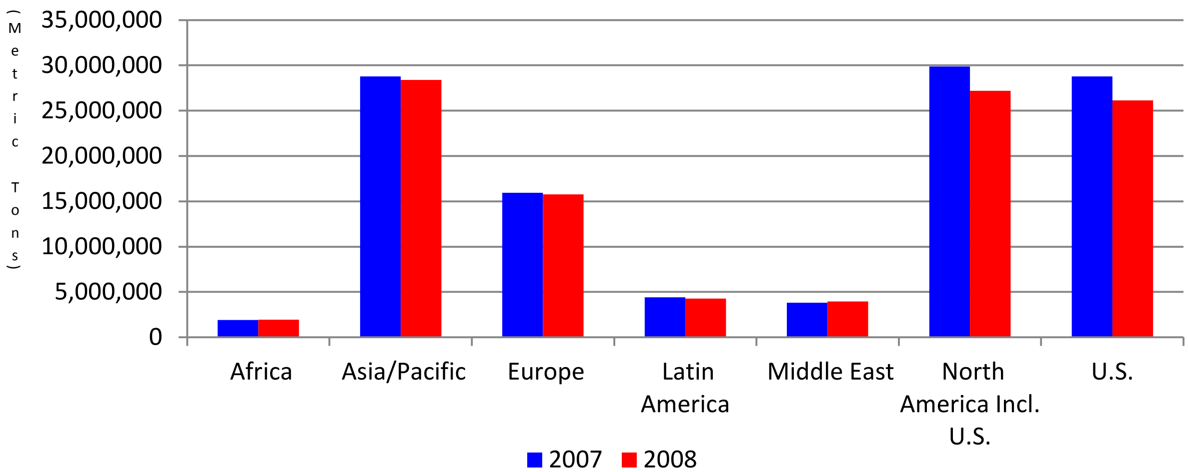
Table 2. Shares of Shipment by Mode and Weight for 2007, 2012, and 2040

Mode \ Shipment	2007[1]				2012				2040[1]			
	Total	Domestic[2]	Exports[2]	Imports	Total	Domestic[2]	Exports[2]	Imports	Total	Domestic[2]	Exports[2]	Imports
Truck	67.7%	74.7%	14.5%	7.1%	64.1%	72.1%	11.9%	9.3%	65.9%	78.3%	14.0%	12.0%
Rail	10.1%	10.4%	9.4%	6.8%	10.8%	11.1%	12.0%	6.6%	9.7%	9.4%	14.7%	7.2%
Water	5.0%	3.0%	10.0%	27.8%	4.7%	3.3%	8.4%	17.9%	3.8%	2.4%	6.2%	12.4%
Air, air & truck	0.1%	0.0%	0.7%	0.4%	0.1%	0.0%	0.5%	0.7%	0.2%	0.0%	0.7%	1.0%
Multiple modes & mail	7.5%	2.5%	59.4%	44.2%	9.2%	2.7%	61.1%	47.6%	12.5%	2.8%	58.8%	49.5%
Pipeline	8.0%	7.9%	0.7%	12.7%	9.4%	9.2%	0.7%	16.9%	6.1%	5.4%	0.6%	16.7%
Other & unknown	1.7%	1.6%	5.5%	1.0%	1.8%	1.6%	5.3%	1.0%	1.8%	1.6%	4.9%	1.2%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: US DOT 2012.
[1]Many 2007 and 2040 numbers in this table were revised as a result of Freight Analysis Framework (FAF) database improvements in FAF version 3.4.
[2]Data do not include imports and exports that pass through the United States from a foreign origin to a foreign destination by any mode

As shown in Figure 1, air cargo generated by the United States dominates the volume shipped from North America. Still, North America as a whole ranked second in air freight volume (In terms of outbound and domestic cargo shipments), following only the Asia/Pacific region. In 2008, the United States generated 32 percent of the global air cargo, slightly below the share (34 percent) reported in 2007.

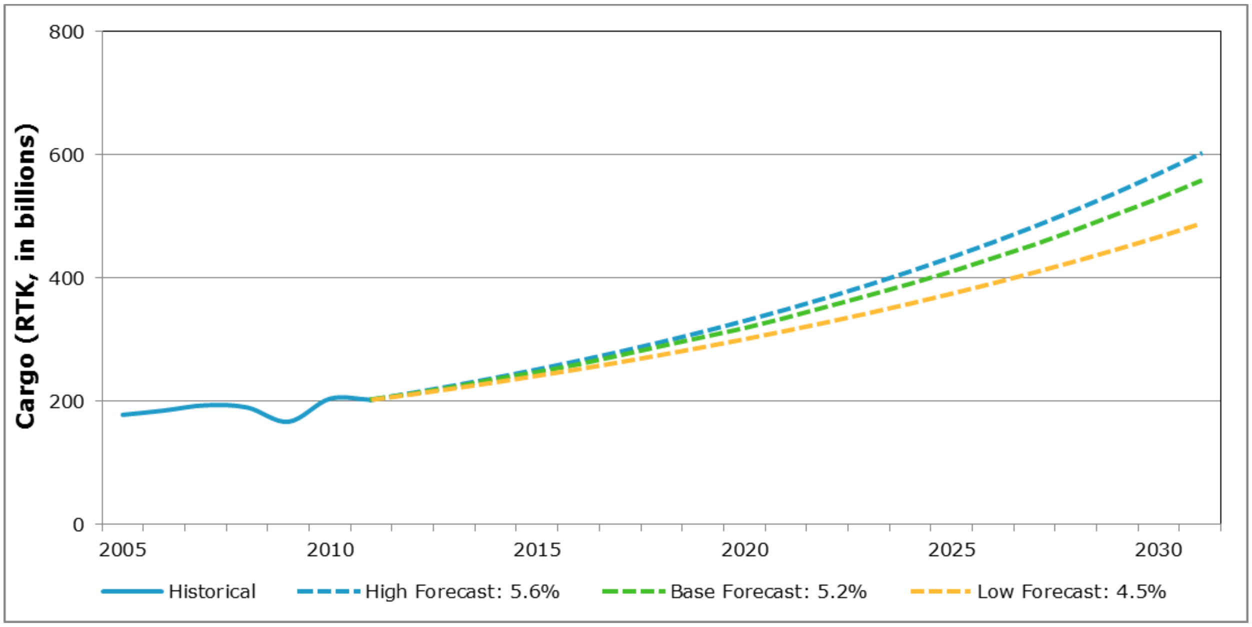
Though the Asia/Pacific region only generated 39 percent of global international outbound cargo in 2008, its international outbound accounted for 72 percent of all (domestic plus international outbound) air cargo generated in the Asia/Pacific region.



Source: Airport Council International

Figure 1. Global Air Cargo Shipments by Major Regions for 2007 and 2008

Global forecasts by Boeing, the FAA, and the Airports Council International call for an annual increase ranging from 4.5 percent to 5.6 percent of air cargo volumes over the next 20 years (See Figure 2) (Boeing 2013). Much of this growth will occur on the trans-Pacific routes but there will also be substantial growth in South and Latin American countries, Eastern European countries, and Africa. The multi-cultural nature and size of gateway cities will be a drawing point for this growth. While a substantial portion of regional growth will be driven by passenger activity, cargo growth is expected to also be based on cost effectiveness and operational efficiency.



Source: Boeing World Air Cargo Forecast (2012-2013).

Figure 2. Global Air Cargo Shipments by Major Regions for 2007 and 2008

Critical Cargo Variables

The goods movement industry continues to experience dramatic changes. Factors such as consolidations, rising fuel costs, changing distribution patterns, increased reliance on speed, e-commerce, and high-speed logistics will require that individual airports re-examine their business goals, market priorities, physical capacity, and the compatibility of these three criteria in meeting the challenges of accelerating growth. The remainder of this section outlines several critical variables driving goods movement by air. All of these variables impact air cargo operations to some degree. Although some of the variables are not air cargo specific, they reflect changes that will eventually affect air cargo volumes at the airports and their long-term compatibility with industry needs.

Key shipping windows: There is a misperception that air cargo aircraft either operate around the close or only at night. Integrators typically schedule departures on the west coast between 8:00 and 10:00 p.m. to reach mid-west sortation facilities by midnight (Central Time). While not as time specific as the integrated carriers, freight carriers must also operate out of shipping windows to allow for:

- coordinated pickup and delivery at local and regional destinations,
- integration of transshipments, and
- restrictive overseas airport and government controls.

The result is a clustering of operations and aircraft parking requirements. This causes a peaking of demand for aircraft parking on a daily basis. Most international gateways have late evening departure peaks that are targeted to allow shipments to reach destination markets for early morning distribution.

The size of the gateways enables them to address the diverse airside and landside needs of a large cargo community. The absence of a curfew, the availability of federal agencies, and diligent noise monitoring are critical elements that enable later international cargo operations (as well as integrator connections) to prosper. Frankfort is now confronted with a ban on night flights that has had a measurable impact on cargo activity and the regional economy. While U.S. airports have traditionally been leaders in environmental issues and noise awareness, this is a sensitive issue that should be monitored.

Aircraft parking: Reliability of delivery and cost as opposed to overnight delivery have retained the utilization of freighter traffic on a number of routes, but aircraft parking is not as critical an issue as it was ten years ago. This is largely due to:

- the ability of cargo handling operations to off- and on-load aircraft more quickly,
- carrier strategies to spend less time on the ground, and
- greater use of passenger aircraft belly capacity.

These changes free up existing freighter parking positions more quickly, which extends capacity. Nevertheless, airports focused on international cargo must be able to provide sufficient parking for freighters when the need arises or the flights will divert to another market.
The Boeing and FAA forecasts indicate that freighter operations will increase over the next twenty years. The result will be continuing demand for aircraft parking. Currently, a number of freighter operators are considering the inclusion of Code F aircraft such as the 747-800F (Code F Aircraft – the largest commercial airplanes), in their fleet. This involves upgraded aeronautical infrastructure in order to operate a plane of this size. This infrastructure is in place at most of the larger airports, and is not necessary at the less active facilities: the aircraft will only be flown internationally on trans-oceanic routes.

The growth of truck substitution: One of the most difficult variables to evaluate in air cargo is the truck substitution component. Many air cargo facilities are operating to a great extent as truck terminals, yet requirements to report truck-to-truck traffic are scarce. Airports cannot realistically evaluate comprehensive space demands, effectively plan for and phase new development, or fully capture business opportunities without careful consideration of the truck substitution component. Additionally, as truck substitution continues to play a greater role, airports must address the fact that an air cargo facility is an inter-modal facility, and must be designed to accommodate trucks as well as aircraft. Critical elements include roadway access and truck parking, as well as queuing, maneuvering, and docking challenges. Truck substitution has been accelerated by the new security screening requirements which, because of the associated increases on air shipping costs, have pushed modal diversion. When combined with passenger growth, the constraints of the land envelope warrant business strategies, lease management practices, and physical planning that will optimize airport property and its ability to serve customers.

E-Commerce: Many of the shipments generated by home shopping networks, catalogue shopping, and most recently, e-commerce, require specialized facilities for efficient processing and expedited delivery. Accordingly, these shipments have a greater tendency to move by air or expedited trucking. This has accelerated demand for air cargo operations in general and integrator operations in particular. Much of this fulfillment requirement is met by businesses concentrating operations on or near airports.

Manufacturing creep: Manufacturing facilities, particularly those focused on time-sensitive products, in response to demand for faster delivery, are moving and/or locating key warehouse facilities closer to airports, or onto airports. This is a major element in Asian airport development and can be seen for example with facilities in Shanghai, Pudong, Shenzhen, Guangzhou, and Incheon. In the U.S., this trend has resulted in the development of the 'Aerotropolis' concept in cities such as Memphis, Dallas, Indianapolis, and Detroit. This reduces inventory, trucking costs, and staffing requirements, while increasing levels of customer service. This significant and growing business segment is a major element of the "Airport City" concept, but is difficult to introduce to a mature airport environment, particularly when property around the airport is developed. Nevertheless, there may be opportunities to create a functioning variation of the concept on or around a number of airports.

High-speed logistics: The changes in manufacturing and shipping are giving rise to the design of new high-speed logistics facilities that can effectively integrate a number of diverse industry segments. The facilities can handle throughput and sortation, kitting (minor assembly), and returns (fulfillment), as well as traditional operations. These value-added distribution centers can be major job generators, in some cases, approaching the employment levels of traditional manufacturing operations. While the size of these buildings (often exceeding 500,000 square feet) makes them unlikely to occur on an established U.S. airport (since they would require a footprint of nearly 20 acres and could present some height constraints), they could be accommodated within a reasonable distance from the airport.

Building technology: As a result of the escalating cost of storing goods, and the shortage of on-airport property, modern cargo facilities are being designed to emphasize speed of transition rather than warehousing. The result is taller buildings to handle highly mechanized equipment with sufficient depth and adequate airside and landside doors. It should be noted, however, that not every air cargo operation requires sophisticated equipment. The demand is a function of the size of the operation, the nature of the cargo, the scheduling needs of the shippers and forwarders, local labor costs, and budget. New security requirements (see the Emerging Trends discussion below) have required facility modifications that in some instances reduce existing floor capacity and require more internal storage.

Aircraft technology: Modern freighters are more fuel-efficient, have greater range, and carry larger payloads. The ability of new aircraft such as the 787 to over-fly traditional points of entry, as well as the inability of many airports to accommodate the new larger Code F aircraft, including the A-380 and 747-800 will affect the selection of origin and destination airports. However, despite its size, the belly of the A-380 passenger aircraft will not deliver cargo volumes in excess of what is typically handled in today's routine shipments given the anticipated volumes of luggage. The 747-800 freighters, however, will require more Code F apron and have operational constraints at a number of airports.

Emergent Trends

Some basic changes in the structure of the air cargo industry have taken place in the past decade. This section examines the evolution of the air cargo business from 2000 to the present and summarizes how many important industry trends have affected the air cargo industry in general and the dynamics for a mature airport in particular. The past decade has been characterized by pre-existing factors that have continued in their evolution.

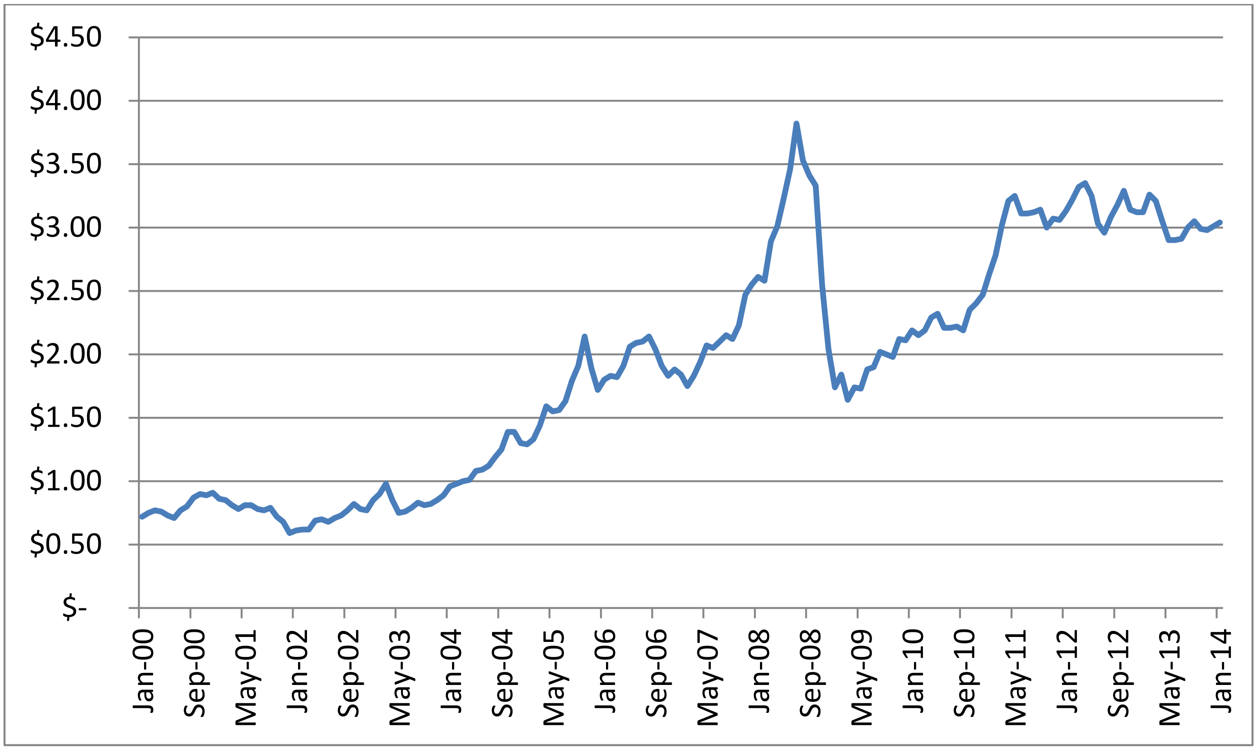
For over a half century, JFK served as the premier gateway to the world's most dynamic city and nation. It was well established as a leading intercontinental gateway, long before other U.S. cities could even consider obtaining international flights. If a foreign destination could serve only one U.S. airport, the destination historically was JFK. Today that has changed dramatically. For Europe, JFK remains the first, and sometimes the only, U.S. destination for many airlines, representing a vital node for both passenger and cargo services. However, other gateways at Los Angeles (LAX), Chicago O'Hare (ORD), San Francisco (SFO), Miami (MIA), Dallas/Fort Worth (DFW), George Bush – Houston (IAH) capture large percentages of the Asian and Latin markets.

Despite fundamental changes in the airline industry, the role of the gateways has remained largely constant. However, the last four decades have seen fundamental changes in the roles of other airports. The success of commercial aviation, its transformation from a luxury for the ultra-wealthy to a mass product for travelers and a routine conduit for goods has caused a worldwide dispersal and fragmentation of commercial passenger and cargo services. International traffic volumes are now large enough to support many gateways and carriers. Dallas/Fort Worth (DFW), Hartsfield-Jackson Atlanta International (ATL), Denver (DEN), George Bush (Houston) (IAH) and Detroit Metro (DTW) International airports now have significant intercontinental flights. In 2012, Boston Logan International (BOS) added nonstop flights to Tokyo, joining fourteen other airports in North America. International passengers and air freight no longer need to transit the historical gateways, but now have a wide range of potential carriers, gateways and routings.

Other parts of the world are experiencing this fragmentation. London's Heathrow Airport shares intercontinental traffic with more than six intercontinental gateways in the United Kingdom. Smaller continental airports such as Dusseldorf, Nice, Stuttgart, and Faro have intercontinental flights. Many Caribbean destinations have nonstop services to Western Europe. A similar pattern of fragmentation holds for Australia and Latin America, the Middle East, and is emerging in India, China, and other world regions.

Jet Fuel Price Volatility: Fuel cost has been extremely volatile over the past several years as well as during other periods during the last century (see Figure 3). According to the Bureau of Transportation Statistics (BTS), jet fuel prices rose from $1.75 in February 2007 (average price) to $3.82 per gallon in July 2008. This spike in fuel prices represented a 118 percent increase in just 17 months. While fuel prices fell significantly in the latter half of

2008 and into 2009, a smaller spike occurred between September 2010 and September 2011 when prices rose by 43 percent from $2.19 to $3.14 per gallon (BTS 2014).



Source: Bureau of Transportation Statistics 2014.

Figure 3. Average Price per Gallon for Jet Fuel

Due to the fluctuations evident in Figure 3, volatility in the cost of fuel has become a prime issue in cost budgeting performed by supply chain managers. As a result, delivered cargo prices set in contracts have led to difficult long-run decisions for many transportation firms, including increased prices to customers not under contract and reduced profits (or even losses), both of which depressed sales and total business revenues. Consequentially, the spike in freight fuel costs in 2008 helped to push the global economy into the recent recession.

In September of 2007, fuel surcharges on air freight by integrators, for example, reached 14.5 percent of the base rate. However, the comparable fuel surcharge on ground was only 4.8 percent. Because the cost of shipping by air was already expensive, high fuel surcharges made it even less competitive with other forms of freight transportation, forcing supply chain managers to consider alternative freight transportation modes. Although high fuel costs affected all modes of transportation equally on a percentage basis, the higher relative share that fuel maintains in the overall costs of air shipments placed airlines at higher risk.

The spike in fuel costs and pressure from international competition on operating margins for shippers have at times had significant negative impact on the air cargo industry, as shippers focused their attention upon managing costs and operating efficiencies, rather than on growth and service expansion. In this process, some shippers shifted to using lower-cost modes of transportation where they could still provide acceptable levels of service and product availability to clients. That is, changes in freight service were accompanied by improvements in forecasting, planning, and other logistical efficiencies (and improved system of production, distribution, and retail centers run by firms). Some logistical changes shortened the average length of haul in the supply chain, resulting in more frequent and smaller shipments. In some cases, however, service and stock availability had to be sacrificed, but generally only those air cargo items with lower value/weight ratios. Because domestic air service is less competitive to truck service over short distances and for commodities with lower value/weight ratios, truck freight service was generally favored at the expense of air for domestic freight.

Air Cargo Security: Perhaps the most significant change over the past ten years has been in the area of security. This recent focus has been on anti-terrorism. Historically, the industry has addressed anti-theft, and systems and facilities both on- and off-airport consider theft deterrence in their planning. While airports tend to focus on TSA Guidelines as they directly impact their own operations, it is important to understand how different elements of the shipping chain are affected.

Shippers and Forwarders: Cargo is generated by shippers that can vary in size from private individuals to multi-national corporations. The TSA originally imposed a “known shipper rule” that required carriers and freight forwarders accepting freight into the system for transport on a passenger aircraft to review the background of the shipper and qualify the entity as legitimate. In October 2002, the FAA strengthened this requirement limiting freight forwarders to submitting cargo to carriers only if the customer had used the forwarder for 24 shipments in the past two years. Further the shipper must have had some business dealings with the forwarder prior to September 1, 1999. If these conditions are not met, the forwarder, as part of a validation process, must inspect the shipper’s facility and review the financial records. These rules made it difficult for shippers to change forwarders and fostered the development of multiple accounts to mitigate potential problems in the event there was a problem with one forwarder.

If the cargo is determined not to be from a known shipper, then it must be screened before it can be placed on board a passenger aircraft. Because of the cost, operational challenges, and occasional delays inherent in the screening of some shipments, diversion to freighter aircraft has in some instances become an attractive alternative for shippers and forwarders. Tighter security and screening requirements have also created incentives for forwarders to consider relocation to an on-airport site in order to extend cut-off times and minimize the potential for delays that might be incurred during truck inspections.

Truck Substitution: A substantial amount of air cargo (anecdotal indicators are that as much as 25 percent of the cargo volumes at an airport are unreported because they move only on trucks) moves on trucks either as origin and destination freight, or as truck-to-truck freight. Since truck-to-truck cargo does not need to be screened, the volumes increased dramatically after September 11, 2001 and much of the diverted freight has remained on trucks. Nevertheless, the truck–air relationship has remained intact if somewhat diminished. New security requirements on the cargo industry involving the implementation of higher levels of screening technology, greater processing costs, and lengthier processing times have reinforced this modal shift. Based on facility volumes and diversity of the shipping base, this translates into the need for a separate screening facility (if physically and operationally feasible), modifications to an airport's infrastructure to include separation of truck and passenger vehicle traffic to and/or on the airport, further separation of vehicles in the air cargo areas, and modifications of the buildings and surrounding roadways to allow for a smooth flow of vehicles, easy truck parking, and minimal potential obstructions caused by queuing.

Added security requirements may have affected the flow of cargo to an airport. In some instances trucks arriving at the cargo facility may be required to move to a holding area for more detailed inspection. More typically, because of lengthier time spent in the truck bays, unloading of trucks may be delayed and additional space could be required for vehicles queuing for routine inspections and access to the cargo areas. Delays to arriving trucks, particularly if those delays tend to be unpredictable, and of varying length, can create additional pressure on local shippers and forwarders to accelerate cut-off times and reduce their consolidation potential. Air cargo typically moves in fairly well defined shipping windows, and most shipments are trucked to the airport as close to that window as possible.

At international gateways several hundred trucks could arrive at the airport over a two-hour period. In many instances, these trucks and their cargo must be screened and without proper facilities, delays can be extensive. The problem is exacerbated if the cargo is trucked over a large distance to airports with unpredictable screening delays. Ideally, an airport will provide the space necessary to develop effective screening facilities to reduce or eliminate screening delays. This is an issue now being explored by the major gateways.

Belly Carriers: The passenger airlines, for which cargo often represents the margin of profit on many routes, have experienced decreases in both capacity and demand domestically. On the airside, the effects of September 11, 2001 were immediate. First, the number of commercial flights was dramatically reduced. The resultant loss in belly cargo capacity forced the diversion of cargo to trucking and freighter/integrator traffic. Second, the TSA restricted the nature and sources of cargo that could be carried in passenger aircraft. Increased emphasis of the "Known Shipper" rule also accelerated the diversion. Third, carriers in many instances reduced the size of the aircraft, lowering operating costs, but also reducing belly capacity. Fourth, restrictions on the amount of personal possessions that passengers may carry on board forced additional baggage into the bellies, and further reduced available capacity for freight and mail. Lastly, because of the more stringent application of the Known Shipper rule, carriers became reluctant to, or constrained from, accepting freight, and as a result referred many shippers to freight forwarders.

Internationally, to better manage costs and achieve higher revenues, carriers are now utilizing wide-body belly capacity to a much greater extent. The challenge is to create consistent universally-accepted standards for belly cargo inspection which has become an issue for the TSA. The key to this is to ensure that only "Known Shippers" can have cargo loaded in passenger aircraft. Despite a recent accord with Europe, a number of foreign countries are resisting the imposition of U.S. driven standards for operational and political reasons. As the industry works to resolve the issues, the fundamentals of the goods movement infrastructure have shifted, and the result has and will continue to impact the nature of, and demand for, relevant airport facilities. Overall, as the air cargo market expands and volumes continue to grow, international belly cargo will remain viable but has become more expensive than in the past. Domestically the market will be challenged as freight forwarders continue to focus on the trucking alternative.

Freighter Operators: On a limited basis, freighter operators have been beneficiaries of the industry's diminished belly capacity. As security requirements remain less stringent for these carriers, it enables them to theoretically capture a greater percentage of the market. As security requirements are finalized and enforced, the potential for operating delays due to screening both inbound and outbound cargo may eventually impact the use of freighters at heavily trafficked airports. Additionally, with a shift of traffic to freighters in some markets, demand for aircraft parking positions may increase. If airports cannot meet this demand through modification or additions to existing infrastructure, then the demand may shift away from some current gateways. Overall however, the tendency to utilize available belly capacity and more efficient handling services will mitigate demand and enable gateways to accommodate current and future freighter operations.

With most wide-body freighter operations focusing on international traffic, the challenge is to establish a level of confidence with security controls at international shipping points, given the almost limitless shipping points from which freight for the system can be generated. The imposition of unilateral security standards on a global basis is not immediately practical or politically viable, and restrictions on carriers or points of origin may appear arbitrary and be deemed undue constraint of trade. While it is likely that most nations and carriers will agree upon some basic common guidelines, the interim period will continue to be problematic from a security perspective.

Integrators: Integrators historically have created and operated security-oriented facilities and cargo systems. As a result, modifications to their existing operations were less extensive than for most other carriers. However, their facilities and operations have been designed for tracking and safeguarding shipments once they have been accepted into the system. They perform random screening, but because of the nature of their business, they cannot and do not conform to the constraints of the known shipper rule. Though different from each other, their superior tracking systems and time-definite delivery guarantees provide elements of operational security that other carriers typically lack.

A critical element of a number of integrator operations is trucking access to the aircraft ramp. At a number of airports this is permitted particularly when facilities are constrained or in some cases located entirely off-airport. This presents challenges to site design, administrative controls, and responding to competitive interests. The physical aspects are the most easily addressed.

The ground element of integrators' operations is expanding. The continued and increasing use of time-definite, second, and third day delivery means more utilization of trucks with greater on-airport queuing and parking requirements as well as additional levels of traffic. If time constraints on truck flows increase as a result of the screening requirements, integrators may shift more operations off-airport or seek an alternate airport where other truck traffic is not as heavy, from which to operate.

Ground Handlers: While ground-handling companies have little to do with the entry and exit of goods into the system, handling company employees have access to cargo when it is on-loaded and off-loaded from aircraft and trucks, and in the warehouse prior to and after shipment. Many handling companies employ part-time workers and experience high turnover particularly at entry-level positions. This sometimes creates operating problems for cargo facilities. At larger airports there are sufficient options for handling so that this is not an issue.

Major Gateway Shipping: One of the major side effects of the air cargo security guidelines has been that the economies of scale offered by the gateways and the proportionately higher costs of screening at small to mid-size facilities encourages the migration of cargo screening to the gateways. The utilization of a centralized cargo screening facility at a gateway can offer further incentives to this shift.

Rationing of Belly Capacity: As carrier fleets expand to accommodate international passenger demand, they have almost universally up-gauged to wide-body aircraft. Both Emirates and Etihad are prime examples of carriers whose long-term plans for the carriage of cargo shifted from a 70 percent to 30 percent ratio of freighter to passenger lift, to a ratio of 30 percent to 70 percent. Freight forwarders have been quick to capitalize on this shift, which allows them to ship freight in the lower-priced bellies. Although the use of freighters will still continue to grow as gross industry volumes increase, carriers will continue to make better use of previously underutilized space in the passenger fleets. This exacerbates gateway fragmentation and has had an ongoing impact on mature gateways.

Trade Liberalization: International air service liberalization continued after 2000 although the pace has been much slower than in the previous decade. Major liberalizations include Turkey (2000), France (2001), India (2005), Australia (2008), Brazil (2010), and Japan (2010). The Single Market Agreement with the European Union in 2007 lifted restrictions on services to London Heathrow. While the Chinese bilateral remains somewhat restrictive, negotiations in 2011 allowed substantial additional services, resulting in new routes from ORD, EWR, and ATL. The changes created tangible benefits for some airports. This is consistent with a broader pattern, in which liberalization creates very large opportunities for new gateways, but only incremental gains for established gateways.

Growth of Aircraft, Crew, Maintenance and Insurance (ACMI) Cargo Operators: As carriers move to "right-size their fleets, many are shifting away from owning their freighters preferring instead to "wet-lease" their all-cargo aircraft to include the ACMI. This strategy also reflects the greater reliance on wide-body belly capacity for most shipping, and an increasing dependence on outsourcing for unusual or peak shipping requirements. The higher costs of the leases are offset by reduced maintenance and operating costs incurred by the carriers. A side effect of this trend is that airports do not always know which carrier has chartered the operation. This can be problematic for planning both aircraft ramp and facility size unless appropriate tracking is in place that tells the airport where the aircraft is parking and for which carrier the aircraft is flying.

The Cargo Village: Perhaps the most visible and discussed recent phenomenon in the air cargo industry is the emergence of the "Cargo Village." Despite its increasing popularity, this is simply a new name for an on-airport logistics complex. It can include virtually any element of the air cargo industry, but given restrictions on commercial development at most airports, is best focused on carriers, forwarders, customs brokers, and other directly supporting services as opposed to manufacturing and assembly. These facilities may or may not attract cargo. They are usually most successful if there is an existing or strong potential market. While they have a limited marketing appeal, their value, if properly constructed is to create functional proximities that will enable tenants and users to realize cost benefits and time savings.

Centralized Screening Facilities: Because of the costs associated with screening belly cargo, independent contractors have begun developing certified screening facilities that are designed to service multiple small users including shippers, forwarders, and carriers. Using economies of scale, these facilities (best located on-airport) enable users to reduce the cost of screening, or the issues associated with retrofitting their own facilities to accommodate the screening process. These costs are discussed in more detail in Section 4.3.

Industry Consolidation: The 2000-2010 period was characterized by mergers and consolidations. These included America West/US Airways (2005), Delta/Northwest (2008), United/Continental (2010), British Airways/Iberia (2010), Lufthansa/Austrian (2009), Lufthansa/Swiss (2007), Air France/KLM (2004), and others. The U.S. mergers resulted in extensive corporate, operational and marketing integration. The European mergers created holding companies, with the original entities continuing as subsidiaries. The decade also saw UPS acquire Menlo Worldwide Forwarding (and Emery), DHL absorb Airborne, and BAX Global be taken over by Shenkers – a major freight forwarder.

The United-Continental merger set the stage for network realignment. The reconfigured airline currently has hubs at both EWR and IAH. Their proximity could create redundancies. Mergers have resulted in large losses of service at some secondary hubs such as Cincinnati/Northern Kentucky International Airport ("CVG") and Memphis. At the major gateways, they prompted the consolidation of terminals, leases, gates, and counter space. They have not significantly affected total capacity or the availability of international services. It is unclear at this time what the fall out will be from the American Airlines/U.S. Airways merger.

Emissions Trading: The growing concerns about anthropogenic carbon dioxide and its impact on climate have prompted several governments to impose carbon taxes and emissions trading schemes. Although aviation is a relatively small source of greenhouse gases, it is growing rapidly. The European Union proposes to extend its ETS to aviation and include foreign carriers. The political and economic issues are very complicated. Each airline would be granted an initial quantity of carbon allowances, but must purchase the remainder. Most planners use a baseline of 30 Euros per ton of carbon dioxide for each allowance. The cost of the allowance would raise the effective price of fuel by 12.56 percent if applied. Since an airline would be granted initial allowances and not all of a flight's path would necessarily be subject to ETS, the effective cost increase would be less than 12.56 percent.

The industry outside the European community has resisted this policy change. The added costs will lead to higher fares and air cargo charges which will reduce the growth of the industry. Changes will be particularly detrimental to the smallest commercial aircraft and short routes, where fuel consumption per unit of capacity is the highest. If implemented industry-wide consequences could affect gateway traffic, but would not directly impact the airports. The European Union ("EU") recently issued a decision against exempting US and other non-EU carriers from the program.

Value-Added Logistics Activities Related to Air Cargo

The wide availability of air transportation service created value-adding opportunities for supply chain managers by reducing overall logistics costs and the reliability of service. Examples of the value-added services include assembly and kitting operations such as customizing products for specific markets or customers, fulfilling orders to specifications ordered by users of laptop computers or other products, or shipping direct from a vendor to an end customer to eliminate intermediate handling. Supply chain owners may undertake those activities in-house, or source them to 3PLs or their vendors. Integrators and freight forwarders have expanded their services to include some value-added services, which are performed in conjunction with the movement of goods by air. By shrinking the time-space continuum through air cargo, the service and cost of products available to distant markets can be improved: lead time and backroom (buffer stock) inventory can be reduced and customers can have choices of more items.

Air cargo also allows supply chain activities to be performed at some distance to markets; in locations where it is most economically advantageous to the seller. Examples presented in subsections below show how economies of scale for high-skilled labor or capital-intensive production processes can be achieved and how low-cost labor can be leveraged to lower the delivery cost of products.

Optical

Conceptualized by Airborne Logistics Services in late 1990s, Optical Village® was created as a production and distribution complex where makers of raw materials, manufacturing equipment, lenses, frames, and finished eyewear form an integrated vertical supply chain and operate in one place. From the concentrated location, the vertical supply chain would supply retailers and customers on a nationwide basis. That supply chain is ideally suited for air cargo: the product is largely delivered in the form of small, light packages, quick turn-around from order to delivery typically is highly valued by customers, and economies of scale are beneficial to suppliers. The Optical Village is located in a single campus in Columbus, Ohio. The benefit of late cutoffs (pick up times from integrators) means a longer processing window for firms to meet next-day delivery requirements. Companies gain advantage of economies of scale in specialized equipment and skilled labor. They pass these cost savings to customers in the form of lower prices for optical goods.

Firms located in the Optical Village have some opportunity to substitute air service by ground, but must condition consumers to the longer order lead times or establish smaller regional centers to maintain next-day service levels. These regional centers would lose the benefit of the industry's economies of scale that justify the use of more-efficient specialized equipment and enable reduced delivery costs of the industry's raw materials and components. It would also disassociate production from the localization economies associated with the region's skilled labor force. Thus, devolution of the present-day centralized large-scale production into smaller regional centers undoubtedly would drive up operating costs.

Consumer Electronics

Desktop and laptop computers have become necessary for both home life and businesses. As the computer industry has evolved, consumers have become ever more sophisticated and discriminating in their tastes for computer attributes, yet typically preferring lower-cost options. As a result, a market has arisen for customized computers at competitive prices, often accompanied by high levels of support services. To compete, computer makers have made the supply chain their major battleground in their market-share war. Firms relying on lean and nimble supply chains have become the winners, and air cargo has been the key to their success.

At present, personal computer assembly and related component production is primarily consolidated in Asia and Mexico, while serving the global market. Air cargo adds value by enabling firms to consolidate global production since it makes global product availability possible while minimizing inventory investment in high margin products and high cost components. Meanwhile, computer distributors can bundle the customized computer with support services provided by local repair service operators. Also, it will team up with knowledgeable diagnosticians from across the globe, who not only have the lowest prevailing labor costs but who also can be contacted by customers at no charge via phone and internet at any time of day.

Many finished products need to be kitted to meet country-specific or regional requirements, such as electrical outlet adaptors and consumer labeling. Many of these products can also be customized by consumers who order on-line. Air cargo enables firms to meet these requirements without carrying lots of costly inventory. A make-to-order laptop can be delivered to a consumer half a world away within a week. The computer maker configures the assembled product and charges the consumer's credit card even before they order components from vendors. The consumer gets the product they want using less of their valuable time than they would spend to buy it at a local computer store. The product costs less to make and deliver as a result of intermediate supply chain costs that are stripped away.

For overseas production, ocean transportation would not provide a suitable replacement of service for high-end, non-commoditized products. Likely, some final assembly and kitting would need to be regionalized to support consumers with high product availability and replenishment. Firms would need to stock more inventory to support these regional locations in order to achieve the comparable levels of product availability.

Pharmaceutical/Bio-medical Products

Customized surgical operating kits contain high-value instruments packaged under strict environmental controls. Air freight enables medical distributors and hospitals to maintain high service levels and to control inventory-carrying cost by centrally locating kitting facilities. Orders are fulfilled at these kitting facilities and air-freighted (or trucked for shorter distances) to be merged with standard deliveries to the hospitals.

Air freight enables live tissue and bio-medical devices to be delivered in time to save patients' lives. Beyond a certain distance, ground transportation has limited ability to deliver most products in a timely manner, especially those with active life spans of 48 hours or less.

Fashion

Fashion apparel can be viewed as a perishable commodity. In some cases, its ticket price drops as soon as a competitor lands a comparable style on retailers' shelves. The keys to profitability in this business are staying fresh and releasing new concepts ahead of the competition. Therefore, speed is an essential element to success in the industry. Fashion apparel can leave a factory in China on a Friday, move via bulk air cargo to a U.S. distribution center in Los Angeles by Monday, and be on a store shelf in Omaha, Nebraska, on Wednesday. As a result, success in this operation largely depends on the scheduled air freighter services from Asia.

Agriculture

The agriculture industry has traditionally depended on air cargo to ship certain products on a timely basis. For example, the value of California agricultural exports shipped by air cargo increased almost 69 percent from 1996 to 2004 (an average annual rate of 6.8 percent), growing from $396 million to $669 million during the period (CAB 2007). Though the principal destinations of their exports remain in the North American Free Trade Agreement (NAFTA) bloc, air cargo services have opened up Far East markets. While air cargo accounted for between 4.5-6.4 percent of California's agricultural exports over the 10-year span from 1996-2005, it accounted for a much larger share of highly perishable commodities. As the second largest cherry-producing state in the United States, 77 percent of the state's cherry exports moved via air in 2006 (CAB 2007).

Key Drivers of Airport Selection

Airport selection by shippers is heavily influenced by frequency and capacity of service, and total transportation cost per unit of product. Manufacturers, shippers, or their customers rarely set up on-airport facilities, though trucking is required for virtually all air cargo shipments. A significant portion of the time a product spends in getting from the airport ramp to retail door is in the air cargo terminal or truckers' origin facility—even for a shipment as long as 500 miles. Therefore, shippers do not need to use airports closest to their product retail destination. So they are typically able to select among a number of airports based on service schedules and total costs. A fashion apparel firm in Cleveland can receive imported products through airports in Ohio, Pittsburgh, Chicago, Louisville, and New York to feed its supply chain.

Large freight forwarders build on hub systems at international gateways and major metropolitan markets. The need to feed a large hub consolidation center perpetuates a hub and spoke system and makes it more difficult for a new regional airport to emerge as a competitor. In the early 2000s, an all-cargo carrier attempted to serve multiple Midwest markets via a regional airport, instead of a major gateway at Chicago's O'Hare in order to improve service and cost. They were able to lower their operating costs and deliver to off-airport customer facilities in Chicago sooner, or in comparable time, to when the plane actually landed in Chicago. However, the service was abandoned because it was not considered "Direct Service from Asia" for Chicago-based forwarders, and this perception hurt their marketing.

Airport selection by airlines is heavily influenced by the expected yields on cargo and passenger traffic. The bases of airlines' decisions for selecting airports vary by the type of airline. Domestic airlines, with a heavy focus on passenger traffic, do not consider cargo a key criterion in airport selection. Foreign carriers, limited to the number of domestic ports they serve by trade agreements, service large forwarder hubs and base their decisions on passenger markets. They take a regional approach to cargo distribution, using the forwarder gateways or arranging over-the-road distribution through specialized trucking companies.

Integrators base airport selection on the volume of packages in the service area and on minimizing round-trip ground costs between the hub and their service market. Service markets are defined by a same-day transit radius, which is established by their commitment to meet the highest level of service offered—normally the next-day express option with a guaranteed delivery time. As markets grow, integrators first increase the size of the aircraft on the route and add flights. If this tactic still does not meet demand, the integrator splits the market and searches for a second local airport with available service. Integrators' decisions are driven solely by economics—an efficient network that minimizes both costs and delivery time, and yet meets all other customer service requirements.

Opportunities may arise for emerging airports as cargo volume moving through major airports saturate capacity and infrastructure. This is because delays that are caused by the congestion have negative impacts on customer satisfaction. Thus, cargo airlines and forwarders wind up finding alternative airports to serve their market demands.

Impact of Integrators

The U.S. domestic air cargo market is primarily served by several major integrators such as FedEx and United Parcel Service (UPS). Integrators typically are highly diversified in their service offerings: acquiring traditional freight forwarders, customs brokers, and trucking companies to offer a full suite of transportation and logistics services. In addition to air transportation, integrators have ground, package, heavy freight, multi-modal services, and value-added supply chain services. This diversification allows integrators to weather the economic downturn and hold on to customers who might want to switch from air to ground.

Sheer size affords integrator companies significant opportunities and buying power over both fuel and aircraft, which create competitive advantages and cost efficiencies for them. By operating their own cargo aircraft they also are not subject to TSA screening that is required for cargo on passenger aircraft, which yields further cost-reducing benefits.

Analysis of Linkage between Air Cargo and Supply Chain

The previous discussion details activities along the basic elements of the supply chain where at each level of supply, production and commodity delivery air cargo services may be involved. Input-output (I-O) accounts compiled by Bureau of Economic Analysis (BEA), illustrate average set of linkages between air cargo and supply chains. These accounts not only offer insight to the linkage between industries and their first level of suppliers, but also reveal the relationship with multiple levels of suppliers who use air cargo. The analysis performed in this section takes two steps. First, the I-O accounts are used to show the set of industries that use air transportation most intensively. Second, based on a model derived from the accounts, linkages between air cargo and the supply chains of U.S. manufacturing industries will be examined.

To examine which industries use air cargo more often, one needs only examine industries' expenses on air transportation reported in the I-O account. In terms of air transportation use intensity, the top 20 sectors among the more than 400 industrial sectors in the accounts are presented in Table 3. Those 20 sectors are ranked based on their share of total spending devoted to air transportation.

Wholesale trade sector ranks highest with more than 5 percent of its total net receipts allocated to air transportation. Interestingly, two financial sectors (monetary authorities and depository credit intermediation, and non-depository credit intermediation and related activities) rank second and third on this dimension, while another financial sector (securities, commodity contracts, investments, and related activities) ranks a distant 15^{th}. Since the Federal Reserve and financial institutions frequently use air cargo services to ship checks and other financial products, their heavy spending on air transportation should not be a surprise. This usage, however, is expected to decline due to a transition from paper checks to electronic checks. Another possible explanation involves data coverage. Since the air transportation data reported by BEA mixed air cargo and business travel to avoid disclosure related issues, the service sectors in fact may bear heavy business-related passenger travel costs.

It is worth pointing out that service-oriented sectors are the heaviest users of air transportation. As shown in Table 3, doctors in the health care sector, five professional service sectors, three information service sectors, the real estate sector, and the employment service sector are all part of top 20 industries in terms of spending on air transportation. One possible explanation is that the service sectors use express packages extensively and incur higher air transportation cost than other sectors. As suggested above, heavy spending on air transportation by these sectors may also be related to business passenger travel.

Table 3. Top 20 Industries in Intensity of Use of Air Transportation

Rank	Name of Major Sector	Name of Detailed Industry	% of Total Air Transportation	Rank	Name of Major Sector	Name of Detailed Industry	% of Total Air Transportation
1	Wholesale trade	Wholesale trade	5.2	11	Professional Services	Management, scientific, and technical consulting services	1.9
2	Finance and Insurance	Monetary authorities and depository credit intermediation	4.1	12	Real Estate	Real estate	1.9
3	Finance and Insurance	Non-depository credit intermediation and related activities	3.1	13	Admin. and Waste Services	Employment services	1.8
4	Health Care	Offices of physicians, dentists, and other health practitioners	2.6	14	Professional Services	Legal services	1.7
5	Accommodation and Food Services	Food services and drinking places	2.5	15	Finance and Insurance	Securities, commodity contracts, investments, and related activities	1.7
6	Professional Services	Architectural, engineering, and related services	2.4	16	Professional Services	Computer systems design services	1.6
7	Information	Telecommunications	2.4	17	Manuf.	Printing	1.4
8	Transportation	Truck transportation	2.4	18	Professional Services	Accounting, tax preparation, bookkeeping, and payroll services	1.3
9	Gov't Industry	Postal service	2.3	19	Information	Software publishers	1.3
10	Retail Trade	Retail trade	2.0	20	Information	Data processing, hosting, and related services	1.2

Source: The 2002 Benchmark Input-Output Accounts, Bureau of Economic Analysis, the U.S. Department of Commerce

An interesting observation can be made for the trucking sector. Although the trucking sector provides land transportation, it uses air transportation extensively. In terms of the percentage of spending on air transportation, trucking ranks 8th in terms of spending on air transportation. According to BEA,[1] about a third of spending on air transportation by the trucking sector reflects contracted agreements between the trucking and air transportation sectors. Under certain circumstances, air transportation is used by the trucking sector when it finds it cannot deliver commodities itself to meet its customers' needs.

The only manufacturing industry in the top 20 sectors in air transportation use intensity is the printing sector. Since manufacturers generally have a lower propensity than service sectors to use air transportation for passenger travel than for shipping for air freight, the dependence of these industries as well as that of *their* suppliers' on air transportation is examined further. The total requirements matrix (Miller and Blair 2009) in the I-O model, which is derived from the I-O accounts, is used in the ensuing analysis since it captures all levels of relationships between suppliers and their potential impacts to manufacturing industries.

Table 4 shows the 10 manufacturing industries in terms of spending on air transportation. Five key manufacturing supplier industries are also listed for each. The selection of suppliers for each of the top 10 manufacturing industries is based on the following two criteria:

- The sector is identified as a "key supplier" industry if it uses air transportation, is a manufacturing industry, and also meets the criterion below.

- Ranked by the coefficients in the total requirements matrix from the U.S. I-O model, a sector with higher value of coefficients for each of the top 10 manufacturing industries is selected. The coefficients in the total requirements matrix capture direct and indirect requirements in industry production process. While the direct requirement indicates manufacturing industries' purchases from the first level of suppliers, the indirect requirement denotes purchases from the second and other levels of suppliers.

The results in Table 4 reveal not only the dependency between manufacturing sectors and air transportation, but also show industries with strong linkages within the key suppliers' supply chain. As shown in Table 4, for instance, the printing industry's key suppliers include paper mills; coated and laminated paper, packaging paper, and plastics film manufacturing; support activities for printing; paperboard mills; and petroleum refineries. All five of those suppliers rely on air transportation to ship their products to the printing industry.

As might be expected, the motor vehicle parts manufacturing industry depends on key suppliers such as iron and steel mills, ferrous and nonferrous metals, screw and nut manufacturing, and plate work manufacturing. The motor vehicle parts industry itself spent about 1 percent of its net receipts on air transportation, while its key suppliers all used air cargo, although their proportional shares of net receipts spent on air transportation were smaller.

[1] A telephone communication with Mr. Alvin Blake (202-606-9327) at BEA in April, 2009.

Table 4. Top 10 Manufacturing Industries with Top 5 Manufacturing Suppliers

Manufacturing Industry	Key Suppliers	Manufacturing Industry	Key Suppliers
Printing	• Paper mills • Coated and laminated paper, packaging paper and plastics film manufacturing • Petroleum refineries • Support activities for printing • Paperboard mills	Petroleum refineries	• Oil and gas extraction • Support activities for oil and gas operations • Other basic organic chemical manufacturing • Valve and fittings other than plumbing • Motor vehicle parts manufacturing
Motor vehicle parts manufacturing	• Iron and steel mills and ferroalloy manufacturing • Nonferrous metal foundries • Ferrous metal foundries • Turned product and screw, nut, and bolt manufacturing • Plate work and fabricated structural product manufacturing	Other basic organic chemical manufacturing	• Petroleum refineries • Petrochemical manufacturing • Plastics material and resin manufacturing • All other basic inorganic chemical manufacturing • All other chemical product and preparation manufacturing
Other plastics product manufacturing	• Plastics material and resin manufacturing • Other basic organic chemical manufacturing • Petrochemical manufacturing • Plastics packaging materials and unlaminated film and sheet manufacturing • Petroleum refineries	Machine shops	• Iron and steel mills and ferroalloy manufacturing • Plate work and fabricated structural product manufacturing • Nonferrous metal foundries • Aluminum product manufacturing from purchased aluminum • Ferrous metal foundries
Animal (except poultry) slaughtering, rendering, and processing	• Cattle ranching and farming • Grain farming • Petroleum refineries • Other animal food manufacturing • Paperboard container manufacturing	Plastics material and resin manufacturing	• Other basic organic chemical manufacturing • Petroleum refineries • Petrochemical manufacturing • All other basic inorganic chemical manufacturing • All other chemical product and preparation manufacturing

Manufacturing Industry	Key Suppliers	Manufacturing Industry	Key Suppliers
Aircraft manufacturing	• Aircraft engine and engine parts manufacturing • Other aircraft parts and auxiliary equipment manufacturing • Search, detection, and navigation instruments manufacturing • Semiconductor and related device manufacturing • Iron and steel mills and ferroalloy manufacturing	Light truck and utility vehicle manufacturing	• Motor vehicle parts manufacturing • Iron and steel mills and ferroalloy manufacturing • Semiconductor and related device manufacturing • Other plastics product manufacturing • Other engine equipment manufacturing

Source: The 2002 Benchmark Input-Output Accounts, Bureau of Economic Analysis, the U.S. Department of Commerce.

Air Cargo Success Factors

As the industry undergoes major changes, the basic ingredients of an airport's successful air cargo operation have remained essentially intact. These factors have played major roles in the success of gateways to date. However, as airports mature, regional growth and evolving goods movement dynamics may negatively impact the airport's ability to meet the needs of the air cargo industry, and eventually force shifts in operations to alternate facilities. In looking at these factors, there are indications that growing challenges develop as airports mature.
The challenges create opportunities to be explored regarding more efficient utilization of existing airport assets as well as development of new facilities and infrastructure.

Substantial passenger market – both Origin & Destination and transfers: Despite their interest in air cargo, the gateways all stress that one of their top priorities is maintaining a preeminent position in passenger traffic. To grow this segment of the business will require an airport to accommodate substantial amounts of belly cargo and, in the instances of carriers that fly both passenger and freighter aircraft, provide adequate aircraft apron for the freighter component of the business. Given the existing high levels of passenger activity, and the projected growth for the industry, most of the national gateways are well-positioned to achieve this goal and have the physical capacity to address physical constraints.

Large regional consuming and producing marketplace: The large and growing population of a gateway city and the surrounding region, along with the city's interest in the promotion of logistics and the related jobs generates substantial volumes of both inbound and outbound freight. Trade flows to Europe and to Asia typically favor exports and imports respectively as a result of international monetary standards. This creates shortfalls in outbound shipments to Asia and inbound product from Europe. A balance is critical to the financial success of a cargo operation. The flow of cargo to and from certain global regions will vary based on economic trends. In the event the economics substantially decrease in either direction, there is a strong probability that cargo in general and freighter traffic in particular will be reduced accordingly. The challenge for a region is to create an operating environment with sufficient financial benefits to attract product form the surrounding region. Air cargo business reacts to economies of scale; large volumes enable all parties to reduce costs and potentially pass on savings to customers.

Substantial lift to a large number of markets: A substantial number of operations to global markets and sufficient volumes of cargo to each destination enables shippers to consolidate shipments thus reducing overall shipping rates. Gateways have a large and diverse user universe that enables efficient interlining between passenger and freighter aircraft with a resultant global outreach. Forwarders are attracted to larger facilities because of the ability to backstop flights with other options in the event the targeted flight is missed. The other major element of this factor is that the amount of lifts and the competition helps control costs.

Supporting business infrastructure of freight forwarders, customs brokers, and trucking: While integrated carriers control the vast majority of domestic cargo shipments, freight forwarders and customs brokers control the majority of the international market. Although this split has remained fairly consistent, the role of forwarders in domestic shipping continues to shrink and the integrators are pursuing a larger share of the international business as well. Typically, these segments of the industry cluster on or near the transportation facility they wish to utilize. The result is the existence in the areas immediately surrounding the airport of substantial square footage of logistics facilities. Many gateways also have expanded supporting business infrastructure reflecting related ocean-borne shipping that is served by regional customs brokers and freight forwarders. In an ideal environment many of these supporting businesses would prefer to locate on airport (space permitting) to help reduce operating costs. Historically, the biggest issues are the inability of an airport to sell property and the comparative high leasing costs of on versus off airport property.

Roadway infrastructure providing ready access to the airport and to an effective highway distribution system: One of the side effects of air cargo growth is a corresponding increase in trucking traffic and its impact on regional traffic patterns and flows. An original determinant of air cargo success at the larger airports was the regional roadway infrastructure and the links it provided between the airport and a highway distribution system. The growth in passengers and cargo, as well as overall regional growth, can cause congestion making effective access and efficient rates of travel increasingly problematic. The resultant shipping inefficiencies and higher costs can place the more mature regions at a disadvantage. The traffic is an issue at the larger airports. Nevertheless, the other advantages of the major gateways continue to offset most traffic concerns.

Physical capacity to accommodate growth: The most obvious criterion for the future success of an air cargo program is the physical capacity to accommodate the airside and landside requirements of both tenants and users. This includes aeronautical infrastructure, physical facilities, landside parking and queuing, and roadway geometry. The latter two elements are important to ensure that the airport functions efficiently as an intermodal facility. While the cargo operations continue to experience solid growth, there are some very real constraints facing airports as buildings age and carrier requirements change.

Geographic positioning to serve effectively as a major cargo center with clear advantages over potential competitors: Historically, the gateways were coastal airports best-positioned for international cargo growth. Inland airports such as Dallas, Houston and Chicago are in a sense better positioned for overall growth because of the greater catchment areas (the areas around the airport to and from which cargo is typically shipped, which is typically considered the market that can be reached within a day's drive).

Bilateral and Open Skies Agreements: The use of U.S. airports by foreign flag carriers is based on international trade agreements which formally grant nations and carriers access and are discussed at greater length later in this section. The gateways are usually the first markets to which international carriers seek, and are granted access.

The Economic Impact of Air Cargo

A facility, industry, or event can affect the local economy in many ways. The most common measures of "economic impact" are the jobs created, the total revenues brought to local businesses, and contributions to the gross domestic product ("GDP") of an area.

