CARILION CLINIC'S ECONOMIC CONTRIBUTION TO THE STATE AND SERVICE REGION

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EXECUTIVE SUMMARY

Carilion Clinic is the largest health system in Virginia's Blue Ridge and Southwest Virginia. It serves the public through seven hospital campuses, over 700 physicians in more than 75 specialties, a Level I Trauma Center, several major specialty medicine centers, and over 200 other ambulatory care and related health care facilities. Carilion Clinic has developed strong connections to clinical research in order to improve the quality of patient care. It provides a variety of clinical trial options to patients and matches Carilion medical specialists with academic collaborators conducting innovative research. Carilion also serves as a major teaching site for medical students, physicians in residency, nursing and other allied health professionals.

The purpose of this study is to evaluate the economic contribution that Carilion Clinic makes to the state, its service region and individual service areas where it operates. The mission of Carilion Clinic is to improve the health of the communities it serves. However, the clinic also produces important secondary benefits to the region and state through increased economic activity and other ancillary benefits such as charitable giving and uncompensated care, education and research, and improving the productivity of the region's workforce.

The study has two components. The first part examines the economic contribution that results from clinic-related spending. This contribution includes the economic activity stimulated by clinic payroll and procurement of supplies and services. These effects not only include the direct injection of clinic-related expenditures into the regional economy but the consequent chain reaction of spending and re-spending that occurs as the result of this initial stimulus. The second part examines a broader set of economic and social benefits that result from the presence of the clinic, including workforce productivity improvement, education and research, and provision of regional amenities.

This study gauges the contribution of Carilion Clinic to the state, region, and local economies with the use of input-output analysis. Input-output analysis produces industry economic multipliers that show how changes in a firm or organization's activity affects a regional economy. Carilion Clinic expenditures made in the region and state are counted as direct injections into the local and state economies. Linkages with other industries in the area means this initial injection has further stimulative effects that result from the purchases of goods and services and payments to employees. The stimulus causes a "multiplier effect" that results when money is re-spent in the local or state economy.

The total impact of this activity consists of three parts, a "direct effect," "an indirect effect," and an "induced effect." The "direct effect" consists of Carilion Clinic economic activity, including its employment, payments, and revenues. The "indirect effect" consists of the injection of local procurement spending in the region and its effects. In many instances, the specialized equipment, supplies and services required to operate a major medical institution are purchased from outside the region. These expenditures are not included in the indirect effect. The indirect effect measures the cumulative change that results from Carilion Clinic-related spending on goods and service input purchases within the region including subsequent rounds of firm goods and service purchases needed to supply other producers. For example, Carilion Clinic purchases marketing and advertising services from Roanoke businesses, which causes a "ripple effect" on the local economy when money is re-spent by these businesses on equipment, supplies, business services and other goods and services from local businesses. These businesses spend a portion of their sales revenues on their supplies and services from other local firms which, in turn, purchase a portion of their supplies and services from other local firms. This cascading sequence of spending continues until the subsequent rounds of spending dissipate due to leakages in the form of saving or spending outside the area. The sum of these cascading rounds of inter-industry purchases constitutes the "indirect effect." The final component of total impact (the "induced effect" or "induced impact") is attributable to the spending of households. For instance, businesses in the sup-

ply chain pay households for their labor services. These households then purchase goods and services from area firms who in turn receive a portion of their labor, material and service inputs from within the region. Again leakages occur at each round due to purchases of goods and services outside the state. The "induced effect" is the sum of the industry impacts associated with these household purchases.

The impact analysis for this study used IMPLAN (Impact analysis for PLANning). IMPLAN is an industry standard input-output model that has been used in many economic impact studies, including studies of hospitals and health care. The economic impact analysis is based on an IMPLAN multiregional input output model (MRIO) constructed for each primary service area (i.e., Bedford, Buena Vista/Rockbridge, Franklin, New River Valley, Roanoke Valley, and Tazewell/Bland/Wythe) and a region representing the balance of the state.

Results are presented for three different economic measures: employment, output, and value-added. Employment is measured in terms of person-years of employment. A person-year of employment is a job of one year in duration. Employment includes full-time and part-time employment as well as the self-employed and is measured by place of work. Total sales or industry output is the total value of industry production during a period. It measures sales of intermediate inputs for use in production as well as sales of products to final consumers. Value-added is a subset of total industrial output. It reflects only sales to final consumers and therefore avoids the double counting that occurs when intermediate inputs are included. It is the most commonly used measure of economic activity. Value-added is the concept behind gross domestic product (GDP) and can be compared to the GDP numbers provided by the Bureau of Economic Analysis for states and metropolitan areas. It can also be represented as total factor income plus indirect business taxes.

An analysis of fiscal year 2018 data indicated that Carilion Clinic employed 13,317 staff statewide, generated revenues of $1.80 billion (equivalent to sales or output), and accounted for value-added of $892 million. This is the direct impact. The expenditures of Carilion Clinic and its employees create additional impacts for the state as these injections of spending and income generate subsequent rounds of business and household spending that result in the indirect and induced effects described earlier. As a result, an additional 10,402 jobs statewide, $1.39 billion in output, and $766 million in value-added result from Carilion Clinic's presence. The total economic contribution is 23,719 jobs, $3.17 billion in output, and $1.64 billion in value-added.

Carilion Clinic employed 13,089 staff, produced revenues of $1.78 billion and value added of $874 million in its Virginia's Blue Ridge and Southwest Virginia 18-county service region. This direct impact generated a total regional economic impact of 22,782 jobs, $3.05 billion in total output, and $1.57 billion in value added. The statewide indirect and induced effects are bigger than the service region effects because direct employment and in-state spending are higher and the spending leakages for each round of business and household re-spending is smaller for the larger Virginia economy. Similarly, other Virginia-based businesses in the supply chain are more likely to spend within the state than businesses within the service region are to spend within the service region.

Results indicate that the services industry has the largest connection with Carilion operations within the region, with 20,567 in employment, $2.70 billion in output, and $1.39 billion in value-added economic impact. The direct economic activity of Carilion Clinic, which is classified as health care services, is contained in this sector. However, an additional 7,478 jobs in the services sector result from Carilion Clinic's presence, making it the largest industry beneficiary of clinic spending. Most of this impact is due to household income-related impacts (induced effects) because households spend most of their incomes on services. The next largest employment impact is found in the trade industry (retail and wholesale trade) with a 1,425 jobs impact. TIPU (transportation, information, and public utilities) has the third largest impact with 465 jobs followed by the construction sector with 128

jobs. Finally, a total of 197 additional jobs can be attributed to the government (119), manufacturing (55), agriculture (17), and mining (7) sectors. Parallel results are found for output and value-added

Among service areas, the largest economic impacts occur in the Roanoke Valley where the most substantial Carilion Clinic operations are located. Carilion Clinic directly employs 10,215 in the Roanoke Valley, generates an estimated $1.45 billion in patient revenue, and accounts for $671 million in value-added. The total economic impact, once indirect and induced spending is taken into account within the region, is 18,494 jobs, $2.55 billion in output, and $1.28 billion in value-added. The second highest economic impact area is in the New River Valley area which also hosts sizable Carilion Clinic operations. The total economic impact there is 2,780 jobs, $333 million in output, and $197 million in value-added. The total economic impacts for other regions ranged from a high of 614 jobs, $60 million in output, and $38 million in value-added for the Franklin Area to a low of 27 jobs $2.5 million in output, and $1.7 million in value-added for the Bedford area, which is the only service area not to host a Carilion Clinic hospital.

