

**FINAL REPORT**

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**ECLIPSE  
AVIATION**

# The Economic Impact of Very Light Jets

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**INTERNATIONAL**

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## EXECUTIVE SUMMARY

This report describes an assessment of the economic impact of Very Light Jets (VLJs).

- It examines economic impacts of VLJs used either in point-to-point on-demand air taxi services or for personal and business aviation purposes.
- The report provides estimates of economic impacts at the national level as well as the level of local communities served by VLJ.

VLJs represent the next generation in aviation.

- VLJs are a distinctly new class of aircraft combining several technological advances to provide levels of performance, automation, and efficiency at a cost unimaginable even ten years ago.
- This cost/performance advantage will make VLJs particularly well suited for use in per seat, on-demand air taxi services.

Forecasts suggest significant VLJ usage within the next ten years.

- The FAA predicts that a fleet of about 5,000 aircraft will be in service by 2017.
- This study assumes that about two thirds of these aircraft would be used for air taxi service.
- More than 7.7 million trips would be made using these air taxi services in 2017.

VLJs will provide significant benefits to travelers.

- Based on the FAA forecast, users of VLJ-based air taxi services will save over 35 million hours of travel time.
- This time saving is valued at over \$1.8 billion.

VLJs will produce significant economic impacts at the local level.

- Typical communities that serve as bases for the operation and maintenance of VLJ-based air taxi services will experience nearly \$16 million in economic activity and nearly 150 permanent jobs directly associated with VLJs.
- On average, such a community will in total produce over \$76 million in economic output and over 500 jobs that are in some fashion connected with the use of VLJs.

VLJs will play a significant role in the national economy.

- Nationwide, there would be over 23,000 jobs directly connected with the manufacture or operation of VLJs in 2017, representing some \$6.5 billion in output and \$1.7 billion in personal earnings.
- Total economic activity in 2017 related to VLJs in some fashion will total nearly \$24 billion in output, \$6.9 billion in earnings, and over 189,000 jobs.

Higher levels of VLJ production would result in greater economic impacts.

- If the assumed forecast of VLJ production is increased by 50% over the FAA projection (for a total fleet size of 7,425 aircraft), economic activity in 2017 related to VLJs in some fashion would total over \$32 billion in output, \$9.4 billion in earnings, and over 249,000 jobs.
- If, alternatively, the forecast of VLJ production is increased beyond the FAA projection to reflect an additional increment of corporate sales equal to the level of aircraft purchased by air taxi operators (for a total fleet size of 8,250 aircraft), economic activity in 2017 related to VLJs in some fashion would total over \$35 billion in output, \$10.4 billion in earnings, and over 276,000 jobs. A summary of the results for the three assumptions regarding the size of the VLJ fleet in 2017 is shown in the table below.

#### Total Impacts at the National Level in 2017

VLJ Production Assumption	VLJ Fleet Size	Output	Earnings	Employment
FAA forecast	4,950	\$23,953,916,747	\$6,940,560,590	189,853
FAA forecast + 50%	7,425	\$32,376,978,110	\$9,364,471,325	249,393
Higher corporate demand	8,250	\$35,788,382,825	\$10,353,239,630	276,725

Source: CRA International.

## 1. INTRODUCTION

This report describes an assessment of the economic impact of Very Light Jets (VLJs). It examines economic impacts of VLJs used in point-to-point on-demand air taxi services and for personal and business aviation purposes. The report provides estimates of economic impacts at the national level as well as the level of local communities served by VLJ.

This study measures economic impacts in four ways:

- *User benefits*, which reflect the value of travel time savings that users would experience.
- *Direct impacts*, which reflect the spending associated with the manufacturing of aircraft, the operation of air taxi services, and the operation of private VLJ aircraft.
- *Indirect impacts*, which represent the effects of spending by air taxi passengers and other VLJs users in the course of travel.
- *Induced impacts*, which reflect the household spending in other sectors of the economy by those receiving income as a result of the direct and indirect impacts.

Because VLJs are not yet in service, this study must look to the future when a VLJ fleet will have been produced and VLJ-based air taxi services have begun operating. The report therefore estimates what the economic impacts of VLJs will be in the year 2017, which represents a time horizon sufficient to allow the initial development of the industry. It concentrates on presenting the total level of economic activity attributable to VLJ manufacturing and air taxi operations, but also discusses where appropriate the *net* economic impacts or new economic activity that would not have been created but for the advent of VLJs.

### 1.1. VLJS REPRESENT THE NEXT GENERATION IN AVIATION

Very Light Jets (VLJs) are a distinctly new class of aircraft. Defined by the National Business Aviation Association (NBAA) as jet powered aircraft weighing 10,000 pounds or less, they are far more than simply a smaller version of a traditional business jet, or a jet powered version of a traditional light aircraft.

**Exterior and Interior of the Eclipse 500 VLJ**

A confluence of technological advances in engine design, integrated avionics, and manufacturing techniques has made possible a new generation of aircraft that deliver unprecedented performance and efficiency at a cost unimaginable even ten years ago.

While typically seating only about four passengers, VLJs use the same types of sophisticated “glass cockpit” automated flight control, navigation, and engine management systems found on much larger commercial jets, and are capable of flying at altitudes as high as 41,000 feet, significantly higher than typical turboprop aircraft.

VLJs will also provide many of the positive features that users of traditional light aircraft find attractive. In addition to their relatively low purchase cost, VLJs will have very high fuel efficiency and be much quieter than typical jets. Their high performance will allow them to operate even from very small airports, with minimal requirements for ground-based navigation aids.

Nearly a dozen companies have announced intentions to build VLJs, and a few manufacturers have already produced aircraft for certification.

Table 1 provides a summary of the characteristics of the four aircraft that are furthest along in development and flight certification.

The operational characteristics of VLJs will make possible a new type of transportation service: direct point-to-point air travel departing when the traveler wants and with payment on a per seat basis. This is often called an *air taxi* service to emphasize the very personalized and convenient transportation service that it provides. A number of entrepreneurs have recognized the potential of this technology to provide such service and have formed air taxi companies that will begin operations soon after aircraft certification. DayJet is among the companies with the most advanced preparations at this time.

**Table 1. Summary of VLJ Characteristics for Selected Aircraft**

	<b>Eclipse 500</b>	<b>Adam Aircraft A700</b>	<b>Cessna Citation Mustang</b>	<b>Embraer Phenom 100</b>
Passenger capacity	4-5	4-5	4-5	4-5
Maximum cruise speed (knots)	375	340	340	380
Range (nautical miles)*	1,280	1,100	1,158	1,160
Takeoff distance (feet)	2,155	3,400	3,120	3,400
Expected retail price	\$1,500,000	\$2,250,000	\$2,623,000	\$2,750,000
Expected service entry date	2006	2007	2006	2008

\*NBAA IFR range with 4 occupants.

Source: Eclipse Aviation.

## 1.2. FORECASTS SUGGEST SIGNIFICANT VLJ USAGE WITHIN TEN YEARS

This study has adopted Federal Aviation Administration (FAA) forecasts of VLJ fleet growth as the basis for its analysis. The FAA anticipates an annual production rate of 450-500 aircraft, leading to a fleet of almost 5,000 aircraft by 2017. Several other VLJ growth forecasts have been produced, with annual production rates ranging from as low as 140 to as high as 500, as shown in Table 2. Though individual forecasts may differ from the FAA's predictions, on average they generally resemble the FAA fleet size figure.

**Table 2. Summary of VLJ Production Forecasts**

<b>Source</b>	<b>Forecast year/time horizon</b>	<b>Annual Production Rate</b>	<b>Total Fleet Size</b>
Federal Aviation Administration (FAA)	2017	450-500	4,950
Rolls Royce	2024	395	7,500
Honeywell	2016	500	4,500-5,500
Teal Group	2014	140	1,265
Forecast International	2014	386	3,476

Note: annual production rates for Rolls Royce and Forecast International imputed from total fleet size forecast and forecast time horizon.

Source: public estimates of the respective companies/agencies.

This study assumes that two-thirds of the VLJ aircraft produced over the next ten years, or roughly 3,300 aircraft, will be used for point-to-point on-demand air taxi operations.

To analyze the level of passenger ridership that this type of air taxi service would attract, the Transportation Systems Analysis Model (TSAM), developed by Professor Antonio Trani and co-workers at the Virginia Polytechnic Institute (Virginia Tech), was applied. TSAM is a travel demand forecasting tool that was developed to support aviation planning and analysis functions. It is the most sophisticated VLJ demand forecasting model currently available, and has previously been applied to a number of VLJ-related studies sponsored by the National Aeronautics and Space Administration (NASA) and other organizations. TSAM predicts county-to-county passenger flows in the continental U.S. by automobile, commercial air service, and VLJ-based air taxi, given input data describing the projected socio-economic characteristics of travelers in the forecast year and the door-to-door travel time and cost characteristics of the respective travel modes. TSAM is described in greater detail in Appendix A.

