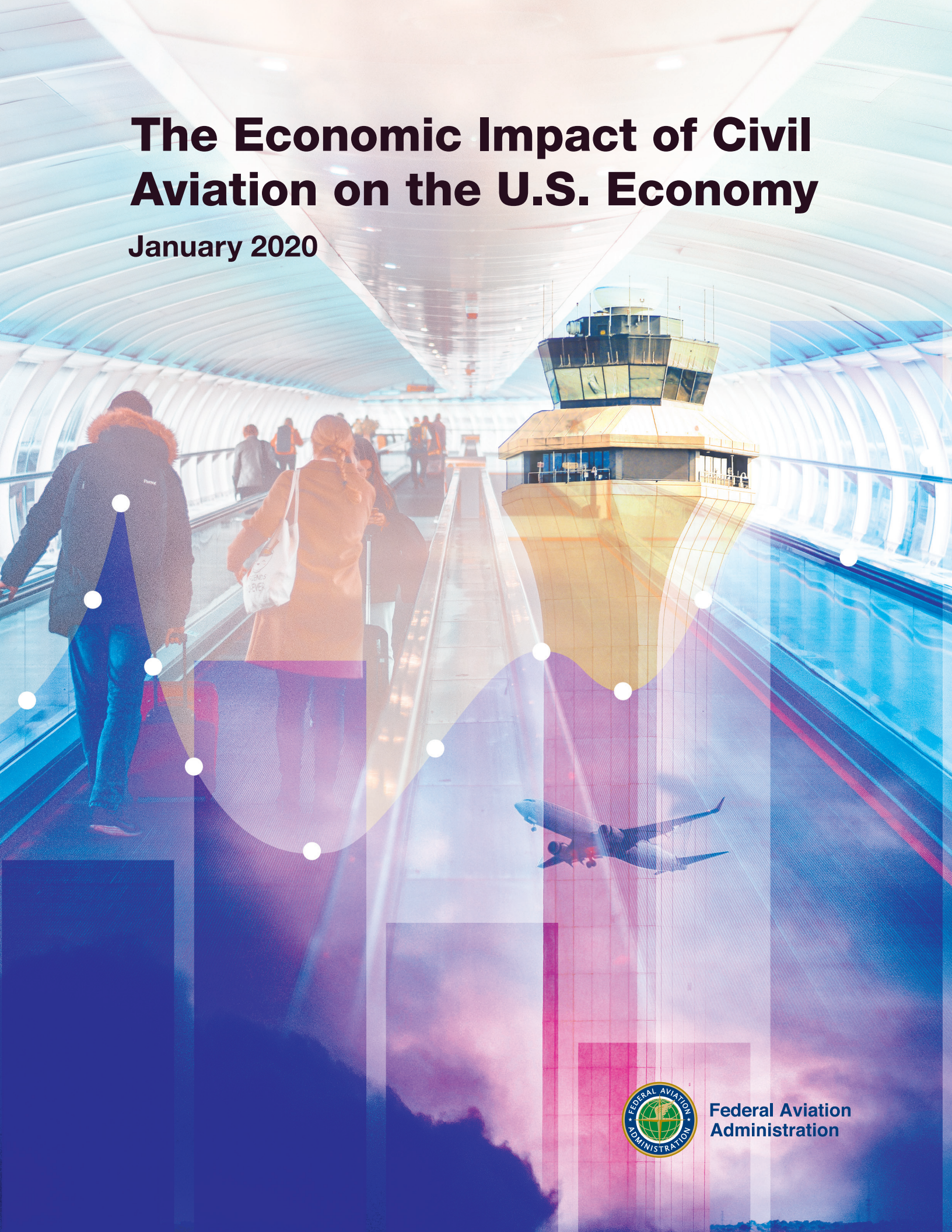
The Economic Impact of Civil Aviation on the U.S. Economy

January 2020



Federal Aviation Administration

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Foreword

Civil air transportation plays a major and growing role in economies around the world. In the U.S., more than 5,000 public-use airports support over 18,000 air transport and 210,000 general aviation aircraft performing about 50 million airport operations. The number of passengers enplaned at U.S. airports is approaching 1 billion, about 100 million more than a decade ago. Since travel demand is derived from other pursuits, whether business or leisure, the extremely active aviation industry supports a range of economic impacts throughout the economy. As this report shows, all this activity, across both direct and catalytic sectors, amounts to more than 5 percent of our Gross Domestic Product, contributes $1.8 trillion in total economic activity and supports nearly 11 million jobs. Considering only the direct sectors, the impact is 2.3 percent of GDP, $850 billion in economic activity, and over 4 million jobs.

The FAA continues in its efforts to support this economic activity, in keeping with our mission to ensure the safest, most efficient aerospace system in the world. As part of our NextGen modernization effort, we're introducing new airspace innovations every day. These innovations include satellite-based (or performance-based) navigation that enables more point-to-point flying which reduces fuel usage and emissions. We're also putting in place Data Communications which enables air traffic controllers and pilots to communicate using text, in addition to voice. Changes like these are making flying more efficient and environmentally friendly, while ensuring that all safety needs are met.

FAA is working to integrate new users like unmanned aircraft and commercial space operations into the national airspace system. These new vehicles are poised to change how we live, in a way not seen since the dawn of the jet age. All of these efforts are bringing positive commercial benefits to our citizens and helping sustain America's leadership in civil aviation.

The FAA's 2020 Economic Impact Report is ideal for policymakers, industry officials and universities. It offers data from 2016 on the economic importance of passenger and cargo transportation, from activities by commercial airlines, air couriers, airports, aircraft and avionics manufacturing, and of aviation research and development. It also discusses the critical role that aviation plays in supporting tourism and other travel-related activities.

Overview

Furthering Economic Growth and Development…

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

As the U.S. economy strengthens further after a prolonged period of muted growth, other U.S. industries and consumers depend on civil aviation's ability to provide reliable services that support business and personal opportunities.

Some highlights of civil aviation in 2016 include:[i]

- Air carriers operating in U.S. airspace transported 946.4 million passengers with 1,377.1 billion revenue passenger miles (RPM).
- More than 66.8 billion revenue ton-miles (RTM) of freight passed through U.S. airports.
- Civil aircraft manufacturing continues to be the top net export in the U.S. with a positive trade balance of $70.9 billion.
- Commercial airline operations supported $357.8 billion of visitor expenditures on goods and services.

A complex industry with many facets…

The U.S. air transportation network continues to support the U.S. economy by providing access to markets beyond the local community. Between 2014 and 2016, U.S. economic growth outpaced growth of the civil aviation industry as a whole. Although the U.S. economy averaged 2.2 percent growth per year while civil aviation saw average annual growth of 1.3 percent during this time, the real primary output of several aviation sectors was much higher.

