PREPARED FOR

Fredericksburg Regional Alliance
at the University of Mary Washington

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Industry Cluster Study

FREDERICKSBURG REGION

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Contents

1. Executive Summary

Why do cluster studies matter to local economies and to those developers that are looking for the next best prospect? It is because clusters, by design, pull together the big picture and an at-a-glance snapshot of the current state of the underlying industries that are growing and declining at the regional level. Clusters share synergies that not only influence the employment growth of a region but also its demographics.

The Fredericksburg Region of Virginia includes the counties of Caroline, King George, Spotsylvania, and Stafford, and the City of Fredericksburg. It is located halfway between Washington D.C. and Richmond, Virginia, and it is roughly bisected north-to-south by Interstate 95. An advantage of its proximity to the nation's capital is the ability to attract employers that prefer a lower cost of living with an hour-drive to Washington D.C. The presence of the interstate allows many retailers in the region to benefit by attracting to their establishments some of the people in the estimated 150,000 vehicles that pass through the region each day on I-95.[1]

The region's proximity to the nation's capital also brings challenges. Forty-six percent of Fredericksburg Region's employed residents commute out of the region to work.[2] Presumably, these residents are driving north for higher-paying jobs at some of the largest headquarters in the nation.

The attraction of living in the Fredericksburg Region is validated by its population growth. Population increased an annual average 1.5% over the past 10 years—double that of the state and nation where annual average population increases were both 0.7% over the same period. Population growth in the Fredericksburg Region is forecast to continue to outpace the state and the nation by expanding an annual average 1.7% from 2020 through 2030 compared to an annual average 0.8% in both the state and the nation.

The pace of growth in the Fredericksburg Region may accelerate if work-from-home policies enforced during the COVID-recession are maintained after a vaccine is widely distributed. Specifically, some people who live in Northern Virginia closer to their place of employment may

[1] http://www.virginiadot.org/newsroom/fredericksburg/2020/interstate-95-northbound-rappahannock-river-crossing-contract-awarded5-21-2020.asp#:~:text=With%20nearly%20150%2C000%20vehicles%20a,traveling%20through%20the%20Fredericksburg%20area.
[2] Source: 2019 Fredericksburg Region Commuter Workforce Study

prefer to live in the Fredericksburg Region as part of that lower cost of living noted above. These preferences are particularly enhanced by the working-from-home practices during the pandemic.

Employment in the region also outpaced that of the state and the nation over the last ten years. From the first quarter of 2010 through the first quarter of 2020, employment in the Fredericksburg Region increased an annual average 1.7% compared with 0.8% in the state and 1.1% in the nation over the same period. Over the past 10 years, the Fredericksburg economy has added more than 21,000 jobs. The largest sector gains have been in the public administration and health care and social services.

The COVID-19 pandemic looms large in the foreground of this study. It continues to have a profound impact causing social, healthcare, and economic issues throughout the country and the Fredericksburg Region. The region is typically less sensitive to recessions than the state and nation. Such has also been the case in the COVID-led recession that began in February 2020. The pre-COVID seasonally adjusted unemployment rate of 4.1% in February 2020 jumped to 7.8% in June and has since fallen to 5.5% in October, the latest data available. Unemployment rates in the state were 4.2%, 8.2%, and 5.8% for the same periods; and in the nation were 5.7%, 11.2%, and 7.5% for the same period.

Targeted clusters are the desired outcome of this report. Knowing the growth trends that include pre-COVID employment data from the first quarter of 2020 is important as COVID[3] has been an explosive interruption, of sorts, to the growth trajectory the Fredericksburg regional developers were tracking. The impacts to the local and regional economies are occurring because government shutdowns in some industries, combined with employee social distancing, has temporarily distorted the industry composition. Even so, the pandemic's impact cannot be ignored.

Three steps are used to identify, screen, and prioritize clusters and specific industries for economic development. First, fifteen preliminary clusters were identified in the Fredericksburg Region based on a weighted evaluation model that considered the clusters' wages, export activity, small firm presence, research and development activity, and location quotient.

The second step ranked and prioritized the clusters based on weights applied to average wages, export activity, forecast job growth (number of jobs and percent growth rate), small business as a percent of total firms, research and development as a percent of total sales, and location quotient.

Thirdly, the cluster-capability matrix considered external market factors as well as Fredericksburg Region capabilities to place each industry within the clusters into one of four opportunity quadrants. Each quadrant presents a unique strategic direction for the region's economic development community.

The following 15 clusters were identified in the region:[4]

1. Agriculture and Food
2. Business Services
3. Construction
4. Consumer Services
5. Education and Non-Profits
6. Electronics
7. Finance, Insurance, and Real Estate
8. Health and Life Sciences
9. Information and Communication
10. Manufacturing
11. Public Administration
12. Tourism
13. Trade and Retail
14. Utility
15. Transportation, Distribution, and Logistics

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[3] Section 7 details both COVID-19's impact on the Fredericksburg Region as well as the forecast recovery path for employment and gross domestic product (GDP).
[4] The industries that make up the clusters can be found in the Appendix.

The table below shows the ranked clusters based on the evaluation model that weights each of seven criteria based on their contribution to wealth, employment growth, innovation, and competitiveness.

Table 1.1 Fredericksburg Region Industry Cluster Matrix Summary, Ranked by Priority

