Uncovering the Stealth Cluster

The Economic Impact of Civilian and Military Aerospace on South Carolina - 2014

Developed by:
Division of Research
Moore School of Business
University of South Carolina

August 2014

UNIVERSITY OF
SOUTH CAROLINA
Darla Moore School of Business

Developed in Partnership With:

UNIVERSITY OF
SOUTH CAROLINA
Ronald E. McNAIR Center for
Aerospace Innovation and Research

South Carolina
Department of Commerce

NEW CAROLINA
SOUTH CAROLINA'S COUNCIL ON COMPETITIVENESS

Study Prepared by:
Joseph Von Nessen, Ph.D.
Research Economist, Division of Research
joey.vonnessen@moore.sc.edu

Executive Summary

- *The aerospace cluster has experienced one of the highest growth rates in employment among all industries in South Carolina over the last decade. From 2002 to 2012, annual employment growth in the aerospace cluster averaged 4.2 percent, compared to just 0.3 percent for the state as a whole.* ***Since 2010, when the state's economy began recovering from the Great Recession, annual employment growth in the aerospace cluster has averaged 11.4 percent, which is approximately eight times higher than the 1.4 percent average annual growth rate for the state overall.***

- ***The Charleston tri-county region (Berkeley, Charleston, Dorchester) has a higher concentration of aerospace employment than in any other region of South Carolina.*** *This is due to a strong presence of both private sector and military employment. The Upstate region has the highest concentration of aerospace employment among areas without a major military aviation facility, and ranks fourth overall behind Charleston, the Lowcountry, and the Midlands.*

- ***The private sector component of the aerospace cluster in South Carolina comprises around 17,114 employees across 466 firms.*** *Approximately 74 percent of these firms contain five or fewer employees.*

- *Because of the large focus of aircraft manufacturing on advanced composite materials, precision metal parts, and systems integration, the jobs supported by the aerospace cluster require expertise in many specialized fields related to aerospace science and engineering. These positions are typically high-skill, high-wage jobs.* ***Specifically, the average job in the aerospace cluster in South Carolina pays an annual total compensation of $70,749. This is approximately 72 percent higher than the average total compensation in South Carolina ($41,206) and 46 percent higher than the average total compensation of manufacturing jobs in South Carolina ($48,453).***

- ***The annual economic impact of the aerospace cluster resulting from private sector activity totals nearly $8 billion in total economic output.*** *This figure reflects the dollar value of all goods and services that can be attributed (either directly or indirectly) to the aerospace-related firms in South Carolina. This $8 billion in economic output is associated with 37,150 total jobs and over $2 billion in total employee compensation.*

- *There are four major military aviation facilities in South Carolina that also form part of the aerospace cluster: the Shaw Air Force Base, the McEntire Joint National Guard Base, the Charleston Air Force Base, and the Beaufort Marine Corps Air Station.* ***When the impact of these military facilities are combined with private sector economic activity in aerospace, the joint***

impact totals over $17 billion in economic output and over 100,000 jobs. This represents approximately 5.9 percent of South Carolina's total annual gross state product.

- *The total economic impact resulting from the private sector component of the aerospace cluster is associated with an employment multiplier of 2.2.* ***This implies that for every 10 jobs that are created in the private sector component of the aerospace cluster in South Carolina, an additional 12 jobs are created elsewhere in the state.***

- *The net annual contribution that the aerospace cluster makes to South Carolina gross state product is approximately $10.4 billion. This implies that* ***the aerospace cluster generates economic activity (directly and indirectly) that brings in over $532 million in tax revenue annually for the state of South Carolina that would not exist otherwise.***

- ***Since Boeing's arrival in South Carolina, the aerospace cluster has generated approximately the same number of direct jobs per year as the automotive cluster did between 1990 and 2007 following the arrival of BMW.*** *These recent growth patterns imply that aerospace has the potential to be a major pillar of South Carolina's economy going forward.*

- ***With a sizeable statewide economic footprint, a uniquely high rate of employment growth, and a rapidly expanding supply chain, increases in the aerospace cluster's employment and income multiplier effects will occur over time.*** *These increased multiplier effects, in turn, will cause subsequent aerospace cluster expansions to generate even larger economic gains for South Carolina.*

Table of Contents

Section I – Introduction and Background

Over the last decade, South Carolina's aerospace industry has experienced sizeable growth that has quickly propelled it to the forefront of statewide economic development. Led in large part by the arrival of the Boeing facilities that currently manufacture the 787 Dreamliner aircraft in Charleston, the aerospace industry has expanded to incorporate substantial investments in capital, research and development, and infrastructure statewide.

The aerospace industry also has significant overlap with the aviation industry, which provides a stable base of economic activity through both civil and military facilities located throughout South Carolina. The aerospace and aviation industries (hereafter referred to as the *aerospace cluster*) both serve as major components of the broader statewide manufacturing cluster, which has also been a primary source of employment growth in South Carolina following the end of Great Recession. Since 2006, the annual employment growth rate for the aerospace cluster has been as high as 37.9 percent, with an average annual rate of growth at 26.2 percent between 2006 and 2012.[1] This rate of growth is among the highest of any industry in South Carolina.

A strong aerospace cluster offers a number of advantages to South Carolina. First, the recent bouts of growth have been accompanied by a growing demand for a variety of *high-skill*, *high-wage* jobs in the fields of science and mathematics, especially engineering. Aircraft manufacturing, with its large focus on advanced composite materials, precision metal parts, and systems integration, requires expertise in many specialized fields related to aerospace science and engineering.

[1] Growth rates refer to North American Industrial Classification System (NAICS) codes 336400 and 481000. Data are compiled from the U.S. Bureau of Labor Statistics' Quarterly Census of Employment and Wages (QCEW).

Second, the aerospace cluster is helping to develop the knowledge economy in South Carolina. The knowledge economy can be generally defined as the industrial sectors that require innovation and technological development along with the commercialization of new ideas. This process – innovation and commercialization – is what leads to long-run economic growth and development. Regions with high concentrations of workers in the knowledge economy (such as the engineers required by the aerospace cluster) generate enormous human capital resources and knowledge spillover effects. In the United States today, regions with a well-educated workforce and a strong innovation sector are those that are growing the fastest and those that have workers who are among the most productive, creative, innovative, and well paid in the country.[2] In South Carolina, regions with the highest number of jobs in the knowledge economy are the regions currently experiencing the fastest rates of income growth – both for those working in the knowledge economy and for those working in the supporting service sectors.

Third, a considerable portion of the aerospace cluster is comprised of the aviation industry, which is critically important to ongoing economic development efforts. As with in-state transportation infrastructure and the Charleston port, commercial and general aviation airports are an essential factor of the transportation needs of businesses of South Carolina. In addition, the state has four major military aviation facilities that support vast amounts of economic activity statewide. These include the Shaw Air Force Base, the McEntire Joint National Guard Base, the Charleston Air Force Base, and the Beaufort Marine Corps Air Station.

Taken together, these advantages highlight why the aerospace cluster currently serves as a key focal point for South Carolina's economic growth going forward. The purpose of this study is to provide a detailed examination of the core civilian and commercial aerospace and aviation industries in South Carolina and to explicitly estimate this cluster's influence and overall statewide presence. This will include

[2] For a full discussion on the benefits of knowledge economies in the United States, see Moretti (2012)

quantifying its components, its industries, its trends, and its regional and statewide economic impacts as measured in a variety of ways.

The report is organized as follows: Section II describes how this study defines the aerospace cluster as well as the data that are used to quantify the cluster; Section III provides an overview of the aerospace cluster itself, including statewide employment and firm growth patterns, in-state location quotients, and county-level growth; Section IV estimates the total economic impact of the aerospace cluster on South Carolina, including all impacts resulting from the economic multiplier effect; Section V then provides a brief conclusion.