Carilion Clinic will also have a significant additional economic impact on the region in the future through its planned capital improvements. Carilion Clinic is embarking on a major capital improvement program in the next seven years that will invest $1 billion into the regional economy by adding new facilities and upgrading existing ones. The first phase, involving improvement to the Roanoke campus, is scheduled to begin in the spring of 2020 and complete in 2024. Total investment will be $500 million of which approximately $300 million will be new construction, $70 million renovation of existing space, and $130 million furniture and equipment purchases. The project will allow Carilion to accommodate recent growth and future growth, replace aging facilities and consolidate services such as cardiovascular health into new spaces. The center of the construction is a new hospital addition, the Crystal Spring Tower and new Behavioral Health building. In addition, spaces in the existing Roanoke Memorial Hospital building will be renovated and reequipped. Other improvements include a new 500-space parking garage and skywalk.

The economic impact of these first phase capital improvements are over 4,200 jobs, $617 million in total output, and $273 million in value-added. Approximately 2,600 person-year jobs (i.e., average annual employment of approximately 664 jobs) will be directly created over the four year construction period due to the construction. The other 1,615 jobs are spinoff jobs that result from indirect and direct effects.

Although the flows of economic activity that result from expenditures and employment related to the operation and capital improvements of Carilion Clinic are important to the service region, Carilion Clinic makes numerous other economic and social contributions to the region and the state. Among these contributions are the following:

- **Contributions for Patient Care**. Carilion Clinic provides significant financial and in-kind contributions to the community. During FY2018, Carilion Clinic provided $75.1 million in financial assistance and $74.7 million in other uncompensated care to uninsured patients and those with limited financial means. It also contributed $38.1 million in educational benefits, provided $5.9 million in community outreach funding and in-kind contributions, and sponsored almost $1 million in research.

- **Support for Community Activities**. Carilion Clinic employees participate in a wide variety of community activities in any given year. For example, Carilion coordinated volunteer services during FY2018 that enlisted 611 volunteers who provided 588,227 hours of service in the community, mostly in the area of health care. Also, 775 employees donated blood during blood drives organized at Carilion locations. Carilion physicians donated almost $120,000 worth of their time to assist patients at the Bradley Free Clinic and Fralin Clinic in Roanoke during the year.

- **Regional Healthcare Planning**. Carilion Clinic has been a leader and active partner in promoting healthcare and wellness strategic planning and assessment in the region to improve health care outcomes. With a wide variety of partners in each of its service regions, Carilion has initiated a series of community-driven processes involving area stakeholders to improve outcomes of community health planning.

- **Clinical Care Access**. Carilion Clinic provides access to clinical care options to hundreds of thousands of patients in the Virginia's Blue Ridge and Southwest Virginia as a result of adopting a clinical health care model that might otherwise not be available at a similar scale without its presence and entrepreneurial efforts. The absence of these clinical care options would mean that many patients would need to travel elsewhere, including out-of-state to receive such care.

- **Education and Research**. Before transitioning into partnership models with both entities in 2018-19, Carilion Clinic helped to create and incubate two of the area's leading medical higher education institutions--Virginia Tech Carilion (VTC) and the Radford University Carilion (RUC) -- providing planning, management and operational support for both entities as they grew to maturity. In 2019, Radford University Carilion graduated over 400 students. The Virginia Tech Carilion School of Medicine has a graduating class of 40 students each year. The Fralin Biomedical Research Institute at VTC has grown into a sizeable research institute conducting nationally and internationally recognized research in cognitive and computational neuroscience, cellular and molecular neurobiology, cardiovascular science and regenerate medicine and cancer, immunity, and infection.

- **Rural Health Care Preservation**. While many rural areas have experienced a significant erosion in hospital access, Carilion's strategy of maintaining significant rural inpatient and outpatient operations with transportation by helicopter and ambulance to Level 1 and 3 Trauma Centers for critical care cases has preserved and improved rural health care access, options, and quality.

- **Resident Labor Participation and Productivity**. Carilion Clinic health care services result in preventative, diagnostic and ameliorative care that improves the mental and physical well-being of its patients inside and outside the community. These improvements enable residents to live longer, more satisfying lives, and better enable them to contribute to their families, communities, and workplaces. Improved health is linked to greater labor productivity, decreased absenteeism, lowered presenteeism, and higher wages.

- **Regional Amenities**. The range and quality of health services that Carilion Clinic offers enhances the attractiveness of the service region to residents and businesses. Residents and businesses often evaluate the availability of affordable and quality health care when making choices of where to live or operate their business. Retirees and young families, in particular, may place a higher emphasis on health care quality because of their greater need for such services. Better quality health care also makes it easier for area firms to attract skilled workers.

INTRODUCTION

The purpose of this study is to evaluate the economic contribution that Carilion Clinic makes to the state, its service region and individual service areas where it operates. The mission of Carilion Clinic is to improve the health of the communities it serves. However, the clinic also produces important secondary benefits to the region and state through increased economic activity and other ancillary benefits such as charitable giving and uncompensated care, education and research, and improving the productivity of the region's workforce.

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This study is divided into four sections. The first section describes the history of Carilion Clinic and examines important features of the clinic, including the scope of its service region and major service areas, number of physicians and other staff, patient figures, and hospital facility characteristics. The second section describes the economic impact model and construction of the input data used to estimate Carilion Clinic's economic contribution. The third section presents the results of the economic impact analysis. The fourth section examines other quantitative and qualitative impacts of the clinic on economic and social development in the service region.

SECTION 1
CARILION CLINIC OVERVIEW

Carilion Clinic is the largest health system in Virginia's Blue Ridge and Southwest Virginia. It serves the public through seven hospital campuses, over 700 physicians in more than 75 specialties, a Level I Trauma Center, several major specialty medicine centers, and over 200 other ambulatory care and related health care facilities. Carilion Clinic has developed strong connections to clinical research in order to improve the quality of patient care. It provides a variety of clinical trial options to patients and matches Carilion medical specialists with academic collaborators conducting innovative research. Carilion also serves as a major teaching site for medical students, physicians in residency, nursing and other allied health professionals.

Carilion Clinic traces its beginnings to Roanoke Hospital, the region's first inpatient hospital which was opened on June 30, 1900, with a handful of patient beds, an operating room, dining facilities, and staff offices (Hart, Hodges and Steuart. 1999). From this small footprint, the hospital and its successor organizations such as the Roanoke Hospital Association and Carilion Health System grew rapidly, admitting 182 patients in 1902, 12,000 in 1958, 24,000 in 1990, and more than 50,000 in 2018. **Table 1** summarizes some of the major milestones during Carilion Clinic's 120-year history.

During the first phase (1900-1975) growth occurred primarily through internal expansions attributable to improvements in specialty care spurred by rising household incomes, increasing demand for medical care, higher performance standards, and the growth of public and private health insurance coverage. Among other activities, Roanoke hospital saw the establishment of an outpatient treatment center, an intensive care unit, specialty care departments for pediatrics, cancer, and cardiology and Virginia's first hospital affiliated nursing school during the period.

