Maxine Goodman Levin
College of Urban Affairs
Center for Economic Development

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NASA GLENN RESEARCH CENTER

The NASA Glenn Research Center:

An Economic Impact Study Fiscal Year 2012

Prepared by:
Iryna Lendel, Ph.D.
Eunkyu Lee

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2121 Euclid Avenue | Cleveland, Ohio 44115
http://urban.csuohio.edu/economicdevelopment

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EXECUTIVE SUMMARY

- NASA Glenn is located at Lewis Field, a 350-acre site adjacent to Cleveland Hopkins International Airport. NASA Glenn's physical plant includes more than 150 buildings that contain a unique collection of world-class laboratories and test facilities. Since the groundbreaking for the Aircraft Engine Research Laboratory of the National Advisory Committee for Aeronautics (forerunner to NASA) on January 23, 1941, more than $433 million has been invested in NASA Glenn's physical plant. The estimated replacement cost is approximately $2 billion. The Lewis Field site and its Plum Brook Station, located in Sandusky, Ohio, is 50 miles west of Cleveland, each host large-scale facilities that are uniquely and specifically designed to test aviation and spaceflight hardware.

- During the period covered in this report, NASA Glenn has several leadership roles that are critical to programs and projects in all of NASA's missions: Exploration, Science, Space Operation, and Aeronautics Research. Within the **Human Exploration & Operations mission portfolio** NASA Glenn provided engineering and technical services and performed a variety of analyses and integration tasks to support development of the Space Launch System (SLS) and the Orion Multi-Purpose Crew Vehicle; led aspects of the Human Research Program, which performs research in support of astronaut health; developed next-generation systems that support humans reaching farther into space, and initiated projects within the Advanced Exploration Systems (AES) program, which is contributing technological advancements for future robotic and human spaceflight missions beyond low Earth orbit. NASA Glenn is leading AES projects in spacecraft fire safety, advanced modular power systems, and power, avionics, software, and communication technologies for extra-vehicular activity applications.

- NASA Glenn's **Science** mission support included managing the Radioisotope Power Systems Program and developing associated technologies; co-managing (with the Department of Energy) the Advanced Stirling Radioisotope Generator (ASRG) project; managing the In-Space Propulsion Technology (ISPT) Program and developing its associated technologies including propulsion systems (e.g. solar electric propulsion), spacecraft bus (e.g. power, extreme environments), sample return, and re-entry; developing new scientific instruments and mission concepts for planetary surfaces (e.g. Venus, Mars) and Earth science (e.g. fresh water); and supporting NASA Headquarters with assessments and panel membership for Planetary Science which includes high altitude balloon research, technology/tools coordination, and science advisory groups.

- In support of the **Aeronautics** mission**,** NASA Glenn continues to build on its world-class aeronautics' heritage through its leadership of a wide variety of fundamental research in subsonic, supersonic, and rotary aircraft, and through its program management efforts to support flight in any atmosphere at any speed and the enhancement of aviation safety. A vast array of research and technologies in support of these areas is performed by NASA Glenn.

- The report structure is as follows: Sections A and B provides an introduction and background for this report. Section C is an economic overview of NASA Glenn, including information related to employment and occupations, employee residences, payroll, expenditures, awards to academia and other institutions, revenues,

and taxes paid by NASA Glenn employees. Section D provides estimates of the economic impact generated by NASA Glenn for an eight-county Northeast Ohio region and the state of Ohio during FY 2012. This report is an update of several earlier studies in which NASA Glenn's economic impact on Northeast Ohio and Ohio was estimated.

ECONOMIC IMPACT GENERATED BY NASA GLENN RESEARCH CENTER SPENDING

- Economic impact is an analytical approach used to estimate the economic benefits generated by an entity for an affected region. This study uses an input-output (I-O) model to estimate the effect of NASA Glenn's spending on the target economies. This model measures economic impact in terms of growth in output (sales), value added (output less intermediary goods), number of new and supported jobs, the increase in household earnings, and additional tax revenues. This year the Center used an improved methodology to measure NASA Glenn's impact on Northeast Ohio and Ohio and the results of this research cannot be compared to the previous reports. The table below summarizes NASA Glenn's economic impact on Northeast Ohio and the state of Ohio during FY 2012.

Economic Impact	Northeast Ohio	State of Ohio
Output	$1,258 million	$1,410 million
Value Added	$596 million	$668 million
Employment	6,250 jobs	7,538 jobs
Labor Income	$465 million	$512 million
Taxes	$83 million	$97 million

Note: According to the new methodology, direct output impact includes both total NASA Glenn's expenditures and payroll. The total payroll was not part of the direct impact in 2012 study.

- NASA Glenn's activities in Northeast Ohio in FY 2012, stimulated by $679 million in revenues originating primarily from outside the region, generated an increased demand in output (sales) valued at $1,258 million for goods and services produced in the region. Stated another way, value-added output increased by $596 million as a result of NASA Glenn's activities. In addition, 6,250 jobs were created and supported in the region, and households in Northeast Ohio saw labor income increase by $465 million. NASA Glenn operations also generated $83 million in local, state, and federal taxes.
- NASA Glenn's activities in Ohio in FY 2012, stimulated by $679 million in revenues originating primarily from outside the state, generated an increased demand in output (sales) for products and services produced across the state (valued at $1,410 million). Value-added output increased by $668 million as a result of NASA Glenn's activities. In addition, 7,538 jobs were created and supported in Ohio, and households across the state saw labor income increase by $512 million. NASA Glenn's activities also generated $97 million in local, state, and federal taxes.

- Industries deriving the most benefit from direct NASA Glenn spending included scientific research and development services, other professional and technical services, businesses and facilities support services, education, power generation, and maintenance and repair construction.
- Industries deriving the most benefit from spending by NASA Glenn personnel and other workers were in line with typical consumer spending patterns. These industries included food services, real estate and rental services, hospitals and healthcare offices, insurance services, commercial banks, and miscellaneous retailers.

NASA Glenn Research Center: An Overview

- In FY 2012, NASA Glenn employed 1,659 civil servants, declining from the previous year by 52 employees. From FY 2009 to FY 2011, NASA Glenn's total civil service employment increased by 3.7% (61 employees) and then decreased between 2011 and 2012 by 3% (52 employees). For the last 5 years, the NASA Glenn's civil employment declined slightly by 0.2% (3 employees). This decline is consistent with the overall Agency's reduction in civil servant employees.
- In FY 2012, 82% of NASA Glenn's employees possessed bachelor's degrees or higher. Of all NASA Glenn's civil service employees, 18% held doctoral degrees, 35% held master's degrees, and 29% held bachelor's degrees. Compared to FY 2011, the level of educational attainment of NASA Glenn's civil service employees increased slightly. For instance, the number of employees holding bachelor's degrees or higher increased 1.1% between FY 2011 and FY 2012. The increased number of highly educated employees between FY 2011 and FY 2012 reflects the increase in the share of scientists and engineers hired by NASA Glenn during this period of time. Overall, the five-year trend at NASA Glenn has been to increase the number of scientists and engineers while reducing the number of clerical and technical staff. NASA Glenn aims to increase the share of its civil servant workforce dedicated to research and technology while reducing the cost of support personal.
- Quantitatively, the largest occupational category in FY 2012 was scientists and engineers, which accounted for 67% of the civil service employees in FY 2012. The share of scientists and engineers at NASA Glenn has gradually increased since FY 2008 from 61% (1,014 employees) to 67% (1,112 employees) in FY 2011. Between FY 2011 and FY 2012, the share of scientists and engineers has increased from 65% to 67%.
- Compensation for NASA Glenn's civil service employees totaled $226.2 million in FY 2012. Total compensation included both payroll ($179.1million) and employee benefits ($47.1 million). Total payroll decreased by $5.3 million (-2.3%) between FY 2011 and FY 2012, after adjusting for inflation.[1] The average wage per civil service employee increased by 0.3% (after adjusting for inflation), from $107,652 in FY 2011 to $107,965 in FY 2012.[2] Compared to FY 2008, in real dollars adjusted for inflation, total compensation in FY 2012 grew by 2.7% ($6 million), including a salary increase of 0.3% and a growth in benefits of

[1] Total nominal payroll decreased by 0.3% ($569,991) between FY 2011 and FY 2012.
[2] The average wage per employee in nominal terms increased 2% between FY 2011 and FY 2012.

13%. During the same time period, the average wage per civil service employee increased by 0.5%, from $107,448 in FY 2008 (inflation adjusted) to $107,965 in FY 2012.

- In FY 2012, NASA Glenn allocated its spending of $434.7 million to vendors in 48 states, Washington, D.C., Puerto Rico, and 6 foreign countries. Compared to its total expenditure of $495.3 million in FY 2011, NASA Glenn reduced its expenditures by 12.2% in FY 2012 ($60.6 million in nominal dollars). The total expenditure decreased by 21.4% ($118 million) between FY 2010 and FY 2012

- In FY 2012, Ohio was the largest beneficiary of expenditures, receiving $290 million, accounting for 66.7% of NASA Glenn's total expenditures. Despite a $22.8 million decrease (in nominal dollars) compared to FY 2011, the share of NASA Glenn's expenditures in Ohio increased from 63.1% in FY 2011 to 66.7% in FY 2012.

- Besides Ohio, three states (California, Maryland, and Virginia) each received over $10 million, or at least 2.4% of NASA Glenn's total expenditures, during FY 2012. California received $24.3 million (5.6%) and Maryland $21.4 million (4.9%), and Virginia $10.5 million (2.4%), making them the second- , third-, and fourth-largest beneficiaries of NASA Glenn's spending.

- In FY 2012, NASA Glenn slightly reduced its already-small expenditure in foreign countries by 10.5% compared to FY 2011. Foreign countries received only $0.4 million, accounting for 0.1% of NASA Glenn's total spending in FY 2012.

- Spending in Ohio and Northeast Ohio had a significant economic impact on their respective regional economies. Northeast Ohio received $231.6 million, which accounted for 80% of NASA Glenn's Ohio spending in FY 2012. Northeast Ohio also accounted for 53% of NASA Glenn's total spending in FY 2012. NASA Glenn's largest expenditures were on scientific research and development, including equipment, supplies and materials, grants, and professional services.

- NASA Glenn provides funding to colleges, universities, and other nonprofit institutions in the form of contracts and grants for research and development assistance. In FY 2012, NASA Glenn awarded $22.4 million to colleges and universities in 34 states and Puerto Rico. Compared to FY 2011, this represented a reduction of academic grants from NASA Glenn of $6.9 million (-23.5% in nominal dollars).

- Universities in six states—Ohio, Oklahoma, Maryland, California, Massachusetts, and Indiana—received over $1 million in funding from NASA Glenn in FY 2012. The academic funding awarded in these six states collectively accounted for 62.7% of the total grants in FY 2012. Academic institutions in Ohio received $4.9 million, which accounted for the largest share (22%) of NASA Glenn's academic awards in FY 2012. NASA Glenn's academic awards to Ohio decreased by 15.9% (-$0.9 million) between FY 2011 and FY 2012.

- Within the state of Ohio, academic institutions in Northeast Ohio received $2.7 million in FY 2012. This accounted for both 12% of NASA Glenn's total academic awards and 55% of all academic grants received by Ohio academic institutions. NASA Glenn slightly reduced its awards to the universities and academic institutions in Northeast Ohio by 5.8% ($0.2 million) compared to FY 2011. NASA Glenn's funding to Ohio academic institutions located outside the 8-county area of Northeast Ohio decreased by 25.5% ($0.8 million) compared to FY 2011.

- NASA Glenn's total revenue in FY 2012 was $687.7 million. Of the last five years, NASA Glenn's total revenue was lowest in FY 2012; it declined between FY 2009 and FY 2010 and after a slight growth of $2.4 million from FY 2010 to FY 2011, it decreased by $51 million (6.9%) in FY 2012. NASA Glenn's revenue decreased by $12 million (-1.7%) from FY 2008 to FY 2012 (in nominal dollars).
- NASA Glenn continues to be an important institution influencing the economic life of both Northeast Ohio and the state of Ohio. NASA Glenn's employees are part of the knowledge-intensive labor force that generates wealth in the region and advances the nation.

A. INTRODUCTION

This report presents an analysis of the economic impact of the National Aeronautics and Space Administration's John H. Glenn Research Center (NASA Glenn) during its fiscal year (FY) 2012. It uses an input-output model, which reflects the buy-sell relationships among industries, the household sector, and the government sector, in a region, to estimate the effect of NASA Glenn's spending on the economies of both Northeast Ohio[3] and the state of Ohio. This model assesses economic impact in terms of growth in total output (sales), value added (output less intermediary goods),[4] household earnings, number of new jobs, and taxes.

The report also provides an overview of NASA Glenn and describes some of its R&D activities. It looks at changes in NASA Glenn's employees through their occupations, place of residence, and payroll.

The report further provides information on NASA Glenn's expenditures and revenues, awards to academic institutions, and taxes contributed by employees.

The analysis was conducted by the Center for Economic Development at Cleveland State University's Maxine Goodman Levin College of Urban Affairs. This FY 2012 report is an update to previous studies published in 1996, 2000, 2005, and annually 2007 through 2012.[5]

[3] For purposes of this study, Northeast Ohio is defined as Ashtabula, Cuyahoga, Geauga, Lake, Lorain, Medina, Portage, and Summit Counties.

[4] Output impact reflects the total value of all additional goods and services produced in the economy. For example, the output economic impact includes the total value of all professional scientific and technical services and all intermediary goods created to secure delivery of the scientific services. Value-added impact reflects the value of only additional output produced in the region, which is calculated as total sales less intermediary goods which are not sold as final products. For example, the value-added impact will account for the value of all professional scientific and technical services excluding intermediary goods produced to deliver these services. Such intermediary goods, among others, include research supplies, utilities, research services of intermediary steps of research, etc.

[5] All previous studies can be found on the Center for Economic Development's website: http://urban.csuohio.edu/economicdevelopment/publications/

B. NASA Glenn Research Center: Background

The NASA Glenn Research Center, in partnership with U.S. industry, universities, and other government institutions, develops critical systems' technologies and capabilities that address national aerospace priorities. The Center is distinguished by a unique blend of aeronautics, space flight, and project management expertise and experience. Its work is focused on technological advances in space flight systems, aero-propulsion, space propulsion, power systems, nuclear systems, advanced communications, materials for use in extreme environments, and targeted technology that enable human health in space. Its research, technology, and capability development efforts are vital to advancing exploration of our solar system and beyond while maintaining global leadership in aeronautics.

B.1. NASA Glenn Test Facilities

NASA Glenn is located at Lewis Field, a 350-acre site adjacent to Cleveland Hopkins International Airport. NASA Glenn's physical plant includes more than 150 buildings that contain a unique collection of world-class laboratories and test facilities. Since the groundbreaking for the Aircraft Engine Research Laboratory of the National Advisory Committee for Aeronautics (forerunner to NASA) on January 23, 1941, more than $433 million has been invested in NASA Glenn's physical plant. The estimated replacement cost is approximately $2 billion.

NASA Glenn's Plum Brook Station, located in Sandusky, Ohio, is 50 miles west of Cleveland. Plum Brook and the Lewis Field site each host several large test facilities which use cryogenic fluids (gases frozen to their liquid state). Because working with large amounts of cryogenic fluids is inherently dangerous, the Station's 6,400 acres particularly allow safe testing of spacecraft and hypersonic vehicles in realistic operating conditions from launch to planetary operations. Most of these capabilities are world-unique, including the largest space simulation chamber, the largest mechanical vibration table, the most powerful resonant acoustic test chamber, the largest electromagnetic test chamber, the largest space simulation chamber which can test in planetary dust, the largest liquid hydrogen-capable space simulation chamber, the only cold soak start/restart rocket engine test facility, and the only clean air hypersonic tunnel. Since 2000, over $567 million has been invested in Plum Brook station. The total replacement cost of all Plum Brook Station facilities is approximately $4 billion.

B.2. NASA Glenn Mission Areas Supporting NASA Themes

During the period covered in this report, NASA Glenn has had several leadership roles that are critical to programs and projects in all of NASA's missions: Exploration, Science, Space Operation, and Aeronautics Research.

Human Exploration & Operations (Human Spaceflight to the International Space Station (ISS), Moon and Beyond)

- Applying human spaceflight engineering and technical capabilities to perform a variety of analysis and integration tasks to support development of the Space Launch System (SLS) and the Orion Multi-Purpose Crew Vehicle.

- Contributing to the Human Research Program, which performs research and technology.
- Developing next-generation systems that support humans in space via specific projects within NASA's Advanced Exploration Systems (AES) program. NASA Glenn is leading AES projects to make advancements in spacecraft fire safety, advanced modular power systems, and power, avionics, software, and communication technologies for extra-vehicular activity applications.
- Developing and operating exploration-related technology and demonstrations as part of International Space Station research.
- Supporting biological and physical science research (specifically combustion science and fluid physics) for the International Space Station.
- Leading planning and eventual development of the Cryogenic Propellant Storage and Transfer project to demonstrate (in space) capabilities required to enable human space exploration farther from Earth.
- Leading planning and eventual development of a solar electric propulsion system to demonstrate (in space) capabilities required to enable an entirely new class of exploration beyond Earth.
- Managing the Service Module (SM) for the shuttle-replacement vehicle (Orion). The SM vitally provides power, propulsion, and communications for Orion's Crew Module (CM), where the astronauts reside in flight.
- Overseeing important elements of the CM project including building test flight hardware.
- Leading development of the fairing system for the new rocket (SLS) that carries Orion to space. The fairing houses and protects payloads atop the SLS during launch and ascent.
- Conducting critical-path environmental testing of the entire Orion spacecraft at Plum Brook Station.
- Managing several research and advanced technology development projects on the ISS and on Earth, in support of human exploration.
- Supporting safe and reliable operation of the International Space Station's electrical power system.
- Leading the operation and utilization of new, advanced communications technology, including the SCaN Testbed - a demonstration on the International Space Station of software-defined radios.

Science

- Managing the Radioisotope Power Systems Program and developing associated technologies. Radioisotope Power Systems enable scientific missions where conventional power systems such as solar power or batteries are impractical. The Advanced Stirling Converter (ASC) and the Advanced Stirling Radioisotope Generator (ASRG) are examples of these technologies.
- Co-managing (with the Department of Energy) the Advanced Stirling Radioisotope Generator (ASRG) project, four times more efficient than previously flown, radioisotope-based power generation systems.
- Managing the In-Space Propulsion Technology (ISPT) Program and developing its associated technologies including propulsion systems (e.g. solar electric propulsion), spacecraft bus (e.g. power, extreme environments), sample return, and re-entry. Conducting system and mission studies to validate benefits.
- Developing new scientific instruments and mission concepts for planetary surfaces (e.g. Venus, Mars) and Earth science (e.g. fresh water).