This report's estimates reveal that sectors experiencing rapid growth of real primary output included avionics manufacturing which expanded at an annual rate of 6.2 percent. Other sectors also grew strongly over the 2014-2016 period, including the largest single category, visitor expenditures. As the U.S. economy was growing at a real rate of 2.2 percent, visitor expenditures grew at a real rate of 3.5 percent and added $23 billion.

However, real growth in civilian commercial aircraft manufacturing output between 2014 and 2016 declined by an average of 2.8 percent per year, and GA aircraft manufacturing declined at a rate of 1.2 percent per year. Nevertheless, civil aircraft manufacturing continues to fuel the U.S. economy as the largest U.S net export in 2016.

[i] Data sources include: Bureau of Transportation Statistics T-100 Segment data for passengers and freight; FAA impact report estimates for visitor expenditures; U.S. Department of Commerce data for trade balance.

Innovating to stabilize a cyclical industry…

Commercial airlines continue to provide fast and increasingly affordable air travel, while facing formidable economic challenges. Through innovations and productivity improvements, the industry continues to support the transport of more people and cargo than ever. Manufacturers steadily make strides in increasing aircraft fuel efficiency and endurance while airlines implement ever-evolving business strategies to adapt to an ever-changing environment.

From 2014 to 2016, growth in real output of aircraft manufacturers declined but even during this cyclical slowdown, real primary output of research and development surged by 24 percent indicating a commitment to increasing productivity.

Airlines also continue to adapt to a changing environment as they restructure and streamline operations to manage operating costs. Airline industry financial data from the Bureau of Transportation Statistics show that the operating net profit margins of large U.S. airlines[ii] rose to 13.5 percent in 2016 versus 8.0 percent in 2014[iii]. Furthermore, this surge in profitability occurred during a period when airline operations (real primary output) declined 4.6 percent.

Research[iv] on air transportation productivity reveals that the industry has an outsized impact on U.S. productivity relative to its size. Despite being ranked 41st in size among the 63 industries in the U.S. economy, air transportation — driven by the forces of productivity and innovation — was found to be the 7th leading contributor to overall productivity in the U.S.

From personal vacations to business meetings, from overnight delivery of time sensitive goods to local traffic news reports — civil aviation is an essential part of everyday life and commerce in the U.S. Air transportation provides a foundation for businesses and families to connect and re-connect while ensuring economic growth and prosperity.

During 2016, the total U.S. economy generated $18.6 trillion in value-added economic activity and supported 144.3 million jobs[v]. At the same time, civil aviation directly or indirectly supported:

- $1.8 trillion in total economic activity,
- 10.9 million jobs, and
- contributed 5.2 percent of U.S. gross domestic product (GDP).

[ii]The large air carriers defined by BTS are those U.S. carriers with annual operating revenues of $20 million or more.

[iii]U.S Department of Transportation, Bureau of Transportation Statistics, Form 41, Schedules P.11 and P.12. June 2016. http://www.rita.dot.gov/bts/ home

[iv]Matthew Russell, "Economic Productivity and Air Transportation: Multifactor and Labor Productivity Trends, 1990-2014." U.S. Department of Labor, Bureau of Labor Statistics, Monthly Labor Review, March 2017.

[v]U.S. Department of Labor, Bureau of Labor Statistics, Labor Force Statistics from the Current Employment Statistics Survey. https://www.bls.gov/data/#employment

INTRODUCTION

What's New?

This report incorporates data from the U.S. Department of Commerce (DOC), Department of Transportation (DOT), Department of Labor (DOL), and the National Science Foundation (NSF) from the years 2014-2016. The DOC's Census Bureau's 2012 Economic Census data, also the most recently available, are incorporated into the estimates for manufacturing, air couriers, and travel arrangements.

More recent RIMS II multipliers from the Bureau of Economic Analysis (BEA) reflecting the 2007 input-output benchmark table (I-O table) and the 2016 regional economic accounts are also incorporated in this report. Compared to those used in the 2016 report, the new multipliers imply a slightly lower impact to output, earnings, and jobs growth across the various industries.

In an organizational change to this report, industry sectors are no longer grouped according to type of operation (commercial or general aviation) but instead according to their primacy in relation to the function of providing air transport. The two categories are now Direct, including airline and airport operations, aircraft manufacturing and others, and Catalytic which comprises only travel arranging services and visitor spending. This change brings the report more closely into alignment with common usage of the terminology that appears in other economic impact studies. This affects only the presentation of the results; the methodology is unchanged from previous reports.

The two sectors added to the 2016 report are included in the economic impact estimates of this report and will continue to be in future reports. The sectors are: aviation research and development (R&D) and avionics manufacturing. These sectors expand the scope of these reports by capturing other economic impacts related to civil aviation. R&D is a key element in economic growth and productivity, while avionics accounts for new technology and products that are continually being integrated into aircraft.

Aviation R&D

R&D, which fosters innovation, has long been recognized as an important contributor to the economy. As part of the effort to better analyze the effects of R&D on the U.S. economy and improve international comparison of economic accounts, the BEA started to capitalize R&D products as an investment in the measurement of gross domestic product (GDP) starting in 2013[vi].

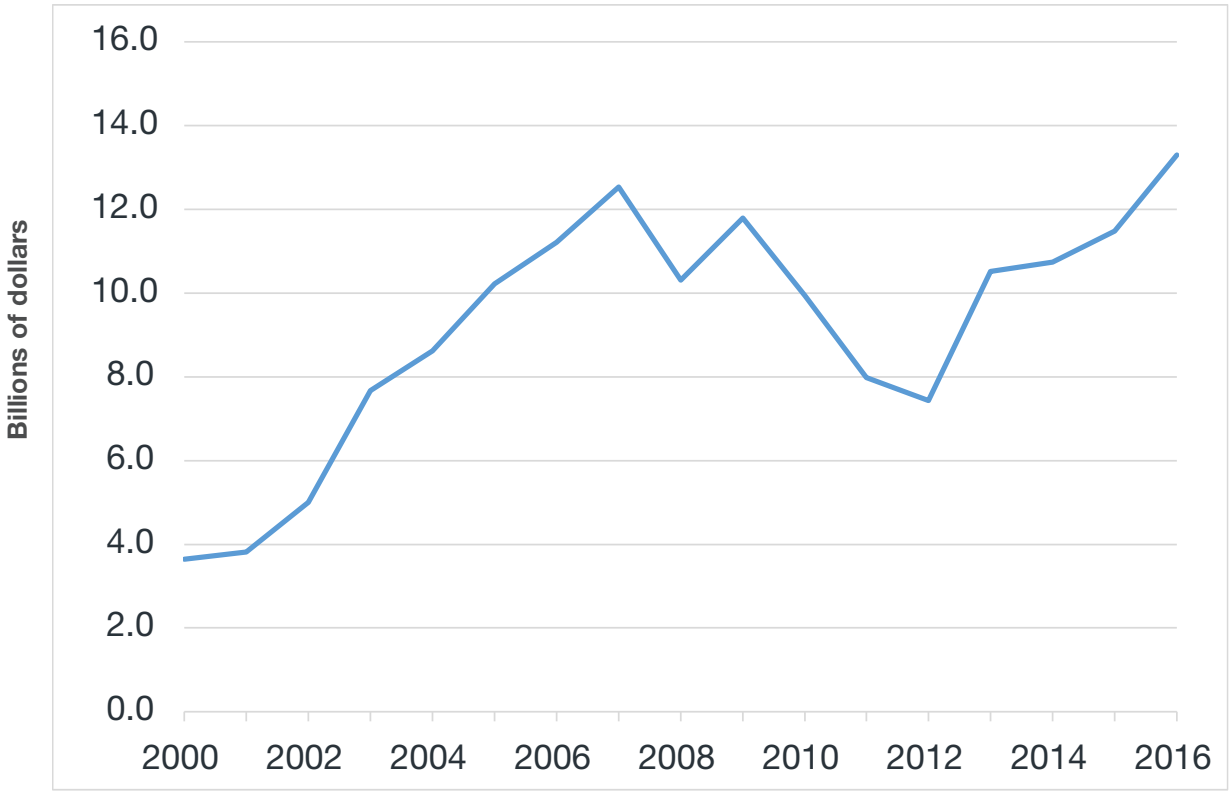
To be consistent in this report's measure of aviation's contribution to U.S. GDP, R&D estimates have been incorporated into the impact estimates.