Table 1. Carilion Clinic Development Timeline

Year	Major Milestone
1900	Roanoke Hospital opened
1914	Jefferson Hospital School of Nursing started
1924	Free Clinic established providing first outpatient treatment
1944	Children's ward created
1952	Cancer tumor clinic established
1954	Graduate medical education program started
1966	Intensive Care Unit (ICU) established
1968	Cardiology Department created; General Practice Residency started
1984	Bedford Memorial Hospital joins Roanoke Hospital Association.
1987	Consolidation of hospitals into one organization named Carilion Health System (CHS)
1988	Giles Memorial Hospital and Franklin Memorial Hospital become affiliates of Carilion Health System
1990	Community Hospital of Roanoke Valley (CHRV) merged with Roanoke Memorial Hospital; Radford Community hospital becomes affiliate of CHS
1992	Saint Albans Psychiatric Hospital becomes Carilion affiliate
1998	Carilion Community Health Fund established
2006	Carilion Health System becomes Carilion Clinic, marking adoption of integrated health care model
2008	Virginia Tech Carilion School of Medicine launches
2010	Virginia Tech Carilion Research Institute opens

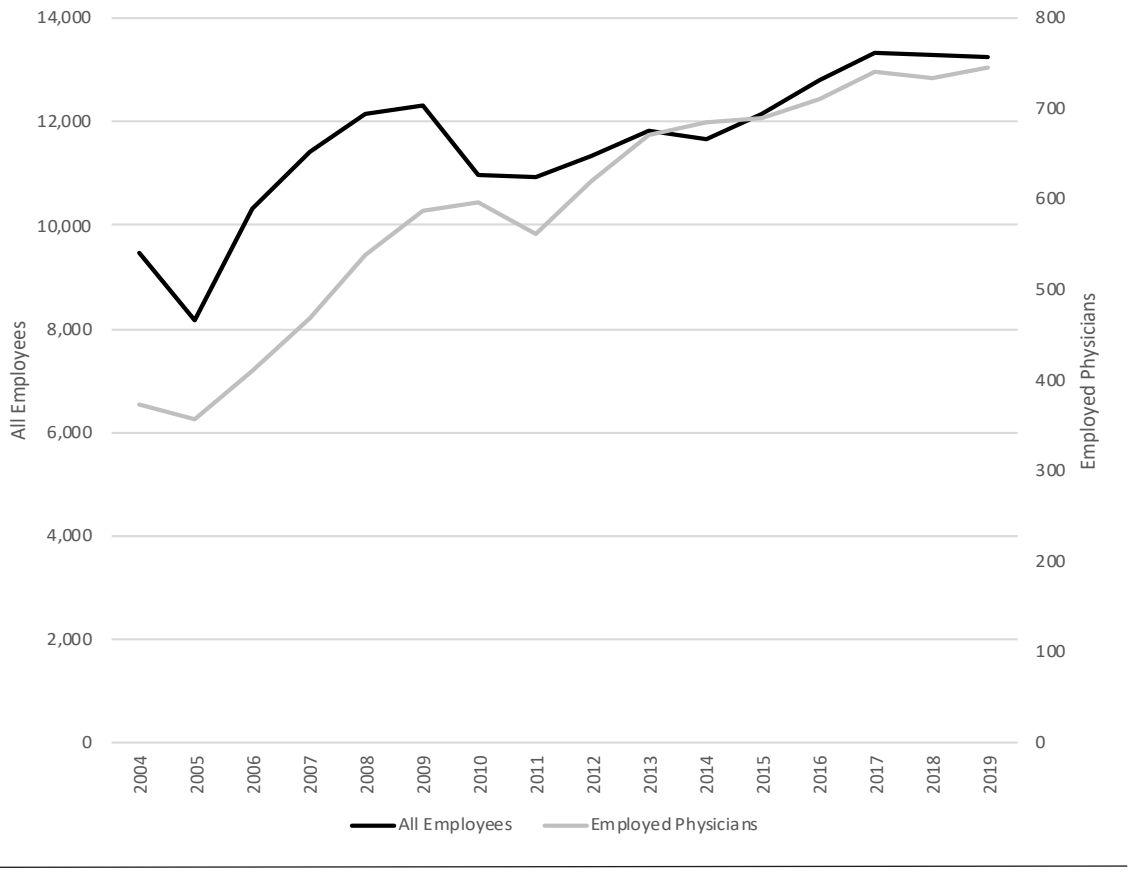
Source: Hart, Hodges, and Steuart (1999) and other Carilion Clinic documents

During the second phase (1976-2005), significant growth occurred though geographical expansion including management agreements and later mergers with several smaller hospitals in the region, in an effort to reduce costs and improve quality and efficiency through coordination and collaboration across care access locations. This consolidation was capped by the adoption of a new name for the resulting health system: Carilion Health System (CHS) in 1987. The word "Carilion" was based on the French word "Carillion" for a series of bells housed in a bell tower that play music to reflect the symbiotic relationship between the component hospitals and other facilities in providing quality and affordable health care services to its service region.

A third phase in development (2006-present) began with the reorganization of CHS as Carilion Clinic in 2006. This strategic change reflected the adoption of the physician-led, primary and prominent specialty care clinical and management model developed by Mayo Clinic and Cleveland Clinic to improve health care outcomes. Complementing these efforts, Carilion Clinic played a formative role in the establishment of partner educational, clinical, and scientific research institutions such as the Radford University Carilion, the Virginia Tech Carilion School of Medicine, and the Virginia Tech Carilion Research Institute (now known as the Fralin Biomedical Research Institute at VTC).

Carilion Clinic growth during the last 15 years has been brisk (see **Figure 1**). In 2019, it employed 13,249 total staff, up from 9,484 in 2004, a growth rate of 40 percent. Of the 13,249 employees, 745 were physicians, up from 374 in 2004, a near doubling in number.

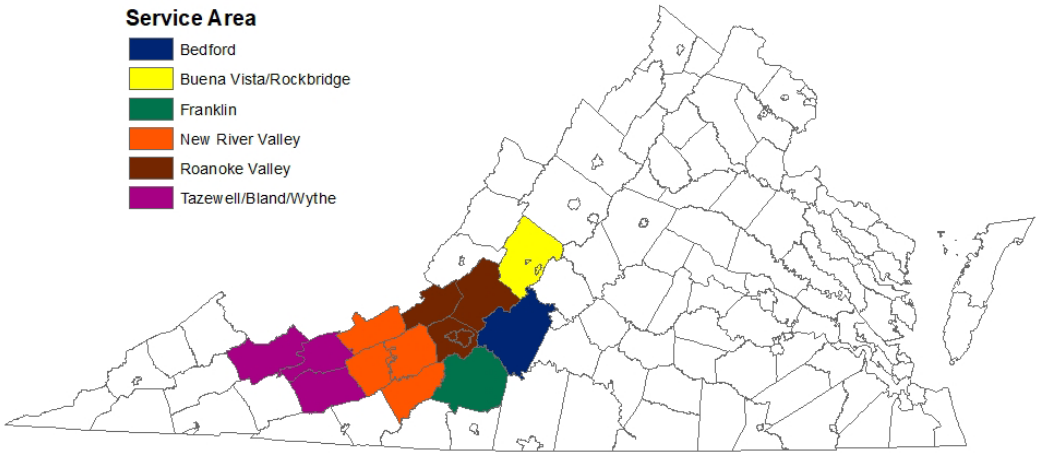
Figure 1. Carilion Clinic Employment, 2004-2019



Carilion Clinic is accredited by the Joint Commission, which is the "recognized symbol of Health Care Quality." It has one Trauma Center rated Level 1 by the Commonwealth of Virginia and the American College of Surgeons at Roanoke Memorial Hospital and another Level 3 at Carilion New River Valley Medical Center. Its member hospitals have received numerous awards and accolades from consumer and health care advocacy organizations for overall quality, health care cost and performance outcomes, quality of staff, and quality of specialty care over the years. U.S. News and World Report (2017-2018) placed Carilion Roanoke Memorial Hospital within the top one percent of hospitals nationally and third best in Virginia. It was rated in the Top 50 Cardiovascular Hospitals nationwide by Watson Health in 2018, received the Silver Beacon Award for Excellence in coronary critical care by the American Association of Critical Care Nurses, and received the Stroke Gold Plus Achievement Award by the American Heart Association and American Stroke Association. Both Carilion Roanoke Memorial Hospital and Carilion Roanoke Community Hospital received Magnet designation for nursing excellence by the American Nurses Credentialing Center. Carilion Roanoke Memorial Hospital and Carilion New River Valley Medical Center are listed as Consumer Choice No. 1 by National Research Corporation, reflecting higher consumer recognition for providing quality healthcare. In addition, Carilion New River Valley Medical Center has received the Healthcare Innovation Award for medication management by the Centers for Medicare and Medicaid Services.