The economic effects of an airport's cargo operations, whatever their form, can reach the community through four principal channels. First, there are the effects of the activities that take place on the airport. These could include the loading and unloading of cargo, work related to leasing and security, and cargo handling in the warehouse. Second, there are activities that occur off-airport. These activities can include a wide range of functions including the work of freight forwarders and customs brokers, trucking, and a number of other diverse supporting firms. Third, there are the effects that arise from the expenditures by the recipients of direct and indirect wages and salaries. Wage earners spend a portion of their income on goods and services, thereby creating employment for additional persons. Finally, there are the catalytic effects that result from the structural changes that a facility such as an airport makes in the business environment of a region. An airport may lower the cost of doing business in a region, or increase the quality of life sufficiently to attract new firms. A firm that establishes a warehouse near an airport to capitalize on the air cargo services would generate such an effect.

The theory and methods for measuring economic impact are well accepted and the processes are straightforward in principle. In practice, an economic impact study could encounter many complications, such as defining the area of interest, ambiguities about the various input-output coefficients (most models assume full employment), quantifying "leakages" to areas outside those of immediate interest, and the practical problem of non-respondents. Most economic impact studies involve detailed questionnaires completed by many business entities. Firms are often reluctant to disclose sensitive financial information. The input-output coefficients and multipliers are statistical averages, and apply to a large population of businesses. Catalytic impacts are particularly difficult to determine. While several European entities have estimated the catalytic impacts arising from aviation, most U.S. airports have concentrated on the traditional direct/indirect/induced effects.

Economic impact models are used to measure changes in the regional economy that result from a change in activity relative to a baseline representation of the economy. The sources of the activity being measured vary, but typically involve changes in production or consumption activities, government policies, infrastructure, or changes in costs or technology. For any change in economic activity, the impacts on the economy can be reported on one of three levels:

- **Direct** impacts represent the initial change in final demand for the industry sector(s) in question. For this analysis, we are estimating the economic activity associated with air cargo in Louisville.

- **Indirect** impacts represent the response as supplying industries increase output to accommodate the initial change in final demand. These indirect beneficiaries spend money for supplies and services, which results in another round of indirect spending, and so on. Indirect impacts are often referred to as "supply-chain" impacts.

- **Induced** impacts are generated by the spending of households who benefit from the additional wages and income they earn through direct and indirect economic activity. The increase in income, in effect, increases the purchasing power of households. Induced impacts are also described as "consumption-driven" effects.

This cycle of direct, indirect, and induced spending does not go on forever. It continues until the spending eventually leaks out of the economy as a result of taxes, savings, or purchases of non-locally produced goods and services or “imports”.

While the modeling tools are well known, the approaches used to evaluate the economic impact of air cargo operations has historically varied significantly between studies. Some studies use gross measures of economic output of the air cargo industry to determine total cargo revenue. Input-output models are then employed to determine overall regional economic impacts, including indirect and induced effects. For example, the 2013 economic impact analysis of Detroit Metropolitan County Airport estimated cargo yields of 36 cents per ton-mile for international shipments and 74.9 cents per ton-mile for domestic shipments to estimate a direct economic impact of $92 million per year (Detroit Metro Willow Run Wayne County Airport Authority and the University of Michigan-Dearborn School of Business 2014). In a study conducted for the Memphis International Airport, the product of the total pounds of air cargo enplaned (4.4 billion in fiscal year 2007) in Memphis and the average revenue per pound ($2.92 taken from the FedEx Express Corporation’s Financial Highlights for 2007) were used to estimate total cargo revenue ($12.8 billion annually). The multiplier effects were, in turn, determined through input-output models and total economic output resulting from air cargo operations was estimated at $27.1 billion annually (University of Memphis 2009).

Other studies evaluating the economic impacts of air cargo operations employ more complex approaches similar to those used in the case studies highlighted in Appendix B. These studies attempt to characterize the regional air cargo industry or air cargo operations at the regional airport. Typical types of air cargo oriented businesses targeted in these studies include: airlines, freight forwarders, cargo handlers, integrated couriers, customs brokers, trucking firms, and warehousers. These assessments are, in turn, used to determine the number of direct jobs tied to the region’s aviation industry and direct wages. For example, the Port Authority of New York and New Jersey (PANYNJ) estimated that air cargo operations serving the region’s three major airports accounted for 40,280 jobs and $2.4 billion in direct wages. When indirect and induced effects were included, the number of jobs rose to 79,650 and total wages exceeded $4 billion (PANYNJ 2005).

CHAPTER 3

ISSUES IN STUDYING THE ECONOMIC IMPACT OF AIR CARGO

To examine economic impact of air cargo, it is not only necessary to articulate the magnitude and nature of the air cargo business itself, but also to describe its potential effects on the complicated economic systems that it generates. The analysis of the air cargo industry, its role in the supply chain and the economic impact of air cargo is reviewed in Chapter 2. In this chapter, the discussion addresses the tools and information required to evaluate the economic impacts of air cargo. The chapter is organized in the following manner:

- Section 3.1 presents a literature review covering topics relevant to air cargo economic impact analysis.
- Section 3.2 examines data available for conducting air cargo economic impact analysis.
- Section 3.3 evaluates survey techniques.

Prior Research and Economic Studies

This section presents a literature review for the following topics:

- Air cargo and supply chain
- Logistics
- Economic impact studies of airports
- Economic impact studies of air cargo services
- Economic tools for economic impact analysis
- Economic tools for supply chain analysis
- Air cargo security and regulations.

Air Cargo and Supply Chain

In many respects, the success of the Berlin Airlift (1948-1949) marks the birth of the modern air cargo industry. Six decades later, air cargo has become an important transportation mode that provides a critical link between shippers/consignees and domestic and international markets. The key participants in the air cargo industry include air carriers, airports, and freight forwarders or third-party logistics providers (3PLs). The three types of air carriers involved in air cargo shipment are: passenger airlines carrying cargo in the “belly” of aircraft, all-cargo carriers, and integrators, which combine all-cargo air service with ground transportation. Passenger and all-cargo airlines may only provide airport-to-airport shipment, while integrators such as FedEx and UPS offer door-to-door delivery services.

Despite high shipping costs relative to other modes, air cargo has been frequently selected for delivering commodities with high value and that have tight time-definite delivery windows. In addition, air freighters often handle perishable goods and emergency deliveries for unexpected shortages. In recent years, greater openness in international trade has stretched the "just-in-time" business model, and air freight has played a key role by enabling quick, regular access to an increasing array of geographic areas on different continents. It also has expanded the types of commodities shipped and types of supply chains served by air cargo.

Today, air freighters transport not only aviation-dependent commodities such as fruit, electronics, telecommunication equipment, and other high-tech products, but also often ships products that could be delivered by truck, rail, and even steamship. To keep ahead on fashion trends, to meet the peak market demand, or simply to maintain its general competitiveness, the garment industry often uses air cargo to transport apparel, even though the cost of ocean shipping is much lower than air cargo. The electronics industry, which also depends heavily on air cargo, accounts a large share of all international air cargo (Kasarda, et al 2006). Indeed, because of the wide usages of electronic products in many industries, some observers claimed that the entire U.S. economy is extensively air-dependent (Kasarda, et al 2006 and O'Connell, et al 2005).

Similar to other industries, the air cargo industry is sensitive to the conditions of the U.S. and world economies. The global economic recession experienced in recent years has added negative pressure on the air cargo industry. The International Air Transport Association (IATA) reported that "in just one year international air cargo traffic fell 23 percent" (Theurmer 2009). International air cargo has stabilized in recent years but the impact of the recession was significant. In addition to economic conditions, the air cargo industry is sensitive to other factors such as changes in fuel prices, aircraft design, regulation, security regulations, and shifts between air and other transportation modes logistical dynamics.

Fuel costs are a main component in airlines' operating costs. The run-up in fuel prices in 1970s, in late 2005, and again 2007-2008 adversely affected airlines' operations and economies. Changes in aircraft design, especially introducing the Boeing 747 "jumbo jet," which included an extraordinary amount of cargo capacity for a passenger liner, have led passenger airlines to enter the air cargo market and compete with all-cargo carriers. Aviation deregulation in the United States not only created more competition among the U.S. airlines, but also broke a practice for which international air fares and rates were set by IATA and oversight by the U.S. DOT prior to late 1970s (O'Connell, et al 2005). To mitigate impact from fuel costs, the airline industry has been testing alternative fuel and requesting new aircrafts with fuel efficiency designs. In 2009, Continental Airlines conducted a Boeing 737 test flight using regular jet fuel, algae oil, and jatropha-based biofuel. The research indicated improvements in engine design could increase the engine fuel per unit thrust by 69 to 75 percent of fuel efficiency (Peeters et al. 2005). The newly designed Boeing 787 Dreamliner would use over 20 percent less fuel than today's similar sized aircraft on comparable flights (Boeing 2010).

The 9/11 event also has caused industries on supply chains to rethink the balance between transportation and inventory strategies. Prior to the 9/11 event, the emphasis was on exploring efficiency of transportation to reach the goal of just-in-time delivery and reducing inventories and warehouse usage. Due to concerns regarding delays caused by air cargo security as well as by volatility in fuel prices, industries on supply chains have intensified their explorations into increased use of ground transportation to supplant air transport. In some instances, trucks have replaced air freight for shipments that require overnight delivery across distances as far as 800 miles. Although such a mode shift may pose a new challenge to air cargo business, it also could introduce new priorities to airports with respect to their overall connectivity to the nation (or some major section of it) via the interstate highway system. Market access with a special focus on the nation's interstate highway has become a main criterion for air cargo operators when selecting airports for use (Mn/DOT 2006).

Logistics

The part of the logistics sector comprised of 3PL providers is fast-growing and maturing, despite establishing itself in 1980s. 3PLs provide logistics services that help shippers control costs and relieve shippers/consignees from complicated and burdensome shipping business. That is, it enables shippers and consignees to outsource some of their logistics services. The big difference between 3PLs and their forwarder counterparts is that 3PLs may own warehouses and other assets for storage and shipping, while forwarders help shippers book space. Today, the logistics sector has grown into a multibillion dollar industry and provides services to many sectors. According to a survey (Langley and Capgemini 2007), 3PL users include a wide array of businesses: telecommunications firms, financial service providers, the health care industry, consumer goods manufacturers, food and beverage producers, automotive companies, chemical manufacturers, and others.

According to Maloni and Carter (2006), several phenomena have led to the success of 3PLs. They include: (1) cost reductions to 3PL customers resulting from economies of scale enabled by the consolidation of services via 3PLs; (2) more efficient operation of logistical services through the specialized, logistics-only focus of 3PLs; (3) efficiency gains by 3PL customers via customers' refocus on core business; (4) improved financial liquidity of assets as shippers eliminate warehouses and other fixed assets that are not needed with the use of 3PLs; (5) improved financial liquidity via payroll as shippers switch to 3PLs; and (6) an increase in complexities of global trade, which would place some shippers at a severe competitive disadvantage if they were not able to tap outside expertise like that provided by 3PLs.

The services provided by 3PLs cover a wide range of logistics topics. The top eight service areas used by 3PL users are freight payment, shipment consolidation, direct transportation service, customs brokerage, warehouse management, freight forwarding, carrier selection, and shipment tracking/tracing. The market demand for 3PL services is dynamic and continues to change. In surveys conducted annually from 2001 to 2004 (Lieb and Bentz 2005), American manufacturers reported that contracting direct transportation services was the main service demand they placed upon 3PLs in both 2001 and 2004. Customs brokerage and freight payment services, however, were reported as being demanded more than any other services in the other two years of the survey—2002 and 2003.

Technology advances, especially those Internet-oriented, bring new challenges to 3PLs. Shippers/consignees are increasingly demanding shipment transparence and expect to know where their packages are located at any given moment. According to a survey of 3PL CEOs

(Lieb and Bentz 2007), 3PLs are facing (1) head-to-head competition from foreign 3PL providers, (2) downward pressure on pricing, in part resulting from the foreign competition; (3) a need to merge with other 3PL providers in North America to take advantage of even greater economies of scale and thereby remain competitive; (4) growing customer interest in outsourcing a broader array of logistics services; (5) increased pressure to internationalize company service offerings; and (6) increasing customer expectations with respect to IT support.

Economic Impact Studies of Airports

In the United States, most airports are owned and operated by local government or quasi-government agencies. Because of this, there is a need to provide convincing evidence of the economic significance of airports to the public and stakeholders for the purpose of competing for public funding. As parts of overall fiscal analyses, economic impact studies commonly help achieve that purpose. They report the number of jobs and economic activities (state and/or local) generated by airports and civil aviation. Although the economic impact study differs from a financial feasibility study, which focuses on return of public investment, some results of economic impact studies feed readily into such financial feasibility analyses and typically are more readily understood and communicated to the public. One of the examples of the economic impact study is the contribution of civil aviation made to the U.S. economy. As estimated by FAA, civil aviation contributed 11 million jobs and $1.2 trillion in economic activities in 2006 (FAA 2008).

To effectively communicate with the public and stakeholders, it is important to understand what an economic impact study covers. The coverage of an economic impact study typically includes two fundamental elements: types of activities and the depth of economic activities. Types of activities can also be referred as parties to be included in the study. In a guideline report issued by FAA, it indicates that types of activities in an economic impact study for airports should include airport employees, employees of an aviation manufacturing plant if the plant locates on or near the airport site, and visitor spending (Butler and Kiernan, 1992). Based on the guideline report, numerous airport economic studies have been conducted to demonstrate the significant economic value that an airport contributes to its local and regional economies. The primary focus of the most airport economic impact studies are in line with the guideline report (Karlsson et al. 2008 and ACI 2002).

The depth of economic activities related to airports refers to the direct, indirect, and induced economic impacts. "The direct impacts result from spending in the local area by visitors who arrive by air, as well as spending in the local area for goods and services by airport tenants. The indirect impacts result from the estimated flow of dollars generated from the supply of materials, goods, and services attributable to the airport by off-airport entities. The induced impacts result from the multiplier effect (or ripple effect) of respending the dollars generated through direct and indirect activities" (Karlsson et al. 2008, p. 6). For instance, the direct job impact reveals the number of people working at an airport. The indirect and induced job impacts reveal the number of jobs generated through the economic system as a result of the direct job impact at the airport. The total economic impact of airports is the sum of the direct, indirect, and induced economic impacts, which can be expressed in terms of jobs, payrolls, or industrial output (or economic activities).

Economic Impact Studies of Air Cargo Services

Measurements of economic contribution made by air cargo services include two parts. In the first part, the economic impact of air cargo services is measured as described in Section 2.3 for measuring economic impacts of airports. The number of people involved in air cargo business at airports is considered to be the direct job impact of air cargo services. Estimated by FAA, the total number of people working directly in air cargo businesses in the United States was 194,000 in 2006. In terms of percentage, air cargo jobs comprise about 19.8 percent of all jobs associated with airlines, airports, aircraft manufacturing, and air cargo in the U.S. civil aviation (FAA 2008). Once the count of direct jobs is known, one can estimate indirect and induced impacts by utilizing appropriate multipliers. Of course, estimating these industry and region appropriate multipliers is a task unto itself.

Besides jobs generated by air cargo businesses, there is another important aspect of air cargo services that deserves a close examination. Consider a scenario that an airport shuts down its air cargo services. Under this scenario, all the shippers/consignees, freight forwarders, and 3PLs that have been using the airport would have to find alternative airports or modes to transport cargo. As a result, costs of doing business (or opportunity costs) for all the parties involved in air cargo business at the airport would increase. Opportunity costs represent the economic efficiencies, which should be taken into account in the economic impact study, contributed by the air cargo industry to the economic system.

Parties involved in air cargo business will, in the long run, attempt to pass on to their customers any increased costs. In this vein, the change in their opportunity costs will reverberate throughout the economic system. That is the second part of economic impact that needs to be examined for air cargo services. An economic impact study for Baltimore/Washington Airport (BWI) estimated that less than 8 percent of the direct jobs generated by BWI could be attributed to air cargo in 2006. After recognizing the importance of the opportunity costs, BWI requested a further examination of the economic impacts of air cargo services with a heightened focus on opportunity costs (Cambridge Systematics 2003; MAA 2007). The analysis performed in this research for studying air cargo-related economic impacts will examine the opportunity costs as discussed above.

Economic Tools for Economic Impact Analysis

The most popular tool for evaluating an airport's economic impact is the regional input-output model. Input-output (I-O) models are built around a matrix that describes how sectors of an economy interact with one another (Miller and Blair, 2009). That is, for a given industry, it shows the "production recipe" for the goods and/or services that it sells as well as the shares of its revenues that are consumed by other industries in the economy. Such models provide multiplier effects (indirect and induced impacts) that attenuate to a specific geography and are typically calibrated using economic data for a local economy. The advantages of using an input-output model are that: (1) its structure is relatively straightforward;[2] (2) it has extraordinary sectoral detail (400-500 industries), which enables refined estimates of multiplier effects; (3) it

[2] See Section 3 for a detailed discussion of the input-output model.

can measure the results of economic changes in terms of jobs, labor compensation, GDP, industry receipts (often the value of shipments), and even local, state, and federal tax revenues; and (4) compared to other economic models its cost of use is low.

Although popular, the input-output model has some shortcomings. Foremost, it lacks an ability to measure an economy's response to price changes. It also lacks the ability to show how an economy's response is likely to be changed over time. As a result, in certain cases, the needs of modeling exercises do not match up well against I-O's capabilities. Of course, other economic models can be used to measure multiplier effects at the regional or national level.

Besides I-O models one of the most established is structural econometric time-series (SETS) models. Such models are built along the lines discussed by Conway (2001). For states, the model is composed of a system of as many as 300 equations, each of which is based on historical data for that state and the nation. Further, such models are tailor-made for an economy. Typically established national forecasts of employment, wages, GDP, and prices drive the model's state or local forecasts. The key focus of such models typically is employment since these data are generally the most current. Equations in SETS models must be updated on a monthly, quarterly, or annual basis to keep them current.

Two major strengths of SETS models are that (1) they produce results that are dynamic (laid out in time schedule) and (2) they can simulate the effects of price changes. Also, they have great sensitivity to historical trends in the local economy. Of course, this strength of their entrenchment in historical trends is also a prime weakness. That is, the past cannot always inform us about how major economic events or activities will affect an economy in the future. The second limitation is that full historical data by industrial sectors for employment and gross product are available at the three-digit NAICS level or less, depending on the sector. That is, they lack the articulation of multiplier effects that is available in I-O models. The third and perhaps most significant limitation is the extreme cost in terms of time and labor required to construct and maintain SETS models.

Computable general equilibrium (CGE) models are another set of models that are frequently used in economic impact analysis. CGE models assume optimal decisions by consumers and producers in response to markets and prices subject to labor, resource, and capital constraints. CGE models, in essence, have blocks of equations that represent key actors in the economy (e.g., consumers, producers, government) and equations that make sure that the different blocks are consistent. The heart of the model is usually a modified I-O model—a so-called "social accounts matrix" (SAM). The models can be built to explicitly consider sectoral resilience and substitution across industries in the equation structure, which is a major advantage, if, in fact, the elasticities in the models realistically reflect resilience, commodity substitution, and other built-in changes.

A chief criticism leveled at CGE models is that they rely on external sources for some of the elasticity values required during their calibration (Patridge and Rickman, 1998). This is especially the case for region-specific models where studies that derive the elasticities are scant. As a result, regional CGE models tend to rely upon elasticities from national or international studies, which are likely not to be comparable. In some cases this may not be a serious fault if the analyst can perform sensitivity analyses on various values of certain key elasticities. But in some cases, particularly for dynamic CGE models, which conceptually could substitute for SETS models, the data are lacking to econometrically estimate some key components equations. Still the costs in terms of time and labor required to produce such a model are not much less (if they are, in fact, less) than those of a SETS model.

The absence of estimated production functions by industry for CGE models also has led to the use of a class of production functions (constant elasticity of substitution) that may not accurately portray economic processes in a nation or region. While this may not be a major issue when trying to get general qualitative and quantitative insight through a CGE simulation, it is an attribute of current CGE modeling practice that Partridge and Rickman (1998) argue could be remedied. Such research has since been undertaken by Adkins, Rickman, and Hameed (2003) who estimate the desired parameters using a translog Bayesian approach to production functions.

Other economic models exist and have been or could be used to model the economic impacts of airports. One option is a model that conjoins I-O and SETS models, which maintains the best of both models but is greater in cost than a SETS model alone for obvious reasons. Other proprietary models implemented for airport economic impact analysis utilize a structure which offers a cross between an input-output model and a SETS model. These are predicated on a panel of data across U.S. states, although as in the case of I-O models its relationships are extrapolated for use for any aggregates of counties. Although, like SETS models, this type of modeling overcomes most shortcomings of the I-O models. The costs of such proprietary models prohibits many users from selecting them for their studies (Lynch 2000). Still, they can prove to be a less costly alternative than building either the CGE or SETS models. Another disadvantage compared to I-O models is the degree of sophistication that is required of the model user and would often require extensive training prior to application.

Economic Tools for Supply Chain Analysis

A supply chain can be defined as an integrated process that involves various organizations, people, technology, activities, information, and resources for transforming raw materials to a product and transporting from suppliers to end users or customers. The complicated structure of supply chains calls for a powerful and easy-to-understand economic tool for analyzing its component activities. On-going research focuses on the use of input-output models to describe and examine effects of supply chain on specific industries or regional economies (Lin and Polenske 1998; Sgouridis 2004; Miller and Blair 2009).

The structure of input-output models is ideal for supply chain analysis because it reveals average direct and indirect relationships among industrial sectors. The model begins with an account of economic transactions—a matrix that records purchases of materials made by each sector from all other sectors involved in their production processes. By normalizing on the columns of the transactions matrix, one can depict the intensity of the dependency between any pair of industries such as the auto-producing industry and the primary metals sector.

Beyond the direct production relationship, the model can also capture additional indirect relationships existing in supply chain. For instance, in responding to the demand from the auto-producing industry, the primary metals sector will call suppliers from its supply chain. In the literature, production by the auto-producing industry is labeled a "first round" response, while actions taken by the primary metals sector is a "second round" response. The effects from one round to other rounds of responses decline as demand shares diminishes as the production extends further and further backward. The input-output model captures the round-by-round effects that inevitably occur in supply chains of an economic system. Indeed, this analytical approach has been implemented in analyzing supply chain for specific industries (Polenske and McMichael 2002; Li 1991). Transportation sectors and the performance and sustainability of their supply chains, as well as environmental impacts, have been analyzed by Hendrickson et al. (2006).

Air Cargo Security Regulations

Since the 9/11 event, aviation security, including air cargo security, has received intensive attention and become a focal point for new air security related regulations. The Implementing Recommendations of the 9/11 Commission Act of 2007 ("Implementation of the 9/11 Act")[3] has set very restrictive requirements that include 100 percent screening of all cargo placed on passenger aircraft by August 2010, with an interim requirement of screening 50 percent of such cargo by February 2009. In contrast to baggage screening, which relies on a single technology, air cargo screening is somewhat limited by available technology, flight schedules, and cargo processing demands (Elias 2008).

In balancing with the risks involved in air cargo shipments, the costs of implementing security checks and the potential delays caused by screening are the two key issues that have economic implications to air cargo business and airport operations. Those two issues will continue to dominate the evolution appropriate technologies and methods for screening air cargo and for meeting the requirements of the Implementation of the 9/11 Act.

More on Implementation of the 9/11 Act

The Implementation of the 9/11 Act states that air cargo placed on passenger aircraft must be screened at a level of security commensurate with the level of security for the screening of passenger checked baggage. That requirement has received the most attention and stirred the most debate, as air cargo stakeholders express concerns that it will impede cargo shipment processes, schedules, and, most of all, the industry's competitiveness. Under the leadership of Airports Council International—North America (ACI-NA), the Air Cargo Committee has been an active participant (along with airlines, government agencies, air freight forwarders) in the TSA federal rulemaking process to implement Congressional air cargo security mandates. The Air Cargo Committee has (i) strongly supported "risk based" security rules, and (ii) pointed out that duplicating the rules adopted for passenger aircraft for all cargo carriers would add additional costs to the U.S. economy.

Because of the large volumes and the complexity of air cargo packaging, airports and air carriers have limited capacities and capabilities to screen all cargo destined for passenger

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[3] Public Law 110-53, August 3, 2007.

aircraft. To relieve the burden on airports and air carriers, TSA created the Certified Cargo Screening Program (CCSP) with the aim of achieving 100 percent screening of passenger carrier cargo by August 2010 in compliance with the 9/11 Act. This program enables screening to take place earlier in the shipping process and at various points in the air cargo supply chain by allowing certified facilities to screen cargo prior to delivering the cargo to the air carrier. Entities volunteering to become Certified Cargo Screening Facilities (CCSF) include freight forwarders and shippers, manufacturing facilities, third party logistics providers, warehouse/distribution centers, and independent cargo screening facilities. By allowing cargo to be screened before it is consolidated and transported to the airport, the time-intensive process of breaking down consolidated cargo at airports for screening purposes is avoided.

Unlike baggage screening performed by TSA personnel, TSA's main responsibility in cargo screening is to provide oversight of the airlines and shippers that are responsible for cargo inspections and screening operations. As a result, the costs to be incurred by TSA are perceived to be relatively small. According to the cost estimated by the Congressional Budget Office, the total costs for TSA over the first six years should be on the order of $3.5 billion. The costs to carriers vary significantly, which has given rise to third party screening facilities. These costs are explored in Section 4.3 of this report.

The 9/11 Act defines screening as a physical examination or other non-intrusive assessment of whether or not cargo poses a threat to transportation security. Various technologies are being considered and tested for enhancing air cargo security including x-ray systems, explosives detection systems, chemical trace detection systems, neutron beam technologies, millimeter wave imaging systems, blast-resistant cargo containers, biometric screening technology, and physical searches conducted in conjunction with manifest verifications. In addition, special packaging and use of canine teams are being considered. Tamper-evident and tamper-resistant packaging and seals offer protection of the cargo's integrity during shipping and handling without adding a significant cost burden. One of the main concerns is that unpacking of cargo pallets for screening poses logistical and theft concerns (Air Safety Week 2009). Breaking up and rebuilding the pallets, which consist of up to 200 pieces of varying sizes, shape and commodity, require significant time, space, and training. Use of explosive-detecting canine teams to identify cargo for in-depth screening would undoubtedly reduce this potential burden.

Known Shipper Program

Established in late 1990s, known shipper programs were originally created as a pre-screening method for distinguishing those shippers who can prove they are known to freight forwarders and air carriers, and shippers who have not previously conducted business with a freight forwarder or air carrier. The current practice is that shipments from known shippers who refuse to allow security checks or from unknown shippers are refused by air carriers. Since the 9/11 event, the effectiveness of the known shipper program has been questioned. Initially, individual freight forwarders and air carriers continued to maintain lists of trusted and known shippers. To address the security concerns, TSA took actions and has since established a standardized, centralized database of known shippers (Elias 2007).

Fuel Tank Flammability Reduction Rule

Federal Aviation Administration (FAA) regulations concerning air cargo are primarily aimed at enhancing the integrity and safety of the aircraft. The major rule in place is related to fuel tank flammability for aircraft engaged in air cargo activities. The impetus for this rule was the National Transportation Safety Board's (NTSB) accident report regarding TWA flight 800. They determined the most likely source of that accident to be "an explosion of the center wing fuel tank, resulting from ignition of the flammable fuel/air mixture in the tank," and identified fuel tank flammability as a critical safety issue. The NTSB directed its safety recommendations to the FAA.

Aircraft manufacturers opposed this rule initially, particularly concerning the required retrofitting of much of the existing fleet of larger aircraft. Concern was also expressed related to the definition of air cargo aircraft, as passenger aircraft carry cargo as well. The final rule grandfathered older all-cargo aircraft, while all newer aircraft (passenger and cargo) aircraft are required to meet flammability reduction means (FRM) standards. The Operational Rules (Parts 121, 125 and 129) concerning cargo airplanes state that all newly delivered passenger and cargo airplanes must be equipped with FRM, as well as any passenger airplanes converted to cargo (Federal Register 2009).

Data Availability and Gaps

Several publicly available freight datasets provide freight shipment data by transportation mode, weight, value of commodities, commodity, or region. Some of these datasets provide estimates of air cargo data, which are valuable for the economic impact analysis of air cargo at airports. A recently compiled dataset, the Freight Analysis Framework (FAF) from the Federal Highway Administration (FHWA), has overcome some shortcomings in older datasets that have a relatively long history of data collection. As the analysis presented in this section shows, however, the FAF still has data gaps for air cargo. After the FAF's data gaps are examined, other data sources that could be used to partially address these data gaps are also discussed, along with their relative advantages/disadvantages.

Air Cargo Data

In economic impact analysis for air cargo, air cargo data play an important role. The air cargo data for an airport reveal the amount of commodities, express packages, and mail shipped by air. In- and out-bound domestic and international air shipment data are useful information for rerouting analysis to examine impacts of opportunity costs, under a scenario of closing an airport. In- and out-bound air shipment data are also useful for analyzing industrial activities near and around airports. At a national or regional level, air cargo data measured by weight and by value of shipment can be used for a comparison analysis between air transportation and other modes.

Through continuous efforts, federal government agencies have collected and compiled aviation-related cargo flow data. Four major publicly available data sources related to air cargo are as follows:

- The Commodity Flow Survey (CFS) from the Bureau of Transportation Statistics (BTS), an establishment-based survey, is conducted every five years as part of the Economic Census. Conducted in 1993, 1997, 2002, 2007 and most recently in 2012, the CFS provides a modal picture of national freight flows.

- The T100 and T100f airline data from the Office of Airline Information (OAI) at BTS contains Air Carrier Traffic and Capacity data and includes two reports, the Non-Stop Segment and On-Flight Market data. The T100 covers all U.S.-certified air carriers and commuter air carriers; the T100f contains similar information on all foreign air carriers operating in the United States.

- The Import/Export data on Merchandise Trade from the U.S. Census Bureau contains data collected by the U.S. Customs and Border Protection for all goods that pass through U.S. Customs other than low-value items and some intergovernmental shipments. The data are broken out by foreign country, U.S. customs district, commodity, value, and mode of transportation.

- The FAF, which covers freight transportation from all modes, including air freight, estimates commodity flows and related freight transportation by mode and between regions, as well as through major international gateways in the United States. The FAF integrates data from several sources, such as CFS, T100, and Import/Export data mentioned above.

Air Cargo Data Coverage and Gaps

This section focuses on coverage and gaps of four publicly available air cargo datasets, including the CFS, T100, Merchandise Imports/Exports, and FAF. The discussion begins with the coverage and gaps for the first three datasets and then discusses how the FAF combines these and other sources to close some, but not all, of the data gaps. Table 5 presents the coverage and key characteristics for each of these datasets. All of the four datasets will be used to minimize gaps that exist in air cargo data.

The CFS Dataset

The CFS is the first major dataset that has laid the foundation for air cargo data. Major advantages of the CFS include its basis in formal survey techniques, multimodality, capture of "door-to-door" shipments, and coverage of weights and values by commodity shipped. However, gaps in the coverage of the CFS are also known (e.g., Southworth 2005):

- Imports are not covered since the CFS surveys U.S. establishments.
- There is evidence that exports in the CFS are underrepresented.
- A limited number of geographic regions are covered by the CFS, which has 114 domestic regions[4].

[4] See Table A-1 in Appendix.

- Intermodal connections may be underrepresented because shippers do not know modal changes in shipping routes.
- The commodities reported by the CFS at a region-to-region level are limited to commodities classified at 2-digit of the Standard Classification of Traded Goods (SCTG[5]).
- Industries out of CFS's survey scope may account for as much as 25 percent of U.S. freight (Southworth 2005).

In addition to those commonly mentioned gaps in the CFS, some issues with respect to air express are particularly relevant to air cargo:

- Parcels or packages shipped by the U.S. Postal Service (USPS) or other couriers by air are either missing or lumped into the much smaller other data category such as "other multi-modal."

- Air express packages classified under the category of administrative/mail/business documents are explicitly excluded from statistics.

The integrators' rapid expansion in shipping business has raised the importance of air express. According to T100 data, the top five integrated carriers account for over 51 percent of U.S. air freight enplaned. Federal Express (FedEx) and United Parcel Service (UPS) alone account for almost 47 percent of U.S. air cargo enplaned (OAI 2008).

[5] See Table A-2 in Appendix.

Table 5. Characteristics of the CFS, T100, Import/Export, and FAF Datasets

Main Category	Detailed Category	CFS	T100	Import/Export	FAF
Air cargo data	Weight	Yes	Yes	Yes	Yes
	Value	Yes	No	Yes	Yes
	Detailed commodity	2 digit	No	10-digit harmonized system	Same as CFS
	Low-value/ weight goods	<100 lbs. included in the box-type of parcels	Yes	Imports <$2,000 and exports <$2,500 are excluded	Same as CFS
	Box-type of parcels shipped by air	Yes, but lumped with other intermodal	Yes	No	Same as CFS
	Letter-type of packages shipped by air	No, excluded from surveys	Yes	No	Same as CFS
Industry coverage	Surveyed by CFS	Manufacturing, mining, wholesale, selected retails, and publishing (except 2002)	Yes	Yes	Same as CFS
	Not surveyed by CFS	Most services, publishing (2002), petroleum, government, and households	Yes	Yes, except intragovernmental	Expanded coverage from CFS for trucks, but little expansion for domestic air and parcel shipments
International trade	Imports	No	Yes	Yes	Yes, expanded by combining the T100 and Import data to account for inbound shipments
	Exports	Yes, but underrepresented	Yes	Yes	Yes; expanded by combining the T100 and Export data to account for outbound shipments

The Merchandise Import/Export Dataset

Census Bureau's Merchandise Import/Export dataset contains information that can be used to fill the first two gaps in the CFS related to international trade. The air cargo data available from the Import/Export dataset include values and weights of the international shipments at the detailed 10-digit commodity level. However, there are at least two shortcomings in the Import/Export dataset:

- Data are reported on customs districts for entry/routes rather than on the actual entry and origin-destination (O-D) points.
- Low-value shipments, parcel, and mail for all modes are excluded, but those shipments could be significant for air cargo.

The T100 Dataset

The T100 (and T100f) dataset is collected from air carriers according to regulatory requirements. The T100 dataset contains monthly air cargo weight data summarized by carrier-origin-destination airports[6] for all U.S. and foreign carriers operating a flight with at least one takeoff/ landing in the United States. The T100 dataset includes two reports, the Non-Stop Segment and On-Flight Market data. While the segment data cover air cargo transported between nonstop segments, the market data contain information of air cargo between airports where it is enplaned and where it is "deplaned."

A caveat to the Market data is that in addition to actual unloading, cargo is also counted as deplaned when there is a change in flight number. From a technical point of view, the T100 data should provide a breakout of shipments between mail and commodities. However, in reality, integrators such as FedEx are less willing to break out mail due to concerns that it would reveal proprietary information regarding its contract with the USPS. The T100 dataset's shortcomings include a lack of information on detailed commodities shipped, first origin/ultimate destination routes, and value. However, the T100 dataset would make a valuable contribution because its complete coverage of inter-airport cargo weight data.

The FAF Dataset

Using the CFS as a base and supplemented by the Import/Export and T100 datasets, the FAF is able to close or reduce the gaps with respect to international air shipments, as well as air shipments missed by the surveys in the CFS. The estimated results of international air freight in the FAF include international shipments in terms of the CFS's O-D as well as weights and values at the 2-digit commodity level. The use of the T100 and Import/Export data also eliminates the data gap existing in the CFS for those industries not covered in the survey for international shipments. Since neither the T100 nor Import/Export data are subject to the same restrictions of data collection as CFS, including the results is an approximately 50 percent increase in the

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[6] Other subcategories are available, such as scheduled vs. nonscheduled and equipment type.

coverage of air freight. Furthermore, the T100 dataset provides actual entry/exit points as opposed to customs districts.

The FAF dataset has made significant improvement in data coverage for air cargo and overcomes shortcomings reported in other three datasets. Nevertheless, data gaps still exist in the FAF as part of inheritance from the CFS, and some of the data gaps—especially in the coverage of air express data—have impacts on air cargo. The major data gaps related to air cargo in the FAF are listed below:

- Box-type of packages—Parcels or packages weighing <100 lbs., which are often shipped by integrators, USPS, or other couriers, are lumped together with other modes such as “other intermodal.” As a result, the air express of these shipments is combined with shipments that were ground only or used other modes in the FAF.

- Letter-type packages—Similar to the CFS, any letter-type of air express packages that fall into the category of Administrative/Mail/Business documents are excluded in the FAF.

Although the coverage of air cargo was increased by 50 percent for the FAF over the CFS with the inclusion of Import/Export information, domestic shipments by industrial establishments not covered in the CFS are still missing. Similar to the CFS, the FAF has limited coverage for commodities and geographic areas. The number of commodities covered by the FAF is limited at the 2-digit commodity level, while the total number of geographic regions covered is still limited to 114 regions and 17 gateways in the United States.

Other Air Cargo Data Sources

Beyond the four publically available datasets discussed in previous sections, there are other data sources that cover air cargo data, provided either by a government agency or private entities. This section discusses the advantages/disadvantages and availability of air cargo data from those sources. A new data source, Freight Assessment System, has been compiled by the Transportation Security Administration (TSA) lately as a result of implementing the regulation of screening cargo on passenger aircraft. The data sources compiled by private entities include air cargo–related data from, for instance, IHS Global Insight’s Transearch database, Colography, and the Official Airline Guide (OAG).

The TSA Dataset. The TSA collects information on all air cargo shipments within the United States as part of its aviation risk analysis system. The resultant database is being developed as the Freight Assessment System (FAS), which is described as follows:[7]

The FAS will screen all air cargo to identify elevated-risk shipments for aircraft operator inspection prior to flight. Data on shippers, agents, IACs, air carriers, consignees, contents of the shipment, and threat information will be incorporated into the risk assessment at a transactional level for domestic and international shipments.

[7] From the Transportation Sector-Specific Plan: Aviation Modal Annex.

As a virtual census of all commodities shipped by air, the FAS might be a valuable source of information on air cargo flows. In particular, the FAS data may be supplemental to shipments missed in the CFS surveys. However, the TSA has treated the FAS data as sensitive security information. At present, little information is available on how the data are collected, the coverage of data, and whether it will be released for public use.

The Transearch Dataset. The Transearch dataset is a database that provides Origin-Destination flows for truck-rail-water and air. This is based on a combination of a shipper's survey conducted by Global Insight and publicly available data such as the CFS. Shipment data in the Transearch dataset are available by commodity and value at the county/state level. The major advantage of the Transearch data is the use of private information from the Motor Carrier Data Exchange, which may be of limited advantage for the analysis of air cargo. The Transearch data has a relatively high purchasing cost as well as methodology for estimating shipment data that is proprietary.

The Official Airline Guide (OAG) Dataset. The OAG is a leading publisher of worldwide airline flight schedules and also provides data on air freight rates. The schedule information could be used to validate routes obtained for air cargo shipments under the estimation procedure above, as well as provide useful information on time of day/day of the week. This dataset also has a relatively high purchasing cost of this product relative to its targeted use is its primary shortcoming.

Colography Group's Dataset. The Colography Group conducts annual shipper surveys and compiles transportation databases based on the data collected. The products do not include specific information on air cargo, Origin-Destination information, or in-bound shipment data.[8] Therefore, the Colography's dataset would not add significant value to what is available from public sources.

In sum, each of the above data sources cannot be used as a single data source on air cargo flows and related air cargo studies. The TSA dataset is restricted and at this time cannot be released to the public, and the other three datasets provided by private entities either lack specific data required for the economic impact analysis, lack an available explanation for their methodologies, or bear relatively high purchasing costs.

Survey Techniques

The research team used principles in *ACRP Report 26 Guidebook for Conducing Airport User Surveys* to gather the information for economic analyses of air cargo. As noted in Report 26:

- "Surveys of air cargo activities and operations at an airport represent a particularly challenging type of survey, because information on shipment characteristics and detailed cargo flows is typically regarded as highly proprietary."

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[8] Based on a review of Colography's website and personal communication with the company's sales manager.

- "Surveys of air cargo carriers, freight forwarders, or selected shippers will typically take the form of an in-person interview. Respondents may be able to provide useful information in general terms, even if they are not willing to provide detailed data on individual shipments."

- "There is little experience to draw upon, and therefore virtually no standard practices that can be applied, or modified, for a particular airport. Any survey designed to capture air cargo data is likely breaking new ground."

- "To date, the most common survey method for air cargo is similar to stakeholder interviews. Although shippers and forwarders may be reluctant to release detailed information on air cargo shipments or cargo activity at their facility, it is possible to construct a survey in the form of an interview. Using the survey purpose as a base, a series of questions can be constructed to form a structured interview to be conducted with all, or selected, air cargo operators at the airport" (Biggs et al. 2009).

The research team followed the guidelines in ACRP Report 26 in developing surveys for the following entities at each airport:

- Airport representative
- Air carriers
- Freight forwarders and air transportation service providers
- Shippers – Single stand-alone businesses; warehouses; distribution centers.

In general, the surveys requested information on the air cargo volumes (dollar value and/or weight) by type (or commodity code) as well as numbers of employees. Survey questions specific to each group are discussed further below. The team had more success in obtaining completed surveys if the individuals were first contacted by telephone, with the survey sent through follow-on email. Follow-up interviews were helpful to answer any questions the respondent might have on specific survey questions. When trying to complete surveys in person, the individual was seldom able to complete the survey at one time due to the varied amount of information being requested.

Given the breadth of the information covered, most individuals needed to conduct some research in order to complete the surveys. In many situations, various data points may be kept in a variety of locations such as: Office of Public Relations has the landing data while the Air Operations Office has data on actual cargo movements on the air field. Recognize that data from each source may not match exactly, but can be cross-referenced and reconciled to determine which data is most robust and accurate.

Due to the proprietary nature of the cargo market, individual companies will need assurance that their individual data will be kept confidential. Be prepared to discuss issues such as how business/competition sensitive corporate data will be used, stored, protected, presented, and published (or not) in a private or public forum.

Some airports with large numbers of carriers and large amount of cargo have local air cargo associations and annual (or more frequent) cargo conferences. Requesting the assistance of the local industry groups or associations may help identify professionals in the field that can assist; however, keep in mind that many organizations keep their membership lists private. To gain the support of the members, it may be most effective to write a formal request for assistance to be introduced at a regular business meeting and/or request a speaking role at one of their meetings. These associations and events provide excellent opportunities to introduce the project's purpose, importance of the survey information, and networking to meet individuals who will assist in providing the necessary data.

Small incentives, such as coffee shop gift cards or airport club passes, may encourage survey responses from private industry participants. However, air cargo revenues provide very small margins to freight forwarders, and even incentives for survey completion did not easily offset the time spent completing a survey vs. working on their standard business items or selling a cargo shipment. It is recommended to identify one or more key individuals at each airport who are knowledgeable about the local air cargo industry; their contacts assist with gathering necessary information and they often can provide estimates if actual detailed information cannot be obtained.

Finally, the initial surveys (as detailed below) included many questions related to elasticity of the market, e.g., how the market would reduce cargo shipments if the price increases and/or air cargo was not available at the specific airport. These sets of questions greatly increased the survey length and thus the time required to complete the survey. In addition, many individuals are uncomfortable answering such subjective questions and did not want their responses perceived as responses from their whole organization. After receiving very few responses to these sets of questions, the economists participating in this study determined this information was not necessary for the analyses; thus, these questions were removed from the interviews to increase overall participation and survey response. The lesson learned is to only build into the survey the necessary pieces of information; extra questions/information unnecessarily lengthens the survey and thus discourages respondents from completing it.

<u>Airport Representative</u>

The airport survey (provided in Appendix B) primarily requests information the airport has readily available, including:

- Total numbers of airport employees
- Number of employees performing air cargo-related operations (airport employees and tenants) by industry sector
- Annual cargo volume by:
    - Inbound/outbound
    - Domestic/international
    - Weight and/or monetary value
    - Airline

- Commodity code
- Passenger, express and all-cargo airlines serving the airport
- Forecasted air cargo growth rates

While the airport likely has the information readily available, it may reside with different offices or departments. Employment for tenants may be estimated from security badging counts, which can be obtained from the airport security manager. Access control records may provide estimates of cargo vehicle movements. In general, airport staff can and will provide all the information requested and will assist in identifying other entities and/or individuals to survey.

The airport manager or cargo manager can send introductory email to air carriers, third-party ground handlers, and freight forwarders to facilitate their understanding of the overall project and encourage their participation.

Reach out list:

- Airport Manager
- Staff person responsible for Air Cargo at that airport
- Security officer (badging or access control office) can help with on-airport employment estimates
- Public Relations (usually has the basic, distilled information)
- FAA Airports All Cargo data: http://www.faa.gov/airports/planning_capacity/passenger_allcargo_stats/passenger/.

Air Carriers

Both commercial passenger airlines (accepting cargo as belly freight) and commercial cargo airlines need to be included in the survey. The airports have information on cargo volume by carrier, thus some of the survey questions were somewhat redundant, but the surveys also attempted to gather more detailed information from the airlines. The air carrier surveys also requested information on the costs for accommodating the Transportation Security Administration (TSA) requirements to screen 100 percent of all air cargo.

Specifically, the air carrier survey (provided in Appendix B) included questions on the following:

- Total numbers of employees on-airport and off-airport, full-time and part-time
- Annual cargo volume by weight and/or monetary value
- Top ten commodity codes
- Forecasted air cargo growth rates
- Estimates of customer reactions (change in volume) to price increases
- Cost implications of TSA screening requirements.

When the airport already provided information about cargo volume by carrier, the research team generally attempted to survey the providers who processed the largest amounts of cargo to maximize the overall percentage of cargo volume represented by completed surveys. Local station managers or sales managers may have authorization to provide only basic information on volumes and employment, but not any speculative information (e.g., forecasts, how the cargo might be transported if this airport could not accommodate the volumes, or how the cargo volumes might change due to price increases). The carriers' corporate headquarters often must be consulted to request the data and/or permission to discuss the information with their local personnel on-site at the airports. Each business has their own procedures regarding participation in surveys and/or releasing company data. (Note that one large overnight express carrier refused to participate in this research project or provide any information.) Most of the carriers will consider all provided as Business Sensitive and/or Confidential. Be prepared to discuss how you will use and protect the data, especially from their competitors.

At airports where individual carriers have small numbers of flights and/or cargo volume, the airlines often contract with third-party ground handlers to process the cargo. It is important to capture their employment numbers as, in some cases, they will have many more employees than the individual carriers. The airport will have a list of third-party ground handlers and cargo terminal operators since they operate on the airfield. The research team also found the ground handlers and terminal operators to be very forthcoming with information, proudly stating their employment numbers and with which airline(s) they are contracted.

Reach out list:

- Commercial passenger &/or cargo airline station managers
- Cargo Airline Sales Managers
- Third-party ground handlers
- Air Cargo Associations:
  - Regional: http://www.raccaonline.org/
  - International: http://www.tiaca.org

Freight Forwarders

Freight forwarders are an important element in the air cargo system. Freight forwarders are third-party logistics providers who contract with originators of shipments (manufacturers, etc.) and with the carriers to deliver items from the shipper's site to the final destination. Most airports have a list of known freight forwarders who work with cargo at their airport, but there may still be additional forwarders in the area that should be surveyed.

The initial survey for forwarders (provided in Appendix B) included the following:

- Total numbers of employees in the specific economic region, on-airport and off-airport, full-time and part-time
- Annual air cargo volume handled in area, by:
  - Weight and/or monetary value
  - Cargo-only airlines vs passenger belly cargo
  - Inbound/outbound
  - Domestic/international

- Air cargo value as percent of total cargo value handled in area
- Top ten commodity codes
- Estimates of customer reactions (change in volume) to price increases for:
  - Cargo-only air cargo
  - Belly air cargo
  - Other modes
- Estimates of customer reactions (change in volume) to reduction of belly cargo capacity
- Estimates of how air cargo would move to other modes if air cargo services were discontinued
- Cost implications of TSA screening requirements.

The freight forwarders were also asked to rank why their customers choose air transportation rather than other modes to ship cargo, including decision parameters such as time to market, frequency of service, reliability of service, value of time relative to other modes, security, ability to track/trace air shipments.

The freight forwarder survey was quite extensive, asking several more items than the air carrier survey. Due to the length of the survey and time required to answer all the questions, the research team had difficulty getting freight forwarders to respond to the entire survey. Freight forwarders' profit margins are thin, and requesting their time for an economic survey simply takes away more time from their business than most are willing to spend. For most airports, the research team relied on employment estimates based on information from the Airforwarders Association, local brokers/freight forwarders organizations, and/or local chambers of commerce.

Reach out list:

- Freight forwarders: http://airforwarders.org/
- Third Party Logistics (3PL) association: http://www.iwla.com/why/members.aspx
- National Customs Brokers and Forwarders Association of America: http://www.ncbfaa.org

Shippers

Shippers may be any type of business/organization, including manufacturers, office/professional businesses, warehouses, distribution centers, or consolidation centers. Requesting the assistance of the local industry groups, chambers of commerce, economic development councils or associations may help identify appropriate businesses to survey. Recognize, however, that these only represent cargo shipments that originate locally, not inbound shipments or connecting cargo at each airport. *ACRP Report 26* states that "surveys of area businesses and other organizations are perhaps the most difficult of all airport user surveys to perform in a way that gives results that accurately reflect the characteristics and views of the targeted population" and "non-response can be a significant problem with surveys of area businesses" (Biggs et al. 2009). The research team certainly found this to be true with very few completed surveys from local shippers.

The initial survey for shippers (provided in Appendix B) included the following:

- Total numbers of employees within the specific economic region
- Company/industry NAICS code
- Annual air cargo handled in area, by:
    - Weight and/or monetary value
    - Cargo-only airlines vs passenger belly cargo
    - Inbound/outbound
    - Domestic/international
- Air cargo value as percent of total cargo value handled in area
- Top five commodity codes shipped by their business
- Estimates of company shipping reactions (change in volume) to price increases for:
    - Cargo-only air cargo
    - Belly air cargo
    - Other modes
- Estimates of company shipping reactions (change in volume) to reduction of belly cargo capacity
- Estimates of how air cargo would move to other modes if air cargo services were discontinued
- Annual spending by company on all air transport services, and proportion to air cargo vs air passenger transport
- Value assigned to a one-hour delay in shipment

The shippers were also asked to rank why they choose air transportation rather than other modes to ship cargo, including decision parameters such as time to market, frequency of service, reliability of service, value of time relative to other modes, security, ability to track/trace air shipments.

Similar to the questions asked of freight forwarders, shippers were initially asked how their air cargo volumes would respond to changes in market prices, capacity, and overall availability of air cargo at this specific airport. However, few shippers answered these questions, and overall employment numbers became the most relevant data for local businesses/shippers.

<u>Reach out list:</u>

- Local/regional chambers of commerce
- Local economic development agencies or city/county departments for economic development

CHAPTER 4

EMPLOYING THE ECONOMIC IMPACT METHODOLOGIES

This chapter presents an analytical framework for estimating the economic impacts of air cargo at airports. The chapter begins with an overview of the analytical framework and discussion of the process used to select the case study airports in Section 4.1 and extends to cover the following subjects:

- Economic impact concepts or the decisions made prior to estimating economic impacts. These steps include the evaluation and selection of models, definition of the study region and determination of the impacts evaluated.

- Tools and techniques used in the case studies, including an overview of the economic models, model preparation, data collection, estimating of demand elasticity.

- Results of the case studies.

Overview

The purpose of this chapter is to present an analytical framework with procedures used to estimate the economic impacts at airports. This section presents an overview of the analytical framework and outlines the process used to select the airports for case studies.

Analytical Framework

The purpose of the analytical framework is to establish a guideline for estimating economic impacts (or economic contributions) associated with air cargo at each airport evaluated in the case studies. Three types of economic impacts are considered in the analytical framework:

- Economic impacts generated by air cargo activities.
- Economic impacts caused by the newly implemented 100 percent screening of cargo on passenger aircraft.
- Economic impact caused by fluctuations in jet fuel prices.

The economic impact is traditionally divided into direct and indirect (and induced) impacts. The direct impact relates to jobs, wages, and revenues generated by air cargo services. The indirect and induced impacts to the economy are generated indirectly by air cargo services: to develop convincing estimates of the actual impacts an economic model is required. Another important contribution made by air cargo services is the intangible opportunity of growth in terms of attracting businesses to the region. It is generally agreed that industries are concentrated within regions with direct access to air cargo operations. In the absence of this access, companies that rely on these services would likely re-locate to other regions with such access.

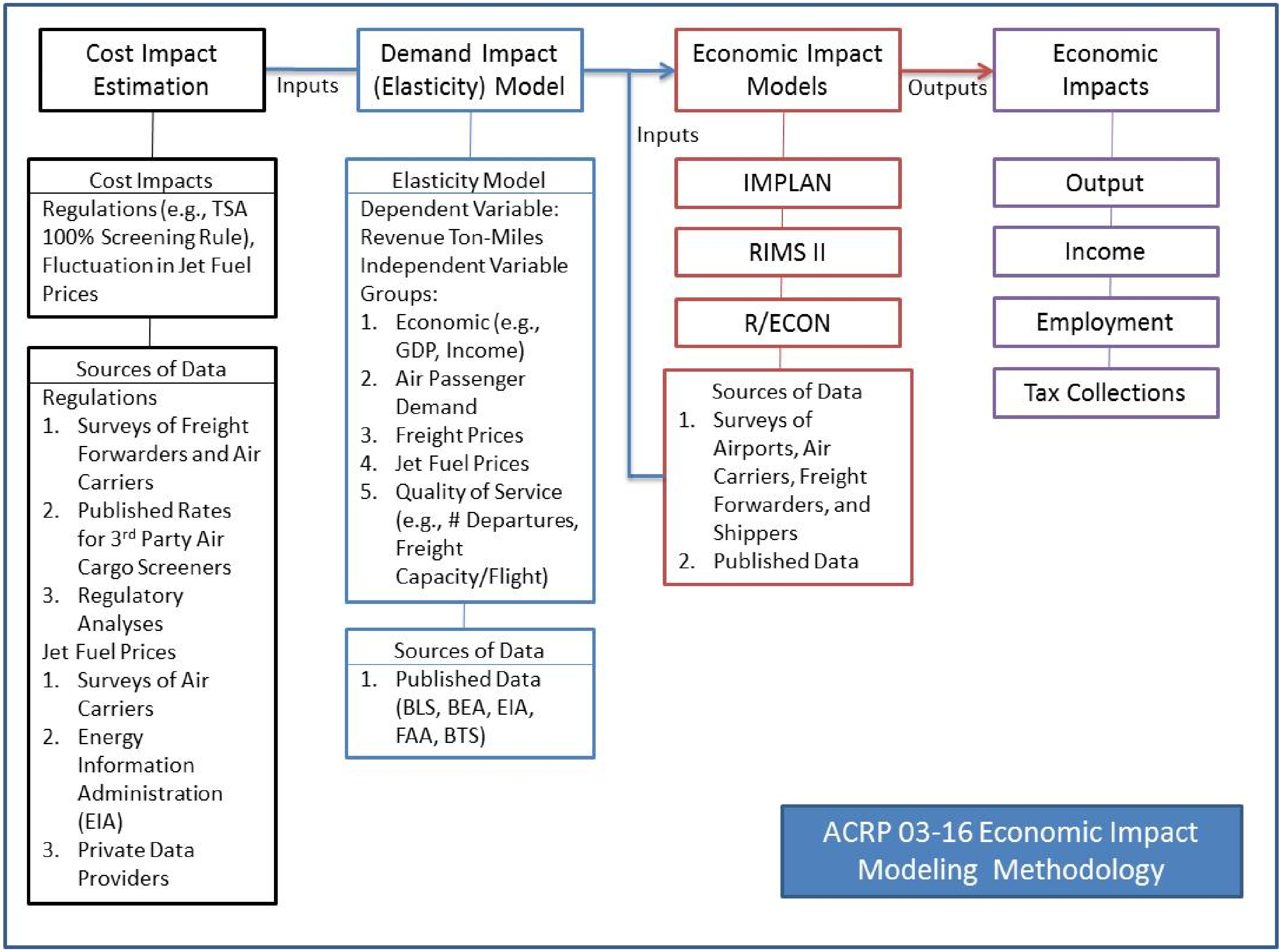

Figure 4. Basic Components of the Analytical Framework

Most of the data related to the direct impact of air cargo services are not readily available from sources released by government agencies either because of disclosure related issues or because they have not been collected. Surveys to airports, air carriers, freight forwarders and air transportation service providers, and shippers were used to help obtain data related to the direct economic impacts such as jobs and wages.