The primary source of data for the R&D estimates in this report is the National Science Foundation's (NSF) Business R&D and Innovation Survey (BRDIS). The NSF defines R&D as "planned, creative work aimed at discovering new knowledge or developing new or significantly improved goods and services." In this sense, R&D includes all innovation implemented by businesses in the production of goods, services, or processes (development).

For this report, R&D conducted by U.S. domestic business in the manufacturing of aircraft and related parts industries—as captured in the NSF Survey — are counted as primary output in the impact estimates.

The estimates of R&D, based on NSF data from 2000-2014 and extrapolated to 2016, are shown in Figure 1. In 2016, U.S. domestic businesses spent nearly $14 billion in activities related to aviation R&D and innovation.

Figure 1. Aviation Research and Development, 2000-2016



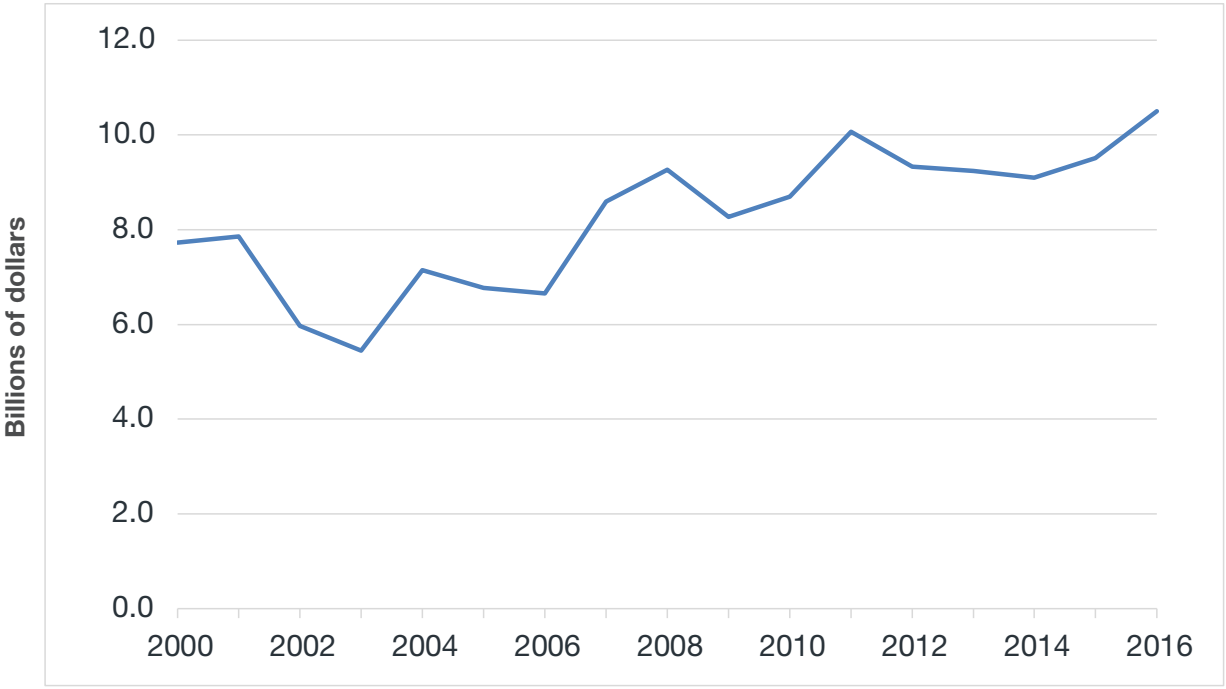
[vi] U.S. Department of Commerce, Bureau of Economic Analysis, National Income and Product Accounts.

Avionics Manufacturing

Avionics equipment manufacturing was another new data series in the 2016 report. Previously, it was assumed all avionics equipment was already included in new aircraft and aircraft parts manufacturing and was therefore accounted for. Research found this was not the case; instead, some new avionics equipment was also used to update, refurbish, or retrofit existing aircraft[vii].

The avionics data appears on Figure 2 and includes the years 2000 through 2016. The graph shows in 2016, $10.5 billion in new avionics equipment was manufactured in the U.S. and includes new equipment (including GPS) used to retrofit, refurbish, or replace avionics on existing aircraft, and equipment exported to other countries. The methods employed to estimate this series are very similar to those used by the BEA to produce components of the U.S. GDP and components of the U.S. benchmark I-O tables, and are based mainly on data collected by the U.S. Census Bureau in various national surveys.

Figure 2. Avionics Manufacturing, 2000-2016



[vii] To avoid double-counting, the value of avionics installed in new aircraft is subtracted from total avionics shipments. Since this report covers civil aviation only, it does not include defense avionics equipment.

What's Coming in Future Reports?

Brief sections on unmanned aircraft systems (UAS) and commercial space are included in this report. The rise in popularity of UAS (also known as drones) is well known. As this segment of the aviation industry matures and more economic data become available, UAS estimates may be incorporated in future editions of this report. The commercial space estimates represent the economic impact of commercial launches of vehicles into orbital or suborbital space carrying payloads for private or government purposes. As the number of commercial space launches and the value of payloads increase, it may also be added to future publications of this report.

Unmanned Aircraft Systems

From a nascent industry only a few years ago, unmanned aircraft systems (UAS) have experienced robust growth in the United States and around the world in recent years. A UAS, sometimes called a drone, includes an aircraft without a human pilot onboard, a ground-based control station, and a communications link connecting all the components. While introduction of UAS in the national airspace system (NAS) has opened up numerous possibilities, it has also brought operational challenges. Integration must be done in a manner that ensures the safety of people and property both in the air and on the ground. Despite these challenges, the UAS sector holds enormous promise. Uses range from modelers experimenting with small UAS to performing aerial photography for personal use, to larger UAS capable of inspecting infrastructure and crops, and package delivery.