The Carilion Clinic service region currently consists of 18 core localities divided into six distinct service areas (see **Figure 2**) in Virginia's Blue Ridge and Southwest Virginia. These service areas include the Bedford Service Area (Bedford County), Buena Vista/Rockbridge Service Area (Buena Vista City, Lexington City, and Rockbridge County), Franklin Service Area (Franklin County), New River Valley Service Area (Floyd County, Giles County, Montgomery County, Pulaski County, and Radford City), Roanoke Valley (Botetourt County, Craig County, Roanoke City, Roanoke County, and Salem City), and Tazewell/Bland/Wythe (Bland County, Tazewell County, and Wythe County). In addition, Carilion Clinic operates outpatient facilities in other nearby localities such as Galax City, Henry County, and Lynchburg City. The service region population is over 600,000 and is more rural than the state or nation with 20 percent of the population located in non-metropolitan counties compared to 13 percent for the state and 15 percent for the nation.

Figure 2. Carilion Clinic Service Areas



The principal inpatient facilities anchoring these service areas (see **Figure 3**) are Carilion Roanoke Memorial Hospital, Carilion Roanoke Community Hospital, Carilion New River Valley Medical Center, Carilion Franklin Memorial Hospital, Carilion Stonewall Jackson Hospital, Carilion Giles Community Hospital, and Carilion Tazewell Community Hospital.

- **Carilion Roanoke Memorial Hospital (CRMH)**. CRMH is Carilion Clinic's flagship hospital founded as Roanoke Hospital at the turn of the last century. It is also the larg-

Figure 3. Carilion Clinic Hospitals

Clockwise from upper right: (a) Carilion Roanoke Community Hospital (CRCH), (b) Carilion Roanoke Memorial Hospital (CRMH), (c) Carilion New River Valley Medical Center (CNRV), (d) Carilion Franklin Memorial Hospital (CFMH), (e) Carilion Stonewall Jackson Hospital (CSJH), (f) Carilion Giles Community Hospital (CGCH), and (g) Carilion Tazewell Community Hospital (CTCH)

est hospital in the clinic--with 703 beds--and 4th largest in the state. It houses the clinic's Level 1 trauma center, a 60-bed Neonatal Intensive Care Unit, a children's hospital, and institutes of cardiovascular health, orthopaedics and neurosciences. It also hosts thirteen residency programs and fifteen fellowships, training almost 300 physicians.

- **Carilion Roanoke Community Hospital (CRCH)**. CRCH is Carilion Clinic's next largest hospital. It houses Carilion's Inpatient Rehabilitation facility and several outpatient services such as Carilion Clinic Community Care, the Wound Care Center, Occupational Medicine, endoscopy services, outpatient surgery, Carilion children's dental care, urogynecology and maternal-fetal medicine (high-risk pregnancy) and a laboratory collection site. It is also home to Radford University Carilion.

- **Carilion New River Valley Medical Center (CNRV)**. CNRV is the third largest facility and contains a 146-bed hospital located in Christiansburg which offers a wide variety of surgical and medical specialties and outpatient services. The facility also provides a Level 3 Trauma Center and an OB/GYN program. Carilion Clinic Saint Albans Hospital, a behavioral medicine and psychiatric facility, is also located on the campus.

- **Carilion Giles Community Hospital (CGCH)**. CGCH is a 25-bed critical access hospital, offering emergency services and outpatient services located in Pearisburg.

- **Carilion Stonewall Jackson Hospital (CSJH)**. CSJH is a 25-bed critical access hospital located in Lexington that provides inpatient and outpatient services, including general surgery and specialty physicians in Cardiology, Gastroenterology, Gynecology and Orthopedics.

- **Carilion Tazewell Community Hospital (CTCH)**. CTCH is a 56-bed facility in Tazewell offering emergency services, primary care, therapy, and imaging.

- **Carilion Franklin Memorial Hospital (CFMH)**. CFMH is a 37-bed hospital in Rocky Mount offering emergency services and inpatient care.

SECTION 2
MEASURING CARILION CLINIC'S ECONOMIC IMPACT

Economic Impact Methodology

This study gauges the contribution of Carilion Clinic to the state, region, and local economies with the use of input-output analysis. Input-output analysis produces industry economic multipliers that show how changes in a firm or organization's activity affects a regional economy. While studies such as this type are often called "economic impact" studies, a more accurate description is "economic contribution" or "economic footprint" study (Watson et al. 2007). An "economic contribution" analysis traces the gross economic activity that results from a given activity. It does not consider whether the expenditure used to generate the economic activity might have been used elsewhere in the economy to generate economic activity and gauge the comparative effect of that alternative activity.[1] While this distinction is important, we will continue to use the term "economic impact" to refer to the results of this analysis as is customary for these kinds of studies.

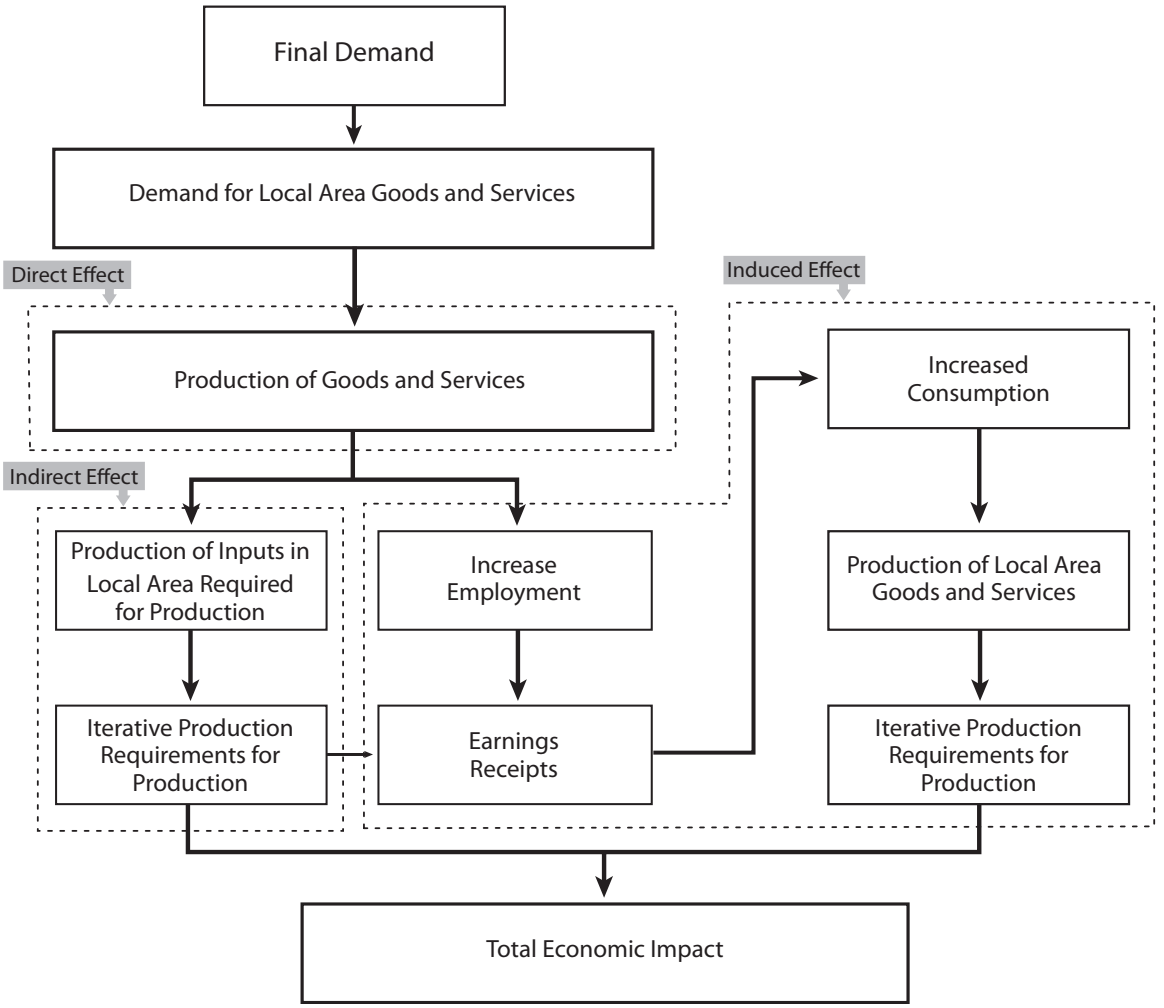
Carilion Clinic expenditures made in the region and state are counted as direct injections into the local and state economies. Most of the revenues that account for the expenditures originate from outside the community including from third party payers such as private insurance companies and public insurance programs (e.g., Medicare and Medicaid). Linkages with other industries in the area means this initial injection has further stimulative effects that result from the purchases of goods and services and payments to employees. The stimulus causes a "multiplier effect" that results when money is re-spent in the local or state economy.