The approach also addresses the economic impacts of the newly implemented rule requiring 100 percent screening of cargo on passenger aircraft and fluctuations in jet fuel prices. The air cargo industry as a whole is responding to the requirements of 100 percent security checks on all air cargo carried by passenger aircraft. This is because the cargo poses a real possible point of attack from terrorists. In addition, the industry continues to face volatile changes in fuel prices. Moreover among transportation modes, air cargo has an inordinate share of costs designated for fuel. Hence, fuel price fluctuations heavily affect the industry's bottom line, forcing them at times to contract their business operations or to compete against specific modes in certain parts of the world. An approach that includes the use of statistical models were developed and are outlined later in this chapter.

Selection of Airports for Case Studies

Prior to carrying out the analytical framework outlined in the previous section, the research team According to FAA, there are nearly 20,000 facilities in the United States that are capable of landing aircraft including helicopters Those facilities are owned and operated either by private or public entities, such as airport authorities, hospitals and medical facilities, cities and municipalities, counties, military, farms, private companies, and others. Among all those facilities, 5,172 are public use airports and 547 are certified to provide service to operators of aircraft carrying more than 9 passengers (FAA 2012).

In 2011, U.S. airports served 807.1 million passengers and handled 57.3 billion pounds of freight (BTS 2012). Most of the air service (83.2 percent of passengers and 88.5 percent of the cargo) was provided by the nation's top 50 airports (ACI 2012). Although the air services supplied by airports were highly concentrated in the nation's largest airports, small and medium airports also were involved and generated substantial economic effects for their local economies.

In selecting a sample of five airports for the case studies, it is certainly critical to understand that air freight and passenger services are dominated by a small number of large airports. Still, it is important to capture the perspective of airports with differing characteristics, since the models deployed for this study must be useful for various types of airports. The selection criteria for sample airports included:

- Geographic dispersion
- Airport characteristics
  - o Major passenger and air freight hub
  - o Specialized airport
  - o Major regional airport.

Below are the detailed discussions of each criterion.

Geographic Dispersion

Four regions as defined by the U.S. Census Bureau are considered for geographic dispersion. Those four regions include:

- Northeast Region that covers New England and Middle Atlantic areas
- Midwest Region that covers East and West North Central areas
- South Region that covers South Atlantic and East and West South Central areas
- West Region that covers Mountain and Pacific areas.

Of the five airports selected, two (IAH in Houston, Texas and SDF in Louisville, Kentucky) are located in the South Region and one is located in each of the remaining regions: JFK (New York, New York) in the Northeast Region, MCI (Kansas City, Missouri) in the Midwest Region, and RNO (Reno, Nevada) in the West Region.

Major Passenger and Air Freight Hub

The air services provided to passengers and air cargo are highly concentrated in large airports in the United States. The large airports or major passenger and air freight hubs with more than one billion pounds of cargo shipments are the key links between markets, producers, suppliers, consumers, and communities, and play a critical role in local, regional, or even national economies. Among those major hubs that carried more than one billion pounds of air cargo in 2008, seven airports were entered into the pool for sample airport selection.

The candidate hub airports included JFK in New York, New York; PHL in Philadelphia, Pennsylvania; ORD in Chicago, Illinois; IND in Indianapolis, Indiana; ATL in Atlanta, Georgia; SFO in San Francisco, California; and LAX in Los Angeles, California. These airports were considered because of the size of their operation, their geographic location across the four census regions, and their similarities with potential alternatives. Among the candidate airports, JFK Airport was selected for the case studies because:

- It is one of the largest airports in the United States and the largest in terms of the volume of air cargo in the Northeast Region

- It managed 47.7 million passengers in 2011, 6^{th} most in the U.S. and most in the Northeast Region (ACI 2012)

- Its ratio of domestic-to-international air cargo shipments is nearly balanced.

Specialized Airports

There are two types of airports that are functionally unique. The first special type of airport is air cargo integrator hubs, which include MEM in Memphis, Tennessee and SDF in Louisville, Kentucky. Integrator hubs primarily focus on air cargo business and are home to intense air freight transshipments. In 2011, the combined volume of air cargo shipments by these two integrator hubs was more than 12.9 billion pounds, or roughly 22.4 percent of the total air cargo shipped by all airports. For the case studies, SDF Airport was selected for the following reasons:

- It is highly specialized and is almost an air freight-exclusive airport. In 2011, passenger enplanements totaled only 1.6 million at SDF, or roughly 38 percent of the 4.3 million enplanements served by MEM (BTS 2012).

- The volume of air cargo handled by SDF Airport ranked 3rd among all U.S. airports.

The second special type of airport is intermediate transferring airports, which includes ANC Airport in Anchorage. This type of airport handles relatively large volumes of air cargo shipment, both outbound and inbound. In terms of volume of shipments, ANC handled approximately 3.1 billion pounds of freight (BTS 2012).

ANC Airport demonstrated a high share (68 percent) of outbound shipments and a low share of inbound shipments for domestic markets, but a low share (32 percent) of outbound shipments and high inbound shipments for international markets. This indicates that ANC Airport was likely a transfer point for a large volume of incoming international air cargo to the U.S. market. This is in line with the observation from international trade data, which show that Asia has sent a great deal more air cargo to the United States than vice versa. While it is hard to underestimate the importance of the this airport, it also should be noted that its characteristics makes it sufficiently unique that lessons learned from it might not be readily applied to other airports. As a result, it was not selected for further case-study work.

Major Regional Airport

Beside major hub/international gateway-type airports, major regional airports also play an important role in passenger travel and air cargo shipments. A major regional airport is defined as an airport that handles between 100 million and 1 billion pounds of air cargo annually. The major regional airport tends to be a hub that heavily influences regional economies.

IAH, MCI, and RNO were selected for the case studies for the following reasons:

- IAH and MCI represent key connecting points between the east and west parts of the United States. Strategically located in the Midwest and South, IAH and MCI play critical roles in the U.S. civil aviation as well as the U.S. economy.

- RNO is located in the West and has a 59 percent share of outbound cargo. A high share of outbound air cargo indicates that the local area either supplies or transfers more products by air to other areas than it receives.

Airports Selected

Based on the criteria set up for selecting sample airports for case studies, the following five airports were selected:

- JFK in New York, NY
- RNO in Reno, NV
- IAH in Houston, TX
- SDF in Louisville, KY
- MCI in Kansas City, MO

These airports represent a sample of major hubs, special types of large airports, and major regional airports in diversified regions. Each airport has its characteristics and specialties, which are summarized in Table 6.

Table 6. Characteristics of Airports Selected for Case Studies

Airport Code	City, State	Selection Criterion	Region	Freight Shipment (million lbs.)	# of Passengers Enplaned (thousands)	% of Outbound
JFK	New York, NY	Hub	NE	2,824.2	23,663.0	44.3
SDF	Louisville, KY	Integrator	S	4,640.0	1,647.5	51.6
MCI	Kansas City, MO	Regional	MW	182.7	5,007.3	50.2
IAH	Houston, TX	Regional	S	919.2	19,303.1	50.4
RNO	Reno, NV	Regional	W	109.3	1,8178.0	59.3

Source: Bureau of Transportation Statistics (2012).

Economic Impact Concepts

This section outlines the decisions that were made prior to estimating economic impacts, including the evaluation and selection of models, definition of the study region and determination of the impacts evaluated.

Evaluation and Selection of Models

Economic impacts generated by air cargo can be classified as direct, indirect, or induced effects. The direct impacts are air cargo activities or changes in them that are usually related in terms of operation and transportation costs. Although the measurement of the direct impacts may be straightforward, intensive research is needed to ensure the coverage and quality of measurement. The indirect economic impacts reflect changes in industrial productions throughout the economic system that are caused by the direct economic impacts such as changes in transportation costs. The induced economic impacts reflect changes in personal income caused by changes in industrial production. Both the indirect and induced economic impacts demonstrate how the direct impacts reverberate through an economy. The estimation of the indirect and induced economic impacts requires an economic tool/model that can catch repercussions that are caused by the direct impacts.

This section of the report discusses the following topics:

- Types of tools/models that are capable of conducting economic impact analysis
- Advantages and disadvantages of the models
- Selection of tools for economic impact analysis of air cargo.

Types of Tools and Models

Four types of economic models have been commonly used for economic impact analysis. The first type of model is the input-output (I-O) model, including the frequently used regional versions of it that are available under the rubrics of IMPLAN, RIMS II, and R/ECON. Though I-O models have the disadvantage of being static including fixed technology over time, their structure is relatively easy to understand and their limitations are well-defined and known when it is compared to other economic models. The IMPLAN model is a commercially available I-O model and is produced by Minnesota IMPLAN Group, Inc.[9] The RIMS II model is generated and maintained by the Bureau of Economic Analysis (BEA) of the U.S. Department of Commerce.[10] The R/ECON model is maintained by Rutgers University.[11]

There are proprietary economic forecasting and simulation models which are more much more complex and often include an I-O model to describe detailed industrial production processes. Compared to a typical I-O model such as the IMPLAN model, these types of models are dynamic and generates annual forecasts with or without the direct impacts introduced into the model by users. Other features of these more complex models include interactions between income and expenditures and price/cost responses that play a role in determining the supply and demand on labor, product, and other markets (Treyz, Rickman, and Shao 1992; Treyz 1993).

The third type of economic model is the computable general equilibrium (CGE) model. In economic theory, a market for a commodity reaches equilibrium when its supply and demand are equal. When supply and demand in all the markets–commodities, labor, capital, and other inputs–attain equilibrium simultaneously, an economic system reaches a “general equilibrium.” Implementing this concept through a mathematical modeling, CGE models have been developed by expanding the I-O framework along with a set of constraining behavior equations and elasticities permitting some degree of substitution across commodity-industries (Shoven and Whalley 1992). Although theoretically sound, there are many difficulties involved in developing off-the-shelf and commercially available CGE models. As a result, CGE models tend to only be used by their builder-analyst. Therefore, details on the practical guidance of CGE models will not be discussed in the following section.

The fourth type of model is structural econometric time-series (SETS) models. The capabilities of SETS are limited only by the equations the builder wants or is able to build with historic data. Moreover, the economic interrelatedness among the equations in the model forms its structure of inter-industry relationships. The development of the equations in the model is as

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[9] http://www.implan.com.
[10] http://www.bea.gov/regional/rims/index.cfm.
[11] http://policy.rutgers.edu/cupr/recon/about3.php

much art as it is economic science. Due to the unique characteristics economics, relationships are not typically transferable from one economy to the next. Hence, economic impact analysis using SETS models typically must be performed by the models' builders, who best understand the integrity and stability of the models. Because of that, pragmatic details related to this type of models will not be offered in the next section.

Advantaged and Disadvantages of Widely Used Tools/Models

I-O Models. I-O models are built to benchmark the gross domestic product (GDP) and constitute a double-accounting approach, where GDP is estimated through a set of expenditure accounts (spending by government, households, and private capital investment) and a set of income accounts (indirect business tax revenues, labor income, profits, dividends, interest, rents). I-O models tend to operate on the part of the input-output accounts that do not articulate GDP. That is, they work on the inter-industry transactions that are subtracted from industry net receipts to arrive at GDP. Interestingly, GDP itself then is essentially derived as a remainder since some individual components of GDP (e.g., private capital investment and corporate profits) must ultimately be interpolated.

The U.S. national benchmark I-O accounts contain interrelationships for more than 400 industries and are released by BEA. Built upon BEA's benchmark I-O models, all of the I-O models evaluated here (IMPLAN, RIMS II, and R/ECON) are regionalized I-O models that cover either a single state/county or a combination of states/counties. In general, in producing regional I-O models, its vendors generally assume that national average technology prevail everywhere in the nation. Regional specificity can be derived, but these models focus on accounting for the relative size of a region's industries compared to their national counterparts as well as each regional industry's ability to fulfill local demand for its product. By focusing on just these forms of regionalization, constructing a regional I-O model is a relatively inexpensive venture, although it is quite data intensive. The obvious alternative, creating a survey-based equivalent, is quite cost prohibitive. Still, regional I-O models that adjust for state-level productivity differences and that use more sophisticated means of estimating interregional trade do exist.

The I-O models yield total impacts (direct, indirect, and induced) in terms of jobs, net business receipts (output), and GDP contribution, which is often broken out into its various components. These most often include at least labor income and indirect business taxes. Each of these measures can be articulated for each of the 400 plus industries, although they are typically aggregated into more readily viewed and comprehended formats.

IMPLAN offers software that is fairly easy to use and that is well documented. RIMS II only provides multipliers and a spreadsheet with a total requirements matrix that yields impact results for only about 20 industries, although the direct effects can be articulated using 400-sector detail, according to the RIMS website. R/ECON is available on a fee-for-service basis. The cost of purchasing IMPLAN data varies depending on the configuration of the region to be modeled, though the cost for software is fixed. For many applications, the price for the combination of a model and concordant data is within a relatively affordable range. To receive the multiplier report generated by the RIMS II model, users order online at BEA's website and pay a small fee.

As mentioned in the previous chapter, the limitation that I-O models are unable to effectively capture price effects (if at all), argues against their general use. Indeed, examples that I-O models are most commonly used include estimating (1) a single typical years' worth of economic impacts of a spending program stream and (2) the impacts of the installation/construction portion only of an investment in infrastructure for which a spending schedule is not yet known.

Selection of Tools for Economic Impact Analysis of Air Cargo

Selecting an economic tool/model that is appropriate for economic impact analysis for air cargo requires finding a balance between modeling flexibility, model structure, industry detail, model capabilities, practitioner sophistication and price. So it should come as little surprise that models capable of handling a wider array of applications are typically more expensive. Likewise, those models containing industry production and household consumption functions that are tailor-made to a specific economy are also more expensive. Hence, different applications call for the use of different models.

Even for a particular model two other parameters also influence a model's price: the number of industries and the number of regions that the model should include. Regional coverage can vary and depends on users' needs, which are typically based on the intended audience or sets of audiences for which the analysis is being performed. More regions cost more than less: this is especially poignant to model builders. In the same vein, for a model of a given genre, a construct with more sectors costs more. Both greater spatial and sectorial detail impinge favorably on the quality of the results that are obtained. Lahr and Stevens (2001) have shown how large proportional error can result from the use of overly aggregated regional economic models, and Robison and Lahr (2005) have demonstrated how spatial misspecification can also lead to erroneous results. This research shows that it is important to obtain regional economic models that provide industry detail and model on interactions among functional economic areas, as opposed to strictly political ones.

In addition, there are two cost-related issues that can have major influence on the decision of selecting an economic tool. First, there is the obvious leasing/purchasing price (or production costs) for the tool. Second, it should be aware that considerable additional investment in both time and money may be necessary once the tool is in hand. This is the set of costs involved in training (and hiring) staff to use the tool. The additional investment can be quite significant for a tool with such complex modeling. They also require considerable time and effort to operate comfortably and to learn how to properly analyze and interpret the results that it delivers.

From the modeling perspective, an I-O model such as the IMPLAN, RIMS II or R/ECON is straightforward. But I-O models have no ability to examine the impact of price changes or to provide annual forecast for the economic response that it estimates. It is fairly clear that most issues facing the air cargo industry are likely to experience shocks in its costs, such as changes in transportation costs, fuel prices, and changing regulations. Hence, it appears critical that an economic impact analysis of air cargo services be able to handle issues that will handle changes in the industry's pricing and cost structures.

In this vein, the SETS and CGE models would work for an analysis of the industry. All three can estimate impacts caused by changes in prices and costs. All require specialized economic knowledge and extensive training. Compared to CGE and SETS models, there are proprietary models available on the market which are readily available with off-the-shelf software and databases.

In sum, the selection of an economic tool/model for economic impact analysis of air cargo should satisfy the following criteria:

- Be able to describe the interactions and interrelationships between economic players, such as industries, consumers, and governments
- Be able to report the impact results in terms of industrial output, gross domestic product, employment, and personal income
- Cover regions and industries at a desirable level
- Provide user-friendly software and off-the-shelf datasets
- Rental/purchasing price within an affordable range.

The first two criteria relate to capabilities of the models, while the last three criteria also play an important role in selecting an economic tool. Thus, three I-O models were selected to examine the economic impact of air cargo for the case studies.

Selecting a Study Region

Airports play an essential role in supporting the growth of a metropolitan economy. They directly employ hundreds of workers and provide millions of dollars in direct economic activity and taxes, and other revenues to local government. They also support the growth of the regional economy by moving people, goods, and services in, or are transported through the region, in response to its market opportunities. Airports and related aviation facilities become structurally integrated into a region's economy and provide it with competitive advantages. Airports enable industries that either depend on, or learn to take advantage of, efficient air transportation to access domestic and international markets.

In determining a study region, in all cases the research team began with the counties within the Metropolitan Statistical Area (MSA) within which each airport is located. The study region is defined at the county level because the datasets underlying each of the I-O models reside at that level. For MCI, that included 15 counties located in Missouri and Kansas. For SDF, it included an eight-county region in Kentucky and Indiana. The IAH analysis covers a ten-county region entirely within Texas. The JFK study region includes the 23-county Ney Work-Northern New Jersey-Long Island MSA. Finally, the RNO study region includes only Washoe and Storey counties in Nevada. Appendix C contains a detailed listing of each county included in the case studies.

Tools and Techniques Used in the Case Studies

Measuring the economic impact of the cargo activity at the airport involves tracing the linkages between the airport's cargo activity level, expressed in terms of airport operations and air cargo volumes, and the sectors of the economy that interact with them. These linkages produce the "direct," or initial round of economic impact. Direct impacts, in turn, stimulate "indirect" impacts, from the supply of goods and services to businesses at the airport or production of goods for shipment by air. A third round of economic impacts, called "induced" impacts, results from the spending of income earned by direct and indirect employees. The sum of indirect and induced impacts is often referred to as the "multiplier effect" on direct impacts. Total economic impact is the sum of the direct, indirect, and induced impacts.

Data Collection and Preparation

As the first step of the analytical framework, it is necessary to identify data needed for the economic impact analysis. The data identified will help analysts recognize specific data items to be used in the analysis. Following are the key data items that are needed to produce a proper economic impact analysis:

- Jobs and wage related to air cargo services from the participants of the air cargo industry such as freight forwarders/3PLs, airports, airlines, and others at the selected airport
- Air cargo shipments in tons handled by the industry participants such as freight forwarders/3PLs
- Commodities shipped by air and other modes
- Revenue related to air cargo business from the industry participants such as airports and freight forwarders/3PLs
- Industry concentrations within the defined study region.

Once the data items needed for an economic impact analysis and the sources for them are identified, the next step is data collection. Data collection consists of two main activities: (a) conducting surveys that includes design of surveys, sample selection, and interviews; and (b) gathering data from existing data sources.

Surveys

Surveys are an important tool for collecting missing data, i.e., information not collected and released by government agencies. Questionnaires, which are survey instruments, were designed to collect data from airport operators, air carriers, freight forwarders, and shippers. Though specific questions varied by organization, the questionnaires were designed to gather information related to the following issues: organizations' associations with and contributions to air cargo at an airport and responses by organizations if the airport shuts down air cargo services, new and proposed security and other regulations, and changes in fuel prices.

Before designing a sample framework for the surveys, it was important to define the catchment area that covered by an airport for air cargo services. Organizations and companies located in the catchment area were identified to inform each case study. However, unlike passenger catchment areas, which can generally be defined by their own metropolitan area plus a radius of certain miles, the decisions of airport use by air cargo shippers/consignees are typically driven by the service and capacity of airlines and location of forwarders to handle their product. The catchment area for each case study is defined in the case study reports presented in Appendix C. The remainder of this section summarizes the survey responses received at each airport. Appendix B presents the surveys used for each surveyed group.

Kansas City International Airport, Kansas City, MO. The Air Service Development Department for the Kansas City International Airport (MCI) responded to the airport survey and provided air cargo statistics from 1999 through 2010. Data included volume by inbound/outbound (all domestic), and by airline. Volume by commodity code was also provided for one calendar year. The Airport also provided a 2006 economic impact study and the number of badged employees by airline and ground handler.

The team obtained completed surveys from eight passenger carriers, which represent 7 percent of the airport's cargo volume. However, of the two largest express carriers, which carry 87 percent of the air cargo at MCI, neither provided detailed survey response as they considered the requested information to be proprietary. Since the large express carriers refused to provide information, the economic analysis relied on the air cargo volume information provided by the Airport. Also, two freight forwarders completed surveys, however the amount of time necessary to complete this survey was discouraging to freight forwarders as they did not perceive any benefit to spending time on the survey instead of their own work responsibilities that help achieve their firm's business goals. After discussions with the economists, it was determined that employment information was the only data needed from freight forwarders, thus it was estimated from online research, and confirmed with Airforwarders Association, that approximately 18 employees work for freight forwarders serving MCI.

KC Smartport (www.kcsmartport.com) provided information on the local region's economic development. Several shippers were identified; however, despite several attempts, none of the local area shippers were able to provide useful information for or participate in the project. Instead, employment information directly related to air cargo services at MCI were estimated KC Smartport information.

Louisville International Airport, Louisville, KY. The Public Relations department for Louisville International Airport (SDF) responded to the airport survey and provided 2009 and 2010 volume by inbound/outbound (combined domestic/international) and by airline. SDF staff also provided a summary brochure of an airport economic impact survey completed in 2009, as well as station manager contact information for all airlines, federal government agencies, and local cargo-related business entities.

The team completed surveys from five passenger carriers and UPS, representing over 98 percent of the cargo volume. Also, three freight forwarders completed surveys, and employment data were obtained from the major third-party ground handlers. Customs and Border Protection also provided employment information.

Greater Louisville, The Metro Chamber of Commerce (www.greaterlouisville.com), and the University of Louisville's College of Business provided excellent support in identifying nearby businesses that are large shippers at the airport. For example, the local groups confirmed that several businesses and distribution centers made their decisions to locate in nearby Shepherdsville based in part on the proximity to the airport and UPS.

George Bush Intercontinental Airport, Houston, TX. The Air Services group within the Commercial Development Department at George Bush Intercontinental Airport – Houston (IAH) – responded to the airport survey and provided 2009 and 2010 volume by inbound/outbound, by domestic/international, by commodity, and by airline, as well as forecast growth. IAH staff also provided telephone contacts for all cargo airlines serving IAH and other related businesses as well as extensive market information on IAH's cargo reach. IAH staff also sent an email introduction to all airport cargo contacts regarding the importance of the study and encouraging their participation.

In efforts to gather as many surveys as possible, the research team attended a monthly meeting of the Houston Air Cargo Association (www.aircargohouston.org). The team completed surveys from nine carriers, representing 18 percent of the cargo volume. As a follow-up, the team then requested employment information and obtained that data from another ten carriers and four third-party ground handlers. Overall, the employment figures obtained represent approximately 60 percent of the airport's cargo volume.

Also, two freight forwarders completed surveys, however the amount of time necessary to complete this survey was discouraging to freight forwarders as they did not perceive any direct benefits from completing the survey. After discussions with the economists on the research team, it was determined that employment information was the only data needed from freight forwarders. Thus, it was estimated from online research, and confirmed with the Airforwarders Association, that approximately 194 employees work for freight forwarders serving IAH.

Other information provided by the Airport includes current rates and charges, numbers of badged employees by company, the 2003 IAH Economic Impact Study (Campbell-Hill Aviation Group and Craig 2004) and operating instruction for aircraft utilizing the air cargo ramp at IAH.

John F. Kennedy International Airport, New York, NY. The Port Authority of New York and New Jersey (PANYNJ) Air Cargo Business Development responded to the airport survey and provided air cargo volume for 2001-2009 for John F. Kennedy International Airport (JFK). The 2009 data were provided by in great detail, including ranking by airline (domestic/international), exports/imports by weight, and exports/imports by value. PANYNJ staff also provided major air freight forwarders who work at JFK. Finally, PANYNJ also provided their 2005 economic impact report (PANYNJ 2005).

In efforts to gather as many surveys as possible, the research team attended a monthly meeting of the JFK Air Cargo Association (www.jfkaircargo.org). The team completed surveys from five carriers, representing less than 10 percent of the cargo volume. As a follow-up, the team then only requested employment information and obtained that data from another seven carriers and all eight third-party ground handlers. Overall, the employment figures obtained represent over 70 percent of the airport's cargo volume. Also, 11 freight forwarders completed surveys; it is estimated from online research, and confirmed with the Airforwarders Association, that approximately 600-800 freight forwarder companies serve JFK.

Reno-Tahoe International Airport, Reno, Nevada. The Air Service and Cargo Development department for Reno-Tahoe International Airport (RNO) responded to the airport survey and provided 2010 volume by inbound/outbound (all domestic) by commodity and by airline, as well as forecast growth and estimates of elasticity by metric tons. RNO staff also provided a summary of their *International Air Cargo Study* which analyzed the level of regional air trade and provided excellent background information on the location of RNO's cargo origination demand.

The team completed surveys from three carriers which represents 64 percent of the airport's cargo volume. Also, four freight forwarders completed surveys; it is estimated from online research, and confirmed with the Airforwarders Association, that eight forwarders work at RNO. Thus, the completed surveys represent 50 percent of the freight forwarders at the airport.

Through the local Reno Sparks Chamber of Commerce (www.renosparkschamber.org/) and the Economic Development Authority of Western Nevada, EDAWN (www.edawn.org), several large shippers were identified in the RNO area, including several distribution centers. Despite numerous attempts, none of the local area shippers were willing to participate in the project. Instead, employment was estimated from information provided by the chamber of commerce and EDAWN.

Data Preparation

As noted earlier, the first and most obvious source of airport-related economic impacts is the employees who work there. Those associated with air cargo include airlines handling cargo, third-party cargo-handling companies, customs agents, TSA, customs brokers, container freight stations, freight forwarders, trucking companies, and other cargo-related services.

Employment data at the airports can be obtained through the airport authority based on the number of employees with security badges. Additional data are then supplemented through the project surveys of air carriers and third-party cargo handling companies. These combined data yield cargo-related employment estimates. The employment levels estimated using this approach for IAH are presented in Table 7. When these direct employment numbers were run through the IMPLAN model, the model estimated total direct, indirect, and induced employment at 3,431 with a total annual output of $617.7 million.

Table 7. Estimated Employment by Industry Group, IAH (2010)

Industry	Estimated Employment
Transport by Air	726
Support Activities for Air Transportation	439
Couriers and Messengers	686
Total	**1,851**

When estimating cargo-related employment, it is important to note that there are instances when single employers will have a significant regional impact. For example, SDF is a major hub of express freight, with over 20,000 UPS employees based in the Louisville region. Though UPS had a hub in Louisville since 1980, it was in 2002 that the company made its first $1 billion expansion, establishing Louisville as "Worldport", the company's worldwide air hub. A second $1 billion expansion was completed in April 2010, bringing its facility to 5,200,000 square feet, with capacity to handle 416,000 packages per hour (UPS 2011).

More difficult to quantify is the contribution of air cargo to the regional economy. However, it is generally agreed that industries are concentrated within regions with direct access to air cargo operations. In the absence of this access, companies that rely on these services would likely re-locate to other regions with such access.

Given the lack of data, one approach is to utilize the linkage of interdependence between businesses, industries and clusters. One tool common with cluster analysis is to study the Location Quotient (LQ), which measures industry concentration in a regional economy. It does so by comparing the ratio of employment in a certain sector of a local economy to the same ratio in a comparison economy, identifying specializations in the local economy. An LQ value of 1.0 indicates that employment in an industry in the regional economy is exactly the same proportion as the national average, while an LQ value greater than 1.0 indicates that employment in that industry has a higher concentration than that of the reference economy.

One approach is to attribute the portion of the industry exceeding an LQ of 1.0 to the presence of air cargo operations. However, Stevens, Treyz, and Lahr (1989) found that the portion of industries with LQs in excess of 0.3 should be included in the assessment of economic impacts. The remainder of this section outlines the approach used to evaluate the economic effects of cargo-dependent industries with shipments originating at JFL.

The first step was to identify total air exports from the New York portion of the MSA. The best and most complete publicly available data on trade for subregions of U.S. states are widely known to be Version 3 of the Freight Analysis Framework (FAF^3) Origin-Destination Data, which are available online from the U.S. Department of Transportation.[12] Table 8 shows the total weight and value of goods shipped by air from the New York portion of the NYC MSA.

[12] Last accessed in June 2012 at http://www.ops.fhwa.dot.gov/freight/freight_analysis/faf/. For details on how the FAF^3 data are estimated see Southworth et al. (2010) at http://faf.ornl.gov/fafweb/Data/FAF3ODCMOverview.pdf.

Table 8. Total Air Exports from NY Portion of NYC MSA, 2007

SCTG	Total Out Air	Total Tons in 2007 (Thousands)	Total M$ in 2007	Air Share (Value)
1	Live animals/fish	11.3	$176	68.8%
2	Cereal grains	0.0	$0	0.0%
3	Other ag prods.	5.1	$47	0.5%
4	Animal feed	1.6	$18	2.5%
5	Meat/seafood	1.0	$8	0.1%
6	Milled grain prods.	0.5	$1	0.0%
7	Other foodstuffs	10.5	$45	0.3%
8	Alcoholic beverages	1.7	$17	0.2%
9	Tobacco prods.	1.0	$6	0.2%
13	Nonmetallic minerals	2.2	$4	1.6%
14	Metallic ores	0.9	$21	58.8%
19	Coal-n.e.c.	1.9	$4	0.1%
20	Basic chemicals	16.0	$822	30.0%
21	Pharmaceuticals	12.5	$2,383	7.9%
23	Chemical prods.	49.5	$1,314	16.2%
24	Plastics/rubber	27.5	$689	6.2%
26	Wood prods.	1.9	$10	0.2%
27	Newsprint/paper	0.7	$1	0.1%
28	Paper articles	13.7	$68	2.5%
29	Printed prods.	19.1	$452	4.4%
30	Textiles/leather	24.8	$890	2.2%
31	Nonmetal min. prods.	9.4	$214	7.1%
32	Base metals	33.5	$323	5.7%
33	Articles-base metal	37.3	$677	5.5%
34	Machinery	79.4	$9,470	20.7%
35	Electronics	51.9	$8,225	26.7%
36	Motorized vehicles	8.5	$252	1.4%
37	Transport equip.	7.0	$3,511	75.2%
38	Precision instruments	31.6	$6,017	34.0%
39	Furniture	2.6	$82	1.4%
40	Misc. mfg. prods.	17.0	$24,364	41.0%
43	Mixed freight	1.9	$199	1.2%
	Total	483.7	$60,310	14.5%

To meaningfully employ the FAF3 data, Quarterly Census of Employment and Wages (QCEW) were matched to Standard Classification of Transported Goods (SCTG) categories used by FAF[3] (Appendix D provides a NAICS to SCTG crosswalk). Table 9 resulted from these calculations. Note that less than 6 percent of all employment and payroll reported in Table 9 for the New York portion of the New York City MSA is in sectors producing those commodities.

Table 9. Employment and Payroll of Commodity-producing Industries by Commodity, New York State portion of NYC Metropolitan Area, 2007

SCTG	Description	LQ	Emp.	Payroll
1	Live animals/fish	0.21	1,489	$67,459,095
2	Cereal grains	0.01	9	$313,142
3	Other ag prods.	0.09	3,518	$114,126,711
4	Animal feed	0.18	569	$40,136,638
5	Meat/seafood	0.15	3,498	$175,169,538
6	Milled grain prods.	0.22	2,922	$104,804,942
7	Other foodstuffs	0.44	16,088	$904,859,929
8	Alcoholic beverages	0.39	1,386	$99,556,465
9	Tobacco prods.	2.28	156	$216,797,013
10	Building stone	0.40	709	$36,701,908
11	Natural sands	0.12	349	$25,576,641
12	Gravel	0.44	272	$12,390,538
13	Nonmetallic minerals	0.06	49	$4,374,383
14	Metallic ores	1.23	2,543	$270,136,299
15	Coal	0.00	0	$0
16	Crude petroleum	0.01	377	$36,284,079
17	Gasoline	0.00	22	$1,913,800
18	Fuel oils	0.00	0	$0
19	Coal-n.e.c.	0.34	931	$111,528,579
20	Basic chemicals	0.21	1,433	$119,152,224
21	Pharmaceuticals	0.67	15,693	$1,247,241,929
22	Fertilizers	0.05	110	$5,279,624
23	Chemical prods.	0.41	6,012	$466,855,355
24	Plastics/rubber	0.28	9,567	$645,602,769
25	Logs	0.01	55	$2,208,505
26	Wood prods.	0.20	4,482	$205,309,182
27	Newsprint/paper	0.34	3,016	$267,105,167
28	Paper articles	0.43	5,153	$312,156,461
29	Printed prods.	0.47	11,680	$615,971,776
30	Textiles/leather	1.39	26,189	$1,408,427,481
31	Nonmetal min. prods.	0.38	4,541	$324,702,646
32	Base metals	0.39	5,765	$542,462,439
33	Articles-base metal	0.31	21,694	$1,216,749,349
34	Machinery	0.28	13,278	$1,037,817,034
35	Electronics	0.44	25,338	$2,375,145,863
36	Motorized vehicles	0.26	9,550	$719,227,279
37	Transport equip.	0.48	12,881	$1,535,496,275
38	Precision instruments	0.38	17,234	$1,396,006,181
39	Furniture	0.48	8,221	$386,109,983
40	Misc. mfg. prods.	0.81	14,610	$804,782,303
41	Waste/scrap	0.00	0	$0
43	Mixed freight	0.25	147	$6,510,656
	Total		251,536	$17,862,450,181

Moreover, Table 9 shows that most of the industries have payroll location quotients that are substantially lower than 1.0, the threshold typically used to identify industries that export. The list of exported commodities does not appear to be closely connected to production in the local economy, suggesting again that many of the goods exiting from JFK have their origins outside the study region.

Table 10 shows payroll of the production sectors that were identified as producing goods for export via air freight. As described above, these are aggregate QCEW sectors related to the commodities shipped that have a location quotient greater than 0.3. The “air base payroll” is calculated by taking the portion of the total sector payroll beyond the 0.3 threshold and then the percentage of that commodity that is shipped by air. The data in Table 10 were then used to estimate the total economic impacts of JFK air cargo outflows on the entire New York metropolitan area.

Table 10. Portion of Commodity-producing Industries Directly Related to Air Freight, New York Portion of NYC MSA

SCTG	Description	M$07 Air	Air Share $$	LQ	Air Base Payroll
7	Other foodstuffs	$44.8	0.3%	0.44	$1,040,526
8	Alcoholic beverages	$17.3	0.2%	0.39	$74,492
9	Tobacco prods.	$6.2	0.2%	2.28	$310,873
14	Metallic ores	$21.5	59%	1.23	$127,847,192
19	Coal-n.e.c.	$4.2	0.1%	0.34	$31,426
21	Pharmaceuticals	$2,382.6	7.9%	0.67	$59,613,934
23	Chemical prods.	$1,314.0	16.2%	0.41	$40,355,620
27	Newsprint/paper	$0.7	0.1%	0.34	$87,850
28	Paper articles	$67.8	2.5%	0.43	$2,049,620
29	Printed prods.	$452.2	4.4%	0.47	$11,048,581
30	Textiles/leather	$889.6	2.2%	1.39	$24,547,022
31	Nonmetal min. prods.	$214.2	7.1%	0.38	$8,583,580
32	Base metals	$323.5	5.7%	0.39	$14,115,803
33	Articles-base metal	$676.7	5.5%	0.31	$12,371,578
35	Electronics	$8,224.6	26.7%	0.44	$259,300,819
37	Transport equip.	$3,511.0	75.2%	0.48	$647,811,775
38	Precision instruments	$6,016.6	34.0%	0.38	$173,109,521
39	Furniture	$82.4	1.4%	0.48	$2,398,472
40	Misc. mfg. prods.	$24,363.6	41.0%	0.81	$171,630,950
	Total				$1,556,329,635

Economic Impact Model Preparation

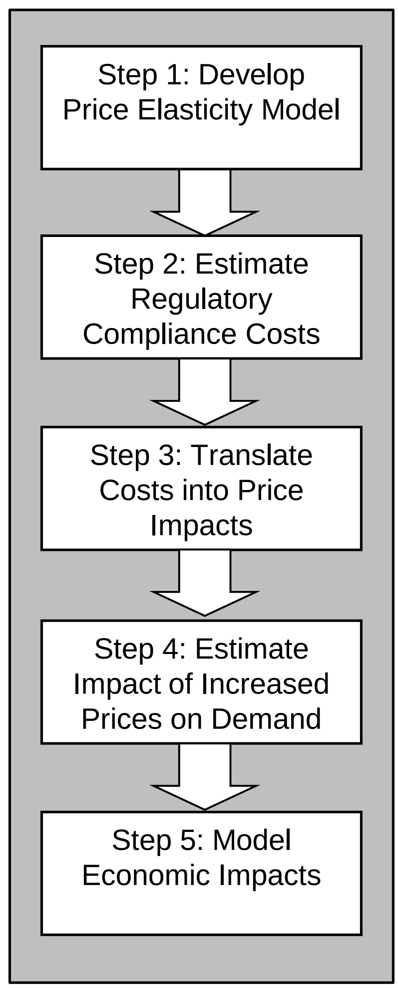
All three of the aforementioned I-O models were used to examine economic impacts for the selected airports in the case studies. More specifically, RIMS-II was used for MCI, IMPLAN was used for SDF and IAH, and the R/ECON model was employed to estimate the economic impacts of air cargo at RNO and JFK. The preparation of economic tools/models includes defining regions to be covered by the models, as well as renting/purchasing the models. Region definition was addressed previously in this chapter.

The I-O models can be built for any regions composed of counties, and all require users to specify the regions of analysis before renting/purchasing. Therefore, the first action is to define the regions, which can be a single county or a combination of counties to be covered by the models. Once the regions are defined, the model vendors need to be contacted for renting/purchasing the models.

Before use in economic impact analysis, economic tools and models must be tested for several reasons. First, bugs can turn up in the economic tools/models. They tend to be produced in low-volume with somewhat frequent updates. Testing it will ensure that it has the capabilities promised by the model vendors. Second, users can make sure they fully understand how to use the model and interpret its results when they are not under the pressure of project deadlines. Third, the data related to the direct impact such as the opportunity costs need to feed in and run through the models to test the validity of the models. Fourth, tests can reveal whether additional data are needed for a complete economic impact analysis.

Estimating Demand Elasticity

Air Cargo is an important mode of transport for goods within the United States. The role of air cargo in the nation's supply chain has continued to expand in recent years, with system revenue freight ton miles expanding from 7.0 billion in 1996 to more than 28.8 billion in 2011 (BTS 2011). The nation's growing reliance on air cargo, however, does not come without some uncertainty. Two issues that have raised concern within the industry in recent years are the implementation of the Transportation Security Administration's (TSA) 100 percent air cargo screening rule and jet fuel price volatility.



In estimating the economic impact of the TSA 100 percent screening rule, which requires a security screening of all cargo transported in the belly of passenger aircraft, the research team developed a five-step approach. The five-step approach is outlined both in the steps below and the graphic to the right. This graphic will be used to guide you through the steps outlined in this section. As each step is addressed, the corresponding step in the graphic will be shown in black with white text. The five-step approach is as follows:

Step 1. Develop a statistical price elasticity model relating the quantity of air cargo services demanded to certain economic variables, including shipping prices, to model the potential impacts of the TSA 100 percent screening rule as well as those associated with other future regulations.

Step 2. Develop an approach for estimating the costs associated with the 100 percent screening rule.

Step 3. Translate these costs into price impacts.

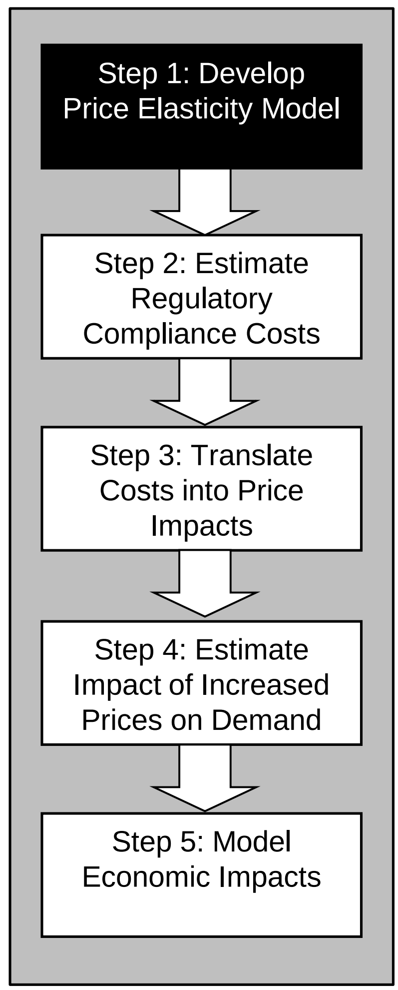
Step 4. Using the price elasticity model, estimate the impact of the upward price pressure on the demand for air cargo.

Step 5. Model the economic impacts of the reduced demand for air cargo, increased shipping prices, and increased use of air transportation support industries using the input-output (I-O) models in order to determine the direct, indirect, and induced economic effects of the 100 percent screening rule as these associated costs ripple through the local economies.

This approach was tested at each of the five case study airports: Houston, Texas (IAH), New York City, New York (JFK), Kansas City, Missouri (MCI), Reno, Nevada (RNO), and Louisville, Kentucky (SDF). A second model was prepared to estimate the demand response to changes in jet fuel prices. This second model was requested to support airports’ efforts to better understand the demand and economic impacts associated with diesel fuel price volatility. This section outlines the models and associated findings.

Air Cargo Price Elasticity of Demand Model

The data collected in support of the air cargo price elasticity of demand model captured 50 variables, and was obtained from a number of sources, including the Bureau of Economic Analysis (BEA), Energy Information Administration (EIA), Bureau of Transportation Statistics (BTS), Bureau of Labor Statistics (BLS), and Association of American Railroads (AAR). Broadly, the variables fell into the following categories:



- Economic indicators including gross domestic product (GDP) and national income
- Price data including jet fuel prices, consumer price index (CPI), and price/revenue per ton-mile of air freight
- Price data from competing modes including the general freight trucking producer price index (PPI)
- Quality of service variables including flight stage length.

The dependent variable used in the model is the sum of international and domestic freight enplaned as measured in pounds. All of the data series were reported at a quarterly interval with the most complete covering 1991 through 2010. In all, 79 observations were used in constructing the models detailed in this section of the report.

A thorough exploration of the data was performed and a pronounced data anomaly was discovered in the domestic cargo volume variable. An inquiry was made to the US Department of Transportation (US DOT) and the research team was informed that there was a change in reporting regulations beginning in October 2002. Prior to October 2002, carriers did not report nonstop segment and market data. There was, therefore, no information between city pairs. Following changes made to reporting regulations, domestic freight tonnage grew significantly. A dummy (i.e. flag or indicator) variable was designed to address the impact of the anomaly.

Even with the rich data available, one derivation and a few simple transformations were necessary. The transformations were log transforms and were taken of the dependent and key independent variables. The derivation was needed to provide an air cargo price variable. The air cargo price variable was calculated by simply dividing the aggregate cargo revenue by the total cargo ton-miles and then correcting for inflation and hence deriving a real air cargo operating revenue per ton-mile.[13] This variable turned out to be quite significant in the resulting national model.

A small number of binary flag variables were created to indicate quarters with uncommon behavior (like the aforementioned data anomaly) or to account for seasonality. Many of these variables were significant and were included in the final models. Some variables were squared and raised to the fourth power (e.g. jet fuel price) to better model nonlinearity. However, none of these higher power variables were significant.

A number of cross terms or interactions were tested for significance. Although some of these interaction variables were predictive of cargo volume, their relative contributions did not justify the lower model interpretability attendant to these terms.

Model Results

The final models discussed in this report were only a few of many candidate models tested that utilize many variable permutations and various statistical techniques. A linear regression technique was employed using log transformed input variables. Although these regression models are linear in their parameters, they are in fact log-log models since the input variables are all log transformed. Some exploratory data analysis was performed to tease out variables which accomplished two primary objectives: 1) find variables that had practical and reasonable interpretability, and 2) identify variables that would contribute to the best-fitting model possible given the data.

The model selected for use included the real air cargo operating revenue per ton-mile (essentially real air cargo price) as an independent variable. This real air-cargo operating revenue per ton-mile variable is of significance because its coefficient will determine, at the national level, the elasticity (or relationship) between the price and demand of air cargo. Besides the two flag variables addressing seasonality and the aforementioned data anomaly, there were two other inputs selected: log-GDP (real), and log-air cargo operating revenue per ton-mile(real).

[13] Revenue was used as a proxy for price due to the absence of direct air cargo price data. Revenue is equal to price in this case, however. Price effectively represents the cost to the consumer while revenue is the payment from the consumer to the service provider.

The parameter estimates in Table 11 give the observed relationship between air cargo demand and the selected explanatory variables. Of the four selected inputs (not counting the intercept), two are positive and two are negative in sign indicating a positive or negative correlation, respectively, with air cargo demand. As expected, the air cargo operating revenue per ton-mile parameter estimate was negative in sign. One of the flag variables helped the model better fit the aforementioned data anomaly, and the other one was the 1st quarter flag. This latter variable was negative in sign indicating a decrease in air cargo shipments in the 1st quarter. The model output suggests that the long-run price elasticity of demand for air transport is -0.501. Thus, for every 10 percent increase in air cargo prices, air cargo demand would be expected to fall by approximately 5.01 percent. This finding is below the surveyed range (-0.80 to -1.60) presented in Oum et al. (1990) and is significantly less elastic than the results (-5.6) recently presented by Chi and Baek (2012).

Table 11. Air Cargo Price Elasticity of Demand Model Parameter Estimates

Variable	Parameter Estimate	Standard Error	T Value	Pr > |t|
Intercept	8.538	0.675	12.645	<.0001
log(Chained GDP)	1.687	0.076	22.209	<.0001
log(National Operating Revenue per Ton-Mile)	-0.501	0.078	-6.459	<.0001
Anomaly Flag	0.275	0.043	6.457	<.0001
1st Quarter Flag	-0.052	0.017	-3.149	0.002

Modeling Price Elasticity at the Case Study Airports

Data were collected at five case study airports where the price elasticity model was used to statistically examine the impacts of the TSA 100 percent screening rule on prices and demand for air freight services. While the same general data types were used, the specific data sources and calculations differed slightly at the local level. Furthermore, some variables that were important at the national level were not important at the local level and vice-versa. As noted previously in this section, the five case study airports where data were collected were Houston, Texas (IAH), New York City, New York (JFK), Kansas City, Missouri (MCI), Reno, Nevada (RNO), and Louisville, Kentucky (SDF).

Similar to the national-level model, the purpose of the local-level models was to assess the relationship between air cargo price and demand. In all airports modeled, the dependent variable was the sum of enplaned and deplaned freight (in pounds) per quarter. The data consist of quarterly measurements taken between 1991 and 2010. Generally speaking, local GDP-type values were less important than local personal income values. Therefore, the local models use the log of personal income as an important explanatory variable. Table 12 gives the modeled results for each of the five airports. The results are consistently higher than those estimated using the national model, with the exception of Houston's George Bush Intercontinental Airport (IAH), which registered a low elasticity measure of -.23. The research team was unable to produce a statistically defensible model for Reno and, therefore, used the national model for estimating impacts in the Reno/Sparks, Nevada area.

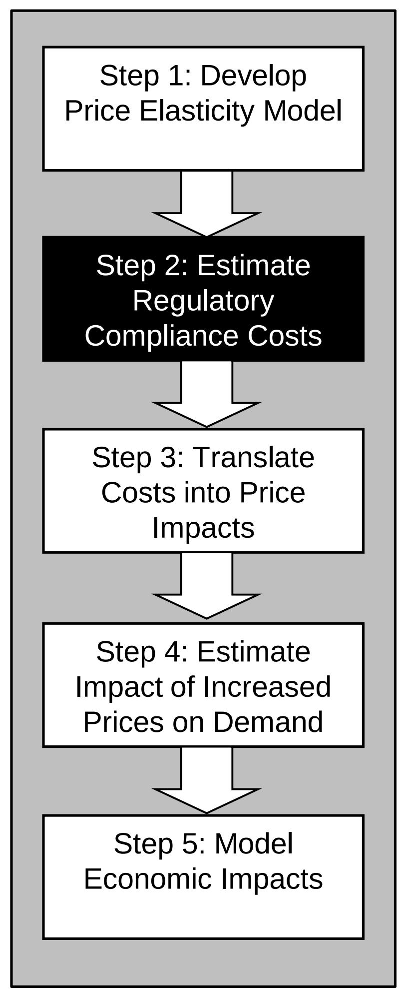
Table 12. Air Cargo Price Elasticity at Case Study Airports

Airport	Elasticity Measure
IAH	-0.23
JFK	-0.96
MCI	-1.02
RNO	N/A
SDF	-1.15

Estimating the Compliance Costs Associated with the TSA 100 Percent Screening Rule

To determine the economic impacts of reduced air cargo operations on local regions, it was necessary to determine the screening costs associated with the 100 percent screening rule. Two sources of information were used to assess these costs: the regulatory evaluation of the 100 screening rule carried out by the Transportation Security Administration (TSA) and data collected from third party entities.

The Air Cargo Screening Initial Regulatory Evaluation carried out by the TSA presents a methodology for assigning costs to the 100 percent air cargo screening rule. These costs include those associated with the certification of shippers, indirect air carriers (IACs), logistics companies and other companies to be Certified Cargo Screening Facilities (CCSFs) for screening air cargo off-airport. Costs also include training requirements, the adoption and assessment of security programs, labor costs associated with screening air cargo, equipment costs, and the costs associated with delays (TSA 2009).



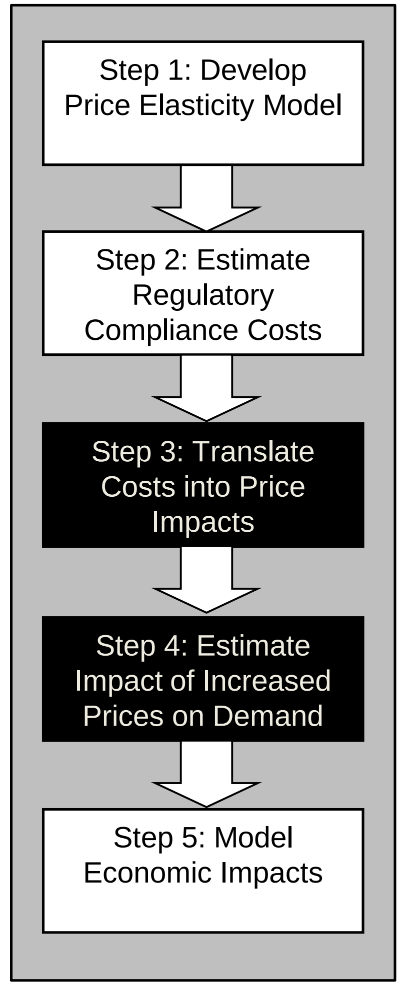
The cost framework developed by TSA in its regulatory evaluation was used to estimate the costs of the 100 percent screening rule on the operations of commercial airline facilities located in a small number of airports across the country. The estimated screening cost per pound varied significantly from as low as 1 cent per pound to as high as 57 cents per pound. The results demonstrated that due to the significant fixed costs associated with the purchase of equipment and associated facility design and construction, costs per pound declined significantly as the number of parcels passing through the facility was expected to grow. This point is demonstrated in Figure 5, which compares the screening price per pound to the annual number of parcels expected to be screened at each facility. When the results for each facility are weighted based on the number of parcels expected to be screened annually, the estimated weighted average cost per pound is 4.8 cents.

Figure 5. TSA Estimated Total Direct Costs of Complying with the 100 Percent Screening Rule

The results presented in Figure 5 suggest there are strong incentives for airlines with small cargo operations to seek third-party screeners who can take advantage of economies of scale to reduce the screening price. To test this assumption and validate TSA's estimates, the research team collected data from industry experts. The data collected to date suggests screening costs from third party entities range from 5-10 cents per pound. The average price presented for third party screeners was 15 cents per kilogram or 6.8 cents per pound.

Translate Costs into Price Impacts and Estimate the Impact of Increased Prices on Demand

To determine the economic impact of the 100 percent screening rule, the costs presented in the previous section must be translated into price impacts in percentage terms. Using the model outlined in this report, price impacts are translated into demand impacts, which are then fed into the input-output models (e.g., IMPLAN, RIMS II) to determine regional economic impacts.



To determine the price effects of the screening costs, the BEA's input-output (I-O) accounts were used to apply an industry overhead charge to the screening costs. This overhead charge was set equal to the gross operating surplus for the air transportation industry. Between 2008 and 2010, gross operating surplus added an average of 8.4 percent to total output in the air transportation industry. Applying this 1.084 industry markup to the screening costs resulted in a final screening price impact of 5.7-7.4 cents per pound (BEA 2011).

To determine the percentage increase in air cargo prices resulting from the added screening costs, the average revenue per pound of air freight in the US was calculated using Form 41 financial data and traffic statistics published by the BTS. Using freight weight and revenue data for 2010, the average revenue per pound of air cargo transported by U.S. carriers was estimated at 86.2 cents. To calculate this value, freight data for specific carriers were obtained from the T-100 Market (US Carriers) BTS data file and compared with revenues from the P-1.2 data file. All carriers with zero values for either freight or revenue were removed from the data set. The price impacts associated with the 100 percent screening rule must be translated into percentage terms in order to apply the price elasticity model. Based on the methods outlined in this section, the TSA 100 percent screening rule was estimated to increase the overall price of air cargo transported on-board passenger aircraft by 6.0-8.6 percent.

Table 13 presents the results of the analysis using the approach outlined in this section as applied to the five case study airports. The table presents the estimated reduction in freight on-board aircraft using the first three steps of the approach outlined in this section, and then translates those reductions into overall reductions in freight. For each airport, BTS data were used to determine the share of total freight comprised of air cargo transported on-board passenger aircraft. At airports with the largest share of freight comprised of cargo transported on-board passenger aircraft (e.g., JFK), impacts were the most significant. At airports dominated by air cargo only operations (e.g., RNO, SDF), demand reductions were estimated to be relatively less significant.

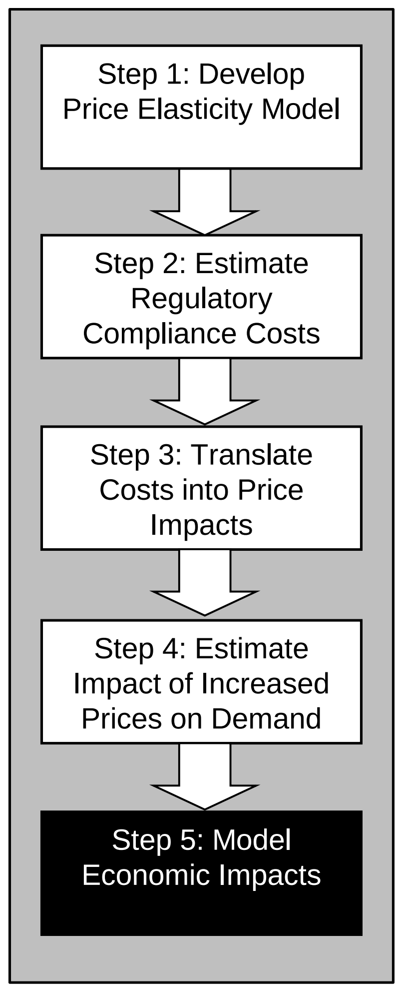
Table 13. Estimated Impact of Increase Prices on Demand for Air Cargo

Airport	Reduction in Freight On-board Passenger Aircraft		Air Cargo On-board Passenger Aircraft as Share of Total Freight	Reductions in Total Freight	
	TSA Analysis	Industry Estimates		TSA Analysis	Industry Estimates
IAH	-1.4%	-2.0%	47.1%	-0.6%	-0.9%
JFK	-5.7%	-8.2%	46.1%	-2.7%	-3.8%
MCI	-6.1%	-8.7%	6.8%	-0.4%	-0.6%
RNO*	-3.0%	-4.3%	3.3%	-0.1%	-0.1%
SDF	-6.9%	-9.8%	0.1%	0.0%	0.0%

*The national model was used as a default for estimating the price elasticity of air cargo demand in Reno due to the inadequate results generated using local data.