The FAA's online registration system – the primary source of data to understand the evolution of small UAS in the United States – went into effect on December 21, 2015. On August 29, 2016, the rules on the small UAS (14 CFR part 107) were put into place. The regulations require all UAS weighing more than 0.55 pounds (250 grams) and less than 55 pounds be registered using the online system (https://www.faa.gov/uas/getting_started/registration/). Since launching the online registration system, more than 1.1 million users have registered. By the end of June 2018, over 929,000 individuals registered as modelers (with multiple equipment ownership) and more than 206,000 registered equipment for use in commercial purposes. The FAA's 2019 Aerospace Forecast shows that both model and commercial registration and thus ownership of small UAS are well distributed, with denser ownership consolidated in larger population and economic centers across the country (https://www.faa.gov/data_ research/aviation/aerospace_forecasts/). Given the trend observed in the number of registrations, expert opinions, review of available industry forecasts, and market/industry research, the forecast indicates that the model fleet will likely (i.e. base scenario) more than double in size over the next five years, from 1.25 million units to over 1.39 million units. The high scenario shows the fleet may reach 1.66 million units while the low scenario projects as low as 1.32 million units in five years. On the other hand, the non- model fleet is forecasted (i.e., base scenario) to be three- times larger (four and a half times under the high scenario) than the present size of around 277,000 in five years.

UAS provide a wide array of economic benefits to users and the overall economy but FAA's definitive estimation of benefits of direct (i.e., to users), indirect (i.e., spill-overs) and induced (i.e., multiplier) effects of UAS is at an early stage. This is due to the fact that these markets are just starting to emerge. At present, there are four broad areas where direct benefits can be accounted for with varying maturity and thus accuracy, the first being UAS manufacturers.

The number of manufacturers has consolidated but manufacturers continue to compete for market share. This manufacturing sector is well developed and its contribution, i.e., in value and employment, can be accounted for. Second, a UAS is not complete without its components and systems such as frames, engines, propellers, batteries, transmitters and autopilots. This sub-sector is evolving with increasing research and development spending and new innovations, but the value and employment contributions are somewhat murky. Third and most importantly, data and analytics (i.e., mapping, 3D modeling, computer vision, etc.) are constantly evolving with the changing sectoral demands and newer sectors using UAS-based data and analytics. Thus, this sub-sector is in flux and expected to grow over time. Fourth and finally, by the end of December 2018, over 116,000 remote pilot certificates had been issued. If each remote pilot operates 2.4 small UAS, there are expected to be about 350,000 remote pilots by the end of 2023. This additional employment of about 230,000 new remote pilots over the next five years yields direct benefits of using UAS in commercial activities.

Due to variations, availability of data, and phases of the evolution of UAS, commercial in particular, drone market estimates vary. Using a multitude of data and various methodologies, market research projects the size of the commercial drone market ranges from $500 million (in 2014) to as high as over $6 billion in 2020 as reported by Deloitte in 2016 (see for example, https://www2.deloitte.com/il/en/pages/technology-media-and-telecommunications/articles/drones_from_military_to_civilian.html). These estimates account only for the value of commercial UAS without taking into account other economic impacts.

This study and others demonstrate the variation in potential economic impact of the UAS industry in the United States in particular. As the industry evolves and economic gains of UAS integration become increasingly apparent, efficiency, safety, security, and the true economic impact will become transparent. At this point, studies that report the economic impact of UAS are somewhat lacking in comprehensive data and/or demonstrate shortfalls in methodology. As the FAA collects more information through the registration database and targeted surveys of commercial or non-model UAS equipment this year, it expects to better quantify the economic impact of UAS in the future.

Commercial Space

Commercial space is making its presence felt in the national airspace. The commercial space industry historically launched communications satellites into space; but today the commercial space industry is planning to send scientific payloads to the Moon, tourists into orbit and possibly even mine the asteroids. Launching these varied payloads into space is becoming a big business, with numerous companies entering the commercial launch market. The FAA estimates there are over half a dozen commercially licensed launch vehicles in service today in the United States, with at least a dozen more in various stages of the licensing pipeline.[viii]

The FAA Office of Commercial Space Transportation (AST) is charged[ix] with regulating the safety of commercial space transportation in the U.S. Among other regulations, the FAA requires that: all commercial suborbital and orbital space launches operated by an American citizen or corporation must be licensed or permitted by AST; and all non-governmental launch and reentry sites in the United States must be licensed by AST. FAA/AST is primarily a public safety regulator: it ensures the uninvolved third party public is protected from the risks of commercial spaceflight.

Currently, areas of direct economic impacts from commercial space remain somewhat narrow. In 2016, the majority of global space revenue was generated by companies providing services like television; mobile, fixed, and broadband communications; remote sensing; satellite systems; ground equipment manufacturing; and launch services. Other spending resulted from government space budgets and commercial human spaceflight. The U.S. space industry was approximately $158 billion in 2016. This figure includes over $110 billion in revenues generated by satellite services, satellite manufacturing, satellite ground equipment, and launch services, as well as almost $48 billion spent on space programs by the U.S. government. U.S. launch service providers accounted for about $2.2 billion in total internationally competed contract revenues (40 percent of global revenues)[x].

As of January 2018, there were 19 private, commercial and government launch sites in the U.S. These sites were located in California, Florida, Alaska, Virginia, Texas, Oklahoma, New Mexico, and the Republic of the Marshall Islands[xi]. With launches no longer limited to coastal regions, air traffic controllers will need to incorporate commercial space operations into the NAS. As new air management policies are developed for inclusion of commercial space traffic, more information regarding launches will be necessary. Decision makers will need to approve airspace usage based on a variety of factors.

In the years 2015, 2016, and 2017, the numbers of U.S. commercial launches were 14,17, and 22, respectively[xii]. World-wide there were 90 commercial launches, in 2017[xiii]. However, although the worldwide market for commercial space launches has not increased significantly over the past 10 years, growth is expected to increase in the near future[xiv]. Annual revenues of U.S. private commercial launch providers were approximately $0.6 billion in 2015[xv], $1.2 billion in 2016[xvi], and $1.7 billion in 2017[xvii].

In the future, the commercial space industry intends to send tourists into space as well. Several U.S. companies, including Blue Origin and Virgin Galactic, hope to take passengers to the fringe of space on suborbital reusable vehicles (SRV)[xviii].

The FAA will continue to study how these and other commercial space industry numbers can be incorporated into future editions of this report.