- Supporting NASA Headquarters with assessments and panel membership for Planetary Science including high altitude balloon research, technology/tools coordination, and science advisory groups.

Aeronautics Research

- Continuing to improve upon Glenn's world-renowned aeronautics' heritage by concentrating research and program management efforts on the mastery of the principles of flight in any atmosphere at any speed and the enhancement of aviation safety.

- Providing technical project management leadership for the Fundamental Aeronautics Program, and conducting research for the following four projects:
  - High Speed Project: Research in propulsion and high temperature materials, instrumentation, and dynamic controls to enable very high speed flight, and to eliminate environmental (e.g., sonic boom) and performance barriers.
  - Subsonic Fixed Wing: Development of revolutionary technologies and aircraft concepts to achieve highly improved performance (e.g., fuel efficiency) while satisfying strict noise and emission constraints.
  - Subsonic Rotary Wing: Research to improve civilian potential of rotary wing vehicles (helicopters) so that they can carry more payload to farther destinations.
  - Aeronautical Sciences: Development of computer-based tools and models as well as scientific knowledge that will lead to significant advances in our ability to understand and predict flight performance for a wide variety of air vehicles.

- Providing technical project management leadership for the Aviation Safety Program for the following three projects:
  - Atmospheric Environment Safety Technologies (AEST)
  - System-wide Safety & Assurance Technologies (SSAT)
  - Vehicle Systems Safety Technologies (VSST)

- Conducting long-term, cutting-edge research that will produce tools, methods, concepts, and technologies to improve the intrinsic safety features of aircraft engines. Also, investigating sources of risk and providing technologies needed to help ensure safe flight in and around atmospheric hazards.

- Providing technical project management leadership and subject matter expertise for the Integrated Systems Research Program (ISRP) for two projects:
  - Environmental Responsible Aircraft (ERA): Propulsion Technology Sub-element focused on developing and demonstrating, in collaboration with industry and other government agencies, integrated systems technologies that enable industry to meet the NASA goals for reduction in aircraft emissions, noise, and fuel burn for the 2025 time frame. Unmanned Aircraft Systems (UAS) Integration in the National Airspace System (NAS): contributes capabilities that reduce the technical barriers related to the safety and operational challenges associated with enabling routine UAS to the NAS. NASA Glenn has primary responsibility for the communication technology sub-element for the UAS in the NAS.

C. NASA Glenn Research Center: Economic Overview

This section presents an economic overview of the NASA Glenn Research Center during FY 2012. Changes between FY 2008 and FY 2012 are described in terms of number of employees, occupational distribution, and places of residence for employees, payroll, expenditures, academic awards, revenues, and income taxes paid by NASA Glenn employees.

C.1. Employment and Occupations

The labor force of NASA Glenn Research Center consists of two components: civil service employees and local contractors. Federal laboratories commonly contract for specific tasks and services, which also instills more flexibility in their overall labor cost. The number of contracted employees can be more quickly adjusted to be aligned with the varying amount and nature of work at the laboratories.

In contrast, the NASA civil servant cadre has been relatively constant in number in order to retain an enduring core expertise, which is especially important for efficient and effective execution of aerospace projects that often last many years from conception through completion.

Table 1 shows the total number of NASA Glenn's civil service employees and the shares of four occupational categories between FY 2008 and FY 2012. In FY 2012, NASA Glenn had 1,659 civil service employees. Within the past five years, Glenn civil service employment peaked in FY 2011 at a total of 1,711. NASA Glenn's employment increased between FY 2009 and FY 2011 by 3.7%. Since FY 2011, however, Glenn civil service employment has decreased by 3.0% through the end of FY 2012. For the last five fiscal years, NASA Glenn's civil employment slightly decreased by 0.2% (3 employees).

Table 1. NASA Glenn Civil Service Employment Distribution by Occupational Category, FY 2008-FY 2012

Fiscal Year	Total	Occupational Category			
		Administrative Professional	Clerical	Scientists & Engineers	Technician
2008	1,662	21%	5%	61%	12%
2009	1,650	20%	4%	63%	12%
2010	1,658	20%	4%	65%	11%
2011	1,711	20%	4%	65%	10%
2012	1,659	21%	4%	67%	9%

Note: Table does not include local contractors.[6]

[6] A detailed listing of NASA Glenn's local contractors can be found at http://www.grc.nasa.gov/WWW/Procure/ContractorList/On-siteServiceContractorListing.htm

NASA Glenn's civil service employment consists of four occupational categories: administrative professional, clerical, scientists and engineers, and technicians. The occupational structure of NASA Glenn's employment has changed slightly during the study period.

The largest occupational category in FY 2012 was scientists and engineers, which accounted for 67% of the civil service employees in that fiscal year. The share of scientists and engineers at NASA Glenn has gradually increased since FY 2008 from 61% (1,014 employees) to 67% (1,112 employees) in FY 2012. Between FY 2011 and FY 2012, the share of scientists and engineers has increased from 65% to 67%.

The administrative professional group was the second-largest occupational category at NASA Glenn in all previous years studied. This category consistently accounted for about 20% of the total civil service employees during the study periods. Between FY 2011 and FY 2012, the share of the administrative professional group has increased slightly from 20% to 21%. The number of technicians has decreased by 50 employees from 199 employees in FY 2008 to 149 employees in FY 2012. The technician group accounted for 9% of NASA Glenn's civil service employment in FY 2012. The increase of scientists and engineers accompanied the loss of technicians over the years. The number of clerical staff accounted for 4% of the total civil service employees in FY 2012, a decrease of 17 employees since FY 2008.

NASA Glenn employs highly educated and highly skilled civil service workers. In FY 2012, 82% of NASA Glenn's employees possessed bachelor's degrees or higher. Of all NASA Glenn's civil service employees, 18% held doctoral degrees, 35% held master's degrees, and 29% held bachelor's degrees. Compared to FY 2011, the level of educational attainment of NASA Glenn's civil service employees has increased slightly. The number of employees holding bachelor's degrees or higher degrees increased 1.1% between FY 2011 and FY 2012. The increased number of highly educated employees between FY 2011 and FY 2012 reflects the increase in the share of scientists and engineers hired by NASA Glenn during this period of time.

NASA Glenn employed 1,688 on- or near-site contractors in FY 2012. NASA Glenn's employment of local contractors grew (by 2%) between FY 2008 and FY 2010 (Table 2). However, between FY 2010 and FY 2012, the number of local contractors employed by NASA Glenn decreased 11.7%.

The total number of NASA Glenn employees, including both civil service employees and local contractors, was 3,347 in FY 2012. The total labor force decreased by 6.2% from FY 2011 (3,569) to FY 2012 (3,347): NASA Glenn lost a net total of 52 civil service employees and 170 on- or near-site local contractors between FY 2011 and FY 2012. Overall, NASA Glenn's total labor force was reduced by 5.3% over the past 5 years from 3,536 in FY 2008 to 3,347 in FY 2012.

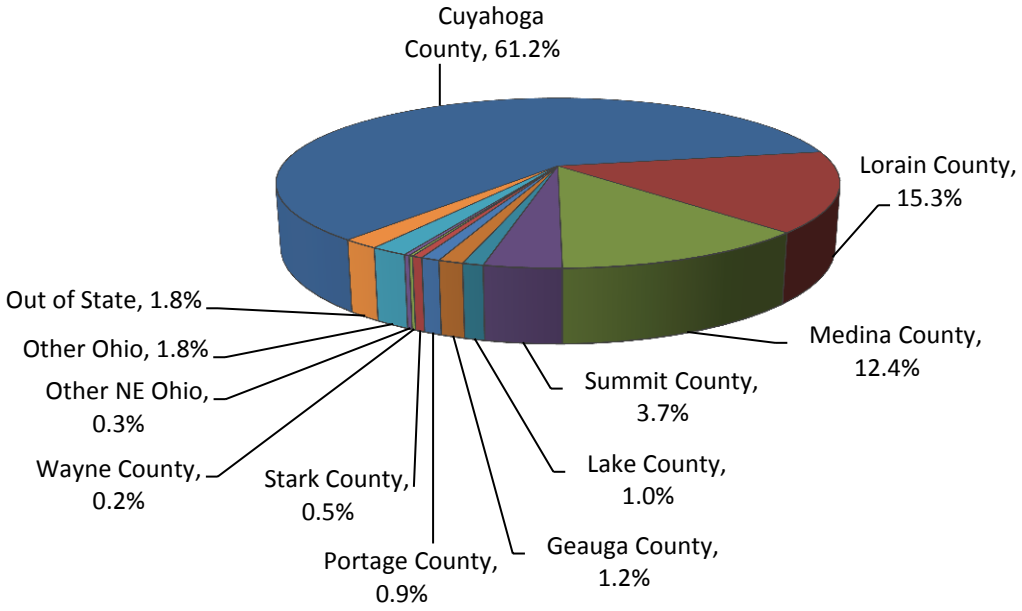
Table 2. NASA Glenn On- or Near-Site Contractors Employment, FY 2008-FY 2012

Fiscal Year	Employment of On- or Near-Site Contractors
2008	1,874
2009	1,895
2010	1,912
2011	1,858
2012	1,688

C.2. Place of Residence for Glenn Employees

NASA Glenn Research Center is located near Cleveland Hopkins International Airport in Cuyahoga County, Ohio. NASA Glenn also includes Plum Brook Station, located near Sandusky, Ohio, west of the main facility. Most civil service employees working at NASA Glenn live in Cuyahoga County or the other surrounding counties that comprise Northeast Ohio. Figure 1 shows the breakdown of employees' postal addresses by geographic region. During FY 2012, almost all of NASA Glenn's civil service employees (1,599 employees; 96.4%) resided in Northeast Ohio. Specifically, 61.2% of civil servants (1,015 employees) lived in Cuyahoga County, where NASA Glenn is located. NASA Glenn employees also lived in Lorain (254 employees; 15.3%), Medina (206 employees; 12.4%), and Summit Counties (61 employees; 3.7%), as well as in counties southwest of Cuyahoga County. Of the total 1,659 civil service workers employed by NASA Glenn in FY 2012, 30 employees (1.8%) lived in the remainder of Ohio and 30 employees (1.8%) possessed postal addresses located in other states. Compared to FY 2011, the number of NASA Glenn employees who resided outside Ohio decreased by 14 (-33%).

Figure 1. NASA Glenn Civil Service Employees by County of Residence, FY 2012



The places of residence of NASA Glenn's civil service employees are shown by occupation in Table 3. Cuyahoga County served as the place of residence for the highest share of employees in each occupational category. More than 55% of NASA Glenn's scientists and engineers, administrative professionals, and clerical employees lived in Cuyahoga County in FY 2012. Approximately 3% to 4% of NASA Glenn's scientists and engineers and administrative professionals have postal addresses outside of Northeast Ohio.

Table 3. NASA Glenn Civil Service Employees by Occupation and Place of Residence, FY 2012

Residence	Administrative Professional	Clerical	Scientists & Engineers	Technicians	Total
Northeast Ohio	96.6%	97.7%	96.1%	98.3%	96.4%
Cuyahoga County	59.3%	68.2%	62.3%	54.6%	61.2%
Lorain County	18.5%	18.2%	13.9%	17.6%	15.3%
Medina County	11.2%	9.1%	12.3%	18.5%	12.4%
Summit County	5.1%	0.0%	3.7%	1.7%	3.7%
Lake County	0.6%	0.0%	1.2%	0.8%	1.0%
Geauga County	0.6%	2.3%	1.2%	2.5%	1.2%
Portage County	0.6%	0.0%	1.0%	1.7%	0.9%
Stark County	0.6%	0.0%	0.4%	0.8%	0.5%
Wayne County	0.3%	0.0%	0.2%	0.0%	0.2%
Other NE Ohio	0.3%	0.0%	0.3%	1.3%	0.3%
Remainder of Ohio	2.5%	2.3%	1.5%	1.7%	1.8%
Out of State	0.8%	0.0%	2.4%	0.0%	1.8%

C.3. PAYROLL

Total compensation for NASA Glenn's civil service employees was $226.2 million in FY 2012. Total compensation in this report includes both payroll ($179.1 million) and employee benefits ($47.1 million). Total payroll decreased by $5.3 million (-2.3%) between FY 2011 and FY 2012, after adjusting for inflation.[7] The average wage per civil service employee increased by 0.3% (after adjusting for inflation), from $107,652 in FY 2011 to $107,965 in FY 2012.[8]

Compared to FY 2008, in real dollars adjusted for inflation, total compensation in FY 2012 grew by 2.7% ($6 million), including a salary increase of 0.3% and a growth in benefits of 13%. During the same time period, the average wage per civil service employee increased by 0.5%, from $107,448 in FY 2008 (inflation adjusted) to $107,965 in FY 2012.[9]

[7] Total nominal payroll decreased by 0.3% ($0.6 million) between FY 2011 and FY 2012.

[8] The average wage per employee in nominal terms increased 2% between FY 2011 and FY 2012.

[9] In nominal dollars, the average employee wage increased by 7.1%, from $100,760 in FY 2008 to $107,965 in FY 2012.

C.4. NASA GLENN EXPENDITURES, FY 2012

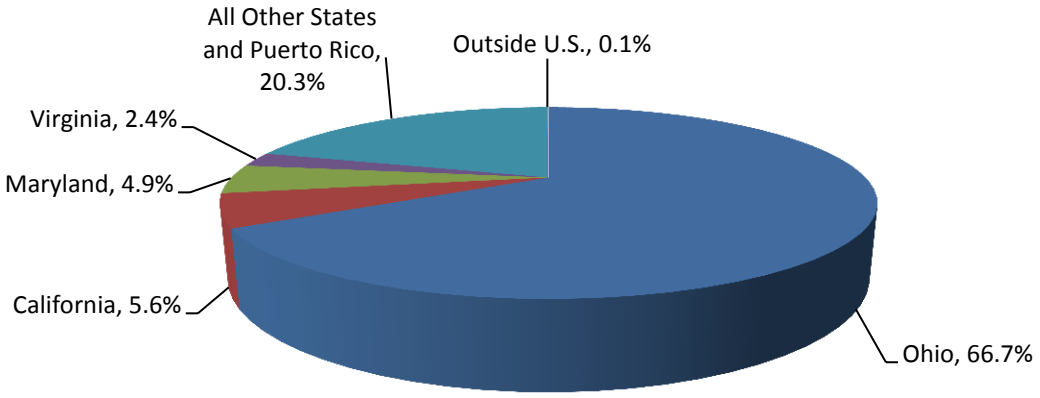
In FY 2012, NASA Glenn allocated its spending of $434.7 million to vendors in 48 states, Washington, D.C., Puerto Rico, and 6 foreign countries. Compared to its total expenditures of $495.3 million in FY 2011, NASA Glenn reduced its expenditures by 12.2% in FY 2012 ($60.6 million in nominal dollars). Total expenditures decreased by 21.4% ($118 million) between FY 2010 and FY 2012.

Figure 2 shows the geographic distribution of NASA Glenn's spending in FY 2012. Ohio was the largest beneficiary of expenditures, receiving $290 million, accounting for 66.7% of NASA Glenn's total expenditures. Despite a $22.8 million decrease (in nominal dollars) compared to FY 2011, the share of NASA Glenn's expenditures in Ohio increased from 63.1% in FY 2011 to 66.7% in FY 2012. Of Ohio's total expenditures, Northeast Ohio received $231.6 million, which accounted for 80% of NASA Glenn's Ohio spending in FY 2012. Northeast Ohio also accounted for 53% of NASA Glenn's total spending in FY 2012.

Other states and Puerto Rico received $144.3 million in FY 2012 (33.2% of NASA Glenn's total expenditure). Besides Ohio, three states (California, Maryland, and Virginia) each received over $10 million or at least 2.4% of NASA Glenn's total expenditures during FY 2012. California received $24.3 million (5.6%) and Maryland $21.4 million (4.9%), and Virginia $10.5 million (2.4%), making them the second- , third-, and fourth-largest beneficiaries of NASA Glenn's spending. Compared to FY 2011, however, NASA Glenn reduced its expenditures in Oklahoma by $15.4 million in FY 2012. Oklahoma had ranked as the fourth-largest beneficiary of NASA Glenn's expenditures in FY 2011 but ranked twentieth in FY 2012. Meanwhile, NASA Glenn increased its spending in Iowa from $0.4 million in FY 2011 to $1.6 million in FY 2012. (See Appendix Table A.1. for more information.)

In FY 2012, NASA Glenn reduced its expenditure in foreign countries by 10.5% compared to FY 2011. Foreign countries received $0.4 million, accounting for only 0.1% of NASA Glenn's total spending in FY 2012. The largest beneficiaries were Canada, which accounted for 63.2% of NASA Glenn's total spending in foreign countries in FY 2012. (See Appendix Table A.1. for more information.)

Figure 2. NASA Glenn Spending in Select States, FY 2012



Note: Figures in nominal dollars.

Total Expenditure: $ 434.7 million

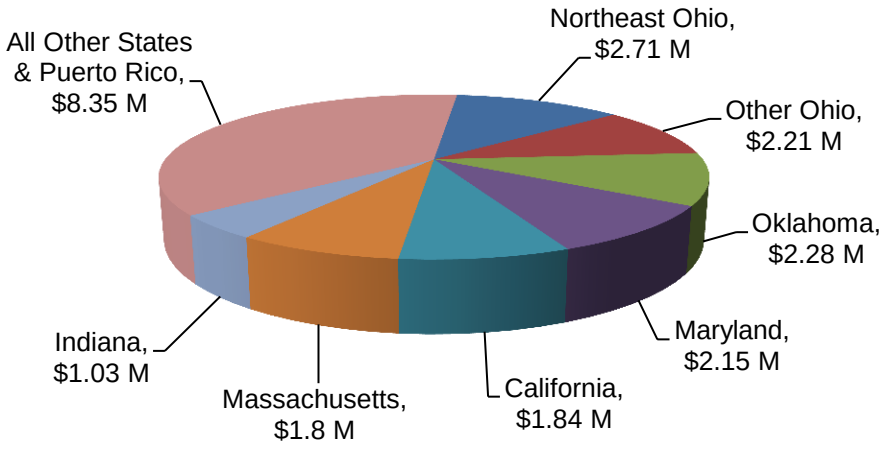
C.5. NASA Glenn Awards to Academic and Other Institutions

NASA Glenn Research Center awards funding to colleges, universities, and other nonprofit institutions in the form of R&D contracts and grants for assisting NASA in their research and development activities. The amount of NASA Glenn's funding to academic and major institutions is driven by NASA Glenn's goals and mission for each year.

