9-1-2008

The NASA Glenn Research Center: An Economic Impact Study Fiscal Year 2007

Iryna Lendel
Cleveland State University, i.lendel@csuohio.edu

Cleveland State University
Maxine Goodman Levin College of Urban Affairs

Prepared for:
NASA GLENN RESEARCH CENTER

Prepared by:
Iryna Lendel, Ph.D.

September 2008

The NASA Glenn Research Center:

An Economic Impact Study Fiscal Year 2007

CENTER FOR ECONOMIC DEVELOPMENT

The Ohio Urban University Program

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

ACKNOWLEDGEMENTS

The author would like to thank the employees of the NASA Glenn Research Center for their contributions to this project, including management and coordination, data provision, and feedback on the report's content. They include Ronald Alexander, Robert Sefcik, Traci Savage, and Jean Rogers. This project is truly a result of our teamwork.

The author of this report also wishes to recognize the assistance of persons within the Levin College whose efforts were instrumental to the success of this project. Dr. Ziona Austrian, Director of the Center for Economic Development, offered suggestions and insights throughout the duration of this project, which added to the analytical value of the report. Natalie Dukes, Administrative Assistant, assumed the responsibility of formatting and producing the final report.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

- The John H. Glenn Research Center at Lewis Field (Glenn) is one of 10 National Aeronautics and Space Administration (NASA) Centers. Glenn is situated on 350 acres adjacent to Cleveland Hopkins International Airport. Its physical plant includes more than 150 buildings that contain a unique collection of world-class test facilities. Glenn also includes the 6,400-acre Plum Brook Station near Sandusky, Ohio, 50 miles west of Cleveland. It specializes in large-scale tests that would be hazardous within the confines of the main campus.
- NASA Glenn is focused on efforts related to all of NASA's missions: Exploration, Science, Space Operation, and Aeronautics Research. Within the Exploration mission, Glenn provides NASA oversight of important elements of the Service Module for the Shuttle-replacement vehicle (Orion) and vital support for the new rocket (Ares) that carries Orion to space. For the Science mission, among others, NASA Glenn manages the In-Space Propulsion Technology Program and develops its associated technologies. It also develops new ways to power scientific spacecraft, including the Advanced Stirling Convertor for the Advanced Stirling Radioisotope Generator. For the Space Operations mission, NASA Glenn supports the Space Shuttle Program by providing expert engineers for the Shuttle's multiple systems and for determination of Stress, Loads, and Dynamics on the vehicle. For the Aeronautics mission, NASA Glenn continues to improve upon its world-class 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.
- In addition to the background section, this report has two major sections. Section C is an economic overview of Glenn, including information related to employment and occupations, employee residence, 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 on an eight-county Northeast Ohio region and the state of Ohio during FY 2007. The report is an update of earlier studies (published in May 2000, December 2005, and September 2007) in which Glenn's FY 1998, FY 2004, and FY 2006 economic impacts on Northeast Ohio and the state of Ohio were estimated.

ECONOMIC IMPACT GENERATED BY GLENN RESEARCH CENTER SPENDING

- Economic impact is an analytical approach used to estimate economic benefits generated by an entity on an affected region. It uses an input/output (I-O) model to estimate the effect of NASA Glenn spending on the studied economies. This model measures economic impact in terms of growth in output (sales), the number of new jobs created, and the increase in household earnings. The table below summarizes Glenn's economic impact on Northeast Ohio and the state of Ohio during FY 2007.

IMPACT FY 2007	NORTHEAST OHIO	STATE OF OHIO
Output	$1.045 Billion	$1.2 Billion
Employment	6,407 Jobs	8,051 Jobs
Household Earnings	$333.7 Million	$401.6 Million

- NASA Glenn activities in Northeast Ohio in FY 2007, stimulated by $647 million in revenues primarily from outside the region, generated an increased demand in output (sales) for products and services produced in Northeast Ohio that were valued at more than $1 Billion. In addition, 6,407 jobs were created in the region, and households in Northeast Ohio saw their earnings increase by $333.7 million.
- Glenn activities in Ohio in FY 2007, stimulated by $647 million in revenues primarily from outside the state, generated an increased demand in output (sales) for products and services produced across the state that were valued at $1.2 billion. In addition, 8,051 jobs were created in Ohio and households across the state saw their earnings increase by $401.6 million.
- Industries deriving the most benefit from direct NASA Glenn spending include scientific research and development services, other professional and technical services, colleges and universities, information services, power generation, business and facilities support, and facilities' maintenance and repair.
- Businesses deriving the most benefit from spending by Glenn personnel and other workers, whose earnings are due, in part, to Glenn expenditures, follow typical consumer spending patterns. These include food services, real estate companies, hospitals and healthcare services, motor vehicle dealers, accounting services, commercial banks, and miscellaneous retailers.

GLENN RESEARCH CENTER: AN OVERVIEW

- Civil service employment at NASA Glenn declined slightly each year between 1999 and 2004 and then more substantially between 2004 and 2006. It remains almost unchanged between 2006 and 2007. In FY 1999, Glenn reported 2,021 employees. By the end of FY 2004, the labor force had declined about four percent to 1,945 workers; by FY 2007 Glenn employed 1,672 civil service workers. These figures do not include employees who work for NASA Glenn's local prime contractors. The number of on- or near-site contractors was approximately 1,450 in 2006 and 1,755 in 2007.
- Total compensation for NASA Glenn's civil service employees was $194.2 million in FY 2007. Of this amount, payroll accounted for $157.2 million while employee benefits accounted for another $36.9 million. Compared to FY 2006, total compensation increased 1.4 percent, total payroll increased 1.5 percent, and total benefits increased by one percent (after adjustment for inflation). Compared to 1998, Glenn employees experienced a total payroll increase of $25.6 million (19.5%) in nominal terms. During this same time period, civil service employment decreased by 349 employees (a drop of 17.3%). As a result, the average wage per Glenn employee increased from $64,350 in FY 1998 to $94,045 in FY 2007 in nominal dollars. Accounting for inflation, in real dollars, the average employee wage rose by 19.4 percent or about 2.2 percent per year.

Compared to FY 2006, the average employee wage in FY 2007 increased 1.8 percent (adjusted for inflation). In 2007, Glenn employees paid $9.2 million in state and local taxes.

- Total Glenn expenditures, excluding monies allocated for payroll and benefits, were $478 million in FY 2007. Glenn spending in FY 2007 was approximately 24 percent lower than in FY 1998 when adjusted for inflation. Compared to FY 2006, NASA Glenn increased its expenditures by 7 percent, spending $31.3 million more in FY 2007. The expenditure share for Northeast Ohio and the state of Ohio vendors increased significantly between 1998 and 2007, and it was rising between 2006 and 2007. During FY 1998, Glenn distributed 32.9 percent of its total spending to Northeast Ohio vendors. This spending share increased to 45.6 percent in FY 2006; and to 47.5 percent ($226.8 million) in FY 2007. Likewise, the spending share across the state of Ohio increased from 47.3 percent in FY 1998 to 60.9 percent in FY 2006; and to 64 percent ($306 million) in FY 2007. The share of expenditures accounted for by Northeast Ohio and Ohio have a strong influence on economic impact in both the region and the state since the greater the amount of money Glenn spends locally, the greater the impact on local economies.
- In FY 2007, Glenn received $626.9 million in revenues from NASA. This amount represents 97 percent of its total income. Glenn revenues remained nearly stable (in nominal dollars) between FY 1999 and FY 2007. During the interim period, NASA Glenn saw its revenues decline in 1999 and 2000 and then began to increase, reaching a peak of $821.3 million in FY 2003.
- NASA Glenn continues to be an important economic player in Northeast Ohio and across the state, continually increasing its economic impacts on the region and Ohio. NASA Glenn's employees are part of the knowledge-intense labor force with unique skills at the cutting edge of science and technologies that generate wealth in the region and advance the nation.

A. INTRODUCTION

This report describes the economic impact of the National Aeronautics and Space Administration's (NASA) Glenn Research Center (Glenn) on the eight-county Northeast Ohio region and the state of Ohio during FY 2007.[1] The report also provides some background information related to NASA Glenn's R&D activities and an overview of Glenn. The analysis was conducted by the Center for Economic Development at Cleveland State University's Maxine Goodman Levin College of Urban Affairs.

This report is an update to previous studies (published in February 1996, May 2000, December 2005, and September 2007), which estimated Glenn's FY 1994, FY 1998, FY 2004, and FY 2006 economic impact on Northeast Ohio and the state of Ohio.[2] Economic impact is an analytical approach used to estimate economic benefits generated by an entity on an affected region. It uses an input/output (I-O) model to estimate the effect of Glenn spending on the studied economies. This model measures economic impact in terms of growth in total output (sales), household earnings, and the number of new jobs created.

[1] For purposes of this study, Northeast Ohio is limited to the Akron and Cleveland metropolitan areas, which include Ashtabula, Cuyahoga, Geauga, Lake, Lorain, Medina, Portage, and Summit Counties.

[2] Austrian, Z. (1996) *The NASA Lewis Research Center: An Economic Impact Study*. Cleveland State University, Center for Economic Development.
Austrian, Z. & Wolf, A. (2000). *The NASA Glenn Research Center: An Economic Impact Study*. Cleveland State University, Center for Economic Development.
Sadowski, B. (2005). *The NASA Glenn Research Center: An Economic Impact Study, Fiscal Year 2004*. Cleveland State University, Center for Economic Development.
Norton, J. (2006). *The NASA Glenn Research Center: An Economic Impact Study, Fiscal Year 2006*. Cleveland State University, Center for Economic Development.

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, aeropropulsion, space propulsion, power systems, nuclear systems, communications, and technology to 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. Glenn's physical plant includes more than 150 buildings that contain a unique collection of world-class 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 Glenn's physical plant. The estimated replacement cost is approximately $1.6 billion.

NASA Glenn also includes the 6,400-acre Plum Brook Station near Sandusky, Ohio, 50 miles west of Cleveland. It specializes in large-scale tests that would be hazardous within the confines of the main campus. Plum Brook contains the world's largest space environment simulation chamber (100 feet in diameter by 122 feet high). Its large size made it ideal for testing full-size Mars lander systems and International Space Station hardware. This facility is undergoing a $62 million expansion to add spacecraft vibration and acoustic test capability and will then be used to conduct integrated system level testing of the new Orion Crew Exploration Vehicle, simulating conditions from launch through insertion into orbit. The total replacement cost of all Plum Brook facilities is approximately $651 million.

B.2 GLENN MISSION AREAS SUPPORTING NASA THEMES

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:

Exploration (human spaceflight to the International Space Station (ISS), Moon and beyond)

- Oversight of the Service Module (SM) for the Shuttle-replacement vehicle (Orion). The SM provides power, propulsion, and communications for Orion's Crew Module (CM), where the astronauts reside in flight.
- Oversight of important elements of the CM project, including building test flight hardware.
- Vital support for the new rocket (Ares) that carries Orion to space, including development of Ares I power and delivery of the Upper Stage Simulator (USS) for the Ares I-X mission, the first planned test flight of the Crew Launch Vehicle.
- Environmental testing at Plum Brook Station of the entire Orion spacecraft.
- Management of several research and advanced technology development projects on the ISS and on Earth, in support of human exploration.

Science

- Management of the In-Space Propulsion Technology Program and development of its associated technologies.
- Development of new ways to power scientific spacecraft, including the Advanced Stirling Convertor (ASC) for the Advanced Stirling Radioisotope Generator (ASRG). These developments will allow much longer scientific missions that will enable more scientific research to be obtained from each mission.

Space Operations

- Supports the Space Shuttle Program (SSP) by providing expert engineers for the Shuttle's electrical power system, its purge, vent and drain subsystem and for determination of Stress, Loads, and Dynamics on the vehicle. The Lead Quality Auditor role for the SSP is also at Glenn.
- Supports the International Space Station by providing the electrical power system management and integration expertise.
- Leads the development of new, advanced Communications Technology.

Aeronautics

NASA Glenn continues to improve upon its world-class 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.

For the Fundamental Aeronautics Program, NASA Glenn provides technical project management leadership for the following four projects:

- Hypersonics Project: Research in propulsion and high temperature materials, instrumentation and dynamic controls to enable very-high speed flight, and re-entry into planetary atmospheres.
- Supersonics Project: Scientific leadership in propulsion, combustion, and acoustic research to eliminate environmental and performance barriers.
- Subsonics: Fixed Wing: Developing revolutionary technologies and aircraft concepts to achieve highly improved performance while satisfying strict noise and emission constraints.
- Subsonics: Rotary Wing: Research to improve civilian potential of rotary wing vehicles (helicopters).

For the Aviation Safety Program, NASA Glenn plays key roles in conducting long-term, cutting-edge research that will produce tools, methods, concepts, and technologies to improve the intrinsic safety attributes of current and future aircraft engines.

C. NASA GLENN RESEARCH CENTER: ECONOMIC OVERVIEW

In this section, we present a brief economic overview of the NASA Glenn Research Center (Glenn) for fiscal year (FY) 2007. Topics discussed include employment and occupations, workers place of residence, payroll, expenditures, awards to academia and other institutions, revenues, and taxes paid by Glenn employees. Where data is available, we present a comparison between FY 2007 and earlier years.

C.1 EMPLOYMENT AND OCCUPATIONS

The NASA Glenn labor force has two components: civil service employees and local contractors. This dual approach is common to federal labs because contract employees provide the necessary labor force flexibility. The number of contract employees can easily be adjusted according to the needs of the research lab, while hiring of civil servants is more complex and permanent.

Civil service employment at NASA Glenn declined slightly each year between 1999 and 2004, then more substantially between 2004 and 2006, and remained almost unchanged in 2007, compared to 2006. In FY 1999, Glenn reported 2,021 employees. By the end of FY 2004, the labor force had declined about four percent to 1,945 workers; by FY 2007 Glenn employed 1,672 civil service workers.[3] These figures do not include employees who work for NASA Glenn's local prime contractors.[4] The number of on- or near-site contractors was approximately 1,755 in 2007 compared to 1,450 in 2006 and 1,800 in 2005.

Glenn's civil servant labor force is highly skilled and highly educated. In FY 2007, almost 50 percent of NASA employees possessed a graduate degree. More specifically, 15 percent of NASA Glenn's civil servants held a doctoral degree, 34 percent had a master's degree, and an additional 25 percent had a bachelor's degree. Consequently, any major Glenn staff reduction might contribute to a "brain drain" from Northeast Ohio.

Civil service employees at Glenn are categorized into five occupational groups: administrative professional, clerical, scientists and engineers, technicians, and trades. Table 1 shows the changing occupational mix at Glenn between FY 1999 and FY 2007.