[viii] Office of Commercial Space Transportation, Federal Aviation Administration, The Annual compendium of Commercial Space Transportation: 2018, January 2018, p.17.
[ix] Commercial Space Launch Amendments Act of 2004, PL 108-492.
[x] Ibid. VIII, p. 9-10
[xi] Ibid. VIII, p. 22.
[xii] Office of Aviation Policy and Plans, Federal Aviation Administration, FAA Aerospace Forecast Fiscal Years 2018-2038, March 2018, p. 36.
[xiii] Ibid. VIII, p. 1.
[xiv] Office of Commercial Space Transportation, Federal Aviation Administration, The Annual Compendium of Commercial Space Transportation: 2016, January 2016, p. 2.
[xv] Ibid. p. 40.
[xvi] Office of Commercial Space Transportation, Federal Aviation Administration, The Annual Compendium of Commercial Space Transportation: 2017, January 2017, p. 40.
[xvii] Ibid. VIII, p. 40.
[xviii] Ibid. VIII, p. 19..

NATIONAL IMPACT OF U.S. CIVIL AVIATION

The report estimates the economic contribution of the civil aviation industry to the U.S. economy. Civil aviation has numerous and far-reaching economic impacts. While some of these impacts cannot be measured quantitatively, this report captures economic activity generated by the air transport of passengers and cargo using the best data available from government and private sources.

FAA has produced numerous economic impact reports since 2003 at both the national and state levels. Recently, an alternate-year schedule has been adopted, with the national and state versions staggered and each being produced every other year. Ideally, reports are released with a two-year data lag such that the 2018 report references 2016 data.

Methodology

The total economic impact of an industry is a summation of primary and secondary spending of that particular industry. This definition is standard for economic- impact studies and is used to estimate aviation's unique economic contribution to the national economy. The data used to measure the primary economic impacts of civil aviation were collected from reliable government and private sources. This study estimated those impacts by looking at industry output, earnings, and jobs. Multipliers from the RIMS II Input-Output Model, a model developed by the U.S. Department of Commerce's Bureau of Economic Analysis, were applied to derive the amounts of secondary spending[xix]. Primary and secondary amounts were then summed to produce a measure of civil aviation's total impact on the U.S. economy.

Types of Economic Impacts

Primary Impacts: The primary impacts of aviation are a summation of the revenue earned from the sale of goods and services by each of the sectors, whether categorized as direct or catalytic, relevant to the civil aviation industry. For example, these sources of revenue include:

- Air carrier ticket sales
- Value of aircraft manufacturer shipments
- General aviation operating costs
- Visitor spending (excluding airfare) on trips taken by air

Secondary Impacts: Secondary impacts result from expenditures made by sectors identified in the measurement of primary impacts to supporting businesses and entities, as well as the spending of employees. In other words, secondary impacts capture, through multiplier effects, the spending down the supply chain, and payroll impacts that circulate. As noted above, secondary impacts are derived from primary impacts through the use of the RIMS II model.

[xix] The multipliers typically change over time thereby affecting these secondary impacts as compared to earlier years. For example, 2016 jobs multipliers were generally lower than those for 2014, resulting in lower estimates for total jobs. from gross domestic product, which only counts value added.

Measures of Economic Impacts

Primary expenditure estimates are input into the RIMS II model to estimate the secondary effects of those expenditures on the U.S. economy. The output of the RIMS II model includes the secondary effects on economic output, earnings, and jobs.

Output: The total economic value of goods and services produced[xx].

Earnings: Wages and salaries, other labor income, benefits, and proprietors' income paid to all employed persons who deliver final demand output and services.

Jobs: The number of people employed full-time in industries that provide civil-aviation services, manufacture aircraft and aircraft engines, or work in other industries (such as hospitality) that are indirectly affected by activity in the civil aviation sector.

[xx] "Output" includes the sum of all of intermediate goods and services used in production, plus value added by the industry itself. This distinguishes output from gross domestic product, which only counts value added.

Results

Table 1 summarizes the total impact of U.S. civil aviation on output, earnings, and jobs, in addition to providing the breakdown between direct and catalytic sectors for each measure. The direct category includes airline and airport operations, aircraft manufacturing and others, while the catalytic category comprises only travel arranging services and visitor spending.

In 2016, economic activity attributed to civil aviation-related goods and services totaled $1.8 trillion, generating 10.9 million jobs with $488 billion in earnings. Aviation contributed 5.2 percent of GDP, the value- added measure of overall U.S. economic activity. Considering only the direct sectors, aviation contributed 2.3 percent of GDP, $850 billion in economic activity, and over 4 million jobs.

Table 1. Summary - Civil Aviation Economic Impact on U.S. Economy 2014-2016 (Current Dollars)

Year	Sector Category	Output ($Billions)	Earnings ($Billions)	Jobs (Thousands)	Percent of GDP
2016	Direct	847.3	221.7	4,121	2.3
	Catalytic	918.6	266.5	6,736	2.9
	Total	**1,765.9**	**488.2**	**10,857**	**5.2**
2015	Direct	839.1	218.7	4,057	2.4
	Catalytic	907.1	263.2	6,653	2.9
	Total	**1,746.2**	**481.9**	**10,710**	**5.3**
2014	Direct	845.4	220.0	4,363	2.5
	Catalytic	841.4	244.1	6,652	2.8
	Total	**1,686.8**	**464.1**	**11,015**	**5.3**

Table 2 reports the change from previously published FAA economic impact estimates for civil aviation. For 2014, the total difference between the current and previously published (November 2016) estimates were about $63 billion higher in total output, or, approximately 0.2 percentage point greater in contribution to GDP.

The upward revisions to output, earnings, jobs, and percent of GDP are primarily attributable to revisions of underlying data in two categories: Visitor Expenditures and GA Operations. Visitor Expenditure increases largely resulted from higher estimates of overseas visitor spending while estimates for GA Operations rose due to the use of more recent hourly cost estimates not available to the previous report.

The two categories added with the 2016 report (Avionics and R&D) saw only small revisions that largely offset each other in the topline numbers.

Table 2. Revisions to Previously Published Estimates (Current Dollars)

	Year	Output ($Billions)	Earnings ($Billions)	Jobs (Thousands)	Percent of GDP
Current	**2014**	1,686.8	464.1	11,015	5.3
Previous	**2014**	1,623.8	446.8	10,589	5.1
Difference (Revision)		**63.0**	**17.3**	**426**	**0.2**
Revision by Sector		**Output ($Billions)**	**Earnings ($Billions)**	**Jobs (Thousands)**	**Value Added ($Billions)**
Airline Operations		0.2	0.1	1	0.1
Airport Operations		0.1	0.0	0	0.0
Civilian Aircraft Manufacturing		6.1	1.5	27	3.1
Civilian Aircraft Engine and Engine Parts Manufacturing		0.0	0.0	0	0.0
Civilian Other Aircraft Parts and Equipment Manufacturing		0.4	0.1	2	0.2
Civilian Avionics Manufacturing		-0.3	-0.1	-2	-0.2
Civilian Research and Development		0.4	0.1	2	0.2
GA Operations		16.3	4.0	77	8.1
GA Aircraft Manufacturing		-0.5	-0.1	-2	-0.3
Air Couriers		0.2	0.1	2	0.1
Subtotal - Direct		**22.8**	**5.7**	**107**	**11.4**
Airline Visitor Expenditures		40.4	11.7	320	23.6
GA Visitor Expenditures		0.0	0.0	0	0.0
Travel Arrangements		-0.2	0.0	-1	-0.1
Subtotal - Catalytic		**40.2**	**11.7**	**319**	**23.5**