The total impact of this activity consists of three parts, a "direct effect," "an indirect effect," and an "induced effect" (see **Figure 4**). The "direct effect" consists of Carilion Clinic economic activity, including its employment, payments, and revenues. The "indirect effect" consists of the injection of local procurement spending in the region and its effects. In many instances, the specialized equipment, supplies and services required to operate a major medical institution are purchased from outside the region. These expenditures are not included in the indirect effect. The indirect effect measures the cumulative change that results from Carilion Clinic-related spending on goods and service input purchases within the region including subsequent rounds of firm goods and service purchases needed to supply other producers. For example, Carilion Clinic purchases marketing and advertising services from Roanoke businesses, which causes a "ripple effect" on the local economy when money is re-spent by these businesses on equipment, supplies, business services and other goods and services from local businesses. These businesses spend a portion of their sales revenues on their supplies and services from other local firms which, in turn, purchase a portion of their supplies and services from other local firms. This cascading sequence of spending continues until the subsequent rounds of spending dissipate due to leakages in the form of saving or spending outside the area. The sum of these cascading rounds of inter-industry purchases constitutes the "indirect effect." The final component of total impact (the "induced effect" or "induced impact") is attributable to the spending of households. For instance, businesses in the supply chain pay households for their labor services. These households then purchase goods and services from area firms who in turn receive a portion of their labor, material and service inputs from within the region. Again leakages occur at each round due to purchases of goods and services outside the state. The "induced effect" is the sum of the industry impacts associated with these household purchases.

The impact analysis for this study used IMPLAN (Impact analysis for PLANning). IMPLAN is an industry standard input-output model that has been used in many economic impact studies, including

1 Nor does it measure the economic impact to the region of the closure of Carilion Clinic, since closure of the facilities would induce other providers within the region to expand their activities to provide health care services to some degree within the region, thus offsetting some amount of the negative economic impact (Miller, Pender, and Hertz 2017).

Figure 4. Economic Impact Diagram



studies of hospitals and health care systems (Ona and Davis 2011; Doeksen and Johnson 1998). The economic impact analysis is based on an IMPLAN Multiregional Input/Output Model (MRIO) constructed for each primary service area (i.e., Bedford, Buena Vista/Rockbridge, Franklin, New River Valley, Roanoke Valley, Tazewell/Bland/Wythe, and a region representing the balance of the state). This model is constructed using baseline U.S. data and area-specific data for each constituent county of the corresponding region and areas.

The first stage of estimating economic impact was to obtain Carilion Clinic payroll, other operational expenditures, patient revenues, and employment by service region. This process is described in **Appendix A**. The next stage involved mapping these inputs onto appropriate IMPLAN categories using multi-regional input-output (MRIO) analysis with IMPLAN Pro 3.1 software. Seven regional models representing the six service areas and a residual "remainder of the state" regional model constituting the 115 other (133 localities minus 18 service region counties) were linked. The third stage involves running the IMPLAN model and generating the economic impact results.

Results are presented for three different economic measures: employment, output, and value-added. Employment is measured in terms of person-years

of employment. A person-year of employment is a job of one year in duration. Employment includes full-time and part-time employment as well as the self-employed and is measured by place of work. Total sales or industry output is the total value of industry production during a period. It measures sales of intermediate inputs for use in production as well as sales of products to final consumers. Value-added is a subset of total industrial output. It reflects only sales to final consumers and therefore avoids the double counting that occurs when intermediate inputs are included. It is the most commonly used measure of economic activity. Value-added is the concept behind gross domestic product (GDP) and can be compared to the GDP numbers provided by the Bureau of Economic Analysis for states and metropolitan areas. It can also be represented as total factor income plus indirect business taxes.

SECTION 3
CARILION CLINIC ECONOMIC IMPACT

This section presents the results of the economic impact analyses. **Table 2** shows the results of the statewide and service region economic analysis. In FY2018, Carilion Clinic employed 13,317 staff statewide, generated revenues of $1.80 billion (equivalent to sales or output), and accounted for value-added of $892 million. This is the direct impact. The expenditures of Carilion Clinic and its employees create additional impacts for the state as these injections of spending and income generate subsequent rounds of business and household spending that result in the indirect and induced effects described earlier. As a result, an additional 10,402 jobs statewide, $1.39 billion in output, and $766 million in value-added result from Carilion Clinic's presence. The total economic contribution is 23,719 jobs, $3.17 billion in output, and $1.64 billion in value-added.

Carilion Clinic employed 13,089 staff, produced revenues of $1.78 billion and value added of $874 million in its Virginia's Blue Ridge and Southwest Virginia 18-county service region. This direct impact generated a total regional economic impact of 22,782 jobs, $3.05 billion in total output, and $1.57 billion in value added. The statewide indirect and induced effects are bigger than the service region effects because direct employment and in-state spending are higher and the spending leakages for each round of business and household re-spending is smaller for the larger Virginia economy. Similarly, other Virginia-based businesses in the supply chain are more likely to spend within the state than businesses within the service region are to spend within the service region.

Table 3 shows a breakdown of service region impacts by major industry. Results indicate that the services industry has the largest connection with Carilion operations, with 20,567 in employment, $2.70 billion in output, and $1.39 billion in value-added economic impact. The direct economic activity of Carilion Clinic, which is classified as health care services, is contained in this sector. However, an additional 7,478 jobs in the services sector result from Carilion Clinic's presence, making it the largest industry beneficiary of clinic spending. Most of this impact is due to household income-related impacts (induced effects) because households spend most of their incomes on services. The next largest employment impact is found in the trade industry (retail and wholesale trade) with a 1,425 jobs impact. TIPU (transportation, information, and public utilities) has the third largest impact with 465 jobs followed by the construction sector with 128 jobs. Finally, a total of 197 additional jobs can be attributed to the government (119), manufacturing (55), agriculture (17), and mining (7) sectors. Parallel results are found for output and value-added

Table 2. Carilion Clinic Economic Impacts, State and Service Region

	Direct	Indirect	Induced	Total	Multiplier
Virginia					
Employment	13,317	4,106	6,296	23,719	1.8
Output	$1,802,639,790	$560,048,792	$829,896,093	$3,167,297,037	1.8
Value Added	$891,889,968	$297,057,582	$469,319,857	$1,640,633,563	1.8
Carilion Service Region					
Employment	13,089	3,872	5,821	22,782	1.7
Output	$1,777,352,152	$517,476,533	$752,237,496	$3,047,066,182	1.7
Value Added	$874,256,124	$273,873,913	$424,186,074	$1,572,316,111	1.8