[3] In FY 2005, Glenn lost an estimated 150 civil servants and 340 contractors according to *Crain's Cleveland Business*: Pettypiece, S. (2005, September 26-October2). Whitlow tagged to tackle challenges at NASA Glenn. *Crain's Cleveland Business*, p.6. These losses are due to NASA refocusing its mission to send humans to the moon and Mars.

[4] For a detailed listing of Glenn's local contractors, go to http://www.grc.nasa.gov/WWW/Procure/ContractorList/On-siteServiceContractorListing.htm

Table 1. Glenn Civil Service Employment Distribution by Occupational Category, 1999-2007

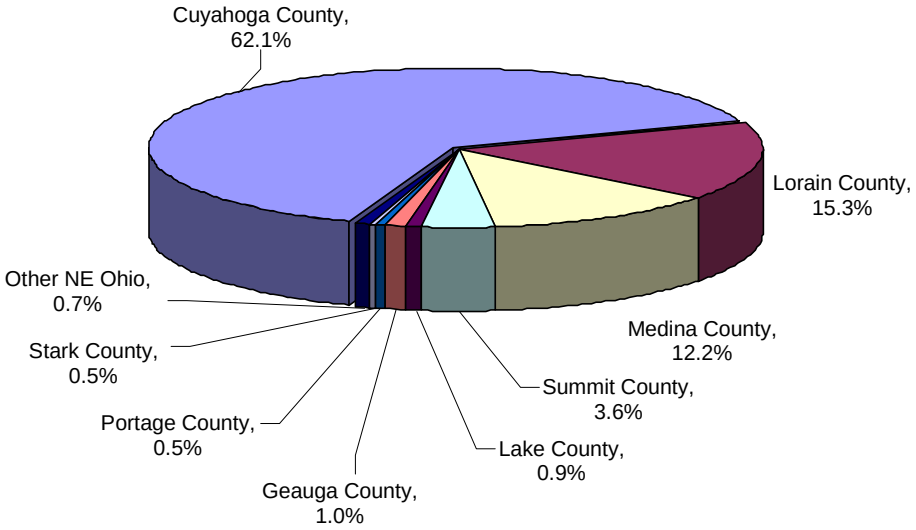
Fiscal Year	Total Employment	Occupational Category				
		Administrative Professional	Clerical	Scientists & Engineers	Technician	Trades
1999	2,021	15.1%	6.3%	55.9%	12.8%	9.9%
2000	1,982	15.5%	6.0%	56.5%	13.5%	8.6%
2001	1,967	15.6%	6.1%	55.8%	21.9%	0.6%
2002	1,955	19.4%	6.2%	55.9%	18.1%	0.4%
2003	1,948	20.0%	6.1%	56.5%	17.4%	0.1%
2004	1,945	20.2%	6.0%	57.2%	16.6%	0.1%
2005	1,769	20.6%	5.5%	58.3%	15.4%	0.1%
2006	1,678	20.9%	5.2%	59.5%	14.4%	0.0%
2007	1,672	21.2%	5.2%	60.0%	13.6%	0.0%

Scientists and engineers are the largest occupational category at NASA Glenn, accounting for an average of 57.3 percent of civil service employment between 1999 and 2007. The share of scientists and engineers relative to total employment has increased gradually from 1999 (55.9%) through 2007 (60%). Administrative professionals reported an increased employment share of more than six percentage points between 1999 and 2007 (resulting in additional 49 workers). There was little variation in the share of clerical workers between 1999 and 2004, but they felt the impact of job cuts between 2004 and 2006 (the number of clerical workers declined from 116 in 2004 to 87 in 2006 and remain unchanged in 2007). The number of technicians had a significant increase in 2001, growing to 431 (its peak during all analyzed years) compared to 259 in 1999. In following years, the number of workers in this category declined from 431 in 2001 to 227 in 2007, losing 203 employees between 2001 and 2007. Compared to 1999, the number of technicians declined by 31 employee. Persons working in the trades saw their employment share decrease from 10 percent in 1999 to zero in 2006 and 2007, accounting for a loss of 200 employees.

C.2 Place of Residence for Glenn Employees

The vast majority of NASA Glenn's civil servants (97%) live in Northeast Ohio. The majority live in Cuyahoga County (62.1%) but a significant number also live in Lorain (15.3%) and Medina Counties (12.2%). The Akron metropolitan area is the place of residence for four percent of the Glenn workforce (Figure 1).

Figure 1. Glenn Civil Service Employees by County of Residence, 2007



As expected, the majority of Glenn employees, regardless of occupation, live in Cuyahoga County (Table 2). Likewise, Lorain and Medina Counties have the second and third highest residential share, respectively, for each occupational category. The results of occupations by place of residence in 2007 were similar to previous years.

Table 2. Glenn Civil Service Employees by Occupation and Place of Residence, 2007

Residence	Administrative Professional	Clerical	Scientists & Engineers	Technician & Trades	Total
Northeast Ohio	97.0%	96.6%	96.0%	99.1%	96.7%
Cuyahoga County	59.4%	60.3%	64.5%	55.9%	62.1%
Lorain County	18.2%	24.1%	12.6%	20.3%	15.3%
Medina County	11.9%	6.9%	11.9%	15.3%	12.2%
Summit County	5.0%	0.0%	3.7%	1.8%	3.6%
Lake County	1.1%	1.7%	0.7%	1.4%	0.9%
Geauga County	0.0%	1.7%	1.2%	1.4%	1.0%
Portage County	0.0%	0.0%	0.7%	0.9%	0.5%
Stark County	0.6%	0.0%	0.4%	0.9%	0.5%
Other NE Ohio	0.8%	1.7%	0.4%	1.4%	0.7%
Other Ohio	2.5%	3.4%	1.8%	0.9%	1.9%
Out of State	0.6%	0.0%	2.1%	0.0%	1.4%

C.3 PAYROLL

Total compensation for NASA Glenn's civil service employees was $194.2 million in FY 2007. Of this amount, payroll accounted for $157.2 million while employee benefits accounted for another $36.9 million. Glenn employees experienced a total payroll increase of $25.6 million (19.5%) between 1998 and 2007 in nominal terms, however, in real dollars adjusted for inflation, the total payroll fell 2.4 percent. During this same time period, civil service employment decreased from 2,045 to 1,672 workers. As a result, the average wage per Glenn employee increased from $64,350 in FY 1998 to $94,045 in FY 2007 in nominal dollars. Accounting for inflation, in real dollars, the average employee wage rose by a total of 19.4 percent, or about 2.2 percent per year. Between FY 2006 and FY 2007, average employee wage increased 1.8 percent (adjusted for inflation).

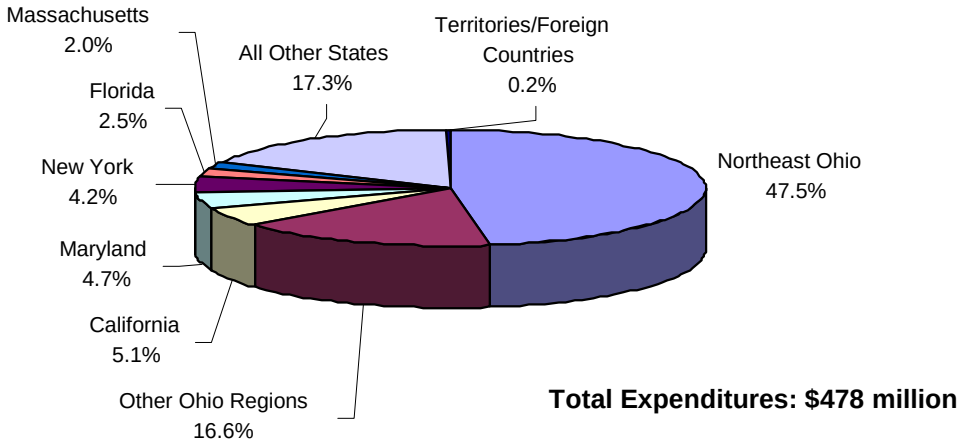
C.4 GLENN EXPENDITURES, FY 2007

NASA Glenn expenditures extend far beyond the state of Ohio. Vendors in 47 states (including Ohio) and several foreign countries were beneficiaries of Glenn spending. Expenditures generally fall within one of the following classifications: equipment, supplies and materials, grants, R&D contracts, and advisory services. Total Glenn expenditures, excluding monies allocated for payroll and benefits, were $478 million in FY 2007. Glenn spending in FY 2007 was 24 percent lower than expenditures in FY 1998 when adjusted for inflation.[5] Compared to FY 2006, however, NASA Glenn increased its expenditures by 7 percent, spending $31.3 million more in FY 2007. The expenditure share for Northeast Ohio and the state of Ohio vendors increased significantly between 1998 and 2007, including a rise between 2006 and 2007. During FY 1998, Glenn distributed 32.9 percent of its total spending to Northeast Ohio vendors. This spending share increased to 45.6 percent in FY 2006 and 47.5 percent ($226.8 million) in FY 2007. Likewise, the spending share across the state of Ohio increased from 47.3 percent in FY 1998 to 60.9 percent in FY 2006 and 64 percent ($306 million) in FY 2007. The share of expenditures accounted for by Northeast Ohio and Ohio have a strong influence on the economic impact in both the region and the state since the greater the amount of money Glenn spends locally, the greater the impact on local economies.

[5] NASA nominal expenditures totaled $514 million in 1998, however adjusted for inflation, these expenditures amount to $629.2 million in 2007 dollars. All further comparisons using data adjusted for inflation use 2007 as the base year. That means that data for earlier years are inflated using Consumer Price Index to be comparable to the data in 2007 dollars.

Four states other than Ohio received more than $10 million in expenditures from NASA Glenn during FY 2007, including California, Maryland, New York, and Florida in descending order (See Appendix Table A.1). The state of Massachusetts accounted for $9.6 million in FY 2007, concluding the list of the five states other than Ohio that received more than 2 percent of the total NASA Glenn funding. Figure 2 shows Glenn spending in select states.

Figure 2. NASA Glenn Spending in Select States, FY 2007



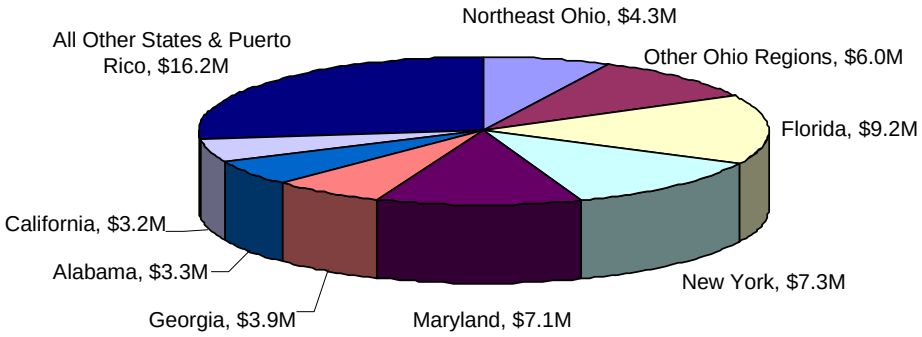
C.5 GLENN AWARDS TO ACADEMIA AND OTHER INSTITUTIONS

In support of its mission, NASA Glenn provides funding for research and educational activities to colleges, universities, and other nonprofit institutions around the country. This funding is primarily in the form of R&D contracts and grants. In FY 2007, total funding allocated to academia and other nonprofits across the U.S. and Puerto Rico was $71.6 million, compared to $96.4 million for FY 2006 and $78.1 million for FY 2004. In nominal dollars, it constitutes a 25.7 percent decrease compared to FY 2006 and an 8.3 percent decline compared to FY 2004. In real dollars (adjusted for inflation), FY 2007 funding for colleges and universities fell by a 27.4 percent compared to FY 2006 and by a 14.9 percent compared to FY 2004. In FY 2007, colleges and universities received $60.7 million, or 84.8 percent of the $71.6 million allocated.

Even though the total funding awarded to colleges and universities is declining, of all 50 states, in FY 2007 Ohio continues to receive the largest share —$10.4 million (17.1 percent of the total). This amount of funding compares to $15.2 million given to Ohio colleges and universities in FY 2006 and $17.3 million in FY 2004 (all values are in nominal dollars). The share of funding to Ohio colleges and universities was 20.5 percent in FY 2006 and 22.2 percent in FY 2004. Table A.2, Appendix A, provides a complete listing of NASA Glenn awards

to colleges and universities by state in FY 2007. Colleges and universities in Florida, New York and Maryland each received more than $7 million from NASA Glenn during FY 2007, while colleges and universities in 10 more states received more than $1 million. Figure 3 shows the distribution of funding awarded to educational institutions in select states. Academic institutions in Northeast Ohio received $4.3 million (41.8%) of the Ohio amount.

Figure 3. NASA Glenn Awards to Colleges and Universities, FY 2007



Total Academic Awards: $60.7M

Table 3 shows Glenn awards to colleges and universities in the state of Ohio for FY 2004, FY 2006, and FY 2007 (if applicable). Four universities received more than $1 million each in FY 2007: the University of Toledo ($3.8 million), Case Western Reserve University ($2.2 million), the Ohio State University ($2.0 million), and Cleveland State University ($1.6 million). The University of Akron received grants totaling approximately $542,000. Combined, these five universities received more than 97 percent of the monies allocated by NASA Glenn to academic institutions across the state of Ohio.

Table 3. Glenn Educational Grants in Ohio by Academic Institution (FY 2004, FY 2006, FY2007)

OHIO COLLEGES & UNIVERSITIES	FY 2004	FY 2006	FY 2007	2007 SHARE
University of Toledo	$3,217,582	$4,718,151	$3,765,307	36.3%
Case Western Reserve University	$3,384,290	$3,095,665	$2,195,759	21.2%
Ohio State University	$4,238,483	$3,536,141	$1,972,347	19.0%
Cleveland State University	$3,693,230	$2,246,489	$1,609,787	15.5%
University of Akron	$1,403,576	$797,122	$541,567	5.2%
University of Cincinnati	$224,511	$74,045	$176,546	1.7%
Wright State University	$53,599	$78,029	$44,598	0.4%
Ohio University	$225	$114,875	$36,875	0.4%
Bowling Green State University	$384,728	$285,612	$31,039	0.3%
University of Dayton	$2,798	$151,847	$12,568	0.1%
Kent State University	$138,687	$12,177	$2,322	0.02%
Cuyahoga Community College	$32,305	$36,382	$553	0.01%
John Carroll University	$35,385	n/a	($10,016)	
Lake County Community College	n/a	n/a	($0)	
Baldwin Wallace College	$77,835	$19,687	n/a	
Myers University	$19,431	$6,401	n/a	
Lorain County Community College	$2,517	$1,174	n/a	
Malone College	n/a	$640	n/a	
Capital University	n/a	($80)	n/a	
Central State University	$419,282	n/a	n/a	
Oberlin College	$22,888	n/a	n/a	
Xavier University	$4,221	n/a	n/a	
Notre Dame College of Ohio	$1,215	n/a	n/a	
Youngstown State University	$749	n/a	n/a	
Ohio Northern University	$210	n/a	n/a	
TOTAL	**$17,357,746**	**$15,174,357**	**$10,379,251**	**100.00%**

Other organizations in Ohio that received major grants from NASA Glenn in FY 2007 included the Ohio Aerospace Institute ($7.1 million), Battelle Memorial Institute ($496,164), the Cleveland Clinic Foundation ($427,783), University Hospitals of Cleveland ($150,000), and Glennan Microsystems Initiative ($31,241).