Table 3. Primary Output (Current Dollars)

Description	2016 ($Billions)
Airline Operations	131.9
Airport Operations	27.6
Civilian Aircraft Manufacturing	58.0
Civilian Aircraft Engine and Engine Parts Manufacturing	8.0
Civilian Other Aircraft Parts and Equipment Manufacturing	29.0
Civilian Avionics Manufacturing	10.5
Civilian Research and Development	13.3
GA Operations	21.9
GA Aircraft Manufacturing	11.6
Air Couriers	24.6
Subtotal - Direct	**336.4**
Airline Visitor Expenditures	357.8
GA Visitor Expenditures	4.7
Travel Arrangements	7.1
Subtotal - Catalytic	**369.6**
Total Primary Output	**706.1**

Table 3 reports primary output for 2016 and is the basis for calculating the total economic impact of civil aviation for the year. As described above, these amounts are then applied against the BEA's RIMS II multipliers to arrive at the secondary and total impacts.

Airline operations is, by more than a factor of two, the largest single sector in the Direct category with primary output of $132 billion. Among all sectors, however, airline visitor expenditures is clearly in the lead with primary output of $358 billion, reflecting the scope and importance of air travel as a means of transport. Total primary output for the industry as a whole is measured at $706 billion in 2016.

These primary output amounts are used in conjunction with the RIMS II multipliers to calculate the secondary amounts. Total output, or the sum of primary and secondary impacts, is reported in Table 4, which shows the following:

- In 2016, airline operations generated $316 billion in total output, representing the largest single sector of civil aviation's direct contribution
- GA operations accounted for $52 billion of total output in 2016. While the impact is less than for airline operations, the GA contribution continues to reflect the sector's unique role in the nation's transportation system.
- As domestic and foreign airline passengers reach their destinations in the U.S., their total expenditures on hotels, rental cars, and entertainment contributed $886 billion in total output, more than double the output supported by airlines' operations

Table 4. Total Output, Earnings and Jobs Estimates, 2016 (Current Dollars)

Description	Output ($Billions)	Earnings ($Billions)	Jobs (Thousands)
Airline Operations	315.6	77.0	1,362
Airport Operations	81.7	26.1	542
Civilian Aircraft Manufacturing	144.4	36.2	607
Civilian Aircraft Engine and Engine Parts Manufacturing	18.6	4.5	78
Civilian Other Aircraft Parts and Equipment Manufacturing	71.0	17.8	331
Civilian Avionics Manufacturing	25.7	6.5	120
Civilian Research and Development	40.4	12.9	223
GA Operations	52.3	12.8	226
GA Aircraft Manufacturing	28.8	7.2	121
Air Couriers	68.7	20.8	512
Subtotal - Direct	**847.3**	**221.7**	**4,121.0**
Airline Visitor Expenditures	886.5	257.2	6,522
GA Visitor Expenditures	11.7	3.4	86
Travel Arrangements	20.5	6.0	129
Subtotal - Catalytic	**918.6**	**266.5**	**6,736.2**
Total Impact	**1,765.9**	**488.2**	**10,857**

Aviation's Contribution to Gross Domestic Product

U.S. GDP was $18,625 billion in 2016[xxi]. GDP represents the sum of all value-added activities in an economy, so intermediate goods and services used in the production of other goods and services are not included. This contrasts with the previous section where the total output calculation included intermediate goods and services that were purchased as part of the production process. In order to assess aviation's contribution to GDP, these intermediate goods and services must be subtracted from total output.

In order to estimate civil aviation's contribution to GDP, each impact category is calculated separately using the RIMS II value added coefficients. The results are shown in Table 5. In 2016, value-added economic activity from aviation and other related sectors totaled $969 billion, or 5.2 percent of U.S. GDP.

In 2016, the direct sectors contributed $432 billion or 2.3 percent of GDP, while the catalytic sectors contributed $537 billion or 2.9 percent of GDP. Among all sectors, the largest component is airline visitor expenditures totaling $519 billion, or 2.8 percent of GDP, followed by airline operations at $156 billion, or 0.8 percent of GDP. General aviation, including operations, manufacturing and visitor spending, while small in comparison to commercial aviation, still contributed 0.3 percent to GDP, or $47 billion.

See the Appendix for civil aviation's contribution to GDP for the years 2014 through 2016.

Table 5. Civil Aviation's Contribution to GDP, 2016 (Current Dollars)

Description	Value Added ($Billions)	Percent of GDP
Airline Operations	156.1	0.8
Airport Operations	43.8	0.2
Civilian Aircraft Manufacturing	72.9	0.4
Civilian Aircraft Engine and Engine Parts Manufacturing	9.1	0.0
Civilian Other Aircraft Parts and Equipment Manufacturing	37.8	0.2
Civilian Avionics Manufacturing	13.7	0.1
Civilian Research and Development	21.4	0.1
GA Operations	25.9	0.1
GA Aircraft Manufacturing	14.5	0.1
Air Couriers	36.8	0.2
Subtotal - Direct	**432.0**	**2.3**
Airline Visitor Expenditures	519.2	2.8
GA Visitor Expenditures	6.8	0.0
Travel Arrangements	10.9	0.1
Subtotal - Catalytic	**536.9**	**2.9**
Total Impact	**968.9**	**5.2**

[xxi] U.S. Department of Commerce, Bureau of Economic Analysis, National Income and Product Accounts.

Real Change from Previous Years

Three measures highlight the economic contribution of the civil aviation sector: the value of total output, earnings paid to employees, and the number of jobs supported by civil aviation. These measures are shown in Table 6. The output and earnings are presented in 2014 dollars to remove changes due to inflation in order to facilitate the comparison.

Real total output of civil aviation increased 2.3 percent between 2014 and 2016, while real earnings increased 2.8 percent and total jobs edged down 1.4 percent during the same time.