Table 3. Carilion Clinic Service Region Economic Impact by Industry

Description	Direct	Indirect	Induced	Total
Employment				
Total	13,089	3,872	5,821	22,782
Agriculture	0	2	15	17
Mining	0	3	4	7
Construction	0	47	81	128
Manufacturing	0	24	31	55
TIPU	0	221	243	465
Trade	0	190	1,235	1,425
Service	13,089	3,331	4,147	20,567
Government	0	53	66	119
Output				
Total	$1,777,352,152	$517,476,533	$752,237,496	$3,047,066,182
Agriculture	$0	$94,041	$591,548	$685,589
Mining	$0	$731,762	$855,397	$1,587,158
Construction	$0	$7,001,937	$12,428,189	$19,430,126
Manufacturing	$0	$8,722,599	$12,143,797	$20,866,396
TIPU	$0	$59,703,323	$66,788,605	$126,491,928
Trade	$0	$40,777,413	$114,630,479	$155,407,892
Service	$1,777,352,152	$390,058,985	$528,079,794	$2,695,490,932
Government	$0	$10,386,474	$16,719,687	$27,106,161
Value-added				
Total	$874,256,124	$273,873,913	$424,186,074	$1,572,316,111
Agriculture	$0	$43,432	$292,647	$336,079
Mining	$0	$12,479	$61,148	$73,628
Construction	$0	$2,780,275	$4,734,695	$7,514,970
Manufacturing	$0	$3,160,194	$3,985,680	$7,145,874
TIPU	$0	$23,947,708	$27,707,759	$51,655,467
Trade	$0	$24,922,845	$71,421,779	$96,344,623
Service	$874,256,124	$212,626,582	$307,076,720	$1,393,959,426
Government	$0	$6,380,397	$8,905,646	$15,286,043

Table 4 shows the results of spending and employment in each service area. The results reflect only the spending of the principal Carilion Clinic facilities located in each of those areas and not total Carilion Clinic expenditures in those areas. For example, the economic impact of Carilion's operations in the Franklin service area includes the spending of Carilion Franklin Memorial Hospital but not spending in the area attributable to Carilion Roanoke Memorial Hospital. The largest economic impacts occurs in the Roanoke Valley where the most substantial Carilion Clinic operations are located. Carilion Clinic directly employs 10,215 in the region, generates an estimated $1.45 billion in revenue, and accounts for $671 million in value-added. The total economic impact, once indirect and induced spending is taken into account within the region, is 18,494 jobs, $2.55 billion in output, and $1.28 billion in value-added. The second highest economic impact area is in the New River Valley area which also hosts sizable Carilion Clinic operations. The total economic impact there is 2,780 jobs, $333 million in output, and $197 million in value-added. The total economic impacts for other regions are 614 jobs, $60 million in output, and $38 million in value-added for the Franklin Area;

Table 4. Carilion Clinic Economic Impacts by Service Area

	Direct	Indirect	Induced	Total	Multiplier
Bedford Area					
Employment	20	1	6	27	1.4
Output	$1,642,058	$80,308	$708,062	$2,430,427	1.5
Value Added	$1,308,243	$36,864	$354,874	$1,699,981	1.3
Buena Vista/Rockbridge Area					
Employment	328	42	104	474	1.6
Output	$38,974,467	$3,996,018	$11,471,136	$54,441,621	1.4
Value Added	$23,402,044	$1,965,426	$6,209,788	$31,577,258	1.3
Franklin Area					
Employment	477	34	103	614	1.3
Output	$44,736,959	$3,153,519	$11,754,351	$59,644,828	1.3
Value Added	$29,694,954	$1,747,871	$6,474,496	$37,917,321	1.3
New River Valley Area					
Employment	1,883	238	659	2,780	1.5
Output	$229,334,886	$25,818,686	$77,980,722	$333,134,294	1.5
Value Added	$138,169,647	$14,039,841	$44,616,385	$196,825,873	1.4
Roanoke Valley Area					
Employment	10,215	3,491	4,788	18,494	1.8
Output	$1,446,879,580	$475,066,570	$628,174,714	$2,550,120,863	1.8
Value Added	$670,629,917	$252,207,768	$355,685,865	$1,278,523,550	1.9
Tazewell/Bland Wythe Area					
Employment	166	10	49	225	1.4
Output	$15,784,203	$1,049,986	$5,809,351	$22,643,540	1.4
Value Added	$11,051,319	$522,962	$3,158,796	$14,733,078	1.3

Note: Service area totals will not add up to service region totals due to spending leakages outside the areas and model geographical coverage

474 jobs, $54 million in output, and $32 million in value-added for the Buena-Vista/Rockbridge area; 225 jobs, $23 million in output, and $15 million in value-added for the Tazewell/Bland/Wythe area; and 27 jobs $2.5 million in output, and $1.7 million in value-added for the Bedford area.

The economic multipliers for the rural Carilion Clinic service regions (obtained by dividing the total impacts for each metric by direct impacts) are consistent with other economic impacts studies of hospitals with significant rural population service areas. Most studies report employment multipliers within the 1.1 to 1.7 and income multipliers (e.g. value added of 1.1 to 1.5 (Miller, Pender, and Hertz 2017) for such areas. These multipliers tend to be bigger for metropolitan and micropolitan areas than more rural areas.

SECTION 4
OTHER ECONOMIC AND SOCIAL CONTRIBUTIONS

The previous section examined how Carilion Clinic contributes to the state, regional, and area economies through its operational spending. Although the flows of economic activity that result from expenditures related to the operation of Carilion Clinic are important to the region and area economies it serves, Carilion Clinic makes numerous other economic and social contributions to the state and service region. The social and economic impacts described here are not reflected in the figures reported in the previous section.

Capital Spending Economic Impacts

Carilion Clinic is embarking on a major capital improvement program in the next seven years that will invest $1 billion into the regional economy by adding new facilities and upgrading existing ones.[2] The first phase, involving improvement to the Roanoke campus, is scheduled to begin in the spring of 2020 and complete in 2024. Total investment will be $500 million of which approximately $300 million will be new construction, $70 million renovation of existing space, and $130 million furniture and equipment purchases. The project will allow Carilion to accommodate recent growth and anticipate future growth, replace aging facilities and consolidate services such as cardiovascular health into new spaces. The center of the construction is a new hospital addition, the Crystal Spring Tower and new Behavioral Health building. In addition, spaces in the existing Roanoke Memorial Hospital building will be renovated and reequipped. Other improvements include a new 500-space parking garage and skywalk.

The economic impact of these first phase capital improvements are over 4,200 jobs, $617 million in total output, and $273 million in value-added. Approximately 2,650 person-year jobs (i.e., average annual employment of approximately 664 jobs) will be directly created over the four year construction period due to the construction. The other 1,615 jobs are spinoff jobs that result from indirect and direct effects. **Table 5** shows the breakdown of economic impacts by major capital project.

2 May 16, 2019. "Carilion announces $300 million expansion in Roanoke." *Roanoke Times*

Contributions for Patient Care and Other Community Activities

During FY2018, Carilion Clinic provided a large number of financial and in-kind contributions to the community (see **Figure 5**), including $75.1 million in financial assistance and $74.7 million in other uncompensated care to uninsured patients and those with limited financial means. It also provided $38.1 million in educational benefits, and provided $5.9 million in community outreach funding and in-kind contributions, and sponsored almost $1 million in research.

Carilion Clinic employees participate in a wide variety of community activities in any given year. For example, Carilion coordinated volunteer services during FY2018 that enlisted 611 volunteers who provided 588,227 hours of service in the community, mostly in the area of health care. Also, 775 employees donated blood during blood drives organized at Carilion locations. Carilion physicians donated almost $120,000 worth of their time to assist patients at the Bradley Free Clinic and Fralin Clinic in Roanoke during the year.