This approach does not estimate the impact of the higher cost of doing business on local industries that are reliant on air cargo services. The impact of these higher prices would be expected to result in changes to the supply chain and potentially a loss in productivity for these industries.

Estimate Regional Economic Impacts



From an economic perspective, there are three effects that will be captured in the I-O models applied at the case-study airports:

- The reduced demand for air cargo modeled as a contraction in the industries engaged in air cargo operations
- Increased output by air transportation engaged in air cargo screening activities
- Increased output for air transportation companies due to overhead applied to air-cargo screening costs (this third impact serves to counterbalance the first effect)

Table 14 present the air cargo inputs required for the I-O models. The reduction in freight presented in this table represents the percentage reduction in total (cargo-only and cargo transported on-board passenger airplanes) cargo. The impacts vary depending on the price elasticity modeled at each airport and the scale of air cargo transported on-board passenger aircraft. As noted previously in this report, the screening rule does not affect cargo-only aircraft. Thus, impacts are isolated to cargo transported on-board passenger aircraft.

The negative economic effects reduce the economic output of the industry. Had the regulation applied to only the modeled airport, the impact would only be associated with enplaned pounds. Since the impact of the TSA 100 percent screening rule applies to all air cargo transported on-board passenger aircraft, it is expected to impact both enplaned and deplaned cargo volumes. Since it does not impact cargo-only aircraft, the overall reductions in freight are less than the impacts on cargo on-board passenger aircraft. The cargo screening costs and industry markup attached to those costs reflect the price increase that is passed on to the customer. These values reflect increased revenue/output to the air transportation and supporting industries.

Table 14. Air Cargo Screening Inputs for I-O Models

Airport	Reductions in Freight		Cargo Screening Costs		Gross Industry Surplus on Cargo Screening Costs	
	TSA Analysis	Industry Estimates	TSA Analysis	Industry Estimate	TSA Analysis	Industry Estimate
IAH	-0.6%	-0.9%	$8,944,118	$12,775,705	$751,501	$1,073,438
JFK	-2.7%	-3.8%	$25,241,205	$36,054,330	$2,120,813	$3,029,352
MCI	-0.4%	-0.6%	$247,949	$354,169	$20,833	$29,758
RNO*	-0.1%	-0.1%	$71,619	$102,300	$6,018	$8,595
SDF	0.0%	0.0%	$101,236	$144,605	$8,506	$12,150

Jet Fuel Price Elasticity of Demand Model

The second model developed for this study examines the impacts of jet fuel price increases on air cargo demand. This section presents the model designed for this purpose and examines the impacts on demand associated with 10-30 percent increases in jet fuel prices.

To model the price elasticity of air cargo demand with respect to jet fuel prices, the research team employed a stepwise regression approach in order to target variables that had a statistically significant impact on air cargo demand. One variable, log-GDP, was manually entered (or forced) into the model. The variable selection process is reviewed in Table 15. Besides the five flag variables, there were three other inputs selected: log-GDP(real), log-Jet Fuel Price(real), and domestic passengers enplaned. Here, we see that the log of the real rail operating revenue variable was significant and gained entry to the model, but as more variables were added, its significance dropped below the minimum threshold for acceptance and hence was dropped from the model.

Table 15. Summary of Stepwise Regression

Step	Variable Entered	Variable Removed	Partial R-Square	Model R-Square	F Value	Pr>F
1	post_flag		0.0472	0.9322	56.44	<.0001
2	anom_flag		0.0210	0.9533	36.01	<.0001
3	pasenplanedd		0.0091	0.9624	19.16	<.0001
4	Lrailrev		0.0025	0.9649	5.65	0.0199
5	q3_flag		0.0016	0.9666	3.80	0.0550
6	q2_flag		0.0036	0.9701	9.03	0.0036
7		lrailrev	0.0009	0.9693	2.21	0.1412
8	Lrealjetfuel		0.0014	0.9706	3.59	0.0619
9	q1_flag		0.0012	0.9719	3.30	0.0733

Results of the final jet fuel price elasticity model are summarized in Table 16. The model fits the data well with an R-Squared and an adjusted R-Squared of approximately 0.97. The overall model is highly significant with a p-value less than 0.001.

Table 16. Jet Fuel Price Elasticity Model – Analysis of Variance

Source	Degrees of Freedom (DF)	Sum of Squares	Mean Square	F Value	Pr > F
Model	8	20.00432	2.50054	324.07	<.0001
Error	75	0.570	0.00772		
Corrected Total	83	20.58302			
Root MSE	0.08784	R-Square	0.9719		
Dependent Mean	22.44098	Adj R-Square	0.9689		
Coeff Var	0.39143				

An inspection of the parameter estimates table (Table 17) reveals much about the observed relationship between air cargo demand and the selected explanatory variables. As important as the magnitude of the parameter estimates is the arithmetic sign. Of the eight inputs (not counting the intercept), four are positive and four are negative in sign indicating a positive or negative correlation, respectively, with air cargo demand. Of the three non-flag variables, only the jet fuel variable was negative in sign as expected. Two of the flag variables helped the model better fit the aforementioned data anomaly, and the other three were quarterly flags. These latter variables were all negative in sign – indicating a steady quarterly decrease in Air Cargo shipments culminating in an offsetting increase in the 4th quarter. The parameter estimate for the real jet fuel price variable is -.07537 indicating that for every 10 percent increase in jet fuel prices, air cargo demand would be expected to drop by 0.75 percent.

Table 17. Jet Fuel Price Elasticity Parameter Estimates

Variable	Parameter Estimate	T Value	Pr > |t|
Intercept	2.50542	0.49	0.6286
lgdp05	0.62514	3.54	0.0007
q1_flag	-0.04974	-1.82	0.0733
q2_flag	-0.12919	-4.22	<.0001
q3_flag	-0.13259	-4.24	<.0001
anom_flag	0.45435	8.84	<.0001
post_flag	0.56740	12.18	<.0001
lrealjetfuel	-0.07539	-2.06	0.0433
pasenplanedd	7.313436E-9	6.32	<.0001

Table 18 presents the impacts of a 10, 20, and 30 percent increase in jet fuel prices on demand for air cargo at each of the five case study airports. As shown, the impacts range from less than 1 million pounds for RNO under the 10 percent jet fuel price increase scenario to over 100 million pounds for SDF under the 30 percent price increase scenario. For every 10 percent increase in jet fuel prices, air cargo demand is estimated to decline by 0.7 percent.

Table 18. Impacts of Jet Fuel Price Increases (10, 20, and 30 percent) on Demand for Air Cargo

	Impacts of Jet Fuel Prices Increases on Demand for Air Cargo		
Airport	10%	20%	30%
IAH	(6,368,857)	(12,737,715)	(19,106,572)
JFK	(21,150,552)	(42,301,105)	(63,451,657)
MCI	(1,354,130)	(2,708,260)	(4,062,390)
RNO	(781,291)	(1,562,582)	(2,343,873)
SDF	(33,956,926)	(67,913,853)	(101,870,779)
Reduction in Air Cargo	-0.7%	-1.5%	-2.2%

Referring back to the five-step approach outlined previously for the TSA 100 percent air cargo screening rule, note that Steps 2 and 3 (estimate regulatory compliance costs and translate cost into price impacts) are not required for this analysis because there are no overhead costs associated with constant price fluctuations in jet fuel. Thus, the output of the model can be applied directly to freight totals to estimate reductions in air cargo demand. In terms of applying these results at the local level, reduced demand for air cargo would be modeled as a contraction in the industries engaged in air cargo operations. For every 10 percent increase in price, air cargo operations would be expected to contract by 0.7 percent.

Simplified Economic Impact Analysis Model

To determine the contribution of additional air cargo freight activity at a given airport on the total economic output in the market area influenced by that airport, there are several decisions must be make in structuring a model. Decisions will involve several characteristics of the air cargo's potential economic impact on final demand. Final demand is an economic term defining the total amount of economic activity for a defined region. Final demand would include the direct impacts of expanding air cargo freight capacity at the airport, plus the additional economic activity generated by these direct changes. These indirect and induced effects are why the additional impacts are often called multipliers.

Developing a Simple RIMS II Multiplier Model

To determine the relationship between freight and economic output key questions about changes to the status quo must be addressed. The following provides those questions supported by specific guidance for finding the answers to support inputs for structuring the suggested simplified model.

1. How much additional economic activity would be generated?
   - The following are the key data items that are needed to evaluate additional economic activity:

   a. Jobs and wage related to air cargo services from the participants of the air cargo industry such as freight forwarders/3PLs, airports, airlines, and others at the selected airport
   b. Air cargo shipments in tons handled by the industry participants such as freight `forwarders/3PLs
   c. Commodities shipped by air and other modes
   d. Revenue related to air cargo business from the industry participants such as airports and freight forwarders/3PLs
   e. Industry concentrations within the defined study region. (See page 72 of the main report)

2. What industries would be most affected by such changes?
   a. Inspection of the BEA RIMS II 471 industry types would suggest which detailed industries would best match to the main industries needing the support of air cargo operations. (Table 3 above in this study list those industries with the most intensive use of air cargo)
   b. Stakeholders and their respective survey response would also provide extra data and information in answering this question. (Survey information provided in detail in Appendix B).

3. What area (economic region) would the changes affect?
   a. In determining a study region, most cases should begin with the counties within the Metropolitan Statistical Area (MSA) where each airport is located.
   b. The study region is defined at the county level because the datasets underlying each of the I-O models reside at that level.

After considering the three key questions above, the first action is to define the regions, which can be a single county or a combination of counties that that will be covered by the impacts generated by air cargo freight capacity changes within an airport market area. Once the regions are defined, the Bureau of Economic Analysis (BEA) should be contacted for renting/purchasing the needed models.

The BEA has developed input-output (I-O) models for any United States regions composed of counties, and requires users to specify the regions of analysis before renting/purchasing. This I-O model from BEA is called RIMS II.

- The URL to purchase RIMS II multipliers is https://bea.gov/regional/rims/rimsii/
- Multipliers may be ordered for any region that consists of one or more contiguous counties at a cost of $275 per region.
- For each region ordered includes Type I and Type II (detailed below) final-demand and direct-effect multipliers for all the RIMS II industries in the region.
  - Note: Multipliers for each county or state within the region will not be provided.
  - Type II multipliers should be used as it includes both inter-industry and household spending of a final demand changes. Type I multipliers only account for the inter-industry effect, which is not the full impact being sought with a regional air cargo estimate.

In addition, BEA has published two useful reference documents. The first is a RIMS II user guide, which can be found at the URL: http://www.bea.gov/regional/pdf/rims/RIMSII_User_Guide.pdf.

- While the BEA guide is useful material, the streamlined model offered here is intended to further simplify a description of the use of RIM II multipliers.

The second suggested resource to support structuring this simplified model is entitled *Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System* (Third Edition, 1997), found at the URL: http://www.bea.gov/scb/pdf/regional/perinc/meth/rims2.pdf. This document has appendices to aid in choosing the appropriate industries whose multipliers would be most affected by air cargo freight expansion.

In assessing economic impact the use of economic output measures combined with basic input-output account data to find direct, indirect, and induced effects. This was accomplished executing the various data collection and survey techniques discussed in this study. Information was generated on basic economic measures such as employment (number of jobs and earnings) value and value-added output (expressed in dollars). This provides analysts the basic information on changes in economic activity to which economic multipliers will be applied.

As discussed in *Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II)*, massive tables of multipliers are provided. For 38 industry aggregations, and 471 detailed industries, four tables of multipliers exist. Rather than discuss in detail each of these options, we recommend using the table of total final-demand multipliers for output, earnings, employment (Labeled Table 1.4 in the 1997 edition) be used. Since the air cargo industry is limited in the types of industries that use its services, it would be best to use the more detailed 471 industry multipliers rather than the 38 industry aggregation.

As offered with Table 199, a simple table was developed to total these full impacts. The first column lists all the detailed industries that would be impacted by the expansion of air cargo capacity. The second column, lists the direct impact to the column 1 industry either as dollars for most items or the number of jobs for the additional employment provided. This then generates up to three columns (3, 4, and 5, below) listing the final demand multipliers. These multipliers would be provided by BEA in accordance with what the analyst ordered from them for the modeled region. The final set of columns (6, 7, and 8) provide then the final demand multiplier columns (3, 4, and 5) times the second column displaying the resulting full impact on the defined region. The last three columns would be added up for all the industries listed to determine the estimated final full impact.

Table 19. Simplified Economic Impact Estimation Model

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
			Final Demand Multiplier			Full Impact	
Industry 1	Direct impact ($ or employ)	Output ($)	Earnings ($)	Employment (jobs)	Output ($)	Earnings ($)	Employment (jobs)
					Col. 2X3	Col. 2x4	Col. 2x5
Industry 2							
Industry 3, etc.							
					Total	Total	Total

CHAPTER 5

FUTURE RESEARCH OPPORTUNITIES

This report evaluates the air cargo industry and its role in the supply chain, and presents a methodology for estimating the regional economic impacts of air cargo operations. In preparing the case studies presented in Appendix B, several data and modeling gaps were identified and evaluated. These gaps could be transformed into research opportunities.

When performing economic impact analysis, data gaps were identified and examined in Section 3.2. Data gaps were identified for the CFS, Census Bureau's Merchandise Import/Export and T100 datasets. The FAF dataset has made significant improvement in data coverage for air cargo and overcomes several shortcomings reported in other three datasets. Nevertheless, data gaps still exist in the FAF as part of inheritance from the CFS, and some of the data gaps—especially in the coverage of air express data—have impacts on air cargo.

The main air cargo–related data gaps in the FAF involve three types of shipments: box-type of packages weighing <100 lbs., letter-type of packages, and domestic shipments by industries not covered in the CFS. These data gaps are defined as follows:

- For box-type of packages, both weight and value data are either intentionally ignored or lumped with other modes.

- For letter-type of packages, there is no coverage for value data in any sources, except that their weight data are included in the T100 data.

- For industries not covered by the CFS, though imports and exports data are available with a better geographic representation and shipment characteristics (commodity, weight, and value), domestic shipments are missing from census surveys.

- An additional limitation of the FAF data is that it is not presented at the desired airport level.

These data gaps and limitation could be addressed using an estimation algorithm to impute weight and value data at the airport level for all but letter-type of shipments, for which only weight could be imputed. Imputing the missing air cargo data would require an evaluation of the air cargo flows already in the FAF but needing to be distributed to airports, air cargo flows for box-type of packages and their distribution to airports, domestic air cargo flows originating from industries not covered by the CFS and their distribution to airports, and weight data for letter-type of packages. The final gap is tied to the implicit value of letter-type packages. Exclusion of the implicit values for the letter-type packages will underestimate the value of shipment contributed by air freight. The difficulty involved in estimating the implicit values is that there are no data readily available for use. Research is needed to understand the value that firms place on the flexible and expedient service provided by the air cargo industry.

Opportunity cost is one of the important parts of the economic impacts related to air cargo that has not been fully addressed in this research. Opportunity cost being the difference in value between the alternative chosen and the alternative forgone. The contribution to the economy made by an airport can be revealed by examining a scenario in which the airport is closed. As a result of closing the airport, shippers would face changes in transportation and other costs (i.e., opportunity costs) and would possibly face the increase in cost. While there are no data readily available for estimating the opportunity cost, such value could be assessed through a series of surveys to shippers, third-party logistics providers, and freight forwarders, information related to potential cost increases for the scenario of airport closing could be obtained. Alternatively, researchers could conduct a rerouting analysis based on the T100 dataset to determine amount of cargo shipped to alternative airports if the airport under consideration is closed. Surveys and the rerouting analysis complement each other for estimating the opportunity costs that may incur to air shipments.

While the methods used to evaluate regional economic impacts using I-O models is well known, less understood is the correlation between the availability of air cargo services and the presence of air cargo-dependent industries. It is generally agreed that industries are concentrated within regions with direct access to air cargo operations. In the absence of this access, companies that rely on these services would likely re-locate to other regions with such access. The analysis of these location benefits is part of a developing area of economic research that is still limited by two key factors: 1) the lack of a complete and workable theory of the role of air cargo in economic development; and 2) the lack of data describing the quantity and value of exported goods.

Given the lack of data, one approach is to utilize the linkage or interdependence between businesses, industries and clusters. One tool common with cluster analysis is to study the Location Quotient (LQ)[14], which measures industry concentration in a regional economy. It does so by comparing the ratio of employment in a certain sector of a local economy to the same ratio in a comparison economy, identifying specializations in the local economy. This approach, combined with surveys and the identification of large air cargo-dependent local businesses, was employed with varying degrees of success in the case studies presented in Appendix B. With that noted, there exists no industry standard from a methodology or modeling perspective for conducting such an analysis. This is an area worth further research.

[14] Location Quotient: Ratio of analysis-industry employment in the analysis area to base-industry employment in the analysis area divided by the ratio of analysis-industry employment in the base area to base-industry employment in the base area.

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APPENDIX A.

REGIONS AND COMMODITIES COVERED BY THE FAF DATASET

Table A-1. Regions and Gateways Covered by the CFS and the FAF

#	Region	#	Region	#	Region	#	Region
1	AL - Birmingham-Hoover-Cullman	34	IN - Remainder of Indiana	67	NY - Buffalo-Cheektowaga-Tonawanda	100	TX - San Antonio
2	AL - Remainder of Alabama	35	IA - Iowa	68	NY - New York-Newark-Bridgeport	101	TX - Remainder of Texas
3	AK – Alaska	36	KS - Kansas City	69	NY - Rochester-Batavia-Seneca Falls	102	UT - Salt Lake City-Ogden-Clearfield
4	AZ - Phoenix-Mesa-Scottsdale	37	KS - Remainder of Kansas	70	NY - Remainder of New York	103	UT - Remainder of Utah
5	AZ – Tucson	38	KY - Louisville-Elizabethtown-Scottsburg	71	NC - Charlotte-Gastonia-Salisbury	104	VT - Vermont
6	AZ - Remainder of Arizona	39	KY - Remainder of Kentucky	72	NC - Greensboro--Winston-Salem--High Point	105	VA - Richmond
7	AR – Arkansas	40	LA - New Orleans-Metairie-Bogalusa	73	NC - Raleigh-Durham-Cary	106	VA - Virginia Beach-Norfolk-Newport News
8	CA - Los Angeles-Long Beach-Riverside	41	LA - Remainder of Louisiana	74	NC - Remainder of North Carolina	107	VA - Washington-Baltimore-Northern Virginia
9	CA - San Diego-Carlsbad-San Marcos	42	ME – Maine	75	ND - North Dakota	108	VA - Remainder of Virginia
10	CA - Sacramento--Arden-Arcade--Truckee	43	MD - Baltimore-Towson	76	OH - Cincinnati-Middletown-Wilmington	109	WA - Seattle-Tacoma-Olympia
11	CA - San Jose-San Francisco-Oakland	44	MD - Washington-Arlington-Alexandria	77	OH - Cleveland-Akron-Elyria	110	WA - Remainder of Washington
12	CA - Remainder of California	45	MD - Remainder of Maryland	78	OH - Columbus-Marion-Chillicothe	111	WV - West Virginia
13	CO - Denver-Aurora-Boulder	46	MA - Boston-Worcester-Manchester	79	OH - Dayton-Springfield-Greenville	112	WI - Milwaukee-Racine-Waukesha
14	CO - Remainder of Colorado	47	MA - Remainder of Massachusetts	80	OH - Remainder of Ohio	113	WI - Remainder of Wisconsin
15	CT - New York-Newark-Bridgeport	48	MI - Detroit-Warren-Flint	81	OK - Oklahoma City-Shawnee	114	WY - Wyoming
16	CT - Remainder of Connecticut	49	MI - Grand Rapids-Wyoming-Hollan	82	OK - Tulsa-Bartlesville	115	AK - Anchorage Gateway
17	DE - Delaware	50	MI - Remainder of Michigan	83	OK - Remainder of Oklahoma	116	WA - Blaine Gateway
18	DC - Washington-Arlington-Alexandria	51	MN - Minneapolis-St Paul-St Cloud	84	OR - Portland-Vancouver-Beaverton	117	MN - International Falls Gateway
19	FL - Jacksonville	52	MN - Remainder of Minnesota	85	OR - Remainder of Oregon	118	NY - Alexandria Bay Gateway
20	FL - Miami-Fort Lauderdale-Miami Beach	53	MS - Mississippi	86	PA - Philadelphia-Camden-Vineland	119	NY - Champlain/Rouses Point Gateway
21	FL - Orlando-The Villages	54	MO - Kansas City	87	PA - Pittsburgh-New Castle	120	ME - Portland Gateway
22	FL - Tampa-St Petersburg-Clearwater	55	MO - St Louis-St Charles-Farmington	88	PA - Remainder of Pennsylvania	121	SC - Charleston Gateway
23	FL - Remainder of Florida	56	MO - Remainder of Missouri	89	RI - Rhode Island	122	GA - Savannah Gateway
24	GA - Atlanta-Sandy Springs-Gainesville	57	MT - Montana	90	SC - Greenville-Anderson-Seneca	123	AL - Mobile Gateway
25	GA - Remainder of Georgia	58	NE - Nebraska	91	SC - Spartanburg-Gaffney-Union	124	LA - Baton Rouge Gateway
26	HI - Honolulu	59	NV - Las Vegas-Paradise-Pahrump	92	SC - Remainder of South Carolina	125	LA - Morgan City Gateway
27	HI - Remainder of Hawaii	60	NV - Remainder of Nevada	93	SD - South Dakota	126	LA - Lake Charles Gateway
28	ID - Idaho	61	NH - New Hampshire	94	TN - Memphis	127	TX - Beaumont Gateway
29	IL - Chicago-Naperville-Michigan City	62	NJ - New York-Newark-Bridgeport	95	TN - Nashville-Davidson-Murfreesboro-Columbia	128	TX - Corpus Christi Gateway
30	IL - St Louis	63	NJ - Philadelphia-Camden-Vineland	96	TN - Remainder of Tennessee	129	TX - Brownsville/Hidalgo Gateway
31	IL - Remainder of Illinois	64	NJ - Remainder of New Jersey	97	TX - Austin-Round Rock	130	TX - Laredo Gateway
32	IN - Chicago-Naperville-Michigan City	65	NM - New Mexico	98	TX - Dallas-Fort Worth	131	TX - El Paso Gateway
33	IN - Indianapolis-Anderson-Columbus	66	NY - Albany-Schenectady-Amsterdam	99	TX - Houston-Baytown-Huntsville		

Note that the first 114 regions are geographic areas covered by the CFS and the FAF and others are international gateways.

Table A-2. Commodities Covered by the CFS and the FAF

SCTG Code	Commodity	SCTG Code	Commodity
1	Live animals and live fish	23	Chemical products and preparations, n.e.c.
2	Cereal grains	24	Plastics and rubber
3	Other agricultural products	25	Logs and other wood in the rough
4	Animal feed and products of animal origin, not elsewhere classified (n.e.c.)	26	Wood products
5	Meat, fish, seafood, and their preparations	27	Pulp, newsprint, paper, and paperboard
6	Milled grain products and preparations, and bakery products	28	Paper or paperboard articles
7	Other prepared foodstuffs and fats and oils	29	Printed products
8	Alcoholic beverages	30	Textiles, leather, and articles of textiles or leather
9	Tobacco products	31	Nonmetallic mineral products
11	Natural sands	32	Base metal in primary or semi-finished forms and in finished basic shapes
12	Gravel and crushed stone	33	Articles of base metal
13	Nonmetallic minerals n.e.c.	34	Machinery
14	Metallic ores and concentrates	35	Electronic and other electrical equipment and components and office equipment
15	Coal	36	Motorized and other vehicles (including parts)
17	Gasoline and aviation turbine fuel	37	Transportation equipment, n.e.c.
19	Coal and petroleum products, n.e.c.	38	Precision instruments and apparatus
20	Basic chemicals	39	Furniture, mattresses and mattress supports, lamps, lighting fittings
21	Pharmaceutical products	40	Miscellaneous manufactured products
22	Fertilizers	41	Waste and scrap
		43	Mixed freight

Note that SCTG stands for Standard Classification of Transported Goods.

APPENDIX B.

SURVEYS

Airport Representatives

Purpose of the Survey

Air cargo is vital to global commerce and our nation's economic strength. To aid airports in fully understanding the benefits and the economic impact of air cargo to their communities, the Airport Cooperative Research Program (ACRP) of the Transportation Research Board approved this project.

A research team, led by Battelle, is preparing a Guidebook for the Estimation of the Economic Impact of Air Cargo at Airports under ACRP 03-16. This guidebook will provide the essential and effective tools and techniques to create a uniform approach for airports to measure and value the contribution of air cargo activity to local, regional, and national economies – essentially help airports place real dollar amounts as to the value of air cargo at their airport.

A key component of the Guidebook is a series of case studies at selected airports around the country. The research team is conducting interviews with airport operators, cargo handlers, forwarders, trucking companies, shippers, and others impacted by air cargo service. The survey is being conducted by TransSolutions, a leader in modeling and analysis to the aviation industry. The telephone interview process will take 20 to 30 minutes. The researcher will attempt to gather available information to help answer questions prior to the call.

For airport representatives, the key issues to be investigated are:

- The largest users of air cargo in the region by industry and commodity.
- Proportion of the airport's spending related to air cargo services.
- Carriers and annual volumes of air cargo on passenger aircraft operating at the airport.
- Employment associated with air cargo at the airport.

In addition to the questions in this survey, the airport operator is also asked to provide:

- **Contact information for the local economic development entity**
- **Contact information for forwarder or air cargo shipper associations**
- **Other information that will help us identify and contact shippers and users of the air cargo industry**

For further information, contact: Lisa Anderson Spencer, TransSolutions, 703-682-6981, lspencer@transsolutions.com or Bob Fredman, Battelle, 614-424-4532, fredmanr@battelle.org

General Information

1. Please provide contact information for the individual completing this survey.

   Name: ____

   Title or Role: ____

   Organization: ____

   Address: ____

   City, State, Zip: _______________________________________

   Phone Number: ____

   Email Address: ____

2. Has your airport completed an air cargo economic impact study and if so, in what year was it completed?

   □Yes   □ No (skip to question 3)

   Year survey completed _____________

   Would you be willing to share it with the research team?

   □Yes   □ No

3. The Transportation Security Administration (TSA) has implemented rules that require screening 100% of air cargo on passenger aircraft. Have you examined the cost implications of this rule or participated in any studies that estimate the costs associated with this rule for air carriers at your airport?

   □ Yes   □No (skip to question 4)

   Would you be willing to share these studies with the research team?

   □ Yes   □ No

Air Cargo Information

4. How many people are currently employed by your airport, including contractors (excluding tenants)?

   Number of employees _______

5. How many people are employed performing air cargo-related operations at your airport?

   a) Employees ________ (related to 4, above)   b) Tenants ________   c) Total ________

6. Please provide current employment by industry sector for the air cargo operations employees (identified in 5.c, above). These data should include all on-airport employment (including tenants) related to the movement of air cargo. This information is reported by the company's Human Resources department to the Department of Labor.

Industry Sector	Number of Employees	Industry Sector	Number of Employees
Air transportation		Business support services	
Truck transportation		Investigation and security services	
Transit and ground passenger transportation		Other support services	
Couriers and messengers		Waste management and remediation services	
Warehousing and storage		Other Federal Government enterprises	
Scenic and sightseeing transportation and support activities for transportation		State and local government passenger transit	
Facilities support services		State and local government electric utilities	
Services to buildings and dwellings		Other state and local government enterprises	

7. What was the volume of air cargo, in metric tons, shipped through your airport domestically versus internationally and inbound versus outbound for the most recently reported full calendar year?

   Year of data: 2009   ☐ Other __________

Shipments (MT)	Domestic	International
Inbound		
Outbound		
Total		

Please provide for prior years to 2004, if available, on a separate sheet. Provide supporting files, if available.

8. With regard to the current scheduled carriers serving the airport, please provide the following:
   a) Number of passenger airlines ________
   b) Number of express and all-cargo airlines ________

9. What is the annual revenue of air cargo operations and passenger air transportation accruable to the airport (inclusive of all revenue-generating items) for the most recent full calendar year for which data are available?

   Year of data: 2009 ☐ Other __________

   a) Air cargo operations revenue ($) _________

   b) Passenger air transportation revenue ($) _________

10. What is the forecasted annual growth rate in air cargo tonnage passing through your airport over the next 20 years, if known?

    Annual Growth Rate ___________ ☐ Don't know

11. Please list the passenger airlines that provide air cargo services at/through your airport, along with the number of pieces each airline carried through your airport, their total volume in metric tons, and their value (if available) for the most recent full calendar year for which data are available. *(Make additional copies of the table if necessary)*

    Year of data: ☐ 2009 ☐ Other __________ source of data: _____________________________

Airline	Number of Pieces	Volume (tons)	Value ($)

Airline	Number of Pieces	Volume (tons)	Value ($)

12. Of the air cargo at your airport, what are the top ten commodities being shipped (See Attachment A for commodity codes):

Year of data: □ 2009 □ Other __________ source of data: ______________________________

Commodity	Code	Volume (tons)	Value ($)

Air Carrier Representatives

Purpose of the Survey

Air cargo is vital to global commerce and our nation's economic strength. To aid airports in fully understanding the benefits and the economic impact of air cargo to their communities, the Airport Cooperative Research Program (ACRP) of the Transportation Research Board approved this project.

A research team, led by Battelle, is preparing a Guidebook for the Estimation of the Economic Impact of Air Cargo at Airports under ACRP 03-16. This guidebook will provide the essential and effective tools and techniques to create a uniform approach for airports to measure and value the contribution of air cargo activity to local, regional, and national economies – essentially help airports place real dollar amounts as to the value of air cargo at their airport. There is a very practical benefit in this effort for the entire air cargo business community since it will provide important information that can help airports justify and pursue available funding and lower the operating costs for tenants and users.

A key component of the Guidebook is a series of case studies at selected airports. The research team is conducting interviews with airport operators, air carriers, cargo handlers, forwarders, trucking companies, shippers, and others impacted by air cargo service. The survey is being conducted by TransSolutions, a leader in modeling and analysis to the aviation industry. The telephone interview process will take 20 to 30 minutes. The researcher will attempt to gather available information to help answer questions prior to the call. We understand the competitive nature of your business and respect the importance of client relationships. In that regard, your answers will be completely confidential, and no specific product, business or client information will appear in the final report**.**

For air carrier representatives, the key issues to be investigated are:

- employment related to air cargo operations at ***[insert airport name]***
- annual volume of air cargo shipped by the air carrier on passenger aircraft at ***[insert airport name]***
- responsiveness of demand to market price
- top commodities shipped by the air carrier through ***[insert airport name]***

General Information

1. Please provide contact information for the individual completing this survey.

Name: ____

Title or Role: _______________________________________

Organization: _______________________________________

Address: ____

City, State, Zip: _____________________________________

Phone Number: ______________________________________

Email Address: ______________________________________

2. The Transportation Security Administration (TSA) is implementing rules that require screening 100% of air cargo on passenger aircraft. Have you:

   a) examined the cost implications of this rule or participated in any studies that estimate the costs associated with this rule for your company? □ Yes □ No (skip to question 3)

   b) measured the costs associated with complying with it? □ Yes □ No (skip to question 3)

   c) participated in any studies that estimate the costs associated with this rule for your company? □ Yes □ No (skip to question 3)

   d) instituted surcharges or price increases to pass these costs along to your customers?

      □ Yes □ No (skip to question 3)

   e) would you be willing to share this information with the research team? □ Yes □ No

3. How many of your employees are engaged in air cargo operations associated with ***[insert airport name]***, including off-airport?

   a) On-Airport ________ b) Off-Airport ________ c) Total ________

4. What percentage of these employees are full-time employees?

   a) On-Airport ________ b) Off-Airport ________ c) Total ________

5. What is the average hourly wage or annual salary of these employees?

   ____________ □ Hourly wage □ Annual salary

6. Please specify the number of loose pieces, total volume, and value (if available) of outbound air cargo (on passenger aircraft) your airline handled at ***[insert airport name]*** during the most recent full calendar year for which data are available.

   Year of data: □ 2010 □ Other _________

   How do you measure volume? □ metric tons □ kilograms □ pounds

   a) Number of Pieces ________ b) Volume ________ c) Value ($) ________

7. How would your customers respond to a sustained, long-term increase in the market price of belly cargo space (place one X in each column)?

	Market Price Increase			
	10%	**25%**	**33%**	**50%**
No change in volume				
Reduce volume by 1-15%				
Reduce volume by 16-33%				
Reduce volume by 34-50%				
Reduce volume by 51-75%				
Reduce volume by 76-100%				

8. What is the forecasted annual growth rate in outbound air cargo volume handled at ***[insert airport name]*** by your airline over the next 20 years, or less, if known?

Annual Growth Rate _____ ◻ Time frame, if less than 20 yrs ◻ Don't know

9. Of the air cargo your airline handled at ***[insert airport name]***, what are the top ten commodities being shipped (See Attachment A for commodity codes):

Commodity	**Code**	**Volume (UOM)**	**Value ($)**

Freight Forwarders / Air Transportation Service Providers

Purpose of the Survey

Air cargo is vital to global commerce and our nation's economic strength. To aid airports in fully understanding the benefits and the economic impact of air cargo to their communities, the Airport Cooperative Research Program (ACRP) of the Transportation Research Board approved this project.

A research team, led by Battelle, is preparing a Guidebook for the Estimation of the Economic Impact of Air Cargo at Airports under ACRP 03-16. This guidebook will provide the essential and effective tools and techniques to create a uniform approach for airports to measure and value the contribution of air cargo activity to local, regional, and national economies – essentially help airports place real dollar amounts as to the value of air cargo at their airport. There is a very practical benefit in this effort for the entire air cargo business community since it will provide important information that can help airports justify and pursue available funding and lower the operating costs for tenants and users.

A key component of the Guidebook is a series of case studies of select airports. The research team is conducting interviews with airport operators, air carriers, cargo handlers, forwarders, trucking companies, shippers, and others impacted by air cargo service. The survey is being conducted by TransSolutions, a leader in modeling and analysis to the aviation industry. The telephone interview process will take 20 to 30 minutes. The researcher will attempt to gather available information to help answer questions prior to the call. We understand the competitive nature of your business and respect the importance of client relationships. In that regard, your answers will be completely confidential, and no specific product or client information will appear in the final report**.**

For air transportation service providers, the key issues to be investigated are:

- employment related to air cargo operations at ***[insert airport name]***
- annual value, volume and type of cargo handled by your business and how that cargo is transported. The economic impact is derived from the value, rather than weight, of air cargo.
- responsiveness of customer demand to market price

General Information

1. Please provide contact information for the individual completing this survey:

   Name: ____

   Title or Role: ______________________________________

   Organization: ______________________________________

   Address: ____

   City, State, Zip: ____________________________________

   Phone Number: _____________________________________

   Email Address: ______________________________________

2. How many of your employees are engaged in air cargo operations associated with ***[insert airport name]***?

   a) On-Airport ________ b) Off-Airport ________ c) Total ________

3. What percentage of these employees are full-time employees?

   a) On-Airport ________ b) Off-Airport ________ c) Total ________

4. What percentage of your total staff time is spent on air cargo related activities ?

   a) On-Airport ________ b) Off-Airport ________ c) Total ________

5. What is the average hourly wage or annual salary of these employees?

   ____________ ☐ Hourly wage ☐ Annual salary

Air Cargo Information

6. What was the annual **value** of the cargo handled by your company in the ***[insert airport name]*** economic region (defined by the counties in Attachment B) for the most recent full calendar year on record (include all modes)? Year of data: ☐ 2010 ☐ Other _________

   a) Value of **ALL** cargo handled in the region (000's dollars) _________

   b) Value of **AIR** cargo handled through ***[insert airport name]*** airport (000's dollars) _________

7. What was the annual **volume** of **all** cargo handled by your company in the ***[insert airport name]*** economic region (defined by the counties in Attachment B) for the most recent full calendar year on record (include all modes)? Year of data: ☐ 2010 ☐ Other _________

   How do you measure volume? ☐ metric tons ☐ kilograms ☐ pounds

   Volume _________

   % volume of small package items v. large package items?? [important for express carriers and certain other airlines; otherwise will you miss a key air cargo value indicator?]

8. Please provide the **volume** of **air** cargo your company handled through ***[insert airport name]*** domestically versus internationally and inbound versus outbound for the most recently reported full calendar year. Year of data: ☐ 2010 ☐ Other _____ ____

Volume	Domestic	International	Total
Inbound			
Outbound			
Total			

Market Response Information

9. Please distribute the **volume** (including all domestic and international, outbound and inbound) of air cargo handled or forwarded through ***[insert airport name]***, as identified in your response to Question 8, between cargo-only air and belly air.

   a) Cargo-Only Air _____ b) Belly Air _____

10. Please enter the volume totals from Question 9 in the base case column of the table below. Please estimate how the volume in the base case would be handled or forwarded following a sustained, long-term increase in the market price of **air cargo**? Please make sure that the totals of each column are equal. [Q relating to "other modes" and "no longer shipped:" if these increases are independent of general transportation industry inflation, this data will be clean and useful; if these increases occur as other modes of shipping sustain increases it muddies the analysis of modal shift due to price increases and also loss of demand in general. Should you clarify the assumptions to the respondent?]

	Base Case	Market Price Increase			
		10%	25%	33%	50%
Cargo-Only Air					
Belly Air					
Other modes					
No Longer Shipped					
Total					

11. Please enter the volume totals from Question 9 in the base case column of the table below. Please estimate how the volume in the base case would be handled or forwarded following a sustained, long-term [relative?] increase in the market price of **only belly cargo space**? Please make sure that the totals of each column are equal.

	Base Case	Market Price Increase			
		10%	25%	33%	50%
Cargo-Only Air					
Belly Air					
Other modes					
No Longer Shipped					
Total					

12. In your opinion, if belly cargo capacity were reduced (by the amount shown in the table below), to what mode would that volume be shifted? Please make sure that each column totals to the belly cargo capacity reduction (e.g., 10%, 25%, 33%, 50%). [Again, is it important to distinguish size of shipments, small v. large? In the express freight industry small packages are much more profitable and are tracked separately, and they apply to distinct airports in large parts (regional or international hubs)]

Percentage shifted to other modes	Belly Cargo Capacity Reduction			
	10%	25%	33%	50%
Cargo-Only Air				
Other modes				
No Longer Shipped				
Total	10%	25%	33%	50%

13. Hypothetically speaking, suppose that air cargo services at ***[insert airport name]*** were discontinued for an extended period, what alternative airports/modes would be used to ship the cargo? These percentages should be expressed in terms of value (if known, otherwise, expressed in terms of volume). The sum of all percentages should equal 100%.

Expressed in terms of: ☐ Value ☐ Volume

	Percentage shifted to:	Percentage of Air Cargo Switched to Other Airports					
		1st Airport		2nd Airport		3rd Airport	
		Name	Pct	Name	Pct	Name	Pct
Air	%						
Other modes	%						
No longer shipped	%						
Total	100 %						

Products Shipped by Air Cargo

14. What are the reasons that your customers select air transportation rather than other modes to ship cargo? Please rank the importance of each reason on a scale of 1 to 10 (**1** being extremely important):

___ Time to market

___ Time-definite service

___ Frequency of service

___ Reliability of service

___ Value of time relative to other modes

___ Security

___ Ability to track and trace

___ Perishability of product

___ Relative value of product

___ Proximity to ***[insert airport name]***

15. Among these air cargo shipments at ***[insert airport name]***, what are the top ten commodities that your company handled (See Attachment A for commodity codes):

Commodity	Code	Volume (metric tons)	Value ($)

Attachment A – Commodity Codes

Commodity Code	Commodity	Commodity Code	Commodity
1	Live animals		
2	Meat and edible meat offal	26	Ores, slag and ash
3	Fish and crustaceans, mollusks and other aquatic invertebrates	27	Mineral fuels, mineral oils and products of their distillation; bituminous substances; mineral waxes
4	Dairy produce; birds' eggs; natural honey; edible products of animal origin, not elsewhere specified or included	28	Inorganic chemicals; organic or inorganic compounds of precious metals, of rare-earth metals, of radioactive elements or of isotopes
5	Products of animal origin, not elsewhere specified or include	29	Organic chemicals
6	Live trees and other plants; bulbs, roots and the like; cut flowers and ornamental foliage	30	Pharmaceutical products
7	Edible vegetables and certain roots and tubers	31	Fertilizers
8	Edible fruit and nuts; peel of citrus fruit or melons	32	Tanning or dyeing extracts; tannins and their derivatives; dyes, pigments and other coloring matter; paints and varnishes; putty and other mastics; inks
9	Coffee, tea, maté and spices	33	Essential oils and resinoids; perfumery, cosmetic or toilet preparations
10	Cereals	34	Soap, organic surface-active agents, washing preparations, lubricating preparations, artificial waxes, prepared waxes, polishing or scouring preparations, candles and similar articles, modeling pastes, "dental waxes" and dental preparations with a basis of plaster
11	Products of the milling industry; malt; starches; inulin; wheat gluten	35	Albuminoidal substances; modified starches; glues; enzymes
12	Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; industrial or medicinal plants; straw and fodder	36	Explosives; pyrotechnic products; matches; pyrophoric alloys; certain combustible preparations
13	Lac; gums, resins and other vegetable saps and extracts	37	Photographic or cinematographic goods
14	Vegetable plaiting materials; vegetable products not elsewhere specified or included	38	Miscellaneous chemical products
15	Animal or vegetable fats and oils and their cleavage products; prepared edible fats; animal or vegetable waxes	39	Plastics and articles thereof

Commodity Code	Commodity	Commodity Code	Commodity
16	Preparations of meat, of fish or of crustaceans, mollusks or other aquatic invertebrates	40	Rubber and articles thereof
17	Sugars and sugar confectionery	41	Raw hides and skins (other than furskins) and leather
18	Cocoa and cocoa preparations	42	Articles of leather; saddlery and harness; travel goods, handbags and similar containers; articles of animal gut (other than silk-worm gut)
19	Preparations of cereals, flour, starch or milk; pastry cooks' products	43	Furskins and artificial fur; manufactures thereof
20	Preparations of vegetables, fruit, nuts or other parts of plants	44	Wood and articles of wood; wood charcoal
21	Miscellaneous edible preparations	45	Cork and articles of cork
22	Beverages, spirits and vinegar	46	Manufactures of straw, of esparto or of other plaiting materials; basket ware and wickerwork
23	Residues and waste from the food industries; prepared animal fodder	47	Pulp of wood or of other fibrous cellulosic material; recovered (waste and scrap) paper or paperboard
24	Tobacco and manufactured tobacco substitutes	48	Paper and paperboard; articles of paper pulp, of paper or of paperboard
25	Salt; sulfur; earths and stone; plastering materials, lime and cement	49	Printed books, newspapers, pictures and other products of the printing industry; manuscripts, typescripts and plans
50	Silk	74	Copper and articles thereof
51	Wool, fine or coarse animal hair; horsehair yarn and woven fabric	75	Nickel and articles thereof
52	Cotton	76	Aluminum and articles thereof
53	Other vegetable textile fibers; paper yarn and woven fabrics of paper yarn	77	(Reserved for possible future use in the Harmonized System)
54	Man-made filaments	78	Lead and articles thereof
55	Man-made staple fibers	79	Zinc and articles thereof
56	Wadding, felt and nonwovens; special yarns; twine, cordage, ropes and cables and articles thereof	80	Tin and articles thereof
57	Carpets and other textile floor coverings	81	Other base metals; cermets; articles thereof
58	Special woven fabrics; tufted textile fabrics; lace; tapestries; trimmings; embroidery	82	Tools, implements, cutlery, spoons and forks, of base metal; parts thereof of base metal

Commodity Code	Commodity	Commodity Code	Commodity
59	Impregnated, coated, covered or laminated textile fabrics; textile articles of a kind suitable for industrial use	83	Miscellaneous articles of base metal
60	Knitted or crocheted fabrics	84	Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof
61	Articles of apparel and clothing accessories, knitted or crocheted	85	Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles
62	Articles of apparel and clothing accessories, not knitted or crocheted	86	Railway or tramway locomotives, rolling-stock and parts thereof; railway or tramway track fixtures and fittings and parts thereof; mechanical (including electro-mechanical) traffic signaling equipment of all kinds
63	Other made up textile articles; sets; worn clothing and worn textile articles; rags	87	Vehicles other than railway or tramway rolling-stock, and parts and accessories thereof
64	Footwear, gaiters and the like; parts of such articles	88	Aircraft, spacecraft, and parts thereof
65	Headgear and parts thereof	89	Ships, boats and floating structures
66	Umbrellas, sun umbrellas, walking-sticks, seat-sticks, whips, riding-crops and parts thereof	90	Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus; parts and accessories thereof
67	Prepared feathers and down and articles made of feathers or of down; artificial flowers; articles of human hair	91	Clocks and watches and parts thereof
68	Articles of stone, plaster, cement, asbestos, mica or similar materials	92	Musical instruments; parts and accessories of such articles
69	Ceramic products	93	Arms and ammunition; parts and accessories thereof
70	Glass and glassware	94	Furniture; bedding, mattresses, mattress supports, cushions and similar stuffed furnishings; lamps and lighting fittings, not elsewhere specified or included; illuminated signs, illuminated name-plates and the like; prefabricated buildings
71	Natural or cultured pearls, precious or semi-precious stones, precious metals, metals clad with precious metal and articles thereof; imitation jewelry; coin	95	Toys, games and sports requisites; parts and accessories thereof
72	Iron and steel	96	Miscellaneous manufactured articles
73	Articles of iron or steel	97	Works of art, collectors' pieces and antiques

Shippers & Industry Representatives

Purpose of the Survey

Air cargo is vital to global commerce and our nation's economic strength. To aid airports in fully understanding the benefits and the economic impact of air cargo to their communities, the Airport Cooperative Research Program (ACRP) of the Transportation Research Board is conducting this project.

A research team, led by Battelle, is preparing a Guidebook for the Estimation of the Economic Impact of Air Cargo at Airports under ACRP 03-16. This guidebook will provide the essential and effective tools and techniques to create a uniform approach for airports to measure and value the contribution of air cargo activity to local, regional, and national economies – essentially help airports place real dollar amounts as to the value of air cargo at their airport. A very practical benefit in this effort for the entire air cargo business community will the provision of important information that can help airports justify and pursue available funding and lower the operating costs for tenants and users.

A key component of the Guidebook is a series of case studies of select airports. The research team is conducting interviews with airport operators, air carriers, cargo handlers, forwarders, trucking companies, shippers, and others impacted by air cargo service. The survey is being conducted by TransSolutions, a leader in modeling and analysis to the aviation industry. The telephone interview process will take 20 to 30 minutes. The researcher will attempt to gather available information to help answer questions prior to the call. We understand the competitive nature of your business and respect the importance of client relationships. In that regard, your answers will be completely confidential, and no specific product or client information will appear in the final report**.**

For air transportation service providers, the key issues to be investigated are:

- proportion of your company's / industry's use of air cargo relative to other modes of transport for air
- degree to which your company / industry could substitute other modes of transport for air
- proportion of your company's / industry's spending on air passenger transportation versus air cargo

General Information

1. Please provide contact information for the individual completing this survey:

   Name: ____

   Title or Role: ____

   Organization: ____

   Address: ____

   City, State, Zip: ____

   Phone Number: ____

   Email Address: ____

2. How many people are employed in your company / industry within the ***[insert airport name]*** economic region (defined by the counties in Attachment B)?

   ____

3. What is the average hourly wage or annual salary of these employees?

   ____________ □ Hourly wage □ Annual salary

4. Please identify your company / industry by NAICS code(s) (see Attachment A).

   ____

Air Cargo Information

5. What was the annual **value** of cargo handled by your company in the ***[insert airport name]*** economic region (defined by the counties in Attachment B) for the most recent full calendar year on record (include all modes)? Year of data: □2010 □ Other _________

   c) Value of **ALL** cargo handled in the region (000's dollars) _________

   d) Value of **AIR** cargo handled in the region (000's dollars) _________

   e) Value of **AIR** cargo handled through ***[insert airport name]*** airport (000's dollars) _________

6. What was the annual **volume** of cargo handled by your company in the ***[insert airport name]*** economic region (defined by the counties in Attachment B) for the most recent full calendar year on record (include all modes)? Year of data: □ 2010 □ Other _________

   How do you measure volume? □ metric tons □ kilograms □ pounds

   a) Volume of **ALL** cargo handled in the region _________

   b) Volume of **AIR** cargo handled in the region _________

   c) Volume of **AIR** cargo handled through ***[insert airport name]*** airport _________

7. Provide a breakdown the **volume** of **air** cargo your company handled through ***[insert airport name]*** domestically versus internationally and inbound versus outbound for the most recently reported full calendar year (should equal 6c). Year of data: □ 2010 □ Other _________

Volume	Domestic	International	Total
Inbound			
Outbound			
Total			

[Note: 1. Inbound or outbound may be handled in more than one airport on the way to or from the customer/supplier, so an estimate of secondary airports affected should be requested.

2. Shipments may also be coming or going multimodal, on rail or truck before or after it gets to an airport. 3. If shipper operates multiple shipping/receiving centers (e.g. General Motors GE, etc.) should the shipper be asked for data on each major shipping center?]

Market Response Information

8. Enter the **value** total from Question 5b in the Base Case column of the table below. Please estimate how that value in the base case would be distributed following a sustained, long-term increase in the market price of **air cargo.** Make sure that the totals of each column are equal. [See comment on Freight forwarder questionnaire regarding defining whether or not these increases are independent of general transportation industry prices.]

	Base Case	Market Price Increase			
		10%	25%	33%	50%
Air					
Other modes					
No Longer Shipped					
Total					

9. Enter the **value** total from Question 5b in the Base Case column of the table below. Estimate how that value in the base case would be distributed following a sustained, long-term increase in the market price of **only belly cargo space**. Make sure that the totals of each column are equal. [Same comment as above]

	Base Case	Market Price Increase			
		10%	25%	33%	50%
Cargo-Only Air					
Belly Air					
Other modes					
No Longer Shipped					
Total					

10. Enter the **volume** total from Question 6b in the Base Case column of the table below. Estimate how the percentage in the base case would be shipped following a sustained, long-term increase in the market price of **air cargo**. Make sure that the totals of each column are equal.

	Base Case	**Market Price Increase**			
		10%	**25%**	**33%**	**50%**
Air					
Other modes					
No Longer Shipped					
Total					

[Same comment as above]

11. Enter the **volume** total from Question 6b in the Base Case column of the table below. Estimate how the percentage in the base case would be shipped following a sustained, long-term increase in the market price of **only belly cargo space**? Please make sure that the totals of each column are equal.

	Base Case	**Market Price Increase**			
		10%	**25%**	**33%**	**50%**
Cargo-Only Air					
Belly Air					
Other modes					
No Longer Shipped					
Total					

12. Hypothetically speaking, suppose that air cargo services at ***[insert airport name]*** were discontinued for an extended [1 month? 1 year?] period, what alternative airports/modes would be used to ship the cargo? These percentages should be expressed in terms of value. The sum of all percentages should equal 100%.

		Percentage of Air Cargo Switched to Other Airports					
		1st Airport		2nd Airport		3rd Airport	
	Percentage shifted to:	**Name**	**Pct**	**Name**	**Pct**	**Name**	**Pct**
Air	%						
Other modes	%						
No longer shipped	%						
Total	100%						

Products Shipped by Air Cargo

13. What are the reasons that your customers select air transportation rather than other modes to ship cargo? Please rank the importance of each reason on a scale of 1 to 10 (**1** being extremely important):

___ Time to market
___ Time-definite service
___ Frequency of service
___ Reliability of service
___ Value of time relative to other modes
___ Security
___ Ability to track and trace
___ Perishability of product
___ Relative value of product
___ Proximity to ***[insert airport name]***

14. Among these air cargo shipments at ***[insert airport name]***, what are the top five commodities that your company handled (See Attachment C for commodity codes):

Commodity	Code	Volume (metric tons)	Value ($)

15. What is the annual spending of your company / industry on all air transport services? ___________

    What proportion of that amount is air cargo versus air **passenger** transport? ________________ [What proportion is for compliance with TSA requirements?]

16. What value would you assign to a 1-hour delay in shipment (carrying cost) for an average shipment (this number may be expressed as a dollar value or as a percentage of the value of the shipment)? [This is an important issue to the air cargo and airport industries. My experience indicates anecdotal responses are the most you will receive, if any. I needed this type of information to justify a new runway and other expensive improvements. A major express carrier gave me an estimate of the cost of one minute delay, but it only applied to specific "perfect storm" cases wherein they chartered aircraft to make up for missing a connection incoming from Asia. While this information did not reflect typical operational issues, it was useful for the Airport to use in advocating for infrastructure projects before the FAA, signatory airlines and internally within the Airport staff.