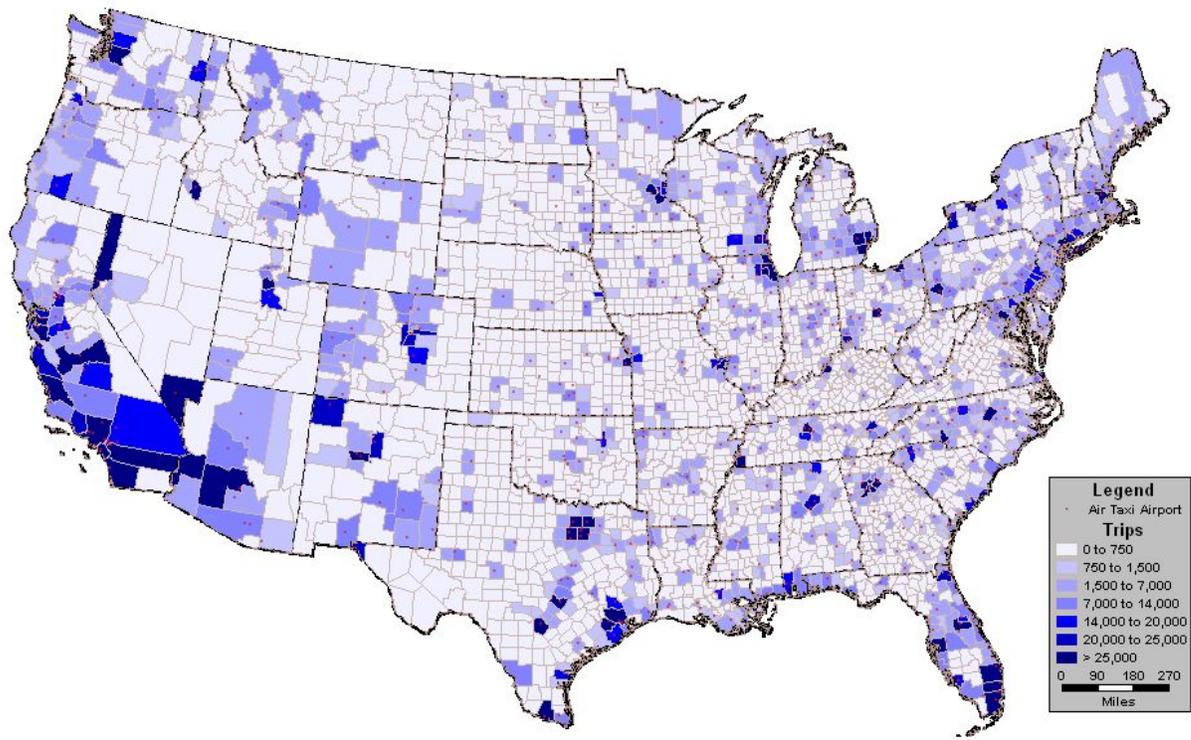
TSAM was first used to identify a set of airports that would support VLJ-based air taxi service. The set of identified airports is consistent with the VLJ fleet size estimate and with reasonable assumptions about air taxi operating parameters that were reviewed with Eclipse Aviation and DayJet. This procedure identified a total of 676 airports with air taxi service in 2017 (the selection of these airports is described in more detail in Appendix A, section A.3).

Based on this set of airports, TSAM predicts that 7.7 million trips will be made using VLJ-based air taxi services in 2017. Of this total, 4.8 million travelers (or 63% of the VLJ total) will divert to VLJ from automobiles, while the other 2.9 million travelers (or 37% of the total) will divert from regular commercial air carriers.<sup>1</sup> These diversions represent respectively 0.5% of all long-distance automobile travel and 0.7% of commercial aviation travel in 2017.

Figure 1 presents the number of annual VLJ air taxi trips originating in each county in the continental US in 2017.

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<sup>1</sup> Induced trips (new trips that occur following the introduction of VLJ service, but that were not made when auto and regular commercial air were the only available travel alternatives) are not considered by TSAM. This is a conservative approach since it seems likely that VLJs' convenient point-to-point service may cause people to make trips that they would not otherwise have made.

**Figure 1. Distribution of Annual Originating VLJ Air Taxi Trips by County, 2017**

Source: CRA International with calculations by Virginia Polytechnic Institute.

## 2. VLJS WILL PROVIDE SIGNIFICANT BENEFITS TO TRAVELERS

The predicted level of usage of new VLJ-based air taxi services will have a variety of impacts on travelers as well as on the national and affected local economies. Perhaps the clearest of these are its impacts on travelers and the transportation system.

### 2.1. AIR TAXI USERS WILL SAVE VALUABLE TRAVEL TIME

Travelers who use VLJs for air taxi services will do so because the benefits that they receive from the service outweigh the costs that they pay for that service. Chief among these benefits are the travel time savings that on-demand point-to-point jet service make possible compared to travel by regular commercial air carriers or automobile. Compared to automobile, the travel time savings result from the much higher speed of a VLJ. Compared to regular air carriers, the travel time savings result from a number of factors including (i) shorter access distance between airports and the ultimate trip origin and destination; (ii) faster airport passenger processing at smaller (generally less congested) airports; (iii) direct point-to-point travel instead of a more indirect routing when transfers are required; and (iv) elimination of waiting time at intermediate transfer points. While the aircraft that regular air carriers operate

typically have a somewhat higher air speed than VLJs, the combination of these other factors will in many cases result in significantly reduced door-to-door travel time by VLJ.<sup>2</sup>

To calculate the travel time savings of VLJ users, TSAM was used to compute the total time spent traveling. Calculations were made first assuming that only automobile and commercial aviation modes were available, and then including VLJ-based air taxi service as a possible mode. The difference in the resulting total travel times represents the time savings attributable to VLJs.

Many studies have shown that time savings have an actual value to travelers, and have estimated the equivalent monetary amount corresponding to a unit (e.g. an hour) of travel time savings. This study made use of values of time that are recommended by the U.S. Department of Transportation. These values, shown in Table 3, were applied to the estimated time savings to calculate the equivalent monetary value of the travel time savings made possible by VLJ-based air taxi services.

**Table 3. Hourly Value of Intercity Travel Time by Trip Purpose and Stage of Journey**

Trip Purpose	Value of Time in \$2000	Value of Time in \$2005
Business	\$48.10	\$54.55
Non-business	\$30.00	\$34.02

Source: US Department of Transportation, Memorandum on *Revised Departmental Guidance – Valuation of Travel Time in Economic Analysis*, 2003. Value in \$2005 computed using Consumer Price Index for all urban consumers.

Table 4 shows that travelers using VLJ-based air taxi services are predicted to save over 35 million hours of travel time nationwide in 2017. Applying the values of time shown in Table 4, this translates into over \$1.8 billion in benefits to these travelers. The vast majority of these benefits, over \$1.7 billion, accrue to business travelers, reflecting the fact that a very large share of air taxi travel will be for business purposes. However, the value to non-business travelers is not insignificant, totaling over \$121 million.

<sup>2</sup> VLJs offer other time-related benefits to their users as well. For example, the ability to schedule a trip according to ones own time constraints, rather than being forced to base the trip departure time to the carriers' schedules, reduces the *schedule delay* and associated inefficiencies. Similarly, infrequent or inconveniently scheduled service by regular carriers may cause travelers to spend an extra night at a destination, where on demand service would allow them to leave (and return home or proceed to their next location) when they are ready. These benefits are not quantified here, which is again a conservative evaluation approach.

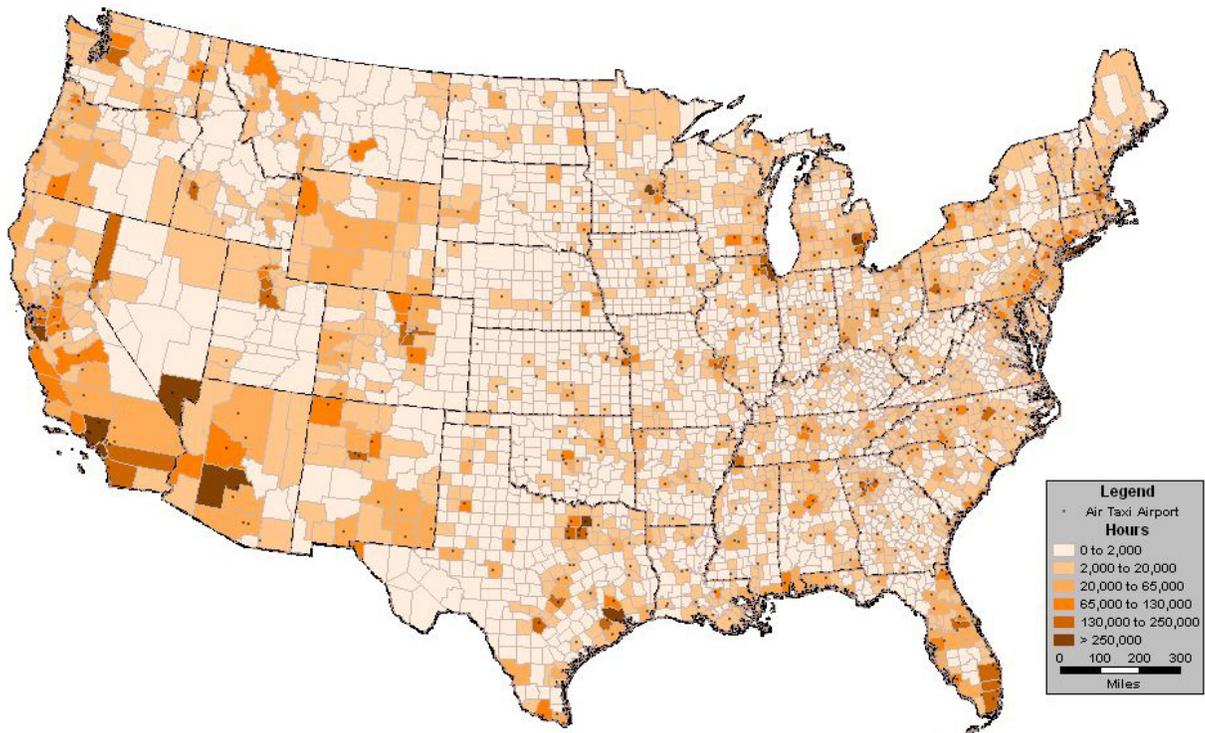
**Table 4. Value of Time Saved with VLJs (\$2005)**

Trip Purpose	Total Hours w/o VLJ Air Taxi	Total Hours with VLJ Air Taxi	Total Time Savings	Value of Time Savings
Business	3,582,513,617	3,550,550,356	31,963,261	\$1,743,673,847
Non-business	11,952,603,322	11,949,043,082	3,560,240	\$121,134,995
Total	15,535,116,939	15,499,593,438	35,523,501	\$1,864,808,842

Source: Virginia Polytechnic Institute with calculations by CRA International.