In FY 2012, NASA Glenn awarded $22.4 million to colleges and universities in 34 states and Puerto Rico. Compared to FY 2011, this represented a reduction of academic grants from NASA Glenn of $6.9 million (-23.5% in nominal dollars).

Figure 3 shows the distribution of funding awarded to colleges and universities with emphasis on select states. Universities in six states—Ohio, Oklahoma, Maryland, California, Massachusetts, and Indiana—received over $1 million in funding from NASA Glenn in FY 2012. The academic funding awarded in these six states collectively accounted for 62.7% of the total grants in FY 2012. (See Appendix Table A.2. for more information.)

Figure 3. NASA Glenn Awards to Colleges and Universities, FY 2012



Total Academic Awards: $22.4 million

Notes:
Figures in nominal dollars
"Other Ohio" refers to colleges and universities located outside the 8-county definition of Northeast Ohio used in this report.

Academic institutions in Ohio received $4.9 million, which accounted for the largest share (22%) of NASA Glenn's academic awards in FY 2012. NASA Glenn's academic awards to Ohio decreased by 15.9% (-$0.9 million) between FY 2011 and FY 2012.

Within the state of Ohio, academic institutions in Northeast Ohio received $2.7 million in FY

2012. Northeast Ohio academic institutions accounted for both 12% of NASA Glenn's total academic awards and 55% of all academic grants given in Ohio. NASA Glenn slightly reduced its awards to the universities and academic institutions in Northeast Ohio by 5.8% ($0.2 million) compared to FY 2011. NASA Glenn's funding to Ohio academic institutions located outside the 8-county of Northeast Ohio decreased by 25.5% ($0.8 million) compared to FY 2011.

In FY 2012, the state of Oklahoma received $2.3 million, Maryland received $2.1 million, California and Massachusetts received $1.8 million each, and Indiana received $1 million in academic grants from NASA Glenn. (See Appendix Table A.2. for more.)

Table 4 shows the distribution of NASA Glenn awards to colleges and universities in Ohio from FY 2008 to FY 2012 (inflated to 2012 dollars). Total academic grants awarded in Ohio decreased by 54%, from $10.8 million in FY 2008 to $4.9 million in FY 2012. Between FY 2011 and FY 2012, NASA Glenn reduced its academic funding to Ohio universities and colleges by 17% or $1 million (adjusted to 2012 dollars).

The University of Toledo and University of Akron each received more than $1.5 million from NASA Glenn in FY 2012. The University of Toledo has been consistently awarded the highest share of funding from NASA Glenn over the last 5 years; it obtained $1.5 million in FY 2012, which accounted for 31.2% of total awards to colleges and universities in Ohio. The academic awards to the University of Toledo decreased by 26% ($0.5 million) between FY 2011 and FY 2012. On the other hand, NASA Glenn's academic funding to the University of Akron slightly increased by 7% ($0.1 million) from $1.4 million in FY 2011 to $1.5 million in FY 2012.

In FY 2012, Case Western Reserve University received $0.7 million, Cleveland State University received $0.5 million, and The Ohio State University received $0.4 million.

Table 4. NASA Glenn Educational Grants in Ohio by Academic Institution, FY 2008-FY 2012

OHIO COLLEGES & UNIVERSITIES	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2012 Share
University of Toledo	$3,606,468	$2,711,932	$2,914,951	$2,073,329	$1,538,346	31.2%
University of Akron	$1,189,779	$1,305,642	$664,867	$1,400,509	$1,505,235	30.6%
Case Western Reserve University	$1,728,124	$852,272	$875,829	$813,856	$676,384	13.7%
Cleveland State University	$1,556,264	$763,005	$1,075,472	$718,430	$531,609	10.8%
Ohio State University	$1,919,213	$2,181,814	$1,526,096	$537,804	$374,264	7.6%
Ohio University	$57,897	$73,133	$204,364	$184,318	$171,897	3.5%
University of Cincinnati	$655,082	$518,040	$284,512	$177,674	$128,654	2.6%
Wright State University	$513	$34,557	$17,789	$33,365		
Kent State University			$367	$18,827		
University of Dayton		$51,357				
Bowling Green State University		$30,141				
Cuyahoga Community College	$38,038	$10,713				
TOTAL	**$10,751,380**	**$8,532,606**	**$7,564,248**	**$5,958,112**	**$4,926,389**	**100%**

Notes:
Table is sorted by FY 2012 column.
Data inflated to 2012 dollars.

C.6. NASA GLENN REVENUES

NASA Glenn's total revenue in FY 2012 was $687.7 million. Of the last 5 years, NASA Glenn's total revenue was lowest in FY 2012; it declined between FY 2009 and FY 2010 and after a slight growth of $2.4 million from FY 2010 to FY 2011, it decreased by $51 million (6.9%) in FY 2012. NASA Glenn's revenue decreased by $12 million (-1.7%) from FY 2008 to FY 2012 (in nominal dollars).

Table 5 shows NASA Glenn's revenue by source from FY 2008 to FY 2012. NASA Glenn's revenue consists of two sources: NASA direct authority and reimbursable commitments. The share of revenue from NASA's direct authority accounted for close to 96% each year from FY 2008 to FY 2010, but dropped slightly to 94% in both FY 2011 and FY 2012. In FY 2012, NASA Glenn received $647.3 million of revenue directly from NASA and an additional $40.4 million from reimbursable commitments.

NASA Glenn's revenue from the direct authority decreased by $50 million (7%) between FY 2011 and FY 2012. As shown in the table below, the growth in reimbursable funding is substantial – more than 25% growth from the 2008 level -- and reflects a growing diversity of non-NASA customers doing business with NASA Glenn in the past two years. Focusing only on those years, Glenn's revenues from reimbursable commitments had increased by 35.8% ($11 million in nominal dollars) from FY 2010 to FY 2011, but the revenue decreased by $1.3 million (3%) in FY 2012. The decrease is owed to less Federal agency investment, but was offset by increases in commercial investments in NASA Glenn. Nonetheless, Federal sources remain the largest investor: during FY 2012, reimbursable commitments included the Department of Defense (5.4%); other federal agencies (62.9%); and domestic and non-federal entities (31.8%).

Table 5. NASA Glenn Revenues, FY 2008-FY 2012

Revenue Source	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012
NASA Direct Authority	671,663	731,026	705,550	696,917	647,256
Reimbursable Commitments	27,886	32,606	30,682	41,680	40,402
Total FY Authority	699,549	763,632	736,232	738,597	687,657
Revenue from NASA	96.0%	95.7%	95.8%	94.4%	94.1%

Note: Data in thousands of nominal dollars.

C.7. Taxes Paid by NASA Glenn Employees

Income taxes paid directly to state and local governments by NASA Glenn employees play an important role in the regional economies of Northeast Ohio and the state of Ohio. NASA Glenn is located in the cities of Brook Park, Fairview Park, and Cleveland, which affects the distribution of income tax paid by Glenn employees.

Table 6 shows the amount of income taxes withheld from the paychecks of NASA Glenn employees and sent directly to state and local governments. These taxes exclude those paid by Glenn employees to local governments based on their place of residence. In FY 2012, the total amount of income tax paid by NASA Glenn's employees was $9.7 million. Compared to FY 2008, NASA Glenn employees paid $280,129 more in income taxes in FY 2012 (in nominal dollars).

The state of Ohio and the city of Brook Park were the two largest beneficiaries of the income taxes paid by NASA Glenn's employees. Together, they accounted for 99.6% of the total state and local income taxes paid in FY 2012.

The state of Ohio's share of income tax in FY 2012 was 64.9% ($6.3 million). Over the past 5 years, NASA Glenn employees paid annually more than $6 million in income taxes to the state of Ohio. The city of Brook Park received $3.4 million in income tax from NASA Glenn employees in FY 2012, a slight decrease (-1.5%) compared to FY 2011.

NASA Glenn employees paid $26,008 in income tax to the city of Fairview Park in FY 2012. This represented a 93.5% decrease in income tax paid by NASA Glenn workers to the city of Fairview Park between FY 2008 and FY 2012. This shift in taxes occurred due to the relocation of civil servants from facilities in Fairview Park to the main campus in 2010. At the same time, income tax paid to the city of Cleveland remained very low, although the total has increased continuously between FY 2008 and FY 2012. In FY 2012, NASA Glenn employees paid $14,205 in income taxes to the city of Cleveland, an 11.4% increase compared to FY 2011.

Table 6. Income Taxes Paid by NASA Glenn Employees

Year	City of Brook Park	City of Cleveland	City of Fairview Park	State of Ohio	Total
2008	$2,844,033	$6,910	$399,634	$6,189,703	**$9,440,279**
2009	$2,941,876	$9,174	$385,752	$6,098,786	**$9,435,588**
2010	$3,264,189	$11,465	$160,915	$6,346,527	**$9,783,096**
2011	$3,421,825	$12,755	$26,097	$6,384,735	**$9,845,412**
2012	$3,370,391	$14,205	$26,008	$6,309,804	**$9,720,408**

Note: Data in nominal dollars.

D. Economic Impact of NASA Glenn

This section discusses the methodology and results of research on economic impact of NASA Glenn on Northeast Ohio[10] and the state of Ohio in FY 2012. Total impact is measured in terms of output (sales), employment, value added, household earnings, and taxes contributed to local and state, and federal governments. Each of these categories is estimated as the sum of three components: direct impact, indirect impact, and induced impact.[11] NASA Glenn's total impact on Northeast Ohio and the state of Ohio are estimated separately.

D.1. Methodology

The estimation of economic impact in this study is based on the assumption that NASA Glenn came into existence at the beginning of FY 2012 and instantly generated a demand for goods and services needed for its operation.

This new demand is called change in final demand and it constitutes the direct impact of NASA Glenn.[12] The increase in demand from NASA's expenditures in the region generates an economic impact (on Northeast Ohio or Ohio). The effects are traced throughout the Northeast Ohio or Ohio economies using an input-output model that reflects the buy-sell relationships among all industry sectors and the household sector.

In order for NASA Glenn to engage in research and development, other goods and services are needed as intermediate inputs and other purchases occur from income received by NASA Glenn employees. This leads to the generation of other components of economic impact: indirect and induced.

Indirect impact measures the value of labor, capital, and other inputs of production needed to produce the goods and services required by NASA Glenn. Induced impact measures the change in spending by local households due to increased earnings by Glenn employees and employees in local industries who produce goods and services for NASA Glenn and its suppliers.

Doing this research, we treated NASA Glenn as any other research and development institution, assuming that NASA Glenn employees have the same spending pattern as employees of any other research institution in a target area.

Economic impact analysis takes into account inter-industry buy-sell relationships within the economy. These relationships largely determine how the economy responds to changes in economic activity. Input-output (I-O) models estimate inter-industry relationships in a county, region, state, or country level by measuring the distribution of inputs purchased and outputs sold by each industry, the government sector, and the household sector. Thus, by using I-O models, it is possible to estimate how the impact of one additional dollar or one additional job required for NASA Glenn to operate ripples through the target economies, creating additional expenditures and jobs. The economic multiplier measures the extent of the ripple effect that an initial expenditure

[10] For this analysis, Northeast Ohio is limited to the Akron and Cleveland metropolitan areas and includes Ashtabula, Cuyahoga, Geauga, Lake, Lorain, Medina, Portage, and Summit counties.

[11] The change in final demand is the direct economic impact created by NASA Glenn on Northeast Ohio and Ohio.

[12] Change in final demand or direct impact, is defined as the purchases of goods and services for NASA Glenn's final consumption.

has on the local economy.[13] This study utilizes regional I-O multipliers from the IMPLAN Professional model.[14] Specifically, SAM multipliers are used to estimate the ripple effect that an initial expenditure made by NASA Glenn has on a local economy.[15]

In this study, we used the IMPLAN methodology of modeling called "bill of goods." Instead of calculating industry change by matching each category of NASA Glenn's expenditures to the industry from which it buys products, we match the actual product NASA Glenn is purchasing for through "Industry Spending Pattern." This technique enables matching goods that NASA Glenn bought to goods and services produced by different industries in a targeted region. This technique delivers slightly lower economic impact, but enables more accurate matching to industry sectors that produced supplies regionally.

Three factors need to be addressed when estimating economic impact: (1) purchases from companies located outside the study region need to be excluded, (2) payroll of employees that live outside the study area needs to be excluded, and (3) the share of revenues received from local sources needs to be considered. For this analysis, NASA Glenn's economic impact on the Northeast Ohio economy is generated only by purchases of goods produced by companies located within Northeast Ohio. In the same vein, the economic impact on the state of Ohio is generated only by NASA Glenn purchases of goods produced by companies located within Ohio. Therefore, when estimating the impact on Northeast Ohio, goods and services purchased from businesses and other entities located outside the 8-county region were excluded from the model. Likewise, when estimating the impact on the state of Ohio, all goods and services purchased from businesses and entities located outside the state were excluded from the model. The spending of employees residing outside the regions studied was also excluded from the respective models. Regarding sources of revenues, all of NASA Glenn's revenues were received from non-local sources (federal sources) and, therefore, no further adjustments were required.

The economic impact is measured in terms of five variables: employment, labor income, value added, output, and taxes:

- Employment impact measures the number of additional jobs created in the region as a result of NASA Glenn expenditures.
- Labor income impact measures the additional household earnings created in the region due to NASA Glenn expenditures.
- Value-added impact measures the additional value-added output created in the region as a result of NASA Glenn expenditures. Value-added is calculated

[13] For example, suppose that Company A reports sales of $1 million. From the revenues, the company pays its suppliers and workers, covers production costs, and takes a profit. Once the suppliers and employees receive their payments, they will spend a portion of their money in the local economy purchasing goods and services, while another portion of the monies will be spent outside the local economy (leakage). By evaluating the chain of local purchases that result from the initial infusion of $1 million, it is possible to estimate a regional economic multiplier.

[14] IMPLAN (IMpact analysis for PLANning) was originally developed by two federal agencies, the Department of Agriculture and the Department of the Interior, to assist in land and resource management planning. The model was later commercialized by the Minnesota IMPLAN Group, Inc. as a software package.

[15] IMPLAN type SAM (Social Accounting Matrices) multipliers are used in this study. SAM multipliers are based on information in a social account matrix that considers social security and income tax leakages, institutional savings, commuting, and inter-institutional transfers.

as output less the value of intermediary goods.[16]

- Output impact measures the additional value of all goods and services produced in the region as a result of NASA Glenn expenditures.
- Tax impact measures the additional federal and state and local tax revenues collected in the region as a result of NASA Glenn expenditures.

The employment, labor income, value-added, and output impacts are each a summation of three components: direct impact, indirect impact, and induced impact. [17]

Figure 4 illustrates the process by which NASA Glenn impacted the local economy through its spending in Northeast Ohio in FY 2012.

Through its attraction of federal dollars, NASA Glenn created new demand for goods and services (change in final demand or direct impact). Some of this demand was generated for goods and services provided by vendors outside the Northeast Ohio, resulting in dollars leaking from the regional economy. However, the majority of goods and services were purchased locally.

[16] Intermediary goods and services—such as energy, materials, and purchased services—are purchased for the production of other goods and services rather than for final consumption.

[17] The summation of direct, indirect, and induced impacts across industries in the impact tables (Tables 7-14) may reflect rounding discrepancies created by multiple iterations of IMPLAN modeling.

D.2. Economic Impact on Northeast Ohio, FY 2012

This section describes the economic impact that NASA Glenn created on the Northeast Ohio economy in FY 2012. The analysis includes a detailed overview of the changes in output (sales), employment, labor income (earnings), value added, and taxes generated by NASA Glenn's activities in Northeast Ohio.

D.2.1. Output Impact on Northeast Ohio, FY 2012

NASA Glenn's expenditures were divided into two groups of spending: (1) goods and services purchased from companies and institutions located in Northeast Ohio and (2) spending for goods and services from businesses and other entities located outside Northeast Ohio. The first group of spending creates an economic impact on the local economy. The second group is considered to be leakage from our economy. Local spending is then categorized by products produced in the local economy, based on an IMPLAN classification system of industries that produced the products and differentiates spending across 440 sectors. IMPLAN sectors are similar to the description of industries used in the North American Industry Classification System (NAICS), but do not completely correspond to the NAICS system. Table A.3., found in Appendix A, provides detailed NASA Glenn expenditures in Northeast Ohio by industry.

Almost half of NASA Glenn spending in Northeast Ohio was for employee compensation. NASA Glenn's largest expenditures on goods and services in Northeast Ohio in FY 2012 were made on scientific research and development services, including equipment, supplies and materials, grants, and professional services. The spending that takes place in Ohio and Northeast Ohio produces significant economic impact on the respective economies.

Table 7 presents the total output impact of NASA Glenn, which represents direct impacts, indirect impacts, and induced impacts. NASA Glenn's expenditures in Northeast Ohio represent the direct output impact. This impact includes all direct purchases made from industries in Northeast Ohio and the regional margin of purchases from the retail industry. Indirect impact is estimated by summing the contributions of individual industries that supply the producers of the goods and services consumed by NASA Glenn. Lastly, induced impact is estimated from the spending of employees of Glenn and its suppliers.