    ________________ □ Dollar value □ Percentage of shipment value

Attachment A – Industry NAICs Codes

Attachment B – Counties included in Airport Economic Region

Sector Num.	Sector
332	Air transportation
333	Rail transportation
334	Water transportation
335	Truck transportation
336	Transit and ground passenger transportation
337	Pipeline transportation
338	Scenic and sightseeing transportation and support activities for transportation
339	Couriers and messengers
340	Warehousing and storage
385	Facilities support services
386	Business support services
387	Investigation and security services
388	Services to buildings and dwellings
389	Other support services
390	Waste management and remediation services
429	Other Federal Government enterprises
430	State and local government passenger transit
431	State and local government electric utilities
432	Other state and local government enterprises

Attachment C – Commodity Codes

Commodity Code	Commodity	Commodity Code	Commodity
1	Live animals		
2	Meat and edible meat offal	26	Ores, slag and ash
3	Fish and crustaceans, mollusks and other aquatic invertebrates	27	Mineral fuels, mineral oils and products of their distillation; bituminous substances; mineral waxes
4	Dairy produce; birds' eggs; natural honey; edible products of animal origin, not elsewhere specified or included	28	Inorganic chemicals; organic or inorganic compounds of precious metals, of rare-earth metals, of radioactive elements or of isotopes
5	Products of animal origin, not elsewhere specified or include	29	Organic chemicals
6	Live trees and other plants; bulbs, roots and the like; cut flowers and ornamental foliage	30	Pharmaceutical products
7	Edible vegetables and certain roots and tubers	31	Fertilizers
8	Edible fruit and nuts; peel of citrus fruit or melons	32	Tanning or dyeing extracts; tannins and their derivatives; dyes, pigments and other coloring matter; paints and varnishes; putty and other mastics; inks
9	Coffee, tea, maté and spices	33	Essential oils and resinoids; perfumery, cosmetic or toilet preparations
10	Cereals	34	Soap, organic surface-active agents, washing preparations, lubricating preparations, artificial waxes, prepared waxes, polishing or scouring preparations, candles and similar articles, modeling pastes, "dental waxes" and dental preparations with a basis of plaster
11	Products of the milling industry; malt; starches; inulin; wheat gluten	35	Albuminoidal substances; modified starches; glues; enzymes
12	Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; industrial or medicinal plants; straw and fodder	36	Explosives; pyrotechnic products; matches; pyrophoric alloys; certain combustible preparations
13	Lac; gums, resins and other vegetable saps and extracts	37	Photographic or cinematographic goods
14	Vegetable plaiting materials; vegetable products not elsewhere specified or included	38	Miscellaneous chemical products
15	Animal or vegetable fats and oils and their cleavage products; prepared edible fats; animal or vegetable waxes	39	Plastics and articles thereof

Commodity Code	Commodity	Commodity Code	Commodity
16	Preparations of meat, of fish or of crustaceans, mollusks or other aquatic invertebrates	40	Rubber and articles thereof
17	Sugars and sugar confectionery	41	Raw hides and skins (other than furskins) and leather
18	Cocoa and cocoa preparations	42	Articles of leather; saddlery and harness; travel goods, handbags and similar containers; articles of animal gut (other than silk-worm gut)
19	Preparations of cereals, flour, starch or milk; pastry cooks' products	43	Furskins and artificial fur; manufactures thereof
20	Preparations of vegetables, fruit, nuts or other parts of plants	44	Wood and articles of wood; wood charcoal
21	Miscellaneous edible preparations	45	Cork and articles of cork
22	Beverages, spirits and vinegar	46	Manufactures of straw, of esparto or of other plaiting materials; basket ware and wickerwork
23	Residues and waste from the food industries; prepared animal fodder	47	Pulp of wood or of other fibrous cellulosic material; recovered (waste and scrap) paper or paperboard
24	Tobacco and manufactured tobacco substitutes	48	Paper and paperboard; articles of paper pulp, of paper or of paperboard
25	Salt; sulfur; earths and stone; plastering materials, lime and cement	49	Printed books, newspapers, pictures and other products of the printing industry; manuscripts, typescripts and plans
50	Silk	74	Copper and articles thereof
51	Wool, fine or coarse animal hair; horsehair yarn and woven fabric	75	Nickel and articles thereof
52	Cotton	76	Aluminum and articles thereof
53	Other vegetable textile fibers; paper yarn and woven fabrics of paper yarn	77	(Reserved for possible future use in the Harmonized System)
54	Man-made filaments	78	Lead and articles thereof
55	Man-made staple fibers	79	Zinc and articles thereof
56	Wadding, felt and nonwovens; special yarns; twine, cordage, ropes and cables and articles thereof	80	Tin and articles thereof
57	Carpets and other textile floor coverings	81	Other base metals; cermets; articles thereof
58	Special woven fabrics; tufted textile fabrics; lace; tapestries; trimmings; embroidery	82	Tools, implements, cutlery, spoons and forks, of base metal; parts thereof of base metal

Commodity Code	Commodity	Commodity Code	Commodity
59	Impregnated, coated, covered or laminated textile fabrics; textile articles of a kind suitable for industrial use	83	Miscellaneous articles of base metal
60	Knitted or crocheted fabrics	84	Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof
61	Articles of apparel and clothing accessories, knitted or crocheted	85	Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles
62	Articles of apparel and clothing accessories, not knitted or crocheted	86	Railway or tramway locomotives, rolling-stock and parts thereof; railway or tramway track fixtures and fittings and parts thereof; mechanical (including electro-mechanical) traffic signaling equipment of all kinds
63	Other made up textile articles; sets; worn clothing and worn textile articles; rags	87	Vehicles other than railway or tramway rolling-stock, and parts and accessories thereof
64	Footwear, gaiters and the like; parts of such articles	88	Aircraft, spacecraft, and parts thereof
65	Headgear and parts thereof	89	Ships, boats and floating structures
66	Umbrellas, sun umbrellas, walking-sticks, seat-sticks, whips, riding-crops and parts thereof	90	Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus; parts and accessories thereof
67	Prepared feathers and down and articles made of feathers or of down; artificial flowers; articles of human hair	91	Clocks and watches and parts thereof
68	Articles of stone, plaster, cement, asbestos, mica or similar materials	92	Musical instruments; parts and accessories of such articles
69	Ceramic products	93	Arms and ammunition; parts and accessories thereof
70	Glass and glassware	94	Furniture; bedding, mattresses, mattress supports, cushions and similar stuffed furnishings; lamps and lighting fittings, not elsewhere specified or included; illuminated signs, illuminated name-plates and the like; prefabricated buildings
71	Natural or cultured pearls, precious or semi-precious stones, precious metals, metals clad with precious metal and articles thereof; imitation jewelry; coin	95	Toys, games and sports requisites; parts and accessories thereof
72	Iron and steel	96	Miscellaneous manufactured articles
73	Articles of iron or steel	97	Works of art, collectors' pieces and antiques

APPENDIX C.

CASE STUDIES

Case Study 1 – Kansas City International Airport, Kansas City, MO

MCI has served the needs of travelers to the Midwest for over 25 years. Opening in 1972, the airport is owned and operated by the city of Kansas City, Missouri. The airport is located approximately 15 miles from the center of the city. Its 10,000-plus acres of airfield make it physically one of the largest airports in the U.S., and its three runways can accommodate up to 139 aircraft operations per hour. There are currently ten major airlines that operate out of the three passenger terminals at MCI, which saw an increase in passenger traffic in 2010 of 1.3 percent from the previous year, despite a decrease in total aircraft movements of 2.5 percent over 2009 (Kansas City Aviation Department 2012).

The airport is well-positioned in the United States for air cargo and distribution development. It must, however, compete with larger gateways where the ability to consolidate freight is a substantial advantage. In 2010, total cargo handling saw a decrease of 1.8 percent from the previous year due to a shift in domestic freight to trucking and total airmail operations. However, international freight saw a substantial 41.3 percent increase from the previous year (from a relatively small base) due mainly to increased charter activity (Kansas City Aviation Department 2012). The airport has a surplus of existing cargo capacity and enough land to expand if needed. The cargo area is comprised of four commercial cargo terminals with airside access. The cargo facilities contain an expansive cargo-handling infrastructure, onsite Foreign Trade Zone, and Enhanced Enterprise Zone tax initiatives. The city is also known for having the nation's second largest rail center, which contributes to the efficiency of the region's overall logistics system.

More than 95 percent of the cargo moving through MCI is processed by the integrators (Kansas City Aviation Department 2012). FedEx and United Parcel Service (UPS) control 73 percent and 25 percent of the cargo moving through the airport, respectively (Kansas City Aviation Department 2012). Since the early 1990's, much of the international origin-and-destination cargo from the Kansas City area has been trucked to international hubs such as Chicago and Dallas/Ft. Worth due to the lack of wide-body passenger aircraft at MCI. In 2011, passenger carriers accounted for less than 6.2 percent of the total freight carried at the airport and this percentage has diminished (BTS 2012). Trans-Pacific and trans-Atlantic air cargo markets may have some future potential if congestion builds at other established gateways. Domestic growth in the cargo industry is expected to increase in the future for integrated carriers, which could potentially have an impact on future cargo operations at MCI. It is likely that growth in the air cargo industry will also require leading carriers such as FedEx and UPS to adjust and update aircraft to accommodate the growing market, potentially affecting cargo operations at MCI.

This section describes the structure of the Kansas City regional economy, and the method for estimating the economic impact of air cargo through MCI airport. These estimates are presented at the scale of the 15-county Kansas City, MO-KS Metropolitan Statistical Area, consistent with the 2009 Office of Management and Budget (OMB) regional definition and comprised of the following counties:

- Franklin County, KS
- Johnson County, KS
- Leavenworth County, KS
- Linn County, KS
- Miami County, KS
- Wyandotte County, KS
- Bates County, MO
- Caldwell County, MO
- Cass County, MO
- Clay County, MO
- Clinton County, MO
- Jackson County, MO
- Lafayette County, MO
- Platte County, MO
- Ray County, MO

Airports play an essential role in supporting the growth of a metropolitan economy like the Kansas City region. They directly employ hundreds of workers and provide millions of dollars in direct economy activity and taxes and other revenues to local government. They also support the growth of the regional economy by moving people, goods, and services that originate in, or are transported through the region, in response to its market opportunities. Airports and related aviation facilities become structurally integrated into a region's economy and provide it with competitive advantages. Airports enable industries that either depend on, or learn to take advantage of, efficient air transportation to access domestic and international markets. In the Kansas City region, MCI plays this vital role.

The airport accommodated over 10 million passengers and nearly 86,000 metric tons of cargo in 2011, making it the 36th busiest passenger airport and 45th busiest cargo airport in North America according to ACI (2011).

Because the purpose of this project is to develop a guidebook for quantifying the economic impacts of air cargo, this analysis focuses on the cargo volumes through MCI, with limited analysis of passengers and airline operations. The primary objective of this analysis is to estimate the current economic impacts associated with the air cargo movement, estimating the economic output, employment, personal income, of that activity, and to document the analysis so as to make it easily replicable for other airports in other regions.

The analysis is based on RIMS-II multipliers. The RIMS-II multipliers are regional input-output multipliers developed and provided by the Bureau of Economic Analysis (BEA). These multipliers allow the user to estimate the economic impact of a change in final demand,[15] in earnings, or in employment on a region's economy.

[15] Also referred to as "change in output delivered to final users."

The multipliers are used to estimate changes in the regional economy that result from a change in activity relative to a baseline representation of the economy. The sources of the activity being measured vary, but typically involve changes in production or consumption activities, government policies, infrastructure, or changes in costs or technology. For any change in economic activity, the impacts on the economy are typically reported on one of three levels:

- Direct impacts represent the initial change in final demand for the industry sector(s) in question. For this analysis, we are estimating the economic activity associated with air cargo in Kansas City.

- Indirect impacts represent the response as supplying industries increase output to accommodate the initial change in final demand. These indirect beneficiaries spend money for supplies and services, which results in another round of indirect spending, and so on. Indirect impacts are often referred to as "supply-chain" impacts.

- Induced impacts are generated by the spending of households that benefit from the additional wages and income earned through direct and indirect economic activity. The increase in income, in effect, increases the purchasing power of households. Induced impacts are also described as "consumption-driven" effects.

This cycle of direct, indirect, and induced spending does not go on forever. It continues until the spending eventually leaks out of the economy as a result of taxes, savings, or purchases of non-locally produced goods and services or "imports."

The RIMS-II multipliers are provided for Type I and Type II impacts. Type I multipliers account for the direct and indirect impacts based on the supply of goods and services in the region. Type II multipliers account for these same direct and indirect impacts, and for induced impacts, associated with the purchases made by employees. Both types of multipliers include the initial change.

Kansas City Regional Economy

Kansas City is one of 422 Metropolitan Statistical Areas (MSA) in the United States. Based on its 2009 population estimate of 2,067,585, it is ranked 29th in size in the United States. Its per-capita personal income is about 102 percent of the national average.

The scale of economic activity occurring in the Kansas City region would not have been possible without development of the water, rail, highway, and airport infrastructure that enables businesses to take maximum advantage of the region's location.

The economic multiplier effect generated by air cargo activities depends on the geographic boundary or defined "region of analysis." A dollar spent in the City of Kansas City has a smaller impact on the city alone than it would have on the 15-county region. When selecting the region of analysis, the goal is to balance selecting an area that is large enough to capture a substantial portion of the economic multiplier effect and an area that is small enough to be relevant for the regional analysis.

Estimating MCI's Air-Cargo Contribution to the Regional Economy

This section summarizes the methods used to estimate MCI's current contribution to the regional economy. This effort quantifies the impact the air-cargo through the airport has on the economy at a particular moment in time, using input-output modeling and analysis recommended by the FAA (Butler and Kiernan 1992).

Measuring the economic impact of the cargo activity at the airport involves tracing the linkages between the airport's cargo activity level, expressed in terms of airport operations and air cargo volumes, and the sectors of the economy that interact with them. These linkages produce the "direct," or initial round of economic impact. Direct impacts, in turn, stimulate "indirect" impacts, from the supply of goods and services to businesses at the airport or production of goods for shipment by air. A third round of economic impacts, called "induced" impacts, results from the spending of income earned by direct and indirect employees. The sum of indirect and induced impacts is often referred to as the "multiplier effect" on direct impacts. Total economic impact is the sum of the direct, indirect, and induced impacts.

The first and perhaps most obvious source of MCI-related economic impact is the employees who work there. Though many are present to support the air passengers (such as passenger and visitor service providers), many are associated with airport operations and air cargo, including cargo-handling companies, customs agents, TSA, customs brokers, container freight stations, freight forwarders, trucking companies, and other cargo-related services.

A second important impact related to airport economic activity is the passenger impact, including expenditures for lodging, food, retail purchases, entertainment, transportation services and parking, among others. Again, the scope of this effort is focused on air cargo, rather than on passengers.

The final category of impact is the contribution of air cargo to the regional economy. The analysis of economic impacts of air cargo shipments is part of a developing area of economic research that is still limited by two key factors: 1) the lack of a complete and workable theory of the role of air cargo in economic development; and 2) the lack of data describing the quantity and value of exported goods at any level of specificity. We will explore these limitations and some analytic approaches to them in the next section.

Airport Operations

As noted earlier, the first and most obvious source of MCI-related economic impact is the employees who work there. Those associated with air cargo include airlines handling cargo, other cargo-handling companies, customs agents, TSA, customs brokers, container freight stations, freight forwarders, trucking companies, and other cargo-related services.

Employment data were provided by the airport authority and supplemented by the project surveys of air carriers. These combined data yielded the cargo-related employment estimates presented in the remainder of this section.

Cargo-related employment for airlines and forwarders were estimated from survey responses, employment data from the airport, and analyses of other similar airports.

Despite repeated attempts to gather employment data for several of the cargo-related categories listed above (customs agents, customs brokers, TSA, etc.), we were unable to secure such data. Therefore, it is likely that some of the categories are underrepresented in this analysis.

Information received on Kansas City airport cargo operations includes limited employment information from the airport and information from the survey of airlines. Given the information available, the figures for employment and employment categories were estimated from the information provided by the airport, and are shown in Table C-1.

Table C-1. Estimated Employment by Industry Group, MCI, 2010

	Number of Jobs (a)
Air Transport	27
Transportation Support Activities	380
Couriers and Messengers	55
Total	462

Source: Employer surveys and MCI Airport Authority.

Resulting output was estimated from these employment figures and the RIMS-II multipliers. Using the RIMS-II multipliers, we can determine the average number of direct jobs per million dollars change in final demand, as shown in Table C-2.

Table C-2. Using the Multipliers and an Estimate of the Number of Jobs the Final-demand Industry to Calculate Final-demand*

Industry	Final-demand Multiplier				Direct-effect Multiplier		
	Output (total industry output per $1 change in final-demand)	Earnings (total household earnings per $1 in final-demand)	Employment (total jobs per $1m change in final-demand)	Value-added (total value-added per $1 change in final-demand)	Earnings (total household earnings per $1 change of household earnings in the final-demand industry)	Employment (total jobs per 1 job change in the final-demand industry)	Direct jobs per $1m change in final-demand (col. c ÷ col. f)
	(a)	(b)	(c)	(d)	(e)	(f)	(g)
Air transportation	2.20	0.71	17.82	1.15	2.02	2.68	6.66
Support activities for transportation	2.44	0.87	22.41	1.42	2.07	2.79	8.04
Couriers and messengers	2.09	0.63	22.27	1.24	2.15	1.91	11.65

**Multipliers for the final-demand industry are used to calculate the final-demand change. The change in earnings in the final-demand industry is often referred to as the direct or initial earnings. Similarly, the change in jobs in the final-demand industry is often referred to as the direct or initial jobs.*

Source: BEA 2011.

From there, the number of direct jobs is divided by the direct jobs per $1 million in final demand to arrive at an estimated final demand, as shown in Table C-3.

Table C-3. Estimated Final Demand from Multipliers and Estimate of Jobs

	Direct Employment	Direct jobs per $1m change in final-demand (col. H from Table 2)	Estimated final-demand based on RIMS II assumptions and estimated new jobs in the final-demand industry (millions of dollars) (col. a / col. b)
	(a)	(b)	(c)
Air transportation	27	6.66	4.06
Support activities for transportation	380	8.04	47.25
Couriers and messengers	55	11.65	4.72

Source: BEA 2011.

For most types of goods-producing industries, the resulting estimated output would be adjusted for regional purchases in purchasers' prices, adjusting for transport costs and wholesale and retail margins. However, according to the I-O commodity composition of NIPA (BEA's National Income and Product Accounts) final use by exports of goods and services, the purchaser value is equivalent to the producer value for these industry categories, therefore, margining for producer prices does not apply.

These 462 direct jobs have an estimated output value of over $56 million as shown in Table C-4. In addition to the direct impacts, they would have an additional total impact estimated of over $134 million in output, over $47 million in aggregated earnings, and over 1,230 total jobs, as shown in Table C-4.

Table C-4. Estimated Economic Impact, Air Cargo Operations, MCI

	Regional Purchases (millions of dollars)	Final Demand Multiplier			Impact		
		Output (millions of dollars)	Earnings (millions of dollars)	Employment (number of jobs)	Output (millions of dollars) (col a * col b)	Earnings (dollars) (col a * col c)	Employment (number of jobs) (col a* col d)
	(a)	(b)	(c)	(d)	(e)	(f)	(g)
Air transportation	$4.06	$2.20	$0.71	17.82	$8.92	$2.87	72
Support activities for transportation	$47.25	$2.44	$0.87	22.41	$115.48	$41.31	1,059
Couriers and messengers	$4.72	$2.09	$0.63	22.27	$9.85	$2.99	105
Total	$56.02				$134.25	$47.18	1,236

Source: BEA 2011.

Air Cargo Impacts to Regional Economy

More difficult to quantify is the contribution of air cargo to the regional economy. However, it is generally agreed industries are concentrated within regions with direct access to air cargo operations. In the absence of this access, companies that rely on these services would likely re-locate to other regions with such access.

As noted earlier, the analysis of economic impacts of air cargo shipments is part of a developing area of economic research that is still limited by two key factors: 1) the lack of a complete and workable theory of the role of air cargo in economic development; and 2) the lack of data describing the quantity and value of exported goods at any level of specificity.

In the first category, one important issue that remains unanswered is the potential for shippers to utilize other airports in the region to export goods in the presence of air cargo supply constraints. For example, there are other airports within the trade area of MCI. This factor is important for modeling MCI's contribution to the regional economy. It would be unreasonable, for example, to simply subtract the entire value of goods exported by air, because this subtraction would grossly overstate the economic impacts of air cargo (i.e., the value of the goods shipped by air).

In the second category are severe air cargo limitations. There are few systematic sources of air cargo data. One is the US Department of Commerce import and export trade statistics and a second is the Commodity Flow Survey (CFS) undertaken every five years by a partnership between the Bureau of Transportation Statistics and the Census Bureau. Data are available for 89 National Transportation Analysis Regions (NTARs). The challenge is that these NTARs are generally larger in geographic area than the metropolitan regions being analyzed. (There are only 89 NTARs in the United States, compared to 422 Metropolitan Statistical Areas. As such, the NTARs are generally much larger than the metropolitan areas, making the cargo volumes for NTARs generally higher than those for the metropolitan areas.)

The Freight Analysis Framework (FAF) integrates data from a variety of sources to create a comprehensive picture of freight movement among states and major metropolitan areas by all modes of transportation. With data from the 2007 Commodity Flow Survey and additional sources FAF version 3 (FAF^3) provides estimates for tonnage and value by origin, destination, commodity, and mode for 2007, the most recent year, and forecasts through 2040.

According to the FAF, over 8 million tons of goods were shipped from the Kansas City Metropolitan area. Of that, nearly 1,040 tons were shipped via air (including truck and air).[16] The largest proportion of goods shipped by air is machinery by weight, comprising just under 15 percent of the weight of commodities shipped by air. In terms of value, transportation equipment is higher in value terms, nearly 47 percent of the value of goods shipped by air but

[16] The modes tracked by the Commodity Flow Survey are: For-hire truck, Private truck, Rail, Air, Shallow draft vessel, Deep draft vessel, Pipeline, Parcel/U.S. Postal Service/courier, Other, and Unknown.

just over 7 percent of the weight of goods shipped by air in 2007. Other major commodities shipped via air include electronics and precision equipment, as shown in Table C-5.

Table C-5. Shipment Characteristics by Commodity for Air Transportation (including Truck and Air) for Kansas City Metropolitan Area of Origin: 2007

Commodity	Value		Weight	
	Million $ in 2007	Percent of Total Value	KTons in 2007	Percent of Total Weight
Animal feed	0.0062	0.0%	0.0065	0.6%
Articles-base metal	1.3462	1.4%	0.0895	8.6%
Base metals	0.4849	0.5%	0.0524	5.1%
Basic chemicals	1.1997	1.2%	0.0697	6.7%
Cereal grains	0.005	0.0%	0.0038	0.4%
Chemical prods.	1.3744	1.4%	0.0421	4.1%
Coal-n.e.c.	0.0203	0.0%	0.0056	0.5%
Electronics	15.668	16.0%	0.1081	10.4%
Furniture	0.3874	0.4%	0.0122	1.2%
Live animals/fish	0.0372	0.0%	0.0005	0.0%
Machinery	12.9457	13.2%	0.1498	14.5%
Meat/seafood	0.0118	0.0%	0.0037	0.4%
Metallic ores	0.0025	0.0%	0.0075	0.7%
Milled grain prods.	0.0043	0.0%	0.0189	1.8%
Misc. mfg. prods.	0.3542	0.4%	0.0084	0.8%
Mixed freight	0.6968	0.7%	0.0116	1.1%
Motorized vehicles	0.2932	0.3%	0.0235	2.3%
Nonmetal min. prods.	0.6282	0.6%	0.0753	7.3%
Nonmetallic minerals	0	0.0%	0	0.0%
Other ag prods.	0.0054	0.0%	0.0005	0.0%
Other foodstuffs	0.1913	0.2%	0.0608	5.9%
Paper articles	0.1672	0.2%	0.0198	1.9%
Pharmaceuticals	3.2331	3.3%	0.0475	4.6%
Plastics/rubber	0.8406	0.9%	0.0478	4.6%
Precision instruments	11.0804	11.3%	0.0281	2.7%
Printed prods.	1.0938	1.1%	0.0349	3.4%
Textiles/leather	0.2452	0.2%	0.0117	1.1%
Transport equip.	45.8372	46.7%	0.0756	7.3%
Wood prods.	0.0088	0.0%	0.0206	2.0%
Grand Total	98.169	100.0%	1.0364	100.0%

Source: BTS 2009.

Cargo Screening and Jet Fuel Elasticity Modeling

The effects of the 100-percent cargo screening rule and volatility in jet-fuel prices were analyzed and described in a separate chapter, with price models developed to estimate the elasticity of demand upon price changes from the increased costs of the additional cargo screening and the increase in the price of air cargo due to increases in jet-fuel prices.

Cargo Screening Impacts

The elasticity analysis noted that the cargo screening includes three effects to be captured in the I-O models applied at the case-study airports:

- The reduced demand for air cargo modeled as a contraction in the industries engaged in air cargo operations
- Increased output by air transportation engaged in air cargo screening activities
- Increased output for air transportation companies due to overhead applied to air-cargo screening costs (this third impact serves to counterbalance the first effect)

Table C-6 presents the air cargo the inputs required for the I-O models. The reduction in freight presented in this table represents the percentage reduction in total (cargo-only and cargo transported on-board passenger airplanes) cargo. The impacts vary depending on the price elasticity modeled at each airport and the scale of air cargo transported on-board passenger aircraft. The screening rule does not affect cargo-only aircraft. The negative economic effects reduce the economic output of the industry. The cargo screening costs and industry markup attached to those costs reflect the price increase that is passed on to the customer. These values reflect increased revenue/output to the air transportation and supporting industries.

Table C-6. Air Cargo Screening Inputs for I-O Models

Airport	Reductions in Freight		Cargo Screening Costs		Gross Industry Surplus on Cargo Screening Costs	
	TSA Analysis	Industry Estimates	TSA Analysis	Industry Estimate	TSA Analysis	Industry Estimate
IAH	-0.6%	-0.9%	$8,944,118	$12,775,705	$751,501	$1,073,438
JFK	-2.7%	-3.8%	$25,241,205	$36,054,330	$2,120,813	$3,029,352
MCI	-0.4%	-0.6%	$247,949	$354,169	$20,833	$29,758
RNO*	-0.1%	-0.1%	$71,619	$102,300	$6,018	$8,595
SDF	0.0%	0.0%	$101,236	$144,605	$8,506	$12,150

For Kansas City, the reductions in freight and counterbalancing increases in cargo screening impacts results in the following direct impacts:

Table C-7. Air Cargo Screening Inputs for MCI I-O Modeling

Grand Total Changes	Lower Estimate	Upper Estimate
Air Transport	($15,854)	($24,390)
Transportation Support Activities	($182,264)	($280,645)
Couriers/messengers	($28,320)	($42,480)
Total Changes	($226,438)	($347,515)

According to the RIMS-II multipliers, these direct impacts of between $226,400 and $348,000 would result in between $539,400 and $828,600 in total impact, as shown in Table C-8 below.

Table C-8. Economic Impact Associated with Cargo Screening

	Regional Purchases (dollars)	Output (dollars)	Earnings (dollars)	Employment (number of jobs)	Value-added (dollars)
Cargo Screening- lower estimate					
Transport by air	($15,854)	($34,865)	($11,234)	(0.28)	($18,181)
Sup't activities/ air transport	($182,264)	($445,490)	($159,372)	(4.08)	($258,742)
Couriers/messengers	($28,320)	($59,078)	($17,963)	(0.63)	($35,049)
Total Impact	($226,438)	($539,433)	($188,569)	(5.00)	($311,972)
Cargo Screening- upper estimate					
Transport by air	($24,390)	($53,636)	($17,283)	(0.43)	($27,970)
Sup't activities/ air transport	($280,645)	($685,953)	($245,396)	(6.29)	($398,404)
Couriers/messengers	($42,480)	($88,618)	($26,945)	(0.95)	($52,573)
Total Impact	($347,515)	($828,206)	($289,624)	(7.67)	($478,947)

Impacts of Jet Fuel Price Fluctuations

The second elasticity model developed examines the impacts of jet-fuel price increases on air cargo demand. It examined the impacts associated with 10 to 30 percent increases in jet-fuel prices, using a stepwise regression approach.

Table C-9 presents the impacts of a 10, 20, and 30 percent increase in jet fuel prices on demand for air cargo at each of the five case study airports. For every 10 percent increase in jet-fuel prices, air cargo demand is estimated to decline by 0.7 percent.

Table C-9. Impacts of Jet Fuel Price Increases (10, 20, and 30 percent) on Demand for Air Cargo

	Impacts of Jet Fuel Prices Increases on Demand for Air Cargo		
Airport	**10%**	**20%**	**30%**
IAH	(6,368,857)	(12,737,715)	(19,106,572)
JFK	(21,150,552)	(42,301,105)	(63,451,657)
MCI	(1,354,130)	(2,708,260)	(4,062,390)
RNO	(781,291)	(1,562,582)	(2,343,873)
SDF	(33,956,926)	(67,913,853)	(101,870,779)
Reduction in Air Cargo	**-0.7%**	**-1.5%**	**-2.2%**

Applying these values to the on-airport operations yields the following results for the 10, 20, and 30-percent increases in jet-fuel prices. As shown in Table C-10, the reduction in output ranges from $939.7 thousand to $2.8 million for 10 percent and 30 percent increases in jet fuel prices, respectively.

Table C-10. Economic Impacts of Jet Fuel Price Increases (10, 20, and 30 percent)

	Regional Purchases (dollars)	Output (dollars)	Earnings (dollars)	Employment (number of jobs)	Value-added (dollars)
10% increase in fuel price					
.7% decrease in cargo volume					
Transport by air	($28,399)	($62,453)	($20,124)	(0.5)	($32,568)
Sup't activities/ air transport	($330,721)	($808,348)	($289,182)	(7.4)	($469,492)
Couriers/messengers	($33,035)	($68,915)	($20,954)	(0.7)	($40,885)
Total Impact	($392,156)	($939,717)	($330,261)	(8.7)	($542,945)
20% increase in fuel price					
1.5% decrease in cargo volume					
Transport by air	($60,856)	($133,828)	($43,122)	(1.1)	($69,789)
Sup't activities/ air transport	($708,688)	($1,732,175)	($619,677)	(15.9)	($1,006,053)
Couriers/messengers	($70,790)	($147,675)	($44,902)	(1.6)	($87,610)
Total Impact	($840,334)	($2,013,678)	($707,701)	(18.5)	($1,163,453)
20% increase in fuel price					
1.5% decrease in cargo volume					
Transport by air	($85,198)	($187,359)	($60,371)	(1.5)	($97,705)
Sup't activities/ air transport	($992,163)	($2,425,045)	($867,547)	(22.2)	($1,408,475)
Couriers/messengers	($99,106)	($206,746)	($62,863)	(2.2)	($122,654)
Total Impact	($1,176,467)	($2,819,150)	($990,782)	(26.0)	($1,628,834)

Case Study 2 – Louisville International Airport, Louisville, KY

Louisville International Airport (SDF), located just 10 minutes from downtown Louisville, Kentucky was originally established by the U.S. Army Corp of Engineers in 1941. The airport efficiently operates with two parallel runways and one crosswind runway and more than 62,000 linear feet of Taxiways. In 2011, the Airport recorded 152,998 operations (take offs and landings). Situated on 1,200 acres, the airport contains a centralized terminal facility with 23 passenger gates. In 2010, the airport served more than 3.3 million passengers. This represented an increase of 2.6 percent over 2009 traffic volumes (Louisville Regional Airport Authority 2012). Currently, 8 major commercial passenger airlines operate out of SDF. These carriers mainly serve the Midwest and east coast, however, there are a few western destinations including Las Vegas, Nevada and Denver, Colorado. Most of the operations are with narrow-body aircraft or regional jets that provide very limited belly capacity for cargo. SDF is also home to the 123rd Wing of the Kentucky Air National Guard, and one of the top air cargo facilities in the world.

SDF is ranked 10th among the top air cargo airports in the world and ranks 3rd domestically behind Memphis, Tennessee and Anchorage, Alaska (which is essentially a transfer facility and fuel stop for transpacific traffic). SDF processed over 2.3 million tons of total cargo in 2010 - up 11.2 percent from the previous year (Louisville Regional Airport Authority 2012). In 2011, the Airport's cargo volumes were flat due to recent economic stagnation.

Cargo is the fortress hub of United Parcel Service (UPS) and its massive Worldport facility. This substantial operation connects Louisville to 220 countries and territories and process 416,000 packages per hour. In addition to their Worldport facility, UPS added a heavy airfreight hub in 2005 that provides an additional 686,000 square feet of space for operations (UPS 2011). The Worldport facility occupies approximately 5.2 million square feet of space. The second UPS Worldport expansion was completed in 2010 increasing the facilities sorting capacity by 37 percent. The operation, which is dominated by an extremely sophisticated material handling system, is nevertheless extremely labor intensive.

This section describes the structure of the Louisville regional economy, and the method for estimating the economic impact of air cargo through SDF airport. These estimates are presented at the scale of the eight-county region, comprised of Bullitt, Jefferson, Oldham, and Shelby counties in Kentucky, and Clark, Floyd, Harrison, and Scott counties in Indiana.

Airports play an essential role in supporting the growth of a metropolitan economy like the Louisville region. They directly employ hundreds of workers and provide millions of dollars in direct economic activity and taxes and other revenues to local government. They also support the growth of the regional economy by moving people, goods, and services that originate in, or are transported through, the region. Airports and related aviation facilities become structurally integrated into a region's economy and provide it with competitive advantages. Airports enable industries that either depend on, or learn to take advantage of, efficient air transportation to access domestic and international markets. In the Louisville region, SDF plays this vital role.

Because the purpose of this project is to develop a guidebook for quantifying the economic impacts of air cargo, this analysis focuses on the cargo volumes through SDF, with limited analysis of passengers and airline operations. The primary objective of this analysis is to estimate the current economic impacts associated with the air cargo movement, estimating the economic output, employment, personal income, of that activity, and to document the analysis so as to make it easily replicable for other airports in other regions.

This memo first describes the structure of the Louisville metropolitan economy in 2009, using a Louisville region-specific version of the IMPLAN impact analysis software.[17] It then presents the methods used to estimate the air-cargo contribution to the economy, and finally presents estimates of economic impact of that air-cargo movement.

The model is used to measure changes in the regional economy that result from a change in activity relative to a baseline representation of the economy. The sources of the activity being measured vary, but typically involve changes in production or consumption activities, government policies, infrastructure, or changes in costs or technology. For any change in economic activity, the impacts on the economy can be reported on one of three levels:

- **Direct** impacts represent the initial change in final demand for the industry sector(s) in question. For this analysis, we are estimating the economic activity associated with air cargo in Louisville.

- **Indirect** impacts represent the response as supplying industries increase output to accommodate the initial change in final demand. These indirect beneficiaries spend money for supplies and services, which results in another round of indirect spending, and so on. Indirect impacts are often referred to as “supply-chain” impacts.

- **Induced** impacts are generated by the spending of households who benefit from the additional wages and income they earn through direct and indirect economic activity. The increase in income, in effect, increases the purchasing power of households. Induced impacts are also described as “consumption-driven” effects.

This cycle of direct, indirect, and induced spending does not go on forever. It continues until the spending eventually leaks out of the economy as a result of taxes, savings, or purchases of non-locally produced goods and services or “imports”.

Louisville Regional Economy

This section summarizes the Louisville economy, and presents an economic portrait of the region’s economy in terms of employment and output by industry for the base year of 2009.

Louisville is one of 422 MSAs in the United States. Based on its 2009 population estimate of 1.14 million, it is ranked 42nd in size in the United States. Its per-capita personal income is about 95 percent of the national average. There are an estimated 726,742 jobs across 356 industries in the region. The top industries by employment are presented in Table C-11.

[17] The IMPLAN model is based on an input-output modeling framework, and uses secondary source data and proprietary analytic methods to estimate empirical input-output relationships from a combination of national technological relationships and county-level measures of economic activity.

Table C-11. Top Ten Industries, Ranked by Employment
Louisville Region, 2009

Code	Description	Employment	Labor Income	Output
413	Food services and drinking places	49,539	$1,022,839,000	$2,829,005,000
438	State & local govt, education	44,401	$2,489,589,000	$2,828,209,000
360	Real estate establishments	30,527	$285,869,900	$2,811,924,000
319	Wholesale trade businesses	27,909	$2,034,809,000	$5,337,690,000
394	Offices of physicians, dentists, and other health practitioners	22,438	$1,658,313,000	$2,806,253,000
397	Private hospitals	21,994	$1,353,499,000	$2,895,250,000
382	Employment services	20,393	$410,902,500	$599,624,600
339	Couriers and messengers	17,650	$1,341,379,000	$3,645,585,000
357	Insurance carriers	17,154	$1,308,918,000	$5,289,567,000
437	State & local govt, non-education	14,988	$776,938,200	$882,612,900

Source: MIG 2011a.

The top industries ranked by output are presented in Table C-12.

Table C-12. Top Ten Industries, Ranked by Output
Louisville Region, 2009

Code	Description	Employment	Labor Income	Output
277	Light truck and utility vehicle manufacturing	3,314	$349,197,500	$5,516,958,000
319	Wholesale trade businesses	27,909	$2,034,809,000	$5,337,690,000
357	Insurance carriers	17,154	$1,308,918,000	$5,289,567,000
361	Imputed rental activity for owner-occupied dwellings	0	$0	$4,360,240,000
339	Couriers and messengers	17,650	$1,341,379,000	$3,645,585,000
397	Private hospitals	21,994	$1,353,499,000	$2,895,250,000
413	Food services and drinking places	49,539	$1,022,839,000	$2,829,005,000
438	State & local govt, education	44,401	$2,489,589,000	$2,828,209,000
360	Real estate establishments	30,527	$285,869,900	$2,811,924,000
394	Offices of physicians, dentists, and other health practitioners	22,438	$1,658,313,000	$2,806,253,000

Source: MIG 2011a.

The scale of economic activity occurring in the Louisville region would not have been possible without development of the water, rail, highway, and airport infrastructure that enables businesses to take maximum advantage of the region's strategic location at the midpoint of key North American trade routes. Today, the region is a major hub of express freight, with over 20,000 UPS employees based in the Louisville region. Though UPS had a hub in Louisville since 1980, it was in 2002 that the company made its first $1 billion expansion, establishing Louisville as "Worldport", the company's worldwide air hub. A second $1 billion expansion was completed in April 2010, bringing its facility to 5,200,000 square feet, with capacity to handle 416,000 packages per hour (UPS 2011).

The regional economic impacts of air cargo through SDF are directly related to the scale and composition of the air cargo forecasts (i.e., international versus domestic, and belly cargo versus all-cargo freighters).

Estimating SDF's Air-Cargo Contribution to the Regional Economy

This section summarizes the methods used to estimate SDF's current contribution to the regional economy. This effort quantifies the impact the air-cargo through the airport has on the economy at a particular moment in time, using input-output modeling and analysis recommended by the FAA (Butler and Kiernan 1992).

Measuring the economic impact of the cargo activity at the airport involves tracing the linkages between the airport's cargo activity level, expressed in terms of airport operations and air cargo volumes, and the sectors of the economy that interact with them. These linkages produce the "direct," or initial round of economic impact. Direct impacts, in turn, stimulate "indirect" impacts, from the supply of goods and services to businesses at the airport or production of goods for shipment by air. A third round of economic impacts, called "induced" impacts, results from the spending of income earned by direct and indirect employees. The sum of indirect and induced impacts is often referred to as the "multiplier effect" on direct impacts. Total economic impact is the sum of the direct, indirect, and induced impacts.

The first and perhaps most obvious source of SDF-related economic impact is the employees who work there. Though many are present to support the air passengers (such as passenger and visitor service providers), many are associated with airport operations and air cargo, including cargo-handling companies, customs agents, TSA, customs brokers, container freight stations, freight forwarders, trucking companies, and other cargo-related services.

A second important impact related to airport economic activity is the passenger impact, including expenditures for lodging, food, retail purchases, entertainment, transportation services and parking, among others. Again, the scope of this effort is focused on air cargo rather than on passengers.

The final category of impact is the contribution of air cargo to the regional economy. The analysis of economic impacts of air cargo shipments is part of a developing area of economic research that is still limited by two key factors: 1) the lack of a complete and workable theory of the role of air cargo in economic development; and 2) the lack of data describing the quantity and value of exported goods at any level of specificity. We will explore these limitations and some analytic approaches to them in the next section.

Airport Operations

As noted earlier, the first and most obvious source of SDF-related economic impact is the employees who work there. Those associated with air cargo include airlines handling cargo, other cargo-handling companies, customs agents, TSA, customs brokers, container freight stations, freight forwarders, trucking companies, and other cargo-related services.

Employment data were provided by the airport authority and supplemented by the project surveys of air carriers. These combined data yielded the cargo-related employment estimates presented in the remainder of this section.

Cargo-related employment for airlines and forwarders were estimated from survey responses, employment data from the airport, and analyses of other similar airports.

Despite repeated attempts to gather employment data for several of the cargo-related categories listed above (customs agents, customs brokers, TSA, etc.), we were unable to secure such data. Therefore, it is likely that some of the categories are underrepresented in this analysis. Employment with other air freight companies was extrapolated using cargo volumes reported by the airport and UPS' employment in their air business unit.

Of UPS' 20,288 Louisville employees, 13,934 work in the air business unit. Using the employment in the air business unit and the airport-reported air-cargo volume for UPS of 2.396 billion enplaned pounds and 2.280 billion deplaned pounds yields an average of about 167.8 tons of air-cargo volume per employee. There are shortcomings to this approach given UPS' atypical operations. However, other freight-handling companies operating in this area need to do so in a way which effectively competes with UPS, supporting the application of UPS' business model to ratios of other freight-handling companies. Applying that UPS average to the volume of air cargo reported by other air freight carriers to the airport suggests air-cargo related employment in the Louisville region of 243 employees with other air freight employers (Table C-13).

Table C-13. Estimated Employment by Industry Group, SDF, 2010

Industry	Estimated Employment
Airlines	40
Freight forwarders	45
Other express package companies	243
UPS	20,288
Total	20,616

Source: Employer surveys, Louisville Regional Airport Authority.

These 20,616 direct jobs have an estimated aggregated labor income of $1.6 billion, and estimated output value of nearly $4.6 billion. In addition to these direct impacts, they would have an additional indirect impact of an estimate 9,200 indirect with nearly $413 million in labor in come and over $1 billion in output, and an additional 16,200 induced jobs with nearly $624 million in labor in come and over $1.8 billion in output, as shown in Table C-14.

Table C-14. Estimated Economic Impact, Air Cargo Operations, SDF

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	20,616.0	$1,628,987,781	$3,003,199,929	$4,582,713,114
Indirect Effect	9,241.3	$412,823,692	$630,001,968	$1,035,052,465
Induced Effect	16,227.4	$623,604,815	$1,114,000,105	$1,853,075,695
Total Effect	46,084.7	$2,665,416,288	$4,747,202,002	$7,470,841,275

Source: MIG 2011a.

Air Cargo Impacts to Regional Economy

More difficult to quantify is the contribution of air cargo to the regional economy. However, it is generally agreed that industries are concentrated within regions with direct access to air cargo operations. In the absence of this access, companies that rely on these services would likely re-locate to other regions with such access.

As noted earlier, the analysis of economic impacts of air cargo shipments is part of a developing area of economic research that is still limited by two key factors: 1) the lack of a complete and workable theory of the role of air cargo in economic development; and 2) the lack of data describing the quantity and value of exported goods at any level of specificity.

In the first category, one important issue that remains unanswered is the potential for shippers to utilize other airports in the region to export goods in the presence of air cargo supply constraints. For example, there are other airports within the trade area of SDF. This factor is important for modeling SDF's contribution to the regional economy. It would be unreasonable, for example, to simply subtract the entire value of goods exported by air, because this subtraction would grossly overstate the economic impacts of air cargo (i.e., the value of the goods shipped by air).

In the second category are severe air cargo data limitations. There are few systematic sources of air cargo data. One is the US Department of Commerce import and export trade statistics and a second is the CFS undertaken every five years by a partnership between the BTS and the Census Bureau. Data are available for 89 NTARs. The challenge is that these NTARs are generally larger in geographic area than the metropolitan regions being analyzed. (There are only 89 NTARs in the United States, compared to 422 MSAs. As such, the NTARs are generally much larger than the metropolitan areas, making the cargo volumes for NTARs generally higher than those for the metropolitan areas.)

According to the CFS, over 52 million tons of goods were shipped from the Kentucky part of the Louisville/Jefferson County-Elizabethtown-Scottsburg Metropolitan area. Of that, 11,000 tons were shipped via air (including truck and air).[18] The largest proportion of goods shipped by air is machinery by both weight and value terms, comprising 40 percent of the value of goods shipped by air and over 36 percent of the weight of goods shipped by air in 2007. Other major commodities shipped via air include electronics, printed products, pharmaceutical products, miscellaneous manufactured products, and articles of base metal. Unfortunately, the data for many of the commodities are suppressed for confidentiality, as shown in Table C-15.

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[18] The modes tracked by the Commodity Flow Survey are: For-hire truck, Private truck, Rail, Air, Shallow draft vessel, Deep draft vessel, Pipeline, Parcel/U.S. Postal Service/courier, Other, and Unknown.

Table C-15. Shipment Characteristics by Two-Digit Commodity and Mode of Transportation for Metropolitan Area of Origin: 2007
Louisville/Jefferson County-Elizabethtown-Scottsburg, KY-IN (KY part)

		Value	Tons
SCTG (2) Code	**Commodity Description**	**2007 (million $)**	**2007 (thousands)**
07	Other prepared foodstuffs and fats and oils	S	S
08	Alcoholic beverages	S	S
20	Basic chemicals	S	S
21	Pharmaceutical products	3	-
23	Chemical products and preparations, nec	S	S
24	Plastics and rubber	S	S
28	Paper or paperboard articles	S	S
29	Printed products	2	1
30	Textiles, leather, and articles of textiles or leather	S	S
31	Nonmetallic mineral products	-	-
32	Base metal in prim. or semifin. forms & in finished basic shapes	S	S
33	Articles of base metal	4	-
34	Machinery	176	4
35	Electronic & other electrical equip & components & office equip	45	S
36	Motorized and other vehicles (including parts)	S	S
38	Precision instruments and apparatus	S	S
40	Miscellaneous manufactured products	4	S
43	Mixed freight	S	S
00	**All Commodities (5)**	**440**	**11**

S = Estimate does not meet publication standards because of high sampling variability or poor response quality. - = Zero or Less than half the unit shown; thus, it has been rounded to zero.
Notes: (1) Commodity Flow Survey (CFS) geographic areas were drawn from a subset of Combined Statistical Areas (CSAs) and Metropolitan Statistical Areas (MeSAs) as defined by the Office of Management and Budget (OMB). However, CFS metropolitan areas are divided into their state parts when they include more than one state. In addition, the CFS also utilizes a unique geography referred to as, "remainder of state," to represent those areas of a state not contained within a separately published metropolitan area for the CFS (as opposed to not part of any Core-Based Statistical Area (CBSA) as defined by OMB). Because of the differences in the CFS geography, as compared to OMB defined geography, caution should be exercised when comparing CFS estimates to other estimates of similar geography.
(2) Standard Classification of Transported Goods.
(6) "Truck" as a single mode includes any shipment that was made by private truck only, by for-hire truck only, or by a combination of private and for-hire truck.
Source: BTS 2009.

Given the lack of data, one approach is to utilize the linkage or interdependence between businesses, industries and clusters. One tool common with cluster analysis is to study the Location Quotient (LQ)[19], which measures industry concentration in a regional economy. It does so by comparing the ratio of employment in a certain sector of a local economy to the same

[19] Location Quotient: Ratio of analysis-industry employment in the analysis area to base-industry employment in the analysis area divided by the ratio of analysis-industry employment in the base area to base-industry employment in the base area.

ratio in a comparison economy, identifying specializations in the local economy. An LQ value of 1.0 indicates that employment in an industry in the regional economy is in exactly the same proportion as the national average, an LQ value greater than 1.0 indicates that employment in the industry has a higher concentration that of the reference economy, and—similarly—an LQ value lower than 1.0 indicates a lower employment concentration in the industry than that of the reference economy.

This analysis uses the BLS' Location Quotient Calculator of the 2010 Quarterly Census of Employment and Wages (QCEW) data (BLS 2011). It uses the Louisville MSA as the analysis area and the U.S. total as the reference area. Concentrations or specialties in the regional economy emerge at the two-digit NAICS level, as shown in Table C-16.

Table C-16. Location Quotients Calculated from Quarterly Census of Employment and Wages Data, 2010

Industry	Louisville, KY-IN MSA
Base Industry: Total, all industries	1
NAICS 11 Agriculture, forestry, fishing and hunting	0.14
NAICS 21 Mining, quarrying, and oil and gas extraction	ND
NAICS 22 Utilities	0.68
NAICS 23 Construction	0.99
NAICS 31-33 Manufacturing	ND
NAICS 42 Wholesale trade	1.02
NAICS 44-45 Retail trade	0.91
NAICS 48-49 Transportation and warehousing	2.06
NAICS 51 Information	0.74
NAICS 61 Educational services	ND
NAICS 62 Health care and social assistance	0.98
NAICS 71 Arts, entertainment, and recreation	0.95
NAICS 52 Finance and insurance	1.31
NAICS 53 Real estate and rental and leasing	0.79
NAICS 54 Professional and technical services	0.79
NAICS 55 Management of companies and enterprises	ND
NAICS 56 Administrative and waste services	ND
NAICS 72 Accommodation and food services	0.98
NAICS 81 Other services, except public administration	ND
NAICS 99 Unclassified	0.1

Footnotes:
(ND) Not Disclosable
Source: BLS 2011.

Compared to the U.S. average, the Louisville region has relatively lower concentrations of most industry groupings (or LQs) for most industry groups, with exceptions in Wholesale Trade, and Transportation and Warehousing, most likely due to the role of UPS' regional operations and related industries. The relatively high LQ in the Finance and Insurance industry group is likely due to the presence of key Bank of America and Citicorp operations in the Louisville region.

Though some of the data are suppressed for confidentiality reasons, we can explore the employment concentrations at the three-digit level for some codes, including NAICS codes 481 through 493, as shown in Table C-17.

Table C-17. Location Quotients Calculated from Quarterly Census of Employment and Wages Data, 2010
NAICS Codes 481 through 493 Only

Industry	Louisville, KY-IN MSA
Base Industry: Total, all industries	1
NAICS 481 Air transportation	0.25
NAICS 482 Rail transportation	ND
NAICS 483 Water transportation	ND
NAICS 484 Truck transportation	1.47
NAICS 485 Transit and ground passenger transportation	0.46
NAICS 486 Pipeline transportation	ND
NAICS 487 Scenic and sightseeing transportation	ND
NAICS 488 Support activities for transportation	0.9
NAICS 491 Postal service	1.08
NAICS 492 Couriers and messengers	7.29
NAICS 493 Warehousing and storage	2.25

(ND) Not Disclosable
Source: BLS 2011.

At the three-digit level, it is evident that the higher LQs in the transportation and warehousing are related to the very high LQ of NAICS code 492 (couriers and messengers)—most likely attributable to the presence of UPS. At 7.29, the courier and messenger industry is over seven times as concentrated in the Louisville region than in the U.S. national average overall. Warehousing and storage is also very concentrated—more than twice as concentrated as the U.S. national average, likely made possible by the concentration of courier and messenger services. It is interesting to note that these concentrations are present in spite of the fact that truck transportation is just slightly higher than the national average and air transportation actually has a very low LQ—one-quarter the concentration of the U.S. national average.

One way to approach the LQ to estimate the impact of air cargo in the region is to quantify the economic impact of the air cargo on the regional economy is model the portion of the high LQ industries. For example, with the truck transportation LQ at 1.47 and warehousing and storage at 2.25, it is likely that 32 percent of truck transportation (the "extra 0.47") and 55.6 percent of warehousing and storage (the "extra 1.25") are due to the presence of UPS' Worldport operations (Table C-18).

Table C-18. Estimation of Economic Activity Attributable to Presence of UPS' Worldport Operations

	LQ	Percentage over Base	Total Industry Employment	"Extra" Employment due to presence of UPS' Worldport
NAICS 484 Truck transportation	1.47	32.0%	10,741	3,434
NAICS 493 Warehousing and storage	2.25	55.6%	6,022	3,346

Source: Bureau of Labor Statistics 2011and MIG 2011a.

Using total industry employment in each of those industries, we are able to calculate the additional employment in the industry due to the presence of UPS' Worldport operations and to estimate the economic impacts associated with those activities.

As one indicator, the warehousing and storage industry in the Louisville metropolitan region has over 6,000 employees in aggregate. According to the shippers' survey, many of the shippers in this region fall into this warehousing and storage category, and many of them state explicitly that they chose to locate in this region largely due to the presence of UPS' Worldport operations. For example, some of the key shippers engaged in this activity include the employers outlined in Table C-19.

Table C-19. Key Shippers Attributable to Presence of UPS' Worldport Operations

Employer	Number of Employees
Alliance Entertainment LLC	300
Best Buy Co Inc DC #1376	100
Gilt Group	180
GSI Commerce Solutions Inc	325
JOM Pharmaceutical Services Inc	43
Medline Industries Inc	47
Zappos Fulfillment Centers Inc	971
Total	**1,966**

Source: Kentucky Cabinet for Economic Development 2011.

Industries with high LQs built into our estimates (e.g., trucking and warehousing operations) are included because Worldport offers such a strong competitive advantage that it can be argued to be the dominant attractor to those industries. The economic impacts of the companies highlighted in our analysis (and listed in Table C-19) were characterized as warehousing operations and are thus included in the trucking/warehousing employment estimates. These 1,966 direct jobs have an estimated aggregated labor income of $86.4 million, and estimated output value of over $180 million.

Using the increased employment of 6,780 for the truck transportation and warehousing and storage industries from the LQ analysis, the impact of these economic activities includes a total impact of 13,345 jobs, with a total of over $595 million in labor income and total output of over $1.5 billion (Table C-20).

Table C-20. Estimated Economic Impact, Enhanced Truck Transportation and Warehousing and Storage Industries

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	6,780.0	$327,398,501	$420,554,676	$806,524,806
Indirect Effect	2,918.2	$127,869,435	$201,068,011	$326,858,325
Induced Effect	3,646.5	$139,986,987	$250,213,553	$416,130,791
Total Effect	13,344.7	$595,254,923	$871,836,241	$1,549,513,922

Source: MIG 2011a.

The competitive advantage offered by Worldport could be argued to extend to other industries with a heavy reliance on air cargo (such as machinery or electronics); however, because of a lack of data to link these industries empirically to air cargo, any attempt to include them would be speculative and unsupportable. Thus, the economic activity associated with these industries was not included in our estimates.

Cargo Screening and Jet Fuel Elasticity Modeling

The effects of the 100-percent cargo screening rule and volatility in jet-fuel prices were analyzed and described in a separate chapter, with price models developed to estimate the elasticity of demand upon price changes from the increased costs of the additional cargo screening and the increase in the price of air cargo due to increases in jet-fuel prices.

Cargo Screening Impacts

The elasticity analysis noted that the cargo screening includes three effects to be captured in the I-O models applied at the case-study airports:

- The reduced demand for air cargo modeled as a contraction in the industries engaged in air cargo operations
- Increased output by air transportation support industries engaged in air cargo screening activities
- Increased output for air transportation companies due to overhead applied to air-cargo screening costs (this third impact serves to counterbalance the first effect)

Table C-21 presents the air cargo inputs required for the I-O models. The reduction in freight presented in this table represents the percentage reduction in total (cargo-only and cargo transported on-board passenger airplanes) cargo. The impacts vary depending on the price elasticity modeled at each airport and the scale of air cargo transported on-board passenger aircraft. As noted previously in this report, the screening rule does not affect cargo-only aircraft. The negative economic effects reduce the economic output of the industry. The cargo screening costs and industry markup attached to those costs reflect the price increase that is passed on to the customer. These values reflect increased revenue/output to the air transportation and supporting industries.

Table C-21. Air Cargo Screening Inputs for I-O Models

Airport	Reductions in Freight		Cargo Screening Costs		Gross Industry Surplus on Cargo Screening Costs	
	TSA Analysis	Industry Estimates	TSA Analysis	Industry Estimate	TSA Analysis	Industry Estimate
IAH	-0.6%	-0.9%	$8,944,118	$12,775,705	$751,501	$1,073,438
JFK	-2.7%	-3.8%	$25,241,205	$36,054,330	$2,120,813	$3,029,352
MCI	-0.4%	-0.6%	$247,949	$354,169	$20,833	$29,758
RNO*	-0.1%	-0.1%	$71,619	$102,300	$6,018	$8,595
SDF	0.0%	0.0%	$101,236	$144,605	$8,506	$12,150

For Louisville, the reductions in freight and counterbalancing increases in cargo screening impacts results in the direct impacts presented in Table C-22.

Table C-22. Air Cargo Screening Inputs for SDF I-O Modeling

Grand Total Changes	Lower Estimate	Upper Estimate
Transport by air	($51,508.67)	($77,872.01)
Support activities/ air transport	$77,377.38	$108,817.06
Couriers/messengers	($27,412,405.25)	($41,118,607.87)
Off-Airport (Worldport "extra")	*($4,839,148.84)*	*($7,258,723.25)*
Total Changes	($32,225,685.38)	($48,346,386.07)

Due to the size of the Courier/Messenger industry, losses are concentrated in that sector, though they also occur in transport by air and the off-airport traded sectors, in this case study illustrated by the additional truck transportation and warehousing deemed attributable to the presence of UPS' Worldport facility. Some offsetting gains occur in the support activities for air transportation for the additional screening services required.

According to the IMPLAN model, these direct impacts of between $32.2 million and 48.3 million would result in between $53.6 million and $80.4 million in total impact, as shown in Table C-23, below.