C.6 GLENN REVENUES

Funds authorized by NASA accounted for more than 96 percent of Glenn's revenues for fiscal years 1999 through 2007, except in FY 2006 when other sources provided a slightly larger share of Glenn's revenues and NASA authorized funding accounted for 93 percent of total revenues. Glenn revenues remained fairly stable in nominal dollars between FY 1999 and FY 2007, while accounting for inflation (suitable for comparison between years) they decreased 15.8 percent. During the interim period, NASA Glenn revenues declined between 1999 and 2000 and then began to increase, reaching a peak of $821.3 million in FY 2003. Table 4 provides a detailed breakdown of Glenn revenues from FY 1999 through FY 2007. For example, in FY 2007, Glenn received $626.9 million in revenues from NASA. This amount represents 96.9 percent of its total income. An additional $20.2 million in revenues was received from the Department of Defense, other federal agencies, and other domestic, non-federal entities. NASA Glenn's total revenues during FY 2007 were $647.1 million.

Table 4. NASA Glenn Revenues, FY 1999 – FY 2007 (in millions)

Revenue Source	FY99	FY00	FY01	FY02	FY03	FY04	FY05	FY06	FY07
NASA Direct Authority	$602.3	$590.6	$647.4	$668.1	$794.1	$767.3	$704.5	$669.6	$626.9
Reimbursable Commitments	$25.2	$18.9	$16.1	$26.4	$27.2	$27.7	$25.3	$50.2	$20.2
Total FY Authority	$627.5	$609.5	$663.5	$694.5	$821.3	$795	$729.8	$719.8	$647.1
Revenue from NASA	96.0%	96.9%	97.6%	96.2%	96.7%	96.5%	96.5%	93.0%	96.9%

Glenn's revenue from sources other than NASA (reimbursable commitments) declined between FY 2006 and FY 2007 by more than half mainly due to decline of reimbursable commitments from state and local governments. The reimbursable commitments can be categorized as follows: Department of Defense (58%); domestic, non-federal entities including state and local governments (37%); and other federal agencies, excluding Department of Defense (5%).

C.7 TAXES PAID BY GLENN EMPLOYEES

Taxes paid by NASA Glenn employees to state and local governments are important to Ohio's economy. The amounts are determined by the number of civil service employees, their physical location on the Glenn campus, and their earnings. Most Glenn employees' workplaces are located in the city of Brook Park as a result of a land swap with the city of Cleveland in 2001.[6] Other facilities fall within the boundaries of the cities of Cleveland and Fairview Park.

The data shown in Table 5 represent taxes withheld from employee paychecks and sent directly to state and local governments. It excludes taxes paid directly by employees to local governments based on residence. From 2001 to 2007, the amount of paid state and local taxes increased by 13 percent (which in real terms adjusted for inflation constitutes a decline of 1%). During this period of time, the state of Ohio received almost $44 million and local municipalities received $20.5 million in taxes from Glenn employees (calculated in nominal terms). The state of Ohio and city of Brook Park are two the largest beneficiaries of Glenn's taxes. The city of Brook Park received almost 80 percent of the amount of taxes paid to local municipalities. Out of all taxes paid by Glenn's employees, the state of Ohio receives about 68 percent.

Table 5. Income Taxes Paid by Glenn Employees from 2001 to 2007

Year	City of Brook Park	City of Cleveland	City of Fairview Park	State of Ohio	Total
2001	n/a	$2,261,792	$271,014	$5,623,913	**$8,156,719**
2002	$2,546,501	$93,441	$231,963	$6,204,138	**$9,076,043**
2003	$2,625,066	$2,266	$236,884	$6,421,506	**$9,285,722**
2004	$2,968,106	$1,486	$166,488	$6,811,979	**$9,948,059**
2005	$2,625,474	$2,311	$336,740	$6,613,854	**$9,578,379**
2006	$2,600,094	$2,433	$386,722	$6,205,963	**$9,195,211**
2007	$2,748,507	$2,362	$389,630	$6,097,704	**$9,238,203**

[6] In March 2001, Cleveland and Brook Park completed a land swap deal. Under the agreement, 135 acres — including the IX Center and other development parcels in Brook Park — moved into Cleveland's boundaries to be used for airport expansion. In return, Brook Park received portions of NASA Glenn property that were in Cleveland and are worth more than $2 million in annual tax revenue.

D. ECONOMIC IMPACT OF NASA GLENN

This section discusses the economic impact of the NASA Glenn Research Center (Glenn) on Northeast Ohio and the state of Ohio in FY 2007.[7] Impact is measured in terms of output (sales), employment, and household earnings. For each of these categories, total economic impact is estimated as the sum of four components: change in final demand, direct impact, indirect impact, and induced impact. Glenn's total impacts on Northeast Ohio and the state of Ohio are estimated separately.

D.1 METHODOLOGY

If we imagine that the Glenn Research Center came into existence in one day, we can assume that the investment it would bring to the Northeast Ohio or Ohio economy from outside the respective region would stimulate activity by creating demand for goods and services. A value can be placed on this stimulus—known as the change in final demand—and it must be included in any estimate of Glenn's economic impact.[8] The effects of a change in final demand can then be traced throughout the Northeast Ohio or state economy using an input-output model that captures the buy-sell linkages among all industry sectors and the household sector.

In order for Glenn to engage in research and development, other goods and services are needed as intermediate inputs. This leads to the other components of economic impact—direct, indirect, and induced. Direct impact refers to the initial value of goods and services, including labor, purchased by Glenn within Northeast Ohio or the state of Ohio. These purchases are sometimes referred to as the first-round effect. Indirect impact measures the value of labor, capital, and other inputs of production needed to produce the goods and services required by Glenn (second-round and additional-round effects). Induced impact measures the change in spending by local households due to increased earnings by employees in local industries who produce goods and services for Glenn and its suppliers.

As stated earlier, economic impact analysis takes into account inter-industry relationships within an economy—that is, the buy-sell relationships among industries. These relationships largely determine how an economy responds to changes in economic activity. Input-output (I-O) models estimate inter-industry relationships in a county, region, state, or country by measuring the industrial distribution of inputs purchased and outputs sold by each

[7] For the purposes of 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.

[8] Change in final demand is defined as the purchase of goods and services for final consumption—in this case by the Glenn Research Center.

industry and the household sector. Thus, by using I-O models, it is possible to estimate how the impact of one dollar or one job ripples through the local economy, creating additional expenditures and jobs. The economic multiplier measures the ripple effect that an initial expenditure has on the local economy.[9] This study utilizes regional I-O multipliers from IMPLAN Professional.[10]

Generally, two factors need to be taken into account when estimating economic impact: 1) purchases from companies located outside the studied region need to be excluded and 2) share of revenues received from local sources needs to be addressed.

For this analysis, economic impact is generated only by Glenn purchases from companies located within Northeast Ohio or the state of Ohio. Therefore, when estimating the impact on Northeast Ohio, goods and services purchased from businesses and other entities located outside the eight-county region were excluded from the model. Likewise, when estimating the impact on the state of Ohio, goods and services purchased from businesses and other entities located outside the state were excluded from the model. Regarding sources of revenues, all of Glenn's revenues are received from non-local sources (federal sources) and no further adjustments are required.

Before entering local (Northeast Ohio or the state of Ohio) expenditures into the IMPLAN model, the amounts must be discounted by the percentage of revenues that are received from local sources. If expenditures were not discounted by the percentage of revenues coming from local sources, sometimes referred to as "neutral monies," then the economic impact values would simply reflect the redistribution of local funds. The objective of impact analysis is to estimate the effect of monies coming from outside the studied economy rather than the redistribution of monies already existing in that economy. Revenues coming from outside the local economy are sometimes referred to as "good money." Since almost all Glenn revenues are derived from federal sources (97%),[11] discounting of expenditures due to local revenues was not necessary.

Figure 4 illustrates the process by which NASA Glenn impacts the local economy through its spending in the Akron and Cleveland metro areas. Through its attraction of federal

[9] For example, suppose that company XYZ 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.

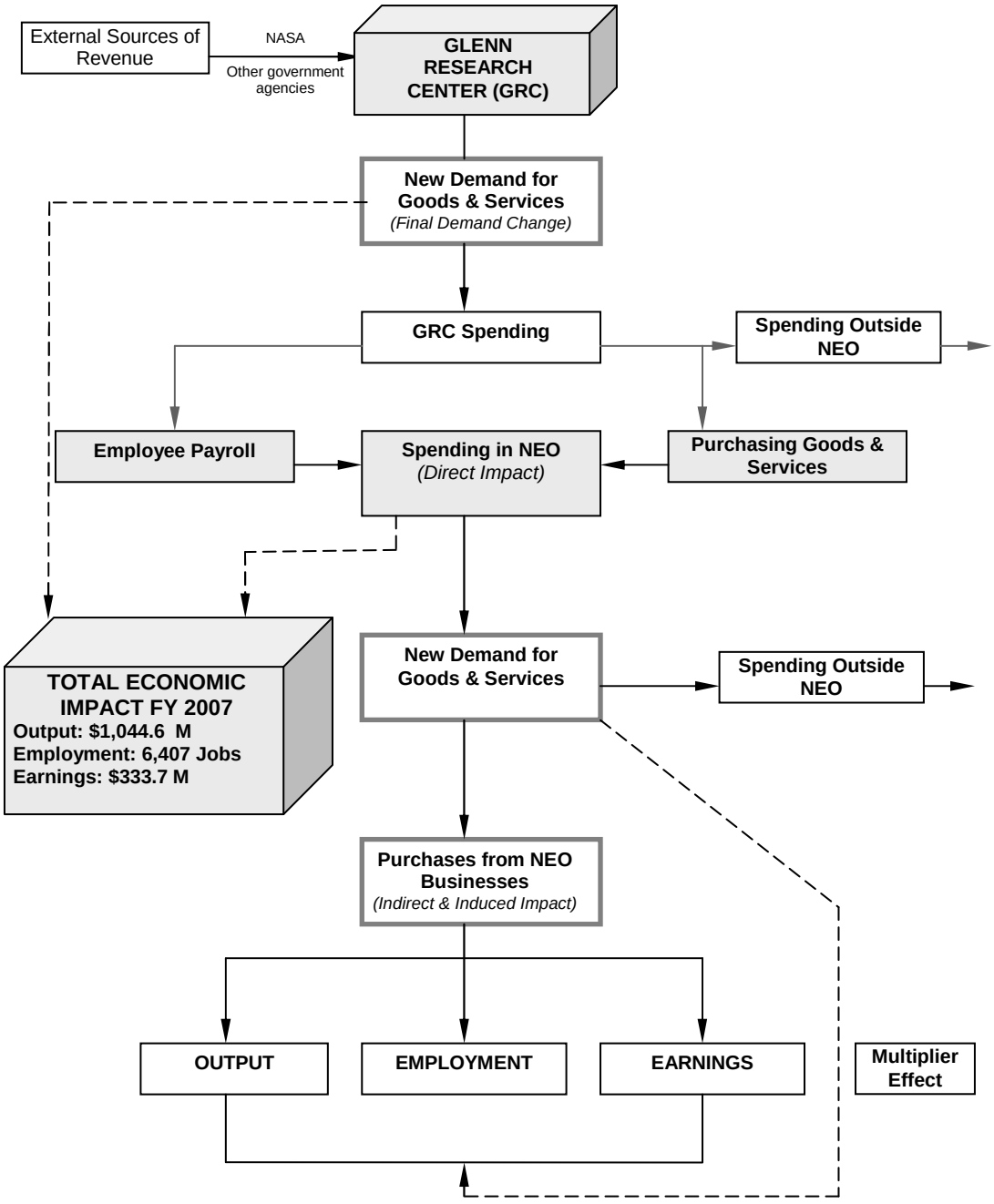
[10] IMPLAN was originally developed by two federal agencies, the Department of Agriculture and the Department of the Interior, to assist in land and resource management planning. The model was later commercialized by the Minnesota IMPLAN Group, Inc. as a software package.

[11] This includes revenue from NASA and other federal agencies.

dollars, Glenn creates new demand for goods and services (final demand change). Some of this demand is generated for goods and services provided by vendors outside the Akron-Cleveland metro areas, resulting in dollars leaking from the local economy. However, many goods and services are purchased locally. Local spending by Glenn for goods, services, and labor is the direct impact. As these dollars move through the economy, they result in additional demand for goods and services, creating indirect and induced impact. The total economic impact of Glenn is equal to the sum of the change in final demand, direct, indirect, and induced impacts.[12]

[12] The summation of direct, indirect, and induced impacts to the total impact across the lines of industries in the impact tables 6-11 may reflect rounding discrepancies created by multiple iterations of IMPLAN modeling.

Figure 4. Glenn Research Center—Economic Impact on Northeast Ohio, FY 2007



D.2 ECONOMIC IMPACT ON NORTHEAST OHIO IN FY 2007

In this section, we discuss the economic impact that NASA Glenn spending generated for the Northeast Ohio economy in FY 2007. More specifically, we present a detailed analysis of the change in output (sales), employment, and household earnings due to Glenn activities.

D.2.1 Output Impact on Northeast Ohio in FY 2007

This analysis uses multipliers to estimate the ripple effect that an initial expenditure has on a local economy.[13] These multipliers measure the effect of Glenn Research Center spending on output (sales) in Northeast Ohio. They provide a quantitative measure of the total change in output produced by Northeast Ohio industries for each additional final demand dollar expended by Glenn.

NASA Glenn expenditures were divided into spending for goods and services purchased from companies and other entities, such as universities, located in Northeast Ohio (local) and spending for goods and services from businesses and other entities located elsewhere. Local spending is then categorized by industry, based upon an IMPLAN industry classification system that is analogous to the North American Industry Classification System (NAICS). Table A.3, Appendix A, provides a detailed Glenn expenditure list by specific industry.

Table 6 presents the total output impact and its components. Local Glenn expenditures represent direct output impact. Indirect impact is estimated by summing the contributions of individual industries that provide inputs to the producers of the goods and services ultimately consumed by Glenn. Induced impact is estimated by measuring the spending of workers who are employed as a result of the demand for products and services created by Glenn. Total output impact is the sum of change in final demand, direct impact, indirect impact, and induced impact. Table 6 reports output impacts by industry sector. It shows how Glenn spending across Northeast Ohio affects all sectors of the economy.[14]

[13] IMPLAN type SAM multipliers are used in this study. SAM multipliers are based on information in a social account matrix that considers social security and income tax leakage, institution savings, commuting, and inter-institutional transfers.