Figure 4. Economic Impact of NASA Glenn Research Center on Northeast Ohio, FY 2012

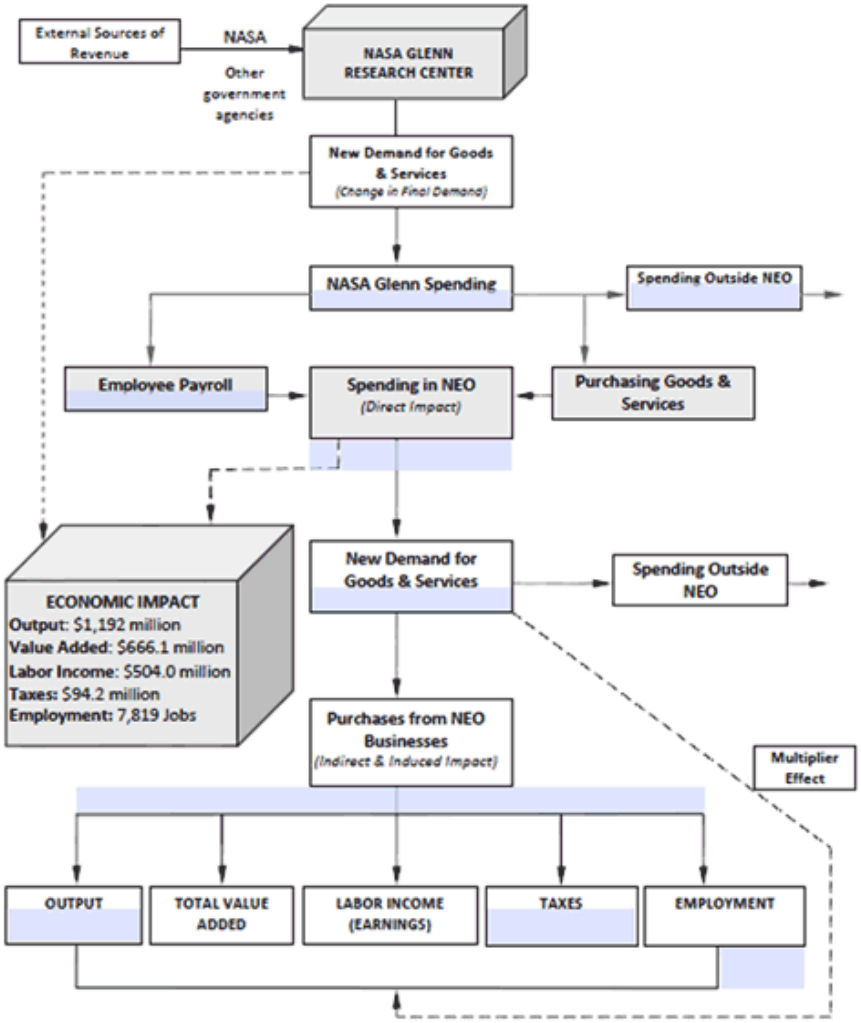


Table 7. Output Impact in Northeast Ohio, FY 2012

Industry	Direct	Indirect	Induced	Total
Agriculture, Forestry, Fishing & Hunting	$0	$90,965	$254,456	$345,421
Mining	$0	$676,429	$600,143	$1,276,572
Utilities	$0	$13,968,012	$5,893,885	$19,861,897
Construction	$0	$34,462,121	$2,555,112	$37,017,233
Manufacturing	$0	$5,836,989	$7,148,133	$12,985,122
Wholesale Trade	$0	$1,544,286	$15,392,807	$16,937,093
Retail trade	$0	$3,124,215	$32,262,027	$35,386,242
Transportation & Warehousing	$0	$3,789,120	$6,948,143	$10,737,263
Information	$0	$5,084,371	$10,627,283	$15,711,654
Finance & insurance	$0	$8,359,494	$36,488,790	$44,848,284
Real estate & rental	$0	$7,523,897	$58,619,014	$66,142,911
Professional- scientific & tech services	$0	$148,423,381	$13,707,247	$162,130,628
Management of companies	$0	$1,843,796	$2,507,272	$4,351,068
Administrative & waste services	$0	$63,487,700	$8,043,647	$71,531,347
Educational services	$0	$1,716,423	$5,149,897	$6,866,320
Health & social services	$0	$1,105,407	$47,609,551	$48,714,958
Arts- entertainment & recreation	$0	$524,110	$4,082,269	$4,606,379
Accommodation & food services	$0	$2,490,971	$15,331,507	$17,822,478
Other services	$0	$2,231,089	$11,284,576	$13,515,665
Government & non NAICs	$660,927,084	$1,708,956	$4,904,938	$667,540,978
TOTAL OUTPUT	$660,927,084	$307,991,732	$289,410,697	**$1,258,329,513**

Notes:
Direct impact of NASA Glenn is a change in final demand that is applied to a sector of NASA Glenn's industry, NAICS 9271 – Space Research and Technology, which is a part of a larger industry sector NAICS 92 – Public Administration (Government & non NAICs). For output impact, the change in final demand or direct impact equals the spending of NASA Glenn for goods and services within and outside Northeast Ohio, including wages and benefits.

The total output impact of NASA Glenn on Northeast Ohio was $1.258 billion in FY 2012. NASA Glenn's $660.9 million worth of expenditures in Northeast Ohio resulted in an output (sales) change of $1.258 billion million across all industry sectors (Table 7). For example, NASA Glenn's spending affected a $162.1 million increase in total sales by all professional, scientific, and technical services industries and a $37.0 million increase in sales (direct, indirect, and induced impacts) by the construction industry. Furthermore, if NASA Glenn did not exist in Northeast Ohio, the regional economy would have a $71.5 million decrease in output within the administrative and waste management services industry. Thus, the impact of NASA Glenn's presence in the area is represented as the increase in output of affected industries in comparison to the hypothetical absence of NASA Glenn in Northeast Ohio.

Of the total output impact, 52% ($660.9 million) is accounted for by the direct spending by NASA Glenn, which constitutes the direct economic impact to Northeast Ohio. The remaining output impact of $597.4 million (47%) is due to the indirect and induced components as NASA Glenn purchases from first-round suppliers ripple through the economy.

A detailed analysis of the IMPLAN model's results indicates that the $597.4 million change in output (sales) due to indirect and induced economic impacts can be divided into three broad categories: NASA Glenn-driven industries, consumer-driven industries, and other industries. NASA Glenn-driven industries are industries that increase sales, employment, and earnings primarily, but not exclusively, due to NASA Glenn's spending. Among these industries are utilities, construction, information, professional and scientific services, administrative and support services, and education. The increase in output due to indirect and induced economic impacts for these industries in FY 2012 was $313 million or 52% of NASA Glenn's overall indirect and induced impact on Northeast Ohio.

The consumer-driven industries are those that increase sales, employment, and earnings primarily due to spending by NASA Glenn employees and other workers who produce goods and services for NASA Glenn and their suppliers. These industries include retail, finance and insurance, real estate, healthcare, entertainment and food, other services, and owner-occupied buildings.[18] The increase in output due to indirect and induced economic impacts for these industries in FY 2012 was $231 million or 39% of the total impact.

Other industries are those that are driven by both NASA Glenn and consumer spending, but their impact is split between NASA Glenn and other businesses in the region. These industries include manufacturing, government enterprises, agriculture, mining, wholesale trade, and transportation, and warehousing. The total increase in output due to indirect and induced economic impacts for these industries in FY 2012 was $53.2 million or 8.9% of the total impact.

The output distributions for select NASA Glenn-driven industries and consumer-driven industries are shown in Figure 5 and Figure 6, respectively. Each of the industries presented in Figure 5 had

[18] An *owner-occupied dwelling* is a special industry sector developed by the Bureau of Economic Analysis. It estimates what owner/occupants would pay in rent if they rented rather than owned their homes. This sector creates an industry out of owning a home. Its sole product (or output) is ownership, purchased entirely by personal consumption expenditures. Owner-occupied dwellings capture the expenses of home ownership such as repair and maintenance construction, various closing costs, and other expenditures related to the upkeep of the space in the same way expenses are captured for rental properties.

additional sales of at least $17 million in FY 2012. Each of the industries presented in Figure 6 had additional sales of at least $10 million in FY 2012.

The scientific research and development industry generated the largest output impact; it increased by $95.8 million in FY 2012 due to NASA Glenn's operations (Figure 5). This amount is the summation of the indirect and induced impacts generated primarily, but not exclusively, by NASA Glenn's spending on research services. The increase of $95.8 million accounted for 31% of the $313.1 million increase in output for all NASA Glenn-driven industries. Other industries shown in Figure 5 can be interpreted similarly.

Figure 6 presents consumer-driven industries of the economy that saw large increases in sales. The imputed rental activity industry generated the largest output impact; it increased by $35.9 million in FY 2012 due to NASA Glenn's operations. This amount is the summation of the indirect and induced impacts generated primarily by NASA Glenn employees and other workers for rental activities. The increase of $35.9 million accounted for 16% of the $231 million increase in output for all industries within the consumer-driven sector. Other industries shown in Figure 6 can be interpreted similarly.

Figure 5. Increase in Sales for Select NASA Glenn-Driven Industries in Northeast Ohio, FY 2012

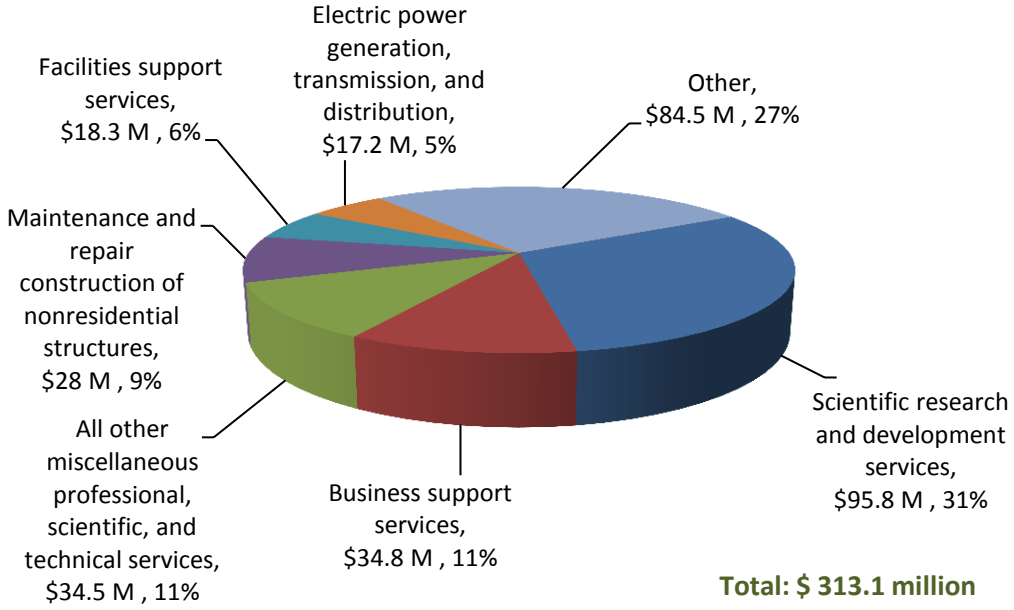
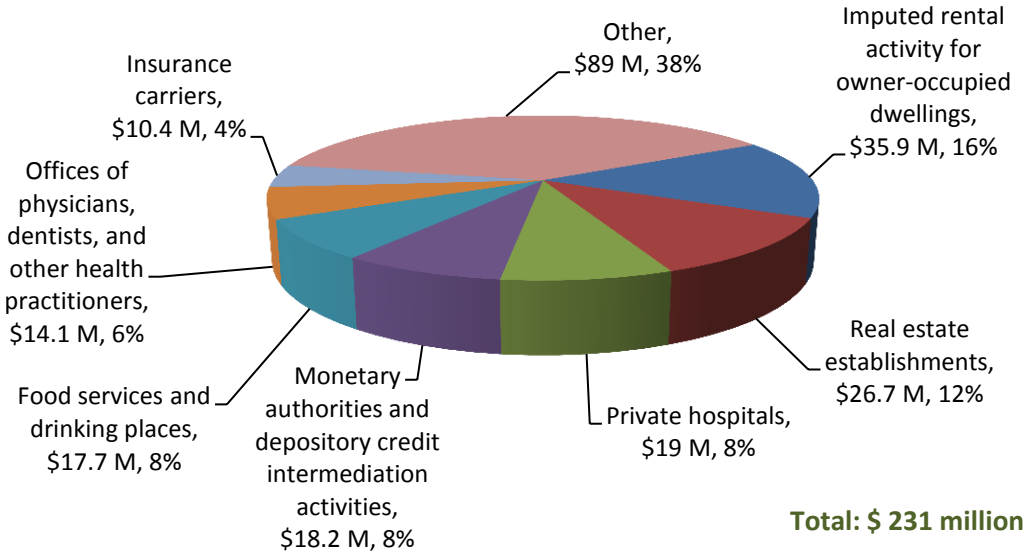


Figure 6. Increase in Sales for Select Consumer-Driven Industries in Northeast Ohio, FY 2012



D.2.2. Employment Impact on Northeast Ohio, FY 2012

NASA Glenn's operation in Northeast Ohio affected job creation beyond NASA Glenn's hiring of its own employees (change in final demand or direct impact). NASA Glenn's spending triggered increased employment in industries from which it purchased goods and services (indirect impact). In addition, money spent by employees of NASA Glenn and of the businesses in the supply chain to NASA Glenn created jobs in a variety of other industries (induced impact). The total employment impact equals the sum of NASA Glenn's employment (direct impact), indirect impact, and induced impact. Table 8 shows the number of jobs created by industry sector.

Table 8. Employment Impact in Northeast Ohio, FY 2012

Industry	Direct	Indirect	Induced	Total
Agriculture, Forestry, Fishing & Hunting	0	3	3	6
Mining	0	2	2	4
Utilities	0	16	7	22
Construction	0	337	21	359
Manufacturing	0	18	17	36
Wholesale Trade	0	8	84	92
Retail trade	0	60	477	537
Transportation & Warehousing	0	22	46	68
Information	0	16	32	48
Finance & insurance	0	35	160	195
Real estate & rental	0	38	127	165
Professional- scientific & tech services	0	814	103	917
Management of companies	0	9	12	21
Administrative & waste services	0	729	131	860
Educational services	0	21	93	113
Health & social services	0	9	493	502
Arts- entertainment & recreation	0	9	73	81
Accommodation & food services	0	44	272	316
Other services	0	28	175	203
Government & non NAICs	1,659	11	32	1,702
TOTAL EMPLOYMENT	1,659	2,230	2,361	**6,250**

Notes:

For employment impact, the change in final demand (direct impact) equals the number of employees working for NASA Glenn. Due to rounding, the total column does not equal the summation of the direct, indirect, and induced columns.

The total employment impact of NASA Glenn on the Northeast Ohio economy in FY 2012 was 6,250 jobs. Of these 6,250 jobs, 1,659 (26.5%) were directly employed at NASA Glenn. As a result of Glenn's direct spending on goods and services, an additional 2,230 jobs (35.7%) were created in the region as indirect economic impact. The remaining employment impact, 2,361 jobs (37.8%), was in the form of induced impact as spending of NASA and suppliers' employees rippled through the regional economy.

Of the 4,591 jobs created in Northeast Ohio due to the indirect and induced impacts, 2,320 (50.5%) were in NASA Glenn-driven industries, 2,001 (43.6%) were in consumer-driven industries, and 270 (5.9%) fell under the category of other industries.[19] The job distribution for select NASA Glenn-driven industries is shown in Figure 7. The job distribution for select consumer-driven industries is shown in Figure 8. The industries presented in Figures 7 and 8 are the leading industries in terms of most increased employment (minimum of 84 and 81 employees per industry, respectively).

The scientific research and development industry generated the highest number of additional jobs. Companies engaged in scientific R&D (professional, scientific, and technical services sector) saw an increase of 504 jobs in FY 2012 due to NASA Glenn's operation (Figure 7). These jobs are the summation of the indirect and induced employment impacts generated primarily, but not exclusively, by NASA Glenn's spending on R&D contractors in Northeast Ohio. The 504 jobs accounted for 22% of the 2,320 jobs that were created in all industries within the NASA Glenn-driven ones.

The food services and drinking places industry saw an increase of 315 jobs in FY 2012 because of NASA Glenn's spending (Figure 8). These jobs are the summation of the direct, indirect, and induced employment impacts generated primarily by NASA Glenn employees and other workers buying food and going to restaurants in Northeast Ohio. The 315 jobs accounted for 16% of the 2,001 jobs that were created in all consumer-driven industries.

[19] NASA Glenn-driven industries include utilities, construction, information, professional and scientific services, administrative and support services, and education. Consumer-driven industries include retail, finance and insurance, real estate, healthcare, entertainment and food, other services, and owner-occupied buildings.

Figure 7. Increase in Jobs for Select NASA Glenn-Driven Industries in Northeast Ohio, FY 2012

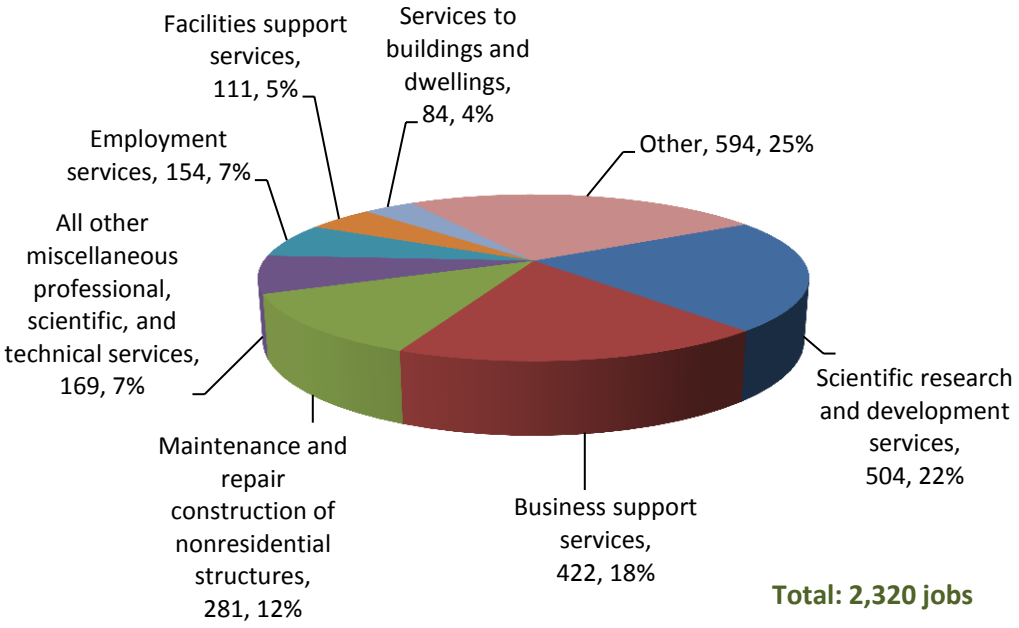
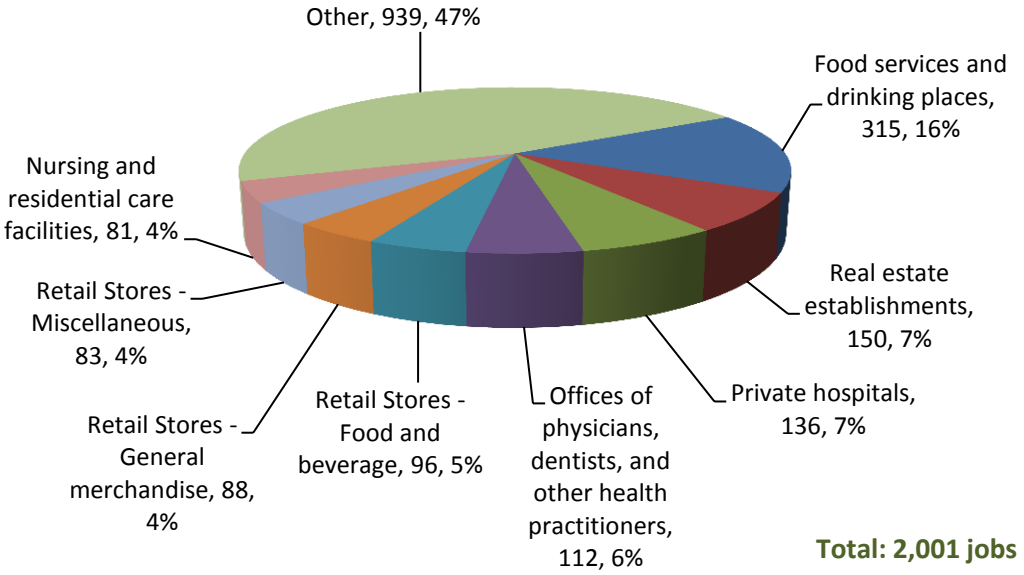


Figure 8. Increase in Jobs for Select Consumer-Driven Industries in Northeast Ohio, FY 2012



D.2.3. Labor Income Impact on Northeast Ohio, FY 2012

Labor income impact is the estimated total change in earnings paid to local households due to spending by NASA Glenn for goods and services purchased in Northeast Ohio and the money paid to employees of NASA Glenn. The latter represents the direct earnings impact.