Section II – Defining South Carolina's Aerospace Cluster

Despite the fact that there is an abundance of research available on various aerospace clusters located throughout the United States, it is not the case that there is a single, industry-standard definition for what constitutes the term "aerospace cluster." While all research incorporates firms operating directly within aerospace manufacturing and their related services, the specific firm types can vary considerably due to the diversity of the industry. The degree to which the military and defense industries are incorporated into the aerospace cluster also varies depending on the location being examined and the focus of the research.[3]

In order to identify all components of the aerospace cluster in South Carolina, this study starts by identifying the NAICS codes[4] that correspond to firms directly associated with (1) aerospace manufacturing and related services and (2) commercial aviation. This NAICS code list and the accompanying descriptions appear in Appendix I. Since each firm in South Carolina is tied to a specific six-digit NAICS code, it is possible to identify all of the firms that are associated with this NAICS code list.

This identification process is accomplished through the use of the National Establishment Time-Series (NETS) database. The NETS database is one of the most comprehensive databases available for information on individual firm activity in South Carolina, containing more than 600,000 firm-level observations between 1989 and 2012. Among the variables that the NETS database tracks is the six-digit NAICS code for each South Carolina firm. Thus, firms that are categorized within the aerospace cluster can be specifically identified. The firms that match up with the NAICS code list in Appendix I will be referred to in this report as constituting the

[3] See Chmura (2011), Commission (2002), Deloitte (2012), Enterprise (2013), and Metro (2014) for recent work on various aerospace clusters in the United States.
[4] NAICS is an abbreviation for the North American Industrial Classification System. NAICS categorizes all U.S. industries, and each U.S. firm fits into one or more of these categories.

aerospace core – that is – firms that operate directly within the aerospace cluster in South Carolina.

There is also a significant component of the aerospace cluster in South Carolina that is not captured using NETS data – namely military aviation facilities. These include the Shaw Air Force Base, the McEntire Joint National Guard Base, the Charleston Air Force Base, and the Beaufort Marine Corps Air Station. Data on the direct employment and economic activity associated with each of these facilities were obtained from the South Carolina Department of Commerce. *Military aviation* is the second component of the aerospace cluster in South Carolina.

Finally, there is a third component to South Carolina's aerospace cluster that consists of private sector firms that fall outside of the aerospace core. These are firms in other industries that service aerospace by providing goods and services to firms within the core. For example, engineering firms are not directly part of the aerospace industry, yet there are some engineering firms that have a client base that is either partially or completely made up of firms within the aerospace core. Thus, these firms support the aerospace industry, even as they are not in the aerospace industry themselves. This smaller component of the cluster is known as the *aerospace periphery*.

Thus, there are three primary components of the aerospace cluster in South Carolina: the aerospace core, military aviation, and the aerospace periphery. This report will focus primarily on analyzing the aerospace core and military aviation. While the aerospace periphery is part of South Carolina's aerospace cluster, it is difficult to quantify the extent to which individual firms outside of aerospace are actively supporting the core. For example, NETS data do not provide any way of accurately determining the percentage of time that employees spend working on aerospace-related projects. Thus, the aerospace periphery is analyzed separately in order to avoid overestimating the size of the aerospace cluster and to avoid misrepresenting the distribution of the cluster within South Carolina.

Section III – Trends in South Carolina's Aerospace Cluster

Statewide Employment and Firm Growth

Over the last decade, aerospace has been one of the fastest growing industries in South Carolina, driven largely by the arrival of Boeing in 2007 in the Charleston market. As of 2012, there were 17,114 employees across 466 firms working in the aerospace core in South Carolina. Figure 1 below highlights annual employment and firm growth for the aerospace core and for South Carolina as a whole over the last decade, separated into pre-Boeing years (2003-2007), post-Boeing years (2007-2012), and post-Boeing years that exclude the Great Recession (2010-2012).

Table 1 – Annual Employment and Firm Growth Rates[5]

	Aerospace Core Employment	South Carolina Employment	Aerospace Core Firms	South Carolina Firms
2003-2007 Annual Growth	+0.1%	+1.9%	+3.9%	+5.2%
2007-2012 Annual Growth	+5.5%	-0.9%	+9.0%	+3.1%
2010-2012 Annual Growth	+11.4%	+1.4%	+19.2%	+4.9%
---	---	---	---	---
2012 Total Figures	17,114	1,859,100	466	307,221

Since 2007, aerospace has consistently outperformed the South Carolina economy, growing at an average annual rate of 5.5 percent from 2007 to 2012, compared to -0.9 percent for the state as a whole. This is especially striking considering that this growth rate incorporates the Great Recession – an eighteen-month period between 2007 and 2009 in which South Carolina lost over 138,000 jobs. Between 2010 and 2012, aerospace employment grew at an average annual rate of 11.4 percent, compared to 1.4 percent for the state as a whole. By contrast, employment growth in South Carolina between 2003 and 2007 far exceeded aerospace, growing at 1.9 percent compared to 0.1 percent for the aerospace core. These comparisons make Boeing's effect on aerospace growth in South Carolina very clear.

[5] Estimates of South Carolina employment in Table 1 are compiled from the QCEW at the U.S. Bureau of Labor Statistics. All other figures are estimated through the NETS database.

Firm growth in aerospace experienced a similar trend, with growth increasing from 3.9 percent in the pre-Boeing years to 9.0 percent in the post-Boeing years. Between 2010 and 2012 this annual growth rate increased further to 19.2 percent. Firm growth in aerospace exceeded overall firm growth in South Carolina between 2007 and 2012, but not between 2003 and 2007.[6]

Of the 466 firms in the aerospace core in South Carolina in 2012, the majority (74.0%) consisted of five or fewer employees – and though small firms have comprised the bulk of the increase in the total number of aerospace firms over the last decade, these firms have not been responsible for the majority of the employment growth. Table 2 below shows the percentage of employment and firm growth between 2007 and 2012 that resulted from firms of different sizes, as well as the total number of firms in each category.

Table 2 – Employment and Firm Growth by Firm Size

Firm Size by Total Employment	Percentage of Total Aerospace Employment Increase 2007-2012	Percentage of Total Aerospace Firm Increase 2007-2012	Total Number of Firms (2012)
5 or Less	+6.9%	+95.3%	345
6-10	+0.5%	+2.0%	41
11-100	+0.1%	-0.7%	56
101-500	+15.1%	+1.3%	17
501+	+77.5%	+2.0%	7

Notice that while firms with fewer than five employees were responsible for over 95 percent of the firm growth in aerospace, they were only responsible for approximately 6.9 percent of aerospace employment growth over the same period. By contrast, firms with over 500 employees were responsible for just two percent of firm growth, but over 77 percent of employment growth between 2007 and 2012.

[6] See Appendix III and Appendix IV for NETS estimates of total employment, total number of firms, and annual employment and firm growth rates.

Regional Concentrations

The standard way to examine regional concentrations in economics is to estimate *location quotients*. Location quotients describe how the concentration of industry employment within a smaller region compares to the concentration of industry employment within a larger surrounding area. For example, in South Carolina, the aerospace core and military aviation together comprise approximately 3.46 percent of total employment in South Carolina.[7] In the United States, the aerospace core and military aviation comprise approximately 2.0 percent of total employment. Thus, South Carolina's location quotient for aerospace is 1.73 (3.46/2.0), which implies that the concentration of aerospace employment in South Carolina is about 73 percent higher than the national average. A location quotient of 1.0, by contrast, would imply that the concentration of aerospace employment in South Carolina is the same as the national average, and a location quotient less than 1.0 would imply that the concentration is less than the national average.

Similarly, location quotients can be calculated for regions within South Carolina. For the purposes of this report, South Carolina is divided into eight regional economic development areas as outlined in Table 3 below.