Figure 2 further illustrates how these time savings would be distributed geographically. The map shows the total amount of travel time saved per year for each county in the US. The pattern resembles the distribution of VLJ trips shown in Figure 1, but also reflects the relative service improvement represented in each local area. It is noteworthy that significant time savings will occur in California and western states, in the southeast, in the northeast corridor, and in particular other areas well-served by VLJ airports.

**Figure 2. Distribution of Annual Time Savings with VLJ-based Air Taxi Service by County, 2017**



Source: CRA International with calculations by Virginia Polytechnic Institute.

## **2.2. VLJS ARE NOT LIKELY TO AFFECT OTHER TRANSPORTATION MODES**

In general, the introduction of VLJ-based air taxi services is unlikely to affect travel conditions on other transportation modes.

Although the detailed simulation of airspace impacts was beyond the scope of this study, the predicted level of VLJ operations is too low compared to the overall volume of commercial aviation operations to have a significant impact on them.

Likewise, given the predicted levels of demand for VLJ-based air taxi services, it is unlikely that these services will substantially affect existing levels of airport or highway congestion. The amount of travel removed from the highway network by these diversions to VLJs would be very small in comparison with the total amount of highway travel across the country. Even in specific corridors with high levels of VLJ ridership, the passenger carrying capacity provided by the VLJ fleet is too small to have an appreciable impact on highway congestion.

Similarly, though VLJs will tend to operate out of smaller and less congested airports, and so have the effect of diverting air travelers from larger airports, the magnitude of these diversions compared to the level of operations at most large airports is likely to be small in the vast majority of cases. Furthermore, if diversions to VLJ were to amount to a significant fraction of the passengers on a particular scheduled flight, the carrier might simply replace the aircraft used by smaller equipment, or replace the route with a different one, in both cases having no impact on airport congestion. Finally, it has been suggested that in some cases travelers may take regular commercial air service for one leg of a trip, and a VLJ for the other, which would likewise reduce the likelihood of airport congestion benefits (in any case, this travel pattern seems unlikely to be widely used because it reduces or negates the advantages of the on-demand point-to-point service offered by VLJs).

Given these conclusions, it follows that the travel-related benefits of VLJs will accrue almost exclusively to VLJ users themselves.

## **3. VLJS WILL PRODUCE SIGNIFICANT ECONOMIC IMPACTS FOR LOCAL COMMUNITIES**

This section and the next discuss the economic impacts at the local and national levels, respectively, that will result from the production and operation of VLJs. The intent is to quantify the overall impact of these activities on local economies and the nation overall, in order to highlight the economic importance of VLJ production and air taxi services. Note, however, that not all these impacts will represent new value in the economy, even if they are large in magnitude. For example, to the extent that VLJs will be used to substitute for other types of aircraft in already on-going activities (e.g. if they are used instead of some other aircraft type to replace aging corporate jets), little net value will be created. On the other

hand, many of the impacts associated with air taxi service will be new, because this form of transportation does not currently exist.

It is likely that the roughly 5,000 VLJ aircraft that the FAA expects to be produced between now and 2017 will be manufactured in a limited number of large-scale facilities. The communities in which these facilities are located will benefit from the jobs associated with VLJ production and the associated spending of the earnings made possible by these jobs. These communities will also benefit from any jobs and associated spending associated with the construction of new aircraft manufacturing facilities.

The deployment and operation of VLJ-based air taxi services will also impact local economies. In this regard, it is likely that air taxi operators will establish a hierarchy of airports offering different levels of services and facilities. This study assumes that VLJ air taxi services will be based at or utilize three different types of airports:

- **Type 1:** Airports at which is based a fleet of VLJ aircraft and their associated flight personnel, as well as dedicated facilities and personnel devoted to the operation and maintenance of this fleet. On-demand air taxi service would be offered from these airports with per seat pricing. Roughly 10% of the total VLJ airports would be of this type;
- **Type 2:** Airports at which aircraft and pilots are based, and which offer on-demand air taxi service with per seat pricing, but which do not have associated maintenance facilities. Roughly 25% of VLJ airports would be of this type.
- **Type 3:** Airports without based aircraft but capable of accommodating VLJ aircraft. Travel to/from these airports can be arranged upon special request by customers, for example by chartering an entire aircraft.

The 676 airports used in the analysis would be distributed among these three airport types as shown in Table 5. Table 6 shows the amount of activity expected, on average, at each of the three airport types.

**Table 5. Airports Served by VLJ-based Air Taxi Services in 2017**

Category	Description	Airports
Type 1	Per seat, on-demand VLJ service and maintenance facilities	68
Type 2	Per seat, on-demand VLJ service only	163
Type 3	Destination and aircraft charter service only	445
Total	Total airports with VLJ-based air taxi operations	676

Source: CRA International based on calculations by Virginia Polytechnic University.

**Table 6. VLJ-based Air Taxi Activity by Type of Community in 2017**

<b>Average per airport:</b>	<b>Type 1 Per Seat On-Demand Service and Maintenance Facilities</b>	<b>Type 2 Per Seat On-Demand Service only</b>	<b>Type 3 Destination or aircraft charter service only</b>
Annual air taxi operations	20,351	7,731	3,677
Annual air taxi passengers	36,632	13,916	6,618
Based aircraft	25	10	0

Source: CRA International based on calculations by Virginia Polytechnic Institute.

### 3.1. DIRECT IMPACTS AT THE LOCAL LEVEL

Because air taxi operators will base their aircraft and maintenance facilities in a number of the communities they serve, personnel associated with the air taxi operations will live in these communities, adding jobs to the local economies. These personnel will include pilots, maintenance workers, and customer service and other ground personnel. Using the number of based aircraft at each type of airport shown in Table 6, and input from DayJet regarding expected staffing levels, estimates were prepared of the number of jobs that would be directly and exclusively associated with air taxi operations in each type of community.<sup>3</sup> These estimates are presented in Table 7.

**Table 7. Air Taxi Service Jobs by Category and Type of Community in 2017**

<b>Category</b>	<b>Type 1 Per Seat On-Demand Service and Maintenance Facilities</b>	<b>Type 2 Per Seat On-Demand Service only</b>	<b>Type 3 Destination or aircraft charter service only</b>
Pilots	118	47	0
Maintenance workers	20	0	0
Ground staff	6	6	0
Total	144	53	0

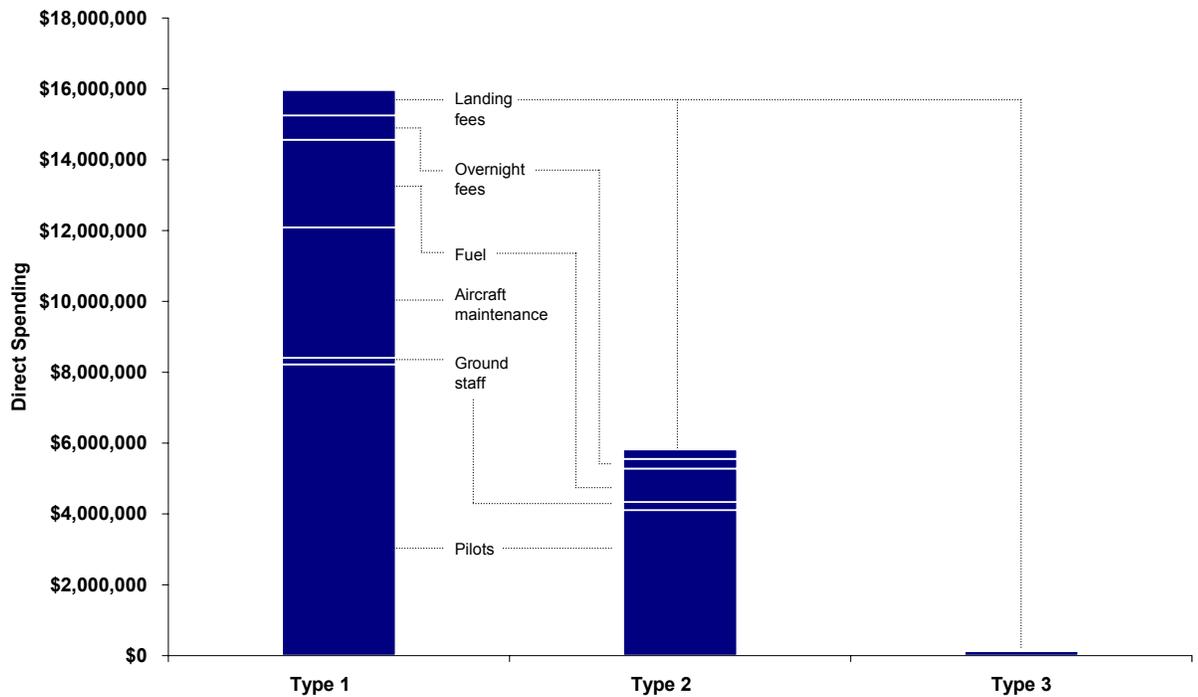
Source: CRA International based on calculations by Virginia Polytechnic Institute.