[14] Households (Glenn employees' disposable income) are not shown as an industry sector in Table 6, although they are included as an industry in Table A.3. The reason for this is that IMPLAN automatically distributes these monies directly to the industries from which households typically make purchases. The industry sector that is the largest beneficiary of household spending is foreign and domestic trade ($43.3 million). This sector represents products that are purchased by households locally but are produced outside Northeast Ohio, either domestically or internationally.

Table 6. Output Impact Based on Glenn Spending in Northeast Ohio, FY 2007

NASA Glenn Expenditures in Northeast Ohio: $354,652,158

Industry	Direct	Indirect	Induced	Total
Utilities	$15,721,146	$1,855,858	$2,525,127	$20,102,130
Construction	$45,437,694	$2,045,311	$664,528	$48,147,534
Manufacturing	$6,757,768	$12,643,527	$9,370,668	$28,771,957
Transportation & Warehousing	$1,493,838	$4,807,128	$3,019,559	$9,320,526
Retail Trade	$15,007,982	$3,924,566	$15,446,104	$34,378,653
Information	$33,949,892	$7,228,501	$3,196,484	$44,374,876
Finance & Insurance	$5,888,209	$7,897,033	$10,175,261	$23,960,505
Real Estate, Rental, Leasing	$1,993,614	$13,135,755	$7,144,847	$22,274,216
Professional, Scientific, Technical Services	$82,712,392	$17,041,974	$4,811,314	$104,565,680
Administrative & Support Services	$43,288,041	$11,115,479	$2,384,959	$56,788,477
Educational Services	$7,010,506	$207,800	$2,396,260	$9,614,565
Health Care & Social Assistance	$19,870,025	$178,790	$20,441,391	$40,490,207
Arts, Entertainment, Recreation	$1,532,033	$802,898	$1,796,173	$4,131,104
Accommodation & Food Services	$5,402,356	$2,642,988	$6,593,095	$14,638,438
Other Services	$4,534,312	$2,399,252	$5,234,445	$12,168,008
Government Enterprises	$4,497,164	$1,319,513	$1,806,879	$7,623,557
Owner-occupied Dwellings	$16,404,371	$0	$16,430,126	$32,834,497
Foreign & Domestic Trade	$43,325,476	$0	$0	$43,325,476
Other [a]	$800,581	$5,484,023	$2,825,091	$9,109,695
Total	$355,627,401	$94,730,395	$116,262,312	$566,620,101

Change in Final Demand [b]	$478,008,086
Direct Impact	$355,627,401
Indirect Impact	$94,730,395
Induced Impact	$116,262,312
Total Output Impact	**$1,044,628,194**

[a] Other includes the following industry sectors: agriculture, forestry, fishing and hunting; mining; wholesale trade; and management of companies.
[b] For output impact, the change in final demand equals spending by Glenn within and outside Northeast Ohio excluding payroll and healthcare benefits.

The total output impact across Northeast Ohio as a result of Glenn Research Center FY 2007 activities was $1.045 billion. Glenn's expenditures of $355 million in Northeast Ohio resulted in a change in output (sales) of $566.6 million across all industry sectors (Table 6). For example, Glenn spending affected a $29 million increase in sales (direct, indirect and induced impacts) by all manufacturing-related industries. Thus, the impact of Glenn's presence in the area is represented as the increase in output in comparison to the hypothetical absence of Glenn in Northeast Ohio.

Forty-six percent ($478 million) of the total output impact is accounted for by the change in final demand that occurs because Glenn activities bring resources into Northeast Ohio from outside the region. Approximately $356 million (34%) of the total output impact is a result of direct spending by Glenn for goods and services purchased within Northeast Ohio. The remaining output impact of $211 million (20%) is attributable to the indirect and induced components as Glenn spending ripples through the economy.

A detailed analysis of the IMPLAN model results indicates that the $566.6 million change in output (sales) generated by the direct, indirect, and induced impacts can be divided into three broad categories—Glenn-driven sectors, consumer-driven sectors, and other sectors. Glenn-driven sectors are those industry groups whose increased sales, employment, and earnings are attributed primarily but not exclusively to Glenn spending. They include utilities, construction, information, professional and scientific services, administrative and support services, and education. The total increase in output for these sectors in FY 2007 was $283.6 million or 50 percent of the total impact generated by the direct, indirect, and induced impacts.

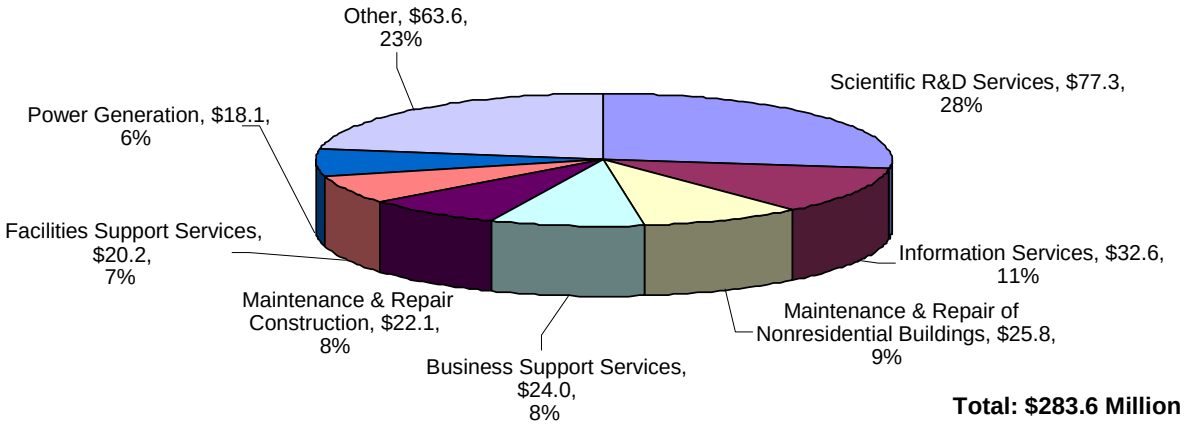
Consumer-driven sectors are those industry groups whose increased sales, employment, and earnings are attributed primarily to spending by Glenn employees and other workers who produce goods and services for Glenn and their suppliers. They include retail, finance and insurance, real estate, healthcare, entertainment and food, other services, and owner-occupied buildings.[15] The total increase in output for these sectors in FY 2007 was $152 million or 26.8 percent of the total impact.

Other sectors are those industry groups that are driven by both Glenn and consumer spending or whose impact is insignificant. They include manufacturing, government enterprises, agriculture, mining, wholesale trade, and transportation and warehousing. The

[15]Owner-occupied dwellings 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.

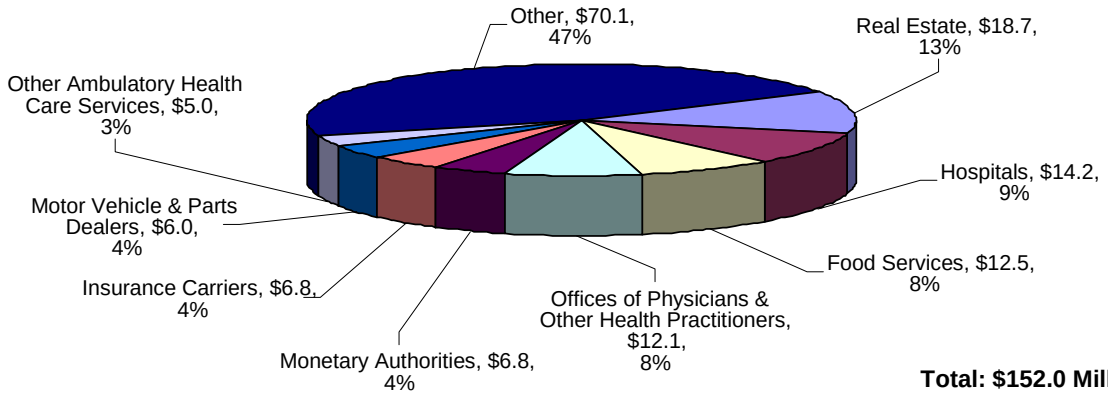
output distribution for select industries within the Glenn-driven sectors is shown in Figure 5 and the output distribution for select industries within the consumer-driven sectors is presented in Figure 6.

Figure 5. Increase in Sales for Select Industries in Glenn-Driven Sectors, Northeast Ohio, FY 2007



The power generation industry (utilities sector) saw an increase in sales of $18.1 million in FY 2007 due to Glenn's spending patterns (Figure 5). This amount is the summation of the direct, indirect, and induced impacts generated primarily but not exclusively by Glenn spending for electric utilities. $18.1 million represents a six percent share of the $283.6 million increase in output for all industries within the Glenn-driven sectors. Other industries shown in Figure 5 can be interpreted in a similar manner.

Figure 6. Increase in Sales for Select Industries in Consumer-Driven Sectors of Northeast Ohio, FY 2007



The food services industry saw an increase in sales of $12.5 million in FY 2007 (Figure 6). This amount is the summation of the direct, indirect, and induced impacts generated primarily by Glenn employees and other workers for food and drink. $12.5 million represents an eight percent share of the $152 million increase in output for all industries within the consumer-driven sectors.

D.2.2 Employment Impact on Northeast Ohio in FY 2007

Glenn Research Center's activities in Northeast Ohio affect job creation beyond Glenn's hiring of its own employees (change in final demand). Glenn spending creates employment in industries from which it purchases goods and services (direct impact) and employment in industries that provide inputs into those goods and services (indirect impact). In addition, monies spent by Glenn employees and employees of those companies with which Glenn does business create jobs in a variety of other industries (induced impact). Total employment impact equals the sum of Glenn Research Center full-time equivalent employment, direct impact, indirect impact, and induced impact. Table 7 shows the number of jobs created by industry sector.

Table 7. Employment Impact Based on Glenn Spending in Northeast Ohio, FY 2007

NASA Glenn Expenditures in Northeast Ohio: $354,652,158

Industry	Direct	Indirect	Induced	Total
Utilities	30	4	5	38
Construction	505	18	6	529
Manufacturing	17	42	23	86
Transportation & Warehousing	11	50	26	87
Retail Trade	247	59	233	539
Information	119	29	12	160
Finance & Insurance	25	45	50	120
Real Estate, Rental, Leasing	15	92	53	160
Professional, Scientific, Technical Services	622	133	41	797
Administrative & Support Services	601	233	44	877
Educational Services	119	4	46	168
Health Care & Social Assistance	239	1	247	487
Arts, Entertainment, Recreation	30	15	36	81
Accommodation & Food Services	110	49	134	293
Other Services	92	37	103	231
Government Enterprises	22	6	9	38
Other [a]	4	25	15	44
Total	2,809	842	1,084	4,735
Change in Final Demand [b]	1,672			
Direct Impact	2,809			
Indirect Impact	842			
Induced Impact	1,084			
Total Employment Impact	6,407			

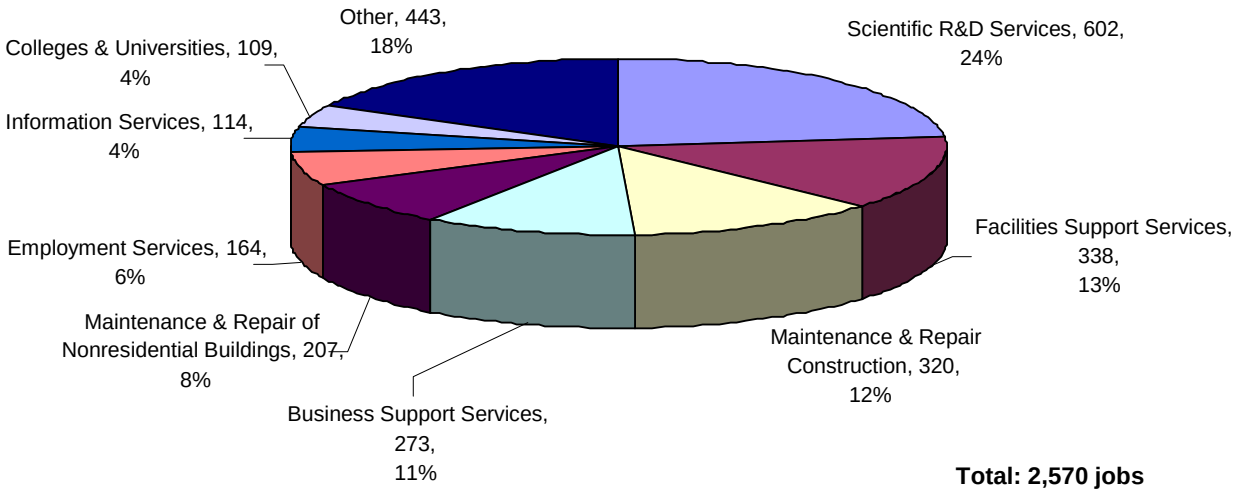
[a] Other includes the following industry sectors: agriculture, forestry, fishing and hunting; mining; wholesale trade; and management of companies.

[b] For employment impact, the change in final demand is equal to the number of full-time equivalent employees working for Glenn.

The total employment impact by Glenn Research Center on the Northeast Ohio economy in FY 2007 is 6,407 jobs. 1,672 of these people (26.1%) are directly employed at NASA Glenn. As a result of Glenn's direct spending for goods and services purchased in the region, 2,809 jobs (43.8%) were created. The remaining employment impact, 1,926 jobs, is in the form of indirect and induced impacts as Glenn spending ripples through the economy.

Of the 4,735 jobs created in Northeast Ohio due to the direct, indirect, and induced impacts, 2,570 (54.3%) are found in the Glenn-driven sectors, 1,910 (40.3%) are in the consumer-driven sectors, and 255 (5.4%) fall under other sectors.[16] The job distribution for select industries within the Glenn-driven sectors is shown in Figure 7. The job distribution for select industries within the consumer-driven sectors is shown in Figure 8.