Table 3 – Regional Definitions within South Carolina

Region	Included Counties
Aiken/Augusta	Aiken, Allendale, Bamberg, Barnwell, Edgefield
Charleston	Berkeley, Charleston, Dorchester
Rock Hill	Chester, Lancaster, York
Grand Strand	Georgetown, Horry
Lowcountry	Beaufort, Colleton, Hampton, Jasper
Midlands	Calhoun, Clarendon, Fairfield, Kershaw, Lee, Lexington, Newberry, Orangeburg, Richland, Saluda, Sumter
Upstate	Abbeville, Anderson, Cherokee, Greenville, Greenwood, Laurens, McCormick, Oconee, Pickens, Spartanburg, Union
Pee Dee	Chesterfield, Darlington, Dillon, Florence, Marion, Marlboro, Williamsburg

To calculate location quotients within South Carolina, employment data from the NETS database were used. Total employment data for the aerospace core and

[7] This percentage is based on 2012 data from the Quarterly Census of Employment and Wages (QCEW), which is compiled by the U.S. Bureau of Labor Statistics.

military aviation were compared to employment data for South Carolina as a whole, and this comparison revealed that approximately 2.4 percent of all South Carolina employment is contained within the aerospace cluster. Notice that this percentage is significantly lower than the same value calculated using data from the Quarterly Census of Employment and Wages (QCEW) compiled by the U.S. Bureau of Labor Statistics mentioned above (3.46%). The reason for this discrepancy is that many of the employment categories used by the QCEW to define industries are relatively broad. This means that it is difficult to capture all aerospace employment data without also capturing data from firms in separate industry categories. The NETS database is not as vulnerable to this problem because it breaks out data at the firm level, thus providing a more accurate portrait of the cluster. Employment concentration percentages for aerospace were calculated for each of South Carolina's eight regional economic development areas and compared against the statewide value, which produced the location quotients described in Table 4 below.

Table 4 – South Carolina Aerospace Location Quotients

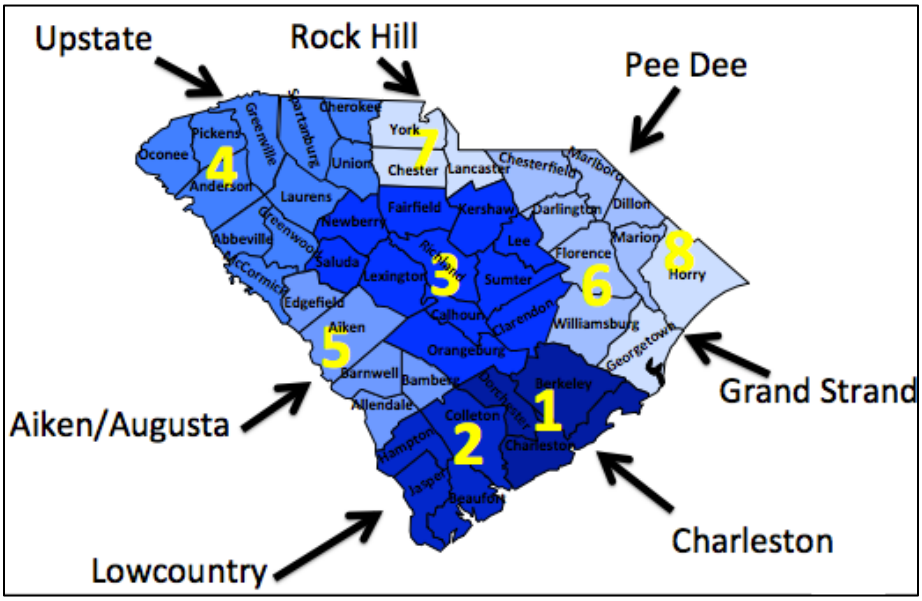
Region	State Cluster Pct.	Regional Cluster Pct.	Location Quotient
Charleston	2.4%	6.5%	2.75
Lowcountry	2.4%	4.7%	1.98
Midlands	2.4%	2.5%	1.03
Upstate	2.4%	1.6%	0.66
Aiken/Augusta	2.4%	0.5%	0.20
Pee Dee	2.4%	0.2%	0.07
Rock Hill	2.4%	0.04%	0.02
Grand Strand	2.4%	0.04%	0.02

The highest aerospace location quotient in South Carolina occurs in Charleston, with a value of 2.75. This implies that aerospace employment is about 2.75 times as concentrated in Charleston as it is in the state overall. This high concentration is driven primarily by Boeing, Boeing's local suppliers and contractors, and the Military Air Force Base located in North Charleston. The Lowcountry contains a concentration of aerospace employment that is about twice the rate of South Carolina (1.98), but in this case it is primarily the result of the Marine Corps Air

Station located in Beaufort County. Its reliance on private sector employment is relatively small by comparison.

The location quotients for the Midlands and the Upstate are significantly lower than those for Charleston and the Lowcountry, with values of 1.03 and 0.66, respectively. At first glance this may seem unusual given that the Midlands contains both the Shaw Air Force Base and the McEntire National Guard Base and the Upstate contains several major aerospace manufacturers. However, the Midlands and Upstate regions have total employment levels that are 23 percent and 44 percent larger than Charleston, respectively. Thus, while both have sizeable aerospace employment in *absolute* terms, their *relative* concentration is lower because of their larger total employment base. Figure 1 highlights the areas of the state where these regional location coefficients apply. Darker regions indicate the most concentrated areas.

Figure 1 – Ranking of Regional Location Quotients



Growth rates within the aerospace cluster can also be examined at the regional level. Specifically, Figures 2 and 3 below detail employment and revenue growth for the aerospace cluster, by county, between 2007 and 2012.[8]

[8] Counties with total aerospace employment under 50 in 2007 were omitted from this analysis. Relatively small increases in total employment in some of these counties led to extraordinarily high

Figure 2 – Aerospace Cluster Emp. Growth by County (Avg. Annual Growth: '07-'12)

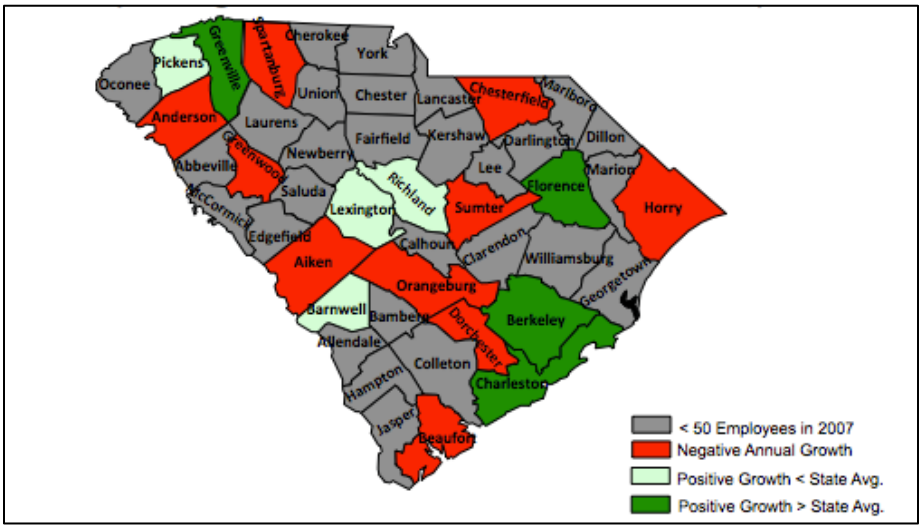
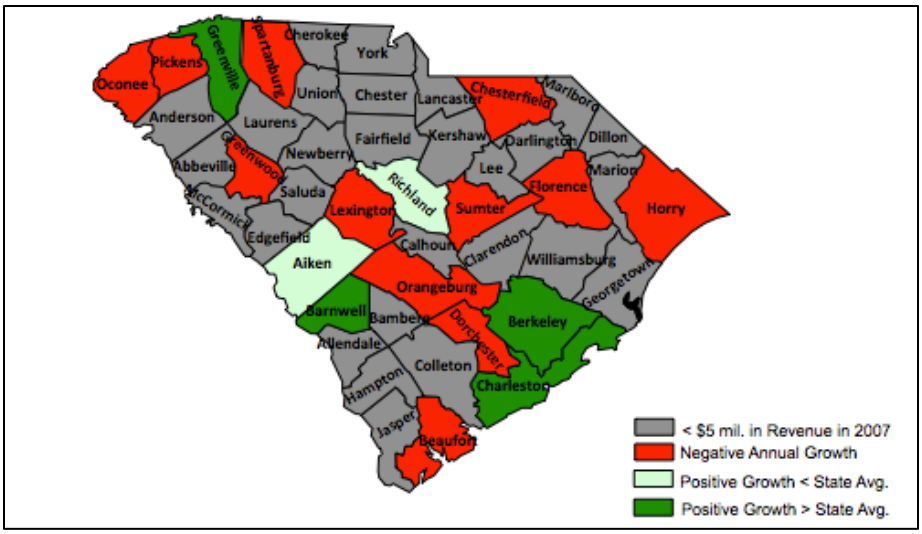