Regional Healthcare Planning

Carilion Clinic has been a leader and active partner in promoting healthcare and wellness strategic planning and assessment in the region to improve health care outcomes. With a wide variety of partners in each of its service regions, Carilion has initiated a series of community-driven processes involving area stakeholders to improve outcomes of community health planning. With the assistance of a community health needs assessment survey, focus groups with stakeholders, and members of the public, and secondary data from public sources, each service region was able to identify health care needs priorities, health care resources, health care gaps, strategies for improving health outcomes,

Table 5. Carilion Clinic Capital Projects Economic Impacts for Service Region

	Direct	Indirect	Induced	Total
Crystal Spring Tower				
Employment	1,413	397	453	2,262
Output	$215,044,998	$62,663,397	$56,467,483	$334,175,878
Value Added	$83,701,524	$31,325,721	$31,229,017	$146,256,262
Behavioral Health Building				
Employment	450	123	142	714
Output	$67,654,999	$19,612,276	$17,652,982	$104,920,257
Value Added	$25,850,458	$9,777,406	$9,763,010	$45,390,874
Parking Garage				
Employment	198	32	58	288
Output	$24,228,961	$5,702,054	$7,235,381	$37,166,396
Value Added	$11,129,802	$2,791,696	$4,003,316	$17,924,814
Pump House				
Employment	85	21	26	132
Output	$11,104,941	$3,107,738	$3,207,220	$17,419,899
Value Added	$4,799,523	$1,592,732	$1,774,923	$8,167,177
Existing Building Renovation				
Employment	510	197	167	874
Output	$75,999,418	$26,175,123	$20,964,025	$123,138,566
Value Added	$29,998,887	$13,603,503	$11,602,339	$55,204,730
Total				
Employment	2,655	770	845	4,270
Output	$394,033,317	$117,260,588	$105,527,091	$616,820,995
Value Added	$155,480,194	$59,091,058	$58,372,605	$272,943,858

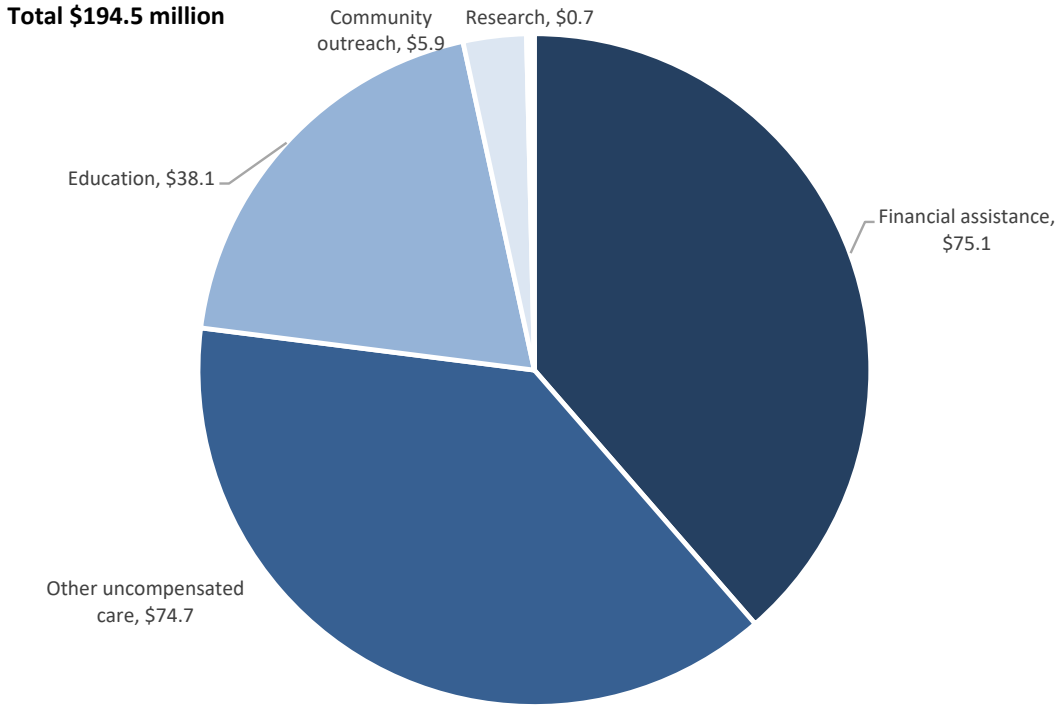
and community measures for tracking health outcome progress. These priorities, strategies, and measurement efforts vary by region to reflect distinct needs and differences but some commonalities exist with higher emphasis generally given to improving primary care access and access to mental health counseling/substance abuse, and addressing the high prevalence of obesity/overweight individuals.[3]

Clinical Care Access

Carilion Clinic provides access to clinical care options to hundreds of thousands of patients in the Virginia's Blue Ridge and Southwest Virginia as a result of adopting a clinical health care model that might otherwise not be available at a similar scale without its presence and entrepreneurial efforts. The absence of these clinical care options would mean that many patients would need to travel elsewhere, including out-of-state to receive such care. As a result, Carilion Clinic is responsible for attracting and retaining patient clinical trial spending that might otherwise occur outside the region and outside the state More importantly, the availability of services in closer proximity means that some patients receiving clinical services will realize cost savings and quality of life improvement by not needing to travel long distances to seek

3 These community health assessments can be found at: https://www.carilionclinic.org/community-health-assessments

Figure 5. Carilion Clinic Community Contributions, FY 2018 ($ Millions)



Source: Carilion Clinic

similar treatment elsewhere Furthermore, patients who might not opt to utilize such services because of distance barriers are more likely to do so.

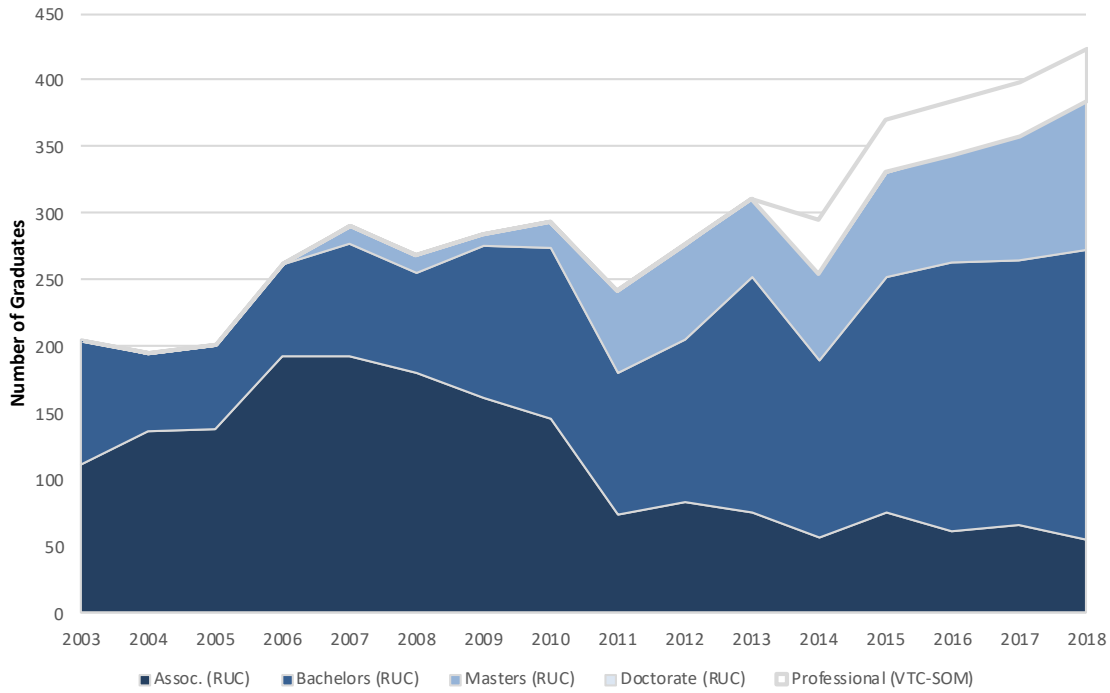
Education and Research

Before transitioning into partnership models with both entities in 2018-19, Carilion Clinic helped to create and incubate two of the area's leading medical higher education institutions--Virginia Tech Carilion (VTC) and Radford University Carilion (RUC) -- providing planning, management and operational support for both entities as they grew to maturity.