The table shows that jobs directly associated with VLJ-based air taxi operations would be concentrated in those communities where aircraft and maintenance facilities are located.

<sup>3</sup> Because there was no feasible means to estimate what portion of the work of non-exclusive airport personnel might be associated with VLJ operations, these impacts were conservatively omitted.

Direct impacts on the local economies would also include the salaries and benefits associated with these jobs as well as other spending by air taxi operators on aircraft maintenance,<sup>4</sup> fuel, and aircraft landing and overnight parking fees.<sup>5</sup> These impacts were estimated based on the jobs figures shown in Table 7 and data on expected salaries for air taxi personnel, the estimated average levels of operations shown in Table 6 and technical data on aircraft fuel consumption and maintenance intervals. The results are shown in Figure 3, which indicates that these spending impacts will be quite significant for a typical community with a based VLJ fleet. The figure shows that this spending will total over \$5.8 million annually by 2017 in a community with per seat, on-demand service (Type 2), and nearly \$16 million in a typical community that is also home to VLJ maintenance facilities (Type 1).

**Figure 3. Direct Spending by Category and Type of Community in 2017**



Source: CRA International.

<sup>4</sup> Note that periodic engine maintenance is typically carried out at the facilities of the engine manufacturer. Engines requiring heavy maintenance would be swapped locally with a loan engine provided by the manufacturer, and the unit to be serviced would be shipped to the manufacturer, which would generally be located outside of the local community. Indeed, the leading manufacturer of jet engines for VLJs, Pratt & Whitney Canada, is located outside of the US.

<sup>5</sup> The two fees can be assumed to cover the portion due to VLJ operations of the expenditures that the airport operator must make to provide and maintain the airport, including its infrastructure and facilities.

Benefits to communities with no based aircraft (Type 3) would be small, by contrast, due to the fact that spending directly related to VLJ operations would be limited to landing and overnight fees. Even fuel purchases at these airports would be limited as refueling would most likely occur at the airports where the aircraft are based.

Direct impacts by community type are summarized in Table 8, which shows that in a Type 1 community over \$10 million in annual income and a total of 144 jobs would be attributable to VLJ service.

**Table 8. Direct Impacts by Type of Community in 2017**

Community Type	Output	Earnings	Employment
Per seat, on-demand service and maintenance facilities	\$15,963,651	\$10,453,394	144
Per seat, on-demand service only	\$5,823,443	\$4,740,191	54
Destination and aircraft charter service only	\$0	\$0	0

Source: CRA International.

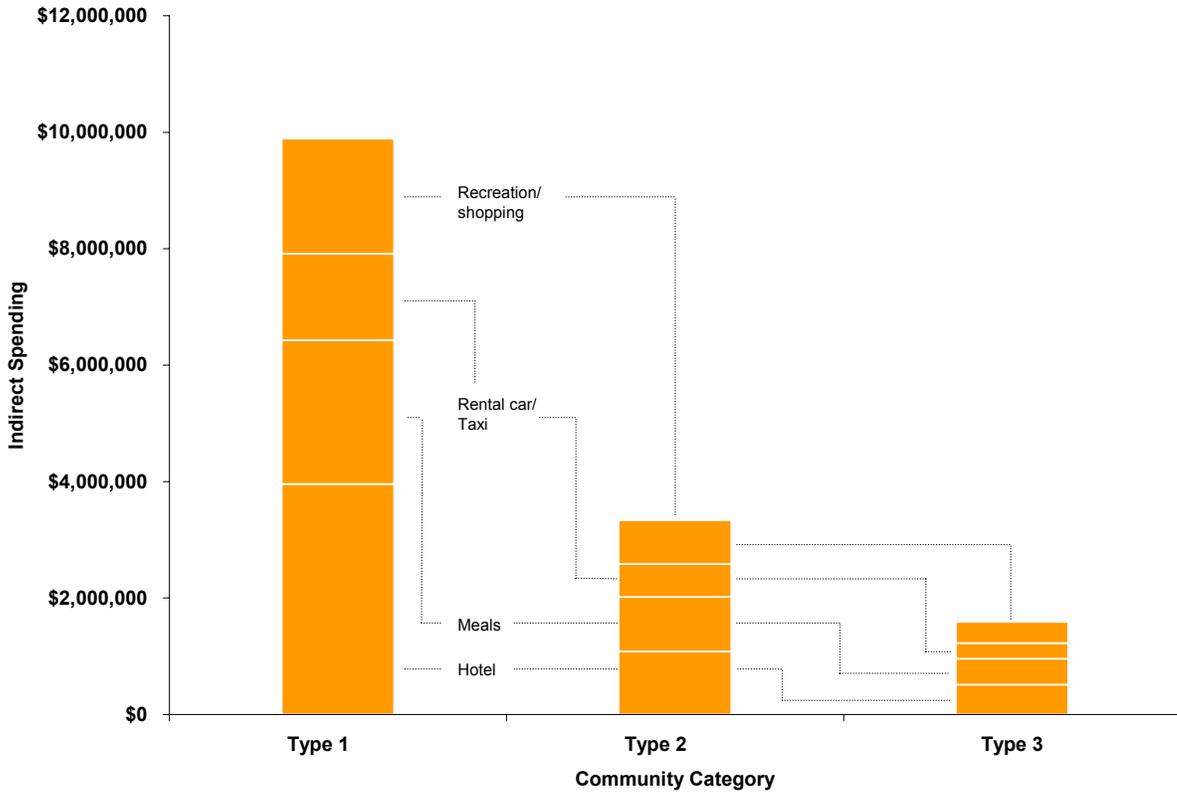
### 3.2. INDIRECT IMPACTS AT THE LOCAL LEVEL

The passengers who travel to a community by VLJ will spend money there on a variety of activities. These expenditures represent an indirect contribution of VLJ service to the local economy.

Arriving passengers will generally need to arrange for ground transportation in the form of rental cars or taxis. These may be offered in the form of a permanent service located at the airport itself or, for smaller airports, of a connection to a business establishment that is physically located in the community but able to serve the airport at short notice. Similarly, passengers brought to the community by VLJs will purchase food and beverages and patronize other local businesses. Those staying for more than a single day will also purchase hotel accommodations, although it may be that some travelers will take advantage of the flexible travel schedule allowed by VLJs to make their return trip sooner, where the longer travel times of automobiles or the less flexible schedule of regular air carriers would have resulted in them staying in the community for an additional night.

Using average per diem costs of each of these expenditure categories, and the expected average number of VLJ-based air taxi passengers using each type of airport shown in Table 6, the average annual indirect spending impacts for each of the three types of communities were estimated, as shown in Figure 4.

**Figure 4. Indirect Spending by Category and Type of Community in 2017**



Source: CRA International.

It can be seen that these annual expenditures will total over \$3.3 million in a community with per seat, on-demand service, and over \$9.8 million in a community that also has VLJ maintenance facilities.

The earnings and employment impacts of this indirect spending are summarized in Table 9, which shows that a number of additional jobs would be related to the presence of VLJ service.

**Table 9. Indirect Impacts by Type of Community in 2017**

Community Type	Output	Earnings	Employment
Per seat, on-demand service and maintenance facilities	\$9,890,606	\$3,039,878	144
Per seat, on-demand service only	\$3,336,533	\$1,009,639	49
Destination and aircraft charter service only	\$1,586,684	\$480,133	23

Source: CRA International.

### 3.3. INDUCED AND TOTAL IMPACTS AT THE LOCAL LEVEL

Air taxi employees will spend a portion of their incomes locally, and the other expenditures made by air taxi operators for fuel and fees will be made through purchases from local businesses. The spending done by visiting air taxi passengers will likewise be done at local establishments. In turn, these local businesses will spend a portion of this income locally, resulting in additional, “induced” economic impacts. These induced impacts will be reflected in additional jobs in the businesses that are the recipients of air taxi related spending, in the incomes of the employees who work there, and in the value of the goods and services they produce.

Induced impacts were estimated using an economic multiplier approach that is commonly applied in economic impact studies. Further details of this methodology are provided in Appendix B. Table 10 shows that a significant amount of additional economic activity would be connected to the presence of VLJ-based air taxi services in these communities. These induced impacts could add as many as 292 more jobs and over \$50 million in annual output in a Type 1 community.

**Table 10. Induced Impacts by Type of Community in 2017**

Community Type	Output	Earnings	Employment
Per seat, on-demand service and maintenance facilities	\$50,864,226	\$8,871,788	292
Per seat, on-demand service only	\$18,137,822	\$2,450,249	102
Destination and aircraft charter service only	\$3,047,041	\$863,691	24

Source: CRA International.

Adding together the direct, indirect, and induced impacts, Table 13 summarizes the total amount of economic activity that would be in some way connected to VLJ services in each type of prototypical community in 2017. The table shows that a typical community served by per seat, on-demand operations would have 205 jobs and over \$27 million in economic activity that could be attributed in some way to the presence of the VLJ service.

**Table 11. Total Local Economic Impact by Type of Community in 2017**

Community Type	Output	Earnings	Employment
Per seat, on-demand service and maintenance facilities	\$76,718,483	\$22,365,060	581
Per seat, on-demand service only	\$27,297,798	\$8,200,079	205
Destination and aircraft charter service only	\$4,762,404	\$1,378,696	47

Source: CRA International.