Figure 3 – Aerospace Cluster Rev. Growth by County (Avg. Annual Growth: '07-'12)



Over this five-year period, eight counties experienced positive employment growth in aerospace and six counties experienced positive revenue growth in aerospace. The major growth in both indicators occurred primarily in Charleston (Berkeley and Charleston counties) and the Upstate (primarily Greenville county). These regions of the state, led by aerospace, have also been the regions with the highest overall levels

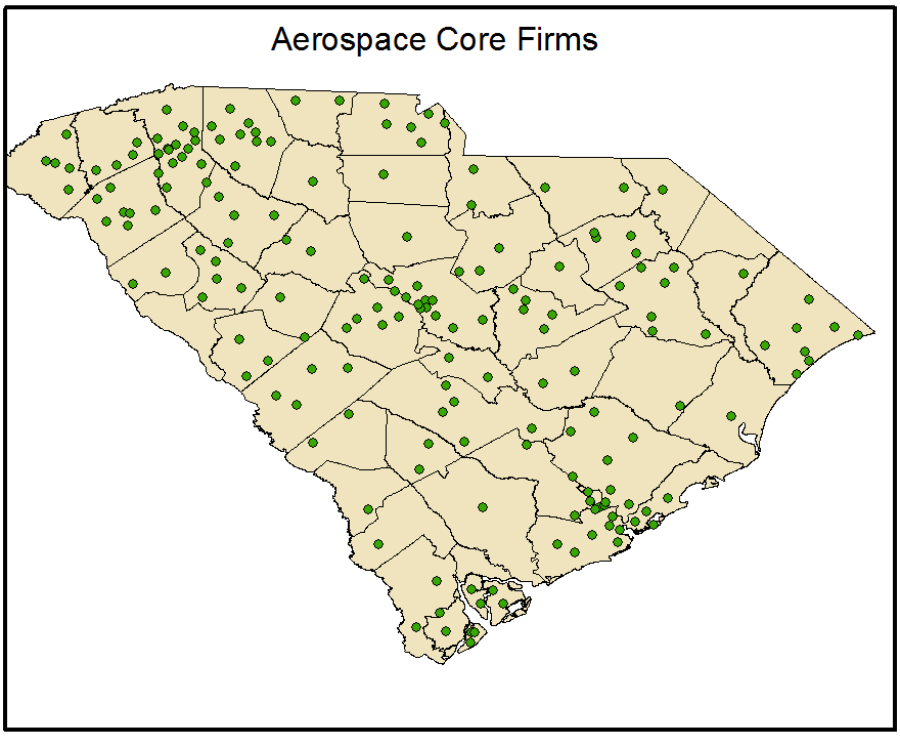
growth rates, but these growth rates do not provide a realistic assessment of their relative contributions to aerospace growth.

of employment growth in South Carolina since the state began recovering from the Great Recession in early 2010.

The four counties that exhibit the most unusual trends over this five-year time period are Florence, Lexington, Pickens, and Aiken. Florence, Lexington, and Pickens counties each had simultaneous increases in total employment and decreases in total revenue over this period. In each of these counties, the increases in employment were the result of increased aviation activity (e.g., airports, aviation oversight), while the decrease in revenue was the result of revenue declines across the majority of firms. By contrast, Aiken County lost employment and gained total revenue in aerospace over this five-year time period. This was due primarily to small changes in both indicators across a majority of firms. Figure 4 below highlights the locations of all firms in the aerospace core operating in 2012.

Figure 4 – Aerospace Core Firm Locations (2012)

Note: Due to proximity, some location points represent multiple firms.



Section IV – The Economic Impact of Aerospace in South Carolina

Methodology

The aerospace cluster in South Carolina directly employs thousands of workers across the state and generates billions of dollars in economic activity every year. Yet these activities do not provide a complete picture of the impact of aerospace on South Carolina's economy. The expenditures that occur within the aerospace cluster also lead to additional job creation and economic activity throughout South Carolina by way of the economic multiplier effect (or economic ripple effect).

Economic multiplier effects can be divided into direct, indirect, and induced impacts. The direct impact reflects all in-state purchases made by organizations within the aerospace cluster. These include, for example, employee wages and benefits, equipment, building construction and remodeling, technology services, vendors, and other overhead or administrative costs. This spending activity increases demand and leads to the creation of new jobs and more income for employees and suppliers of organizations within the cluster.

The indirect impact reflects additional economic activity that results from inter-industry linkages between local firms in South Carolina. For example, when Boeing purchases aircraft components from in-state vendors, these vendors experience an increase in demand. To satisfy this demand, they must purchase additional inputs from their suppliers – such as additional staff and equipment. Suppliers of this additional staff and equipment must then purchase additional supplies as well, and so on. These indirect effects ripple through the economy and affect many sectors of South Carolina.

The induced impact reflects additional economic activity that results from increases in the spending of household income. For example, when Boeing purchases aircraft components from one of its suppliers and the overall demand for this supplier firm rises, some of the staff working for this supplier will see a rise in their income levels.

Part of this income will then be spent locally on, for example, food, entertainment, or housing. These industries will then also see an increase in demand for their goods and services, which will lead to higher incomes for some of their employees, part of which will also be spent locally.

Of course, these successive rounds of indirect and induced spending do not go on forever, which is why we can calculate a value for each of them. In each round, money is "leaked out" for a variety of reasons. For example, firms in the aerospace cluster will purchase some of their supplies from vendors located outside of South Carolina. In addition, employees will save part of their income or spend part of it with firms located outside of the state. In order to determine the total economic impact that will result from an initial direct impact, economic multipliers are used. An economic multiplier can be used to determine the total impact (direct, indirect, and induced) that results from an initial change in economic activity (the direct impact). Multipliers are different in each sector of the economy and are largely determined by the size of the local supplier network as well the particular region being examined. Economic multipliers are available to calculate not just the total economic impact of a cluster, but also the total employment and income levels associated with the total impact.

In this analysis, the direct impact of the aerospace cluster in South Carolina is assumed to consist of activities associated with the aerospace core and military aviation as defined above. Employment data from the NETS database were used to approximate the direct impact of the aerospace core, while data from the South Carolina Department of Commerce were used as the basis for determining the direct impact of military aviation.[9] Table 5 below summarizes these employment figures.

[9] Source: "The Economic Impact of the Military Community in South Carolina," prepared by the South Carolina Department of Commerce, November 2012; see Reference section

Table 5 – Direct Employment Estimates

Description	Employment
Aerospace Core	17,114
Shaw Air Force Base	9,585
McEntire Joint National Guard Base	1,742
Charleston Air Force Base	20,315
Beaufort Marine Corps Air Station	5,012
---	---
Totals	53,768

As already described, the aerospace core consists of 466 firms in South Carolina that employs approximately 17,114 workers. An additional 36,654 employees work in South Carolina military aviation facilities. Thus, an employment base of 53,768 serves as the primary set of data used to model the aerospace cluster's statewide impact.

Multiplier effects based on these data were calculated using input-output analysis, which is the industry-standard method for estimation that is widely implemented across the United States. The Division of Research developed a customized input-output model of the South Carolina economy containing specific information on economic linkages between approximately 500 different industries statewide – including each component of the aerospace industry; the *IMPLAN* software package was used to generate all model estimates.

Primary Results

The structural input-output model estimates economic impacts in terms of four specific measures: economic output, employment, total employee compensation, and value added. Economic output simply reflects the dollar value of all final goods and services that can be attributed (directly or indirectly) to the aerospace cluster in South Carolina. It can also be thought of as an aggregate measure of total spending activity that results from an initial direct expenditure. Because it includes all spending by consumers and businesses on both goods and services, it is an all-inclusive measure of the impact on total economic activity. Employment measures the total number of full-time equivalent positions associated with total economic

output. Total employee compensation reflects all wages, salaries, and benefits associated with total employment estimates. Value added is the dollar value that represents the aerospace cluster's net contribution to the economy. In other words, it is an estimate of the contribution that the aerospace cluster makes to South Carolina's gross state product. Table 6 below highlights these estimates.