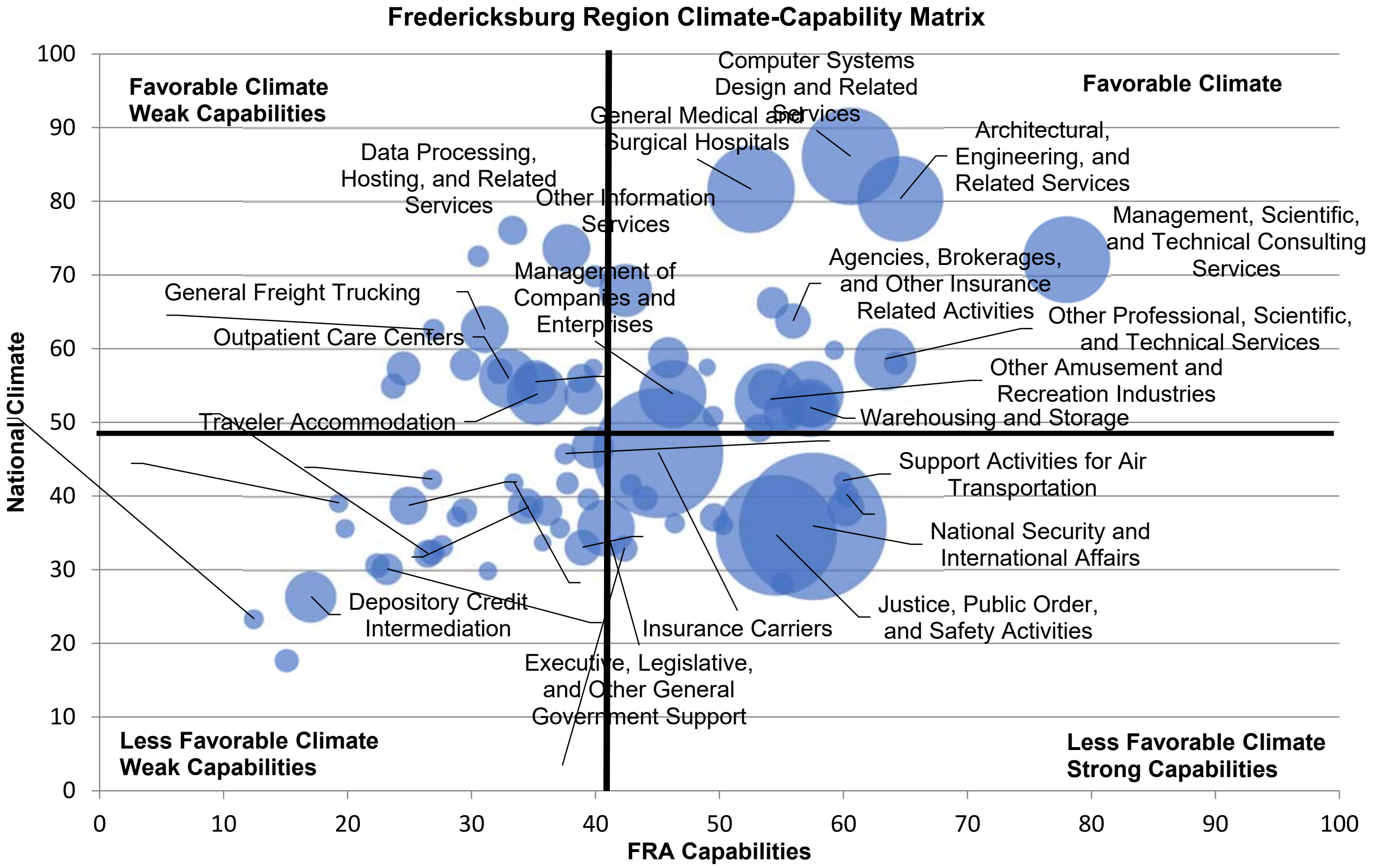
	2020Q1			Forecast 2020-2030 Annual Average Job Growth		R&D 2017	Small Businesses 2017
Cluster	**Location Quotient**	**Average Annual Wages 2020Q1**	**Sales-Export Ratio**	**Rate**	**Absolute Number**	**R&D as Percentage of Total Sales**	**Small Business as a Percentage of All Firms**
Information and Communication	1.07	$71,404	24.3%	1.9%	1,133	7.4%	65.8%
Public Administration	2.20	$99,475	7.1%	0.6%	865	0.3%	67.0%
Finance, Insurance, and Real Estate	1.23	$77,319	22.8%	0.6%	543	2.2%	55.1%
Education and Non-Profits	1.24	$37,696	20.7%	0.7%	1,373	2.7%	59.9%
Business Services	0.72	$56,930	24.9%	1.2%	1,328	1.7%	70.5%
Manufacturing	0.53	$75,430	66.8%	0.5%	234	2.2%	57.3%
Electronics	0.22	$74,929	72.0%	-0.5%	-19	10.7%	59.6%
Utility	1.30	$62,639	27.7%	0.9%	131	0.2%	48.1%
Transportation, Distribution, and Logistics	0.64	$54,286	35.1%	0.5%	328	0.5%	62.9%
Construction	1.01	$50,119	0.3%	1.5%	1,229	0.3%	80.5%
Agriculture and Food	0.29	$27,135	88.5%	0.7%	74	0.5%	73.3%
Health and Life Sciences	0.82	$61,277	5.2%	1.7%	2,352	1.0%	52.5%
Consumer Services	1.13	$25,895	11.8%	1.5%	3,496	0.6%	54.7%
Tourism	0.82	$20,470	39.9%	0.9%	343	0.3%	56.2%
Trade and Retail	1.29	$29,686	12.4%	0.2%	421	0.3%	46.9%

Source: Chmura Economics & Analytics, National Science Foundation, Business R&D Innovation Survey 2017, IMPLAN Pro

The top three weighed industry clusters for economic development targeting are information and communications; public administration; and finance, insurance, and real estate.

All clusters have varying degrees of potential for growth and promise as targets for economic development. The Fredericksburg Regional Alliance will have the most success in attracting clusters that have the greatest potential for growth given national and global trends, as measured by the External Climate Index; and strengths and specialization of the region's industries, as measured by the Capabilities Index.

The figure below shows the relative competitive position of each 4-digit North American Industry Classification System (NAICS) codes that was analyzed for this report. The size of each industry's circle represents its relative employment. For example, national security and international affairs is the largest circle because its employment (7,295 workers in the Fredericksburg Region) is larger than that of the 76 other industries included in the matrix. Each quadrant is unique, and within each industry there may be individual firms that have capabilities that make them competitive and well-positioned for future growth (or conversely, poorly positioned).



The top ten industries with the most favorable external climate and strong local capabilities are:

1. Management, Scientific, and Technical Consulting Services
2. Computer Systems Design and Related Services
3. Architectural, Engineering, and Related Services
4. General Medical and Surgical Hospitals
5. Securities and Commodity Contracts Intermediation and Brokerage
6. Other Professional, Scientific, and Technical Services
7. Business Schools and Computer and Management Training
8. Agencies, Brokerages, and Other Insurance Related Activities
9. Technical and Trade Schools
10. Warehousing and Storage

2. Background

The Fredericksburg Regional Alliance at the University of Mary Washington (FRA or Alliance) is a public-private partnership representing five localities. It is home to more than 334,000 residents and 8,756 firm establishments.[5] Formed in 2000, the FRA is the region's leader in economic development and supports both the public and private sectors through regional marketing and new business attraction. Participating public sector partners are the counties of Stafford, Spotsylvania, King George, and Caroline, and the City of Fredericksburg.