Table C-23. Economic Impact Associated with Cargo Screening

Impact Type	Employment	Labor Income	Value Added	Output
Lower Estimate				
Direct Effect	-157.2	($11,475,207)	($20,125,328)	($32,225,686)
Indirect Effect	-70.1	($3,179,270)	($4,886,944)	($8,072,442)
Induced Effect	-114.3	($4,481,191)	($8,005,972)	($13,313,055)
Total Effect	-341.5	($19,135,668)	($33,018,244)	($53,611,183)
Upper Estimate				
Direct Effect	-235.8	($17,217,366)	($30,192,855)	($48,346,388)
Indirect Effect	-105.1	($4,769,869)	($7,331,823)	($12,110,970)
Induced Effect	-171.5	($6,723,483)	($12,011,991)	($19,974,624)
Total Effect	-512.5	($28,710,718)	($49,536,669)	($80,431,982)

Impacts of Jet Fuel Price Fluctuations

The second elasticity model developed for this study examines the impacts of jet-fuel price increases on air cargo demand. It examined the impacts associated with 10 to 30 percent increases in jet-fuel prices, using a stepwise regression approach.

Table C-24 presents the impacts of a 10, 20, and 30 percent increase in jet fuel prices on demand for air cargo at each of the five case study airports. For every 10 percent increase in jet-fuel prices, air cargo demand is estimated to decline by 0.7 percent.

Table C-24. Impacts of Jet Fuel Price Increases (10, 20, and 30 percent) on Demand for Air Cargo

	Impacts of Jet Fuel Prices Increases on Demand for Air Cargo		
Airport	**10%**	**20%**	**30%**
IAH	(6,368,857)	(12,737,715)	(19,106,572)
JFK	(21,150,552)	(42,301,105)	(63,451,657)
MCI	(1,354,130)	(2,708,260)	(4,062,390)
RNO	(781,291)	(1,562,582)	(2,343,873)
SDF	(33,956,926)	(67,913,853)	(101,870,779)
Reduction in Air Cargo	**-0.7%**	**-1.5%**	**-2.2%**

Applying these values to the on-airport operations yields the following results for the 10, 20, and 30-percent increases in jet-fuel prices. As shown in Table C-25, the reduction in output ranges from $52.3 million to $156.9 million for 10 percent and 30 percent increases in jet fuel prices, respectively.

Table C-25. Economic Impacts of Jet Fuel Price Increases (10, 20, and 30 percent)

Impact Type	Employment	Labor Income	Value Added	Output
10% increase in fuel price .7% decrease in cargo volume				
Direct Effect	-144.3	-$11,402,914	-$21,022,400	-$32,078,992
Indirect Effect	-64.7	-$2,889,766	-$4,410,014	-$7,245,367
Induced Effect	-113.6	-$4,365,234	-$7,798,001	-$12,971,530
Total Effect	-322.6	-$18,657,914	-$33,230,414	-$52,295,889
20% increase in fuel price 1.5% decrease in cargo volume				
Direct Effect	-309.2	-$24,434,817	-$45,047,999	-$68,740,697
Indirect Effect	-138.6	-$6,192,355	-$9,450,030	-$15,525,787
Induced Effect	-243.4	-$9,354,072	-$16,710,002	-$27,796,135
Total Effect	-691.3	-$39,981,244	-$71,208,030	-$112,062,619
20% increase in fuel price 1.5% decrease in cargo volume				
Direct Effect	-432.9	-$34,208,743	-$63,067,199	-$96,236,975
Indirect Effect	-194.1	-$8,669,298	-$13,230,041	-$21,736,102
Induced Effect	-340.8	-$13,095,701	-$23,394,002	-$38,914,590
Total Effect	-967.8	-$55,973,742	-$99,691,242	-$156,887,667

Applying the same reductions to the off-airport traded sector results in additional reductions in output ranging from $10.8 million to $32.5 million for 10 percent and 30 percent increases in jet fuel prices, respectively.

Table C-26. Output Impacts of Jet Fuel Price Increases (10, 20, and 30 percent)

Impact Type	Employment	Labor Income	Value Added	Output
10% increase in fuel price *0.7% decrease in cargo volume*				
Direct Effect	-47.5	-$2,291,790	-$2,943,883	-$5,645,674
Indirect Effect	-20.4	-$895,086	-$1,407,476	-$2,288,008
Induced Effect	-25.5	-$979,909	-$1,751,495	-$2,912,916
Total Effect	-93.4	-$4,166,784	-$6,102,854	-$10,846,597
20% increase in fuel price *1.5% decrease in cargo volume*				
Direct Effect	-101.7	-$4,910,978	-$6,308,320	-$12,097,872
Indirect Effect	-43.8	-$1,918,042	-$3,016,020	-$4,902,875
Induced Effect	-54.7	-$2,099,805	-$3,753,203	-$6,241,962
Total Effect	-200.2	-$8,928,824	-$13,077,544	-$23,242,709
30% increase in fuel price *2.1% decrease in cargo volume*				
Direct Effect	-142.4	-$6,875,369	-$8,831,648	-$16,937,021
Indirect Effect	-61.3	-$2,685,258	-$4,222,428	-$6,864,025
Induced Effect	-76.6	-$2,939,727	-$5,254,485	-$8,738,747
Total Effect	-280.2	-$12,500,353	-$18,308,561	-$32,539,792

The sheer volume of the courier and messenger activity at SDF yields far greater impacts on that than other off-airport operations when applying a similar percentage decline.

Case Study 3 – George Bush Intercontinental Airport, Houston, TX

George Bush Intercontinental Airport (IAH), Houston's largest airport is located just 23 miles north of downtown Houston. Officially opening in the summer of 1969, the Airport is owned and operated by the Houston Airport System which is a self-supporting system generating revenue through user fees and lease agreements. The Airport is the 7th busiest U.S. airport for both total traffic and international passenger traffic and utilizes 5 runways on 11,000 acres of land. The Airport currently offers nonstop service to over 110 destination in the U.S. and 70 destinations worldwide.

IAH ranks in the top 25 airports worldwide for total passengers. In 2010 the airport's five terminals handled 40.5 million passengers, which represented a small 1.2 percent increase from 2009. Similar to most other airports, IAH saw a decrease in the number of total aircraft movements – down 1.3 percent from the previous year (Houston Airport System 2012).

As the 16th largest U.S. air cargo hub, IAH is an ideal consolidation and distribution point. It currently hosts 880,000 square feet of cargo area with a capacity to handle up to 1,450,000 tons of cargo which includes the newly expanded IAH Cargo Center.

The annual amount of cargo handled in 2010 also increased by 13.6 percent. International cargo increased by approximately 20 percent with most of the volume carried in wide-body passenger aircraft. At the same time, domestic cargo increased by 11.5 (Houston Airport System 2012). The industry trend to minimize freighter use was reflected in a one percent decrease in all-cargo movements. Overall, IAH was ranked 7th in the top ten airports in North America by the ACI World Airport Traffic Report in 2010.

IAH has an aggressive marketing program strongly emphasizing Transpacific and Latin American traffic.

This section describes the structure of the Houston regional economy in 2009, and the method for estimating the economic impact of air cargo through IAH airport. These estimates are presented at the scale of the ten-county region, comprised of Austin, Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, San Jacinto, and Waller counties.

Airports play an essential role in supporting the growth of a metropolitan economy like the Houston region. They directly employ hundreds of workers and provide millions of dollars in direct economy activity and taxes and other revenues to local government. They also support the growth of the regional economy by moving people, goods, and services that originate in, or are transported through, the region. Airports and related aviation facilities become structurally integrated into a region's economy and provide it with competitive advantages. Airports enable industries that either depend on, or learn to take advantage of, efficient air transportation to access domestic and international markets. In the Houston region, IAH and the region's smaller airports play this vital role.

Because the purpose of this project is to develop a guidebook for quantifying the economic impacts of air cargo, this analysis focuses on the cargo volumes through IAH, with limited analysis of passengers and airline operations. As such, the primary objective of this analysis is to estimate the current economic impacts associated with the air cargo movement, estimating the economic output, employment, personal income, of that activity, and to document the analysis so as to make it easily replicable for other airports in other regions.

This section describes the structure of the Houston metropolitan economy in 2009, using a Houston region-specific version of the IMPLAN impact analysis software.[20] It then presents the methods used to estimate the air-cargo contribution to the economy, and finally presents estimates of economic impact of that air-cargo movement.

[20] The IMPLAN model is based on an input-output modeling framework, and uses secondary source data and proprietary analytic methods to estimate empirical input-output relationships from a combination of national technological relationships and county-level measures of economic activity.

The model is used to measure changes in the regional economy that result from a change in activity relative to a baseline representation of the economy. The sources of the activity being measured vary, but typically involve changes in production or consumption activities, government policies, infrastructure, or changes in costs or technology. For any change in economic activity, the impacts on the economy can be reported on one of three levels:

- **Direct** impacts represent the initial change in final demand for the industry sector(s) in question. For this analysis, we are estimating the economic activity associated with air cargo in Houston.

- **Indirect** impacts represent the response as supplying industries increase output to accommodate the initial change in final demand. These indirect beneficiaries spend money for supplies and services, which results in another round of indirect spending, and so on. Indirect impacts are often referred to as "supply-chain" impacts.

- **Induced** impacts are generated by the spending of households who benefit from the additional wages and income they earn through direct and indirect economic activity. The increase in income, in effect, increases the purchasing power of households. Induced impacts are also described as "consumption-driven" effects.

This cycle of direct, indirect, and induced spending does not go on forever. It continues until the spending eventually leaks out of the economy as a result of taxes, savings, or purchases of non-locally produced goods and services or "imports".

Houston Regional Economy

This section summarizes the Houston economy, and presents an economic portrait of the region's economy in terms of employment and output by industry for the base year of 2009.

According to the BEA, Houston is one of 366 MSAs in the United States. Based on its 2009 population estimate of 5,867,489, it is ranked 6th in size in the United States. Its per-capita personal income is about 17 percent higher than the national average. According to IMPLAN, there are an estimated 3.5 million jobs across 410 industries in the region. The top industries by employment are presented in Table C-27. Houston's top industries ranked by output are presented in Table C-28.

Table C-27. Top Ten Industries, Ranked by Employment
Houston Region, 2009

Code	Description	Employment	Labor Income	Output
438	State & local govt, education	206,200	$12,000,810,000	$13,633,090,000
413	Food services and drinking places	204,124	$4,454,105,000	$12,042,710,000
319	Wholesale trade businesses	155,329	$13,753,630,000	$35,985,460,000
360	Real estate establishments	144,085	$2,651,987,000	$26,323,530,000
20	Extraction of oil and natural gas	111,311	$20,697,070,000	$78,225,240,000
36	Construction of other new nonresidential structures	105,933	$5,846,335,000	$13,298,820,000
369	Architectural, engineering, and related services	105,312	$9,217,233,000	$15,180,520,000
382	Employment services	98,694	$3,023,581,000	$4,415,131,000
437	State & local govt, non-education	98,470	$5,406,622,000	$6,142,000,000
394	Offices of physicians, dentists, and other health practitioners	73,271	$6,001,712,000	$9,886,075,000

Source: MIG 2011b.

Table C-28. Top Ten Industries, Ranked by Output
Houston Region, 2009

Code	Description	Employment	Labor Income	Output
115	Petroleum refineries	12,319	$5,855,176,000	$131,604,200,000
20	Extraction of oil and natural gas	111,311	$20,697,070,000	$78,225,240,000
120	Petrochemical manufacturing	12,394	$1,932,184,000	$69,195,790,000
319	Wholesale trade businesses	155,329	$13,753,630,000	$35,985,460,000
361	Imputed rental activity for owner-occupied dwellings	0	$0	$26,463,550,000
360	Real estate establishments	144,085	$2,651,987,000	$26,323,530,000
28	Drilling oil and gas wells	16,519	$2,320,788,000	$21,301,580,000
31	Electric power generation, transmission, and distribution	14,795	$3,296,287,000	$16,581,100,000
206	Mining and oil and gas field machinery manufacturing	28,454	$3,101,443,000	$15,422,700,000
369	Architectural, engineering, and related services	105,312	$9,217,233,000	$15,180,520,000

Source: MIG 2011b.

The scale of economic activity occurring in the Houston region would not have been possible without development of the water, rail, highway, and airport infrastructure that enables businesses to take maximum advantage of the region's location in the central US.

The regional economic impacts of air cargo through IAH are directly related to the scale and composition of the air cargo forecasts (i.e., international versus domestic, and belly cargo versus all-cargo freighters).

Estimating IAH Air-Cargo Contribution to the Regional Economy

This section summarizes the methods used to estimate IAH's current contribution to the regional economy. This effort quantifies the impact the air-cargo through the airport has on the economy at a particular moment in time, using input-output modeling and analysis recommended by the FAA (Butler and Kiernan 1992).

Measuring the economic impact of the cargo activity at the airport involves tracing the linkages between the airport's cargo activity level, expressed in terms of airport operations and air cargo volumes, and the sectors of the economy that interact with them. These linkages produce the "direct," or initial round of economic impact. Direct impacts, in turn, stimulate "indirect" impacts, from the supply of goods and services to businesses at the airport or production of goods for shipment by air. A third round of economic impacts, called "induced" impacts, results from the spending of income earned by direct and indirect employees. The sum of indirect and induced impacts is often referred to as the "multiplier effect" on direct impacts. Total economic impact is the sum of the direct, indirect, and induced impacts.

As noted in the introduction, the first and perhaps most obvious source of IAH-related economic impact is the employees who work there. Though many are present to support the air passengers (such as passenger and visitor service providers), many are associated with airport operations and air cargo, including cargo-handling companies, customs agents, TSA, customs brokers, container freight stations, freight forwarders, trucking companies, and other cargo-related services.

A second important impact related to airport economic activity is the passenger impact, including expenditures for lodging, food, retail purchases, entertainment, transportation services and parking, among others. Again, the scope of this effort is focused on air cargo, rather than on passengers.

The final category of impact is the contribution of air cargo to the regional economy. The presence of a well-functioning air-cargo system is what allows a region to export goods and services and develop traded-sector industries for the purposes of export. While every region has some need for local-serving goods and services (haircuts, restaurant meals, etc.), a region's ability to export additional goods and services increases its economic potential. While the concept is simple, the analysis of economic impacts of air cargo shipments is part of a developing area of economic research that is still limited. We will explore these limitations and some analytic approaches to them in this section.

Airport Operations

As noted earlier, the first and most obvious source of IAH-related economic impact is the employees who work there. Those associated with air cargo include airlines handling cargo, third-party cargo-handling companies, customs agents, TSA, customs brokers, container freight stations, freight forwarders, trucking companies, and other cargo-related services.

Employment data were provided by the airport authority for the number of employees with security badges. These data were supplemented by the project surveys of air carriers and third-party cargo handling companies. These combined data yielded the cargo-related employment estimates presented in the remainder of this section.

Table C-29. Estimated Employment by Industry Group, IAH, 2010

Industry	Estimated Employment
Transport by Air	726
Support Activities for Air Transportation	439
Couriers and messengers	686
Total	1,851

Source: IAH Airport, Employer surveys, and estimates by TransSolutions (IAH study 2010).

Running the resulting number of direct jobs through the IMPLAN model generates the direct, indirect, and induced jobs, output, labor income, and value added of this activity (movement of air cargo). These 1,851 direct jobs have an estimated aggregated labor income of over $116 million, or an average per-job compensation of $62,850. The estimated output value generated from those jobs is over $338 million, as shown in Table C-30.

Table C-30. Estimated Economic Impact, Air Cargo Operations, IAH

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	1,851.0	$116,340,215	$166,346,325	$338,456,519
Indirect Effect	654.9	$40,051,279	$72,684,391	$148,621,695
Induced Effect	925.0	$42,122,921	$79,801,351	$130,628,887
Total Effect	3,430.9	$198,514,416	$318,832,067	$617,707,100

Source: MIG 2011b.

In addition to the direct impacts, these 1,851 jobs would have an additional indirect impact of an estimate nearly 655 indirect jobs with over $40 million in labor income and over $148 million in output, and an additional 925 induced jobs with $42 million in labor income and $130 million in output, as shown in Table C-30.

Air Cargo Impacts to Regional Economy

More difficult to quantify is the contribution of air cargo to the regional economy. However, it is generally agreed that export industries are concentrated in regions with direct and efficient access to air cargo operations. In the absence of this access, companies that rely on these services would likely re-locate to other regions with such access.

As noted earlier, the analysis of economic impacts of air cargo shipments is part of a developing area of economic research. One important issue that remains unanswered is the potential for shippers to utilize other airports in the region to export goods in the presence of air cargo supply constraints. For example, there are other airports within the trade area of IAH. This factor is important for modeling IAH's contribution to the regional economy. It would be unreasonable, for example, to simply subtract the entire value of goods exported by air, because this subtraction would grossly overstate the economic impacts of air cargo (i.e., the value of the goods shipped by air).

Another issue is the few systematic sources of air cargo data. ACI-NA collects annual data on airport operations, passengers and weight of air cargo, principally to evaluate airports and rank them by size. For the value of shipments, however, one of the only sources is the CFS undertaken every five years by a partnership between the BTS and the Census Bureau.

FAF integrates data from a variety of sources to create a comprehensive picture of freight movement among states and major metropolitan areas by all modes of transportation. With data from the 2007 CFS and additional sources, FAF version 3 (FAF^3) provides estimates for tonnage and value by origin, destination, commodity, and mode for 2007, the most recent year, and forecasts through 2040.

According to the FAF, over 791 million tons of goods were shipped from the Houston Metropolitan area. Of that, nearly 250,000 tons were shipped via air (including truck and air).[21] The largest proportion of goods shipped by air is machinery by weight, comprising 34 percent of the weight of commodities shipped by air. In terms of value, electronics is slightly higher in value terms, nearly 39 percent of the value of goods shipped by air but less than 17 percent of the weight of goods shipped by air in 2007, which makes sense as those commodities are often light, but of relatively high value. Other major commodities shipped via air include plastics/rubber, precision instruments, and articles of base metal, as shown in Table C-31.

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[21] The modes tracked by the Commodity Flow Survey are: For-hire truck, Private truck, Rail, Air (including Truck and Air), Shallow draft vessel, Deep draft vessel, Pipeline, Parcel/U.S. Postal Service/courier, Other, and Unknown.

Table C-31. Shipment Characteristics by Commodity for Air Transportation (including Truck and Air) for Houston Metropolitan Area of Origin: 2007

	Value		Weight	
	M$	Percent of Total Value	Tons (Thousands)	Percent of Total Weight
Alcoholic beverages	4.33	0.03%	0.61	0.25%
Animal feed	1.31	0.01%	0.11	0.05%
Articles-base metal	432.25	2.57%	22.38	8.96%
Base metals	74.01	0.44%	6.52	2.61%
Basic chemicals	168.13	1.00%	4.43	1.77%
Cereal grains	0.21	0.00%	0.04	0.01%
Chemical prods.	179.59	1.07%	8.68	3.47%
Coal-n.e.c.	2.50	0.01%	1.44	0.58%
Electronics	6,490.16	38.65%	42.25	16.91%
Fertilizers	0.02	0.00%	0.00	0.00%
Furniture	56.13	0.33%	2.03	0.81%
Live animals/fish	22.16	0.13%	2.14	0.86%
Machinery	5,894.25	35.10%	84.33	33.74%
Meat/seafood	1.17	0.01%	0.30	0.12%
Metallic ores	8.61	0.05%	0.36	0.14%
Milled grain prods.	0.68	0.00%	0.30	0.12%
Misc. mfg. prods.	309.02	1.84%	4.98	1.99%
Mixed freight	364.16	2.17%	2.48	0.99%
Motorized vehicles	100.48	0.60%	5.30	2.12%
Newsprint/paper	0.01	0.00%	0.01	0.00%
Nonmetal min. prods.	33.01	0.20%	1.40	0.56%
Nonmetallic minerals	0.55	0.00%	0.66	0.26%
Other ag prods.	18.89	0.11%	1.73	0.69%
Other foodstuffs	5.76	0.03%	1.30	0.52%
Paper articles	5.59	0.03%	1.00	0.40%
Pharmaceuticals	78.86	0.47%	0.56	0.22%
Plastics/rubber	193.35	1.15%	33.53	13.42%
Precision instruments	1,658.07	9.87%	11.91	4.77%
Printed prods.	50.34	0.30%	1.57	0.63%
Textiles/leather	160.44	0.96%	6.22	2.49%
Tobacco prods.	0.92	0.01%	0.03	0.01%
Transport equip.	471.92	2.81%	1.04	0.42%
Wood prods.	3.92	0.02%	0.27	0.11%
Total	16,790.78	100%	249.92	100%

Source: BTS 2009.

Clearly, the presence of the IAH airport and its well-functioning air cargo operations enables the air transport of this nearly $17 billion in exports. However, a portion of these exports would continue to leave the region in the absence of the IAH airport, using other modes, or through a combination of modes to reach an alternative airport.

For an illustration, let us examine the nearly $6.5 billion of electronics exported from the region. The FAF and CFS use Standard Transportation Classification Codes (STCC) whereas IMPLAN uses the IMPLAN industry codes. Unfortunately, international trade in electronics and other commodities not historically carried by railroads is not well-represented in the STCC, and there are several electronics-related manufacturing industries in IMPLAN. To select an appropriate industry, the first thing would be to evaluate total employment and output for a potential industry. For example, in Houston, some of the electronics industries are small, with only a handful of employees, as shown in Table C-32.

Table C-32. Employment, Output, and Employee Compensation of Industry Codes 234 through 249

Industry Code	Description	Employment	Output	Employee Compensation
234	Electronic computer manufacturing	6,496.00	$8,444,266,496	$929,792,000
235	Computer storage device manufacturing	7.6	$5,813,081	$721,615
236	Computer terminals and other computer peripheral equipment manufacturing	358	$161,496,688	$31,774,904
237	Telephone apparatus manufacturing	69.1	$35,220,008	$5,740,229
238	Broadcast and wireless communications equipment manufacturing	79.4	$41,965,576	$6,862,952
239	Other communications equipment manufacturing	167	$56,209,872	$10,589,846
240	Audio and video equipment manufacturing	111.1	$64,382,104	$6,929,096
241	Electron tube manufacturing	0	$0	$0
242	Bare printed circuit board manufacturing	501.5	$102,211,008	$30,264,414
243	Semiconductor and related device manufacturing	1,087.40	$745,661,568	$158,196,944
244	Electronic capacitor, resistor, coil, transformer, and other inductor manufacturing	306	$53,095,824	$16,604,259
245	Electronic connector manufacturing	81.9	$17,726,202	$3,631,496
246	Printed circuit assembly (electronic assembly) manufacturing	622.6	$227,634,032	$52,766,300
247	Other electronic component manufacturing	1,158.70	$267,425,664	$99,531,240
248	Electromedical and electrotherapeutic apparatus manufacturing	745.7	$345,771,392	$64,623,396
249	Search, detection, and navigation instruments manufacturing	346.1	$123,891,152	$23,133,980

Source: MIG 2011b.

The largest is the electronic computer manufacturing industry, with 6,496 employees and $8.4 billion in output. It is likely that the $6.5 billion of exported electronics are commodities produced by a combination of industries, including electronic computer manufacturing. To select the industries for the modeling and to avoid over- or under-stating the impacts, the analyst would want to review the levels of output per worker and compensation-per-worker for the range of industries, as shown in Table C-33.

Table C-33. Per-worker Output and Employee Compensation of Industry Codes 234 through 249

Industry Code	Description	Employment	Output per Worker	Compensation per Worker
234	Electronic computer manufacturing	6,496.00	$1,299,917.87	$143,133.00
235	Computer storage device manufacturing	7.6	$764,879.08	$94,949.34
236	Computer terminals and other computer peripheral equipment manufacturing	358	$451,108.07	$88,756.72
237	Telephone apparatus manufacturing	69.1	$509,696.21	$83,071.33
238	Broadcast and wireless communications equipment manufacturing	79.4	$528,533.70	$86,435.16
239	Other communications equipment manufacturing	167	$336,586.06	$63,412.25
240	Audio and video equipment manufacturing	111.1	$579,496.89	$62,368.10
241	Electron tube manufacturing	0	NA	NA
242	Bare printed circuit board manufacturing	501.5	$203,810.58	$60,347.78
243	Semiconductor and related device manufacturing	1,087.40	$685,728.87	$145,481.83
244	Electronic capacitor, resistor, coil, transformer, and other inductor manufacturing	306	$173,515.76	$54,262.28
245	Electronic connector manufacturing	81.9	$216,437.14	$44,340.61
246	Printed circuit assembly (electronic assembly) manufacturing	622.6	$365,618.43	$84,751.53
247	Other electronic component manufacturing	1,158.70	$230,798.02	$85,899.06
248	Electromedical and electrotherapeutic apparatus manufacturing	745.7	$463,686.99	$86,661.39
249	Search, detection, and navigation instruments manufacturing	346.1	$357,963.46	$66,841.90

Source: MIG 2011b.

For the most part, the electronics-related industries have similar levels of output-per-worker and employee compensation-per-worker; however, levels for the electronic computer manufacturing industry are among the highest (at nearly $1.3 million average per-worker output and over $143,000 in average per-worker compensation). As such, to avoid overstating the impacts, it is reasonable to model the impacts using a combination of this largest industry and another representative industry whose output-per-worker and compensation-per-worker fall more in the middle of the range, such as other electronic component manufacturing (Industry Code 247) with per-worker output averaging $230,800 and per-worker compensation averaging $84,750 (MIG 2011b.)

According to the Houston Airport System, there was an aggregated total value of $7.2 billion in exported goods shipped through the Houston airport in 2009. Of that, $3.1 billion was classified as industrial equipment and computers, as shown in Table C-34. These values are roughly half those reported from the FAF whose "air" category includes truck and air, and therefore, may include goods shipped from other airports.

Table C-34. Top Exports by Weight and their Estimated Value, Houston

2009 Rank	Top Commodities	Air Cargo Exports Weight (KG)	Air Cargo Exports Value ($)
1	Industrial Equipment and Computers	44,840,986	3,127,150,859
2	Articles of Iron or Steel	13,297,438	122,924,227
3	Electrical Machinery, Equipment and Parts	11,397,772	1,178,203,472
4	Optic, Photographic, Medical, Surgical Instruments	7,578,404	1,093,271,364
5	Iron and Steel	4,266,317	9,265,833
6	Plastics and Plastic Articles	3,733,719	66,945,591
7	Metal Tools, Cutlery, Etc.	2,350,414	291,425,435
8	Miscellaneous Chemical Products	1,822,211	59,458,838
9	Aircraft, Spacecraft and Parts Thereof	1,371,784	750,409,353
10	Inorganic Chemicals	1,362,419	37,969,218
	Totals (includes commodities not shown above)	**110,731,668**	**7,230,003,104**

Source: Houston Airport System, Houston and the World, 2012 International Air Cargo Data.

To complete the illustration, evaluating the impacts of $3.1 billion in exported electronics might involve modeling the impacts associated with $1.6 billion electronic computer manufacturing and $1.5 billion in electronic component manufacturing as shown in Table C-35.

Table C-35. Economic Impact of $3.1 Billion in Electronic Manufacturing

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	10,739.4	$1,123,202,763	$1,785,063,755	$3,100,000,063
Indirect Effect	6,140.0	$437,344,449	$727,238,123	$1,215,059,723
Induced Effect	9,240.2	$421,212,476	$797,820,446	$1,306,313,610
Total Effect	26,119.6	$1,981,759,687	$3,310,122,324	$5,621,373,395

Source: MIG 2011b.

The $1.6 billion in electronic computer manufacturing and $1.5 billion in electronic component manufacturing have direct employment of over 10,700 employees, with over $1.1 billion in employee compensation and nearly $1.8 billion in value added, plus an additional 6,140 indirect employees, and another 9,240 induced employees.

This $3.1 billion modeled in this example is but a portion of the nearly $17 billion in value of commodities exported from the Houston region, according to the FAF, and the over $7.2 billion in value of commodities exported from the Houston Airport, according to the Houston Airport System.

Cargo Screening and Jet Fuel Elasticity Modeling

The effects of the 100-percent cargo screening rule and volatility in jet-fuel prices were analyzed and described in a separate section of this report, with price models developed to estimate the elasticity of demand upon price changes from the increased costs of the additional cargo screening and the increase in the price of air cargo due to increases in jet-fuel prices.

Cargo Screening Impacts

The elasticity analysis noted that the cargo screening includes three effects to be captured in the I-O models applied at the case-study airports:

- The reduced demand for air cargo modeled as a contraction in the industries engaged in air cargo operations
- Increased output by air transportation engaged in air cargo screening activities
- Increased output for air transportation companies due to overhead applied to air-cargo screening costs (this third impact serves to counterbalance the first effect)

Table C-36 presents the air cargo inputs required for the I-O models. The reduction in freight presented in this table represents the percentage reduction in total (cargo-only and cargo transported on-board passenger airplanes) cargo. The impacts vary depending on the price elasticity modeled at each airport and the scale of air cargo transported on-board passenger aircraft. As noted previously in this report, the screening rule does not affect cargo-only aircraft. The negative economic effects reduce the economic output of the industry. The cargo screening costs and industry markup attached to those costs reflect the price increase that is passed on to the customer. These values reflect increased revenue/output to the air transportation and supporting industries.

Table C-36. Air Cargo Screening Inputs for I-O Models

Airport	Reductions in Freight		Cargo Screening Costs		Gross Industry Surplus on Cargo Screening Costs	
	TSA Analysis	Industry Estimates	TSA Analysis	Industry Estimate	TSA Analysis	Industry Estimate
IAH	-0.6%	-0.9%	$8,944,118	$12,775,705	$751,501	$1,073,438
JFK	-2.7%	-3.8%	$25,241,205	$36,054,330	$2,120,813	$3,029,352
MCI	-0.4%	-0.6%	$247,949	$354,169	$20,833	$29,758
RNO*	-0.1%	-0.1%	$71,619	$102,300	$6,018	$8,595
SDF	0.0%	0.0%	$101,236	$144,605	$8,506	$12,150

For Houston, the reductions in freight and counterbalancing increases in cargo screening impacts results in the direct impacts identified in Table C-37. Though there are losses in the Transport by Air and Courier/Messenger industries, losses are concentrated in the off-airport traded sectors, in this case study illustrated by the electronics industry. Some offsetting gains occur in the support activities for air transportation for the additional screening services required. For air transport support activities, the increase in output associated with screening activities more than offsets the losses resulting from reductions in freight due to the inelastic demand measure (0.23) calculated for IAH.

Table C-37. Air Cargo Screening Inputs for IAH I-O Modeling

Grand Total Changes	Lower Estimate	Upper Estimate
Transport by air	($696,799.06)	($1,099,012.10)
Support activities/ air transport	$8,617,331.34	$12,285,525.00
Couriers/messengers	($255,652.37)	($383,478.55)
Off-Airport example (electronics)	($18,600,000.00)	($27,900,000.00)
Total Changes	**($10,935,120.10)**	**($17,096,965.64)**

According to the IMPLAN model, these direct impacts of between nearly $11 and $17 million would result in between $19 and $30 million in total impact. As noted earlier, the losses occur mostly in the traded-sector industries, illustrated in this case study by the electronics industry. These industries tend to have high wages and high output per worker, while gains occur in support activities for air transportation, an industry with relatively lower output per worker. As such, employment impacts seem low relative to the output impacts, as shown in Table C-38 below.

Table C-38. Economic Impact Associated with Cargo Screening

Impact Type	Employment	Labor Income	Value Added	Output
Lower Estimate				
Direct Effect	-1.2	($1,416,321)	($5,248,857)	($10,935,010)
Indirect Effect	-20.0	($1,840,594)	($3,228,926)	($5,451,864)
Induced Effect	-19.4	($888,585)	($1,681,356)	($2,756,602)
Total Effect	-40.6	($4,145,501)	($10,159,139)	($19,143,475)
Upper Estimate				
Direct Effect	-7.1	($2,555,684)	($8,335,944)	($17,096,965)
Indirect Effect	-31.5	($2,834,219)	($4,955,888)	($8,373,362)
Induced Effect	-32.1	($1,468,339)	($2,778,740)	($4,554,947)
Total Effect	-70.7	($6,858,241)	($16,070,571)	($30,025,274)

Impacts of Jet Fuel Fluctuations

The second elasticity model developed examines the impacts of jet fuel price increases on air cargo demand. It examined the impacts associated with 10-30 percent increases in jet fuel prices, using a stepwise regression approach.

Table C-39 presents the impacts of a 10, 20, and 30 percent increase in jet fuel prices on demand for air cargo at each of the five case study airports. For every 10 percent increase in jet fuel prices, air cargo demand is estimated to decline by 0.7 percent.

Table C-39. Impacts of Jet Fuel Price Increases (10, 20, and 30 percent) on Demand for Air Cargo

	Impacts of Jet Fuel Prices Increases on Demand for Air Cargo		
Airport	**10%**	**20%**	**30%**
IAH	(6,368,857)	(12,737,715)	(19,106,572)
JFK	(21,150,552)	(42,301,105)	(63,451,657)
MCI	(1,354,130)	(2,708,260)	(4,062,390)
RNO	(781,291)	(1,562,582)	(2,343,873)
SDF	(33,956,926)	(67,913,853)	(101,870,779)
Reduction in Air Cargo	**-0.7%**	**-1.5%**	**-2.2%**

Applying these values to the on-airport operations yields the results for the 10, 20, and 30-percent increases in jet-fuel prices presented in Table C-40.

Table C-40. Economic Impacts of Jet Fuel Price Inreases (10, 20, and 30 percent) on Airport Operations

Impact Type	Employment	Labor Income	Value Added	Output
10% increase in fuel price *.7% decrease in cargo volume*				
Direct Effect	(12.96)	($814,382)	($1,164,424)	($2,369,196)
Indirect Effect	(4.58)	($280,359)	($508,791)	($1,040,352)
Induced Effect	(6.48)	($294,860)	($558,609)	($914,402)
Total Effect	(24.02)	($1,389,601)	($2,231,824)	($4,323,950)
20% increase in fuel price *1.5% decrease in cargo volume*				
Direct Effect	(27.77)	($1,745,103)	($2,495,195)	($5,076,848)
Indirect Effect	(9.82)	($600,769)	($1,090,266)	($2,229,325)
Induced Effect	(13.88)	($631,844)	($1,197,020)	($1,959,433)
Total Effect	(51.46)	($2,977,716)	($4,782,481)	($9,265,607)
20% increase in fuel price *1.5% decrease in cargo volume*				
Direct Effect	(38.87)	($2,443,145)	($3,493,273)	($7,107,587)
Indirect Effect	(13.75)	($841,077)	($1,526,372)	($3,121,056)
Induced Effect	(19.43)	($884,581)	($1,675,828)	($2,743,207)
Total Effect	(72.05)	($4,168,803)	($6,695,473)	($12,971,849)

Applying the same reductions to the off-airport traded sector, results in the economic impacts estimated presented in Table C-41.

Table C-41. Economic Impacts of Jet Fuel Price Increases (10, 20, and 30 percent) on Off-Airport Activities

Impact Type	Employment	Labor Income	Value Added	Output
10% increase in fuel price *0.7% decrease in cargo volume*				
Direct Effect	(75.2)	($7,862,419)	($12,495,446)	($21,700,000)
Indirect Effect	(43.0)	($3,061,411)	($5,090,667)	($8,505,418)
Induced Effect	(64.7)	($2,948,487)	($5,584,743)	($9,144,195)
Total Effect	(182.8)	($13,872,318)	($23,170,856)	($39,349,614)
20% increase in fuel price *1.5% decrease in cargo volume*				
Direct Effect	(161.1)	($16,848,041)	($26,775,956)	($46,500,001)
Indirect Effect	(92.1)	($6,560,167)	($10,908,572)	($18,225,896)
Induced Effect	(138.6)	($6,318,187)	($11,967,307)	($19,594,704)
Total Effect	(391.8)	($29,726,395)	($49,651,835)	($84,320,601)
30% increase in fuel price *2.1% decrease in cargo volume*				
Direct Effect	(225.5)	($23,587,258)	($37,486,339)	($65,100,001)
Indirect Effect	(128.9)	($9,184,233)	($15,272,001)	($25,516,254)
Induced Effect	(194.0)	($8,845,462)	($16,754,229)	($27,432,586)
Total Effect	(548.5)	($41,616,953)	($69,512,569)	($118,048,841)

The sheer volume of the off-airport impacts yields far greater impacts than on-airport operations when applying a similar percentage decline. These results show the importance and far-ranging effects of an efficient air transportation system on a healthy regional economy.

Case Study 4 – John F. Kennedy International Airport, New York, NY

John F. Kennedy International Airport (JFK), originally known as Idlewild Airport, was established in 1942 and is owned and operated by the Port Authority of New York and New Jersey (PANYNJ). The airport is approximately 15 miles from midtown Manhattan. Today, JFK functions as one of America's leading international gateway airports, with more than 80 airlines operating from its gates. JFK sits on 4,930 acres of land and currently contains seven operational passenger terminals that contain more than 150 gates.

JFK is one of the world's leading international air cargo centers with more than six million square feet of office and warehouse space spread out over four cargo areas. The entire area comprising the cargo operation at JFK is designated as a Foreign Trade Zone. A total of 1,700 acres dedicated to air cargo activities is divided into Cargo Areas A, B, C, and D. JFK currently has approximately 500 cargo companies based on or around the airport. The carriers are served by ten ground-handling services and by hundreds of long and short haul trucking companies. JFK is also home to the northeast region's U.S. Customs headquarters.

JFK was ranked 19^{th} in the world for total cargo handling in 2010. Cargo volumes increased by 17.5 percent from 2009 but the total of 1.3 million tons was well below the 2000 peak of 1.9 million. International freight was up by 23 percent in 2010 placing JFK 15^{th} worldwide. Passenger traffic was relatively flat, and aircraft movements at JFK dropped 4.2 percent in 2010 compared to the previous year. However, both domestic and international passenger traffic has grown over the last decade with domestic traffic growing almost 64 percent since 2000. This is due in large part to the growth of JetBlue operations at JFK which has very little cargo capacity (PANYNJ 2012).

Currently, transatlantic freight makes up the largest market share for freight at JFK topping out at 45 percent of the market with transpacific freight making up 31 percent of the market. In total, international freight comprises 82 percent of the cargo being processed at JFK while domestic freight represents the remaining 18 percent of the market (PANYNJ 2012). JFK is expected to pursue South and Latin American, African and Eastern European markets over the next 20 years as the European market reaches maturity (PANYNJ 2012).

New York-Northern New Jersey-Long Island, NY-NJ-PA MSA (NY Portion) Economic Profile

While the overall impact analysis that follows relates to the entire metropolitan area, the market analysis, which focuses on the disposition of exports, necessarily focuses on the New York State portion of the MSA, which hosts JFK International. The assumption is that air freight traffic emanating west of the Hudson River is largely in the market area of Newark Liberty International Airport. The New York state area includes 10 of 23 counties that comprise the entire MSA: the five counties of New York City proper (Bronx, Kings, New York, Queens, and Richmond), the two counties that comprise the western portion of Long Island (Nassau and Suffolk), and three suburban counties on "mainland" New York (Putnam, Rockland, and Westchester).

The 23-county New York-Northern New Jersey-Long Island, NY-NJ-PA (NYC) MSA is the most populous metropolitan area in the United States with 18,897,109 inhabitants as of 2010.[22] That year it also had nation's largest metropolitan economy with a total GDP of $1.28 trillion dollars.[23] It may come as no surprise then that the composition of the regional economy is more diversified and complex than most other regional economies in the U.S.

Major Industries in the New York Portion of the NYC MSA

As shown in Table C-42, the largest sectors of the regional economy (as ranked by payroll-based location quotient) are in the professional service occupations. Number one on the list is the Finance and Insurance sector, with total employment of 360,885 and total annual wages of $84,646,337,886, for an average annual wage per employee of over $230,000. Real estate rental and leasing is next on the list, with total employment of 142,915 earning an aggregate $8,499,094,293 for an average annual salary of approximately $60,000. Commodity-producing sectors such as Manufacturing and Agricultural and Mining come in the bottom three positions. This suggests that large volumes of goods required of New York area residents and firms are not produced in the region. Likewise, the sector Transportation and Warehousing ranks low, suggesting that local distributing agents do not play a dominating role in supplying the region with goods that the region demands. Instead, agents from outside of the area do so.

[22] Census 2010
[23] BEA 2010

Table C-42. Sector Payroll Location Quotient, Employment, and Payroll for NY MSA (New York Portion), 2010

NAICS	Description	LQ	Jobs	Payroll ($1,000)	Average Payroll
11	Agriculture, Forestry, Fishing and Hunting	0.11	5,995	$212,852	$35,505
21	Mining, Quarrying, and Oil and Gas Extraction	0.09	3,403	$339,537	$99,776
22	Utilities	0.57	13,612	$1,798,700	$132,141
23	Construction	0.71	192,510	$12,732,695	$66,140
31	Manufacturing	0.41	256,521	$17,814,825	$69,448
42	Wholesale Trade	0.69	208,714	$15,885,152	$76,110
44	Retail	0.67	517,434	$17,115,621	$33,078
48	Transportation and Warehousing	0.59	143,073	$6,778,352	$47,377
51	Information	1.43	181,055	$18,914,665	$104,469
52	Finance and Insurance	2.77	360,885	$84,646,338	$234,552
53	Real Estate and Rental and Leasing	1.54	142,915	$8,499,094	$59,470
54	Professional, Scientific, and Technical Services	1.09	411,584	$41,572,278	$101,006
55	Management of Companies and Enterprises	1.25	87,489	$15,014,586	$171,617
56	Administrative and Support, Waste Management, & Remediation Services	0.78	270,152	$12,607,593	$46,669
61	Educational Services	1.36	191,278	$9,420,094	$49,248
62	Health Care and Social Assistance	0.81	805,756	$38,036,297	$47,206
71	Arts, Entertainment, and Recreation	1.22	97,168	$4,928,580	$50,722
72	Accommodation and Food Services	0.76	361,040	$9,564,573	$26,492
81	Other Services (except Public Administration)	1.01	214,021	$8,489,208	$39,665
99	Unclassified	1.48	19,112	$751,489	$39,320
	Total		4,483,717	$325,122,529	$72,512

At the finer level of three-digit NAICS codes (Table C-43), white-collar professions continue to dominate. A notable exception is Apparel Manufacture, which employed a total of 18,259 people earning an aggregate $965,840,676 for an average annual salary of $52,897.

Table C-43. Top Ten Industries by Three-Digit NAICS Code, 2010

3-Digit NAICS	Description	LQ	Employment	Payroll	Average Payroll
523	Securities, Commodity Contracts, and Other Financial Investments and Related Activities	5.95	173,765	$61,693,480,861	$355,040
515	Broadcasting (except Internet)	2.89	32,160	$3,920,802,704	$121,916
315	Apparel Manufacturing	2.61	18,259	$965,840,676	$52,897
485	Transit and Ground Passenger Transportation	2.45	47,909	$1,733,842,960	$36,190
512	Motion Picture and Sound Recording Industries	2.42	36,873	$3,541,451,716	$96,045
519	Other Information Services	2.19	19,628	$2,003,248,633	$102,061
712	Museums, Historical Sites, and Similar Institutions	2.17	11,320	$555,762,884	$49,096
525	Funds, Trusts, and Other Financial Vehicles	2.04	7,022	$1,108,889,832	$157,917
531	Real Estate	1.90	128,657	$7,636,604,091	$59,356
533	Lessors of Nonfinancial Intangible Assets (except Copyrighted Works)	1.79	2,274	$250,744,139	$110,266

By drilling down to the finest level of detail, six-digit NAICS, it is evident that the region is a significant exporter of some specific products (Table C-44). Average payroll in these sectors are above average for manufacturing, suggesting that the goods produced are likely of high value, and high value-to-weight items are the most likely to be shipped by air. The top 20 list is comprised almost exclusively of apparel items, including women's dresses, men's neckware, fur and leather, and apparel for infants. Other manufactured goods include beet sugar, cane sugar, and electronic coils.

Table C-44. Top 20 Manufacturing Sectors in New York Portion of NYC MSA by Six-digit NAICS

6-Digit NAICS	Description	LQ	Employment	Payroll	Average Payroll
315231	Women's and Girls' Cut and Sew Lingerie, Loungewear, and Nightwear Manufacturing	7.56	595	$45,065,064	$75,740
315233	Women's and Girls' Cut and Sew Dress Manufacturing	7.42	2,598	$207,840,150	$80,000
315234	Women's and Girls' Cut and Sew Suit, Coat, Tailored Jacket, and Skirt Manufacturing	5.75	584	$52,955,634	$90,677
315993	Men's and Boys' Neckwear Manufacturing	5.46	245	$17,725,458	$72,349
339913	Jewelers' Material and Lapidary Work Manufacturing	4.29	739	$25,007,623	$33,840
315239	Women's and Girls' Cut and Sew Other Outerwear Manufacturing	4.22	2,059	$201,246,500	$97,740
339911	Jewelry (except Costume) Manufacturing	3.94	4,360	$246,165,170	$56,460
315292	Fur and Leather Apparel Manufacturing	3.67	231	$10,121,252	$43,815
315291	Infants' Cut and Sew Apparel Manufacturing	3.49	73	$3,677,728	$50,380
312221	Cigarette Manufacturing	3.19	152	$216,354,787	$1,423,387
315991	Hat, Cap, and Millinery Manufacturing	3.08	574	$28,628,882	$49,876
311313	Beet Sugar Manufacturing	3.05	912	$58,492,605	$64,137
316110	Leather and Hide Tanning and Finishing	2.94	628	$32,607,895	$51,923
316211	Rubber and Plastics Footwear Manufacturing	2.73	244	$17,439,782	$71,475
315212	Women's, Girls', and Infants' Cut and Sew Apparel Contractors	2.72	7,006	$188,334,484	$26,882
315232	Women's and Girls' Cut and Sew Blouse and Shirt Manufacturing	2.28	370	$43,644,231	$117,957
334518	Watch, Clock, and Part Manufacturing	2.14	567	$31,090,410	$54,833
315221	Men's and Boys' Cut and Sew Underwear and Nightwear Manufacturing	2.14	73	$3,460,867	$47,409
311312	Cane Sugar Refining	2.09	258	$33,680,445	$130,544
334416	Electronic Coil, Transformer, and Other Inductor Manufacturing	2.03	754	$47,571,197	$63,092

New York City Area Freight (NY Portion) Freight Movements

New York City MSA (NY Portion) Air Exports

Results from a direct survey data of air freight carriers provided somewhat fragmentary information. This was undoubtedly due to the lack of official PANYNJ support for the endeavor. Clearly, past work was done on the topic for JFK: the objective of this study, however, was to perform an independent assessment in as uniform a manner across airports as possible.

It was therefore clear that the analysis needed to lean on secondary data for air shipments. The best and most complete publicly available data on trade for subregions of U.S. states are widely known to be Version 3 of the Freight Analysis Framework (FAF^3) Origin-Destination Data, which are available online from the U.S. Department of Transportation.[24] Table C-45 shows the total weight and value of goods shipped by air from the New York portion of the NYC MSA.

[24] Last accessed in June 2012 at http://www.ops.fhwa.dot.gov/freight/freight_analysis/faf/. For details on how the FAF^3 data are estimated see Southworth et al. (2010) at http://faf.ornl.gov/fafweb/Data/FAF3ODCMOverview.pdf.

Table C-45. Total Air Exports from NY Portion of NYC MSA, 2007

SCTG	Total Out Air	Total Tons in 2007 (Thousands)	Total M$ in 2007	Air Share (Value)
1	Live animals/fish	11.3	$176	68.8%
2	Cereal grains	0.0	$0	0.0%
3	Other ag prods.	5.1	$47	0.5%
4	Animal feed	1.6	$18	2.5%
5	Meat/seafood	1.0	$8	0.1%
6	Milled grain prods.	0.5	$1	0.0%
7	Other foodstuffs	10.5	$45	0.3%
8	Alcoholic beverages	1.7	$17	0.2%
9	Tobacco prods.	1.0	$6	0.2%
13	Nonmetallic minerals	2.2	$4	1.6%
14	Metallic ores	0.9	$21	58.8%
19	Coal-n.e.c.	1.9	$4	0.1%
20	Basic chemicals	16.0	$822	30.0%
21	Pharmaceuticals	12.5	$2,383	7.9%
23	Chemical prods.	49.5	$1,314	16.2%
24	Plastics/rubber	27.5	$689	6.2%
26	Wood prods.	1.9	$10	0.2%
27	Newsprint/paper	0.7	$1	0.1%
28	Paper articles	13.7	$68	2.5%
29	Printed prods.	19.1	$452	4.4%
30	Textiles/leather	24.8	$890	2.2%
31	Nonmetal min. prods.	9.4	$214	7.1%
32	Base metals	33.5	$323	5.7%
33	Articles-base metal	37.3	$677	5.5%
34	Machinery	79.4	$9,470	20.7%
35	Electronics	51.9	$8,225	26.7%
36	Motorized vehicles	8.5	$252	1.4%
37	Transport equip.	7.0	$3,511	75.2%
38	Precision instruments	31.6	$6,017	34.0%
39	Furniture	2.6	$82	1.4%
40	Misc. mfg. prods.	17.0	$24,364	41.0%
43	Mixed freight	1.9	$199	1.2%
	Total	483.7	$60,310	14.5%

To meaningfully employ the FAF3 data, Quarterly Census of Employment and Wages (QCEW) were matched to Standard Classification of Transported Goods (SCTG) categories used by FAF[3] (Appendix A provides a NAICS to SCTG crosswalk). Table C-46 resulted. Note that less than 6 percent of all employment and payroll reported in Table C-46 for the New York portion of the New York City MSA is in sectors producing those commodities.

Table C-46. Employment and Payroll of Commodity-producing Industries by Commodity, New York State portion of NYC Metropolitan Area, 2007

SCTG	Description	LQ	Emp.	Payroll
1	Live animals/fish	0.21	1,489	$67,459,095
2	Cereal grains	0.01	9	$313,142
3	Other ag prods.	0.09	3,518	$114,126,711
4	Animal feed	0.18	569	$40,136,638
5	Meat/seafood	0.15	3,498	$175,169,538
6	Milled grain prods.	0.22	2,922	$104,804,942
7	Other foodstuffs	0.44	16,088	$904,859,929
8	Alcoholic beverages	0.39	1,386	$99,556,465
9	Tobacco prods.	2.28	156	$216,797,013
10	Building stone	0.40	709	$36,701,908
11	Natural sands	0.12	349	$25,576,641
12	Gravel	0.44	272	$12,390,538
13	Nonmetallic minerals	0.06	49	$4,374,383
14	Metallic ores	1.23	2,543	$270,136,299
15	Coal	0.00	0	$0
16	Crude petroleum	0.01	377	$36,284,079
17	Gasoline	0.00	22	$1,913,800
18	Fuel oils	0.00	0	$0
19	Coal-n.e.c.	0.34	931	$111,528,579
20	Basic chemicals	0.21	1,433	$119,152,224
21	Pharmaceuticals	0.67	15,693	$1,247,241,929
22	Fertilizers	0.05	110	$5,279,624
23	Chemical prods.	0.41	6,012	$466,855,355
24	Plastics/rubber	0.28	9,567	$645,602,769
25	Logs	0.01	55	$2,208,505
26	Wood prods.	0.20	4,482	$205,309,182
27	Newsprint/paper	0.34	3,016	$267,105,167
28	Paper articles	0.43	5,153	$312,156,461
29	Printed prods.	0.47	11,680	$615,971,776
30	Textiles/leather	1.39	26,189	$1,408,427,481
31	Nonmetal min. prods.	0.38	4,541	$324,702,646
32	Base metals	0.39	5,765	$542,462,439
33	Articles-base metal	0.31	21,694	$1,216,749,349
34	Machinery	0.28	13,278	$1,037,817,034
35	Electronics	0.44	25,338	$2,375,145,863
36	Motorized vehicles	0.26	9,550	$719,227,279
37	Transport equip.	0.48	12,881	$1,535,496,275
38	Precision instruments	0.38	17,234	$1,396,006,181
39	Furniture	0.48	8,221	$386,109,983
40	Misc. mfg. prods.	0.81	14,610	$804,782,303
41	Waste/scrap	0.00	0	$0
43	Mixed freight	0.25	147	$6,510,656
	Total		251,536	$17,862,450,181

Table C-47 reveals most of the industries have payroll location quotients substantially lower than 1.0, the threshold typically used to identify industries that export. As with RNO, the list of exported commodities does not appear to be closely connected to production of the local economy, suggesting again many goods exiting JFK have their origins outside the study region.

Table C-47 shows payroll of the production sectors that we have identified as producing goods for export via air freight. As described above, these are aggregate QCEW sectors related to the commodities shipped that have a location quotient greater than 0.3. The "air base payroll" is calculated by taking the portion of the total sector payroll beyond the 0.3 threshold and then the percentage of that commodity that is shipped by air. A threshold of 0.3 has been identified by Stevens, Treyz, and Lahr (1989) as the norm for interstate shipment of commodities.

Table C-47. Portion of Commodity-producing Industries Directly Related to Air Freight, New York Portion of NYC MSA

SCTG	Description	M$07 Air	Air Share $$	LQ	Air Base Payroll
7	Other foodstuffs	$44.8	0.3%	0.44	$1,040,526
8	Alcoholic beverages	$17.3	0.2%	0.39	$74,492
9	Tobacco prods.	$6.2	0.2%	2.28	$310,873
14	Metallic ores	$21.5	59%	1.23	$127,847,192
19	Coal-n.e.c.	$4.2	0.1%	0.34	$31,426
21	Pharmaceuticals	$2,382.6	7.9%	0.67	$59,613,934
23	Chemical prods.	$1,314.0	16.2%	0.41	$40,355,620
27	Newsprint/paper	$0.7	0.1%	0.34	$87,850
28	Paper articles	$67.8	2.5%	0.43	$2,049,620
29	Printed prods.	$452.2	4.4%	0.47	$11,048,581
30	Textiles/leather	$889.6	2.2%	1.39	$24,547,022
31	Nonmetal min. prods.	$214.2	7.1%	0.38	$8,583,580
32	Base metals	$323.5	5.7%	0.39	$14,115,803
33	Articles-base metal	$676.7	5.5%	0.31	$12,371,578
35	Electronics	$8,224.6	26.7%	0.44	$259,300,819
37	Transport equip.	$3,511.0	75.2%	0.48	$647,811,775
38	Precision instruments	$6,016.6	34.0%	0.38	$173,109,521
39	Furniture	$82.4	1.4%	0.48	$2,398,472
40	Misc. mfg. prods.	$24,363.6	41.0%	0.81	$171,630,950
	Total				$1,556,329,635

Table C-48 presents the total economic impacts of JFK air cargo outflows on the entire New York metropolitan area. As can be observed from Section II, Line 1 of the table, the $1.543 billion in payroll required to produce the $6.31 billion in goods shipped out of JFK translates to 22,506 jobs (annual average pay per job of $68,560) and more than $2.4 billion is state GDP for New York. Further Section II, Line 2 shows that this direct economic effect of the goods shipped out of JFK is supported by 23,085 jobs with a combined payroll of nearly $1.74 billion ($75,530 per job) and $3.15 billion in state GDP. In this vein, the lower-paying jobs of the air cargo-producing industries of the region are supported by higher-paying jobs in Finance, Health, and other assorted service industries (see Section I of Table C-48).

Section IV of Table C-48 shows estimates of the total tax revenues that state and local governments receive annually due to the existence of outgoing cargo shipments from JFK. About $619.0 million (44.6 percent) of the $1.39 billion in tax revenues generated are estimated as indirect business taxes. By level of government 50.5 percent of all tax revenues are estimated to be federal tax revenues, 20.8 percent as state revenues, and 21.2 percent as local tax revenues.

Note that the gap between state and local tax revenues is generated largely via indirect business taxes.