Table 6. U.S. Civil Aviation: Growth of Total Output, Earnings, and Jobs (2014 Dollars)

	Output (2014 $Billions)			Earnings (2014 $Billions)			Jobs (Thousands)		
Description	2014	2016	Percent Change	2014	2016	Percent Change	2014	2016	Percent Change
Airline Operations	325.3	308.3	-5.2	79.4	75.3	-5.3	1,529	1,362	-11.0
Airport Operations	76.0	79.8	5.0	24.2	25.4	5.1	525	542	3.2
Civilian Aircraft Manufacturing	149.8	141.0	-5.8	37.5	35.3	-5.9	667	607	-9.1
Civilian Aircraft Engine and Engine Parts Manufacturing	17.6	18.2	3.0	4.2	4.4	2.9	78	78	-0.6
Civilian Other Aircraft Parts and Equipment Manufacturing	74.3	69.4	-6.6	18.6	17.4	-6.6	363	331	-8.7
Civilian Avionics Manufacturing	22.4	25.1	12.4	5.6	6.3	12.4	109	120	9.8
Civilian Research and Development	32.8	39.5	20.4	10.5	12.6	20.4	195	223	14.5
GA Operations	55.1	51.7	-6.2	13.5	12.6	-6.3	259	226	-12.9
GA Aircraft Manufacturing	29.2	28.4	-2.6	7.3	7.1	-2.7	130	121	-7.0
Air Couriers	62.9	67.1	6.7	19.1	20.3	6.7	507	512	1.1
Subtotal - Direct	**845.4**	**828.6**	**-2.0**	**220.0**	**216.8**	**-1.5**	**4,363**	**4,121**	**-5.5**
Airline Visitor Expenditures	811.4	865.9	6.7	235.4	251.2	6.7	6,434	6,522	1.4
GA Visitor Expenditures	11.7	11.5	-1.6	3.4	3.3	-1.6	93	86	-7.6
Travel Arrangements	18.3	20.0	9.1	5.3	5.8	9.1	125	129	2.9
Subtotal - Catalytic	**841.4**	**897.4**	**6.7**	**244.1**	**260.4**	**6.7**	**6,652**	**6,736**	**1.3**
Total Impact	**1,686.8**	**1,726.0**	**2.3**	**464.1**	**477.1**	**2.8**	**11,015**	**10,857**	**-1.4**

CONCLUSION

Civil aviation connects the entire globe, providing much needed economic benefits both seen and unseen for U.S. consumers and businesses. Civil aviation has been a major force connecting America to the global economy, and the U.S. civil aviation industry truly remains a unique engine for innovation and technological progress.

From 2014 to 2016, real GDP averaged 2.2 percent growth per year, and employment grew by over 5 million persons, from 139.0 million to 144.4 million. Civil aviation and related sectors also grew during this time, though at a slightly slower rate, with real primary output averaging increases of 1.3 percent annually. In 2016, civil aviation and the sectors it supports accounted for 5.2 percent of the U.S. economy. Breaking down that total, direct sectors produced 2.3 percent of GDP while catalytic sectors generated 2.9 percent. The total output of civil aviation-related (both direct and catalytic) goods and services amounted to $1.8 trillion and generated 10.9 million jobs, with earnings of $488 billion. Total output and earnings from civil aviation and related sectors has expanded notably since 2014 even as its contribution to employment and share of GDP have edged lower.

Unmanned aircraft systems (UAS or drones) and commercial space launches are both emerging sectors within civil aviation, though as yet, neither category has sufficiently reliable data to be included in the computational breakdown of impacts in this report. Like commercial aviation, the economic impact of UAS and commercial space launches extends beyond their sectors with impacts throughout other parts of the economy. The FAA will continue to monitor availability of data on UAS and commercial space as their impacts expand.

Appendix – Supplemental Tables

Table 7. U.S. Civil Aviation Economic Impact, Total Output: Primary plus Secondary Impacts (Current Dollars)

Total Output ($Billions)			
Description	**2014**	**2015**	**2016**
Airline Operations	325.3	319.5	315.6
Airport Operations	76.0	77.6	81.7
Civilian Aircraft Manufacturing	149.8	147.8	144.4
Civilian Aircraft Engine and Engine Parts Manufacturing	17.6	16.6	18.6
Civilian Other Aircraft Parts and Equipment Manufacturing	74.3	71.4	71.0
Civilian Avionics Manufacturing	22.4	23.3	25.7
Civilian Research and Development	32.8	34.9	40.4
GA Operations	55.1	52.9	52.3
GA Aircraft Manufacturing	29.2	29.8	28.8
Air Couriers	62.9	65.2	68.7
Subtotal - Direct	**845.4**	**839.1**	**847.3**
Airline Visitor Expenditures	811.4	876.1	886.5
GA Visitor Expenditures	11.7	11.6	11.7
Travel Arrangements	18.3	19.4	20.5
Subtotal - Catalytic	**841.4**	**907.1**	**918.6**
Total Impact	**1,686.8**	**1,746.2**	**1,765.9**

Table 8. U.S. Civil Aviation Economic Impact, Total Earnings: Primary plus Secondary Impacts (Current Dollars)

Total Earnings ($Billions)			
Description	**2014**	**2015**	**2016**
Airline Operations	79.4	78.0	77.0
Airport Operations	24.2	24.7	26.1
Civilian Aircraft Manufacturing	37.5	37.0	36.2
Civilian Aircraft Engine and Engine Parts Manufacturing	4.2	4.0	4.5
Civilian Other Aircraft Parts and Equipment Manufacturing	18.6	17.9	17.8
Civilian Avionics Manufacturing	5.6	5.8	6.5
Civilian Research and Development	10.5	11.1	12.9
GA Operations	13.5	12.9	12.8
GA Aircraft Manufacturing	7.3	7.5	7.2
Air Couriers	19.1	19.7	20.8
Subtotal - Direct	**220.0**	**218.7**	**221.7**
Airline Visitor Expenditures	235.4	254.2	257.2
GA Visitor Expenditures	3.4	3.4	3.4
Travel Arrangements	5.3	5.7	6.0
Subtotal - Catalytic	**244.1**	**263.2**	**266.5**
Total Impact	**464.1**	**481.9**	**488.2**

Table 9. U.S. Civil Aviation Economic Impact, Total Jobs: Primary plus Secondary Impacts

Total Jobs (Thousands)			
Description	**2014**	**2015**	**2016**
Airline Operations	1,529	1,378	1,362
Airport Operations	525	514	542
Civilian Aircraft Manufacturing	667	621	607
Civilian Aircraft Engine and Engine Parts Manufacturing	78	70	78
Civilian Other Aircraft Parts and Equipment Manufacturing	363	333	331
Civilian Avionics Manufacturing	109	109	120
Civilian Research and Development	195	193	223
GA Operations	259	228	226
GA Aircraft Manufacturing	130	125	121
Air Couriers	507	486	512
Subtotal - Direct	**4,363**	**4,057**	**4,121**
Airline Visitor Expenditures	6,434	6,445	6,522
GA Visitor Expenditures	93	85	86
Travel Arrangements	125	122	129
Subtotal - Catalytic	**6,652**	**6,653**	**6,736**
Total Impact	**11,015**	**10,710**	**10,857**

Table 10. U.S. Civil Aviation Economic Impact, Value Added (Current Dollars)