In 2013, Chmura developed a priority cluster report for the Alliance that identified clusters representing high-opportunity economic development targets and areas of focus for local and regional partners. This report updates the prior study, incorporating changes since the 2013 report as well as providing a deeper dive into specific industries.

The COVID-19 pandemic looms large in the foreground of this study. It has had a profound impact causing social, healthcare, and economic issues throughout the country and the Fredericksburg Region. Target cluster analysis in this report is based on pre-COVID employment data from the first quarter of 2020 because government shutdowns of some industries and social distancing have temporarily distorted the industry composition of the region. While the cluster analysis is based on pre-COVID data, the pandemic's impact cannot be ignored. Section 7 details both COVID-19's impact on the Fredericksburg Region as well as the forecast recovery path for employment and gross domestic product (GDP).

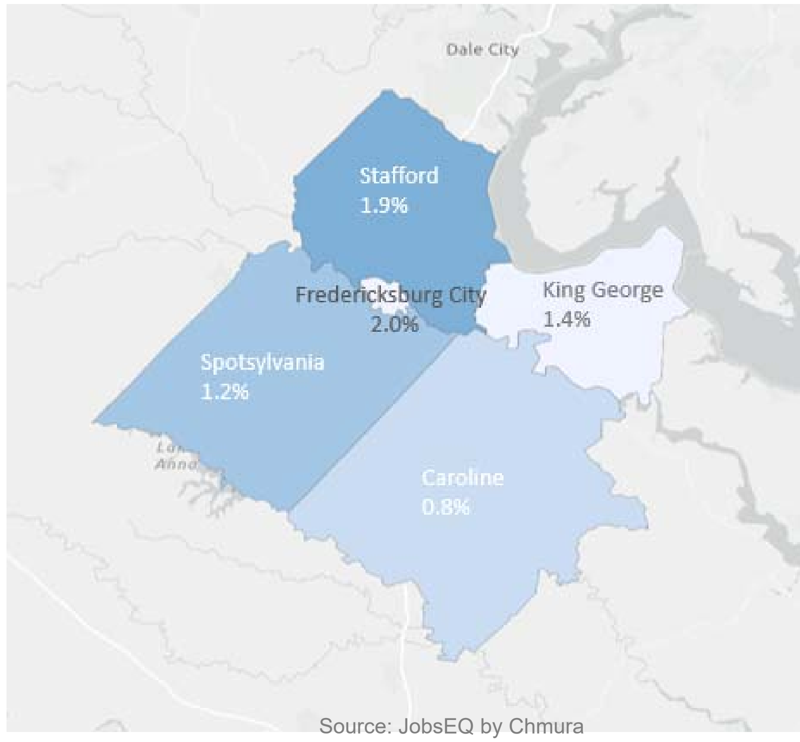
[5]Source: Chmura's JobsEQ®

3. Overview of the Fredericksburg Region

3.1 Population Trends

The Fredericksburg Region, which includes the counties of Caroline, King George, Spotsylvania, and Stafford, and the City of Fredericksburg, is a 1,400-square-mile area that sits between the Washington-Arlington-Alexandria, DC-VA-MD-WV and Richmond metropolitan statistical areas (MSAs).

Figure 3.1: Population Growth, Annual Average 2008-2018



Source: JobsEQ by Chmura

The Fredericksburg Region's geographic location halfway between Washington D.C. and Richmond, Virginia along with Interstate-95 (I-95) that provides easy access to the nation's capital is both an advantage and a challenge. The region's location is an advantage because it is attractive to firms that would prefer a lower cost of living with only a few hours' drive to Washington, D.C. Moreover, because the Fredericksburg Region is roughly bisected north-to-south by I-95, many retailers in the region can benefit by attracting to their establishments some of the estimated 150,000 vehicles that pass through the region each day on I-95.[6]

A disadvantage of its proximity to the nation's capital is that residents have easy access to higher paying jobs by driving north where some of the largest headquarters in the nation are located while enjoying the lower cost of living in the Fredericksburg Region. Forty-six percent of Fredericksburg Region employed residents commute out of the region to work.[7]

The Fredericksburg Region had a population of 372,270 in 2019 and is a fast-growing community (See Table 3.1). Population increased an annual average 1.5% over the past 10 years—double that of the state and nation where annual average population increases were both 0.7% over the same period.

Population growth plays an important role in economic growth and regional business expansion. It provides the labor force required to meet industry needs as well as customers for businesses in the area such as restaurants and retail establishments. Population growth also results in housing market expansion, creates new potential for entrepreneurship, and supports a growing tax base.

Population growth in the Fredericksburg Region is forecast to continue to outpace the state and the nation by expanding an annual average 1.7% from 2020 through 2030 compared to an annual average 0.8% in both the state and the nation. This pace of growth may accelerate if work-from-home policies introduced due to the pandemic are maintained after a vaccine is widely distributed. Specifically, some people who live in Northern Virginia closer to their place of employment may prefer to live in the Fredericksburg Region where the cost of living is lower if they only need to physically report to their place of work on an occasional basis.

The region is expected to experience strong annual average growth of 1.1% in its working-age population (age 20-64) from 2020 through 2030. This exceeds the growth rate projected for this cohort at the state (0.3%) and national (0.3%) level. In fact, population

[6] http://www.virginiadot.org/newsroom/fredericksburg/2020/interstate-95-northbound-rappahannock-river-crossing-contract-awarded5-21-2020.asp#:~:text=With%20nearly%20150%2C000%20vehicles%20a,traveling%20through%20the%20Fredericksburg%20area.
[7] Source: 2019 Fredericksburg Region Commuter Workforce Study

growth is expected to be faster in the Fredericksburg Region than the state and nation in every cohort over the forecast period. The faster growth rate of the younger cohorts may reflect more affordable homes.