Radford University Carilion is the successor to the Jefferson College of Health Sciences. It provides evaluation and training to over 1,000 students in its programs. The Jefferson College of Health Sciences, which was established in 1982, was an outgrowth of the former hospital-based Jefferson Hospital School of Nursing. Curriculum offerings expanded from nursing to varied allied health associate degree and certificate offerings in the 1980s and early 1990s to bachelor's degrees in the late 1990s and graduate degree programs in the last 10 years. The college merged in 2019 with Radford University. It has helped to fill the need for skilled healthcare professionals in a variety of fields since its initiation. In 2019, its graduating cohort was 417 students, nearly doubling in size compared to the turn of the century (see **Figure 6**).

Virginia Tech Carilion, which includes a School of Medicine and the Fralin Biomedical Research Institute at VTC, was established in 2008. The School of Medicine hosts 160 matriculated medical students and has a graduating class of 40 students each year. The Research Institute attracts growing

Figure 6. Graduates of Carilion Clinic Affiliated Programs at Radford University Carilion (RUC) and Virginia Tech Carilion School of Medicine (VTC-SOM)



Source: State Council for Higher Education in Virginia and Virginia Tech

number of undergraduate and graduate students and other researchers. VTC and its economic and social impacts on the state and region are described more fully in another report which highlights how research and development activities, commercialization, and educational activities contribute to regional economic development (Rephann 2018). Among these benefits are the diffusion of new medical knowledge to the community, improved local productivity, new high technology startups, and provision of medical services.[4]

In addition to having substantial operational and capital expenditures and attracting a sizeable portion of their funding from external funding sources such as federal financial aid, extramural grants, and industry sponsorships, both Radford University Carilion and Virginia Tech Carilion stimulate the economy through the spending of students who originate outside of the region. In its fall 2018 matriculating class, six percent of Radford University Carilion students came from outside the state and an additional 36 percent from outside the region. Most VTC School of Medicine entering students are from out-of-state. The consumer spending of these students on items such as rent, utilities, retail goods, restaurants, etc. stimulates additional business activity both directly and indirectly through multiplier effects. These students are also likely to attract friends and family of faculty, staff and students; and participants in Virginia Tech Carilion and Radford University Carilion academic research conferences and seminars who spend money in the community.

Graduates of these institutions who have remained within the region and Virginia enter the Virginia workforce and are more productive and earn higher wages as a result than would otherwise be the

4 Although that study used a different economic impact methodology than used here (REMI instead of IMPLAN), the economic impacts of Carilion spending at the Riverside Campus are included in that report. However, economic impacts in that study also reflect spending by Carilion's Virginia Tech partner.

case. According to the most recent State Council for Higher Education in Virginia data, Radford University Carilion graduates command the highest starting earnings of any Virginia higher education institution (eighteen months after receiving a bachelor's degree, graduates earn $61,077 per year compared to a Virginia higher education institution average of $34,460). They also help to fill workforce gaps for skilled health care technicians and other professionals.

Rural Health Care Preservation

Hospital closures in rural areas have become increasingly common. Many rural and small hospitals have insufficient economies of scale and population density to generate operating surpluses and face the prospect of imminent closure (Strensland, Mueller and Sutton 2002). Between 2010 and present, 104 rural hospitals have closed nationwide, approximately six percent of the total.[5] Hospital closures can have a negative impact on rural economies. Indeed, some research suggests that closures of the last hospital available in a rural county can set the local economy into a prolonged downward spiral (Holmes, et al. 2006). More importantly, their removal creates another impediment to rural citizen health care access, including speedy access to critical care. Carilion's strategy of maintaining significant rural inpatient and outpatient operations with transportation by helicopter and ambulance to Level 1 and 3 Trauma Centers for critical care cases has preserved and improved rural health care access, options, and quality.

Resident Labor Participation and Productivity

Carilion Clinic health care services result in preventative, diagnostic and ameliorative care that improves the mental and physical well-being of its patients inside and outside the community. These improvements enable residents to live longer, more satisfying lives, and better enable them to contribute to their families, communities, and workplaces. Improved health is linked to greater labor productivity, decreased absenteeism, lowered presenteeism (defined as being present but not attentive at work), and higher wages. Furthermore, research also indicates heathier individuals are more likely to make investments in themselves, including in education, savings, and housing (Miller, Pender, and Hertz 2017). Businesses may also experience cost savings from lower worker compensation rates, reduced personnel costs for overtime for replacement employees, and lower costs for employee turnover.

Regional Amenities

The range and quality of health services that Carilion Clinic offers enhances the attractiveness of the service region to residents and businesses. Residents and businesses often evaluate the availability of affordable and quality health care when making choices of where to live or operate their business (Bartik and Erickek 2008). Retirees and young families, in particular, may place a higher emphasis on health care quality because of their greater need for such services (Miller, Pender, and Hertz 2017). Better quality health care also makes it easier for area firms to attract skilled workers (Miller, Pender, and Hertz 2017).

Carilion Clinic also contributes to the regional amenities through its community engagement activities. Carilion Clinic physicians and staff are involved in a number of community activities, dedicating time to efforts such as health promotion, higher education and civic engagement that make the community a better place to live.

5 See North Carolina Rural Health Research Program https://www.shepscenter.unc.edu/programs-projects/rural-health/rural-hospital-closures/

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APPENDIX A. INPUT DATA AND ANALYSIS

The IMPLAN analysis relied on a method called analysis-by-parts to gauge the economic impact of Carilion Clinic expenditures. This method separates the modeling into two tasks: modeling the purchase of goods and services from local firms using expenditure totals by IMPLAN industry and the payment of wages and salaries as an increase in labor income.

Operational expenditures were obtained from the Carilion Clinic Finance Department for FY 2018. Payroll by service area was delivered in one file. Other operating expenditures by service area were derived using two linked files. The first file, drawn from the accounts payable system, identified each transaction by accounting unit code. A second file contained a crosswalk between accounting units and service areas. Clinic spending attributable to operations within each service area was inferred by linking the two files. These expenditures were mapped to an industry expenditure pattern for the IMPLAN hospital sector (IMPLAN industry 482). Default IMPLAN derived SAM local purchase coefficients by industry were used to identify the percentage of purchases from the service area.

Direct output, value-added, and employment were based on Carilion Clinic actual patient revenue, income, and employment data.

The study used multi-regional input-output (MRIO) analysis to estimate the state, service region and service area economic impacts. The analysis was conducted using the IMPLAN Pro 3.1 software. MRIO analysis measures the economic impacts of spending within the service area on the service area as well as impacts on other service areas that are linked with the principal study area. Seven regional models representing the six service areas and a residual "remainder of the state" regional model constituting the 115 other state localities (133 localities minus 18 service region counties) were linked. Service area, service region, and statewide economic impacts reported represent Carilion spending at operations within each of those geographical areas. Service region economic impacts were obtained by adding up the results of the MRIO analysis for each of the six service region area models. Statewide results were obtained by summing the results of the seven (six service area and residual state region) linked models.

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