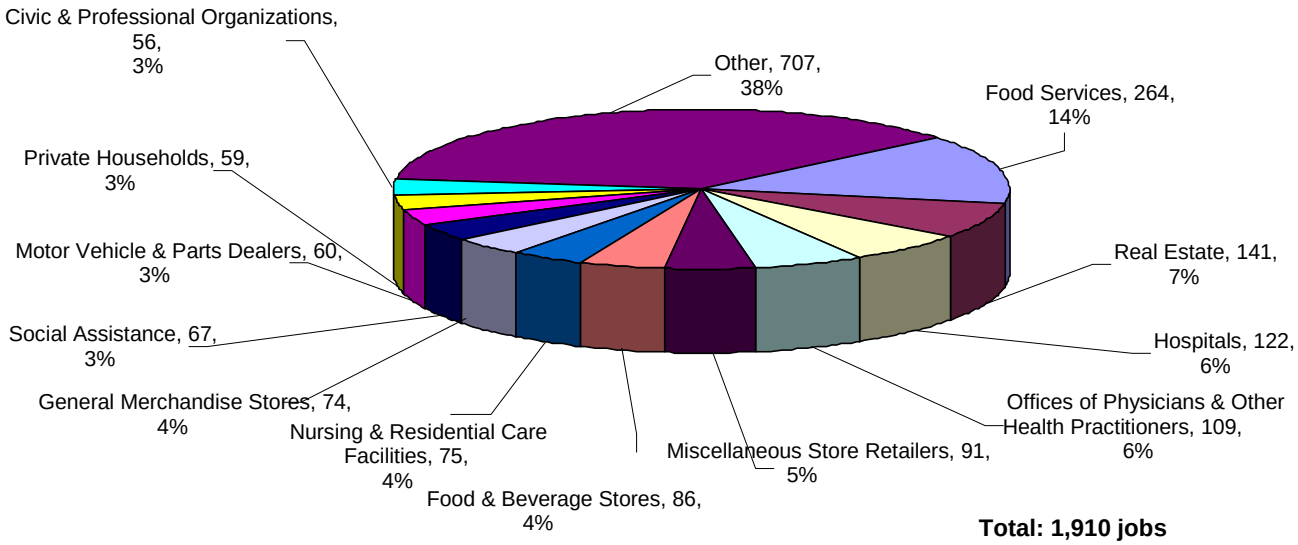
Figure 7. Increase in Jobs for Select Industries in Glenn-Driven Sectors, Northeast Ohio, FY 2007



Companies engaged in scientific R&D (professional, scientific, and technical services sector) saw an increase of 602 jobs in FY 2007 due to NASA Glenn activities (Figure 7). These jobs are the summation of the direct, indirect, and induced employment impacts generated primarily but not exclusively by Glenn spending for local R&D contractors. The 602 jobs represent a 24 percent share of the 2,570 jobs that were created in all industries within the Glenn-driven sectors.

[16] 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, healthcare, entertainment and food, other services, and owner-occupied buildings.

Figure 8. Increase in Jobs for Select Industries in Consumer-Driven Sectors, Northeast Ohio, FY 2007



Food and beverage stores (retail trade sector) saw an increase of 86 jobs in FY 2007 because of Glenn spending (Figure 8). These jobs are the summation of the direct, indirect, and induced employment impacts generated primarily by Glenn employees and other workers for food and drink products. The 86 jobs represent a four percent share of the 1,910 jobs that were created in all industries within the consumer-driven sectors.

D.2.3 Earnings Impact on Northeast Ohio in FY 2007

Earnings impact is the estimated total change in earnings paid to local households due to spending by Glenn Research Center for goods and services from businesses and other entities in Northeast Ohio. Monies paid to employees of companies and other entities who supply goods and services to Glenn represent direct earnings impact. Indirect impact is estimated by summing the monies paid to persons who work for companies that provide inputs to the producers of the goods and services ultimately consumed by Glenn. Induced impact represents monies 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 Glenn. Adding the direct, indirect, and induced impacts to the disposable income and healthcare benefits received by Glenn employees (final demand change) results in total earnings impact. Table 8 shows earnings impact by industry sector.

Table 8. Earnings Impact Based on Glenn Spending in Northeast Ohio, FY 2007

NASA Glenn Expenditures in Northeast Ohio: $354,652,158

Industry	Direct	Indirect	Induced	Total
Utilities	$3,336,973	$384,715	$516,165	$4,237,852
Construction	$24,006,415	$824,095	$273,263	$25,103,773
Manufacturing	$1,177,033	$2,578,809	$1,499,268	$5,255,093
Transportation & Warehousing	$552,180	$2,338,075	$1,282,556	$4,172,813
Retail Trade	$6,356,421	$1,575,015	$6,209,363	$14,140,798
Information	$7,892,263	$1,707,690	$704,749	$10,304,701
Finance & Insurance	$1,561,490	$2,800,116	$3,108,315	$7,469,922
Real Estate, Rental, Leasing	$379,174	$2,220,135	$1,218,336	$3,817,642
Professional, Scientific, Technical Services	$48,098,840	$7,807,283	$2,278,100	$58,184,224
Administrative & Support Services	$23,352,061	$6,000,176	$1,166,599	$30,518,833
Educational Services	$3,937,301	$98,756	$1,290,457	$5,326,515
Health Care & Social Assistance	$10,163,461	$61,095	$10,752,109	$20,976,666
Arts, Entertainment, Recreation	$603,829	$378,013	$731,819	$1,713,663
Accommodation & Food Services	$1,707,113	$869,864	$2,086,822	$4,663,798
Other Services	$2,009,282	$1,087,938	$2,336,518	$5,433,738
Government Enterprises	$602,858	$368,762	$503,398	$1,475,021
Other [a]	$212,967	$1,894,199	$1,015,174	$3,122,339
Total	$135,949,660	$32,994,737	$36,973,013	$205,917,391

Change in Final Demand [b]	$127,812,942
Direct Impact	$135,949,660
Indirect Impact	$32,994,737
Induced Impact	$36,973,013
Total Earnings Impact	**$333,730,352**

[a] Other includes the following industry sectors: agriculture, forestry, fishing and hunting; mining; wholesale trade; and management of companies.
[b] For earnings impact, change in final demand is equal to the disposable income (75 percent of gross income) plus healthcare benefits paid to Glenn employees.

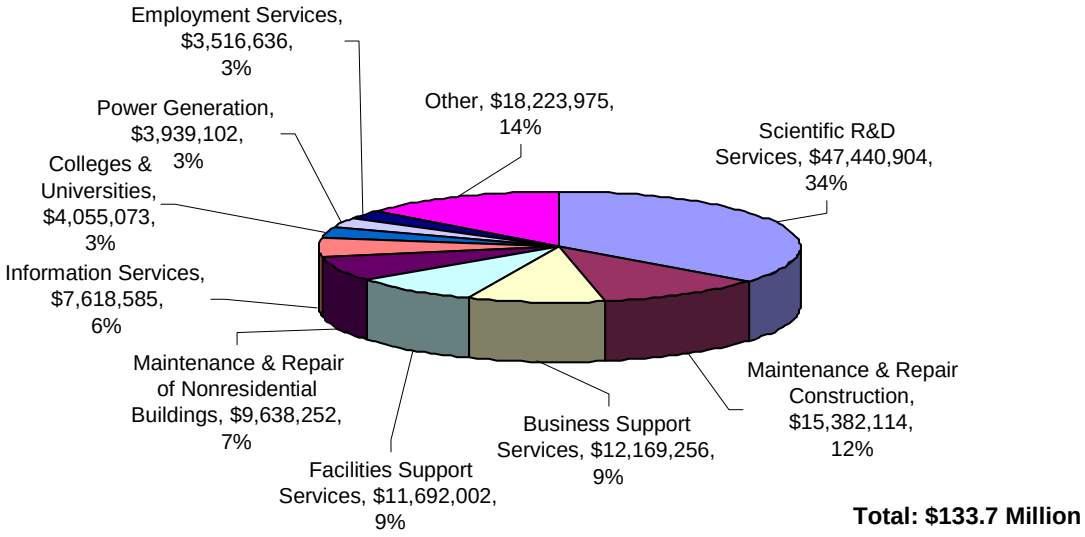
Total household earnings in Northeast Ohio increased by $333.7 million as a result of Glenn's spending in FY 2007 for goods and services. $127.8 million (38%) of this amount is the disposable income plus healthcare benefits paid directly to NASA Glenn employees—change in final demand. $136 million (41%) represents monies paid to employees of companies in Northeast Ohio that supply goods and services to Glenn—direct impact. The remaining earnings impact, (indirect and induced components) estimated at $70 million (21%), occurs as the effects of Glenn spending ripples through the Northeast Ohio economy.

Of the $205.9 million increase in household earnings generated across Northeast Ohio due to the direct, indirect, and induced impacts, $133.7 million (65%) was reported in Glenn-driven sectors; $58.2 (28%) was generated in consumer-driven sectors; and $14 million (7%) was reported in other sectors.[17] The household earnings distribution for select industries within

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

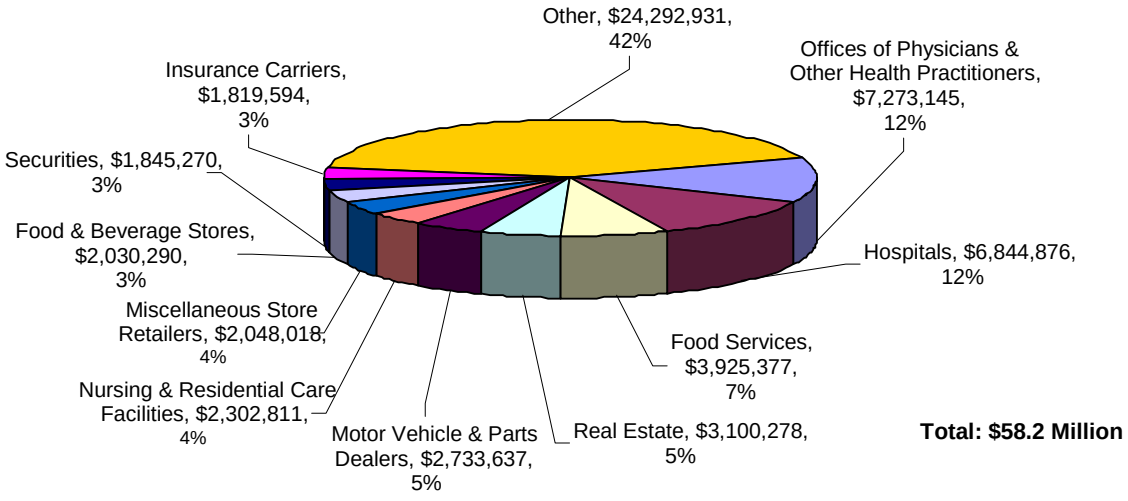
the Glenn-driven sectors is shown in Figure 9. The household earnings distribution for select industries within the consumer-driven sectors is shown in Figure 10.

Figure 9. Increase in Earnings for Select Industries in Glenn-Driven Sectors, Northeast Ohio, FY 2007



Persons engaged in business support services saw their household earnings increase by $12.2 million in FY 2007 (Figure 9). These earnings are the summation of the direct, indirect, and induced impacts generated primarily, but not exclusively, by Glenn spending for business support services. The $12.2 million represents a nine percent share of the $133.7 million earnings increase that was reported by all industries within the Glenn-driven sectors.

Figure 10. Increase in Earnings for Industries in Consumer-Driven Sectors, Northeast Ohio, FY 2007



Persons working in food services saw their household earnings increase by $3.9 million in FY 2007 (Figure 10). These earnings are the summation of the direct, indirect, and induced impacts generated by consumer spending at restaurants and bars. The $3.9 million represents a seven percent share of the $58.2 million earnings increase that occurred in all industries within the consumer-driven sectors.

D.2.4 FY 2007 Northeast Ohio Impact Summary

Economic activity generated by Glenn Research Center produced the following impacts on Northeast Ohio (2007 dollars):

- Total Output Impact: $1.045 billion
- Total Employment Impact: 6,407 jobs
- Total Earnings Impact: $333.7 million

The economic impact presented here reflects NASA Glenn expenditures in Northeast Ohio in FY 2007. During that time period, 60 percent ($213.3 million) of Glenn expenditures were allocated to Glenn payroll, scientific research and development services, other professional and technical services, and colleges and universities.

Other industries deriving significant benefits from direct Glenn spending include information services, power generation, business and facilities support, facilities maintenance and repair. Businesses deriving the most benefit from spending by Glenn personnel and other workers whose earnings are due in part to Glenn expenditures follow typical consumer spending patterns. These include 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 in FY 2007

In this section, we discuss the economic impact that NASA Glenn spending had on the Ohio economy during FY 2007. More specifically, we present a detailed analysis of the change in output (sales), employment, and household earnings due to Glenn activities.

This section follows the structure of Section D.2, Economic Impact on Northeast Ohio. Readers who are less interested in the detailed discussion should proceed to section D.3.4, Ohio Impact Summary.

D.3.1 Output Impact on the State of Ohio in FY 2007

This analysis uses multipliers to estimate the ripple effect that an initial expenditure has on a studied economy. These multipliers measure the effect of Glenn Research Center (Glenn) spending on output (sales) across the state of Ohio. The multipliers that are applied to spending in Ohio are generally larger than those applied to expenditures in Northeast Ohio. The reason being that a larger geographic area assures less leakage from the economy. Stated another way, as the geographic area being analyzed increases in size, the amount of goods and services purchased from outside that area decreases.

NASA Glenn expenditures were divided into spending on goods and services purchased from companies and other entities located in the state of Ohio (local) and spending for goods and services from businesses located elsewhere. Local spending is then categorized by industry based upon the IMPLAN industry classification system. Table A.4 in Appendix A lists detailed Glenn expenditures by specific industry.

Table 9 presents the total output impact and its components. Local Glenn expenditures represent direct output impact. Indirect impact is estimated by summing the contributions of individual industries that provide inputs to the producers of the goods and services ultimately consumed by NASA Glenn. Induced impact is estimated by measuring the spending of workers who are employed as a result of the demand for products and services created by Glenn. Total output impact is the sum of change in final demand, direct impact, indirect impact, and induced impact. Table 9 reports output impacts by industry sector. It shows how Glenn spending across Ohio affects all sectors of the economy.[18]

[18] Disposable income spent by Glenn employees is automatically distributed by IMPLAN to those industries from which households typically make purchases. The result being that "households" is not identified as a unique industry sector in Table 10. The industry sector that is the largest beneficiary of household spending is foreign and domestic trade ($39.7 million). This sector represents products that are purchased by households locally but are produced outside Ohio, either domestically or internationally.