Table 3.1: Fredericksburg Region – Demographic Overview

	FRA Region	Virginia	United States
Population 2019	372,270	8,535,519	328,239,523
Historical Average Annual Growth Rate, 2009-2019	1.5%	0.7%	0.7%
Median Age	36.5	38.1	37.9
Population Forecast, 2030	441,075	9,331,666	357,975,719
Forecast Average Annual Growth Rate 2020-2030	1.7%	0.8%	0.8%
Forecast Average Annual Growth Rate for Working Age Adults 20-64	1.1%	0.3%	0.3%
Forecast Annual Population Growth Rate by Age 2020-2030			
Under 15 years of age	1.6%	0.8%	0.6%
15-19	1.0%	0.3%	0.6%
20-24	1.1%	0.8%	0.7%
25-34	0.8%	0.1%	0.2%
35-44	2.8%	1.5%	1.3%
45-54	0.8%	0.3%	0.3%
55-64	-0.5%	-1.1%	-0.9%
65-74	2.8%	1.7%	1.6%
75+	5.4%	3.6%	3.4%

Source: Demographics & Workforce Group of the University of Virginia's Weldon Cooper Center for Public Service and Chmura's JobsEQ

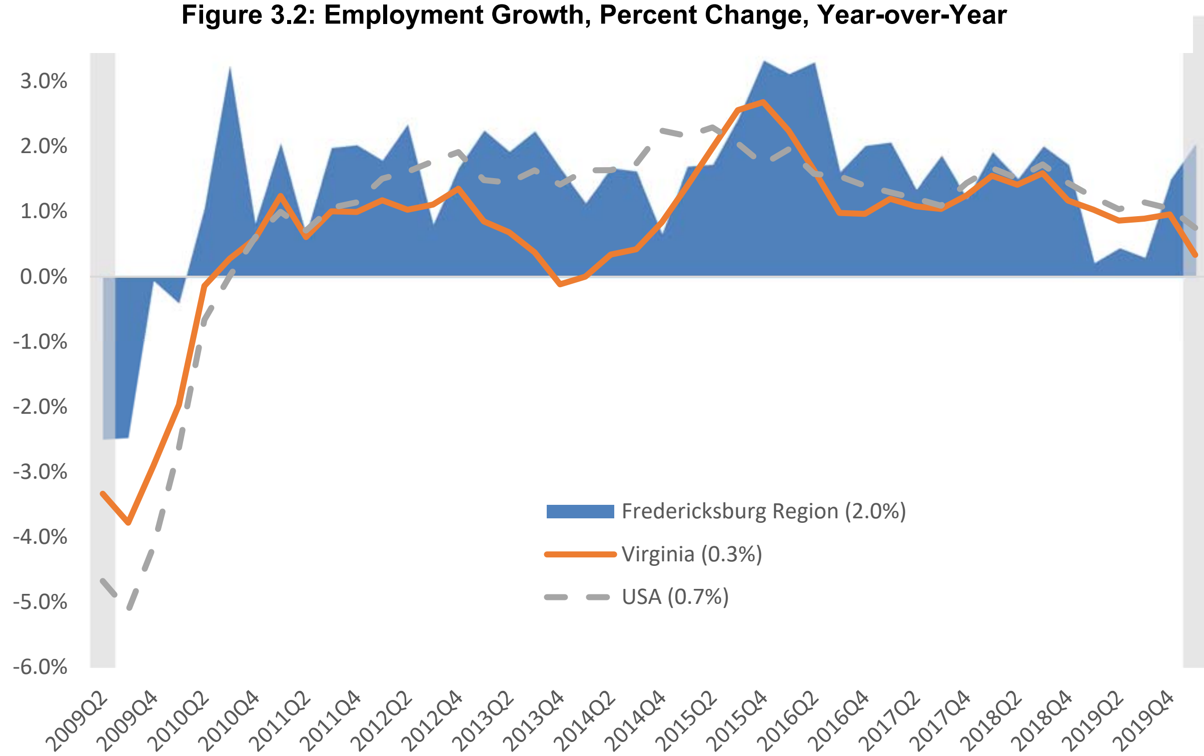
3.2 Economic Trends and Industry Mix

Over the past 10 years ending with the first quarter of 2020, the Fredericksburg regional economy has added 21,169 jobs. On a year-over-year basis the fastest growth occurred in the second quarter of 2016 when employment grew 3.3% (See Figure 3.2). During this period, the health care and social assistance sector added 362 employees and the transportation and warehousing sector added 267 employees.

The Fredericksburg Region is typically less sensitive to recessions than the state and nation. During the Great Recession that lasted from the fourth quarter of 2007 through the second quarter of 2009, employment in the region fell 2.2% (2,611 workers) from peak to trough compared with 4.0% in the state and 5.8% in the nation. In addition, the duration of the employment decline was shorter in the Fredericksburg Region (second quarter of 2008 through the first quarter of 2010) compared with both the state and the nation where peak employment occurred in the first quarter of 2008 and the trough was in the second quarter of 2010.

Social distancing and government mandates to reduce the spread of COVID-19 have resulted in a national recession that started in February 2020 according to the National Bureau of Economic Research, the U.S. arbiter of recessions. Section 7 of this report provides more detail on the impact of the recession and the coronavirus pandemic on the Fredericksburg Region economy. Due to the lag in county-level employment, the recession is not evident in the employment chart below, but it is evident in the more updated unemployment rate shown later in this report.

Figure 3.2: Employment Growth, Percent Change, Year-over-Year



Source: JobsEQ by Chmura, Data through 1st Quarter of 2020

Employment in the Fredericksburg Region increased an annual average rate of 1.7% over the last ten years from the first quarter of 2010 through the first quarter of 2020 (See Table 3.2). Utilities and public administration experienced the fastest employment growth at annual averages of 4.0% and 3.9%, respectively. Employment in the public administration and health care and social services sectors saw the largest increases over that period with 4,475 and 3,011 workers, respectively, added. In contrast, employment in the wholesale trade, manufacturing, and information sectors contracted over the same period.

In terms of size, the retail trade sector employs the largest number of people in the Fredericksburg Region with 17,784 workers in the first quarter of 2020 (See Table 3.2). It is closely followed by health care and social assistance (16,841), educational services (14,034), public administration (13,953), and accommodation and food services (13,424). Together, these five sectors represent 56% of total employment in the region.

Of the top five sectors, the public administration sector paid the highest wages—$99,409 on an annual average basis in the first quarter of 2020. A little over half of public administration is in national security and international affairs, which paid an annual average wage of $115,846 in the first quarter. In each of the remaining top five sectors, the annual average wage is less than the region's average wage of $49,873.