Table 6 – Economic Impact of the Aerospace Cluster on South Carolina

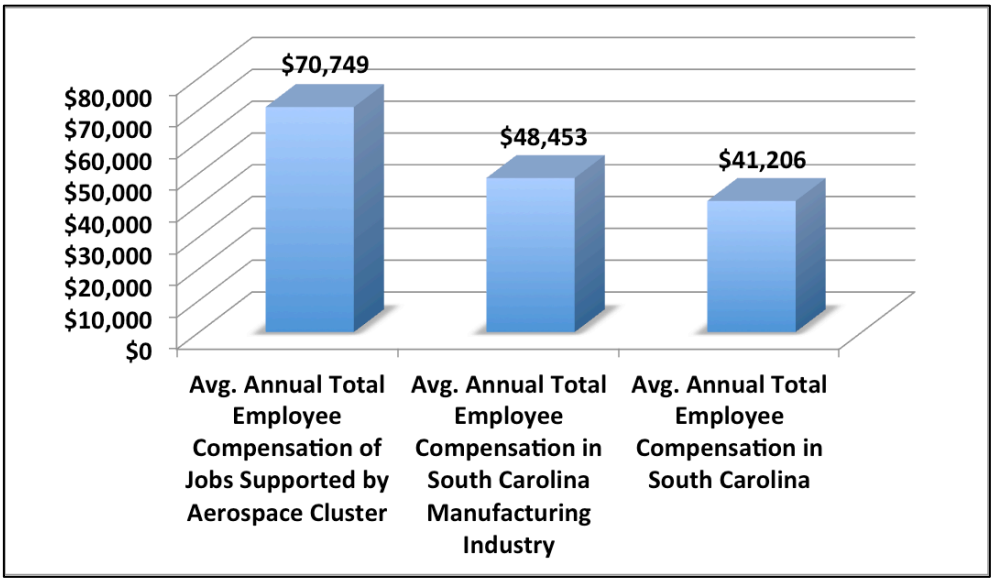
	Economic Output	Employment	Total Employee Compensation	Value Added
Direct Impact	$11,321,164,965	53,768	$5,314,881,079	$6,977,665,384
Indirect Impact	$1,698,912,408	12,742	$597,274,769	$893,822,730
Induced Impact	$4,331,711,740	36,211	$1,355,249,330	$2,535,240,249
----------	----------	----------	----------	----------
Total Impact	$17,351,789,114	102,721	$7,267,405,176	$10,406,728,361

The 53,768 employees that work in the aerospace core and in military aviation generate approximately $11.3 billion in annual economic output. This level of direct economic activity leads to indirect effects totaling approximately $1.7 billion in economic output and 12,742 jobs. These estimates reflect the increased demand for goods and services of in-state suppliers resulting from in-state expenditures on the part of the aerospace core and the military aviation facilities. The direct economic activity also leads to induced effects totaling $4.3 billion in economic output and 36,211 jobs. This is a reflection of economic activity in South Carolina generated across all industries that is the result of increased household spending. The combination of the direct, indirect, and induced effects leads to a total economic impact of approximately $17.4 billion, which is associated with 102,721 jobs across South Carolina. The employment multiplier associated with the aerospace core's portion of this impact is approximately 2.2. This implies that for every 10 jobs that are created in the private sector component of the aerospace cluster in South Carolina, an additional 12 jobs are created elsewhere in the state.

Table 6 also reflects estimates of indirect and induced impacts for total employee compensation. The 53,768 employees working in the aerospace core and military

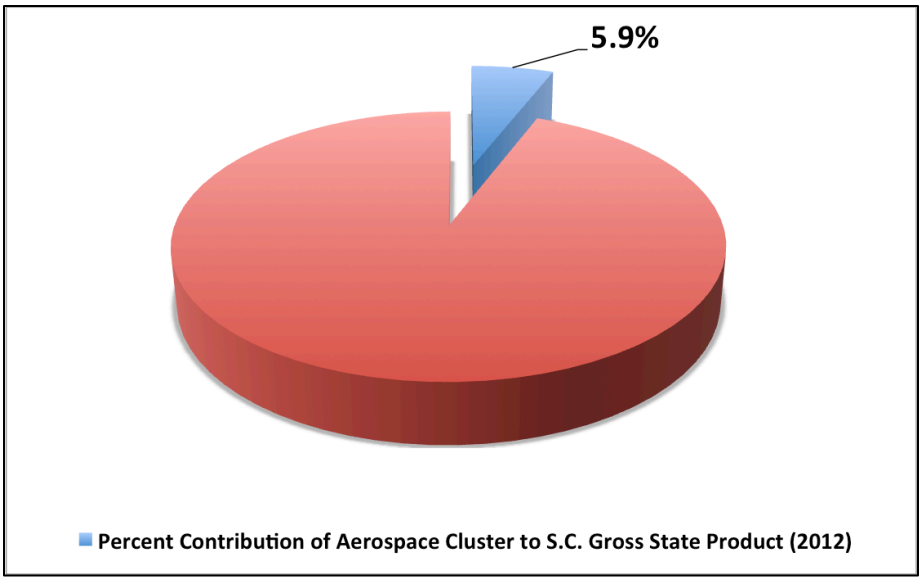
aviation facilities are associated with $5.3 billion in total employee compensation, while the 48,953 jobs created through the indirect and induced effects lead to an additional $1.9 billion in total employee compensation. These figures imply that the average job supported, directly or indirectly, by the aerospace cluster in South Carolina pays an annual total employee compensation of $70,749. This is approximately 72 percent higher than the average total employee compensation in South Carolina ($41,206) and nearly 46 percent higher than the average total employee compensation among all manufacturing jobs in South Carolina ($48,453), as illustrated in Figure 5.

Figure 5 – Annual Total Employee Compensation Comparisons: Aerospace, Manufacturing, & South Carolina



The direct impact of the aerospace cluster on value added (i.e., gross state product) in South Carolina is nearly $7.0 billion, while the indirect and induced impacts generate another $3.4 billion. Thus, the aerospace cluster annually supports approximately $10.4 billion in gross state product. As Figure 6 (next page) indicates, this reflects 5.9 percent of all economic activity in South Carolina.

Figure 6 – Aerospace Cluster Contribution to S.C. Gross State Product (2012)



The Economic Footprint of Aerospace: Broadening the Base

One the major difficulties in accurately determining the size of the aerospace cluster in South Carolina is defining the extent to which private firms that fall outside of the aerospace core actively service the aerospace core. There are specific industries that previous research has identified as being the primary supporters of aerospace. However, not all firms contained in these industries service aerospace firms. In addition, just because a firm services the aerospace industry does not mean that it *exclusively* services the aerospace industry. For example, although a significant number of firms in the Engineering Services industry support aerospace through providing goods and services to firms within the aerospace core, this is not true of all engineering firms. In addition, for many engineering firms, aerospace-related work only comprises a fraction of their total business activities. As outlined in Section II, firms in contained in these support industries are known as the *aerospace periphery.*

In this study, firms in the aerospace periphery were identified by first compiling a list of NAICS codes that previous research has shown to contain firms that at least partially support the aerospace industry (such as Engineering Services). Once these

NAICS codes (listed in Appendix II) were matched with the NETS database, a manual inspection of the matched firms was completed to weed out any captured firms that were unlikely to have realistically serviced the aerospace core in any capacity. For example, while the NAICS code corresponding to "Janitorial Services" was initially included in the aerospace periphery definition, a manual inspection revealed that no firms matching this description in South Carolina were likely to have serviced the aerospace core in any capacity, and so all firms within this category were dropped from the aerospace periphery. The firms that survived the manual inspection process were included in the final aerospace periphery firm list. Table 7 highlights the impact of this final aerospace periphery firm list along with the aerospace core and military aviation.