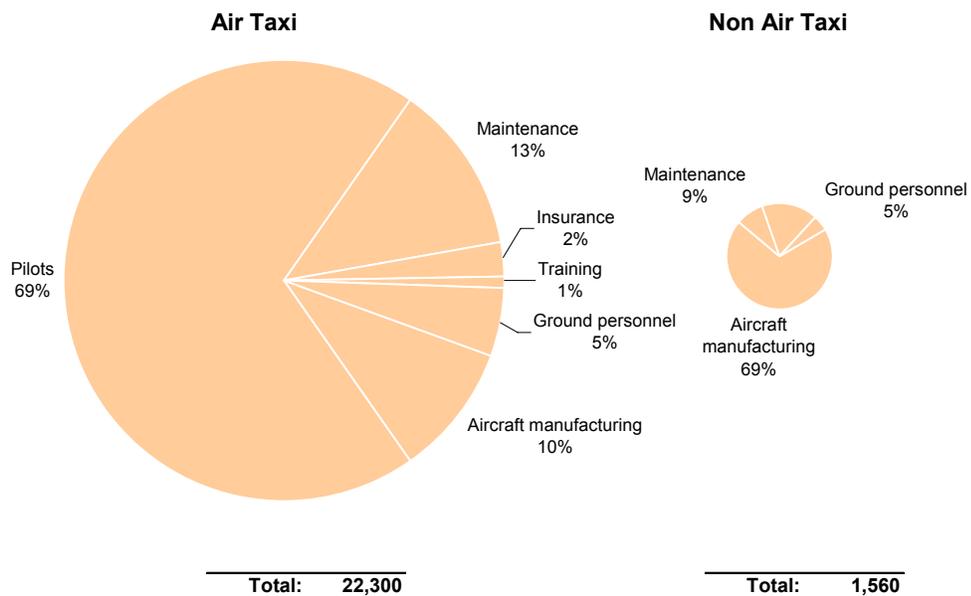
## 4. VLJS WILL PLAY A SIGNIFICANT ROLE IN THE NATIONAL ECONOMY

The production and use of VLJs will have a significant impact on the national economy. If the FAA forecast is realized, the value of the aircraft produced will be substantial, as will the value of the output produced by a large scale air taxi industry. Large numbers of workers will likewise be employed in the manufacturing of the aircraft and the operation of these air taxi services. This section describes the total amount of output, earnings, and employment that would be attributable to VLJs in 2017.

### 4.1. DIRECT IMPACTS AT THE NATIONAL LEVEL

Nationwide, there would be over 23,000 jobs directly connected with the manufacture or operation of VLJs in 2017, as shown in Figure 5. Many of these jobs would reflect the large staff of pilots that would be required to operate a 3,300 aircraft air taxi fleet, though significant numbers would also be employed in building and maintaining these aircraft.

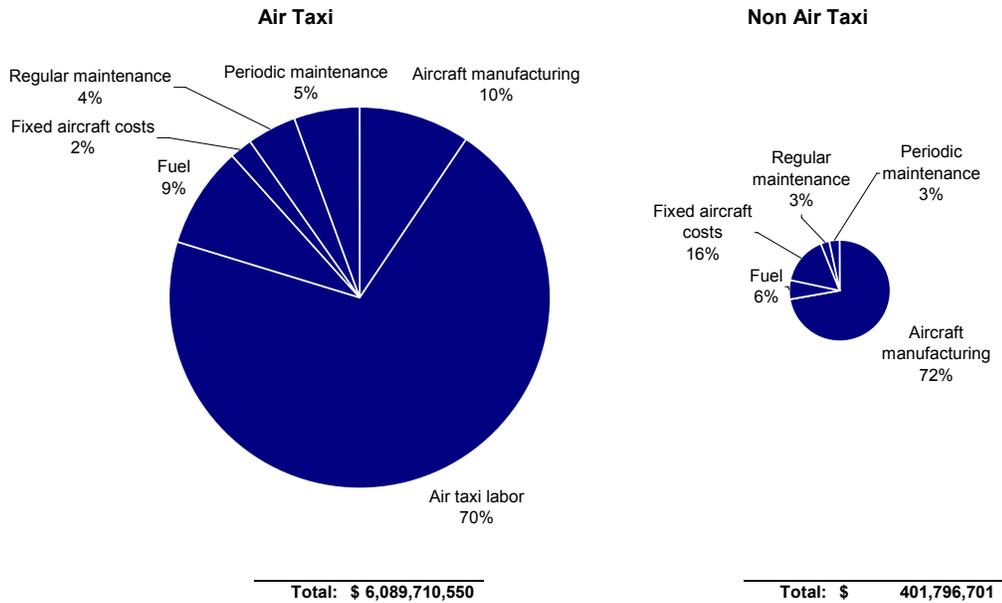
**Figure 5. Jobs Directly Associated with VLJs by Category in 2017**



Source: CRA International based on calculations by Virginia Polytechnic Institute.

Over \$6 billion in output would be associated with VLJs, much of it coming from the many jobs in the air taxi industry and the value of the manufactured aircraft, as detailed in Figure 6. Table 12 shows that in total, these jobs and output represent over \$1.7 billion in earnings.

**Figure 6. Direct Spending Associated with VLJs by Category in 2017**



Source: CRA International based on calculations by Virginia Polytechnic Institute.

**Table 12. Direct Impacts at the National Level in 2017**

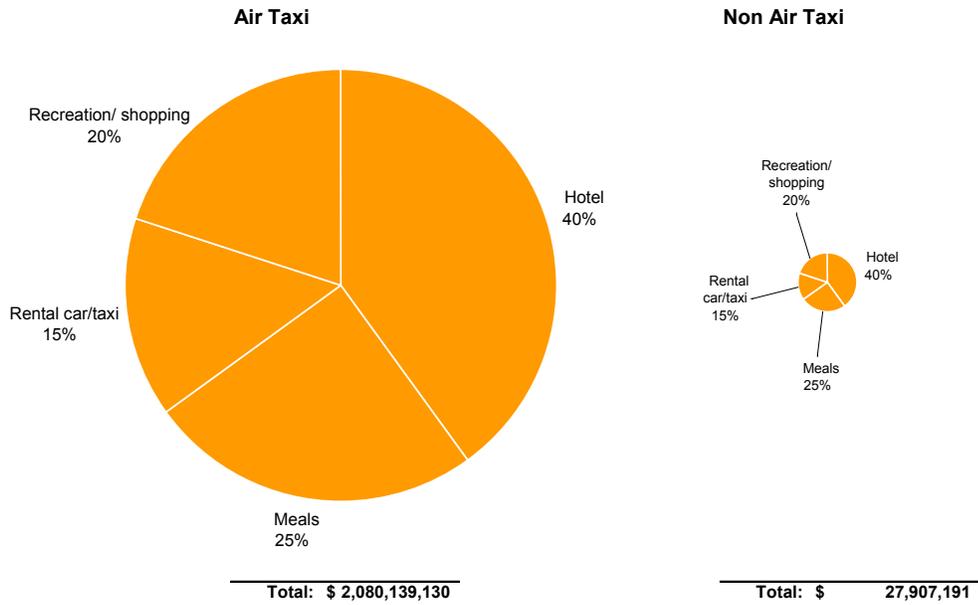
Category	Output	Earnings	Employment
Air taxi	\$6,089,710,550	\$1,650,311,559	22,300
Non air taxi	\$401,796,701	\$108,886,906	1,560
<b>Total</b>	<b>\$6,491,507,251</b>	<b>\$1,759,198,465</b>	<b>23,860</b>

Source: CRA International.

#### 4.2. INDIRECT IMPACTS AT THE NATIONAL LEVEL

The total amount of spending by VLJ users is shown in Figure 7, which indicates that over \$2 billion would be spent annually by air taxi passengers, and another \$28 million by private users of VLJs. Expenditures for hotels represent the largest category of spending, even despite the fact that VLJ-based air taxi services would allow many travelers to reduce the number of nights spent away from home.

**Figure 7. Indirect Spending by Category at the National Level in 2017**



Source: CRA International.

Total indirect impacts at the national level are summarized in Table 13, which shows that over 30,000 jobs would be related to the use of VLJs in 2017, which in turn would pay over \$647 million in earnings to workers.

**Table 13. Indirect Impacts at the National Level in 2017**

Category	Output	Earnings	Employment
Air taxi	\$2,080,139,130	\$639,330,762	30,306
Non air taxi	\$27,907,191	\$8,577,275	407
<b>Total</b>	<b>\$2,108,046,321</b>	<b>\$647,908,037</b>	<b>30,713</b>

Source: CRA International.

**4.3. INDUCED AND TOTAL IMPACTS AT THE NATIONAL LEVEL**

Table 14 summarizes the amount of economic activity associated with the spending of the households receiving the earnings shown in Table 15. These induced impacts would be substantial, totaling \$15.3 billion in output, \$4.5 billion in earnings, and over 135,000 jobs.

**Table 14. Induced Impacts at the National Level in 2017**

Category	Output	Earnings	Employment
Air taxi	\$14,497,172,133	\$4,278,983,068	128,501
Non air taxi	\$857,191,041	\$254,471,020	6,780
Total	\$15,354,363,175	\$4,533,454,088	135,281

Source: CRA International.

The overall combined amount of economic activity is shown in Table 20. Nearly \$24 billion in output and nearly \$7 billion in earnings paid to over 189,000 jobs would be connected with the manufacture and operation of VLJs nationwide in 2017.

**Table 15. Total Impacts at the National Level in 2017**

Category	Output	Earnings	Employment
Air taxi	\$22,667,021,813	\$6,568,625,388	181,107
Non air taxi	\$1,286,894,934	\$371,935,202	8,746
Total	\$23,953,916,747	\$6,940,560,590	189,853

Source: CRA International.