Total Value Added ($Billions)			
Description	**2014**	**2015**	**2016**
Airline Operations	161.0	158.0	156.1
Airport Operations	40.8	41.6	43.8
Civilian Aircraft Manufacturing	75.7	74.6	72.9
Civilian Aircraft Engine and Engine Parts Manufacturing	8.6	8.1	9.1
Civilian Other Aircraft Parts and Equipment Manufacturing	39.5	38.0	37.8
Civilian Avionics Manufacturing	11.9	12.4	13.7
Civilian Research and Development	17.4	18.5	21.4
GA Operations	27.3	26.2	25.9
GA Aircraft Manufacturing	14.7	15.1	14.5
Air Couriers	33.7	34.9	36.8
Subtotal - Direct	**430.5**	**427.4**	**432.0**
Airline Visitor Expenditures	475.1	513.1	519.2
GA Visitor Expenditures	6.8	6.8	6.8
Travel Arrangements	9.8	10.4	10.9
Subtotal - Catalytic	**491.7**	**530.2**	**536.9**
Total Impact	**922.3**	**957.6**	**968.9**

Table 11. U.S. Civil Aviation Economic Impact, Percent Contribution to GDP

Value Added - Percent of GDP			
Description	2014	2015	2016
Airline Operations	0.9	0.9	0.8
Airport Operations	0.2	0.2	0.2
Civilian Aircraft Manufacturing	0.4	0.4	0.4
Civilian Aircraft Engine and Engine Parts Manufacturing	0.0	0.0	0.0
Civilian Other Aircraft Parts and Equipment Manufacturing	0.2	0.2	0.2
Civilian Avionics Manufacturing	0.1	0.1	0.1
Civilian Research and Development	0.1	0.1	0.1
GA Operations	0.2	0.1	0.1
GA Aircraft Manufacturing	0.1	0.1	0.1
Air Couriers	0.2	0.2	0.2
Subtotal - Direct	**2.5**	**2.4**	**2.3**
Airline Visitor Expenditures	2.7	2.8	2.8
GA Visitor Expenditures	0.0	0.0	0.0
Travel Arrangements	0.1	0.1	0.1
Subtotal - Catalytic	**2.8**	**2.9**	**2.9**
Total Impact	**5.3**	**5.3**	**5.2**

Glossary of Economic Terms

Catalytic Sector

This is a term used to categorize the various sectors within the civil aviation industry. In this report, these sectors provide goods and services that are related to and partially dependent upon civil aviation but their main function is not to support aviation. The sectors categorized as catalytic are visitor expenditures and travel arrangers[xxii].

Direct Sector

This is a term used to categorize the various sectors within the civil aviation industry. In this report, these sectors provide goods and services that are fundamental to and inseparable from civil aviation. Airline operations, aircraft manufacturing, air couriers and others all are grouped in this category.

Earnings

Earnings are wages and salaries and other labor income, such as overtime, benefits and proprietors' income, paid to all employed persons by employers for a given unit of work or time. The BLS publishes earnings data.

Employment (Jobs)

The Bureau of Labor Statistics (BLS) is responsible for collecting and publishing data on the number of persons employed within the U.S. According to BLS:

> Employment data refer to persons on establishment payrolls who received pay for any part of the pay period that includes the 12th day of the month. Data exclude proprietors, the unincorporated self-employed, unpaid volunteer or family workers, farm workers, and domestic workers. Salaried officers of corporations are included. Government employment covers only civilian employees; military personnel are excluded. Employees of the Central Intelligence Agency, the National Security Agency, the National Imagery and Mapping Agency and the Defense Intelligence Agency also are excluded[xxiii].

Gross Domestic Product

Gross domestic product (GDP) is a measure of overall economic production during a period of time. It represents the current dollar value of all final goods and services produced within a country during a specified time period, such as a year or quarter. These goods and services include consumption, investment, government expenditures and net exports. GDP also can be viewed as the sum or aggregate of value added over each stage of production over the entire economy. The Bureau of Economic Analysis (BEA) publishes annual and quarterly measures of GDP.

Gross Output

For an industry, gross output is the dollar value of goods or services produced by the industry and made available for use outside that industry during a specified time period[xxiv]. It is measured as total sales or receipts, plus other operating income, commodity taxes (sales and excise taxes) and changes in inventories; or, equivalently, as value added, plus goods and services purchased for use in production. For an entire nation, total gross output is equal to total intermediate inputs plus GDP, and thus exceeds GDP. The BEA publishes annual national and industry-level estimates of gross output.

[xxii] ACI Europe, "The Social and Economic Impact of Airports in Europe," 2004, p. 5.

[xxiii] U.S. Department of Labor, Bureau of Labor Statistics, Handbook of Labor Statistics. March 2011.

[xxiv] Organization for Economic Co-operation and Development, "Glossary of Statistical Terms," 2002.

Multipliers

Multipliers measure the impact of a particular category of spending on the rest of the economy, specifically on output, earnings and employment. The BEA publishes industry-level multiplier estimates.

Output

Output is the current dollar production of goods or services by a production unit and is measured by total sales or receipts of that unit, plus other operating income, commodity taxes (sales and excise taxes) and changes in inventories.

Primary Impact

This is a term used to categorize the dollar amounts that flow through the civil aviation industry. Primary impact refers to the first round of expenditures within each sector that are collected from government and private sources. These amounts are applied against the RIMS II multipliers to derive secondary impacts.

Seasonal Adjustment

Many aviation-related time series data display seasonal patterns. For example, travel tends to pick up during the summer and the end-of-year holiday season and slow down at other times of the year. Seasonal adjustment is a statistical process that removes such patterns to reveal underlying trends. In other words, seasonal adjustment removes the effects of recurring seasonal influences from time series. This process "quantifies seasonal patterns and then factors them out of the series to permit analysis of non-seasonal"[xxv] trends in the data.

Secondary Impact

This is a term used to categorize the dollar amounts that flow through the civil aviation industry. Secondary impacts result from follow-on spending down the supply chain after the initial round or primary impact. This includes payments to suppliers, and suppliers of suppliers, as well as spending by employees of those businesses. Secondary impacts therefore capture both interindustry and household spending that derive from activity in the respective sectors.

Total Economic Activity

Total economic activity is a term used interchangeably with Gross Output.

Total Impact

Total impact is the sum of primary and secondary impacts.

Value Added

Value added refers to the current dollar contribution to production by an individual producer, industry or sector during a specified time period. It is measured as the difference between gross output and goods and services purchased for use in production. (These purchased goods and services are also called input purchases or intermediate inputs.) Measures of value added consist of employee compensation, production-related taxes, imports less subsidies and gross operating surplus. Value added can be summed or aggregated across individual producers over an entire sector, industry or nation; at the national level, total value added equals GDP. The BEA publishes national- and selected sector-level annual and quarterly measures of value added, as well as selected annual industry measures.

[xxv] Bureau of Labor Statistics, "Fact Sheet on Seasonal Adjustment in the CPI." February 23, 2010.

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