Indirect impact is estimated by summing the money paid to people working for companies that provide inputs to the producers of goods and services ultimately consumed by NASA Glenn.

Induced impact represents money paid to workers in all industries who are employed as a result of purchases by households whose income is affected by the demand for products and services created by NASA Glenn. The total earnings impact includes the wages and benefits received by NASA Glenn employees (change in final demand or the direct effect), indirect, and induced impacts. Table 9 shows the earnings impact by industry sector.

Table 9. Labor Income Impact in Northeast Ohio, FY 2012

Industry	Direct	Indirect	Induced	Total
Agriculture, Forestry, Fishing, Hunting	$0	$35,978	$99,708	$135,686
Mining	$0	$55,792	$34,305	$90,097
Utilities	$0	$2,013,581	$823,034	$2,836,616
Construction	$0	$18,076,166	$1,149,601	$19,225,766
Manufacturing	$0	$1,272,974	$1,187,292	$2,460,266
Wholesale Trade	$0	$695,629	$6,933,740	$7,629,369
Retail trade	$0	$1,413,860	$14,481,856	$15,895,716
Transportation & Warehousing	$0	$1,449,277	$2,673,424	$4,122,701
Information	$0	$1,034,637	$1,998,034	$3,032,671
Finance & insurance	$0	$2,081,516	$9,498,510	$11,580,026
Real estate & rental	$0	$1,081,253	$2,869,624	$3,950,877
Professional- scientific & tech services	$0	$70,342,450	$7,480,020	$77,822,469
Management of companies	$0	$933,948	$1,270,022	$2,203,971
Administrative & waste services	$0	$34,411,945	$4,373,000	$38,784,946
Educational services	$0	$894,277	$2,877,387	$3,771,663
Health & social services	$0	$508,016	$25,931,834	$26,439,850
Arts- entertainment & recreation	$0	$220,264	$1,690,294	$1,910,559
Accommodation & food services	$0	$893,122	$5,508,474	$6,401,596
Other services	$0	$1,327,170	$6,527,914	$7,855,084
Government & non NAICs	$226,230,444	$805,091	$1,957,844	$228,993,379
TOTAL LABOR INCOME	$226,230,444	$139,546,946	$99,365,916	**$465,143,306**

Notes:
Labor income constitutes economic impact through households of NASA employees and those affected by NASA operations throughout the economy.

Due to rounding, the total column does not equal the summation of the direct, indirect, and induced columns.

Total labor income in Northeast Ohio increased by $465.1 million as a result of NASA operation in FY 2012. Of the $465.1 million, $226.2 million (48.6%) was the wages and benefits paid directly to NASA Glenn employees (i.e., change in final demand or direct effect). Of the total impact, $139.5 million (30%) represented indirect impact, or the money paid to employees of companies in Northeast Ohio that supply goods and services to NASA Glenn. The remaining induced earnings was estimated at $99.4 million (21.4%) and occurred as the effects of NASA Glenn's spending rippled through the Northeast Ohio economy.

Of the $238.9 million increase in labor income generated across Northeast Ohio due to the indirect and induced impacts, $145.5 million (60.9%) was reported in NASA Glenn-driven industries, $74 million (30.1%) was generated in consumer-driven industries, and $19.4 million (8.1%) was reported in other industries.[20]

The labor income distribution for select NASA Glenn-driven industries is shown in Figure 9.

The labor income distribution for select consumer-driven industries is shown in Figure 10. The select industries shown in Figures 9 and 10 each added over $4 million and $2 million, respectively.

In the NASA Glenn-driven industries, people who were engaged in business support services saw their household earnings increase by $23.4 million in FY 2012 (Figure 9). These earnings are the summation of the indirect and induced impacts generated primarily, but not exclusively, by NASA Glenn using business support services in Northeast Ohio. The $23.4 million accounted for 16% of the $145.5 million increase in labor income reported by all the NASA Glenn-driven industries.

Doctors and other employees, part of the consumer-driven industries, working in the offices of physicians and health practitioners industry saw their household earnings increase by $8.7 million in FY 2012 (Figure 10). These earnings are the summation of the indirect and induced impacts generated by consumer spending for doctors' services. The $8.7 million accounted for 12% of the $74 million labor income increase that occurred in all the consumer-driven industries.

[20] See section D.2.1. Output Impact on Northeast Ohio for definitions of Glenn-driven, consumer-driven, and other industries.

Figure 9. Increase in Labor Income for NASA Glenn-Driven Industries in Northeast Ohio, FY 2012

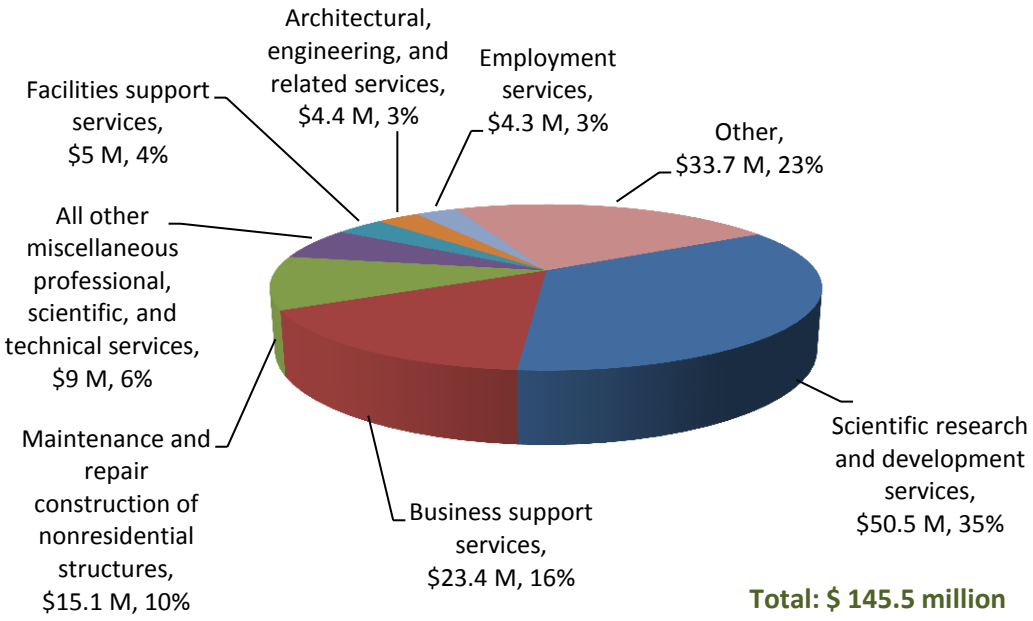
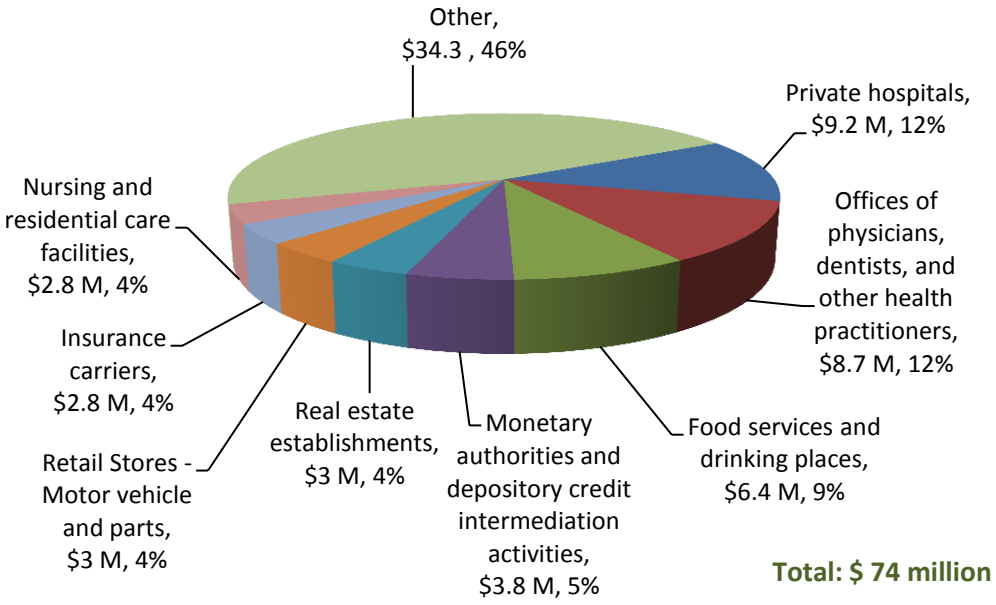


Figure 10. Increase in Labor Income for Consumer-Driven Industries in Northeast Ohio, FY 2012



D.2.4. Value-Added Impact on Northeast Ohio, FY 2012

The total value-added impact[21] in Northeast Ohio was $596.1 million, which resulted from NASA Glenn's regional spending on goods and services. NASA Glenn's spending affected a $596.1 million increase in sales (direct, indirect, and induced impacts) by all industries, excluding intermediary goods and services. The wages and benefits received by NASA Glenn employees, $226.2 million in FY 2012, constituted the change in final demand (or direct impact) for value added. The sales from companies and other suppliers of goods and services to NASA Glenn, excluding the value of intermediary goods and services, represented the indirect value-added impact.

Induced impact represented sales, excluding intermediary goods and services, in all industries that produced products for households whose income was affected by the demand for products and services created by NASA Glenn. The total value-added impact was found by adding the direct, indirect, and induced impacts. Table 10 shows the value-added impact by industry sector.

[21] Value added measures the economic impact of all goods and services produced in Northeast Ohio because of the operation of NASA Glenn, excluding intermediary goods which are goods used in the production of other goods and not for final consumption.

Table 10. Value-Added Impact in Northeast Ohio, FY 2012

Industry	Direct	Indirect	Induced	Total
Agriculture, Forestry, Fishing & Hunting	$0	$36,796	$124,777	$161,573
Mining	$0	$215,196	$164,821	$380,017
Utilities	$0	$8,031,858	$3,064,377	$11,096,235
Construction	$0	$19,414,631	$1,603,292	$21,017,923
Manufacturing	$0	$2,088,504	$2,026,582	$4,115,086
Wholesale Trade	$0	$1,154,941	$11,511,972	$12,666,913
Retail trade	$0	$2,369,241	$22,614,093	$24,983,334
Transportation & Warehousing	$0	$2,103,080	$3,728,966	$5,832,047
Information	$0	$2,333,428	$4,949,226	$7,282,653
Finance & insurance	$0	$4,677,381	$19,640,098	$24,317,479
Real estate & rental	$0	$5,476,158	$40,774,105	$46,250,263
Professional- scientific & tech services	$0	$94,951,025	$9,902,114	$104,853,139
Management of companies	$0	$1,083,954	$1,474,006	$2,557,960
Administrative & waste services	$0	$42,374,718	$5,191,608	$47,566,326
Educational services	$0	$970,937	$3,138,337	$4,109,274
Health & social services	$0	$738,978	$28,690,476	$29,429,454
Arts- entertainment & recreation	$0	$283,155	$2,197,541	$2,480,696
Accommodation & food services	$0	$1,286,703	$7,924,535	$9,211,237
Other services	$0	$1,456,505	$6,874,630	$8,331,135
Government & non NAICs*	$226,230,444	$932,040	$2,245,666	$229,408,150
TOTAL VALUE ADDED	$226,230,444	$191,979,231	$177,841,221	**$596,050,896**

Notes:
For value-added impact, the change in final demand or direct impact equals the wages and benefits paid to NASA Glenn employees.
Due to rounding, the total column does not equal the summation of the direct, indirect, and induced columns.

Total value added in Northeast Ohio increased by $596.1 million in FY 2012 as a result of NASA Glenn's spending on goods and services. Of this total amount, $226.2 million (38%) was the wages and benefits paid to NASA Glenn employees (change in final demand or direct impact). Another $192.0 million (32.2%) represented the value of goods and services, less intermediary goods, companies in Northeast Ohio supply to NASA Glenn (i.e., indirect impact). The remaining value-added impact (induced components) was estimated at $177.8 million (29.8%). It occurred as a result of NASA Glenn's spending rippling through the Northeast Ohio economy.

Of the $369.8 million increase in value added generated across Northeast Ohio due to the indirect ($192.0 million) and induced impacts ($177.8 million), $195.9 million (53%) was reported in NASA Glenn-driven industries, $145 (39.2%) was generated in consumer-driven industries, and $28.9 million (7.8%) was reported in other industries.[22]

The value-added distribution for select NASA Glenn-driven industries is shown in Figure 11. The value-added distribution for select consumer-driven industries is shown in Figure 12. Each of the select industries showed in Figures 11 and 12 added at least $10 million and $6 million each, respectively.

Persons engaged in the business support services industry saw their industry's value added increase by $24.2 million in FY 2012 (Figure 11). This increase in value added is a result of the summation of the indirect and induced impacts generated primarily, but not exclusively, by NASA Glenn using miscellaneous business support services in Northeast Ohio. The $24.2 million accounted for 12% of the $195.9 million value-added increase that was reported by all NASA Glenn-driven industries.

People working at real estate establishments saw their value-added increase by $20.3 million in FY 2012 (Figure 12). This value-added increase is a result of the summation of the indirect and induced impacts generated by consumer spending at real estate establishments. The $20.3 million accounted for 14% of the $145 million value-added increase that occurred in all consumer-driven industries.

[22] See section D.2.1. Output Impact on Northeast Ohio for definitions of NASA Glenn-driven, consumer-driven, and other industries.

Figure 11. Increase in Value Added for NASA Glenn-Driven Industries in Northeast Ohio, FY 2012

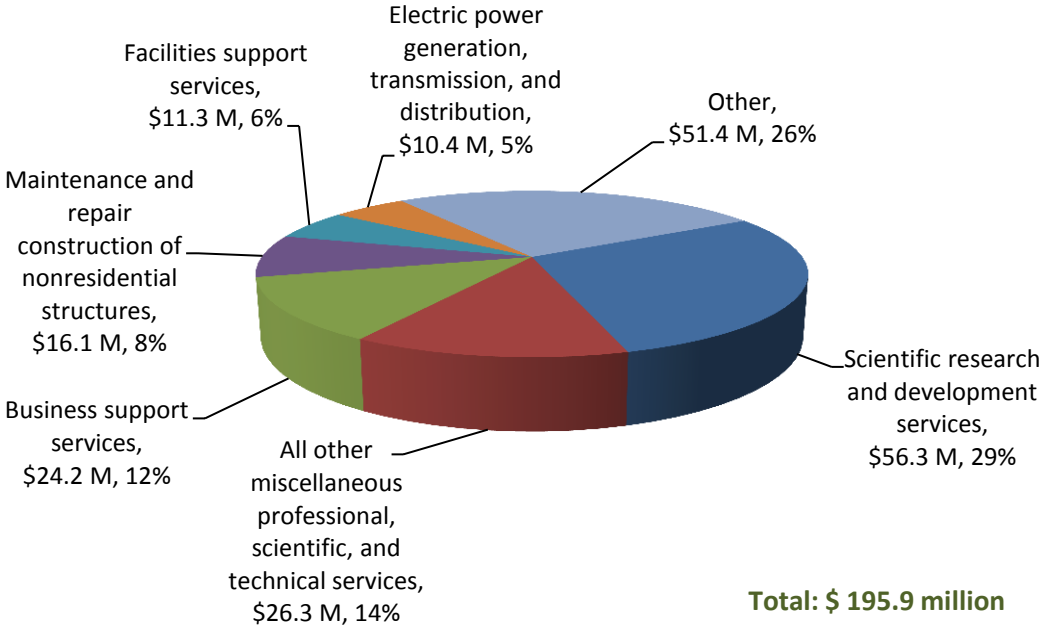
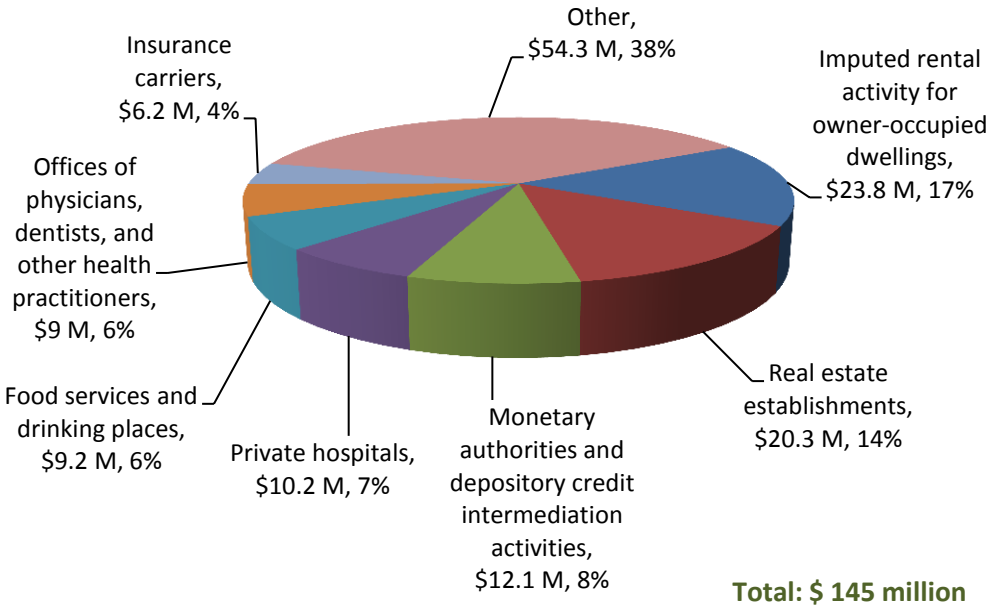


Figure 12. Increase in Value Added for Consumer-Driven Industries in Northeast Ohio, FY 2012



D.2.5. Tax Impact on Northeast Ohio, FY 2012

NASA Glenn's operation in Northeast Ohio generated a total of $83.1 million in tax revenues in FY 2012. Of that amount, local governments in Northeast Ohio and the state of Ohio benefited from increased tax revenues of $38.3 million, and federal tax revenues increased by $44.8 million in FY 2012.