Looking forward to the first quarter of 2030, employment in the region is expected to increase an annual average 1.0% compared with 0.4% in the state and 0.5% in the nation. All sectors are projected to experience net increases in employment, except for

Table 3.2. Fredericksburg Region – Industry Snapshot 2020Q1

		Current		Historical	Forecast
		Four Quarters ending with 2020Q1		Employment 2010Q1 – 2020Q1	Forecast over 2020Q1-2030Q1
NAICS	Industry	Employment	Avg Annual Wages	Avg Annual % Change	Avg Ann % Change
44	Retail Trade	17,784	$29,543	1.0%	0.2%
62	Health Care and Social Assistance	16,841	$48,947	2.0%	1.9%
61	Educational Services	14,034	$43,439	1.2%	0.7%
92	Public Administration	13,953	$99,409	3.9%	0.6%
72	Accommodation and Food Services	13,424	$18,288	1.9%	1.2%
54	Professional, Scientific, and Technical Services	10,670	$83,278	1.9%	1.8%
23	Construction	7,854	$50,328	0.4%	1.5%
52	Finance and Insurance	7,341	$61,422	1.1%	0.5%
81	Other Services (except Public Administration)	7,079	$29,905	1.8%	0.7%
56	Administrative and Support and Waste Management and Remediation Services	5,866	$36,431	3.6%	1.1%
48	Transportation and Warehousing	4,977	$50,018	3.3%	1.1%
42	Wholesale Trade	3,048	$54,830	-1.4%	0.3%
31	Manufacturing	2,586	$45,430	-0.4%	-0.1%
71	Arts, Entertainment, and Recreation	2,491	$18,966	1.8%	1.2%
53	Real Estate and Rental and Leasing	2,043	$46,876	1.9%	1.0%
51	Information	1,704	$46,623	-0.6%	1.3%
55	Management of Companies and Enterprises	1,502	$89,432	2.0%	0.3%
22	Utilities	810	$78,771	4.0%	0.8%
11	Agriculture, Forestry, Fishing and Hunting	675	$22,254	0.0%	0.3%
99	Unclassified	225	$40,162	n/a	0.9%
21	Mining, Quarrying, and Oil and Gas Extraction	199	$46,467	3.6%	0.8%
	Total - All Industries	135,105	$49,873	1.7%	1.0%

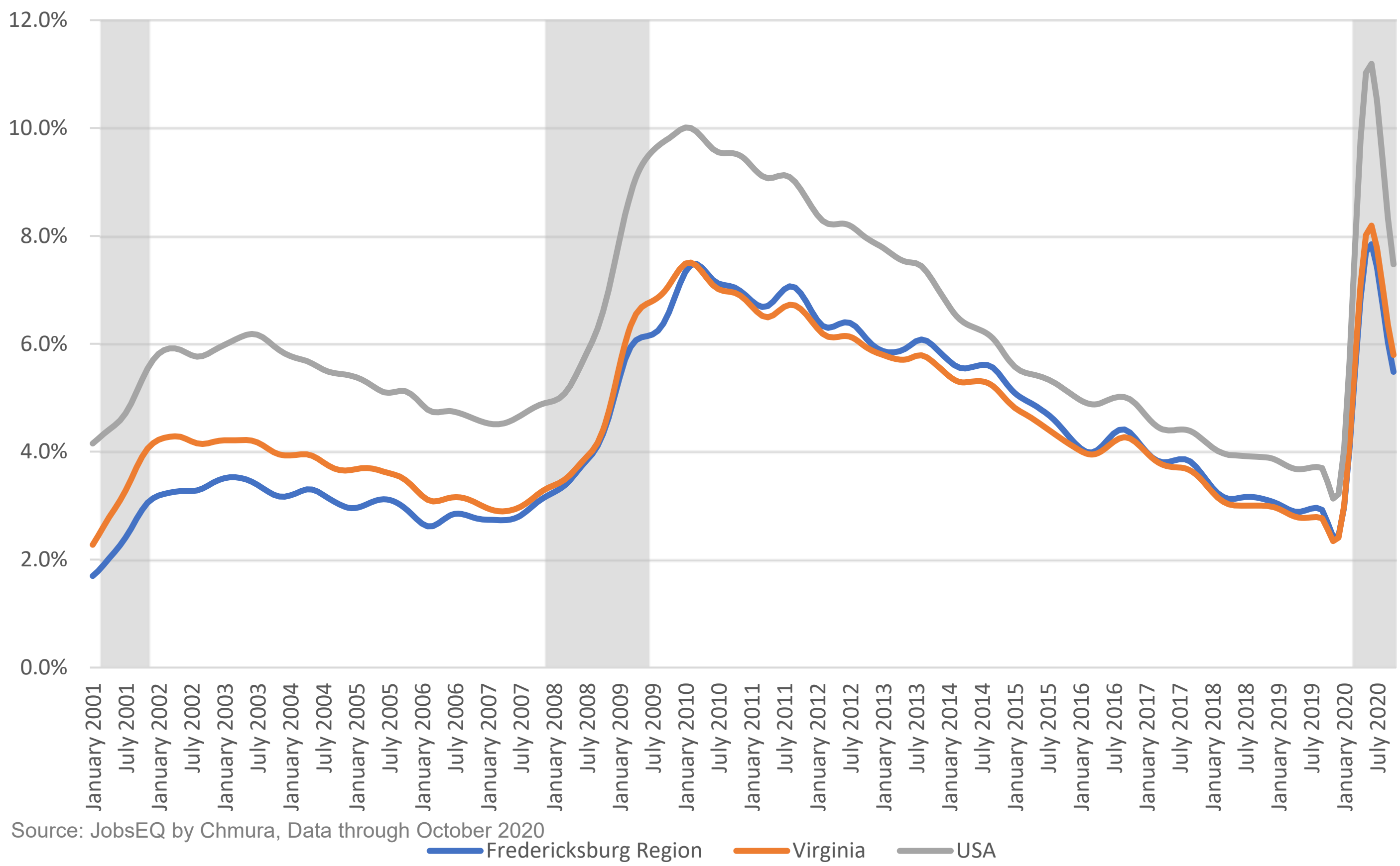
Source: JobsEQ® by Chmura

manufacturing, which is projected to decline by an annual average 0.1% over the period. The largest annual average employment gains are forecast for the health care and social assistance (1.9%); professional, scientific, and technical services sector (1.8%); construction (1.5%); and information (1.3%).

3.3 Unemployment Rate and Occupation Trends

The seasonally adjusted unemployment rate in the Region jumped to 7.8% in June due to stay-at-home policies that were implemented across much of the nation due to the coronavirus pandemic. The unemployment rate in the state rose to a slightly higher 8.2% peak during the same month while the national unemployment rate peaked at 11.2% in the same month. The unemployment remained higher than the peak of the previous recession but has dropped in October 2020 to 5.5% in the Fredericksburg Region, 5.8% in the state, and 7.5% in the nation.