Table 9. Output Impact Based on Glenn Spending in the State of Ohio, FY 2007

NASA Glenn Expenditures in Ohio: $433,808,955

Industry	Direct	Indirect	Induced	Total
Utilities	$15,890,040	$2,466,189	$3,471,263	$21,827,492
Construction	$56,217,057	$2,991,594	$1,029,971	$60,238,623
Manufacturing	$10,151,191	$21,513,023	$18,427,464	$50,091,701
Transportation & Warehousing	$1,463,279	$6,596,238	$4,450,284	$12,509,802
Retail Trade	$17,061,126	$5,141,177	$22,869,686	$45,071,986
Information	$34,308,963	$9,826,417	$4,890,583	$49,025,961
Finance & Insurance	$5,905,715	$9,822,696	$14,079,849	$29,808,260
Real Estate, Rental, Leasing	$1,970,095	$16,807,753	$9,531,448	$28,309,294
Professional, Scientific, Technical Services	$139,024,035	$24,669,882	$6,934,585	$170,628,499
Administrative & Support Services	$48,023,519	$15,057,356	$3,343,679	$66,424,553
Educational Services	$12,565,834	$244,378	$2,769,442	$15,579,652
Health Care & Social Assistance	$20,045,427	$182,879	$28,319,288	$48,547,592
Arts, Entertainment, Recreation	$1,523,305	$962,109	$2,428,383	$4,913,797
Accommodation & Food Services	$5,395,821	$3,188,629	$9,064,254	$17,648,705
Other Services	$4,729,692	$3,107,511	$7,420,215	$15,257,418
Government Enterprises	$5,345,553	$1,850,294	$2,598,510	$9,794,358
Owner-occupied Dwellings	$16,463,296	$0	$22,430,991	$38,894,289
Foreign & Domestic Trade	$39,709,707	$0	$0	$39,709,707
Other [a]	$875,878	$6,123,383	$4,500,945	$11,500,206
Total	$436,669,534	$130,551,508	$168,560,840	$735,781,895

Change in Final Demand [b]	$478,008,086
Direct Impact	$436,669,533
Indirect Impact	$130,551,507
Induced Impact	$168,560,840
Total Output Impact	**$1,213,789,966**

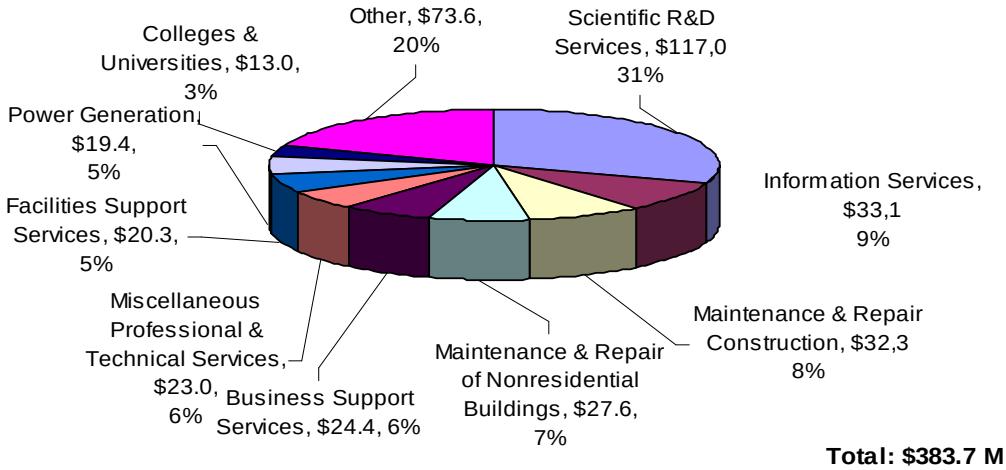
[a] Other includes the following industry sectors: agriculture, forestry, fishing and hunting; mining; wholesale trade; and management of companies.
[b] For output impact, the change in final demand equals spending by Glenn within and outside Ohio excluding payroll and healthcare benefits.

The total output impact across the state of Ohio as a result of Glenn Research Center activities in FY 2007 was over $1.2 billion. Glenn's expenditures of $433.8 million resulted in an increase in output (sales) of $735.8 million across all industry sectors (Table 9). For example, Glenn spending affected a $50.1 million increase in sales (direct, indirect, and induced impacts) by the manufacturing sector and $170.6 million in professional, scientific, and technical services.

Thirty-nine percent ($478 million) of the total output impact is accounted for by the change in final demand that occurs because Glenn activities bring resources into Ohio from outside the state. Approximately $436.7 million (36%) of the total output impact is a result of direct spending by Glenn for goods and services purchased within the state of Ohio. The remaining output impact of $299.1 million (25%) is attributable to the indirect and induced components as Glenn spending ripples through the economy.

An analysis of the IMPLAN model results shows that the $735.8 million increase in sales generated by the direct, indirect, and induced impacts can be divided into the same broad categories that were identified for Northeast Ohio—Glenn-driven sectors, consumer-driven sectors, and other sectors.[19] The output distribution for select industries within the Glenn-driven sectors is shown in Figure 11. The output distribution for select industries within the consumer-driven sectors is shown in Figure 12.

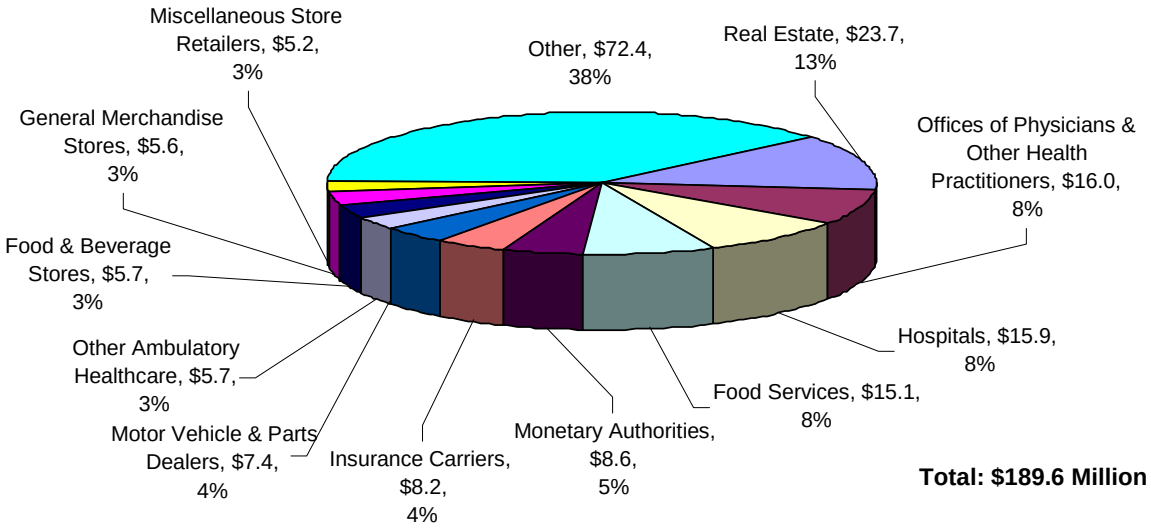
Figure 11. Increase in Sales for Select Industries in Glenn-Driven Sectors, Ohio, FY 2007



[19] 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.

Colleges and universities (education sector) across the state of Ohio saw an increase in revenues of $13 million in FY 2007 (Figure 11). This amount is the summation of the direct, indirect, and induced impacts generated primarily but not exclusively by Glenn spending for research by colleges and universities. $13 million represents a three percent share of the $383.7 million increase in output value for all industries within the Glenn-driven sectors.

Figure 12. Increase in Sales for Select Industries in Consumer-Driven Sectors, Ohio, FY 2007



Insurance carriers (finance and insurance sector) experienced a sales increase of $8.2 million in FY 2007 (Figure 12). This amount is the summation of the direct, indirect, and induced impact components generated primarily by Glenn employees and other workers for insurance products. $8.2 million represents a four percent share of the $189.6 million increase in output for all industries within the consumer-driven sectors.

D.3.2 Employment Impact on the State of Ohio in FY 2007

Glenn Research Center's activities affect job creation beyond Glenn's hiring of its own employees (change in final demand). Glenn spending creates employment across the state of Ohio in industries from which it purchases goods and services (direct impact) and employment in industries that provide inputs into those goods and services (indirect impact). In addition, monies spent by Glenn employees and employees of those companies with which NASA Glenn does business create jobs in a variety of other industries (induced impact). Total employment impact equals the sum of Glenn Research Center full-time equivalent employment and the

direct, indirect, and induced components. Table 10 shows the number of jobs created by industry sector.

Table 10. Employment Impact Based on Glenn Spending in the State of Ohio, FY 2007

NASA Glenn Expenditures in Ohio: $433,808,955

Industry	Direct	Indirect	Induced	Total
Utilities	32	5	7	44
Construction	673	26	9	708
Manufacturing	27	62	41	133
Transportation & Warehousing	11	64	39	115
Retail Trade	307	79	351	736
Information	111	40	19	170
Finance & Insurance	26	58	72	157
Real Estate, Rental, Leasing	15	118	71	203
Professional, Scientific, Technical Services	972	186	60	1217
Administrative & Support Services	795	324	63	1181
Educational Services	210	4	55	269
Health Care & Social Assistance	243	1	344	589
Arts, Entertainment, Recreation	30	21	49	100
Accommodation & Food Services	111	60	186	356
Other Services	95	51	146	293
Government Enterprises	23	10	14	46
Other [a]	6	32	29	68
Total	3,684	1,141	1,554	6,383

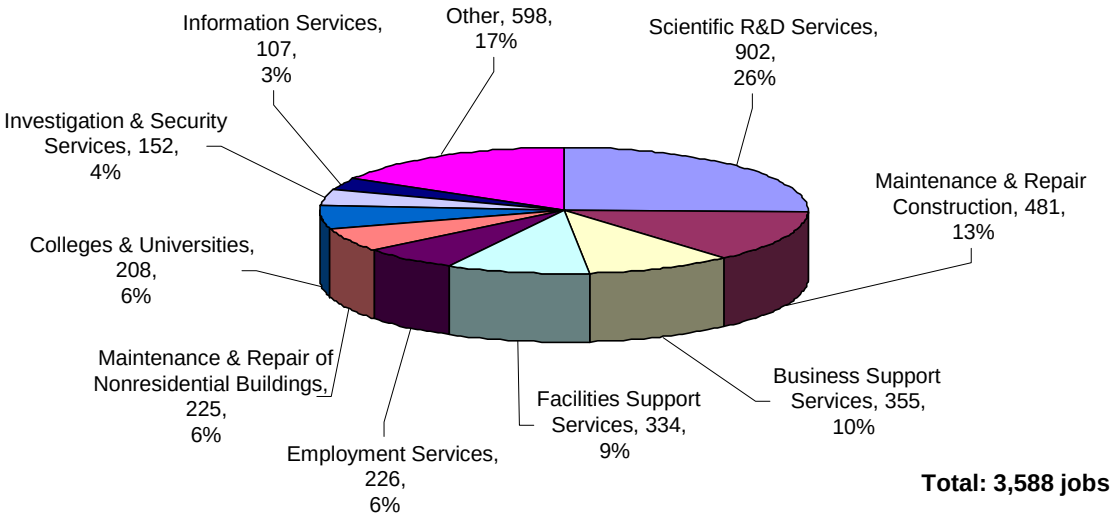
Change in Final Demand [b]	1,672
Direct Impact	3,684
Indirect Impact	1,141
Induced Impact	1,554
Total Employment Impact	**8,051**

[a] Other includes the following industry sectors: agriculture, forestry, fishing and hunting; mining; wholesale trade; and management of companies.
[c] For employment impact, the change in final demand is equal to the number of full-time equivalent employees working for Glenn.

Employment increased by 8,051 jobs across the state of Ohio in FY 2007 due to the presence of NASA Glenn. Of these, 1,672 people (21%) are directly employed at Glenn. As a result of Glenn's direct spending for goods and services purchased in Ohio, 3,684 jobs (46%) were created. The remaining employment impact—2,695 jobs (33%)—is in the form of indirect and induced impacts as NASA Glenn spending ripples through the economy.

Of the 6,383 jobs created in Ohio due to the direct, indirect, and induced components, 3,588 (56%) are found in the Glenn-driven sectors, 2,434 (38%) are in the consumer-driven sectors, and 362 (6%) fall under other sectors.[20] The job distribution for select industries within the Glenn-driven sectors is shown in Figure 13. The job distribution for select industries within the consumer-driven sectors is shown in Figure 14.

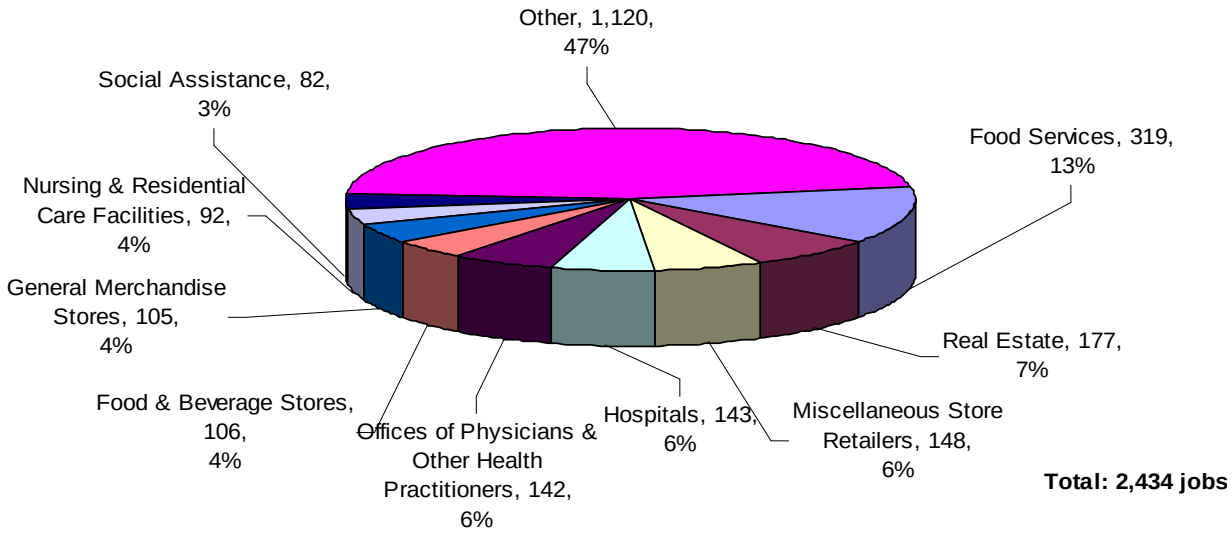
Figure 13. Increase in Jobs for Select Industries in Glenn-Driven Sectors, Ohio, FY 2007



Due to spending by Glenn Research Center in the state of Ohio, 107 jobs were added in information services during FY 2007 (Figure 13). These jobs are the summation of the direct, indirect, and induced employment impacts generated primarily but not exclusively by Glenn's need for information services. The 107 jobs represent a three percent share of the 3,588 jobs that were created in all industries within the Glenn-driven sectors.

[20] 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, healthcare, entertainment and food, other services, and owner-occupied buildings.

Figure 14. Increase in Jobs for Select Industries in Consumer-Driven Sectors, Ohio, FY 2007



The food services industry experienced an increase of 319 jobs in FY 2007 (Figure 14). These jobs are the summation of the direct, indirect, and induced components generated primarily by NASA Glenn employees and other workers who patronize restaurants and bars. The 319 jobs represent a 13 percent share of the 2,434 jobs that were created in all industries within the consumer-driven sectors.