Table C-48. Total Economic Impacts of JFK Air Cargo Outflows on the New York Metropolitan Area

		Output ($Thousands)	Employment (jobs)	Compensation ($Thousands)	GDP ($Thousands)
I. Total Effects (Direct + Indirect/Induced)					
1.	Agriculture, Forestry, Fishing, and Hunting	33,060.7	129	4,957.4	11,727.2
2.	Mining	829,675.7	2,173	140,103.7	388,381.2
3.	Utilities	161,757.5	105	24,701.1	91,278.9
4.	Construction	8,782.9	32	2,852.4	3,942.8
5.	Manufacturing	6,790,085.3	24,310	1,701,870.9	2,387,718.9
6.	Wholesale Trade	596,631.7	2,246	198,673.4	382,679.9
7.	Retail Trade	280,675.0	2,472	98,890.8	165,895.7
8.	Transportation and Warehousing	166,544.3	816	57,211.5	79,643.0
9.	Information	286,988.2	441	55,466.0	158,637.1
10.	Finance, Insurance, Real Estate, Rental, and Leasing	1,159,148.1	1,118	178,962.2	738,157.3
11.	Professional and Business Services	910,323.8	4,032	421,571.3	642,594.9
12.	Educational Services, Health Care, and Social Assistance	556,962.3	4,395	273,070.7	338,308.6
13.	Arts, Entertainment, Recreation, Accommodation, and Food Services	248,019.0	2,380	80,235.8	134,346.3
14.	Other Services (except Government)	115,499.5	943	48,076.2	64,907.8
	Total Effects	12,144,153.9	45,591	3,286,643.2	5,588,219.7
II. Distribution of Effects and Multipliers					
1.	Direct Effects	6,305,048.5	22,506	1,543,002.9	2,435,910.7
2.	Indirect/Induced Effects	5,839,105.5	23,085	1,743,640.3	3,152,309.0
3.	Total Effects	12,144,153.9	45,591	3,286,643.2	5,588,219.7
4.	Multipliers (= 3 / 1)	1.926	2.03	2.130	2.294
III. Composition of GDP					
1.	Compensation (Net of Taxes)				3,286,643.2
2.	Taxes				618,976.2
	a. Local				148,538.6
	b. State				251,407.2
	c. Federal				219,030.4
3.	Profits, Dividends, Rents, and Other				1,682,600.3
4.	Total GDP (= 1 + 2 + 3)				5,588,219.7
IV. Tax Accounts					
			Business	**Household**	**Total**
1.	Earnings (Net of Taxes)		3,286,643.2	3,155,177.4	----------------
2.	Taxes		618,976.2	769,589.9	1,388,566.1
	a. Local		148,538.6	146,126.8	294,665.5
	b. State		251,407.2	140,720.9	392,128.1
	c. Federal		219,030.4	482,742.1	701,772.5

New York City MSA (NY Portion) Air Imports

Table C-49 shows the total weight and value of goods shipped by air from the New York portion of the NYC MSA. All of these shipments were assumed to be distributed by wholesalers within the region.

Table C-49. Total Air Imports to NY Portion of NYC MSA

SCTG	AIR	Total KTons in 2007	Total M$ in 2007	AirShare of $
1	Live animals/fish	23.3	$318	52.4%
2	Cereal grains	0.1	$0	0.0%
3	Other ag prods.	25.8	$248	3.5%
4	Animal feed	2.1	$121	12.4%
5	Meat/seafood	2.7	$44	0.3%
6	Milled grain prods.	0.6	$3	0.1%
7	Other foodstuffs	5.7	$74	0.5%
8	Alcoholic beverages	3.0	$30	0.3%
9	Tobacco prods.	0.2	$5	0.1%
13	Nonmetallic minerals	1.3	$2	0.5%
14	Metallic ores	0.2	$7	8.9%
19	Coal-n.e.c.	1.1	$1	0.0%
20	Basic chemicals	9.8	$2,725	56.6%
21	Pharmaceuticals	19.0	$5,329	24.9%
22	Fertilizers	0.0	$0	0.0%
23	Chemical prods.	18.3	$823	8.8%
24	Plastics/rubber	22.0	$447	5.0%
26	Wood prods.	2.8	$22	0.4%
27	Newsprint/paper	0.0	$1	0.0%
28	Paper articles	4.7	$50	1.5%
29	Printed prods.	10.3	$205	1.6%
30	Textiles/leather	170.8	$6,174	23.6%
31	Nonmetal min. prods.	12.9	$185	3.5%
32	Base metals	13.4	$141	2.2%
33	Articles-base metal	15.4	$535	4.1%
34	Machinery	83.1	$7,325	15.6%
35	Electronics	64.9	$6,507	18.4%
36	Motorized vehicles	18.4	$356	1.6%
37	Transport equip.	2.6	$1,081	34.6%
38	Precision instruments	33.2	$4,767	36.9%
39	Furniture	6.9	$150	2.0%
40	Misc. mfg. prods.	30.7	$24,396	53.5%
43	Mixed freight	13.7	$2,749	6.8%
	Total	618.7	$64,820	15.1%

As noted in the sector detail by two-digit NAICS, the local wholesale sector employs 208,714 workers with an aggregate payroll of $15.8 billion. By applying national wholesale margins to the value of the imported commodities as well as applying labor compensation’s share of the margin at the national level, about 2.0 percent of all wholesale trade production in the region is estimated to be generated by incoming JFK air freight. This amounts to 3,505 jobs and $310.0 million in payroll in the region's wholesale industry.

Freight-Related Airport Operations and Shipping Industry

Usably complete responses were received from 17 freight forwarders, 22 air carriers, the airport, and 2 shippers. Where data on payroll for an organization was missing, we used industry-average pay levels and the number of jobs reported by the survey respondent to estimate the payroll. When jobs were not reported but payroll levels were, industry-average wage levels were used to estimate the number of jobs. Table C-50 summarizes the results of the survey data and the aforementioned estimation procedure for the total population of organizations involved in airport freight-related operations, such as freight forwarders and shippers, at JFK. The figures listed below are the total employees and payroll that are directly related to air cargo freight activities.

Table C-50. Summary of Survey of JFK Airport Freight Operations and Related Activity

Summary	Total Employment	Total Pay
FF Air Service	249	$10,636,571
Air Carrier	2,571	$101,705,988
Airport	24,700	$1,354,194,478
Shipper	172	$6,392,000
Total	27,692	$1,472,929,037

One point of comparison for this survey is the 2010 QCEW for Scheduled Freight Air Transportation (NAICS 481112) and the Air Carrier information in Table C-50 above. The QCEW data reveal that officially, according to the US Bureau of Labor Statistics, 1,067 jobs with a payroll of $120,157,858. Thus, the study survey reports 240 percent the QCEW jobs and about 85 percent of its payroll. Clearly, the payroll figure is within reasonable bounds. Of course, LaGuardia Airport is within this region as well; but it has little freight throughput, so its air freight payroll should be negligible. The employment differential is more of a quandary since with the exception of three smaller firms, the 22 carriers tended to report that their employees in air freight worked full time. In any event, rather than follow jobs numbers from the survey we held by the payroll numbers, and assumed that they represented a census of air freight employers at the airport. Later we use industry-average pay levels to estimate the employment levels in the model.

Total Economic Impacts of Freight-related Airport Operations and Warehousing of Inflows

The Rutgers Economic Advisory Service's input-output modeling system (R/ECON I-O) perfectly estimated the jobs affiliated with the payroll for freight forwarders. To effect (mimic) in the modeling exercise the direct of the "airport industry" (as no such industry exists), however, its payroll was equally split between the model's industry representing "Support activities for transportation" and one representing "Office administrative services." As a result, the model's underlying data system estimated that more jobs should exist than suggested by the survey work. Given the already higher average pay of the Office administrative services industry, only the job count related to the Support activities for transportation was ratcheted downward. The job count estimated by the model for Air carriers was lower than derived via the survey. They were respectfully upwardly adjusted to match that obtained via the survey. Such blatant adjustment of known effects from those estimated via economic models is best practice in the field of economic modeling. The rationale behind the adjustment is that the model produces the job estimates using industry-average rates of pay for a specific year. In the case of the R/ECON I-O model used, the underlying regional economic data are for the year 2010.

Table C-51 presents the total economic impacts of JFK air cargo inflows (related as direct effects only to the wholesale trade sector) plus those for air freight and related industries on the New York metropolitan area. As can be observed from Section II, Line 1 of the table, the $1.783 billion in payroll at the airport and the wholesale trade facilities affiliated with JFK traffic translates to 17,908 jobs (annual average pay per job of $99,560) and nearly $2.78 billion in state GDP for New York. Further Section II, Line 2 shows that this direct economic effect is supported by 24,181 other jobs with a combined payroll of nearly $1.6 billion ($66,000 per job) and $3.09 billion in state GDP. Thus, higher-paying jobs at or near the airport are supported by lower-paying jobs, largely those in Retail Trade, health Care, and Entertainment industries (see Section I of Table C-51), although the supporting jobs are well distributed across a large array of industries.

Section IV of Table C-51 shows estimates of the total tax revenues that state and local governments receive annually due to the existence of outgoing cargo shipments from JFK. About $791 million (50.0 percent) of the $1.582 billion in tax revenues generated are estimated as indirect business taxes. By level of government 46.4 percent are estimated to be federal tax revenues, 34.3 percent as state revenues, and 19.3 percent as local tax revenues. State tax revenues from wholesaling activities are assumed to dominate state tax revenues insofar as indirect business taxes are concerned. Of course, all such revenues, and some federal revenues as well, might not accrue due to the extent of traffic that is likely handled at JFK's Free Trade Zone.

Table C-51. Total Economic Impacts of JFK Air Cargo Inflows on the New York Metropolitan Area

		Output ($Thousands)	Employment (jobs)	Compensation ($Thousands)	GDP ($Thousands)
I. Total Effects (Direct + Indirect/Induced)					
1.	Agriculture, Forestry, Fishing, and Hunting	33,523.4	131	5,028.4	11,894.9
2.	Mining	1,910.3	6	506.5	830.2
3.	Utilities	110,758.6	73	16,669.5	61,599.5
4.	Construction	7,942.7	29	2,579.5	3,565.7
5.	Manufacturing	500,347.8	1,482	99,830.9	169,917.9
6.	Wholesale Trade	1,227,761.1	4,622	408,834.3	787,486.5
7.	Retail Trade	290,574.0	2,559	102,378.5	171,746.7
8.	Transportation and Warehousing	3,817,973.2	11,493	908,657.8	1,465,722.6
9.	Information	329,629.1	488	58,264.2	178,625.3
10.	Finance, Insurance, Real Estate, Rental, and Leasing	1,268,925.1	1,201	184,988.2	813,340.5
11.	Professional and Business Services	2,310,792.1	10,846	1,151,977.4	1,605,976.5
12.	Educational Services, Health Care, and Social Assistance	549,589.4	4,338	269,464.9	333,781.2
13.	Arts, Entertainment, Recreation, Accommodation, and Food Services	385,061.1	3,903	123,432.3	204,244.9
14.	Other Services (except Government)	112,339.8	920	46,670.5	62,983.2
	Total Effects	10,947,127.8	42,089	3,379,282.9	5,871,715.5
II. Distribution of Effects and Multipliers					
1.	Direct Effects	5,645,355.7	17,908	1,782,973.9	2,780,068.1
2.	Indirect/Induced Effects	5,301,772.1	24,181	1,596,309.0	3,091,647.4
3.	Total Effects	10,947,127.8	42,089	3,379,282.9	5,871,715.5
4.	Multipliers (= 3 / 1)	1.939	2.35	1.895	2.112
III. Composition of GDP					
1.	Compensation (Net of Taxes)				3,379,282.9
2.	Taxes				790,920.4
	a. Local				155,037.8
	b. State				398,283.4
	c. Federal				237,599.2
3.	Profits, Dividends, Rents, and Other				1,701,512.1
4.	Total GDP (= 1 + 2 + 3)				5,871,715.5
IV. Tax Accounts					
			Business	**Household**	**Total**
1.	Earnings (Net of Taxes)		3,379,282.9	3,244,111.6	----------------
2.	Taxes		790,920.4	791,282.1	1,582,202.5
	a. Local		155,037.8	150,245.6	305,283.5
	b. State		398,283.4	144,687.4	542,970.8
	c. Federal		237,599.2	496,349.1	733,948.3

Case Study 5 – Reno-Tahoe International Airport, Reno, Nevada

Reno-Tahoe International Airport (RNO) originally built in 1929 was named Hubbard Field. It is currently ranked as the 60th busiest commercial airport in the U.S. and sits on 1,450 acres of land. RNO currently serves eight commercial airlines. These carriers operate out of 23 gates at the main terminal, in which Southwest currently makes up 56.4 percent of the market share. The three runways at RNO provide substantial operating capacity and currently accommodate approximately 140 commercial airline operations daily. RNO is also home to the Reno Air National Guard whose base consists of a 60 acre complex on the west side of the airport. The airport served more than 3.8 million passengers in 2010, up 1.8 percent from the previous year. However, total aircraft movements were down 7.3 percent from 2009 (Reno-Tahoe Airport Authority 2012).

Domestic cargo is the only product processed through the airport. Currently, no scheduled international cargo or airmail is handled at the airport. This is due in large measure to the proximity of Reno to large shipping hubs in San Francisco, Los Angeles, and to a lesser extent Seattle and Vancouver. The airport has the potential to grow its domestic cargo market, since it is ideally located to serve numerous West Coast distribution centers, online fulfillment centers, and the Tahoe/Reno Industrial Center, which is being marketed to be the largest industrial park in the world upon completion. Currently, four cargo companies operate out of RNO, including Capital Cargo International, DHL, FedEx and UPS as well as numerous ad-hoc charters throughout the year. In 2010, the Airport handled more than 56,000 tons of cargo; this is approximately a 10 percent increase from 2009 (Reno-Tahoe Airport Authority 2012).

Reno-Sparks Regional Economy

Reno is a city of 213,000[25] located in western Nevada near Lake Tahoe. The area is known for its casinos and associated gambling industries. Unlike Las Vegas, its larger neighbor to the south, the land around Reno can support development without major water-diverting infrastructure. Prior to Nevada's legalization of gambling in 1931, Reno was a regional transportation hub. Located at a crossing of the Truckee River en route to the Donner Pass in the Sierra Nevada Mountains, the city got its start as a railroad town on the Central Pacific Railway.[26] Reno's sister city, Sparks, developed around a switch yard on the Southern Pacific Railroad. With the rise of Las Vegas and the expansion of legalized gambling nationwide, the area declined as a gambling destination; still, gaming and related tourism remain the area's primary industry. Similarly, with rail freight's decline vis-à-vis truck and air freight, the city's fortunes as a transportation hub have also diminished. Still, the area remains home to numerous distribution centers and online fulfillment centers. For its size, Reno-Tahoe International Airport houses an exceptional number of air cargo carriers, including Capital Cargo International, DHL, FedEx Express, and UPS, as well as numerous ad-hoc charters throughout the year. As a result, on average more than 150 tons of cargo arrive/depart daily through the Reno-Tahoe International Airport. Moreover, tonnages shipped through RNO have been rising in recent years (Reno-Tahoe Airport Authority 2012).

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[25] 2005-2009 ACS
[26] http://www.city-data.com/us-cities/The-West/Reno-History.html

The Reno-Sparks Metropolitan Statistical Area includes Washoe County (Reno) and Storey County (Sparks). The 2010 Census counts 421,407 people in Washoe County (with a nonfarm employment of 173,120)[27] and just 4,010 people in Storey County (with a nonfarm employment of 352 in 2009).[28] Carson City, the capital and an independent city, is not part of the MSA, although it is just a 40 minute drive from Reno. Nonetheless, Carson City's 55,274 residents (and 22,258 in nonfarm employment)[29] also depend on the RNO.

Table C-52 displays the Reno-Sparks MSA economy by supersector. Reflecting well the economic base of the economy, Accommodation and food services; Transportation and warehousing; Arts, entertainment, and recreation are the only supersectors with payroll locations quotients notably greater than 1.0. Given that payroll figures are better indicators of productivity than are employment numbers or job counts, it is presumed that a payroll location quotient (the industry's share of local activity relative to that share for the industry nationwide) yields a proxy for the supply/demand ratio for the industry. Thus, super sectors with LQs greater than 1.0 should be more than self-sufficient (and abnormally concentrated) in the Reno-Sparks MSA, and clearly forming a substantial portion of the region's export base. In this vein, they are expected to yield net sources of wealth to the region.

[27] http://quickfacts.census.gov/qfd/states/32/32031.html
[28] http://quickfacts.census.gov/qfd/states/32/32029.html
[29] http://quickfacts.census.gov/qfd/states/32/32510.html

Table C-52. Employment, Payroll, and Payroll Location Quotients (LQs) by Two-digit NAICS for the Reno-Sparks MSA (2010)

NAICS	Description	LQ	Jobs	Payroll (thousands)	Average Salary
11	Agriculture, Forestry, Fishing and Hunting	0.10	214	$3,973	$18,566
21	Mining, Quarrying, and Oil and Gas Extraction	0.81	548	$62,336	$113,752
22	Utilities	0.93	774	$58,653	$75,779
23	Construction	1.19	8,778	$423,931	$48,295
31-33	Manufacturing	0.72	12,121	$620,010	$51,152
42	Wholesale Trade	1.00	8,346	$455,255	$54,548
44-45	Retail	1.07	20,580	$541,646	$26,319
48-49	Transportation and Warehousing	1.87	10,637	$426,332	$40,080
51	Information	0.49	2,335	$130,075	$55,707
52	Finance and Insurance	0.59	5,628	$361,674	$64,263
53	Real Estate and Rental and Leasing	1.05	3,371	$115,008	$34,117
54	Professional, Scientific, and Technical Services	0.81	9,456	$611,302	$64,647
55	Management of Companies and Enterprises	1.35	3,376	$322,728	$95,595
56	Administrative and Support and Waste Management and Remediation Services	0.95	11,234	$305,799	$27,221
61	Educational Services	0.46	1,828	$62,937	$34,429
62	Health Care and Social Assistance	1.09	19,941	$1,010,593	$50,679
71	Arts, Entertainment, and Recreation	1.48	5,166	$119,226	$23,079
72	Accommodation and Food Services	2.52	28,883	$629,309	$21,788
81	Other Services (except Public Administration)	1.19	5,962	$199,014	$33,380
99	Unclassified	0.70	92	$7,124	$77,437
	Total	0	159,270	$6,466,928	$40,604

Source: R/ECON I-O

<u>Major Industries in Reno-Sparks</u>

With greater sectoral articulation, Table C-53 shows, regardless of size, the ten three-digit NAICS industries that are most heavily concentrated in the Reno-Sparks economy. The economic profile for the metropolitan area solidifies. Accommodation (721), largely casino resort hotels around Lake Tahoe, tops the list with a payroll location quotient of 7.29. The subsector supports an annual average of 16,129 employees at an average annual salary of $26,857 dollars (for a total labor income of over $433.2 million). The Warehousing and storage subsector's LQ of 4.69 puts it in the number two spot, with 4,046 employees who earn an average salary of $39,034 (for a total labor income of $157.9 million). Miscellaneous manufacturing occupies the third spot. In that subsector, 2,003 workers are involved in the manufacture of miscellany, bringing home an average salary of $63,471 (for a total labor income of $127.1 million). Curiously, Amusements, gambling, and recreation (713) – the industry to which the number one industry, accommodation, likely owes a great deal, posts a more modest LQ of 2.72. Mining, except oil and gas; Couriers and messengers; Funds, trusts, and other financial vehicles; and Transit and ground passenger transportation; also have payroll location quotients above 2.0.

Table C-53. Ten Highest Payroll LQ Industries among Three Digit NAICS for the Reno-Sparks MSA, 2010

NAICS	Description	LQ	Jobs	Payroll (thousands)	Average Salary
721	Accommodation	7.29	16,129	$433,178	$26,857
493	Warehousing and Storage	4.69	4,046	$157,933	$39,034
339	Miscellaneous Manufacturing	3.19	2,003	$127,132	$63,471
713	Amusement, Gambling, and Recreation Industries	2.72	4,578	$97,129	$21,216
212	Mining (except Oil and Gas)	2.26	448	$40,840	$91,160
492	Couriers and Messengers	2.24	1,724	$65,561	$38,028
525	Funds, Trusts, and Other Financial Vehicles	2.16	257	$23,375	$90,952
485	Transit and Ground Passenger Transportation	2.13	819	$29,936	$36,552
451	Sporting Goods, Hobby, Book, and Music Stores	1.87	1,444	$27,774	$19,234
484	Truck Transportation	1.74	2,665	$119,658	$44,900

In drilling even deeper, Table C-54 ranks the top 20 manufacturing subsectors with even further refinement (six-digit NAICS) by payroll location quotient. Topping the list is All other miscellaneous manufacturing, which includes “coin-operated amusement machines,” “coin-operated gambling devices,” and “slot machines” manufacturing. Not surprisingly, International Game Technology (IGT), a Reno-based gaming-machine manufacturer, reported revenues of $1.9 billion in 2010. Clearly, legal gaming and related tourism are core industries of the Reno-Sparks metropolitan area. It is also clear that in Reno-Sparks, local commodity exporting six-digit industries are fairly small in size with the possible exceptions of both All Other Miscellaneous Manufacturing and Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing.

Table C-54. The Ten Manufacturing Six-digit NAICS Sectors Most Highly Concentrated in the Reno-Sparks MSA, 2010

NAICS	Description	LQ	Jobs	Payroll (thousands)	Average Salary
339999	All Other Miscellaneous Manufacturing	36.52	1,607	$109,841	$68,352
334418	Printed Circuit Assembly (Electronic Assembly) Manufacturing	6.54	345	$21,201	$61,452
332911	Industrial Valve Manufacturing	5.85	223	$10,785	$48,363
332112	Nonferrous Forging	4.58	40	$2,264	$56,596
314912	Canvas and Related Product Mills	4.51	94	$3,681	$39,165
322215	Nonfolding Sanitary Food Container Manufacturing	4.36	103	$3,030	$29,414
331315	Aluminum Sheet, Plate, and Foil Manufacturing	4.10	103	$5,119	$49,700
331522	Nonferrous (except Aluminum) Die-Casting Foundries	4.10	32	$1,207	$37,713
334511	Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	3.80	945	$70,633	$74,744
337212	Custom Architectural Woodwork and Millwork Manufacturing	3.79	52	$3,450	$66,344
332322	Sheet Metal Work Manufacturing	3.72	499	$20,269	$40,620
322223	Coated Paper Bag and Pouch Manufacturing	3.62	42	$1,650	$39,274
334514	Totalizing Fluid Meter and Counting Device Manufacturing	3.50	68	$2,957	$43,491
322233	Stationery, Tablet, and Related Product Manufacturing	3.34	18	$778	$43,248
334310	Audio and Video Equipment Manufacturing	3.22	98	$6,416	$65,474
326111	Plastics Bag and Pouch Manufacturing	3.18	174	$5,856	$33,658
335129	Other Lighting Equipment Manufacturing	3.12	46	$1,802	$39,181
325910	Printing Ink Manufacturing	3.10	36	$2,382	$66,176
332913	Plumbing Fixture Fitting and Trim Manufacturing	3.07	54	$1,894	$35,069
323119	Other Commercial Printing	3.05	154	$7,132	$46,311

Commodity-producing Industries by SCTG Code

Results from a direct survey of air freight carriers provided fragmentary information at best. The responded population was small, and those who did respond at RNO provided data that were not generally complete. It was therefore clear that the analysis needed to lean on secondary data for air shipments. The best and most complete publicly available data on trade for subregions of U.S. states are widely known to be Version 3 of the Freight Analysis Framework (FAF^3) Origin-Destination Data, which are available online from the U.S. Department of Transportation.[30] To meaningfully employ the FAF3 data, Quarterly Census of Employment and Wages (QCEW) were matched to Standard Classification of Transported Goods (SCTG) categories used by FAF^3 (Appendix A provides a NAICS to SCTG crosswalk).

[30] Last accessed in June 2012 at http://www.ops.fhwa.dot.gov/freight/freight_analysis/faf/. For details on how the FAF^3 data are estimated see Southworth et al. (2010) at http://faf.ornl.gov/fafweb/Data/FAF3ODCMOverview.pdf.

Table C-55 resulted. Note that less than 10 percent of all Reno-Sparks employment and just more than 10 percent of its aggregate payroll are engaged in producing the relevant commodities. Moreover, most pertinent industries have LQs substantially lower than 1.0, the threshold generally applied to assume an industry exports.

Table C-55. Employment and Payroll by SCTG Category in the Reno-Sparks MSA, 2010

SCTG	Description	Payroll LQ	Jobs	Payroll ($Thousands)
1	Live animals/fish	0.29	66	$1,892
2	Cereal grains	0.00	0	$0
3	Other ag prods.	0.04	40	$933
4	Animal feed	0.28	108	$1,229
5	Meat/seafood	0.28	206	$6,387
6	Milled grain prods.	0.58	138	$5,507
7	Other foodstuffs	0.50	443	$20,499
8	Alcoholic beverages	0.01	1	$45
9	Tobacco prods.	0.00	0	$0
10	Building stone	1.65	87	$2,990
11	Natural sands	0.94	72	$3,900
12	Gravel	0.00	0	$0
13	Nonmetallic minerals	0.48	13	$718
14	Metallic ores	12.26	395	$53,515
15	Coal	0.00	0	$0
16	Crude petroleum	0.06	40	$3,332
17	Gasoline	0.05	6	$585
18	Fuel oils	0.00	0	$0
19	Coal-n.e.c.	0.29	36	$1,887
20	Basic chemicals	0.25	47	$2,881
21	Pharmaceuticals	0.04	39	$1,504
22	Fertilizers	0.12	5	$230
23	Chemical prods.	0.36	123	$8,110
24	Plastics/rubber	0.85	925	$38,667
25	Logs	0.34	36	$1,148
26	Wood prods.	0.81	513	$16,615
27	Newsprint/paper	0.21	76	$3,330
28	Paper articles	1.24	407	$18,014
29	Printed prods.	1.25	751	$32,440
30	Textiles/leather	0.28	229	$5,720
31	Nonmetal min. prods.	0.47	158	$8,008
32	Base metals	0.32	191	$8,977
33	Articles-base metal	1.01	1,839	$79,414
34	Machinery	0.47	705	$34,329
35	Electronics	0.57	1,056	$61,640
36	Motorized vehicles	0.18	212	$9,659
37	Transport equip.	0.39	346	$24,898
38	Precision instruments	1.26	1,348	$92,926
39	Furniture	0.50	177	$8,097
40	Misc. mfg. prods.	5.98	1,798	$118,320
41	Waste/scrap	0.00	0	$0
43	Mixed freight	0.00	0	$0
	Total		12,632	$678,345

Reno Area Air Freight Movements

As was discussed previously, the analysis of air freight necessarily leaned on publically available data from FAF^3. Many (74 to be precise) of FAF^3's 123 regions are metropolitan areas. Unfortunately the Reno-Sparks MA is not one of them. In fact, it lies with the FAF3 region called "Remainder of Nevada." That is, it is all of Nevada excluding both Nye County and Clark County, the latter containing Las Vegas and its suburbs. The "Remainder of Nevada" therefore comprises more than just the Reno-Sparks MSA, and while Reno is undoubtedly the largest city of this geography, it contains less than half of the region's population, which itself comprises about half of the state's total. Indeed, it well may be that RNO services much of this broader region with its air freight needs.

"Remainder of Nevada" Outflows

Table C-56 shows air freight export commodities by SCTG code for the year 2007. In total, the Reno-Sparks MSA exported $299.3 million worth of goods by air. Comparing Table C-56 to the profile in the previous section, it is evident that air freight exports are not particularly representative of the economy as a whole. This is not surprising given the economy's heavy reliance on casinos and related tourism as well as the geographical mismatch between the MSA and the FAF^3 region represented by Table C-56. Still, it certainly makes clear that the economy (from either geographic perspective) also does not depend highly on air freight.

Table C-56. Air Freight (including Truck-Air) for the Remainder of Nevada, Total Originating, 2007

SCTG	Description	Kilotons	Air Shipments ($Million)	Air Freight Share ($)
5	Meat/seafood	1.84	$20.1	4.2%
20	Basic chemicals	0.00	$0.8	2.3%
21	Pharmaceuticals	0.03	$90.8	3.0%
23	Chemical prods.	0.34	$2.0	0.1%
24	Plastics/rubber	0.60	$3.0	0.3%
29	Printed prods.	0.77	$4.4	0.6%
30	Textiles/leather	0.33	$26.5	2.2%
31	Nonmetal min. prods.	0.00	$0.2	0.0%
32	Base metals	0.25	$2.0	0.4%
33	Articles-base metal	0.05	$0.6	0.0%
34	Machinery	0.00	$5.6	0.1%
35	Electronics	0.28	$94.4	3.0%
36	Motorized vehicles	0.25	$27.4	1.9%
39	Furniture	0.05	$1.0	0.4%
40	Misc. mfg. prods.	0.00	$1.2	0.1%
43	Mixed freight	1.36	$19.4	0.5%
	Total	6.16	$299.3	

Source: FAF^3 (2007)

Reconciling originating shipments with local MSA production was a challenge. In fact it became immediately apparent since Pharmaceuticals – a top air freight export for the region according to the FAF[3] – does not register as a major production sector in the QCEW data for Reno-Sparks (addressed below). Regardless, $90.8 million worth of pharmaceuticals left RNO by aircraft in 2007. SCTG category 21, Pharmaceutical Products, refers to finished products ready for medical use (and not the raw base chemicals). It also includes bandages, sutures, dental fillings, and other such non-medicinal products. Although Pharmaceuticals loom large as an export from RNO, the largest export sector actually was SCTG Code 35, Electronic and other Electrical Equipment and Components, and Office Equipment. This commodity category includes computer equipment and circuits, audio-video equipment, light bulbs, some (mainly smaller) domestic appliances, electric motors, among other things. In 2007, $94.4 million in electronics were shipped from Reno. Both of these top commodities have high value-to-weight ratios, consistent with expectations for expensive air shipment. The largest next category, Meat, Fish, and Seafood, and their Preparations has a lower value-to-weight ratio, but considerably more urgency since such food goods are typically deemed best when fresh. The category includes meat, poultry, fish fresh, chilled or frozen (or dried, salted, or boiled in the case of some sea foods). About $20.1 million in meat, fish, and seafood and their preparations took flight from RNO in 2007.

Table C-57 shows payroll of the Reno-Sparks MSA production sectors that likely produce goods for export by air freight. As described above, these are aggregate QCEW sectors related to the commodities shipped that have a location quotient greater than 0.3. The “air base payroll” is calculated by taking the portion of the total sector payroll beyond the 0.3 threshold and then the percentage of that commodity that is shipped by air. We use a threshold of 0.3 rather than 1.0 here for two reasons (1) because using the more conventional LQ threshold of 1.0 yielded insufficient capacity for a reasonable estimate of air freight from the Reno-Sparks area given its dominance in the “Rest of Nevada” space economy and (2) Stevens, Treyz, and Lahr (1989) found that assuming an LQ threshold of 0.3 was better than using the usual 1.0 threshold when estimating the share of production that is used locally for goods-producing sectors.

Table C-57. Air Freight (including Truck-Air) for the Remainder of Nevada, Total Originating from Reno-Sparks MSA, 2007

CTG	Description	Air Shipments ($Million)	Air Share of $s	Payroll LQ	Est. Payroll (Thousands)
23	Chemical prods.	$2.0	0.1%	0.36	$3.1
24	Plastics/rubber	$3.0	0.3%	0.85	$75.3
29	Printed prods.	$4.4	0.6%	1.25	$162.4
31	Nonmetal min. prods.	$0.2	0.0%	0.47	$1.7
32	Base metals	$2.0	0.4%	0.32	$25.8
33	Articles-base metal	$0.6	0.0%	1.01	$23.4
34	Machinery	$5.6	0.1%	0.47	$34.2
35	Electronics	$94.4	3.0%	0.57	$1,205.0
39	Furniture	$1.0	0.4%	0.50	$21.9
40	Misc. mfg. prods.	$1.2	0.1%	5.98	$73.7
	Total	$114.40			$1,626.4

Despite the lower threshold a disjoint clearly exists. After combining data from FAF[3] and on local production capabilities, just $6.87 million of goods that are shipped out of RNO can derive from the Reno-Sparks metropolitan area. As shown in Table C-57 this equates to $1.626 million in payroll estimated for the metropolitan area. That is, those commodities shipped from RNO, according to FAF[3], tend not to have a corresponding production presence according to the US Bureau of Labor Statistics. This forces the conclusion that outward-bound goods from RNO's catchment area tend to be produced outside the MSA itself. Still, the MSA benefits from the economic activity, presumably through warehousing and other support services.

Table C-58 presents the total economic impacts of RNO air cargo outflows on the Reno-Sparks metropolitan area. As can be observed from Section II, Line 1 of the table, the $1.623 million in payroll required to produce the $6.87 million in goods shipped out of RNO translates to 44 jobs (annual average pay per job of $37,200) and nearly $2.5 million in state GDP for Nevada. Further Section II, Line 2 shows that this direct economic effect of the goods shipped out of RNO is supported by 33 jobs with a combined payroll of nearly $1.70 million ($51,900 per job) and $3.30 million in state GDP. In this vein the lower-paying jobs of the air cargo-producing industries of the region are supported by higher-paying jobs in Finance, Health, and other assorted service industries (see Section I of Table C-58).

Section IV of Table C-58 shows estimates of the total tax revenues that state and local governments receive annually due to the existence of outgoing cargo shipments from RNO. About $0.67 million (56.8 percent) of the $1.18 million in tax revenues generated are estimated as indirect business taxes. By level of government 61.9 percent are estimated to be federal tax revenues, 22.7 percent as state revenues, and 15.4 percent as local tax revenues. Low local property taxes and a lack of state personal income taxes in Nevada account for this unusually skewed revenue distribution.

Table C-58. Total Economic Impacts of RNO Air Cargo Outflows on the Reno-Sparks Metropolitan Area

		Output ($Thousands)	Employment (jobs)	Compensation ($Thousands)	GDP ($Thousands)
I. Total Effects (Direct + Indirect/Induced)					
1.	Agriculture, Forestry, Fishing, and Hunting	$36.2	0	$5.6	$12.6
2.	Mining	$1.3	0	$0.2	$0.7
3.	Utilities	$130.0	0	$16.3	$70.6
4.	Construction	$10.7	0	$3.2	$4.8
5.	Manufacturing	$7,662.1	48	$1,802.0	$2,773.4
6.	Wholesale Trade	$747.2	3	$250.5	$479.2
7.	Retail Trade	$312.7	3	$103.6	$184.8
8.	Transportation and Warehousing	$273.2	2	$88.1	$140.7
9.	Information	$194.6	1	$42.4	$109.0
10.	Finance, Insurance, Real Estate, Rental, and Leasing	$1,146.7	1	$107.9	$738.0
11.	Professional and Business Services	$954.1	7	$441.6	$666.8
12.	Educational Services, Health Care, and Social Assistance	$612.4	6	$312.4	$372.4
13.	Arts, Entertainment, Recreation, Accommodation, and Food Services	$269.4	4	$86.9	$146.5
14.	Other Services (except Government)	$153.0	1	$58.7	$87.3
	Total Effects	$12,503.6	76	$3,319.6	$5,786.8
II. Distribution of Effects and Multipliers					
1.	Direct Effects	$6,874.2	44	$1,623.8	$2,488.9
2.	Indirect/Induced Effects	$5,629.4	33	$1,695.8	$3,297.9
3.	Total Effects	$12,503.6	76	$3,319.6	$5,786.8
4.	Multipliers (= 3 / 1)	1.819	1.75	2.044	2.325
III. Composition of GDP					
1.	Compensation (Net of Taxes)				$3,319.6
2.	Taxes				$671.8
	a. Local				$158.9
	b. State				$268.0
	c. Federal				$244.9
3.	Profits, Dividends, Rents, and Other				$1,795.5
4.	Total GDP (= 1 + 2 + 3)				$5,786.8
IV. Tax Accounts					
			Business	**Household**	**Total**
1.	Earnings (Net of Taxes)		3,319.6	3,186.8	----------------
2.	Taxes		671.8	510.8	1,182.6
	a. Local		158.9	23.3	182.1
	b. State		268.0	0.0	268.0
	c. Federal		244.9	487.6	732.5

Remainder of Nevada Inflows

Table C-59 shows air freight inflows by SCTG code for the year 2007. These cargo inflows total $395.8 million. The commodities flown in by air are strikingly similar to the commodities flow outwardly by air. With just only 43 SCTG codes in total, some overlap is inevitable. Interestingly, Pharmaceuticals and Electronics occupy the top two spots on both lists. Both sectors produce highly specialized products, so having a strong local supply does not preclude the need to import like goods.

Table C-59. Air Freight (including Truck) to the "Remainder of Nevada," 2007

SCTG	Description	Air Shipments		Air Share (of $)
		Kilotons	$ Millions	
5	Meat/seafood	0.00	$0.0	0.0%
20	Basic chemicals	0.01	$0.3	0.1%
21	Pharmaceuticals	0.41	$96.3	5.5%
23	Chemical prods.	0.81	$10.3	1.0%
27	Newsprint/paper	0.58	$0.6	0.3%
29	Printed prods.	0.02	$6.5	0.9%
30	Textiles/leather	0.05	$0.3	0.0%
33	Articles-base metal	0.00	$3.8	0.3%
34	Machinery	2.49	$25.4	0.6%
35	Electronics	0.35	$116.5	2.2%
36	Motorized vehicles	4.03	$37.4	1.4%
37	Transport equip.	0.00	$9.2	15.5%
38	Precision instruments	0.02	$24.1	1.8%
39	Furniture	0.00	$0.0	0.0%
40	Misc. mfg. prods.	9.02	$64.3	5.0%
43	Mixed freight	0.00	$0.8	0.0%
	Total	17.79	$395.8	

Source: FAF[3] (2007)

A significant import that does not register as an export is SCTG 38, Precision Instruments. In 2007, 24.1 million dollars in precision instruments were flown into the Remainder of Nevada. The precision instruments category includes eyeglasses, photographic equipment, surveying instruments, medical apparatus, and certain items for industrial testing. As evidenced by the high (highest, even) weight-to-value ratio, such pieces can be very expensive, likely rendering their shipping cost comparatively insignificant.

As noted in the sector detail by two-digit NAICS, the local wholesale sector employs 8,346 workers with an aggregate payroll of $455 million. This sector is undoubtedly affected by the incoming air shipments. Hence we applied wholesale margins to all of the incoming air shipments. The average of these margins was around 18 percent or about $7.4 million in net income for the Wholesale Trade sector. This corresponds to about $2.47 million in labor compensation to the industry or about 0.5 percent of the local payroll share.

Freight-related Airport Operations and Shipping Industry

Table C-60 summarizes data from a survey of airport freight operations and the related industries, freight forwarders and shippers were included in the population of potential survey respondents. No results were reported for shippers. The table displays the total employees and payroll that are directly related to air cargo freight activities. In total, usably complete responses were received for four freight forwarders, three carriers, and the airport.

Table C-60. Air Freight and Related Industries at RNO, 2011

Summary	Jobs	Payroll (Thousands)
Freight forwarding	9	$356.7
Air carrier	13	$554.8
Airport	220	$12,061.7
Shippers	-	$0.0
Total	242	$12,973.2

Total Economic Impacts of Freight-related Airport Operations and Warehousing of Inflows

The Rutgers Economic Advisory Service's input-output modeling system (R/ECON I-O) perfectly estimated the jobs affiliated with the payroll for freight forwarders. To effect (mimic) in the modeling exercise the direct of the "airport industry" (as no such industry exists), however, its payroll was equally split between the model's industry representing "Support activities for transportation" and one representing "Office administrative services." As a result, the model's underlying data system estimated that more jobs should exist than suggested by the survey work. Given the already higher average pay of the Office administrative services industry, only the job count related to the Support activities for transportation was ratcheted downward. The job count estimated by the model for Air carriers was lower than derived via the survey. They were upwardly adjusted to match that obtained via the survey. Such blatant adjustment of known effects from those estimated via economic models is best practice in the field of economic modeling. The rationale behind the adjustment is that the model produces the job estimates using industry-average rates of pay for a specific year. In the case of the R/ECON I-O model used, the underlying regional economic data are for the year 2010.

Table C-61 presents the total economic impacts of RNO air cargo inflows (related as direct effects only to the wholesale trade sector) and air freight and related industries on the Reno-Sparks metropolitan area. As can be observed from Section II, Line 1 of the table, the $15.29 million in payroll at airport and the wholesale trade facilities affiliated with RNO traffic translates to 274 jobs (annual average pay per job of $55,800) and nearly $23.4 million in state GDP for Nevada. Further Section II, Line 2 shows that this direct economic effect is supported by 261 other jobs with a combined payroll of nearly $12.1 million ($46,300 per job) and $24.3 million in state GDP. Thus, higher-paying jobs at or near the airport are supported by lower-paying jobs, largely those in Retail Trade and Entertainment industries (see Section I of Table C-61), although the supporting jobs are well distributed across a large array of industries.

Section IV of Table C-61 shows estimates of the total tax revenues that state and local governments receive annually due to the existence of outgoing cargo shipments from RNO. About $0.67 million (57.4 percent) of the $9.88 million in tax revenues generated are estimated as indirect business taxes. By level of government 56.8 percent are estimated to be federal tax revenues, 28.3 percent as state revenues, and 14.9 percent as local tax revenues. Recall that low local property tax rates and a lack of state personal income taxes in Nevada account for the low tax accumulations for these jurisdictions.

Table C-61. Total Economic Impacts of RNO Air Cargo Inflows on the Reno-Sparks Metropolitan Area

		Output ($Thousands)	Employment (jobs)	Compensation ($Thousands)	GDP ($Thousands)
I. Total Effects (Direct + Indirect/Induced)					
1.	Agriculture, Forestry, Fishing, and Hunting	$314.4	2	$48.4	$109.6
2.	Mining	$2.5	0	$0.5	$1.3
3.	Utilities	$882.0	1	$111.7	$483.3
4.	Construction	$84.0	0	$25.0	$37.7
5.	Manufacturing	$3,151.8	18	$672.4	$1,086.6
6.	Wholesale Trade	$9,810.1	43	$3,289.6	$6,292.2
7.	Retail Trade	$2,837.7	26	$940.3	$1,677.3
8.	Transportation and Warehousing	$25,696.4	171	$7,717.0	$12,634.0
9.	Information	$1,873.6	10	$385.1	$1,040.6
10.	Finance, Insurance, Real Estate, Rental, and Leasing	$10,274.9	13	$949.5	$6,614.0
11.	Professional and Business Services	$17,468.9	155	$9,236.2	$12,423.1
12.	Educational Services, Health Care, and Social Assistance	$5,388.5	50	$2,748.6	$3,275.8
13.	Arts, Entertainment, Recreation, Accommodation, and Food Services	$2,394.0	35	$767.0	$1,292.8
14.	Other Services (except Government)	$1,240.2	11	$476.3	$706.0
	Total Effects	$81,418.9	535	$27,367.8	$47,674.4
II. Distribution of Effects and Multipliers					
1.	Direct Effects	$40,714.5	274	$15,287.4	$23,398.9
2.	Indirect/Induced Effects	$40,704.4	261	$12,080.5	$24,275.5
3.	Total Effects	$81,418.9	535	$27,367.8	$47,674.4
4.	Multipliers (= 3 / 1)	$2.000	1.95	$1.790	$2.037
III. Composition of GDP					
1.	Compensation (Net of Taxes)				$27,367.8
2.	Taxes				$5,672.2
	a. Local				$1,281.7
	b. State				$2,795.2
	c. Federal				$1,595.4
3.	Profits, Dividends, Rents, and Other				$14,634.3
4.	Total GDP (= 1 + 2 + 3)				$47,674.4
IV. Tax Accounts					
			Business	**Household**	**Total**
1.	Earnings (Net of Taxes)		$27,367.8	$26,273.1	----------------
2.	Taxes		$5,672.2	$4,211.6	$9,883.8
	a. Local		$1,281.7	$191.8	$1,473.5
	b. State		$2,795.2	$0.0	$2,795.2
	c. Federal		$1,595.4	$4,019.8	$5,615.2

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MIG—Minnesota IMPLAN Group, Inc. 2011b. Implan Professional 3.0.17.2 [Modeling software]: Houston region comprised of Austin, Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, San Jacinto, and Waller counties. Stillwater, MN.

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APPENDIX D.

NAICS TO SCTG CROSSWALK

SCTG	SCTG Description	NAICS	NAICS Description	I-O	I-O Description
1	Live animals/fish	112111	Beef Cattle Ranching and Farming	1121A0	Cattle ranching and farming
1	Live animals/fish	112112	Cattle Feedlots	1121A0	Cattle ranching and farming
1	Live animals/fish	112130	Dual-Purpose Cattle Ranching and Farming	1121A0	Cattle ranching and farming
1	Live animals/fish	112210	Hog and Pig Farming	112A00	Animal production, except cattle and poultry and eggs
1	Live animals/fish	112320	Broilers and Other Meat Type Chicken Production	112300	Poultry and egg production
1	Live animals/fish	112330	Turkey Production	112300	Poultry and egg production
1	Live animals/fish	112340	Poultry Hatcheries	112300	Poultry and egg production
1	Live animals/fish	112390	Other Poultry Production	112300	Poultry and egg production
1	Live animals/fish	112410	Sheep Farming	112A00	Animal production, except cattle and poultry and eggs
1	Live animals/fish	112420	Goat Farming	112A00	Animal production, except cattle and poultry and eggs
1	Live animals/fish	112511	Finfish Farming and Fish Hatcheries	112A00	Animal production, except cattle and poultry and eggs
1	Live animals/fish	112519	Other Aquaculture	112A00	Animal production, except cattle and poultry and eggs
1	Live animals/fish	112910	Apiculture	112A00	Animal production, except cattle and poultry and eggs
1	Live animals/fish	112920	Horses and Other Equine Production	112A00	Animal production, except cattle and poultry and eggs
1	Live animals/fish	112930	Fur-Bearing Animal and Rabbit Production	112A00	Animal production, except cattle and poultry and eggs
1	Live animals/fish	112990	All Other Animal Production	112A00	Animal production, except cattle and poultry and eggs
1	Live animals/fish	114111	Finfish Fishing	114100	Fishing
1	Live animals/fish	114119	Other Marine Fishing	114100	Fishing
1	Live animals/fish	115210	Support Activities for Animal Production	115000	Support activities for agriculture and forestry
2	Cereal grains	111140	Wheat Farming	1111B0	Grain farming
2	Cereal grains	111150	Corn Farming	1111B0	Grain farming
2	Cereal grains	111160	Rice Farming	1111B0	Grain farming
2	Cereal grains	111199	All Other Grain Farming	1111B0	Grain farming
3	Other ag prods.	111110	Soybean Farming	1111A0	Oilseed farming
3	Other ag prods.	111120	Oilseed (except Soybean) Farming	1111A0	Oilseed farming
3	Other ag prods.	111130	Dry Pea and Bean Farming	1111B0	Grain farming
3	Other ag prods.	111191	Oilseed and Grain Combination Farming	1111B0	Grain farming
3	Other ag prods.	111211	Potato Farming	111200	Vegetable and melon farming
3	Other ag prods.	111219	Other Vegetable (except Potato) and Melon Farming	111200	Vegetable and melon farming

SCTG	SCTG Description	NAICS	NAICS Description	I-O	I-O Description
3	Other ag prods.	111310	Orange Groves	1113A0	Fruit farming
3	Other ag prods.	111320	Citrus (except Orange) Groves	1113A0	Fruit farming
3	Other ag prods.	111331	Apple Orchards	1113A0	Fruit farming
3	Other ag prods.	111332	Grape Vineyards	1113A0	Fruit farming
3	Other ag prods.	111333	Strawberry Farming	1113A0	Fruit farming
3	Other ag prods.	111334	Berry (except Strawberry) Farming	1113A0	Fruit farming
3	Other ag prods.	111335	Tree Nut Farming	111335	Tree nut farming
3	Other ag prods.	111336	Fruit and Tree Nut Combination Farming	111335	Tree nut farming
3	Other ag prods.	111339	Other Noncitrus Fruit Farming	1113A0	Fruit farming
3	Other ag prods.	111411	Mushroom Production	111400	Greenhouse, nursery, and floriculture production
3	Other ag prods.	111419	Other Food Crops Grown Under Cover	111400	Greenhouse, nursery, and floriculture production
3	Other ag prods.	111421	Nursery and Tree Production	111400	Greenhouse, nursery, and floriculture production
3	Other ag prods.	111422	Floriculture Production	111400	Greenhouse, nursery, and floriculture production
3	Other ag prods.	111910	Tobacco Farming	111910	Tobacco farming
3	Other ag prods.	111920	Cotton Farming	111920	Cotton farming
3	Other ag prods.	111930	Sugarcane Farming	1119A0	Sugarcane and sugar beet farming
3	Other ag prods.	111991	Sugar Beet Farming	1119A0	Sugarcane and sugar beet farming
3	Other ag prods.	111992	Peanut Farming	1119B0	All other crop farming
3	Other ag prods.	111998	All Other Miscellaneous Crop Farming	1119B0	All other crop farming
3	Other ag prods.	115111	Cotton Ginning	115000	Support activities for agriculture and forestry
3	Other ag prods.	115112	Soil Preparation, Planting, and Cultivating	115000	Support activities for agriculture and forestry
3	Other ag prods.	115113	Crop Harvesting, Primarily by Machine	115000	Support activities for agriculture and forestry
3	Other ag prods.	115114	Postharvest Crop Activities (except Cotton Ginning)	115000	Support activities for agriculture and forestry
3	Other ag prods.	115115	Farm Labor Contractors and Crew Leaders	115000	Support activities for agriculture and forestry
3	Other ag prods.	115116	Farm Management Services	115000	Support activities for agriculture and forestry
3	Other ag prods.	311222	Soybean Processing	31122A	Soybean and other oilseed processing
3	Other ag prods.	311223	Other Oilseed Processing	31122A	Soybean and other oilseed processing
4	Animal feed	111940	Hay Farming	1119B0	All other crop farming
4	Animal feed	112310	Chicken Egg Production	112300	Poultry and egg production

SCTG	SCTG Description	NAICS	NAICS Description	I-O	I-O Description
4	Animal feed	311111	Dog and Cat Food Manufacturing	311111	Dog and cat food manufacturing
4	Animal feed	311119	Other Animal Food Manufacturing	311119	Other animal food manufacturing
5	Meat/seafood	112512	Shellfish Farming	112A00	Animal production, except cattle and poultry and eggs
5	Meat/seafood	114112	Shellfish Fishing	114100	Fishing
5	Meat/seafood	114210	Hunting and Trapping	114200	Hunting and trapping
5	Meat/seafood	311611	Animal (except Poultry) Slaughtering	31161A	Animal (except poultry) slaughtering, rendering, and processing
5	Meat/seafood	311612	Meat Processed from Carcasses	31161A	Animal (except poultry) slaughtering, rendering, and processing
5	Meat/seafood	311613	Rendering and Meat Byproduct Processing	31161A	Animal (except poultry) slaughtering, rendering, and processing
5	Meat/seafood	311615	Poultry Processing	311615	Poultry processing
5	Meat/seafood	311711	Seafood Canning	311700	Seafood product preparation and packaging
5	Meat/seafood	311712	Fresh and Frozen Seafood Processing	311700	Seafood product preparation and packaging
6	Milled grain prods.	311211	Flour Milling	311210	Flour milling and malt manufacturing
6	Milled grain prods.	311212	Rice Milling	311210	Flour milling and malt manufacturing
6	Milled grain prods.	311213	Malt Manufacturing	311210	Flour milling and malt manufacturing
6	Milled grain prods.	311221	Wet Corn Milling	311221	Wet corn milling
6	Milled grain prods.	311230	Breakfast Cereal Manufacturing	311230	Breakfast cereal manufacturing
6	Milled grain prods.	311811	Retail Bakeries	311810	Bread and bakery product manufacturing
6	Milled grain prods.	311812	Commercial Bakeries	311810	Bread and bakery product manufacturing
6	Milled grain prods.	311813	Frozen Cakes, Pies, and Other Pastries Manufacturing	311810	Bread and bakery product manufacturing
6	Milled grain prods.	311821	Cookie and Cracker Manufacturing	311820	Cookie, cracker, and pasta manufacturing
6	Milled grain prods.	311822	Flour Mixes and Dough Manufacturing from Purchased Flour	311820	Cookie, cracker, and pasta manufacturing
6	Milled grain prods.	311823	Dry Pasta Manufacturing	311820	Cookie, cracker, and pasta manufacturing
6	Milled grain prods.	311830	Tortilla Manufacturing	311830	Tortilla manufacturing
6	Milled grain prods.	311991	Perishable Prepared Food Manufacturing	311990	All other food manufacturing

SCTG	SCTG Description	NAICS	NAICS Description	I-O	I-O Description
7	Other foodstuffs	112120	Dairy Cattle and Milk Production	112120	Dairy cattle and milk production
7	Other foodstuffs	311225	Fats and Oils Refining and Blending	311225	Fats and oils refining and blending
7	Other foodstuffs	311311	Sugarcane Mills	31131A	Sugar cane mills and refining
7	Other foodstuffs	311312	Cane Sugar Refining	31131A	Sugar cane mills and refining
7	Other foodstuffs	311313	Beet Sugar Manufacturing	311313	Beet sugar manufacturing
7	Other foodstuffs	311320	Chocolate and Confectionery Manufacturing from Cacao Beans	311320	Chocolate and confectionery manufacturing from cacao beans
7	Other foodstuffs	311330	Confectionery Manufacturing from Purchased Chocolate	311330	Confectionery manufacturing from purchased chocolate
7	Other foodstuffs	311340	Nonchocolate Confectionery Manufacturing	311340	Nonchocolate confectionery manufacturing
7	Other foodstuffs	311411	Frozen Fruit, Juice, and Vegetable Manufacturing	311410	Frozen food manufacturing
7	Other foodstuffs	311412	Frozen Specialty Food Manufacturing	311410	Frozen food manufacturing
7	Other foodstuffs	311421	Fruit and Vegetable Canning	311420	Fruit and vegetable canning, pickling, and drying
7	Other foodstuffs	311422	Specialty Canning	311420	Fruit and vegetable canning, pickling, and drying
7	Other foodstuffs	311423	Dried and Dehydrated Food Manufacturing	311420	Fruit and vegetable canning, pickling, and drying
7	Other foodstuffs	311511	Fluid Milk Manufacturing	31151A	Fluid milk and butter manufacturing
7	Other foodstuffs	311512	Creamery Butter Manufacturing	31151A	Fluid milk and butter manufacturing
7	Other foodstuffs	311513	Cheese Manufacturing	311513	Cheese manufacturing
7	Other foodstuffs	311514	Dry, Condensed, and Evaporated Dairy Product Manufacturing	311514	Dry, condensed, and evaporated dairy product manufacturing
7	Other foodstuffs	311520	Ice Cream and Frozen Dessert Manufacturing	311520	Ice cream and frozen dessert manufacturing
7	Other foodstuffs	311911	Roasted Nuts and Peanut Butter Manufacturing	311910	Snack food manufacturing
7	Other foodstuffs	311919	Other Snack Food Manufacturing	311910	Snack food manufacturing
7	Other foodstuffs	311920	Coffee and Tea Manufacturing	311920	Coffee and tea manufacturing
7	Other foodstuffs	311930	Flavoring Syrup and Concentrate Manufacturing	311930	Flavoring syrup and concentrate manufacturing

SCTG	SCTG Description	NAICS	NAICS Description	I-O	I-O Description
7	Other foodstuffs	311941	Mayonnaise, Dressing, and Other Prepared Sauce Manufacturing	311940	Seasoning and dressing manufacturing
7	Other foodstuffs	311942	Spice and Extract Manufacturing	311940	Seasoning and dressing manufacturing
7	Other foodstuffs	311999	All Other Miscellaneous Food Manufacturing	311990	All other food manufacturing
7	Other foodstuffs	312111	Soft Drink Manufacturing	312110	Soft drink and ice manufacturing
7	Other foodstuffs	312112	Bottled Water Manufacturing	312110	Soft drink and ice manufacturing
8	Alcoholic beverages	312120	Breweries	312120	Breweries
8	Alcoholic beverages	312130	Wineries	312130	Wineries
8	Alcoholic beverages	312140	Distilleries	312140	Distilleries
9	Tobacco prods.	312210	Tobacco Stemming and Redrying	3122A0	Tobacco product manufacturing
9	Tobacco prods.	312221	Cigarette Manufacturing	3122A0	Tobacco product manufacturing
9	Tobacco prods.	312229	Other Tobacco Product Manufacturing	3122A0	Tobacco product manufacturing
10	Building stone	212311	Dimension Stone Mining and Quarrying	212310	Stone mining and quarrying
10	Building stone	327121	Brick and Structural Clay Tile Manufacturing	32712A	Brick, tile, and other structural clay product manufacturing
10	Building stone	327991	Cut Stone and Stone Product Manufacturing	327991	Cut stone and stone product manufacturing
11	Natural sands	212312	Crushed and Broken Limestone Mining and Quarrying	212310	Stone mining and quarrying
11	Natural sands	212313	Crushed and Broken Granite Mining and Quarrying	212310	Stone mining and quarrying
11	Natural sands	212319	Other Crushed and Broken Stone Mining and Quarrying	212310	Stone mining and quarrying
11	Natural sands	212321	Construction Sand and Gravel Mining	212320	Sand, gravel, clay, and ceramic and refractory minerals mining and quarrying
11	Natural sands	212322	Industrial Sand Mining	212320	Sand, gravel, clay, and ceramic and refractory minerals mining and quarrying
12	Gravel	327992	Ground or Treated Mineral and Earth Manufacturing	327992	Ground or treated mineral and earth manufacturing