## 5. HIGHER LEVELS OF VLJ PRODUCTION WOULD RESULT IN GREATER ECONOMIC IMPACTS

The analysis presented above is based on the most recent FAA forecast of VLJ production. As described in more detail in Appendix A, this forecast represents a consensus view reached at a workshop of industry experts, rather than a systematic analysis of each of the several market segments that represent prospective purchasers of VLJ aircraft (air taxi operators, corporations, owner/operators, etc.). There is at least anecdotal evidence that VLJ demand could be higher than that predicted by the FAA. Eclipse Aviation has already received 2,400 aircraft orders<sup>6</sup> – nearly half of the entire FAA fleet forecast for 2017 – and it is only one of several companies developing VLJs. In addition, the FAA forecast did not explicitly take into account the possibility that the advent of VLJs could create new markets for aircraft, spurring both companies and individuals to purchase an aircraft for the first time.

Two alternatives to the above analysis were therefore examined that assume higher levels of VLJ production:

- *Higher overall demand scenario.* This scenario assumes that the level of VLJ production would be 50% above that forecast by the FAA.
- *Higher corporate demand scenario.* This scenario assumes an additional increment of aircraft would be purchased by corporate users, equal to that of the air taxi segment.

The economic impact results for each of these alternative scenarios are summarized below.

### 5.1. HIGHER OVERALL DEMAND SCENARIO

The higher overall demand scenario assumes that the total size of the VLJ fleet in 2017 would be 50% larger than that forecast by the FAA. The total VLJ fleet size for this scenario is therefore 7,425 aircraft. As in the analysis described above, it was assumed that two-thirds of the total fleet would be used for per seat, on-demand air taxi services. Thus the fleet of 7,425 VLJs assumed in this scenario would comprise 4,950 air taxi aircraft and another 2,475 aircraft used for other purposes.

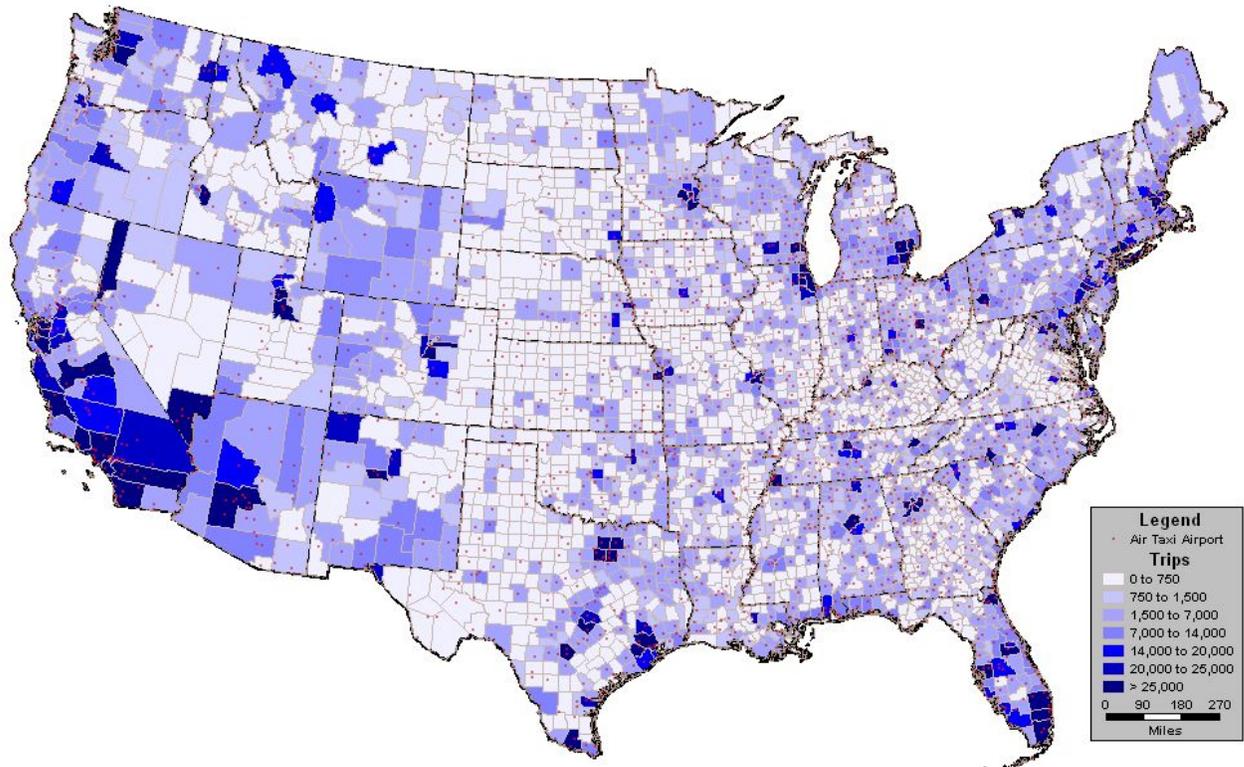
With a larger VLJ fleet more travelers could use VLJ-based air taxi services. The Virginia Tech TSAM model predicts that, with a larger fleet of 4,950 aircraft, air taxis would serve a total of 10.8 million passengers in 2017.<sup>7</sup> The geographic distribution of these trips is shown in Figure 8.

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<sup>6</sup> "Small World: Bucking Skeptics, One Man Tries Selling Tiny Jets," *Wall Street Journal*, May 6, 2006, p. 1.

<sup>7</sup> With this larger fleet size all 2,074 candidate airports described in Appendix A could be used for air taxi service, and thus the entire set of 2,074 airports was used in the simulation. All other assumptions were held constant.

**Figure 8. Distribution of Annual Originating VLJ Air Taxi Trips by County, 2017 - Higher Overall Demand Scenario**



Source: CRA International with calculations by Virginia Polytechnic Institute.

The greater availability of air taxi services would also mean larger time savings benefits. Table 16 shows that air taxi passengers would save over 48 million hours of travel time. These time savings would translate into benefits of over \$2.5 billion in 2017, an increase of 35% over the result based on the FAA forecast.

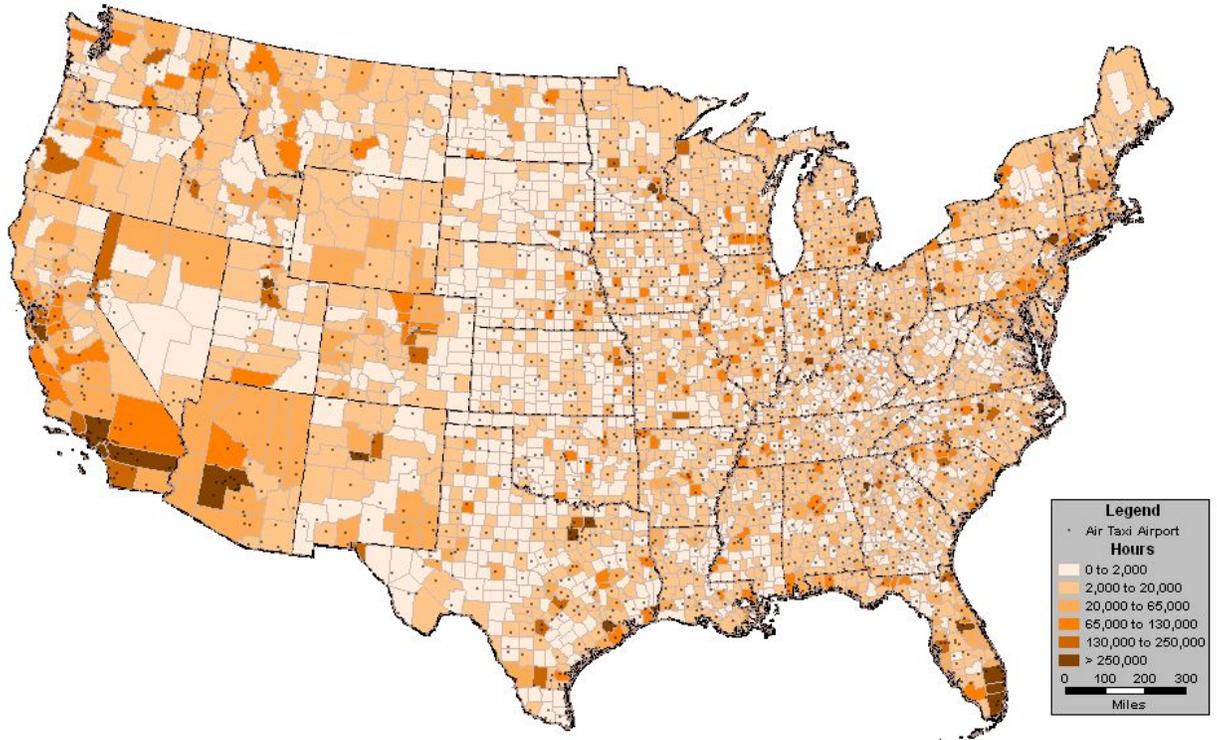
**Table 16. Value of Time Saved with VLJs – Higher Overall Demand Scenario (\$2005)**

Trip Purpose	Total Hours w/o VLJ Air Taxi	Total Hours with VLJ Air Taxi	Total Time Savings (hours)	Value of Time Savings
Business	3,582,513,617	3,539,721,563	42,792,054	\$2,334,410,917
Non-business	11,952,603,322	11,947,292,626	5,310,696	\$180,693,193
Total	15,535,116,939	15,487,014,189	48,102,750	\$2,515,104,110

Source: Virginia Polytechnic Institute with calculations by CRA International.

The geographic distribution of these time savings, illustrated in Figure 9, confirms that a greater air taxi fleet size would bring further benefits to areas currently lacking significant air service (by comparison to Figure 2).

**Figure 9. Distribution of Annual Time Savings with VLJ-based Air Taxi Service by County, 2017 Higher Overall Demand Scenario**



Source: CRA International with calculations by Virginia Polytechnic Institute.