D.2.6. FY 2012 Northeast Ohio Impact Summary

Economic activity conducted by NASA Glenn generated the following impact on Northeast Ohio (adjusted to 2013 dollars):

- Total Output Impact: $1,258 M
- Total Employment Impact: 6,250 jobs
- Total Labor Income Impact: $465.1 M
- Total Value-Added Impact: $596.1 M
- Total Tax Impact: $83.1 M

The economic impact presented here reflects the benefits of NASA Glenn's total expenditures of $448.7 million spent in Northeast Ohio in FY 2012. Excluding expenditures on households ($217.1 million), more than 55% ($128.2 million) of NASA Glenn's expenditures were allocated to professional, scientific and technical services; 22.2% ($51.6 million) was spent on administrative and support services; and 13.2% ($30.6 million) was spent on construction – the three largest groups of NASA Glenn expenditures in Northeast Ohio. These three sectors together accounted for 90.4% of all NASA Glenn's FY 2012 expenditures in Northeast Ohio, excluding household spending. Two more sectors, education and utilities, together accounted for another 6.8% of total expenditures.

Businesses deriving the most benefit from spending by NASA Glenn personnel and other workers whose earnings are due in part to NASA Glenn's expenditures followed typical consumer spending patterns. These included businesses in the following industries: food services, real estate companies, hospitals and healthcare services, motor vehicle dealers, accounting services, commercial banks, and miscellaneous retailers.

D.3. Economic Impact on the State of Ohio, FY 2012

In this section, we present the economic impact of NASA Glenn on the Ohio economy in FY 2012. The economic impact is presented through a detailed analysis of the change in output (sales), employment, labor income (household earning), value added, and taxes due to NASA Glenn's activities in Ohio. This section follows the structure of Section D.2., Economic Impact on Northeast Ohio, FY 2012.

D.3.1. Output Impact on the State of Ohio, FY 2012

The economic impact analysis uses multipliers to estimate the ripple effect that an initial expenditure has on a studied economy. These multipliers measure the effect of NASA Glenn's spending on output (sales) across the state of Ohio. The multipliers applied to spending in Ohio are generally larger than those applied to expenditures in Northeast Ohio because a larger geographic area allows for the capture of more purchases within the region, which, in turn, enables more purchases from the regional economy suppliers and, therefore, less leakage from the economy.

NASA Glenn's expenditures were divided into two categories: (1) spending on goods and services purchased from companies and other institutions located in the state of Ohio (local) and (2) spending on goods and services from businesses located outside the state of Ohio. Local spending is then categorized by products produced in local economy, based on an IMPLAN classification system of industries that produced the products and differentiates spending across 440 sectors. Table A.4. in Appendix A provides a detailed list of NASA Glenn's expenditures by industry in the state of Ohio.

Table 11 presents the total output impact and its components. Local NASA Glenn expenditures represented the direct output impact (change in final demand). Indirect impact was estimated by summing the contributions of individual industries that provided inputs to the producers of goods and services ultimately consumed by NASA Glenn. Induced impact was estimated by measuring the spending of workers who were employed as a result of the increased demand for products and services created by NASA Glenn. Total output impact is the sum of direct impact, indirect impact, and induced impact. Table 11 reports output impacts by industry sector, illustrating how NASA Glenn's spending across Ohio affects all sectors of the state economy.

Table 11. Output Impact in the State of Ohio, FY 2012

Industry	Direct	Indirect	Induced	Total
Agriculture, Forestry, Fishing, Hunting	$0	$384,435	$1,287,720	$1,672,155
Mining	$0	$2,000,711	$1,702,733	$3,703,444
Utilities	$0	$14,772,304	$7,849,619	$22,621,923
Construction	$0	$36,361,706	$3,421,776	$39,783,482
Manufacturing	$0	$14,069,292	$23,803,672	$37,872,964
Wholesale Trade	$0	$2,099,247	$17,238,911	$19,338,158
Retail trade	$0	$3,818,161	$38,784,866	$42,603,027
Transportation & Warehousing	$0	$4,955,068	$8,580,261	$13,535,329
Information	$0	$7,411,181	$13,224,071	$20,635,252
Finance & insurance	$0	$10,447,793	$40,435,235	$50,883,028
Real estate & rental	$0	$8,987,056	$66,297,731	$75,284,787
Professional- scientific & tech services	$0	$201,589,605	$14,065,748	$215,655,353
Management of companies	$0	$2,577,820	$3,264,638	$5,842,458
Administrative & waste services	$0	$73,028,706	$9,541,620	$82,570,326
Educational services	$0	$2,750,596	$5,383,196	$8,133,792
Health & social services	$0	$1,097,574	$55,944,005	$57,041,579
Arts- entertainment & recreation	$0	$585,903	$4,567,470	$5,153,373
Accommodation & food services	$0	$3,430,728	$18,426,937	$21,857,665
Other services	$0	$2,930,216	$13,559,430	$16,489,646
Government & non NAICs	$660,927,084	$2,225,544	$5,779,930	$668,932,558
TOTAL OUTPUT	$660,927,084	$395,523,646	$353,159,569	**$1,409,610,299**

Notes:
Direct impact of NASA Glenn is a change in final demand that is applied to a sector of NASA Glenn's industry, NAICS 9271 – Space Research and Technology, which is a part of a larger industry sector NAICS 92 – Public Administration (Government & non NAICs). For output impact, the change in final demand or direct impact equals the spending of NASA Glenn for goods and services within and outside Ohio, including wages and benefits.

The total output impact across the state of Ohio of NASA Glenn's spending on goods and services was $1,410 million in FY 2012. NASA Glenn's expenditures of $660.9 million resulted in an increase in output (sales) of $1,410 million across all industry sectors (Table 11). For example, NASA Glenn's spending affected a $215.7 million increase in sales (direct, indirect, and induced impacts) in professional, scientific, and technical services, and a $37.9 million increase in sales in the manufacturing sector.

Of the total output impact, 47% ($660.9 million) was accounted for by the change in final demand or direct impact that occurred because NASA Glenn's activities bring resources into Ohio from outside the state. Approximately $395.5 million (28%) of the total output impact was a result of indirect spending by NASA Glenn on goods and services purchased within the state of Ohio. The remaining output impact of $353.2 million (25%) was due to the induced component as NASA Glenn's spending rippled through the state economy.

An analysis of the IMPLAN model shows that the $748.7 million increase in sales generated by the indirect and induced impacts can be divided into the same broad categories that were identified for Northeast Ohio: NASA Glenn-driven industries ($389.4 million, 52%), consumer-driven industries ($269.3 million, 36%), and other industries ($90 million, 12%).[23]

The output distribution for select NASA Glenn-driven industries is shown in Figure 13. The output distribution for select consumer-driven industries is shown in Figure 14. The select industries shown in Figures 13 and 14 each added over $9 million.

The electric power generation and transmission industry in the state of Ohio saw an increase in revenue of $19.8 million in FY 2012 (Figure 13). This amount is the summation of the indirect and induced impacts generated primarily, but not exclusively, by NASA Glenn's spending. This increase of $19.8 million accounted for a 5% share of the $389.4 million increase in output value for all NASA Glenn-driven industries.

Food services and drinking places industry experienced a sales increase of $21.6 million in FY 2012 (Figure 14). This amount is the summation of the indirect and induced impact components generated primarily by NASA Glenn employees and other workers for dining at restaurants and using other food services. This increase of $21.6 million represented an 8% share of the $269.3 million increase in output for all consumer-driven industries.

[23] NASA Glenn-driven sectors include utilities, construction, information, professional and scientific services, administrative and support services, and education. Consumer-driven sectors include retail, finance and insurance, real estate, health care, entertainment and food, other services, and owner-occupied buildings.

Figure 13. Increase in Sales for Select NASA Glenn-Driven Industries in Ohio, FY 2012

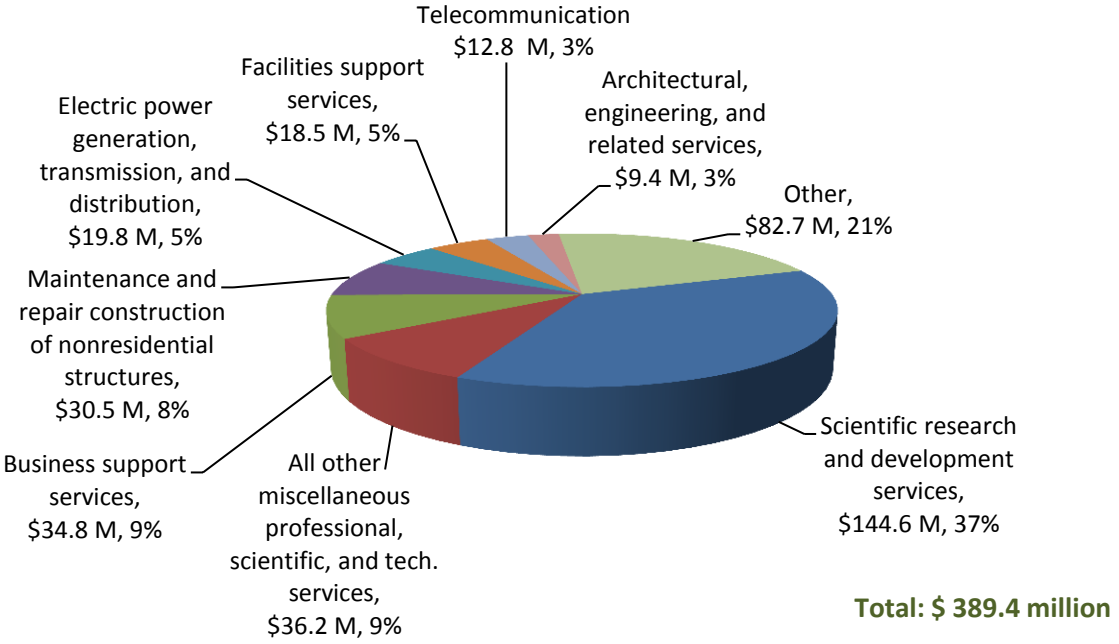
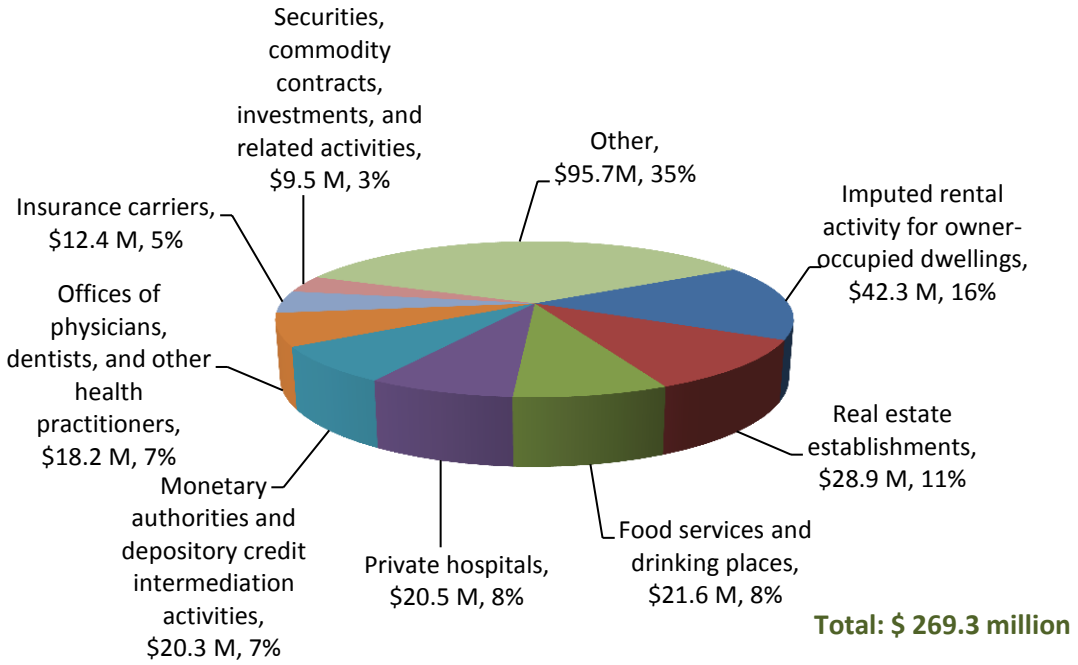


Figure 14. Increase in Sales for Select Consumer-Driven Industries in Ohio, FY 2012



D.3.2. Employment Impact on the State of Ohio, FY 2012

NASA Glenn's activities affected job creation beyond its own hiring of employees (change in final demand or direct impact). NASA Glenn's spending created employment across the state of Ohio in the supply-chain industries from which it purchases goods and services (indirect impact).

In addition, money spent by NASA Glenn employees and employees of supply companies created jobs in a variety of other industries (induced impact). The total employment impact equals the sum of NASA Glenn's employment (direct impact) and the indirect and induced components. Table 12 shows the number of jobs created by industry sector.

Table 12. Employment Impact in the State of Ohio, FY 2012

Industry	Direct	Indirect	Induced	Total
Agriculture, Forestry, Fishing & Hunting	0	6	12	18
Mining	0	6	5	12
Utilities	0	17	9	26
Construction	0	363	29	393
Manufacturing	0	36	41	77
Wholesale Trade	0	12	99	111
Retail trade	0	73	577	650
Transportation & Warehousing	0	34	62	96
Information	0	23	41	64
Finance & insurance	0	45	184	229
Real estate & rental	0	46	138	184
Professional- scientific & tech services	0	1,151	114	1,265
Management of companies	0	12	15	27
Administrative & waste services	0	1,034	155	1,189
Educational services	0	35	102	138
Health & social services	0	9	591	600
Arts- entertainment & recreation	0	11	82	93
Accommodation & food services	0	61	332	393
Other services	0	41	219	260
Government & non NAICs*	1,659	16	39	1,713
TOTAL EMPLOYMENT	1,659	3,031	2,846	**7,538**

Notes:

For employment impact, the change in final demand (direct impact) equals the number of employees working for NASA Glenn. Due to rounding, the total column does not equal the summation of the direct, indirect, and induced columns.

Employment increased by 7,538 jobs in Ohio in FY 2012 because of NASA Glenn's presence in the state. Of these jobs, 1,659 people (22%) were directly employed at NASA Glenn. As a result of NASA Glenn's direct spending for goods and services purchased in Ohio, 3,031 jobs (40.2%) were created (indirect effect). The remaining employment impact—2,846 jobs (37.7%)—was in the form of induced impact as NASA Glenn's spending rippled through the state economy.

Of the 5,877 jobs created in Ohio due to the indirect and induced components, 3,074 (52.3%) were found in NASA Glenn-driven sectors, 2,410 (41%) were in consumer-driven sectors, and 393 (6.7%) fell under the category of other sectors.[24]

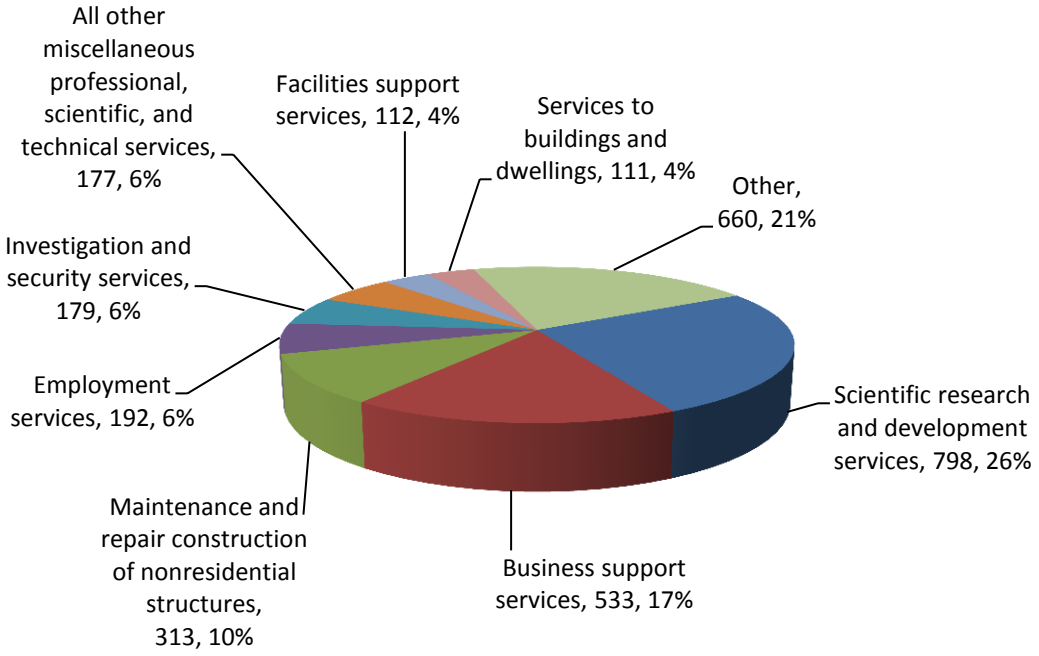
The job distribution for select NASA Glenn-driven industries is shown in Figure 15. The job distribution for select consumer-driven industries is shown in Figure 16. Each of the selected industries shown in Figures 15 and 16 each added over 100 jobs.

Because of NASA Glenn's spending in the state of Ohio, 533 jobs were added in business support services during FY 2012 (Figure 15). These jobs are the summation of the direct, indirect, and induced employment impacts generated primarily, but not exclusively, by NASA Glenn's need for business support services. The 533 jobs accounted for a 17% share of the 3,074 jobs that were created in all NASA Glenn-driven industries.

The general merchandise retail stores industry experienced an increase of 113 jobs in FY 2012 (Figure 16). The 113 jobs accounted for a 5% share of the 2,410 jobs that were created in all consumer-driven industries.