Table 7 – Total Economic Footprint of the Aerospace Cluster on South Carolina

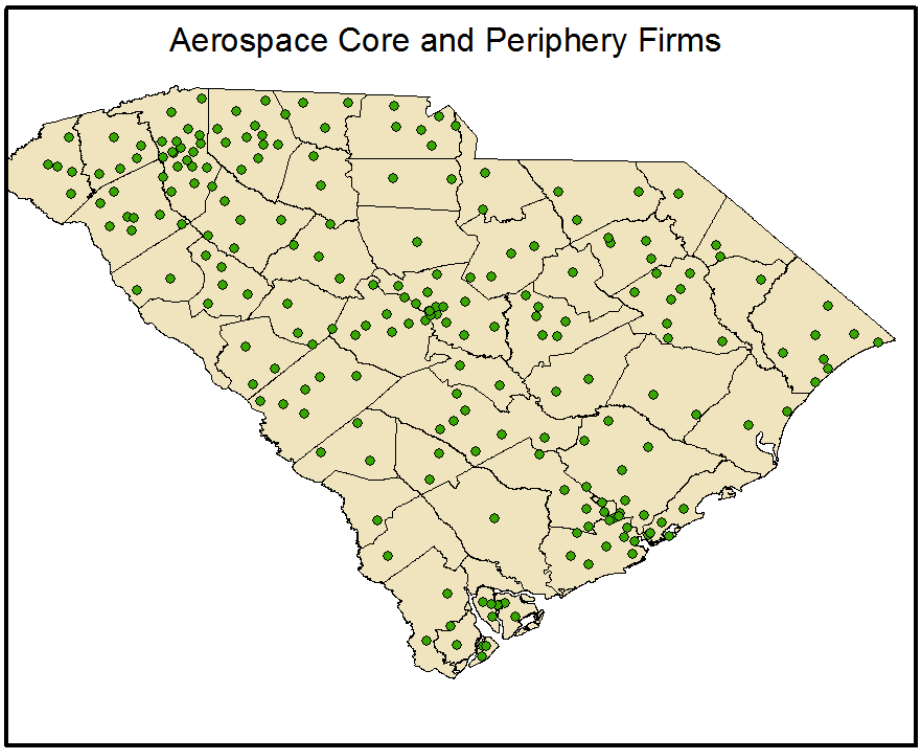
	Economic Output	Employment	Total Employee Compensation	Value Added
Aerospace Core	$7,882,345,729	37,150	$2,009,189,977	$3,050,612,896
Military Aviation	$9,469,443,385	65,571	$5,258,215,199	$7,356,115,465
Total Economic Impact	$17,351,789,114	102,721	$7,267,405,176	$10,406,728,361
---	---	---	---	---
Aerospace Periphery	$5,120,124,722	24,113	$1,296,485,997	$1,975,484,312
Total Economic Footprint	$22,471,913,836	126,834	$8,563,891,173	$12,382,212,673

After the relevant industry parameters were incorporated into the NETS database and the resulting matched firms were manually inspected, the aerospace periphery in South Carolina was estimated to contain 13,983 employees across 288 firms, which yields a total economic impact of approximately $5.1 billion in output and approximately 24,113 employees across the state of South Carolina. This is also associated with nearly $1.3 billion additional total employee compensation.

In this report, the *economic footprint of the aerospace cluster* will be defined as the combined impact of the aerospace core, military aviation, and the aerospace periphery. The total economic footprint of aerospace on the state of South Carolina is approximately $22.5 billion in output, 126,834 employees, and nearly $8.6 billion

in total employee compensation. Figure 7 below highlights all firms in the aerospace core as well as the additional firms that constitute the aerospace periphery.

Figure 7 – Aerospace Core and Aerospace Periphery Firm Locations



Note: Due to proximity, some location points represent multiple firms.

A comparison between the *total economic impact* and *total economic footprint* provides the best perspective on the aerospace cluster's true impact on the state of South Carolina. Because the aerospace periphery will contain some firms that either do not support or only marginally support aerospace, the true impact of the aerospace cluster on South Carolina is between $17.4 billion and $22.5 billion – with a total employment base between 102,721 and 126,834.

...the true impact of the aerospace cluster on South Carolina is between $17.4 billion and $22.5 billion – with a total employment base between 102,721 and 126,834.

Contributions to State Tax Revenue

The aerospace cluster clearly has a profound impact on the state of South Carolina. It has been a major contributor to economic growth over the last decade and has played a critical role in the expansion of the Upstate and Charleston markets following the Great Recession. It creates high-wage, high-skilled jobs for South Carolinians that pay significantly above the state average wage, and its supply chain helps South Carolina reap the benefits of economies of agglomeration that it could not otherwise attain.

The increased economic activity associated with each of these activities also generates new tax revenue for the state of South Carolina. Historically, every additional dollar that is generated in economic activity (i.e., nominal gross state product) within South Carolina also generates 5.1 cents in new state tax revenue.[10] By applying this figure to the economic activity (i.e., value added) generated by the aerospace cluster (aerospace core and military aviation), the tax revenue from this activity can be estimated. Table 8 displays this result.

Table 8 – State Tax Revenue Generated from the S.C. Aerospace Cluster (Aerospace Core & Military Aviation)

**All Dollar Values Represent Annual Estimates*	
Total Contribution to South Carolina Gross State Product	$10,406,728,361
Estimated Increase in Tax Revenue	$532,096,021

The total estimated state tax revenue that results from the activities of the aerospace cluster in South Carolina is approximately $532 million annually. Thus, the aerospace cluster not only benefits South Carolinians directly by providing high-paying jobs and indirectly by furthering overall statewide economic growth, but it also provides benefits to the state as whole through the increased tax revenue that is derived from this economic activity.

[10] This historical relationship between South Carolina nominal gross state product and the South Carolina general funds revenue (as measured and tracked by the South Carolina Board of Economic Advisors) was estimated by the Division of Research using industry-standard time-series regression techniques.

Comparisons to the Automotive Cluster

Over the last thirty years, South Carolina has developed a thriving, globally competitive automotive cluster that has become a major engine of economic growth in the state. One of the principal anchors of this automotive cluster is BMW, which located in Spartanburg County in 1994 and is BMW's largest manufacturing plant in the world. While the automotive cluster is not exclusively the result of BMW and its in-state supply chain, BMW's location decision provided an important endorsement for South Carolina. By choosing to locate in South Carolina, BMW highlighted the fact that South Carolina had become a competitive platform for global manufacturing – and global automotive manufacturing in particular. This endorsement helped to attract other businesses to South Carolina in subsequent years, which has been a major factor in the state's ability to maintain consistent growth momentum within the cluster.

Boeing's decision to locate in North Charleston in 2007 has provided a similar effect for the state's burgeoning aerospace cluster. With the ability to attract a significant number of suppliers to the state as well as other major aerospace related firms, Boeing is providing a solid foundation from which the aerospace cluster can grow. In addition, Boeing's location decision also provides a strong signal to other investors in the sector and draws attention to the positive economic landscape of South Carolina.

One way to measure the effects these two manufacturers have had on their respective clusters is to examine employment changes over time. Table 9 (next page) displays average annual employment growth for the aerospace and automotive clusters as reported by the U.S. Bureau of Labor Statistics (BLS) – broken down into the years leading up to and following the arrival of BMW and Boeing. Notice that in both cases, average employment gains increased significantly immediately after each company located in South Carolina. Between 1990 and 1994, South Carolina added an average of 564 jobs per year in the automotive cluster, compared to 1,035 jobs per year following BMW's arrival in 1994. Similarly, the

aerospace cluster added an average of 38 jobs per year between 1990 and 2007, with the rate jumping to 1,032 jobs per year following Boeing's arrival in 2007.[11]

...the aerospace cluster is currently adding the same number of jobs per year as the automotive cluster was during the 1990s following BMW's arrival.

What is striking about these employment numbers is the fact that the aerospace cluster is currently adding the same number of jobs per year as the automotive cluster was during the 1990s following BMW's arrival.