D.3.3 Earnings Impact on the State of Ohio in FY 2007

Earnings impact is the estimated change in earnings received by households in the state of Ohio due to spending by Glenn Research Center for goods and services from businesses and other entities across the state. Monies paid to employees of companies and other entities who supply goods and services to Glenn represent direct earnings impact. Indirect impact is estimated by summing the monies paid to persons who work for companies that provide inputs to the producers of the goods and services ultimately consumed by Glenn. Induced impact represents monies paid to workers in all industries who are employed as a result of the demand for products and services created by NASA Glenn. Adding the direct, indirect, and induced impacts to the disposable income and healthcare benefits received by Glenn employees (final demand change) results in total earnings impact. Table 11 shows earnings impact by industry sector.

Table 11. Earnings Impact Based on Glenn Spending in the State of Ohio, FY 2007

NASA Glenn Expenditures in Ohio: $433,808,955

Industry	Direct	Indirect	Induced	Total
Utilities	$3,417,053	$508,864	$707,256	$4,633,175
Construction	$30,812,566	$1,170,406	$415,472	$32,398,444
Manufacturing	$1,715,410	$3,836,344	$2,591,019	$8,142,756
Transportation & Warehousing	$552,740	$3,225,823	$1,914,098	$5,692,663
Retail Trade	$7,267,475	$2,038,226	$9,083,311	$18,389,015
Information	$8,785,078	$2,339,998	$1,066,821	$12,191,897
Finance & Insurance	$1,584,831	$3,455,516	$4,316,568	$9,356,915
Real Estate, Rental, Leasing	$381,019	$2,882,694	$1,649,791	$4,913,504
Professional, Scientific, Technical Services	$75,175,866	$10,918,250	$3,219,319	$89,313,435
Administrative & Support Services	$25,529,020	$8,095,648	$1,614,149	$35,238,817
Educational Services	$6,929,823	$112,282	$1,480,354	$8,522,460
Health Care & Social Assistance	$10,190,415	$62,490	$14,808,563	$25,061,466
Arts, Entertainment, Recreation	$602,411	$449,551	$991,422	$2,043,383
Accommodation & Food Services	$1,693,140	$1,043,422	$2,849,951	$5,586,513
Other Services	$1,981,894	$1,338,261	$3,134,687	$6,454,843
Government Enterprises	$604,850	$494,502	$702,455	$1,801,807
Other [a]	$224,243	$2,239,847	$1,559,247	$4,023,338
Total	$177,447,835	$44,212,125	$52,104,483	$273,764,430

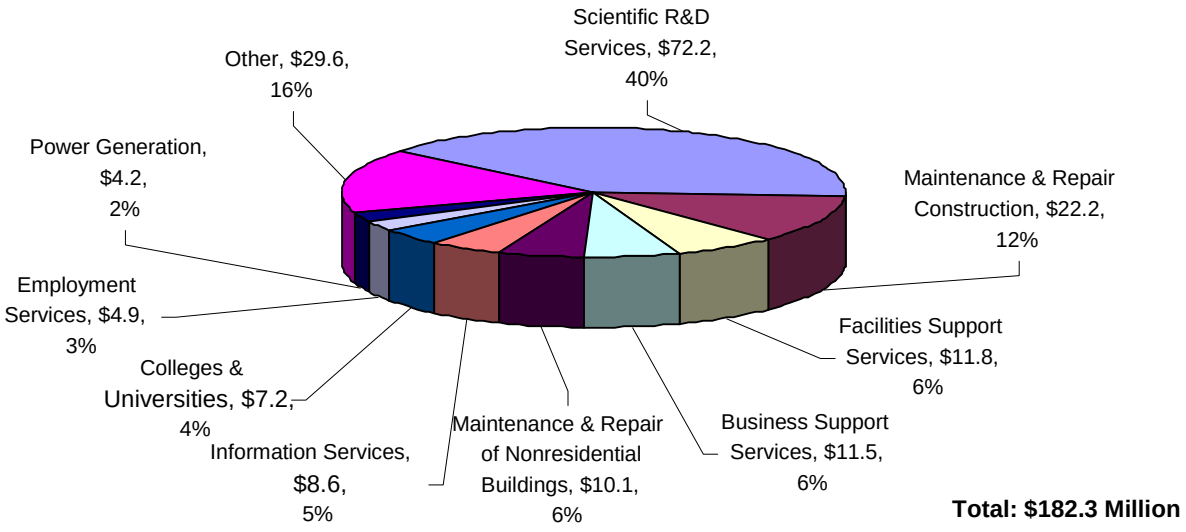
Change in Final Demand [b]	$127,812,942
Direct Impact	$177,447,835
Indirect Impact	$44,212,125
Induced Impact	$52,104,483
Total Earnings Impact	**$401,577,385**

[a] Other includes the following industry sectors: agriculture, forestry, fishing and hunting; mining; wholesale trade; and management of companies.
[b] For earnings impact, change in final demand is equal to the disposable income (75 percent of gross income) plus healthcare benefits paid to Glenn employees.

Total household earnings in the state of Ohio increased by $401.6 million as a result of Glenn's spending in FY 2007 for goods and services. Of this amount, $127.8 million (32%) is the disposable income and healthcare benefits paid to NASA Glenn employees—change in final demand. $177.5 million (44%) represents monies paid to employees of companies across the state that supply goods and services to Glenn—direct impact. The remaining earnings impact (indirect and induced components), estimated at $96.3 million (24%), occurs as the effects of Glenn spending ripples through the Ohio economy.

Of the $273.8 million increase in household earnings attributed to the direct, indirect, and induced components, $182.3 million (67%) was reported in Glenn-driven sectors, $71.8 million (26%) occurred in consumer-driven sectors, and $19.7 million (7%) was reported in other sectors.[21] The household earnings distribution for select industries within the Glenn-driven sectors is shown in Figure 15. The household earnings distribution for select industries within the consumer-driven sectors is shown in Figure 16.

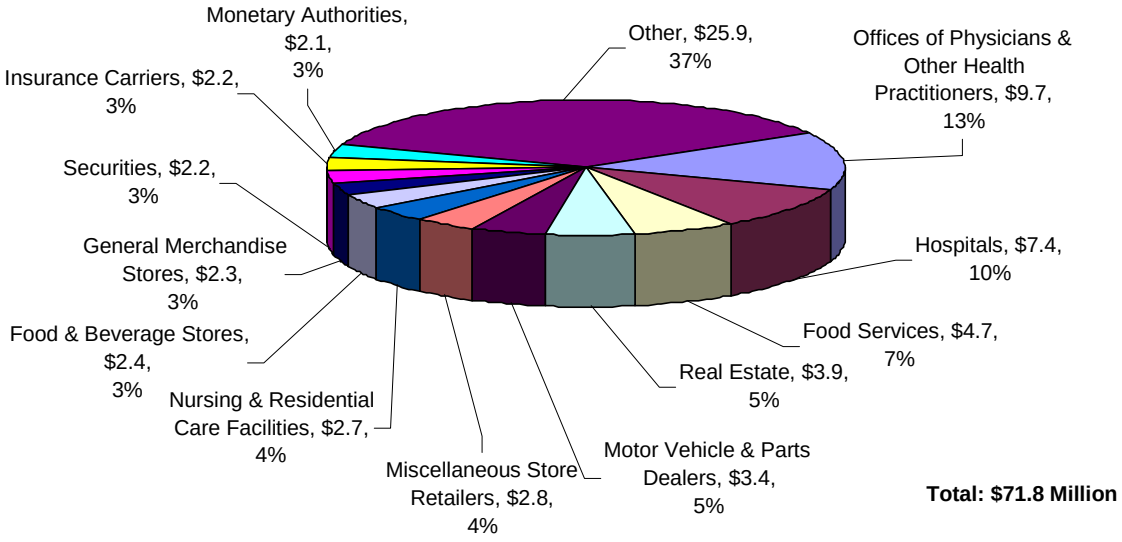
Figure 15. Increase in Earnings for Select Industries in Glenn-Driven Sectors, Ohio, FY 2007



Employees in facilities support services industries (administrative and support services sector) across the state of Ohio saw their household earnings increase by $11.8 million in FY 2007 (Figure 15). These earnings are the summation of the direct, indirect, and induced impacts generated primarily but not exclusively by NASA Glenn for facilities support services. The $11.8 million represents a six percent share of the $182.3 million earnings increase that occurred in all industries within the Glenn-driven sectors.

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

Figure 16. Increase in Earnings for Select Industries in Consumer-Driven Sectors, Ohio, FY 2007



Persons working for motor vehicle and parts dealers (retail trade sector) experienced an increase in household earnings of $3.4 million in FY 2007 (Figure 16). This amount is the summation of the direct, indirect, and induced impacts generated primarily by Glenn employees and other workers on spending for automobiles and other types of motor vehicles. The $3.4 million represents a five percent share of the $71.8 million earnings increase that was reported by all industries within the consumer-driven sectors.

D.3.4 FY 2007 Ohio Impact Summary

Economic activity generated by the Glenn Research Center produced the following impacts on the state of Ohio (2007 dollars):

- Total Output Impact: $1.2 billion
- Total Employment Impact: 8,051 jobs
- Total Earnings Impact: $401.6 million

The impact of NASA Glenn's expenditure in the state of Ohio is only slightly higher than the impact on Northeast Ohio. This is due to the fact that the majority of Glenn's Ohio expenditures are in Northeast Ohio (including all of Glenn's payroll expenditures). In FY 2007, NASA Glenn's expenditures in the state of Ohio, excluding the eight-county Northeast Ohio region, were only $79 million. Almost all of this spending (93 percent) was allocated to just five industries: scientific R&D ($38.8 million), miscellaneous professional and technical services ($14.1 million), other maintenance and repair ($9.9 million), colleges and universities ($5.9 million), and investigation and security services ($4.6 million). The result is that Ohio businesses, excluding those located in the eight-county Northeast Ohio region, experienced an increase in sales of $169.2 million, added 1,644 jobs, and saw an increase in household earnings of $67.9 million.

Since major Glenn expenditures elsewhere in the state of Ohio mirrored expenditures in Northeast Ohio, industries across Ohio that derive the most benefit from Glenn spending and spending by NASA Glenn employees and other workers are similar to those reported for Northeast Ohio.[22]

[22] 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 (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.

E. COMPARISON OF NASA GLENN ECONOMIC IMPACTS IN FY 2006 AND FY 2007

NASA Glenn continues to be an important economic player in Northeast Ohio and across the state, continually increasing its economic impacts on the region and Ohio (Table 12). The economic impact in FY2007 was higher than the economic impact in FY2006 for all measures. Generating more than 8,000 jobs statewide in FY2007, NASA Glenn increased its impact on the state economy not only by generating almost 700 more jobs (9% increase) than in the previous year, but also significantly increasing its output impact (by $90 million, or 8%) and earnings impact (by $28 million, or 7%).

Table 12. NASA Glenn Economic Impacts, FY 2006- FY 2007

Economic Impact	Northeast Ohio		State of Ohio	
	FY 2006	FY 2007	FY 2006	FY 2007
Output Impact	$977.5 million*	$1,044.6 million	$1,124.2 million*	$1,213.8 million
Employment Impact	6,046 jobs	6,407 jobs	7,360 jobs	8,051 jobs
Earnings Impact	$312.4 million*	$333.7 million	$373.8 million*	$401.6 million

* 2006 monetary values are adjusted to $2007 for comparison

In Northeast Ohio, NASA Glenn generated 6,407 jobs in FY 2007, 361 more jobs (6% increase) than the employment impact in FY2006. In addition, the output impact on Northeast Ohio in FY 2007 generated $67 million (7%) more than the impact in FY2006 and the earning impact was $21 million (7%) higher than the earnings impact in the previous year. This growth in economic impacts on the state and regional economies emphasizes the important value of NASA Glenn's activities as well as the jobs that NASA Glenn provides to the region and the state.

NASA Glenn continues to be one of the major economic anchors of Northeast Ohio and a crucial part of the region's intellectual infrastructure. It is an invaluable asset for Northeast Ohio as it struggles to restructure and transform its economy with hopes to grow and attract more knowledge-based, research-intense businesses and organizations. The presence of NASA Glenn in Northeast Ohio is a positive attribute for many of these types of businesses and potential start-up companies that grow their business based on innovation. NASA Glenn's employees are part of the region's knowledge-intense labor force with unique skills at the cutting edge of science and technology that generate wealth in the region and advance the nation.

APPENDIX A: DATA TABLES

Table A.1. Glenn Spending by State, FY 2007

State	Spending	Share
Ohio	$305,996,012	64.01%
California	$24,193,455	5.06%
Maryland	$22,552,869	4.72%
New York	$20,192,841	4.22%
Florida	$11,733,584	2.45%
Massachusetts	$9,608,526	2.01%
Alabama	$7,061,825	1.48%
Virginia	$6,951,159	1.45%
Illinois	$6,445,645	1.35%
Connecticut	$6,160,284	1.29%
New Jersey	$6,088,987	1.27%
Colorado	$5,982,094	1.25%
Pennsylvania	$4,994,676	1.04%
Texas	$4,900,577	1.03%
Georgia	$4,610,897	0.96%
Michigan	$4,049,174	0.85%
Arizona	$3,919,704	0.82%
North Carolina	$2,731,110	0.57%
Washington	$2,333,761	0.49%
Indiana	$2,107,645	0.44%
New Hampshire	$1,850,929	0.39%
Louisiana	$1,137,043	0.24%
Oregon	$1,080,216	0.23%
Washington DC	$1,000,530	0.21%
Missouri	$996,019	0.21%
Minnesota	$938,894	0.20%
West Virginia	$937,858	0.20%
New Mexico	$913,567	0.19%
Wisconsin	$825,733	0.17%
Arkansas	$824,096	0.17%
Kansas	$766,331	0.16%
Iowa	$634,310	0.13%
Tennessee	$628,328	0.13%
Nevada	$585,638	0.12%
Mississippi	$430,847	0.09%
Kentucky	$212,200	0.04%
Rhode Island	$210,152	0.04%
Delaware	$150,985	0.03%
Oklahoma	$134,124	0.03%
Idaho	$99,589	0.02%
Utah	$48,204	0.01%
South Carolina	$26,731	0.01%
Montana	$25,896	0.01%
Nebraska	$23,651	0.00%
Hawaii	$13,320	0.00%
Maine	$3,208	0.00%
South Dakota	$2,131	0.00%
Outside U.S.	$892,729	0.19%
Total	**$478,008,086**	**100.00%**

Spending in Ohio excludes Glenn employee payroll and benefits.