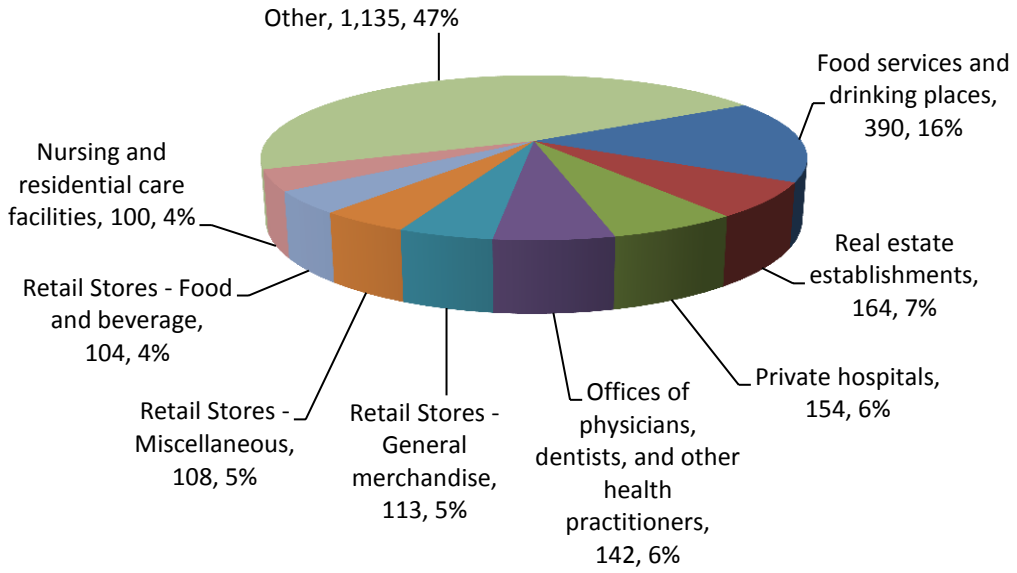
[24] Glenn-driven industries include utilities, construction, information, professional and scientific services, administrative and support services, and education. Consumer-driven industries include retail, finance and insurance, real estate, healthcare, entertainment and food, other services, and owner-occupied buildings.

Figure 15. Increase in Jobs for Select NASA Glenn-Driven Industries in Ohio, FY 2012



Total: 3,074 jobs

Figure 16. Increase in Jobs for Select Consumer-Driven Industries in Ohio, FY 2012



Total: 2,410 jobs

D.3.3 Labor Income Impact on the State of Ohio, FY 2011

Labor income (household earnings) is the estimated change in earnings received by households in the state of Ohio due to NASA Glenn's spending on goods and services within the state. Wages and benefits paid to NASA Glenn employees in Ohio constituted the change in final demand or direct impact of NASA Glenn in Ohio measured in Labor Income. Money paid to employees of companies and other suppliers of goods and services to NASA Glenn represented the indirect earnings impact. Induced impact was generated through the spending of workers in all industries who were employed as a result of the increased demand for products and services created by NASA Glenn. Adding the direct, indirect, and induced impacts together we define the total earnings impact of NASA Glenn. Table 13 shows the labor income impact by industry sector.

Table 13. Labor Income Impact in the State of Ohio, FY 2012

Industry	Direct	Indirect	Induced	Total
Agriculture, Forestry, Fishing, Hunting	$0	$97,160	$278,823	$375,983
Mining	$0	$274,587	$159,804	$434,391
Utilities	$0	$2,158,505	$1,126,287	$3,284,792
Construction	$0	$18,749,101	$1,538,977	$20,288,078
Manufacturing	$0	$2,445,087	$2,728,405	$5,173,492
Wholesale Trade	$0	$886,522	$7,280,074	$8,166,596
Retail trade	$0	$1,715,836	$17,130,440	$18,846,276
Transportation & Warehousing	$0	$1,711,118	$3,182,859	$4,893,977
Information	$0	$1,572,315	$2,453,074	$4,025,389
Finance & insurance	$0	$2,398,021	$10,154,909	$12,552,931
Real estate & rental	$0	$1,207,327	$2,959,653	$4,166,980
Professional- scientific & tech services	$0	$94,505,606	$7,090,191	$101,595,797
Management of companies	$0	$1,336,003	$1,691,959	$3,027,961
Administrative & waste services	$0	$37,271,846	$5,034,525	$42,306,372
Educational services	$0	$1,335,930	$2,902,561	$4,238,491
Health & social services	$0	$496,754	$30,165,640	$30,662,394
Arts- entertainment & recreation	$0	$228,159	$1,737,133	$1,965,292
Accommodation & food services	$0	$1,191,759	$6,429,846	$7,621,605
Other services	$0	$1,702,159	$7,395,720	$9,097,879
Government & non NAICs	$226,230,444	$1,012,891	$2,196,269	$229,439,604
TOTAL LABOR INCOME	$226,230,444	$172,296,685	$113,637,150	**$512,164,280**

Notes:
Labor income constitutes economic impact through households of NASA Glenn employees and those affected by NASA Glenn operations throughout the economy.
For labor income impact, the change in final demand or direct impact equals the wages and benefits paid to NASA Glenn employees.
Due to rounding, the total column does not equal the summation of the direct, indirect, and induced columns.

Total labor income in the state of Ohio increased by $512.2 million as a result of NASA Glenn's spending on goods and services in FY 2012. Of this amount, $226.2 million (44.2%) was wages and benefits paid to NASA Glenn employees (change in final demand or direct impact). Monies paid to employees of companies across the state that supplied goods and services to NASA Glenn (indirect impact) represented $172.3 million (33.6%). The remaining earnings impact (induced component), estimated to be $113.6 million (22.2%), and was the result of NASA Glenn's spending rippling through the Ohio economy.

Of the $285.9 million increase in household earnings attributed to the indirect and induced impacts, $175.7 million (61.5%) was reported in Glenn-driven industries, $84.9 million (29.7%) occurred in consumer-driven industries, and $25.3 million (8.8%) was reported in other industries.[25]

The household-earnings distribution for select NASA Glenn-driven industries is shown in Figure 17. The household earnings distribution for select consumer-driven industries is shown in Figure 18. The selected industries shown in these figures experienced the most gains in earnings (over $4 million each in Figure 17 and over $3 million each in Figure 18).

Within the NASA Glenn-driven industries, employees in scientific research and development services across the state of Ohio saw their household earnings increase by $73 million in FY 2012 (Figure 17). These earnings are the summation of the indirect and induced impacts generated primarily, but not exclusively, by NASA Glenn's purchases of architectural and engineering services. The $73 million represented a 42% of the $175.7 million earnings increase that occurred in all NASA Glenn-driven industries.

Within the consumer-driven industries, persons working for private hospitals experienced an increase in household earnings of $9.5 million in FY 2012 (Figure 18). This amount is the summation of the indirect and induced impacts generated primarily by the spending of NASA Glenn employees and other workers on private hospitals. The $9.5 million accounted for an 11% share of the $84.9 million earnings increase that was reported by all consumer-driven industries.

[25] See section D.2.1. Output Impact on Northeast Ohio, FY 2011 for detailed definitions of NASA Glenn-driven, consumer-driven, and other industries.

Figure 17. Increase in Labor Income for Select NASA Glenn-Driven Industries in Ohio, FY 2012

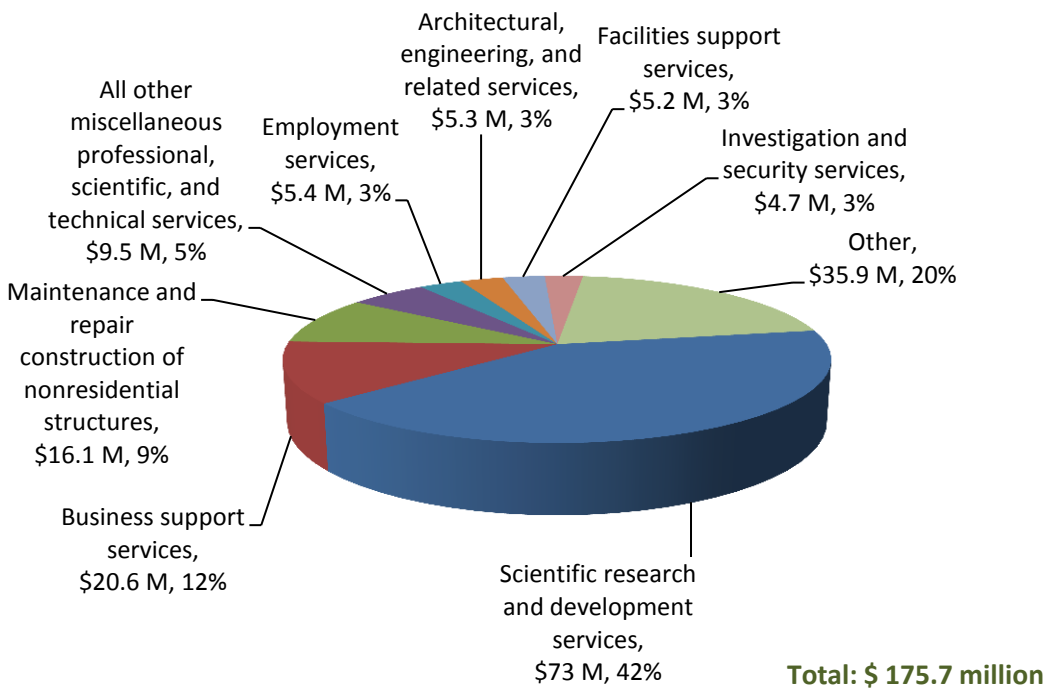
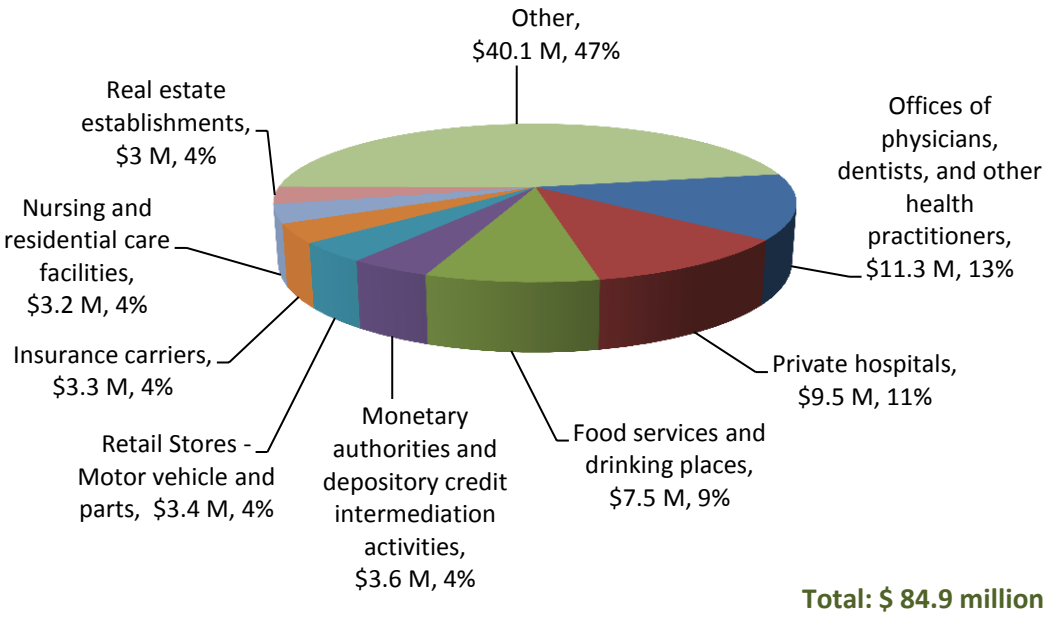


Figure 18. Increase in Labor Income for Select Consumer-Driven Industries in Ohio, FY 2012



D.3.4. Value-Added Impact on the State of Ohio, FY 2012

NASA Glenn's spending affected an increase of $668.4 million in value added for all industries.[26] The wages and benefits received by NASA Glenn employees constituted the change in final demand (direct impact) for value added. Sales (less intermediary goods and services) of companies and other entities who supply goods and services to NASA Glenn represented the indirect value-added impact. Induced impact represented sales, excluding intermediary goods and services, in all industries that produced products for households whose income is affected by the demand for products and services created by NASA Glenn. The total value-added impact is a summation of the direct, indirect, and induced impacts (Table 14).

[26] Value added measures the economic impact of all goods and services produced in the state of Ohio due to NASA Glenn's operation (excluding intermediary goods).

Table 14. Value-Added Impact in the State of Ohio, FY 2012

Industry	Direct	Indirect	Induced	Total
Agriculture, Forestry, Fishing, Hunting	$0	$147,177	$517,091	$664,268
Mining	$0	$771,591	$523,616	$1,295,207
Utilities	$0	$8,531,133	$4,223,174	$12,754,307
Construction	$0	$20,190,791	$2,122,106	$22,312,897
Manufacturing	$0	$4,249,636	$5,411,365	$9,661,000
Wholesale Trade	$0	$1,541,833	$12,661,458	$14,203,291
Retail trade	$0	$2,901,293	$27,217,949	$30,119,242
Transportation & Warehousing	$0	$2,503,665	$4,424,807	$6,928,472
Information	$0	$3,355,565	$6,097,345	$9,452,910
Finance & insurance	$0	$5,789,570	$21,650,193	$27,439,763
Real estate & rental	$0	$6,539,004	$45,847,665	$52,386,669
Professional- scientific, tech services	$0	$123,439,091	$9,787,178	$133,226,268
Management of companies	$0	$1,540,468	$1,950,900	$3,491,368
Administrative & waste services	$0	$46,114,743	$6,052,785	$52,167,528
Educational services	$0	$1,464,587	$3,179,920	$4,644,507
Health & social services	$0	$731,838	$33,449,183	$34,181,021
Arts- entertainment & recreation	$0	$297,870	$2,356,760	$2,654,630
Accommodation & food services	$0	$1,744,433	$9,382,625	$11,127,057
Other services	$0	$1,855,654	$7,951,526	$9,807,180
Government & non NAICs*	$226,230,444	$1,148,093	$2,537,822	$229,916,359
TOTAL VALUE ADDED	$226,230,444	$234,858,031	$207,345,467	**$668,433,943**

Notes:
For value-added impact, the change in final demand (direct impact) equals the wage and benefits paid to NASA Glenn employees.
Due to rounding, the total column does not equal the summation of the direct, indirect, and induced columns.

Total value added in the state of Ohio increased by $668.4 million as a result of NASA Glenn's spending on goods and services in FY 2012. Of this total amount, $226.2 million (33.8%) was the wages and benefits paid directly to NASA Glenn employees (change in final demand or direct impact). Another $234.9 million (35.1%) represented the value of goods and services (less intermediary goods) companies in Ohio to NASA Glenn (indirect impact). The remaining value-added impact (induced component), estimated to be $207.3 million (31%), occurred as the effects of NASA Glenn's spending rippled through the Ohio economy.

Of the $442.2 million increase in value added generated across Ohio due to the indirect and induced impacts, $234.6 million (53%) was reported in NASA Glenn-driven industries, $167.7 (37.9%) was generated in consumer-driven industries, and $39.9 million (9%) was reported in other industries.[27]

The value-added distribution for select NASA Glenn-driven industries is shown in Figure 19. The value-added distribution for select consumer-driven industries is shown in Figure 20. Selected industries in Figure 19 and Figure 20 each added over $11 million.

Within the NASA Glenn-driven industries, persons engaged in miscellaneous professional, scientific and technical services saw the sector's value added increase by $27.6 million in FY 2012 (Figure 19). This increase is a result of the summation of the indirect and induced impacts generated primarily, but not exclusively, by NASA Glenn's spending on miscellaneous professional, scientific, and technical services. The $27.6 million accounted for 12% of the $234.6 million value-added increase that was reported by all NASA Glenn-driven industries.

Within the consumer-driven industries, persons working for monetary authorities saw the industry's value added increase by $13.2 million in FY 2012 (Figure 20). This increase is a result of the summation of the indirect and induced impacts generated by consumer spending on monetary authorities. The increase of $13.2 million accounted for 8% of the $167.7 million value-added increase that occurred in all consumer-driven industries.

[27] See section D.2.1 Output Impact on Northeast Ohio, FY 2011 for definitions of NASA Glenn-driven, consumer-driven, and other industries.

Figure 19. Increase in Value Added for NASA Glenn-Driven Industries in the State of Ohio, FY 2012

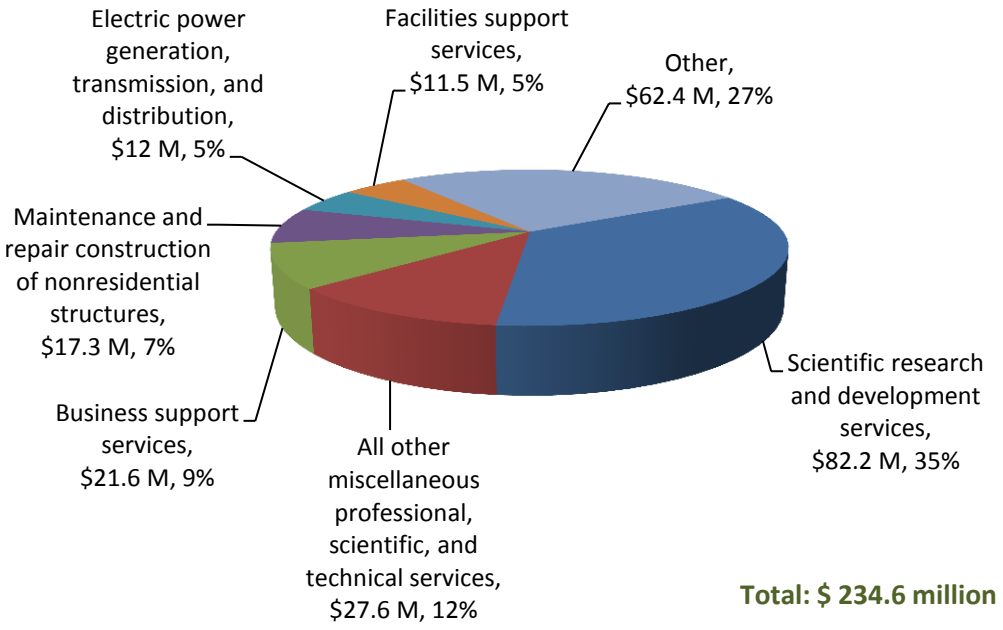
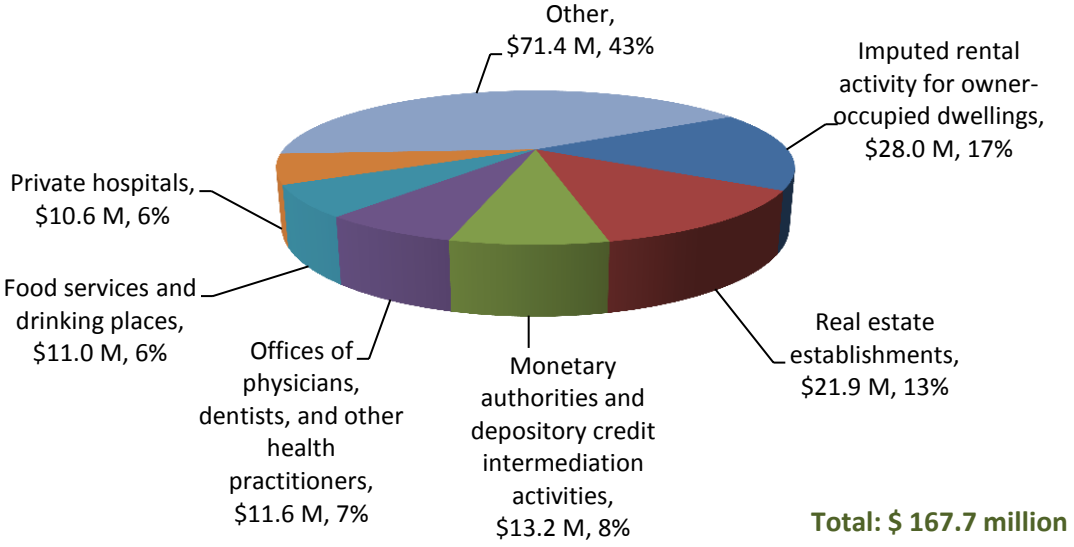


Figure 20. Increase in Value Added for Consumer-Driven Industries in the State of Ohio, FY 2012



D.3.5. Tax Impact on the State of Ohio, FY 2012

NASA Glenn's operation and economic impact on the state of Ohio in FY 2012 increased tax revenues by a total of $97.1 million. Of that total, state and local governments in Ohio benefited from increased tax revenues of $43.9 million, and federal tax revenues increased by $53.1 million.