Figure 3.3: Unemployment Rate (Seasonally Adjusted)



Source: JobsEQ by Chmura, Data through October 2020

The largest major occupation group in the Fredericksburg Region in the four quarters ending with the first quarter of 2020 is office and administrative, representing 15,686 workers (See Table 3.3).[8] This group is followed by sales and related (15,198) and food preparation and serving-related (12,861). The top five also includes education and training (10,137) and transportation and material moving (9,879).

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[8] All occupation data are presented in terms of at-place employment except for occupation unemployment and unemployment rate which are calculated by place of residence. Occupation employment data are derived from the most recent industry employment (from the Bureau of Labor Statistics, updated quarterly) and the industry/occupation matrix available for the region. Occupation average wage data are derived from national occupation/industry wage data provided by the Bureau of Labor Statistics modified where necessary. Occupation unemployment figures are imputed by Chmura. Employment forecasts are developed by Chmura using occupation forecasts from the BLS.

Table 3.3: Fredericksburg Region Occupational Employment Profile, Four Quarters Ending 2020Q1

SOC		Employment	Avg Annual Wages	Unemployment Rate
43-0000	Office and Administrative Support	15,686	$38,700	2.6%
41-0000	Sales and Related	15,198	$36,500	3.6%
35-0000	Food Preparation and Serving Related	12,861	$24,800	4.5%
25-0000	Educational Instruction and Library	10,137	$53,000	2.4%
53-0000	Transportation and Material Moving	9,879	$33,500	3.7%
13-0000	Business and Financial Operations	9,757	$76,800	2.2%
11-0000	Management	7,651	$112,800	1.4%
29-0000	Healthcare Practitioners and Technical	7,362	$78,300	1.3%
47-0000	Construction and Extraction	6,095	$43,000	3.7%
15-0000	Computer and Mathematical	5,308	$89,600	1.8%
49-0000	Installation, Maintenance, and Repair	5,292	$47,900	1.9%
31-0000	Healthcare Support	5,288	$28,100	2.5%
37-0000	Building and Grounds Cleaning and Maintenance	4,673	$28,000	3.9%
39-0000	Personal Care and Service	4,139	$28,500	3.3%
51-0000	Production	3,065	$36,700	2.9%
33-0000	Protective Service	2,743	$55,300	2.2%
17-0000	Architecture and Engineering	2,398	$90,300	1.8%
21-0000	Community and Social Service	2,335	$48,100	1.6%
27-0000	Arts, Design, Entertainment, Sports, and Media	2,064	$55,500	3.0%
23-0000	Legal	1,556	$89,900	1.7%
19-0000	Life, Physical, and Social Science	1,324	$82,000	2.1%
45-0000	Farming, Fishing, and Forestry	297	$35,700	5.8%
00-0000	Total - All	135,105	$51,000	2.8%

Source: JobsEQ® by Chmura

The region's labor pool is a critical factor in supporting the growth of existing businesses and a key determinate for companies choosing a new location. The region's mix of occupations is an important factor to consider as part of an economic development strategy. Aligning economic development strategies with the industries that closely match existing labor capabilities can ensure that expanding businesses and new entrants into the market will be able to recruit the skilled workers they need.

3.4 The Defense Community

The Fredericksburg Region is home to three prominent military installations. Fort A.P. Hill was established as an Army training facility in 1941 and is now used for year-round training for all branches of the U.S. military, as well as for U.S. State Department and foreign military allies. According to an Economic Impact report from the Matrix Design Group, more than 44,657 soldiers were trained at Fort A.P. Hill in the 2016 fiscal year. There are an estimated 337 civilian and active-duty military personnel at the Fort, which generates an estimated $93.2 million in gross domestic product.[9] There are also 2,087 military personnel, 14,742 members of military families and retirees, and 73 federal contractors at the Fort, according to the Virginia Military Advisory Council 2017 Annual Report. This 77,000-acre facility in Caroline County was awarded $15 million in federal contracts that were spent in Virginia.[10] Significant activities at this base include direct and indirect fire ranges, helicopter and aerial gunnery range activities, and complex live-fire exercises.

There are an estimated 11,224 workers on site at Naval Support Facility Dahlgren located in King George County. This includes 6,102 civilian workers, 4,739 individuals working for defense contractors doing business with Dahlgren, and 383 active military personnel. According to a recent report, the base is responsible for more than $7.7 billion in impact generated through payroll and defense contracts with area businesses.[11] The report also states that there were $2.8 billion in contracts awarded in FY2017 to businesses in the region.

Quantico is a 100-square-mile Marine Corps installation that straddles Stafford County, Prince William County, and Fauquier County. Like Fort AP Hill, Quantico serves as a significant training center as well as the U.S. Marine Corp's Combat Development Command. Approximately 18,937 civilian and enlisted military personnel make up the community.[12] The Marine Corps Officer Candidate School, the Marine Corps Research Center at Quantico, and the Marine Corps Brig (military prison) are also located at Quantico. The research center specializes in telecommunications equipment. Other agency functions on site include the Federal Bureau of Investigation (FBI) Academy and the U.S. Drug Enforcement Agency training and research facilities.

The combined impact of the civilians employed by the government, the defense contractor community, and enlisted military represent significant economic activity in the Fredericksburg Region.

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[9] https://home.army.mil/aphill/application/files/1115/4021/7144/Fort_A.P._Hill_Economic_Impact_Assessment.pdf

[10] https://rga.lis.virginia.gov/Published/2018/RD35/PDF

[11] Naval Support Facility Dahlgren, *2019 Profile: Naval Support Facility Dahlgren, Virginia.* Naval Support Activity South Potomac Public Affairs, June 2019. https://www.kinggeorgecountyva.gov/DocumentCenter/View/5048/Econ-Demo-FY-2018-DL-FINAL

[12] https://installations.militaryonesource.mil/in-depth-overview/marine-corps-base-quantico

4. Target Cluster Selection

In the next three sections, three steps are used to identify, screen, and prioritize clusters and specific sectors for economic development. First, fifteen preliminary clusters were identified in the Fredericksburg Region based on a weighted evaluation model that considered the clusters' wages, export activity, small firm presence, research and development activity, and location quotient.

The second step ranked and prioritized the clusters based on weights applied to average wages, export activity, forecast job growth (number of jobs and percent growth rate), small business as a percent of total firms, research and development as a percent of total sales, and location quotient.