Table 17 summarizes the economic impacts at that national level for this alternative scenario, showing that nationally a total of over \$32 billion in output and nearly 250,000 jobs would be in some way associated with VLJs in 2017.

**Table 17. Total Impacts by Category in 2017 – Higher Overall Demand Scenario**

Category	Output	Earnings	Employment
Direct	\$9,476,617,262	\$2,568,163,278	35,188
Indirect	\$2,121,999,917	\$652,196,674	30,916
Induced	\$20,778,360,931	\$6,144,111,372	183,289
<b>Total</b>	<b>\$32,376,978,110</b>	<b>\$9,364,471,325</b>	<b>249,393</b>

Source: CRA International.

Table 18 breaks out the total economic impacts by segment, indicating that the air taxi segment alone would be associated with over \$30 billion in output and over 236,000 jobs in this scenario.

**Table 18. Total Impacts by Segment in 2017 – Higher Overall Demand Scenario**

Category	Output	Earnings	Employment
Air taxi	\$30,446,635,709	\$8,806,568,522	236,273
Non air taxi	\$1,930,342,401	\$557,902,803	13,120
Total	\$32,376,978,110	\$9,364,471,325	249,393

Source: CRA International.

## 5.2. HIGHER CORPORATE DEMAND SCENARIO

The higher corporate demand scenario assumes that an additional increment of VLJs would be purchased by corporate customers, equal to that purchased by the air taxi segment at 3,300 aircraft. Another 1,650 aircraft would be purchased by other customers for a total fleet size of 8,250 in 2017 (67% higher than the FAA forecast). This scenario reflects the possibility that VLJs may make aircraft ownership an attractive proposition for a much wider range of companies, and/or that VLJs may provide an economical means to significantly expand existing corporate flight departments for new and innovative aircraft uses.

Under this scenario, the size of the air taxi fleet would remain the same, and therefore the time savings benefits summarized in Table 4 would still obtain. Likewise, the economic impacts generated by the production and use of aircraft for air taxi services would remain the same. Further benefits would be experienced by the users of the 3,300 additional corporate VLJs, however, and the manufacturing and operation of these aircraft would generate additional economic benefits.

The TSAM model is not designed to predict total trips by users of corporate aircraft, so an estimate of total passengers using the assumed additional 3,300 aircraft was derived separately. Based on assumptions about the nature and extent of VLJ utilization,<sup>8</sup> an estimated 2.5 million passengers would use these corporate aircraft. While the time savings experienced by these passengers cannot be calculated directly with TSAM, the approximate level of these benefits can be estimated by analogy to the air taxi segment. Assuming the

<sup>8</sup> Annual operations were estimated based on the assumption of an annual utilization of 400 hours, average stage length of 575 miles, and average aircraft speed of 313 knots (over the course of a trip). Estimated total passengers were estimated from operations based on an assumed load factor of 0.75.

same average time savings per person trip predicted by TSAM for air taxi users on business trips, the additional corporate VLJ users would experience an estimated \$662 million in time savings benefits in 2017, as illustrated in Table 19.

**Table 19. Value of Time Saved in 2017 by Additional Corporate Segment Users (\$2005)**

Total passengers using 3,300 additional corporate segment aircraft	2,480,639
<i>Times</i> Average time savings per business trip, in hours, from TSAM air taxi analysis	4.89
<i>Equals:</i> Annual time savings (hours)	12,137,144
<i>Times</i> Hourly value of time for business travel from Table 3 (\$2005)	\$54.55
<i>Equals:</i> Total value of time savings	\$662,110,834

Source: CRA International.

The production and operation of the additional 3,300 aircraft in this scenario would also generate significant economic impacts. As with the air taxi segment, these aircraft would be staffed by professional pilots, require regular maintenance, consume significant amounts of fuel, and be serviced by ground staff and administrative personnel (it is likely that these aircraft would be operated either by management companies or corporate flight departments). These direct impacts were estimated in a manner consistent with that used for the air taxi segment. The users of these aircraft would also produce indirect impacts through spending on meals, lodging, and ground transportation, and induced impacts would likewise be created by the household spending generated by the direct and indirect impacts. The estimated total national economic impacts for the higher corporate demand scenario are shown in Table 20.

**Table 20. Total Impacts by Category in 2017 – Higher Corporate Demand Scenario**

Category	Output	Earnings	Employment
Direct	\$10,385,379,812	\$2,814,437,929	39,298
Indirect	\$2,442,932,617	\$750,835,340	35,592
Induced	\$22,960,070,396	\$6,787,966,361	201,835
Total	\$35,788,382,825	\$10,353,239,630	276,725

Source: CRA International.

The table shows that a total of \$35.8 billion in output, \$10.3 billion in earnings, and over 276,000 jobs would be associated with VLJs in this scenario in 2017. This represents an increase of 49% in output and earnings, and an increase of 46% in jobs over the results using the FAA forecast of VLJ demand.

Table 21 breaks out the total impacts by segment. The table shows that the 3,300 additional corporate aircraft assumed in this scenario would be responsible for a significant level of economic impact, representing \$11.8 billion in output, \$3.4 billion in earnings, and 86,872 jobs.

**Table 21. Total Impacts by Segment in 2017 – Higher Corporate Demand Scenario**

Category	Output	Earnings	Employment
Air taxi	\$22,667,021,813	\$6,568,625,388	181,107
Additional corporate	\$11,834,466,078	\$3,412,679,040	86,872
Other	\$1,286,894,934	\$371,935,202	8,746
Total	\$35,788,382,825	\$10,353,239,630	276,725

Source: CRA International.

This impact is less than that produced by the air taxi segment, despite the fact that the number of aircraft is assumed to be the same between the two segments (3,300). This results from the fact that the VLJs used for air taxi services will be used much more intensively (1,200 hours per year vs. 400), air taxi services will employ more personnel, and the duration of air taxi trips will be longer, resulting in more indirect spending impacts.

## 6. SUMMARY AND CONCLUSIONS

VLJs are a distinctly new class of aircraft combining several technological advances to provide levels of performance, automation, and efficiency at a cost unimaginable even ten years ago. The FAA predicts that a fleet of 4,950 aircraft will be in service by 2017. The cost/performance advantage of VLJs will make them particularly well suited for use in per seat, on-demand air taxi services. Based on the FAA forecast of VLJ production, more than 7.7 million trips would be made using these air taxi services in 2017, and these travelers would save over 35 million hours of travel time, valued at over \$1.8 billion. Were actual VLJ production to be 50% higher than the FAA forecast level (the Higher Overall Demand Scenario), 2017 air taxi trips would increase to 10.8 million, resulting in time savings valued at over \$2.5 billion. If, alternatively, VLJ production is assumed to be higher than the FAA projection by an additional increment of corporate sales equal to the level of aircraft purchased by air taxi operators (the Higher Corporate Demand Scenario), users of these additional corporate aircraft would save over 12 million hours of travel time valued at over \$662 million.

VLJs will produce significant economic impacts at the local level. Typical communities that serve as bases for the operation and maintenance of VLJ-based air taxi services will experience nearly \$16 million in economic activity and nearly 150 permanent jobs directly

associated with VLJs. On average, such a community will in total produce over \$76 million in output and over 500 jobs that are in some fashion connected with the use of VLJs.

VLJs will also play a significant role in the national economy. Based on the FAA forecast, total economic activity in 2017 related to VLJs in some fashion will total nearly \$24 billion in output, \$6.9 billion in earnings, and over 189,000 jobs. Under the Higher Overall Demand Scenario, economic activity in 2017 related to VLJs in some fashion would total over \$32 billion in output, \$9.4 billion in earnings, and over 249,000 jobs. Under the Higher Corporate Demand Scenario, economic activity in 2017 related to VLJs in some fashion would total over \$35 billion in output, \$10.4 billion in earnings, and over 276,000 jobs.

A summary of the results for the three assumptions regarding the size of the VLJ fleet in 2017 is shown in Table 22.

**Table 22. Summary of Total Impacts at the National Level in 2017**

VLJ Production Assumption	VLJ Fleet Size	Output	Earnings	Employment
FAA forecast	4,950	\$23,953,916,747	\$6,940,560,590	189,853
FAA forecast + 50%	7,425	\$32,376,978,110	\$9,364,471,325	249,393
Higher corporate demand	8,250	\$35,788,382,825	\$10,353,239,630	276,725

Source: CRA International.

## APPENDIX A: FLEET AND PASSENGER DEMAND FORECAST

The analysis presented in this document is closely tied to a number of assumptions and modeling approaches discussed in this Appendix.

### A.1 VLJ FLEET FORECAST

The impact of VLJ deployment in the analysis year 2017 will depend on the number of VLJ aircraft that are produced and in service by that time. This question has been examined by the FAA's Office of Policy and Plans in the document *FAA Aerospace Forecasts: Fiscal Years 2006-2017* (2006). Drawing on a workshop of industry experts' deliberations, the FAA expects that the VLJ fleet will reach 4,950 aircraft by 2017. This figure underlies many of the analysis calculations and results presented here. It should be noted that the FAA's estimate lies between similar, but independently prepared, forecasts for the same year by Embraer (somewhat over 5,000 aircraft) and Honeywell (around 4,000 aircraft).

Not all VLJs will be used for air taxi service: It is reasonable to expect that some portion will serve as corporate or personal jets, or serve other general aviation purposes. While on-demand, point-to-point air taxi service represents a new activity in the transportation sector and the economy, these other uses are ongoing activities. Over time, VLJs will replace existing aircraft because of the economy and flexibility that they offer. These two distinct uses have very different economic impacts and have thus been distinguished in the analysis.