Table A.2. Glenn Monies Allocated to Academic Institutions by State, FY 2007

STATE	AMOUNT	SHARE
Ohio	$10,379,251	17.09%
Florida	$9,235,510	15.21%
New York	$7,331,754	12.07%
Maryland	$7,115,448	11.71%
Georgia	$3,905,714	6.43%
Alabama	$3,340,564	5.50%
California	$3,240,724	5.34%
Virginia	$1,743,877	2.87%
Illinois	$1,548,467	2.55%
Pennsylvania	$1,348,197	2.22%
North Carolina	$1,336,384	2.20%
Michigan	$1,319,447	2.17%
Louisiana	$1,137,043	1.87%
Massachusetts	$1,049,330	1.73%
Missouri	$855,051	1.41%
Colorado	$740,047	1.22%
Kansas	$719,054	1.18%
Indiana	$615,855	1.01%
Texas	$494,857	0.81%
New Jersey	$461,810	0.76%
Tennessee	$391,629	0.64%
Puerto Rico	$372,295	0.61%
Washington	$318,770	0.52%
Iowa	$296,763	0.49%
Arizona	$257,000	0.42%
Connecticut	$219,511	0.36%
Oregon	$192,366	0.32%
Rhode Island	$164,268	0.27%
Wisconsin	$151,479	0.25%
Kentucky	$118,744	0.20%
Oklahoma	$109,773	0.18%
Minnesota	$83,396	0.14%
Idaho	$60,795	0.10%
Washington DC	$47,309	0.08%
Arkansas	$23,127	0.04%
Hawaii	$13,320	0.02%
New Mexico	$6,100	0.01%
Mississippi	$3,551	0.01%
Montana	-$9,104	-0.01%
Total	**$60,739,477**	**100.00%**

Table A.3. NASA Glenn Detailed Expenditures in Northeast Ohio, FY 2007

Description	IMPLAN Sector [a]	Expenditure [b]	Basis [c]
Utilities		**$14,261,991**	
Electricity	30	$13,593,624	Industry
Natural Gas	31	$668,367	Industry
Construction		**$45,112,348**	
Maintenance & Repair of Nonresidential Buildings	43	$23,463,691	Industry
Other Maintenance & Repair	45	$21,648,657	Industry
Manufacturing		**$1,963,455**	
Stationery & Related Product	133	$11,708	Commodity
Commercial Printing	139	$48,620	Industry
Petroleum Lubricating Oil & Grease	145	$105,518	Commodity
All Other Petroleum & Coal Products	146	$58,512	Commodity
Industrial Gas	148	$42,571	Commodity
Organic Chemicals	151	$3,585	Commodity
Paint & Coatings	161	$55	Commodity
Adhesives	162	$4,146	Commodity
Rubber & Plastics Hose & Belting	180	$25,235	Commodity
Other Rubber Products	181	$6,370	Commodity
Glass & Glass Products, Except Glass Containers	190	$1,499	Commodity
Rolled Steel Shape	206	$92,112	Commodity
Primary Nonferrous Metals	215	$4,260	Commodity
Copper Wire, Except Mechanical, Drawing	217	$4,524	Commodity
Iron & Steel Forging	224	$3,083	Commodity
All Other Forging & Stamping	227	$3,630	Commodity
Fabricated Structural Metal	233	$31,771	Commodity
Machine Shops	243	$368,828	Industry
Metal Coating	246	$5,700	Commodity
Electroplating, Anodizing & Coloring Metal	247	$3,185	Commodity
Metal Valves	248	$139,733	Commodity
Fabricated Pipe & Pipe Fitting	252	$28,568	Commodity
Miscellaneous Fabricated Metal Products	255	$151,938	Commodity
Photographic & Photocopying Equipment	272	$1,700	Commodity
Air Purification Equipment	275	$3,308	Commodity
Heating Equipment	277	$19,760	Commodity
Pump & Pumping Equipment	288	$13,975	Commodity
Fluid Power Pump & Motor Manufacturing	300	$71,579	Commodity
Electronic Computer	302	$63,903	Commodity
Other Computer Peripheral Equipment	305	$38,106	Commodity
Broadcast & Wireless Communications Equipment	307	$16,138	Commodity
All Other Electronic Components	312	$59,614	Commodity
Industrial Process Variable Instruments	316	$32,074	Commodity
Electricity & Signal Testing Instruments	318	$92,400	Commodity
Analytical Laboratory Instruments	319	$202,636	Commodity
Lighting Fixtures	326	$3,400	Commodity
Wiring Devices	341	$27,625	Commodity
Carbon & Graphite Products	342	$9,292	Commodity
Miscellaneous Electrical Equipment	343	$1,464	Commodity
Heavy Duty Truck	345	$88,170	Commodity
Surgical & Medical Instruments	375	$73,157	Commodity
Transportation & Warehousing		**$25,602**	
Truck Transportation	394	$18,982	Industry
Transit & Ground Passenger Transportation	395	$6,620	Industry

Description	IMPLAN Sector [a]	Expenditure [b]	Basis [c]
Retail Trade		**$2,333,189**	
Electronics & Appliance Stores	403	$18,561	Industry
Building Material Supply Stores	404	$12,479	Industry
Miscellaneous Retail Stores	411	$2,302,148	Industry
Information		**$32,464,458**	
Telecommunications	422	$240,074	Industry
Information Services	423	$32,179,979	Industry
Data Processing Services	424	$44,405	Industry
Real Estate and Rental & Leasing		**$293,260**	
Machinery & Equipment Rental & Leasing	434	$293,260	Industry
Professional, Scientific & Technical Services		**$81,010,386**	
Legal Services	437	$230,914	Industry
Architectural & Engineering Services	439	$15,500	Industry
Custom Computer Programming Services	441	$34,800	Industry
Management Consulting Services	444	$7,400	Industry
Scientific Research & Development Services	446	$76,106,489	Industry
Photographic Services	448	$65,399	Industry
Miscellaneous Professional & Technical Services	450	$4,549,884	Industry
Administrative & Support and Waste Management Services		**$42,858,553**	
Office Administrative Services	452	$92,363	Industry
Facilities Support Services	453	$20,035,130	Industry
Business Support Services	455	$22,689,068	Industry
Travel Arrangement & Reservation Services	456	$41,993	Industry
Education		**$4,504,360**	
Colleges & Universities	462	$4,503,360	Industry
Other Educational Services	463	$1,000	Industry
Health Care & Social Assistance		**$1,653,654**	
Ambulatory Health Care Services	466	$1,503,654	Industry
Hospitals	467	$150,000	Industry
Accommodation & Food Services		**$4,032**	
Other Accommodations	480	$4,032	Industry
Repair & Maintenance		**$2,680**	
Electronic Equipment Repair & Maintenance	484	$540	Industry
Commercial Machinery Repair & Maintenance	485	$2,140	Industry
Other Services		**$20,600**	
Civic, Social, Professional & Similar Organizations	493	$20,600	Industry
Government Enterprises		**$330,647**	
Federal Government Enterprises	496	$330,394	Industry
State & Local Government Enterprises	499	$254	Industry
Households		**$127,812,942**	
Household Spending [d]	10007	$127,812,942	Industry
TOTAL EXPENDITURES		**$354,652,158**	

[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 Research Center (Glenn) in FY 2007. Values shown in Table A-3 are limited to expenditures made in Northeast Ohio.

[c] **Basis:** Industries consist of businesses producing goods and services; commodities are the goods and services. An **industry** impact gives the entire sector dollar value to the industry that has been selected. For example, Glenn spent $45.1 million for maintenance and repairs of its buildings and infrastructure. Therefore, the entire dollar value spent for this work in the impact analysis is assigned to the construction sector. A **commodity** impact splits the sector dollar value among all industries producing that commodity. For example, Glenn spent $139,733 on metal valves (IMPLAN sector 248). Since Glenn purchased these valves from distributors rather than the actual manufacturer, IMPLAN splits

the dollar value among all industries that produce valves. If these industries are located outside Northeast Ohio, IMPLAN only assigns margin values (transportation, wholesale, and retail) in the impact analysis.

[d] **Households:** Household expenditures include Glenn employee payroll and medical insurance. Payments have been reduced to include only disposable income. In this analysis, disposable income equals 75 percent of the gross amount and medical benefits. Disposable income excludes income that is used for savings and to pay taxes.

Table A.4. NASA Glenn Detailed Expenditures in the State of Ohio, FY 2007

Description	IMPLAN Sector [a]	Expenditure [b]	Basis [c]
Utilities		**$14,414,521**	
Electricity	30	$13,609,768	Industry
Natural Gas	31	$668,367	Industry
Water & Sewage	32	$136,386	Industry
Construction		**$55,614,756**	
Maintenance & Repair of Non-residential Buildings	43	$24,036,432	Industry
Other Maintenance & Repair	45	$31,578,324	Industry
Manufacturing		**$3,303,290**	
Footwear	110	$21,607	Commodity
Stationery & Related Product	133	$11,708	Commodity
Commercial Printing	139	$48,620	Industry
Petroleum Lubricating Oil & Grease	145	$105,518	Commodity
All Other Petroleum & Coal Products	146	$58,512	Commodity
Industrial Gas	148	$57,286	Commodity
Organic Chemicals	151	$14,645	Commodity
Paint & Coatings	161	$55	Commodity
Miscellaneous Chemical Products	171	$5,641	Commodity
Foam Product	178	$14,355	Commodity
Rubber & Plastics Hose & Belting	180	$25,235	Commodity
Other Rubber Products	181	$6,370	Commodity
Glass & Glass Products, Except Glass Containers	190	$1,499	Commodity
Ferroalloy & Related Products	204	$43,310	Commodity
Rolled Steel Shape	206	$92,112	Commodity
Primary Nonferrous Metals	215	$4,260	Commodity
Copper Wire, Except Mechanical, Drawing	217	$4,524	Commodity
Iron & Steel Forging	224	$3,083	Commodity
All Other Forging & Stamping	227	$3,630	Commodity
Fabricated Structural Metal	233	$31,771	Commodity
Power Boiler & Heat Exchangers	238	$24,990	Commodity
Machine Shops	243	$431,322	Industry
Metal Coating	246	$5,700	Commodity
Electroplating, Anodizing & Coloring Metal	247	$3,185	Commodity
Metal Valves	248	$139,733	Commodity
Fabricated Pipe & Pipe Fitting	252	$28,568	Commodity
Miscellaneous Fabricated Metal Products	255	$222,478	Commodity
Photographic & Photocopying Equipment	272	$1,700	Commodity
Other Commercial & Service Industry Machinery	273	$3,860	Commodity
Air Purification Equipment	275	$3,308	Commodity
Heating Equipment	277	$19,760	Commodity
Rolling Mill & Other Metalworking Machinery	284	$449,360	Commodity
Pump & Pumping Equipment	288	$101,608	Commodity
Air & Gas Compressors	289	$14,042	Commodity
Fluid Power Pump & Motor Manufacturing	300	$80,279	Commodity
Electronic Computer	302	$63,903	Commodity
Other Computer Peripheral Equipment	305	$38,106	Commodity
Broadcast & Wireless Communications Equipment	307	$16,138	Commodity
Other Communications Equipment	308	$19,571	Commodity
All Other Electronic Components	312	$72,250	Commodity
Industrial Process Variable Instruments	316	$32,074	Commodity
Electricity & Signal Testing Instruments	318	$192,222	Commodity
Analytical Laboratory Instruments	319	$284,929	Commodity

Description	IMPLAN Sector [a]	Expenditure [b]	Basis [c]
Lighting Fixtures	326	$3,400	Commodity
Wiring Devices	341	$27,625	Commodity
Carbon & Graphite Products	342	$9,292	Commodity
Miscellaneous Electrical Equipment	343	$1,464	Commodity
Heavy Duty Truck	345	$88,170	Commodity
Aircraft Engine & Engine Parts	352	$47,843	Commodity
Other Aircraft Parts & Equipment	353	$59,118	Commodity
All Other Transportation Equipment	361	$169,182	Commodity
Office Furniture, Except Wood	370	$21,207	Commodity
Surgical & Medical Instruments	375	$73,157	Commodity
Transportation & Warehousing		**$25,602**	
Truck Transportation	394	$18,982	Industry
Transit & Ground Passenger Transportation	395	$6,620	Industry
Retail Trade		**$3,431,278**	
Electronics & Appliance Stores	403	$18,561	Industry
Building Material Supply Stores	404	$12,479	Industry
Miscellaneous Store Retailers	411	$3,400,238	Industry
Information		**$32,518,488**	
Telecommunications	422	$240,074	Industry
Information Services	423	$32,219,369	Industry
Data Processing Services	424	$59,045	Industry
Real Estate and Rental & Leasing		**$293,260**	
Machinery & Equipment Rental & Leasing	434	$293,260	Industry
Professional, Scientific & Technical Services		**$136,570,831**	
Legal Services	437	$239,574	Industry
Architectural & Engineering Services	439	$2,629,081	Industry
Custom Computer Programming Services	441	$37,805	Industry
Management Consulting Services	444	$7,400	Industry
Scientific Research & Development Services	446	$114,942,913	Industry
Photographic Services	448	$65,399	Industry
Miscellaneous Professional & Technical Services	450	$18,648,659	Industry
Administrative & Support and Waste Management Services		**$47,424,681**	
Office Administrative Services	452	$92,363	Industry
Facilities Support Services	453	$20,035,130	Industry
Business Support Services	455	$22,689,068	Industry
Travel Arrangement & Reservation Services	456	$41,993	Industry
Investigation & Security Services	457	$4,566,128	Industry
Education		**$10,380,251**	
Colleges & Universities	462	$10,379,251	Industry
Other Educational Services	463	$1,000	Industry
Health Care & Social Assistance		**$1,653,654**	
Ambulatory Health Care Services	466	$1,503,654	Industry
Hospitals	467	$150,000	Industry
Accommodation & Food Services		**$4,032**	
Other Accommodations	480	$4,032	Industry
Repair & Maintenance		**$2,680**	
Electronic Equipment Repair & Maintenance	484	$540	Industry
Commercial Machinery Repair & Maintenance	485	$2,140	Industry
Other Services		**$23,600**	
Civic, Social, Professional & Similar Organizations	493	$23,600	Industry

Description	IMPLAN Sector [a]	Expenditure [b]	Basis [c]
Government Enterprises		**$335,087**	
Federal Government Enterprises	496	$330,394	Industry
State & Local Government Enterprises	499	$4,694	Industry
Households		**$127,812,942**	
Household Spending [d]	10007	$127,812,942	Industry
TOTAL EXPENDITURES		**$433,808,955**	

[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 Research Center (Glenn) in FY 2004. Values shown in Table A-4 are limited to expenditures made in the state of Ohio.

[c] **Basis:** Industries consist of businesses producing goods and services; commodities are the goods and services. An **industry** impact gives the entire sector dollar value to the industry that has been selected. A **commodity** impact splits the sector dollar value among all industries producing that commodity.

[d] **Households:** Household expenditures include Glenn employee payroll and medical insurance. Payments have been reduced to include only disposable income. In this analysis, disposable income equals 75 percent of the gross amount. Disposable income excludes income that is used for savings and to pay taxes.