Thirdly, the cluster-capability matrix considered external market factors as well as Fredericksburg Region capabilities to place each industry within the clusters into one of four opportunity quadrants. Each quadrant presents a unique strategic direction for the region's economic development community.

4.1 Cluster Evaluation Methodology and Ranking Criteria

Regional clusters are groups of related industries in a specific geographic area. Companies within clusters benefit from access to shared resources, such as labor pools, supplier networks, workforce training programs, or other resources that develop to support business growth. Regions that possess clusters offer a competitive advantage to firms in the cluster; and, as such, are in a better position to grow and attract similar businesses.

Cluster analysis differs from traditional sector analysis in that it acknowledges interdependencies between sectors and better describes supply-chain relationships occurring within a region.[13] After modeling the buyer-supplier relationship between industries, 15 distinct clusters were identified in the Fredericksburg Region. This modeling used the clusters identified in the 2013 study as the launch point. To further refine the clusters, the modeling also incorporated industry changes over the past seven years, changes to industry definitions in the North American Industry Classification System (NAICS),[14] and input from the Fredericksburg Regional Alliance.

The largest change from the 2013 cluster definitions is reflected in the trade and retail cluster and the transportation, distribution, and logistics cluster. Specifically, employment in the trade and retail cluster fell from 19,533 in 2013 to 7,784 in the first quarter of 2020 while employment in the transportation, distributions and logistics cluster rose from 2,429 in 2013 to 6,391 in the first quarter of 2020. The employment change is largely due to the reclassification of wholesalers from trade and retail to the transportation, distribution, and logistics cluster. Additionally, the 'Amazon effect' of online purchases and delivery to consumers contributed to the growth in transportation, retail, and logistics. The Fredericksburg Region is well-positioned to benefit from this trend due to its location on I-95.

Table 4.1 identifies the total employment, percent of employment, and annual average wages of each cluster in the region. Table A1 in the appendix details the 4-digit NAICS sector-levels included in each of the clusters.

[13] Chmura used IMPLAN Pro software's input-output matrix to identify relationships between industries.

[14] For example, wired (2012 NAICS 5171) and wireless (2012 NAICS 5172) telecommunications carriers were reclassified under the same four-digit code in 2017: NAICS 5173.

Table 4.1 Fredericksburg Region Industry Clusters 2020Q1

Cluster	Total Employment	Percent of Total Employment	Average Annual Wage
Agriculture and Food	980	0.7	$27,135
Business Services	10,055	7.5	$56,930
Construction	7,853	5.8	$50,119
Consumer Services	21,753	16.1	$25,895
Education and Non-Profits	18,098	13.4	$37,696
Electronics	386	0.3	$74,929
Finance, Insurance, and Real Estate	9,383	7.0	$77,319
Health and Life Sciences	13,056	9.7	$61,277
Information and Communication	5,369	4.0	$71,404
Manufacturing	4,627	3.4	$75,430
Public Administration	13,954	10.3	$99,475
Tourism	3,770	2.8	$20,470
Trade and Retail	17,784	13.2	$29,686
Utility	1,426	1.1	$62,639
Transportation, Distribution, and Logistics	6,391	4.7	$54,286
Cluster Total/Average	**134,885**	**99.8**	**$49,873**

Source: Chmura Economics & Analytics and JobsEQ®.
*Note: sum does not equal total employment in the FRA region due to unclassified employment and rounding.

The clusters that employ the most people in the region are consumer services (21,753), followed by education and non-profits (18,098), and trade and retail (17,784). Other clusters with employment over 10,000 workers include public administration, health and life sciences, and business services. These top six clusters represent 70.2% of the region's total employment.

4.1.1 Competitiveness

Once clusters are identified, the location quotient (LQ) measures whether the region has a competitive advantage relative to other regions in the country. The LQ is simply the cluster's employment concentration relative to the nation.[15] A cluster

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[15] By formula, the location quotient is the ratio of an industry's share of total employment within the region to the same industry's share of employment in the nation. For example, if the employment ratio in the industry Grocery Stores for a region is 17% and that is divided by the ratio of Grocery Stores employment to the nation, which is 17%, then the Location Quotient (LQ) would equal 1.0. If another region's Motor Vehicle employment ratio is 1.9% compared to .2% for the nation, the LQ would equal 9.5 meaning the employment concentration is 9.5 times the average in the nation.

$$\textit{Location Quotient } (\boldsymbol{LQ}) = \frac{\left(\frac{\text{Region's Industry Employment}}{\text{Region's Total Employment}}\right)}{\left(\frac{\text{U.S. Industry Employment}}{\text{U.S. Total Employment}}\right)}$$

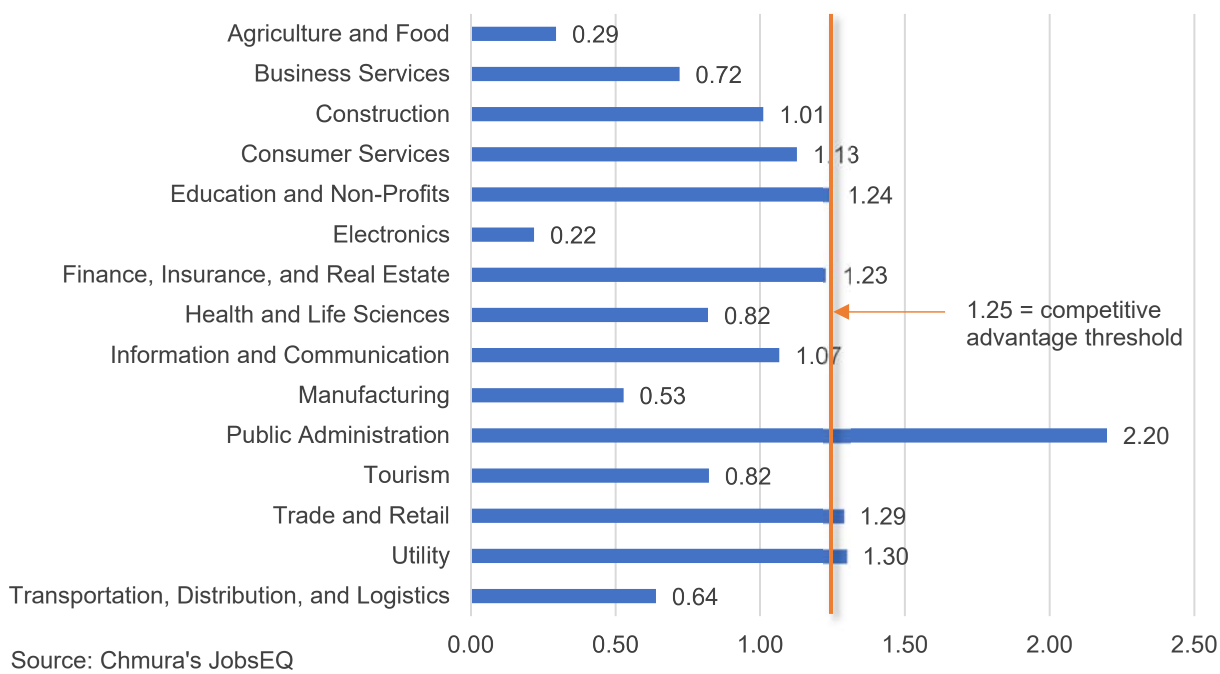
$$\textit{Location Quotient } (\boldsymbol{LQ}) = \frac{17\%}{17\%} = \mathbf{1}$$