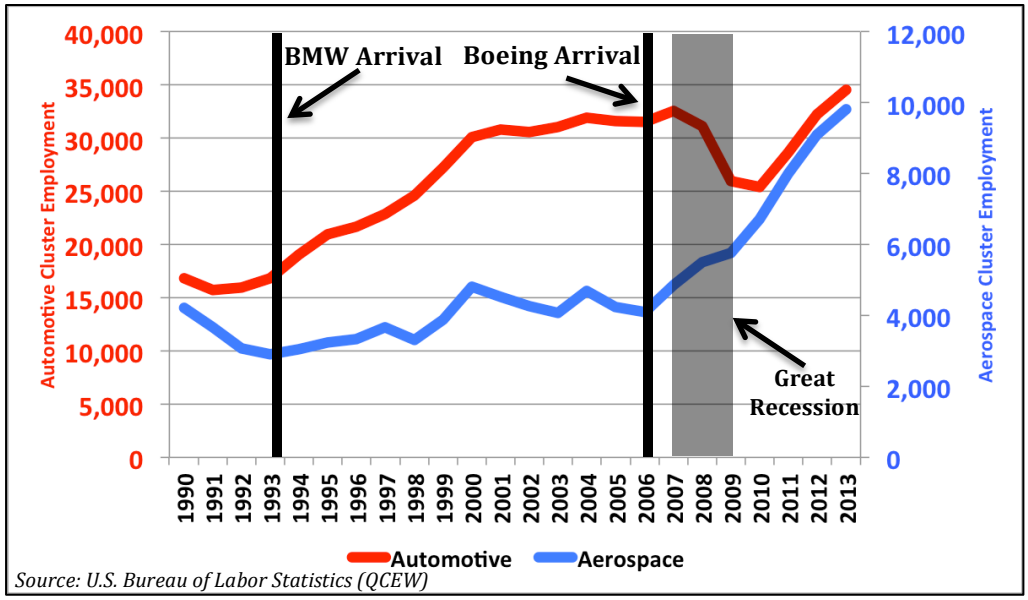
Table 9 – South Carolina Employment Gains: Aerospace and Automotive Clusters

Cluster & Time Period	Average Annual Employment Gains
Automotive Cluster Pre-BMW (1990-1994)	564
Automotive Cluster Post-BMW (1994-2007)	1,035
----------	----------
Aerospace Cluster Pre-Boeing (1990-2007)	38
Aerospace Cluster Post-Boeing (2010-2013)	1,032

These employment trends can also be observed more specifically over time. Figure 8 (next page) tracks total employment for the aerospace and automotive clusters from 1990 through 2013. The two black bars denote the arrival of BMW (in 1994) and Boeing (in 2007). The abrupt increase in slope of the automotive and aerospace employment lines following the entry of BMW and Boeing is clear. These increases show the immediate effect that each of these firms had on the growth patterns of their respective clusters.

[11] Employment trends from 2007 to 2010 are omitted due to the distorted effects that the Great Recession had on the labor market.

Figure 8 – Aerospace and Automotive Cluster Employment: 1990-2013



Source: U.S. Bureau of Labor Statistics (QCEW)

The South Carolina automotive cluster was built over many years (1994-2007) of *consistently high growth rates.* Following the arrival of Boeing, the aerospace cluster has shown similar growth patterns, though obviously over a much shorter time period (2010-2013). The aerospace cluster is experiencing a similar growth phenomenon to that of the automotive cluster in the 1990s following the arrival of BMW.

According to the most recent data from the BLS, the automotive cluster is currently about 3.5 times larger than the aerospace cluster in terms of total direct employment. Specifically, BLS data report that total direct employment within the automotive cluster is 34,526, while total direct employment within the aerospace cluster is 9,824 (see Figure 8). Thus, while the aerospace cluster is adding jobs at the same rate as the automotive cluster, the automotive cluster remains significantly larger because it has had many more years of high growth.

Going forward, there is every reason to expect that the recently observed growth patterns in the aerospace cluster will continue. Boeing, for example, has been explicit in its stated goals of further increasing its aerospace capabilities in South Carolina, including expansions of both production and research and development

activities. The economic impact that the automotive cluster currently has on South Carolina offers a preview of what the aerospace cluster will become if it continues along its current path. The aerospace cluster is in a unique position to become another economic powerhouse for South Carolina, which is why long-term investment and support for high-tech and aerospace related industries is so important. If the observed growth patterns within the aerospace cluster persist, the aerospace cluster will likely evolve into one of the pillars of South Carolina's economy.

Section V – Conclusion

South Carolina's aerospace cluster has been a major contributor to the state's economic growth over the past decade and has been a key factor in South Carolina's recovery from the Great Recession. With major investments – led by the Boeing Company – in capital, research and development, and infrastructure, South Carolina is becoming a hotspot for aerospace activity. For example, Charleston is currently ranked as one of the leaders in aerospace and aviation cluster development in the southern United States.[12]

This is the first study to quantify South Carolina's aerospace cluster in detail and to estimate its total economic impact statewide. The private sector component of the aerospace cluster in South Carolina is made up of approximately 466 firms that employ a total workforce of 17,114, with the majority of these firms employing 5 or fewer workers.

South Carolina is also home to four major military aviation facilities that form part of the aerospace cluster: the Shaw Air Force Base, the McEntire Joint National Guard Base, the Charleston Air Force Base, and the Beaufort Marine Corps Air Station. The private sector and military components of the aerospace cluster combine for a total economic impact on South Carolina of nearly $17.4 billion in annual economic output, 102,721 jobs, and nearly $7.3 billion in total employee compensation.

The private sector component of this total impact is associated with a statewide employment multiplier of 2.2, implying that for every 10 jobs created in the private sector component of the aerospace cluster an additional 12 jobs are created elsewhere in the South Carolina economy. The aerospace cluster also supports high-wage, high-skilled jobs that require expertise in technical fields related to aerospace science and engineering. The average job supported by aerospace in South Carolina

[12] Source: Southern Business and Development, "Ten Successful Aviation and Aerospace Clusters in the South," Winter 2012

pays an annual total employee compensation of $70,749, which is approximately 72 percent higher than the state average.

In addition, the commercial and general aviation components of the aerospace cluster are critically important for the transportation needs of South Carolina businesses. Airports serve as gateways for global transportation, which directly support ongoing economic development.

The aerospace cluster also generates a sizeable amount in state tax revenue. The total annual economic impact of $17.4 billion brings with it over $532 million in annual tax revenue.

South Carolina is well equipped to take advantage of opportunities for growth and expansion in the aerospace industry going forward. With a growing number of manufacturers and suppliers drawn to the state due to the existing supply chain, the Charleston port facilities, the pro-business climate, and the highly desirable lifestyle, the aerospace cluster has the potential to lead South Carolina's economic growth for years to come.

The estimates cited in this report serve as a benchmark against which future aerospace growth in South Carolina can be measured. Periodic updates to this report using the same methodology are recommended to track changes in growth patterns, as well as to track the impacts that various policy initiatives have on the size and scope of South Carolina's aerospace cluster.

References

Chmura Economics and Analytics & Performance Management Group. (January 2011). "Virginia's Aerospace Industry." Retrieved March 12, 2014 from the Virginia Department of Aviation: http://www.doav.virginia.gov/Downloads/Studies/Workforce/Aerospace%20Impact%202010%20ADA.pdf

Commission on the Future of the U.S. Aerospace Industry. (October 2002). "U.S. Aerospace and Aviation Industry: A State-by-State Analysis." Retrieved March 11, 2014 from NASA Headquarters: http://www.hq.nasa.gov/office/hqlibrary/documents/o51456552.pdf

Deloitte. (March 2012). "The Aerospace and Defense Industry in the U.S.: A Financial and Economic Impact Study." Retrieved March 12, 2014 from the Aerospace Industries Association: http://www.aia-aerospace.org/assets/deloitte_study_2012.pdf

Enterprise Innovation Institute: Georgia Institute of Technology. (January 2013). "Economic Impact Analysis of Georgia's Aerospace Industry." Retrieved March 3, 2014 from the Georgia Department of Economic Development: http://aerospace.georgiainnovation.org/images/public/reports/Aerospace%20impact%20analysis%20FINAL%202%2025%2013.pdf

Metro Denver Economic Development Corporation. (January 2014). "Aerospace: Metro Denver and Northern Colorado Industry Profile." Prepared by Development Research Partners, Inc., http://www.developmentresearch.net

Moretti, E. (2012). *The New Geography of Jobs.* New York: Houghton Mifflin Harcourt.