SCTG	SCTG Description	NAICS	NAICS Description	I-O	I-O Description
13	Nonmetallic minerals	212324	Kaolin and Ball Clay Mining	212320	Sand, gravel, clay, and ceramic and refractory minerals mining and quarrying
13	Nonmetallic minerals	212325	Clay and Ceramic and Refractory Minerals Mining	212320	Sand, gravel, clay, and ceramic and refractory minerals mining and quarrying
13	Nonmetallic minerals	212391	Potash, Soda, and Borate Mineral Mining	212390	Other nonmetallic mineral mining and quarrying
13	Nonmetallic minerals	212392	Phosphate Rock Mining	212390	Other nonmetallic mineral mining and quarrying
13	Nonmetallic minerals	212393	Other Chemical and Fertilizer Mineral Mining	212390	Other nonmetallic mineral mining and quarrying
13	Nonmetallic minerals	212399	All Other Nonmetallic Mineral Mining	212390	Other nonmetallic mineral mining and quarrying
14	Metallic ores	212210	Iron Ore Mining	212210	Iron ore mining
14	Metallic ores	212221	Gold Ore Mining	2122A0	Gold, silver, and other metal ore mining
14	Metallic ores	212222	Silver Ore Mining	2122A0	Gold, silver, and other metal ore mining
14	Metallic ores	212231	Lead Ore and Zinc Ore Mining	212230	Copper, nickel, lead, and zinc mining
14	Metallic ores	212234	Copper Ore and Nickel Ore Mining	212230	Copper, nickel, lead, and zinc mining
14	Metallic ores	212291	Uranium-Radium-Vanadium Ore Mining	212210	Iron ore mining
14	Metallic ores	212299	All Other Metal Ore Mining	2122A0	Gold, silver, and other metal ore mining
14	Metallic ores	213114	Support Activities for Metal Mining	21311A	Support activities for other mining
14	Metallic ores	213115	Support Activities for Nonmetallic Minerals (except Fuels)	21311A	Support activities for other mining
15	Coal	212111	Bituminous Coal and Lignite Surface Mining	212100	Coal mining
15	Coal	212112	Bituminous Coal Underground Mining	212100	Coal mining
15	Coal	212113	Anthracite Mining	212100	Coal mining
15	Coal	213113	Support Activities for Coal Mining	21311A	Support activities for other mining
16	Crude petroleum	211111	Crude Petroleum and Natural Gas Extraction	211000	Oil and gas extraction
16	Crude petroleum	211112	Natural Gas Liquid Extraction	211000	Oil and gas extraction
16	Crude petroleum	213111	Drilling Oil and Gas Wells	213111	Drilling oil and gas wells
16	Crude petroleum	213112	Support Activities for Oil and Gas Operations	213112	Support activities for oil and gas operations
17	Gasoline	324110	Petroleum Refineries	324110	Petroleum refineries

SCTG	SCTG Description	NAICS	NAICS Description	I-O	I-O Description
19	Coal-n.e.c.	324191	Petroleum Lubricating Oil and Grease Manufacturing	324191	Petroleum lubricating oil and grease manufacturing
19	Coal-n.e.c.	324199	All Other Petroleum and Coal Products Manufacturing	324199	All other petroleum and coal products manufacturing
19	Coal-n.e.c.	325110	Petrochemical Manufacturing	325110	Petrochemical manufacturing
19	Coal-n.e.c.	325120	Industrial Gas Manufacturing	325120	Industrial gas manufacturing
20	Basic chemicals	325181	Alkalies and Chlorine Manufacturing	325181	Alkalies and chlorine manufacturing
20	Basic chemicals	325182	Carbon Black Manufacturing	325182	Carbon black manufacturing
20	Basic chemicals	325188	All Other Basic Inorganic Chemical Manufacturing	325188	All other basic inorganic chemical manufacturing
20	Basic chemicals	325191	Gum and Wood Chemical Manufacturing	325190	Other basic organic chemical manufacturing
20	Basic chemicals	325192	Cyclic Crude and Intermediate Manufacturing	325190	Other basic organic chemical manufacturing
20	Basic chemicals	325193	Ethyl Alcohol Manufacturing	325190	Other basic organic chemical manufacturing
20	Basic chemicals	325199	All Other Basic Organic Chemical Manufacturing	325190	Other basic organic chemical manufacturing
20	Basic chemicals	325221	Cellulosic Organic Fiber Manufacturing	325221	#N/A
20	Basic chemicals	325222	Noncellulosic Organic Fiber Manufacturing	325220	Artificial and synthetic fibers and filaments manufacturing
21	Pharmaceuticals	325411	Medicinal and Botanical Manufacturing	325411	Medicinal and botanical manufacturing
21	Pharmaceuticals	325412	Pharmaceutical Preparation Manufacturing	325412	Pharmaceutical preparation manufacturing
21	Pharmaceuticals	325413	In-Vitro Diagnostic Substance Manufacturing	325413	In-vitro diagnostic substance manufacturing
21	Pharmaceuticals	325414	Biological Product (except Diagnostic) Manufacturing	325414	Biological product (except diagnostic) manufacturing
22	Fertilizers	325311	Nitrogenous Fertilizer Manufacturing	325310	Fertilizer manufacturing
22	Fertilizers	325312	Phosphatic Fertilizer Manufacturing	325310	Fertilizer manufacturing
22	Fertilizers	325314	Fertilizer (Mixing Only) Manufacturing	325310	Fertilizer manufacturing
23	Chemical prods.	325131	Inorganic Dye and Pigment Manufacturing	325130	Synthetic dye and pigment manufacturing
23	Chemical prods.	325132	Synthetic Organic Dye and Pigment Manufacturing	325130	Synthetic dye and pigment manufacturing

SCTG	SCTG Description	NAICS	NAICS Description	I-O	I-O Description
23	Chemical prods.	325320	Pesticide and Other Agricultural Chemical Manufacturing	325320	Pesticide and other agricultural chemical manufacturing
23	Chemical prods.	325510	Paint and Coating Manufacturing	325510	Paint and coating manufacturing
23	Chemical prods.	325520	Adhesive Manufacturing	325520	Adhesive manufacturing
23	Chemical prods.	325611	Soap and Other Detergent Manufacturing	325610	Soap and cleaning compound manufacturing
23	Chemical prods.	325612	Polish and Other Sanitation Good Manufacturing	325610	Soap and cleaning compound manufacturing
23	Chemical prods.	325613	Surface Active Agent Manufacturing	325610	Soap and cleaning compound manufacturing
23	Chemical prods.	325620	Toilet Preparation Manufacturing	325620	Toilet preparation manufacturing
23	Chemical prods.	325910	Printing Ink Manufacturing	325910	Printing ink manufacturing
23	Chemical prods.	325920	Explosives Manufacturing	3259A0	All other chemical product and preparation manufacturing
23	Chemical prods.	325991	Custom Compounding of Purchased Resins	3259A0	All other chemical product and preparation manufacturing
23	Chemical prods.	325992	Photographic Film, Paper, Plate, and Chemical Manufacturing	3259A0	All other chemical product and preparation manufacturing
23	Chemical prods.	325998	All Other Miscellaneous Chemical Product and Preparation Manufacturing	3259A0	All other chemical product and preparation manufacturing
24	Plastics/rubber	325211	Plastics Material and Resin Manufacturing	325211	Plastics material and resin manufacturing
24	Plastics/rubber	325212	Synthetic Rubber Manufacturing	325212	Synthetic rubber manufacturing
24	Plastics/rubber	326111	Plastics Bag and Pouch Manufacturing	326110	Plastics packaging materials and unlaminated film and sheet manufacturing
24	Plastics/rubber	326112	Plastics Packaging Film and Sheet (including Laminated) Manufacturing	326110	Plastics packaging materials and unlaminated film and sheet manufacturing
24	Plastics/rubber	326113	Unlaminated Plastics Film and Sheet (except Packaging) Manufacturing	326110	Plastics packaging materials and unlaminated film and sheet manufacturing
24	Plastics/rubber	326121	Unlaminated Plastics Profile Shape Manufacturing	326121	Unlaminated plastics profile shape manufacturing
24	Plastics/rubber	326122	Plastics Pipe and Pipe Fitting Manufacturing	326122	Plastics pipe and pipe fitting manufacturing

SCTG	SCTG Description	NAICS	NAICS Description	I-O	I-O Description
24	Plastics/rubber	326130	Laminated Plastics Plate, Sheet (except Packaging), and Shape Manufacturing	326130	Laminated plastics plate, sheet (except packaging), and shape manufacturing
24	Plastics/rubber	326140	Polystyrene Foam Product Manufacturing	326140	Polystyrene foam product manufacturing
24	Plastics/rubber	326150	Urethane and Other Foam Product (except Polystyrene) Manufacturing	326150	Urethane and other foam product (except polystyrene) manufacturing
24	Plastics/rubber	326160	Plastics Bottle Manufacturing	326160	Plastics bottle manufacturing
24	Plastics/rubber	326191	Plastics Plumbing Fixture Manufacturing	32619A	Other plastics product manufacturing
24	Plastics/rubber	326192	Resilient Floor Covering Manufacturing	32619A	Other plastics product manufacturing
24	Plastics/rubber	326199	All Other Plastics Product Manufacturing	32619A	Other plastics product manufacturing
24	Plastics/rubber	326211	Tire Manufacturing (except Retreading)	326210	Tire manufacturing
24	Plastics/rubber	326220	Rubber and Plastics Hoses and Belting Manufacturing	326220	Rubber and plastics hoses and belting manufacturing
24	Plastics/rubber	326291	Rubber Product Manufacturing for Mechanical Use	326290	Other rubber product manufacturing
24	Plastics/rubber	326299	All Other Rubber Product Manufacturing	326290	Other rubber product manufacturing
24	Plastics/rubber	339991	Gasket, Packing, and Sealing Device Manufacturing	339991	Gasket, packing, and sealing device manufacturing
25	Logs	113110	Timber Tract Operations	113A00	Forest nurseries, forest products, and timber tracts
25	Logs	113210	Forest Nurseries and Gathering of Forest Products	113A00	Forest nurseries, forest products, and timber tracts
25	Logs	113310	Logging	113300	Logging
25	Logs	115310	Support Activities for Forestry	115000	Support activities for agriculture and forestry
26	Wood prods.	321113	Sawmills	321100	Sawmills and wood preservation
26	Wood prods.	321114	Wood Preservation	321100	Sawmills and wood preservation
26	Wood prods.	321211	Hardwood Veneer and Plywood Manufacturing	32121A	Veneer and plywood manufacturing
26	Wood prods.	321212	Softwood Veneer and Plywood Manufacturing	32121A	Veneer and plywood manufacturing
26	Wood prods.	321213	Engineered Wood Member (except Truss) Manufacturing	32121B	Engineered wood member and truss manufacturing
26	Wood prods.	321214	Truss Manufacturing	32121B	Engineered wood member and truss manufacturing

SCTG	SCTG Description	NAICS	NAICS Description	I-O	I-O Description
26	Wood prods.	321219	Reconstituted Wood Product Manufacturing	321219	Reconstituted wood product manufacturing
26	Wood prods.	321911	Wood Window and Door Manufacturing	321910	Wood windows and doors and millwork
26	Wood prods.	321912	Cut Stock, Resawing Lumber, and Planing	321910	Wood windows and doors and millwork
26	Wood prods.	321918	Other Millwork (including Flooring)	321910	Wood windows and doors and millwork
26	Wood prods.	321920	Wood Container and Pallet Manufacturing	321920	Wood container and pallet manufacturing
26	Wood prods.	321991	Manufactured Home (Mobile Home) Manufacturing	321991	Manufactured home (mobile home) manufacturing
26	Wood prods.	321992	Prefabricated Wood Building Manufacturing	321992	Prefabricated wood building manufacturing
26	Wood prods.	321999	All Other Miscellaneous Wood Product Manufacturing	321999	All other miscellaneous wood product manufacturing
26	Wood prods.	337110	Wood Kitchen Cabinet and Countertop Manufacturing	337110	Wood kitchen cabinet and countertop manufacturing
27	Newsprint/paper	322110	Pulp Mills	322110	Pulp mills
27	Newsprint/paper	322121	Paper (except Newsprint) Mills	322120	Paper mills
27	Newsprint/paper	322122	Newsprint Mills	322120	Paper mills
27	Newsprint/paper	322130	Paperboard Mills	322130	Paperboard Mills
27	Newsprint/paper	322221	Coated and Laminated Packaging Paper Manufacturing	32222A	Coated and laminated paper, packaging paper and plastics film manufacturing
27	Newsprint/paper	322222	Coated and Laminated Paper Manufacturing	32222A	Coated and laminated paper, packaging paper and plastics film manufacturing
27	Newsprint/paper	322223	Coated Paper Bag and Pouch Manufacturing	32222B	All other paper bag and coated and treated paper manufacturing
27	Newsprint/paper	322224	Uncoated Paper and Multiwall Bag Manufacturing	32222B	All other paper bag and coated and treated paper manufacturing
27	Newsprint/paper	322225	Laminated Aluminum Foil Manufacturing for Flexible Packaging Uses	32222B	All other paper bag and coated and treated paper manufacturing
27	Newsprint/paper	322226	Surface-Coated Paperboard Manufacturing	32222B	All other paper bag and coated and treated paper manufacturing
27	Newsprint/paper	322231	Die-Cut Paper and Paperboard Office Supplies Manufacturing	322230	Stationery product manufacturing
28	Paper articles	322211	Corrugated and Solid Fiber Box Manufacturing	322210	Paperboard container manufacturing

SCTG	SCTG Description	NAICS	NAICS Description	I-O	I-O Description
28	Paper articles	322212	Folding Paperboard Box Manufacturing	322210	Paperboard container manufacturing
28	Paper articles	322213	Setup Paperboard Box Manufacturing	322210	Paperboard container manufacturing
28	Paper articles	322214	Fiber Can, Tube, Drum, and Similar Products Manufacturing	322210	Paperboard container manufacturing
28	Paper articles	322215	Nonfolding Sanitary Food Container Manufacturing	322210	Paperboard container manufacturing
28	Paper articles	322232	Envelope Manufacturing	322230	Stationery product manufacturing
28	Paper articles	322233	Stationery, Tablet, and Related Product Manufacturing	322230	Stationery product manufacturing
28	Paper articles	322291	Sanitary Paper Product Manufacturing	322291	Sanitary paper product manufacturing
28	Paper articles	322299	All Other Converted Paper Product Manufacturing	322299	All other converted paper product manufacturing
29	Printed prods.	323110	Commercial Lithographic Printing	323110	Printing
29	Printed prods.	323111	Commercial Gravure Printing	323110	Printing
29	Printed prods.	323112	Commercial Flexographic Printing	323110	Printing
29	Printed prods.	323113	Commercial Screen Printing	323110	Printing
29	Printed prods.	323114	Quick Printing	323110	Printing
29	Printed prods.	323116	Manifold Business Forms Printing	323110	Printing
29	Printed prods.	323117	Books Printing	323110	Printing
29	Printed prods.	323118	Blankbook, Looseleaf Binders, and Devices Manufacturing	323110	Printing
29	Printed prods.	323119	Other Commercial Printing	323110	Printing
29	Printed prods.	323121	Tradebinding and Related Work	323120	Support activities for printing
29	Printed prods.	323122	Prepress Services	323120	Support activities for printing
30	Textiles/leather	313111	Yarn Spinning Mills	313100	Fiber, yarn, and thread mills
30	Textiles/leather	313112	Yarn Texturizing, Throwing, and Twisting Mills	313100	Fiber, yarn, and thread mills
30	Textiles/leather	313113	Thread Mills	313100	Fiber, yarn, and thread mills
30	Textiles/leather	313210	Broadwoven Fabric Mills	313210	Broadwoven fabric mills
30	Textiles/leather	313221	Narrow Fabric Mills	313220	Narrow fabric mills and schiffli machine embroidery

SCTG	SCTG Description	NAICS	NAICS Description	I-O	I-O Description
30	Textiles/leather	313222	Schiffli Machine Embroidery	313220	Narrow fabric mills and schiffli machine embroidery
30	Textiles/leather	313230	Nonwoven Fabric Mills	313230	Nonwoven fabric mills
30	Textiles/leather	313241	Weft Knit Fabric Mills	313240	Knit fabric mills
30	Textiles/leather	313249	Other Knit Fabric and Lace Mills	313240	Knit fabric mills
30	Textiles/leather	313311	Broadwoven Fabric Finishing Mills	313310	Textile and fabric finishing mills
30	Textiles/leather	313312	Textile and Fabric Finishing (except Broadwoven Fabric) Mills	313310	Textile and fabric finishing mills
30	Textiles/leather	313320	Fabric Coating Mills	313320	Fabric coating mills
30	Textiles/leather	314110	Carpet and Rug Mills	314110	Carpet and rug mills
30	Textiles/leather	314121	Curtain and Drapery Mills	314120	Curtain and linen mills
30	Textiles/leather	314129	Other Household Textile Product Mills	314120	Curtain and linen mills
30	Textiles/leather	314911	Textile Bag Mills	314910	Textile bag and canvas mills
30	Textiles/leather	314912	Canvas and Related Product Mills	314910	Textile bag and canvas mills
30	Textiles/leather	314991	Rope, Cordage, and Twine Mills	314990	All other textile product mills
30	Textiles/leather	314992	Tire Cord and Tire Fabric Mills	314990	All other textile product mills
30	Textiles/leather	314999	All Other Miscellaneous Textile Product Mills	314990	All other textile product mills
30	Textiles/leather	315111	Sheer Hosiery Mills	315100	Apparel knitting mills
30	Textiles/leather	315119	Other Hosiery and Sock Mills	315100	Apparel knitting mills
30	Textiles/leather	315191	Outerwear Knitting Mills	315100	Apparel knitting mills
30	Textiles/leather	315192	Underwear and Nightwear Knitting Mills	315100	Apparel knitting mills
30	Textiles/leather	315211	Men's and Boys' Cut and Sew Apparel Contractors	315210	Cut and sew apparel contractors
30	Textiles/leather	315212	Women's, Girls', and Infants' Cut and Sew Apparel Contractors	315210	Cut and sew apparel contractors
30	Textiles/leather	315221	Men's and Boys' Cut and Sew Underwear and Nightwear Manufacturing	315220	Men's and boys' cut and sew apparel manufacturing
30	Textiles/leather	315222	Men's and Boys' Cut and Sew Suit, Coat, and Overcoat Manufacturing	315220	Men's and boys' cut and sew apparel manufacturing
30	Textiles/leather	315223	Men's and Boys' Cut and Sew Shirt (except Work Shirt) Manufacturing	315220	Men's and boys' cut and sew apparel manufacturing
30	Textiles/leather	315224	Men's and Boys' Cut and Sew Trouser, Slack, and Jean Manufacturing	315220	Men's and boys' cut and sew apparel manufacturing

SCTG	SCTG Description	NAICS	NAICS Description	I-O	I-O Description
30	Textiles/leather	315225	Men's and Boys' Cut and Sew Work Clothing Manufacturing	315220	Men's and boys' cut and sew apparel manufacturing
30	Textiles/leather	315228	Men's and Boys' Cut and Sew Other Outerwear Manufacturing	315220	Men's and boys' cut and sew apparel manufacturing
30	Textiles/leather	315231	Women's and Girls' Cut and Sew Lingerie, Loungewear, and Nightwear Manufacturing	315230	Women's and girls' cut and sew apparel manufacturing
30	Textiles/leather	315232	Women's and Girls' Cut and Sew Blouse and Shirt Manufacturing	315230	Women's and girls' cut and sew apparel manufacturing
30	Textiles/leather	315233	Women's and Girls' Cut and Sew Dress Manufacturing	315230	Women's and girls' cut and sew apparel manufacturing
30	Textiles/leather	315234	Women's and Girls' Cut and Sew Suit, Coat, Tailored Jacket, and Skirt Manufacturing	315230	Women's and girls' cut and sew apparel manufacturing
30	Textiles/leather	315239	Women's and Girls' Cut and Sew Other Outerwear Manufacturing	315290	Other cut and sew apparel manufacturing
30	Textiles/leather	315291	Infants' Cut and Sew Apparel Manufacturing	315290	Other cut and sew apparel manufacturing
30	Textiles/leather	315292	Fur and Leather Apparel Manufacturing	315290	Other cut and sew apparel manufacturing
30	Textiles/leather	315299	All Other Cut and Sew Apparel Manufacturing	315290	Other cut and sew apparel manufacturing
30	Textiles/leather	315991	Hat, Cap, and Millinery Manufacturing	315900	Apparel accessories and other apparel manufacturing
30	Textiles/leather	315992	Glove and Mitten Manufacturing	315900	Apparel accessories and other apparel manufacturing
30	Textiles/leather	315993	Men's and Boys' Neckwear Manufacturing	315900	Apparel accessories and other apparel manufacturing
30	Textiles/leather	315999	Other Apparel Accessories and Other Apparel Manufacturing	315900	Apparel accessories and other apparel manufacturing
30	Textiles/leather	316110	Leather and Hide Tanning and Finishing	316100	Leather and hide tanning and finishing
30	Textiles/leather	316211	Rubber and Plastics Footwear Manufacturing	316200	Footwear manufacturing
30	Textiles/leather	316212	House Slipper Manufacturing	316200	Footwear manufacturing
30	Textiles/leather	316213	Men's Footwear (except Athletic) Manufacturing	316200	Footwear manufacturing
30	Textiles/leather	316214	Women's Footwear (except Athletic) Manufacturing	316200	Footwear manufacturing

SCTG	SCTG Description	NAICS	NAICS Description	I-O	I-O Description
30	Textiles/leather	316219	Other Footwear Manufacturing	316200	Footwear manufacturing
30	Textiles/leather	316991	Luggage Manufacturing	316900	Other leather and allied product manufacturing
30	Textiles/leather	316992	Women's Handbag and Purse Manufacturing	316900	Other leather and allied product manufacturing
30	Textiles/leather	316993	Personal Leather Good (except Women's Handbag and Purse) Manufacturing	316900	Other leather and allied product manufacturing
30	Textiles/leather	316999	All Other Leather Good and Allied Product Manufacturing	316900	Other leather and allied product manufacturing
31	Nonmetal min. prods.	324121	Asphalt Paving Mixture and Block Manufacturing	324121	Asphalt paving mixture and block manufacturing
31	Nonmetal min. prods.	324122	Asphalt Shingle and Coating Materials Manufacturing	324122	Asphalt shingle and coating materials manufacturing
31	Nonmetal min. prods.	327122	Ceramic Wall and Floor Tile Manufacturing	32712A	Brick, tile, and other structural clay product manufacturing
31	Nonmetal min. prods.	327123	Other Structural Clay Product Manufacturing	32712A	Brick, tile, and other structural clay product manufacturing
31	Nonmetal min. prods.	327124	Clay Refractory Manufacturing	32712B	Clay and nonclay refractory manufacturing
31	Nonmetal min. prods.	327125	Nonclay Refractory Manufacturing	32712B	Clay and nonclay refractory manufacturing
31	Nonmetal min. prods.	327211	Flat Glass Manufacturing	327211	Flat glass manufacturing
31	Nonmetal min. prods.	327212	Other Pressed and Blown Glass and Glassware Manufacturing	327212	Other pressed and blown glass and glassware manufacturing
31	Nonmetal min. prods.	327213	Glass Container Manufacturing	327213	Glass container manufacturing
31	Nonmetal min. prods.	327215	Glass Product Manufacturing Made of Purchased Glass	327215	Glass product manufacturing made of purchased glass
31	Nonmetal min. prods.	327310	Cement Manufacturing	327310	Cement manufacturing
31	Nonmetal min. prods.	327320	Ready-Mix Concrete Manufacturing	327320	Ready-mix concrete manufacturing
31	Nonmetal min. prods.	327331	Concrete Block and Brick Manufacturing	327330	Concrete pipe, brick, and block manufacturing
31	Nonmetal min. prods.	327332	Concrete Pipe Manufacturing	327330	Concrete pipe, brick, and block manufacturing
31	Nonmetal min. prods.	327390	Other Concrete Product Manufacturing	327390	Other concrete product manufacturing
31	Nonmetal min. prods.	327410	Lime Manufacturing	3274A0	Lime and gypsum product manufacturing
31	Nonmetal min. prods.	327420	Gypsum Product Manufacturing	3274A0	Lime and gypsum product manufacturing

SCTG	SCTG Description	NAICS	NAICS Description	I-O	I-O Description
31	Nonmetal min. prods.	327910	Abrasive Product Manufacturing	327910	Abrasive product manufacturing
31	Nonmetal min. prods.	327993	Mineral Wool Manufacturing	327993	Mineral wool manufacturing
31	Nonmetal min. prods.	327999	All Other Miscellaneous Nonmetallic Mineral Product Manufacturing	327999	Miscellaneous nonmetallic mineral products
32	Base metals	331111	Iron and Steel Mills	331110	Iron and steel mills and ferroalloy manufacturing
32	Base metals	331112	Electrometallurgical Ferroalloy Product Manufacturing	331110	Iron and steel mills and ferroalloy manufacturing
32	Base metals	331210	Iron and Steel Pipe and Tube Manufacturing from Purchased Steel	331200	Steel product manufacturing from purchased steel
32	Base metals	331221	Rolled Steel Shape Manufacturing	331200	Steel product manufacturing from purchased steel
32	Base metals	331222	Steel Wire Drawing	331200	Steel product manufacturing from purchased steel
32	Base metals	331311	Alumina Refining	33131A	Alumina refining and primary aluminum production
32	Base metals	331312	Primary Aluminum Production	33131A	Alumina refining and primary aluminum production
32	Base metals	331314	Secondary Smelting and Alloying of Aluminum	331314	Secondary smelting and alloying of aluminum
32	Base metals	331315	Aluminum Sheet, Plate, and Foil Manufacturing	33131B	Aluminum product manufacturing from purchased aluminum
32	Base metals	331316	Aluminum Extruded Product Manufacturing	33131B	Aluminum product manufacturing from purchased aluminum
32	Base metals	331319	Other Aluminum Rolling and Drawing	33131B	Aluminum product manufacturing from purchased aluminum
32	Base metals	331411	Primary Smelting and Refining of Copper	331411	Primary smelting and refining of copper
32	Base metals	331419	Primary Smelting and Refining of Nonferrous Metal (except Copper and Aluminum)	331419	Primary smelting and refining of nonferrous metal (except copper and aluminum)
32	Base metals	331421	Copper Rolling, Drawing, and Extruding	331420	Copper rolling, drawing, extruding and alloying
32	Base metals	331422	Copper Wire (except Mechanical) Drawing	331420	Copper rolling, drawing, extruding and alloying
32	Base metals	331423	Secondary Smelting, Refining, and Alloying of Copper	331420	Copper rolling, drawing, extruding and alloying

SCTG	SCTG Description	NAICS	NAICS Description	I-O	I-O Description
32	Base metals	331491	Nonferrous Metal (except Copper and Aluminum) Rolling, Drawing, and Extruding	331490	Nonferrous metal (except copper and aluminum) rolling, drawing, extruding and alloying
32	Base metals	331492	Secondary Smelting, Refining, and Alloying of Nonferrous Metal (except Copper and Aluminum)	331490	Nonferrous metal (except copper and aluminum) rolling, drawing, extruding and alloying
32	Base metals	331511	Iron Foundries	331510	Ferrous metal foundries
32	Base metals	331512	Steel Investment Foundries	331510	Ferrous metal foundries
32	Base metals	331513	Steel Foundries (except Investment)	331510	Ferrous metal foundries
32	Base metals	331521	Aluminum Die-Casting Foundries	331520	Nonferrous metal foundries
32	Base metals	331522	Nonferrous (except Aluminum) Die-Casting Foundries	331520	Nonferrous metal foundries
32	Base metals	331524	Aluminum Foundries (except Die-Casting)	331520	Nonferrous metal foundries
32	Base metals	331525	Copper Foundries (except Die-Casting)	331520	Nonferrous metal foundries
32	Base metals	331528	Other Nonferrous Foundries (except Die-Casting)	331520	Nonferrous metal foundries
33	Articles-base metal	332111	Iron and Steel Forging	33211A	All other forging, stamping, and sintering
33	Articles-base metal	332112	Nonferrous Forging	33211A	All other forging, stamping, and sintering
33	Articles-base metal	332114	Custom Roll Forming	332114	Custom roll forming
33	Articles-base metal	332115	Crown and Closure Manufacturing	33211B	Crown and closure manufacturing and metal stamping
33	Articles-base metal	332116	Metal Stamping	33211B	Crown and closure manufacturing and metal stamping
33	Articles-base metal	332117	Powder Metallurgy Part Manufacturing	33211A	All other forging, stamping, and sintering
33	Articles-base metal	332211	Cutlery and Flatware (except Precious) Manufacturing	33221A	Cutlery, utensil, pot, and pan manufacturing
33	Articles-base metal	332212	Hand and Edge Tool Manufacturing	33221B	Handtool manufacturing
33	Articles-base metal	332213	Saw Blade and Handsaw Manufacturing	33221B	Handtool manufacturing
33	Articles-base metal	332214	Kitchen Utensil, Pot, and Pan Manufacturing	33221A	Cutlery, utensil, pot, and pan manufacturing
33	Articles-base metal	332311	Prefabricated Metal Building and Component Manufacturing	332310	Plate work and fabricated structural product manufacturing

SCTG	SCTG Description	NAICS	NAICS Description	I-O	I-O Description
33	Articles-base metal	332312	Fabricated Structural Metal Manufacturing	332310	Plate work and fabricated structural product manufacturing
33	Articles-base metal	332313	Plate Work Manufacturing	332310	Plate work and fabricated structural product manufacturing
33	Articles-base metal	332321	Metal Window and Door Manufacturing	332320	Ornamental and architectural metal products manufacturing
33	Articles-base metal	332322	Sheet Metal Work Manufacturing	332320	Ornamental and architectural metal products manufacturing
33	Articles-base metal	332323	Ornamental and Architectural Metal Work Manufacturing	332320	Ornamental and architectural metal products manufacturing
33	Articles-base metal	332410	Power Boiler and Heat Exchanger Manufacturing	332410	Power boiler and heat exchanger manufacturing
33	Articles-base metal	332420	Metal Tank (Heavy Gauge) Manufacturing	332420	Metal tank (heavy gauge) manufacturing
33	Articles-base metal	332431	Metal Can Manufacturing	332430	Metal can, box, and other metal container (light gauge) manufacturing
33	Articles-base metal	332439	Other Metal Container Manufacturing	332430	Metal can, box, and other metal container (light gauge) manufacturing
33	Articles-base metal	332510	Hardware Manufacturing	332500	Hardware manufacturing
33	Articles-base metal	332611	Spring (Heavy Gauge) Manufacturing	332600	Spring and wire product manufacturing
33	Articles-base metal	332612	Spring (Light Gauge) Manufacturing	332600	Spring and wire product manufacturing
33	Articles-base metal	332618	Other Fabricated Wire Product Manufacturing	332600	Spring and wire product manufacturing
33	Articles-base metal	332710	Machine Shops	332710	Machine shops
33	Articles-base metal	332721	Precision Turned Product Manufacturing	332720	Turned product and screw, nut, and bolt manufacturing
33	Articles-base metal	332722	Bolt, Nut, Screw, Rivet, and Washer Manufacturing	332720	Turned product and screw, nut, and bolt manufacturing
33	Articles-base metal	332811	Metal Heat Treating	332800	Coating, engraving, heat treating and allied activities
33	Articles-base metal	332812	Metal Coating, Engraving (except Jewelry and Silverware), and Allied Services to Manufacturers	332800	Coating, engraving, heat treating and allied activities
33	Articles-base metal	332813	Electroplating, Plating, Polishing, Anodizing, and Coloring	332800	Coating, engraving, heat treating and allied activities
33	Articles-base metal	332911	Industrial Valve Manufacturing	33291A	Valve and fittings other than plumbing

SCTG	SCTG Description	NAICS	NAICS Description	I-O	I-O Description
33	Articles-base metal	332912	Fluid Power Valve and Hose Fitting Manufacturing	33291A	Valve and fittings other than plumbing
33	Articles-base metal	332913	Plumbing Fixture Fitting and Trim Manufacturing	332913	Plumbing fixture fitting and trim manufacturing
33	Articles-base metal	332919	Other Metal Valve and Pipe Fitting Manufacturing	33291A	Valve and fittings other than plumbing
33	Articles-base metal	332991	Ball and Roller Bearing Manufacturing	332991	Ball and roller bearing manufacturing
33	Articles-base metal	332996	Fabricated Pipe and Pipe Fitting Manufacturing	332996	Fabricated pipe and pipe fitting manufacturing
33	Articles-base metal	332997	Industrial Pattern Manufacturing	33299C	Other fabricated metal manufacturing
33	Articles-base metal	332998	Enameled Iron and Metal Sanitary Ware Manufacturing	33299C	Other fabricated metal manufacturing
33	Articles-base metal	332999	All Other Miscellaneous Fabricated Metal Product Manufacturing	33299C	Other fabricated metal manufacturing
34	Machinery	333111	Farm Machinery and Equipment Manufacturing	333111	Farm machinery and equipment manufacturing
34	Machinery	333112	Lawn and Garden Tractor and Home Lawn and Garden Equipment Manufacturing	333112	Lawn and garden equipment manufacturing
34	Machinery	333120	Construction Machinery Manufacturing	333120	Construction machinery manufacturing
34	Machinery	333131	Mining Machinery and Equipment Manufacturing	333130	Mining and oil and gas field machinery manufacturing
34	Machinery	333132	Oil and Gas Field Machinery and Equipment Manufacturing	333130	Mining and oil and gas field machinery manufacturing
34	Machinery	333210	Sawmill and Woodworking Machinery Manufacturing	33329A	Other industrial machinery manufacturing
34	Machinery	333220	Plastics and Rubber Industry Machinery Manufacturing	333220	Plastics and rubber industry machinery manufacturing
34	Machinery	333291	Paper Industry Machinery Manufacturing	33329A	Other industrial machinery manufacturing
34	Machinery	333292	Textile Machinery Manufacturing	33329A	Other industrial machinery manufacturing
34	Machinery	333293	Printing Machinery and Equipment Manufacturing	33329A	Other industrial machinery manufacturing
34	Machinery	333294	Food Product Machinery Manufacturing	33329A	Other industrial machinery manufacturing
34	Machinery	333295	Semiconductor Machinery Manufacturing	333295	Semiconductor machinery manufacturing
34	Machinery	333298	All Other Industrial Machinery Manufacturing	33329A	Other industrial machinery manufacturing

SCTG	SCTG Description	NAICS	NAICS Description	I-O	I-O Description
34	Machinery	333312	Commercial Laundry, Drycleaning, and Pressing Machine Manufacturing	33331A	Vending, commercial, industrial, and office machinery manufacturing
34	Machinery	333411	Air Purification Equipment Manufacturing	33341A	Air purification and ventilation equipment manufacturing
34	Machinery	333412	Industrial and Commercial Fan and Blower Manufacturing	33341A	Air purification and ventilation equipment manufacturing
34	Machinery	333414	Heating Equipment (except Warm Air Furnaces) Manufacturing	333414	Heating equipment (except warm air furnaces) manufacturing
34	Machinery	333415	Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing	333415	Air conditioning, refrigeration, and warm air heating equipment manufacturing
34	Machinery	333511	Industrial Mold Manufacturing	333511	Industrial mold manufacturing
34	Machinery	333512	Machine Tool (Metal Cutting Types) Manufacturing	33351A	Metal cutting and forming machine tool manufacturing
34	Machinery	333513	Machine Tool (Metal Forming Types) Manufacturing	33351A	Metal cutting and forming machine tool manufacturing
34	Machinery	333514	Special Die and Tool, Die Set, Jig, and Fixture Manufacturing	333514	Special tool, die, jig, and fixture manufacturing
34	Machinery	333515	Cutting Tool and Machine Tool Accessory Manufacturing	333515	Cutting tool and machine tool accessory manufacturing
34	Machinery	333516	Rolling Mill Machinery and Equipment Manufacturing	33351B	Rolling mill and other metalworking machinery manufacturing
34	Machinery	333518	Other Metalworking Machinery Manufacturing	33351B	Rolling mill and other metalworking machinery manufacturing
34	Machinery	333611	Turbine and Turbine Generator Set Units Manufacturing	333611	Turbine and turbine generator set units manufacturing
34	Machinery	333612	Speed Changer, Industrial High-Speed Drive, and Gear Manufacturing	333612	Speed changer, industrial high-speed drive, and gear manufacturing
34	Machinery	333613	Mechanical Power Transmission Equipment Manufacturing	333613	Mechanical power transmission equipment manufacturing
34	Machinery	333618	Other Engine Equipment Manufacturing	333618	Other engine equipment manufacturing
34	Machinery	333911	Pump and Pumping Equipment Manufacturing	333911	Pump and pumping equipment manufacturing

SCTG	SCTG Description	NAICS	NAICS Description	I-O	I-O Description
34	Machinery	333912	Air and Gas Compressor Manufacturing	333912	Air and gas compressor manufacturing
34	Machinery	333913	Measuring and Dispensing Pump Manufacturing	333911	Pump and pumping equipment manufacturing
34	Machinery	333921	Elevator and Moving Stairway Manufacturing	333920	Material handling equipment manufacturing
34	Machinery	333922	Conveyor and Conveying Equipment Manufacturing	333920	Material handling equipment manufacturing
34	Machinery	333991	Power-Driven Handtool Manufacturing	333991	Power-driven handtool manufacturing
34	Machinery	333992	Welding and Soldering Equipment Manufacturing	33399A	Other general purpose machinery manufacturing
34	Machinery	333993	Packaging Machinery Manufacturing	333993	Packaging machinery manufacturing
34	Machinery	333994	Industrial Process Furnace and Oven Manufacturing	333994	Industrial process furnace and oven manufacturing
34	Machinery	333995	Fluid Power Cylinder and Actuator Manufacturing	33399B	Fluid power process machinery
34	Machinery	333996	Fluid Power Pump and Motor Manufacturing	33399B	Fluid power process machinery
34	Machinery	333999	All Other Miscellaneous General Purpose Machinery Manufacturing	33399A	Other general purpose machinery manufacturing
34	Machinery	335311	Power, Distribution, and Specialty Transformer Manufacturing	335311	Power, distribution, and specialty transformer manufacturing
34	Machinery	335312	Motor and Generator Manufacturing	335312	Motor and generator manufacturing
35	Electronics	327113	Porcelain Electrical Supply Manufacturing	32711A	Pottery, ceramics, and plumbing fixture manufacturing
35	Electronics	333311	Automatic Vending Machine Manufacturing	33331A	Vending, commercial, industrial, and office machinery manufacturing
35	Electronics	333313	Office Machinery Manufacturing	33331A	Vending, commercial, industrial, and office machinery manufacturing
35	Electronics	333319	Other Commercial and Service Industry Machinery Manufacturing	333319	Other commercial and service industry machinery manufacturing
35	Electronics	334111	Electronic Computer Manufacturing	334111	Electronic computer manufacturing
35	Electronics	334112	Computer Storage Device Manufacturing	334112	Computer storage device manufacturing
35	Electronics	334113	Computer Terminal Manufacturing	33411A	Computer terminals and other computer peripheral equipment manufacturing

SCTG	SCTG Description	NAICS	NAICS Description	I-O	I-O Description
35	Electronics	334119	Other Computer Peripheral Equipment Manufacturing	33411A	Computer terminals and other computer peripheral equipment manufacturing
35	Electronics	334210	Telephone Apparatus Manufacturing	334210	Telephone apparatus manufacturing
35	Electronics	334220	Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing	334220	Broadcast and wireless communications equipment
35	Electronics	334290	Other Communications Equipment Manufacturing	334290	Other communications equipment manufacturing
35	Electronics	334310	Audio and Video Equipment Manufacturing	334300	Audio and video equipment manufacturing
35	Electronics	334411	Electron Tube Manufacturing	334411	Electron tube manufacturing
35	Electronics	334412	Bare Printed Circuit Board Manufacturing	334412	Bare printed circuit board manufacturing
35	Electronics	334413	Semiconductor and Related Device Manufacturing	334413	Semiconductor and related device manufacturing
35	Electronics	334414	Electronic Capacitor Manufacturing	33441A	Electronic capacitor, resistor, coil, transformer, and other inductor manufacturing
35	Electronics	334415	Electronic Resistor Manufacturing	33441A	Electronic capacitor, resistor, coil, transformer, and other inductor manufacturing
35	Electronics	334416	Electronic Coil, Transformer, and Other Inductor Manufacturing	33441A	Electronic capacitor, resistor, coil, transformer, and other inductor manufacturing
35	Electronics	334417	Electronic Connector Manufacturing	334417	Electronic connector manufacturing
35	Electronics	334418	Printed Circuit Assembly (Electronic Assembly) Manufacturing	334418	Printed circuit assembly (electronic assembly) manufacturing
35	Electronics	334419	Other Electronic Component Manufacturing	334419	Other electronic component manufacturing
35	Electronics	334611	Software Reproducing	33461A	Software, audio, and video media reproducing
35	Electronics	334612	Prerecorded Compact Disc (except Software), Tape, and Record Reproducing	33461A	Software, audio, and video media reproducing
35	Electronics	334613	Magnetic and Optical Recording Media Manufacturing	334613	Magnetic and optical recording media manufacturing
35	Electronics	335313	Switchgear and Switchboard Apparatus Manufacturing	335313	Switchgear and switchboard apparatus manufacturing

SCTG	SCTG Description	NAICS	NAICS Description	I-O	I-O Description
35	Electronics	335314	Relay and Industrial Control Manufacturing	335314	Relay and industrial control manufacturing
35	Electronics	335911	Storage Battery Manufacturing	335911	Storage battery manufacturing
35	Electronics	335912	Primary Battery Manufacturing	335912	Primary battery manufacturing
35	Electronics	335921	Fiber Optic Cable Manufacturing	335920	Communication and energy wire and cable manufacturing
35	Electronics	335929	Other Communication and Energy Wire Manufacturing	335920	Communication and energy wire and cable manufacturing
35	Electronics	335931	Current-Carrying Wiring Device Manufacturing	335930	Wiring device manufacturing
35	Electronics	335932	Noncurrent-Carrying Wiring Device Manufacturing	335930	Wiring device manufacturing
35	Electronics	335991	Carbon and Graphite Product Manufacturing	335991	Carbon and graphite product manufacturing
35	Electronics	335999	All Other Miscellaneous Electrical Equipment and Component Manufacturing	335999	All other miscellaneous electrical equipment and component manufacturing
36	Motorized vehicles	333924	Industrial Truck, Tractor, Trailer, and Stacker Machinery Manufacturing	333920	Material handling equipment manufacturing
36	Motorized vehicles	336111	Automobile Manufacturing	336111	Automobile manufacturing
36	Motorized vehicles	336112	Light Truck and Utility Vehicle Manufacturing	336112	Light truck and utility vehicle manufacturing
36	Motorized vehicles	336120	Heavy Duty Truck Manufacturing	336120	Heavy duty truck manufacturing
36	Motorized vehicles	336211	Motor Vehicle Body Manufacturing	336211	Motor vehicle body manufacturing
36	Motorized vehicles	336212	Truck Trailer Manufacturing	336212	Truck trailer manufacturing
36	Motorized vehicles	336213	Motor Home Manufacturing	336213	Motor home manufacturing
36	Motorized vehicles	336214	Travel Trailer and Camper Manufacturing	336214	Travel trailer and camper manufacturing
36	Motorized vehicles	336311	Carburetor, Piston, Piston Ring, and Valve Manufacturing	336300	Motor vehicle parts manufacturing
36	Motorized vehicles	336312	Gasoline Engine and Engine Parts Manufacturing	336300	Motor vehicle parts manufacturing
36	Motorized vehicles	336321	Vehicular Lighting Equipment Manufacturing	336300	Motor vehicle parts manufacturing
36	Motorized vehicles	336322	Other Motor Vehicle Electrical and Electronic Equipment Manufacturing	336300	Motor vehicle parts manufacturing

SCTG	SCTG Description	NAICS	NAICS Description	I-O	I-O Description
36	Motorized vehicles	336330	Motor Vehicle Steering and Suspension Components (except Spring) Manufacturing	336300	Motor vehicle parts manufacturing
36	Motorized vehicles	336340	Motor Vehicle Brake System Manufacturing	336300	Motor vehicle parts manufacturing
36	Motorized vehicles	336350	Motor Vehicle Transmission and Power Train Parts Manufacturing	336300	Motor vehicle parts manufacturing
36	Motorized vehicles	336360	Motor Vehicle Seating and Interior Trim Manufacturing	336300	Motor vehicle parts manufacturing
36	Motorized vehicles	336370	Motor Vehicle Metal Stamping	336300	Motor vehicle parts manufacturing
36	Motorized vehicles	336391	Motor Vehicle Air-Conditioning Manufacturing	336300	Motor vehicle parts manufacturing
36	Motorized vehicles	336399	All Other Motor Vehicle Parts Manufacturing	336300	Motor vehicle parts manufacturing
36	Motorized vehicles	336991	Motorcycle, Bicycle, and Parts Manufacturing	336991	Motorcycle, bicycle, and parts manufacturing
36	Motorized vehicles	336992	Military Armored Vehicle, Tank, and Tank Component Manufacturing	336992	Military armored vehicle, tank, and tank component manufacturing
36	Motorized vehicles	336999	All Other Transportation Equipment Manufacturing	336999	All other transportation equipment manufacturing
37	Transport equip.	333923	Overhead Traveling Crane, Hoist, and Monorail System Manufacturing	333920	Material handling equipment manufacturing
37	Transport equip.	336411	Aircraft Manufacturing	336411	Aircraft manufacturing
37	Transport equip.	336412	Aircraft Engine and Engine Parts Manufacturing	336412	Aircraft engine and engine parts manufacturing
37	Transport equip.	336413	Other Aircraft Parts and Auxiliary Equipment Manufacturing	336413	Other aircraft parts and auxiliary equipment manufacturing
37	Transport equip.	336414	Guided Missile and Space Vehicle Manufacturing	336414	Guided missile and space vehicle manufacturing
37	Transport equip.	336415	Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing	33641A	Propulsion units and parts for space vehicles and guided missiles
37	Transport equip.	336419	Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing	33641A	Propulsion units and parts for space vehicles and guided missiles
37	Transport equip.	336510	Railroad Rolling Stock Manufacturing	336500	Railroad rolling stock manufacturing

SCTG	SCTG Description	NAICS	NAICS Description	I-O	I-O Description
37	Transport equip.	336611	Ship Building and Repairing	336611	Ship building and repairing
37	Transport equip.	336612	Boat Building	336612	Boat building
38	Precision instruments	333314	Optical Instrument and Lens Manufacturing	333314	Optical instrument and lens manufacturing
38	Precision instruments	333315	Photographic and Photocopying Equipment Manufacturing	333315	Photographic and photocopying equipment manufacturing
38	Precision instruments	333997	Scale and Balance Manufacturing	33399A	Other general purpose machinery manufacturing
38	Precision instruments	334510	Electromedical and Electrotherapeutic Apparatus Manufacturing	334510	Electromedical and electrotherapeutic apparatus manufacturing
38	Precision instruments	334511	Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	334511	Search, detection, and navigation instruments manufacturing
38	Precision instruments	334512	Automatic Environmental Control Manufacturing for Residential, Commercial, and Appliance Use	334512	Automatic environmental control manufacturing
38	Precision instruments	334513	Instruments and Related Products Manufacturing for Measuring, Displaying, and Controlling Industrial Process Variables	334513	Industrial process variable instruments manufacturing
38	Precision instruments	334514	Totalizing Fluid Meter and Counting Device Manufacturing	334514	Totalizing fluid meters and counting devices manufacturing
38	Precision instruments	334515	Instrument Manufacturing for Measuring and Testing Electricity and Electrical Signals	334515	Electricity and signal testing instruments manufacturing
38	Precision instruments	334516	Analytical Laboratory Instrument Manufacturing	334516	Analytical laboratory instrument manufacturing
38	Precision instruments	334517	Irradiation Apparatus Manufacturing	334517	Irradiation apparatus manufacturing
38	Precision instruments	334518	Watch, Clock, and Part Manufacturing	33451A	Watch, clock, and other measuring and controlling device manufacturing
38	Precision instruments	334519	Other Measuring and Controlling Device Manufacturing	33451A	Watch, clock, and other measuring and controlling device manufacturing
38	Precision instruments	339112	Surgical and Medical Instrument Manufacturing	339112	Surgical and medical instrument manufacturing
38	Precision instruments	339113	Surgical Appliance and Supplies Manufacturing	339113	Surgical appliance and supplies manufacturing
38	Precision instruments	339114	Dental Equipment and Supplies Manufacturing	339114	Dental equipment and supplies manufacturing
38	Precision instruments	339115	Ophthalmic Goods Manufacturing	339115	Ophthalmic goods manufacturing

SCTG	SCTG Description	NAICS	NAICS Description	I-O	I-O Description
38	Precision instruments	339116	Dental Laboratories	339116	Dental laboratories
39	Furniture	335110	Electric Lamp Bulb and Part Manufacturing	335110	Electric lamp bulb and part manufacturing
39	Furniture	335121	Residential Electric Lighting Fixture Manufacturing	335120	Lighting fixture manufacturing
39	Furniture	335122	Commercial, Industrial, and Institutional Electric Lighting Fixture Manufacturing	335120	Lighting fixture manufacturing
39	Furniture	335129	Other Lighting Equipment Manufacturing	335120	Lighting fixture manufacturing
39	Furniture	337121	Upholstered Household Furniture Manufacturing	337121	Upholstered household furniture manufacturing
39	Furniture	337122	Nonupholstered Wood Household Furniture Manufacturing	337122	Nonupholstered wood household furniture manufacturing
39	Furniture	337124	Metal Household Furniture Manufacturing	33712A	Metal and other household furniture (except wood) manufacturing
39	Furniture	337125	Household Furniture (except Wood and Metal) Manufacturing	33712A	Metal and other household furniture (except wood) manufacturing
39	Furniture	337127	Institutional Furniture Manufacturing	337127	Institutional furniture manufacturing
39	Furniture	337129	Wood Television, Radio, and Sewing Machine Cabinet Manufacturing	33721A	Wood television, radio, and sewing machine cabinet manufacturing
39	Furniture	337211	Wood Office Furniture Manufacturing	337212	Office furniture and custom architectural woodwork and millwork manufacturing
39	Furniture	337212	Custom Architectural Woodwork and Millwork Manufacturing	337212	Office furniture and custom architectural woodwork and millwork manufacturing
39	Furniture	337214	Office Furniture (except Wood) Manufacturing	337212	Office furniture and custom architectural woodwork and millwork manufacturing
39	Furniture	337215	Showcase, Partition, Shelving, and Locker Manufacturing	337215	Showcase, partition, shelving, and locker manufacturing
39	Furniture	337910	Mattress Manufacturing	337910	Mattress manufacturing
39	Furniture	337920	Blind and Shade Manufacturing	337920	Blind and shade manufacturing
40	Misc. mfg. prods.	332992	Small Arms Ammunition Manufacturing	33299A	Ammunition manufacturing
40	Misc. mfg. prods.	332993	Ammunition (except Small Arms) Manufacturing	33299A	Ammunition manufacturing
40	Misc. mfg. prods.	332994	Small Arms Manufacturing	33299B	Arms, ordnance, and accessories manufacturing

SCTG	SCTG Description	NAICS	NAICS Description	I-O	I-O Description
40	Misc. mfg. prods.	332995	Other Ordnance and Accessories Manufacturing	33299B	Arms, ordnance, and accessories manufacturing
40	Misc. mfg. prods.	335211	Electric Housewares and Household Fan Manufacturing	335210	Small electrical appliance manufacturing
40	Misc. mfg. prods.	335212	Household Vacuum Cleaner Manufacturing	335210	Small electrical appliance manufacturing
40	Misc. mfg. prods.	335221	Household Cooking Appliance Manufacturing	335221	Household cooking appliance manufacturing
40	Misc. mfg. prods.	335222	Household Refrigerator and Home Freezer Manufacturing	335222	Household refrigerator and home freezer manufacturing
40	Misc. mfg. prods.	335224	Household Laundry Equipment Manufacturing	335224	Household laundry equipment manufacturing
40	Misc. mfg. prods.	335228	Other Major Household Appliance Manufacturing	335228	Other major household appliance manufacturing
40	Misc. mfg. prods.	339911	Jewelry (except Costume) Manufacturing	339910	Jewelry and silverware manufacturing
40	Misc. mfg. prods.	339912	Silverware and Hollowware Manufacturing	339910	Jewelry and silverware manufacturing
40	Misc. mfg. prods.	339913	Jewelers' Material and Lapidary Work Manufacturing	339910	Jewelry and silverware manufacturing
40	Misc. mfg. prods.	339914	Costume Jewelry and Novelty Manufacturing	339910	Jewelry and silverware manufacturing
40	Misc. mfg. prods.	339920	Sporting and Athletic Goods Manufacturing	339920	Sporting and athletic goods manufacturing
40	Misc. mfg. prods.	339931	Doll and Stuffed Toy Manufacturing	339930	Doll, toy, and game manufacturing
40	Misc. mfg. prods.	339932	Game, Toy, and Children's Vehicle Manufacturing	339930	Doll, toy, and game manufacturing
40	Misc. mfg. prods.	339941	Pen and Mechanical Pencil Manufacturing	339940	Office supplies (except paper) manufacturing
40	Misc. mfg. prods.	339942	Lead Pencil and Art Good Manufacturing	339940	Office supplies (except paper) manufacturing
40	Misc. mfg. prods.	339943	Marking Device Manufacturing	339940	Office supplies (except paper) manufacturing
40	Misc. mfg. prods.	339944	Carbon Paper and Inked Ribbon Manufacturing	339940	Office supplies (except paper) manufacturing
40	Misc. mfg. prods.	339950	Sign Manufacturing	339950	Sign manufacturing
40	Misc. mfg. prods.	339992	Musical Instrument Manufacturing	339992	Musical instrument manufacturing
40	Misc. mfg. prods.	339993	Fastener, Button, Needle, and Pin Manufacturing	33999A	All other miscellaneous manufacturing
40	Misc. mfg. prods.	339994	Broom, Brush, and Mop Manufacturing	339994	Broom, brush, and mop manufacturing
40	Misc. mfg. prods.	339995	Burial Casket Manufacturing	33999A	All other miscellaneous manufacturing

SCTG	SCTG Description	NAICS	NAICS Description	I-O	I-O Description
40	Misc. mfg. prods.	339999	All Other Miscellaneous Manufacturing	33999A	All other miscellaneous manufacturing
43	Mixed freight	327111	Vitreous China Plumbing Fixture and China and Earthenware Bathroom Accessories Manufacturing	32711A	Pottery, ceramics, and plumbing fixture manufacturing
43	Mixed freight	327112	Vitreous China, Fine Earthenware, and Other Pottery Product Manufacturing	32711A	Pottery, ceramics, and plumbing fixture manufacturing