To obtain an estimate of the number of VLJs that can be expected to serve as air taxis, discussions were held with Professor Antonio Trani of Virginia Tech, an expert in VLJs and one of the participants in the workshop that led to the FAA's fleet forecasts. Based on these discussions, it was assumed that approximately two-thirds of the 2017 VLJ fleet would operate as air taxis, with the remainder serving as replacement equipment for existing corporate and personal jets. Accordingly, the air taxi fleet in 2017 was assumed to consist of approximately 3,300 aircraft.

### A.2 VLJ LIFECYCLE COST ANALYSIS AND AIR TAXI COST PER SEAT-MILE

Professor Trani and his co-workers at Virginia Tech have developed a very general and powerful aircraft lifecycle cost model. Model inputs consist of values for a comprehensive set of aircraft fixed and variable cost components, together with operations parameters that affect aircraft utilization, costs, and revenues. Inputs include, for example, the aircraft purchase price and resale value, pilot number and salary, flight hours per year, average stage length, percentage repositioning flights, jet fuel costs, engine overhaul costs and intervals, number of passenger trips, load factor, and profit margin, among many others. Using these inputs and their relationships to different cost components, the model calculates the total costs of owning and operating the aircraft over its entire lifecycle (from purchase through resale), and outputs a detailed breakdown of annual costs as well as a number of relevant financial metrics such

as cost per hour and per seat-mile. The cost per seat-mile is of particular interest, because it is the basis for the air taxi fare used as an input to the VLJ demand forecasts.

In prior studies of VLJ air taxi service, Professor Trani and his group developed a set of cost model inputs representative of VLJ aircraft; in fact, the Eclipse 500 (the VLJ closest to being certified) served as a source for many of these data values. As part of the present study, these values were reviewed with Eclipse Aviation and with DayJet. In some cases, the values were modified to reflect the experience or expectations of the reviewers.

Given these revised inputs, the lifecycle cost model calculated a VLJ air taxi seat-mile cost of approximately \$2.00 (in \$2005); this value was in fact relatively robust across variations in the input values. The seat-mile cost was reviewed with Eclipse and DayJet, and found to be near the middle of the range of potential fare values currently under consideration. Accordingly, \$2.00 per seat-mile was used for VLJ air taxi fare calculations in all subsequent analyses.

### A.3 AIR TAXI AIRPORT SET SELECTION AND CHARACTERISTICS

Although VLJs are able to operate at airports that would not accommodate most other conventional passenger aircraft, their use in providing reliable commercial air taxi service presupposes basic minimum criteria at airports to be served. Candidate airports in the FAA's airport database (March 2006) were screened against the following criteria:

- Public use
- Located in the continental United States
- Paved runway
- Runway length of 3,500 feet or more
- Runway width of 75 feet or more
- Runway edge lights.

Moreover, the major hubs (34 airports so designated by the FAA in the continental United States) were excluded from consideration because VLJ-based air taxi plans explicitly avoid these due to high congestion levels.

Out of more than 20,000 landing facilities in the FAA database, 2,074 facilities meet the above criteria. These were used as an initial set of candidate airports.

It would not be feasible to serve all the facilities in this set with a fleet of 3,300 VLJ air taxis. The total level of passenger demand resulting from this number of airports (and the corresponding short access distance to demand generators and attractors) would require a much larger fleet. Moreover, the relatively low levels of demand at many of the airports would result in aircraft utilization levels (defined in terms of load factors and the required number of

non-revenue repositioning flights) that would not be commercially sustainable at the \$2.00/seat-mile fare level assumed above.

Thus, there was a need to ensure overall consistency between the assumed fleet size, airport set, and fare level used in the analysis. Because the fare level was set through the application of the lifecycle cost model using realistic operations parameters, equilibration between VLJ air taxi demand and supply was attained by varying the airport set. This involved a manual process with multiple runs of a VLJ demand forecasting model (described below), applying the model to a different airport set in each run.

Equilibrium was reached with a set of 676 airports, which were identified as those having at least one runway with Instrument Landing System (ILS) capabilities. While VLJs can operate out of airports that do not provide ILS, the presence of these capabilities provided a useful and operationally meaningful criterion with which to screen the initial airport set. Considering these airports in the 2017 analysis ensures that the deployment of VLJ-based air taxi service will not be constrained by the need for investments in airport navigation facilities over the next ten years. Furthermore, VLJ service at these airports should be able to attain a level of dispatch reliability nearly equivalent to that observed at the 443 commercial service airports in the United States.

#### A.4 VLJ AIR TAXI SERVICE DEMAND FORECASTING MODEL

Forecasts of VLJ air taxi service demand were carried out using TSAM. TSAM was initially developed as part of NASA's Small Aircraft Transportation System (SATS) program, and was one of the principal analytical tools used for SATS studies. It has undergone continuing enhancement and refinement.

TSAM predicts the number of trips by auto, commercial air, and VLJ air taxi between each pair of counties in the continental United States (only trips with one-way length greater than 100 miles are considered). The model structure is similar to that used in most conventional transportation-demand modeling efforts, consisting of the following steps:

- Trip generation—a prediction of the total number of trips generated by or attracted to each county as a function of the socioeconomic characteristics of the county
- Trip distribution—a prediction of the total number of trips traveling from each county to each other county, depending on the county production and attraction totals, the distance between them, and county-specific factors (using a standard model form known as a *gravity model*)
- Mode split—a prediction of the division between modes of the total trips for each county pair, which depends on county demographics as well as on the respective modal door-to-door travel times and costs (using a standard model form known as a *nested logit model*).

The model divides travelers into five household income groups and two travel purposes (business and non-business) and predicts the demands by each group separately. The lower nest in the mode split model considers three origin and three destination airports (nine possible routings) for commercial aviation. These are compared against direct (over the road) auto travel between the origin and destination county centroids, and against direct (great circle) VLJ travel between the airports in the VLJ airport set that are closest to the origin and destination county centroids. Auto mode travel time and cost reflect a maximum daily driving distance and the number of people traveling together (both of which vary by purpose and income group). For the air modes, airport access time and cost (by auto), as well as airport processing and wait times, are taken into account. All travel time components are weighted identically, but the utility function travel cost coefficient varies by income group and trip purpose (reflecting different marginal utilities of income).

These various relationships were developed using data sources such as the Population Census, the 1995 American Travel Survey, as well as separately conducted stated preference surveys. Model application uses socioeconomic data from Woods and Poole CEDDS Economics, commercial airline data from the *Official Airline Guide* and the USDOT DB1 ticket sample database, airport location and characteristics from the FAA database, VLJ aircraft performance data from the manufacturers and other sources, and auto travel times and routes from MapPoint travel planning software.

Professor Trani and his co-workers carried out all TSAM model runs under CRA's guidance and direction. For the purposes of this study, TSAM was slightly modified to output total travel demand, time and cost by mode for each origin county. These outputs were the basis for the maps of VLJ demand and time savings as well as the tables of VLJ time savings values, which are presented in the main text.

## APPENDIX B: METHOD FOR DETERMINING ECONOMIC IMPACTS

The economic impacts described in this report represent output, earnings, and employment associated with the production and/or operation of VLJs. Impacts were calculated using multipliers and direct factors published by the US Department of Commerce, Bureau of Economic Analysis (BEA) as part of its Regional Input-Output Modeling System (RIMS II). RIMS II is an industry standard analysis tool developed by the BEA to facilitate the estimation of the regional economic impact of projects or industries without the need to apply highly complex and much more costly modeling tools.

The multipliers and factors included in RIMS are based on the BEA's national Input-Output table, which represents the structure of inputs and outputs in nearly 500 industries, and the BEA's regional economic accounts, from which adjustments are made to the Input-Output table to reflect the industrial structure and trading patterns of a specific region. The multipliers relate changes in the amount of final demand in an industry to changes in output, earnings, and employment in each of the other industries that are related by virtue of supplying inputs or consuming outputs. The direct factors describe the relationships among output, earnings, and employment for a given industry sector. For this study, we have used final demand multipliers and direct factors for the aircraft and parts manufacturing industry, the commercial air transportation industry, and a number of ancillary industries related to the provision of air transportation services. The multipliers and direct factors are shown in the table below.

**Table B-1. National RIMS II Multipliers and Direct Factors (based on 2003 data)**

Industry	Final Demand Multipliers			Direct Factors	
	Output (per \$ of direct output)	Total Earnings (per \$ of direct output)	Employment (jobs per \$ mil of direct output)	Earnings share of output	Average earnings per job
Aircraft & parts manufacturing	3.1125	0.8993	19.7215	28.0%	\$72,622
Commercial air transportation	2.7572	0.7927	19.8248	27.1%	\$58,363
Flight training	2.7714	1.0424	27.0991	52.1%	\$43,112
Visitor - Shopping	2.6651	0.8539	29.8762	36.8%	\$22,591
Visitor - ground transport	3.2278	1.0451	41.6423	40.0%	\$16,693
Visitor - car rental	2.6078	0.6663	18.3879	18.4%	\$37,751
Visitor - recreation & entertainment	2.7355	0.8363	32.1132	34.5%	\$24,175
Visitor - accommodation	2.6062	0.8137	27.7339	34.5%	\$24,175
Visitor - food & drink	3.0374	0.8448	36.9136	29.1%	\$13,790

Source: Campbell Hill Aviation Group, *Commercial Aviation and the American Economy*, Exhibit A-13, 2006

The total impacts reported in this study were computed by applying the multipliers for the appropriate industry to the respective estimates of direct and indirect economic activity. Induced impacts were computed by subtracting these direct and indirect impacts from the total impacts.