South Carolina Department of Commerce. (November 2012). "The Economic Impact of the Military Community in South Carolina." Retrieved March 11, 2014 from the South Carolina Department of Commerce: http://sccommerce.com/sites/default/files/document_directory/the_economic_impact_of_the_military_community_in_south_carolina.pdf

Appendix I – Aerospace and Commercial Aviation Industry Definitions

NAICS	Category	Description
334511	Aerospace	Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing
336414	Aerospace	Guided Missile and Space Vehicle Manufacturing
336415	Aerospace	Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing
336419	Aerospace	Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing
927110	Aerospace	Space research and technology
336411	Com. Aviation	Aircraft Manufacturing
336412	Com. Aviation	Aircraft Engine and Engine Parts Manufacturing
336413	Com. Aviation	Other Aircraft Parts and Auxiliary Equipment Manufacturing
481111	Com. Aviation	Scheduled Passenger Air Transportation
481112	Com. Aviation	Scheduled Freight Air Transportation
481211	Com. Aviation	Nonscheduled Chartered Passenger Air Transportation
481212	Com. Aviation	Nonscheduled Chartered Freight Air Transportation
481219	Com. Aviation	Other Nonscheduled Air Transportation
488111	Com. Aviation	Air Traffic Control
488119	Com. Aviation	Other Airport Operations
488190	Com. Aviation	Other Support Activities for Air Transportation
611512	Com. Aviation	Flight training

Appendix II – Aerospace Periphery Industry Definitions

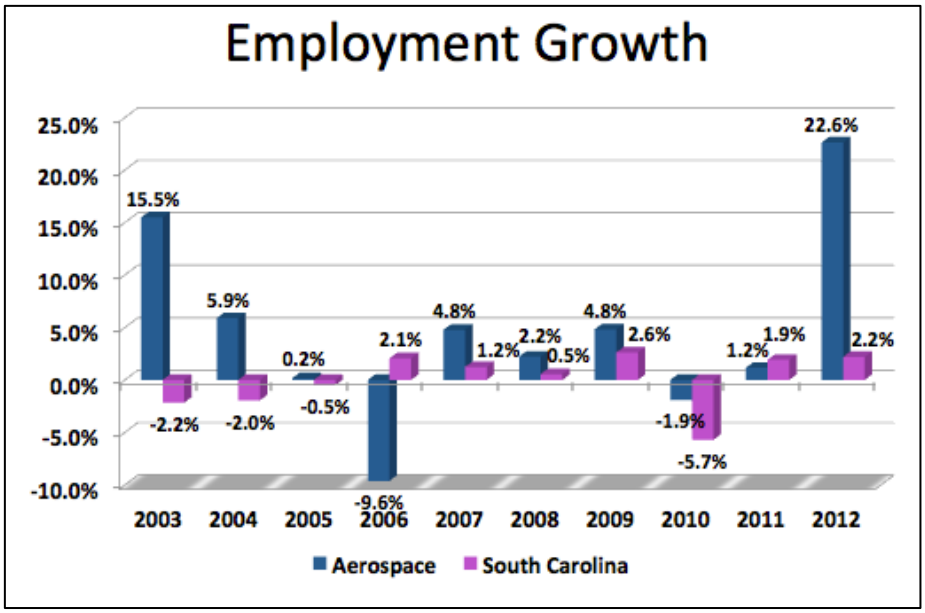
NAICS	Category	Description
331512	Partial	Steel Investment foundries
331524	Partial	Aluminum foundries (except die-casting)
331529	Partial	Other nonferrous metal foundries (except die-casting)
332111	Partial	Iron & steel forging
332112	Partial	Nonferrous Forging
332313	Partial	Plate work mfg.
332813	Partial	Electroplating, plating, polishing, anodizing & coloring
332993	Partial	Ammunition (except small arms) mfg.
333314	Partial	Optical instrument & lens mfg.
334220	Partial	Radio & television broadcasting & wireless communications eqpt. Mfg.
339113	Partial	Surgical appliance & supplies mfg.
423860	Partial	Transportation eqpt. & supplies
517919	Partial	All other telecommunications
541712	Partial	Research and development in the physical engineering and life sciences (except biotechnology)
238320	Partial	Paint & wall covering contractors
314110	Partial	Carpet & rug mills
326211	Partial	Tire mfg (except retreading)
331491	Partial	Nonferrous metal (except copper & aluminum) rolling, drawing & extruding
332312	Partial	Fabricated structural metal mfg.
332510	Partial	Hardware mfg
332912	Partial	Fluid power valve & hose fitting mfg.
332999	Partial	Other misc. fabricated metal product mfg.
333318	Partial	Other commercial & services industry machinery
333924	Partial	Industrial truck, tractor, trailer & stacker machinery mfg.
334519	Partial	Other Measuring and Controlling Device Manufacturing
336310	Partial	Motor vehicle gasoline engine & engine parts mfg.
336320	Partial	Motor vehicle electrical and electronic eqpt mfg
336360	Partial	Motor vehicle seating & interior trim mfg.
424720	Partial	Petroleum & petroleum prdt merchant wholesalers (except bulk stations & terminals)
441228	Partial	Motorcycle, ATV & all other motor vehicle dealers
532411	Partial	Commercial air, rail & water transportation eqpt rental and leasing
541330	Partial	Engineering Services
561330	Partial	Professional employer organizations
561599	Partial	All other travel arrangement & reservation services
561720	Partial	Janitorial services

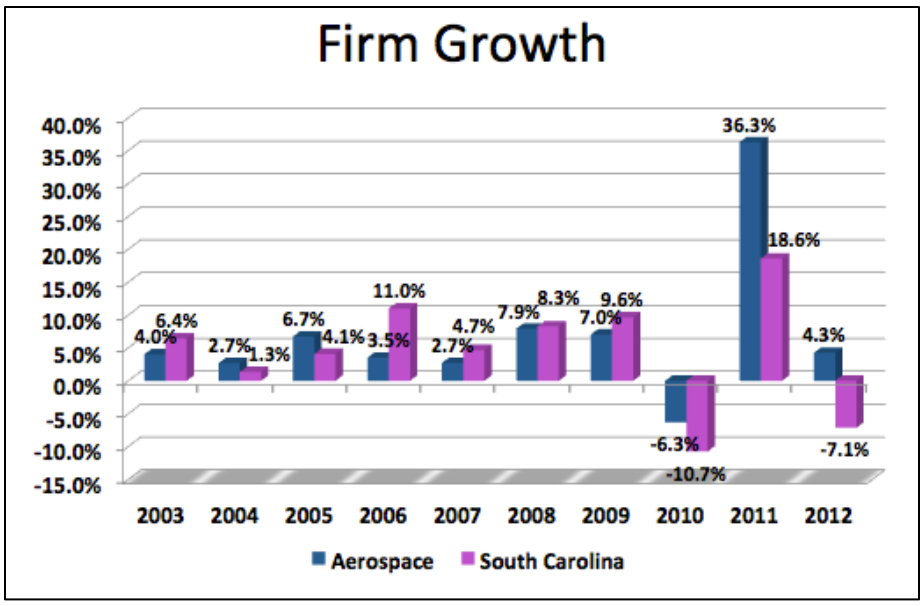
NAICS	Category	Description
621910	Partial	Ambulance services
713990	Partial	All other amusement & recreation industries
811213	Partial	Communication eqpt, repair and maintenance
811219	Partial	Other electronic & precision eqpt. repair and maintenance
926120	Partial	Regulation & administration of transportation programs

Appendix III – Statewide Employment and Firm Totals

Aerospace Core (NETS 2012)			South Carolina Totals (NETS 2012)	
Year	Employment	Firms	Employment	Firms
2002	11,314	250	2,265,477	201,904
2003	13,066	260	2,216,567	214,862
2004	13,836	267	2,173,340	217,698
2005	13,860	285	2,162,514	226,603
2006	12,527	295	2,206,993	251,514
2007	13,125	303	2,234,204	263,338
2008	13,416	327	2,246,437	285,106
2009	14,063	350	2,305,276	312,581
2010	13,797	328	2,173,742	278,979
2011	13,957	447	2,215,329	330,827
2012	17,114	466	2,263,780	307,221

Appendix IV – Annual Growth in Employment and Number of Firms: Aerospace Cluster and South Carolina





Appendix V – Mapped Employment and Firm Totals by County (2012)