D.3.6. FY 2011 Ohio Impact Summary

The economic activity of NASA Glenn generated the following impact on the state of Ohio (adjusted to 2013 dollars):

- Total Output Impact: $1,410 M
- Total Employment Impact: 7,538 jobs
- Total Labor Income Impact: $512.2 M
- Total Value-Added Impact: $668.4 M
- Total Tax Impact: $97.1 M

The impact of NASA Glenn's expenditures on the state of Ohio is only slightly higher than the impact on Northeast Ohio. This is because the majority of NASA Glenn's expenditures in Ohio were spent in Northeast Ohio. In FY 2012,

NASA Glenn's expenditures in the state of Ohio were $512.1 million (only $63.4 million more than in Northeast Ohio).

Compared to FY 2011, NASA Glenn spent less in FY 2012 to buy products and services from Ohio suppliers by $34.4 million (in comparable 2012$). The payments from NASA Glenn for utilities, wholesale and retail, and manufacturing products increased by $0.8 million for three sectors together, but expenditures decreased significantly for the majority of other sectors. The largest cuts in expenditures, compared to FY2011 were in professional, scientific and technical services ($18.4 million) and information and telecommunication ($13.4 million), after accounting for inflation.

More than 97.3% of NASA Glenn spending in Ohio ($282.2 million), excluding household spending, went to the following industry sectors: professional, scientific and technical services ($176.4 million); administrative and support services ($57.2 million); construction ($30.6 million); utilities ($13 million); and education ($5 million).

Since NASA Glenn's statewide expenditures mirrored those spent in Northeast Ohio, the industries across Ohio that derived the most benefit from NASA Glenn's spending and the spending of NASA Glenn employees and other workers were similar to those reported for Northeast Ohio.[28]

[28] A close examination of the IMPLAN results show that a few industry sectors have slightly higher values for the direct impact for Northeast Ohio than for the state of Ohio. The reason for this is the distribution of disposable income (NASA Glenn payroll) by IMPLAN to those industries from which households typically make purchases. When making this distribution for the state of Ohio, IMPLAN assumes that households have the same distribution as the population across the state. Persons living in the Appalachian area of southeast Ohio or the farming regions of western Ohio do not have the same spending patterns as their counterparts in Greater Cleveland. For example, persons living in Appalachia do not spend as much on the arts and financial services as people living in suburban Cleveland. The IMPLAN results simply reflect this reality.

APPENDIX A: DATA TABLES

Table A.1. NASA Glenn Spending by State, FY 2012

Table A.2. NASA Glenn Monies Allocated to Academic Institutions, FY 2012

Table A.3. NASA Glenn Detailed Expenditures in Northeast Ohio, FY 2012

Table A.4. NASA Glenn Detailed Expenditures in the State of Ohio, FY 2012

Table A.1. NASA Glenn Spending by State, Excluding Payroll, FY 2012

State	Spending	Share
Ohio	$289,971,443	66.71%
California	$24,320,718	5.59%
Maryland	$21,372,980	4.92%
Virginia	$10,529,442	2.42%
Massachusetts	$7,710,480	1.77%
Connecticut	$6,735,885	1.55%
Colorado	$6,468,599	1.49%
Missouri	$6,369,308	1.47%
Pennsylvania	$5,103,185	1.17%
New Jersey	$4,687,400	1.08%
Arizona	$4,590,456	1.06%
Texas	$4,248,458	0.98%
Indiana	$3,484,061	0.80%
Florida	$3,427,850	0.79%
Tennessee	$3,382,564	0.78%
Washington DC	$3,299,268	0.76%
New York	$3,129,577	0.72%
Illinois	$2,975,711	0.68%
Michigan	$2,712,390	0.62%
Oklahoma	$2,378,173	0.55%
Iowa	$1,635,687	0.38%
Alabama	$1,486,652	0.34%
Washington	$1,326,586	0.31%
Georgia	$1,311,989	0.30%
New Hampshire	$1,291,137	0.30%
North Carolina	$1,237,761	0.28%
Kansas	$1,103,547	0.25%
Minnesota	$778,818	0.18%
West Virginia	$763,789	0.18%
Wisconsin	$715,953	0.16%
Oregon	$711,399	0.16%
Utah	$667,895	0.15%

State	Spending	Share
Delaware	$651,509	0.15%
Arkansas	$614,078	0.14%
Kentucky	$564,503	0.13%
New Mexico	$529,297	0.12%
Montana	$317,825	0.07%
Wyoming	$313,443	0.07%
Nebraska	$288,026	0.07%
Puerto Rico	$279,864	0.06%
Rhode Island	$219,436	0.05%
South Dakota	$201,940	0.05%
Idaho	$179,805	0.04%
Mississippi	$146,784	0.03%
South Carolina	$118,738	0.03%
Maine	$116,541	0.03%
Vermont	$95,275	0.02%
Louisiana	$15,238	0.00%
Hawaii	$10,503	0.00%
Nevada	$(295,838)	-0.07%
Canada	$253,157	0.06%
Great Britain	$101,113	0.02%
Germany	$39,275	0.01%
ISRAEL	$4,271	0.00%
AUSTRALIA	$2,653	0.00%
SWITZERLAND	$41	0.00%
Outside U.S. Total	$400,511	0.09%
Total	**$434,696,639**	**100%**

Table A.2. NASA Glenn Funding Allocated to Academic Institutions by State, FY 2012

State	Amount	Share
Ohio	$4,926,388	22.0%
Oklahoma	$2,276,850	10.2%
Maryland	$2,145,403	9.6%
California	$1,835,881	8.2%
Massachusetts	$1,804,511	8.1%
Indiana	$1,034,395	4.6%
Texas	$798,792	3.6%
Pennsylvania	$788,219	3.5%
West Virginia	$761,633	3.4%
Illinois	$722,408	3.2%
Kentucky	$480,263	2.1%
Connecticut	$385,988	1.7%
North Carolina	$356,148	1.6%
Michigan	$352,363	1.6%
Oregon	$312,158	1.4%
New Jersey	$304,698	1.4%
Tennessee	$282,849	1.3%
Puerto Rico	$279,864	1.3%
Iowa	$268,636	1.2%
Georgia	$262,929	1.2%
Florida	$261,778	1.2%
Missouri	$252,808	1.1%
New York	$225,356	1.0%
Colorado	$222,201	1.0%
Washington	$173,007	0.8%
New Mexico	$154,119	0.7%
Virginia	$147,283	0.7%
Alabama	$144,618	0.6%
Mississippi	$137,168	0.6%
Delaware	$121,900	0.5%
Vermont	$83,161	0.4%
Arizona	$29,464	0.1%
Wyoming	$13,617	0.1%
Rhode Island	$12,139	0.1%
Hawaii	$10,503	0.0%
Total	**$22,369,498**	**100.0%**

Table A.3. NASA Glenn Detailed Expenditures in Northeast Ohio, FY 2012

NAICS Sector	Description	IMPLAN Sector (a)	Expenditure (b)
Utilities			**$12,954,745**
	Electric power generation, transmission, and distribution	31	$12,230,382
	Natural gas distribution	32	$709,750
	Water, sewage and other treatment and delivery systems	33	$14,613
Construction			**$30,572,796**
	Construction of other new nonresidential structures	36	$7,806,679
	Maintenance and repair construction of nonresidential structures	39	$22,766,117
Manufacturing			**$1,518,182**
	Printing	113	$2,440
	Petroleum lubricating oil and grease manufacturing	118	$104,921
	Industrial gas manufacturing	121	$25,178
	Clay and non-clay refractory manufacturing	155	$23,895
	Plate work and fabricated structural product manufacturing	186	$54,687
	Hardware manufacturing	193	$4,011
	Machine shops	195	$140,366
	Valve and fittings other than plumbing manufacturing	198	$299,070
	Plumbing fixture fitting and trim manufacturing	199	$4,415
	Other fabricated metal manufacturing	202	$209,945
	Other industrial machinery manufacturing	207	$35,546
	Other general purpose machinery manufacturing	230	$21,536
	Industrial process furnace and oven manufacturing	232	$5,890
	Other electronic component manufacturing	247	$23,298
	Industrial process variable instruments manufacturing	251	$23,010
	Totalizing fluid meters and counting devices manufacturing	252	$3,868
	Electricity and signal testing instruments manufacturing	253	$5,530
	Analytical laboratory instrument manufacturing	254	$9,224
	Watch, clock, and other measuring and controlling device manufacturing	256	$35,108
	Switchgear and switchboard apparatus manufacturing	268	$19,085
	All other miscellaneous electrical equipment and component manufacturing	275	$58,581
	Other aircraft parts and auxiliary equipment manufacturing	286	$396,832
	Gasket, packing, and sealing device manufacturing	315	$10,250

NAICS Sector	Description	IMPLAN Sector (a)	Expenditure (b)
	All other miscellaneous manufacturing	317	$1,496
Wholesale & Retail Trade			**$2,204,120**
	Wholesale trade businesses	319	$202,136
	Retail - Electronics and appliances	322	$13,877
	Retail - Miscellaneous	330	$1,986,477
	Retail – Non-store	331	$1,630
Transportation			**$35,514**
	Transport by truck	335	$35,664
	Transit and ground passenger transportation	336	($150)
Information & Telecommunication			**$4,979**
	Book publishers	343	$2,350
	Telecommunications	351	$2,629
Real Estate and Rental & Leasing			**$406,645**
	Commercial and industrial machinery and equipment rental and leasing	365	$406,645
Professional, Scientific, & Technical Services			**$128,155,794**
	Legal services	367	$30,770
	Accounting, tax preparation, bookkeeping, and payroll services	368	$11,200
	Architectural, engineering, and related services	369	$2,332,621
	Other computer related services, including facilities management	373	$1,036,600
	Management, scientific, and technical consulting services	374	$101,275
	Scientific research and development services	376	$92,199,238
	All other miscellaneous professional, scientific, and technical services	380	$32,444,090
Administrative & Support and Waste Management Services			**$51,563,165**
	Facilities support services	385	$17,855,381
	Business support services	386	$32,936,187
	Investigation and security services	387	$769,497
	Other support services	389	$2,100
Education			**$2,750,453**
	Private junior colleges, colleges, universities, and professional schools	392	$2,713,228
	Other educational services	393	$37,225

NAICS Sector	Description	IMPLAN Sector (a)	Expenditure (b)
Health Care & Social Assistance			**$1,182,330**
	Medical and diagnostic labs and outpatient and other ambulatory care services	396	$1,182,330
Arts, Entertainment & Recreation			**$127,290**
	Museums, historical sites, zoos, and parks	406	$127,290
Accommodation & food services			**$37,956**
	Hotels and motels, including casino hotels	411	$15,037
	Food services and drinking places	413	$22,919
Repair & Maintenance			**$125,363**
	Electronic and precision equipment repair and maintenance	416	$23,255
	Commercial and industrial machinery and equipment repair and maintenance	417	$102,108
Household			**$217,079,236**
	Household spending (c)	10001-10009	$217,079,236
TOTAL EXPENDITURES in Northeast Ohio			**$448,718,567**

a. Sector: Industry classification code used by IMPLAN. It is analogous to the North American Industry Classification System (NAICS). IMPLAN provides a cross-reference table bridging their sector numbers and NAICS codes.
b. Expenditure: Actual dollar value for a product or service spent by NASA Glenn in FY 2012. Values shown in Table A-3 are limited to expenditures made in Northeast Ohio.
c. Households: Household expenditures include Glenn employees' wages and benefits.

Table A.4. NASA Glenn Detailed Expenditures in the State of Ohio, FY 2012

NAICS Sector	Description	IMPLAN Sector (a)	Expenditure (b)
Utilities			**$13,049,263**
	Electric power generation, transmission, and distribution	31	$12,230,382
	Natural gas distribution	32	$709,750
	Water, sewage and other treatment and delivery systems	33	$109,131
Construction			**$30,572,796**
	Construction of other new nonresidential structures	36	$7,806,679
	Maintenance and repair construction of nonresidential structures	39	$22,766,117
Manufacturing			**$2,882,092**
	Footwear manufacturing	93	($320)
	Printing	113	$2,930
	Petroleum lubricating oil and grease manufacturing	118	$110,745
	Industrial gas manufacturing	121	$25,178
	Other basic organic chemical manufacturing	126	$4,500
	Plastics material and resin manufacturing	127	$69,289
	All other chemical product and preparation manufacturing	141	$4,716
	Polystyrene foam product manufacturing	146	$12,738
	Clay and non-clay refractory manufacturing	155	$23,895
	All other forging, stamping, and sintering	181	$7,350
	Hand-tool manufacturing	185	$39,783
	Plate work and fabricated structural product manufacturing	186	$79,907
	Ornamental and architectural metal products manufacturing	187	$14,895
	Hardware manufacturing	193	$4,621
	Machine shops	195	$661,300
	Valve and fittings other than plumbing manufacturing	198	$299,070
	Plumbing fixture fitting and trim manufacturing	199	$4,415
	Fabricated pipe and pipe fitting manufacturing	201	$90,863
	Other fabricated metal manufacturing	202	$224,045
	Other industrial machinery manufacturing	207	$35,546
	Mechanical power transmission equipment manufacturing	224	$422
	Material handling equipment manufacturing	228	$24,200
	Other general purpose machinery manufacturing	230	$44,776
	Industrial process furnace and oven manufacturing	232	$5,890
	Other electronic component manufacturing	247	$66,855
	Industrial process variable instruments manufacturing	251	$23,010

NAICS Sector	Description	IMPLAN Sector (a)	Expenditure (b)
	Totalizing fluid meters and counting devices manufacturing	252	$3,868
	Electricity and signal testing instruments manufacturing	253	$46,644
	Analytical laboratory instrument manufacturing	254	$27,058
	Watch, clock, and other measuring and controlling device manufacturing	256	$55,753
	Motor and generator manufacturing	267	$4,224
	Switchgear and switchboard apparatus manufacturing	268	$19,085
	Wiring device manufacturing	273	$4,415
	Carbon and graphite product manufacturing	274	$3,569
	All other miscellaneous electrical equipment and component manufacturing	275	$58,581
	Aircraft engine and engine parts manufacturing	285	$48,540
	Other aircraft parts and auxiliary equipment manufacturing	286	$408,201
	All other transportation equipment manufacturing	294	$299,966
	Upholstered household furniture manufacturing	296	$3,609
	Office furniture and custom architectural woodwork and millwork manufacturing[1]	301	$6,214
	Gasket, packing, and sealing device manufacturing	315	$10,250
	All other miscellaneous manufacturing	317	$1,496
Wholesale & Retail Trade			**$2,849,489**
	Wholesale trade businesses	319	$343,927
	Retail - Electronics and appliances	322	$17,382
	Retail - Miscellaneous	330	$2,486,550
	Retail – Non-store	331	$1,630
Transportation			**$39,509**
	Transport by truck	335	$39,659
	Transit and ground passenger transportation	336	($150)
Information & Telecommunication			**$41,832**
	Book publishers	343	$2,350
	Software publishers	345	$36,853
	Telecommunications	351	$2,629
Real Estate and Rental & Leasing			**$407,575**
	Commercial and industrial machinery and equipment rental and leasing	365	$407,575
Professional, Scientific, & Technical Services			**$176,418,446**
	Legal services	367	$93,128
	Accounting, tax preparation, bookkeeping, and payroll services	368	$11,200

NAICS Sector	Description	IMPLAN Sector (a)	Expenditure (b)
	Architectural, engineering, and related services	369	$3,446,962
	Other computer related services, including facilities management	373	$1,036,600
	Management, scientific, and technical consulting services	374	$178,874
	Scientific research and development services	376	$139,174,619
	All other miscellaneous professional, scientific, and technical services	380	$32,477,063
Administrative & Support and Waste Management Services			**$57,220,128**
	Facilities support services	385	$17,881,705
	Business support services	386	$32,936,187
	Investigation and security services	387	$6,400,136
	Other support services	389	$2,100
Education			**$4,963,613**
	Private junior colleges, colleges, universities, and professional schools	392	$4,926,388
	Other educational services	393	$37,225
Health Care & Social Assistance			**$1,182,330**
	Medical and diagnostic labs and outpatient and other ambulatory care services	396	$1,182,330
Arts, Entertainment & Recreation			**$127,290**
	Museums, historical sites, zoos, and parks	406	$127,290
Accommodation & food services			**$60,058**
	Hotels and motels, including casino hotels	411	$37,139
	Food services and drinking places	413	$22,919
Repair & Maintenance			**$149,219**
	Electronic and precision equipment repair and maintenance	416	$23,255
	Commercial and industrial machinery and equipment repair and maintenance	417	$125,964
Government Enterprise			**$7,800**
	Other state and local government enterprises	432	$7,800
Household			**$222,136,921**
	Household spending (c)	10001-10009	$222,136,921
TOTAL EXPENDITURES in Ohio			**$512,108,364**

a. Sector: Industry classification code used by IMPLAN. It is analogous to the North American Industry Classification System (NAICS). IMPLAN provides a cross-reference table bridging their sector numbers and NAICS codes.
b. Expenditure: Actual dollar value for a product or service spent by NASA Glenn in FY 2012. Values shown in Table A-4 are limited to expenditures made in Ohio.
c. Households: Household expenditures include Glenn employees' wages and benefits.