$$\textit{Location Quotient } (\boldsymbol{LQ}) = \frac{1.9\%}{.2\%} = \mathbf{9.5}$$

with a location quotient above 1.0 has an employment concentration greater than that of the nation. An LQ of 1.25 is typically regarded by regional economists as the threshold for a competitive cluster in a region.

As shown in Figure 4.1, the Fredericksburg Region has three clusters whose LQ meets or exceeds the competitive threshold of 1.25. Those clusters are public administration (LQ=2.20), utility (LQ=1.30), and trade and retail (LQ=1.29). Education and non-profits (LQ=1.24) and finance, insurance, and real estate (FIRE) (LQ=1.23) each have location quotients near the competitive threshold.

Figure 4.1: FRA Cluster Location Quotient 2020Q1



Source: Chmura's JobsEQ

In addition to the LQ, the Fredericksburg Regional Alliance may choose to target certain clusters based on short- and long-term goals for the region's economy. Does the cluster contribute to wealth in the region that enables its citizens to experience a higher standard of living? Is the cluster growing and adding to the employment base in the region? Are firms in the cluster innovating? Creative destruction is always occurring in the economy where revolutionary goods and services displace older products. Innovation contributes to the long-term viability of a region. Similarly, clusters that contain a large percentage of entrepreneurship support long-term employment growth and innovation. A December 2018 Small Business Administration report shows that small businesses account for 44% of U.S. gross domestic product and "they create two-thirds of net new jobs and drive U.S. innovation and competitiveness."[16]

The remainder of this section uses the following metrics to identify cluster targets in addition to LQ that would support short- and long-term growth in the region:

- Wealth,
- Employment Growth,

[16] Source: https://advocacy.sba.gov/2018/12/19/advocacy-releases-small-business-gdp-1998-2014/

- Innovation, and
- Entrepreneurship.

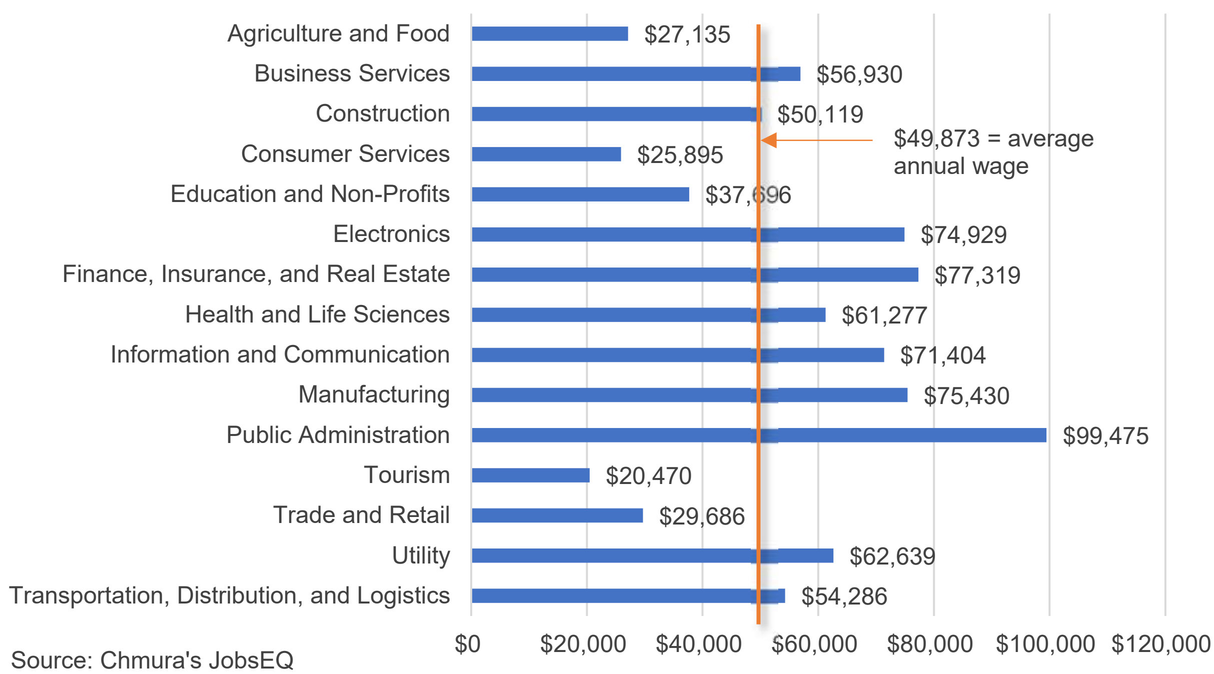
4.1.2 Wealth

Wealth is created in a region through a number of mechanisms including both wages and export activity.

High-wage jobs contribute to regional wealth as individuals buy more housing, durable goods, consumable goods, and personal services in the community relative to those with low-wage jobs. This supports the creation of additional jobs in the regional economy.

Of the 15 clusters in the Fredericksburg Region, ten have average annual wages that exceed the regional average ($49,873). The top five are public administration ($99,475), FIRE ($77,319), manufacturing ($75,430), and electronics ($74,929), and information and communication ($71,404). Wages fall far below the regional average for seven clusters. The agriculture and food, consumer services, and tourism clusters have the lowest annual wages.

Figure 4.2: FRA Cluster Average Annual Wage 2020Q1



Source: Chmura's JobsEQ

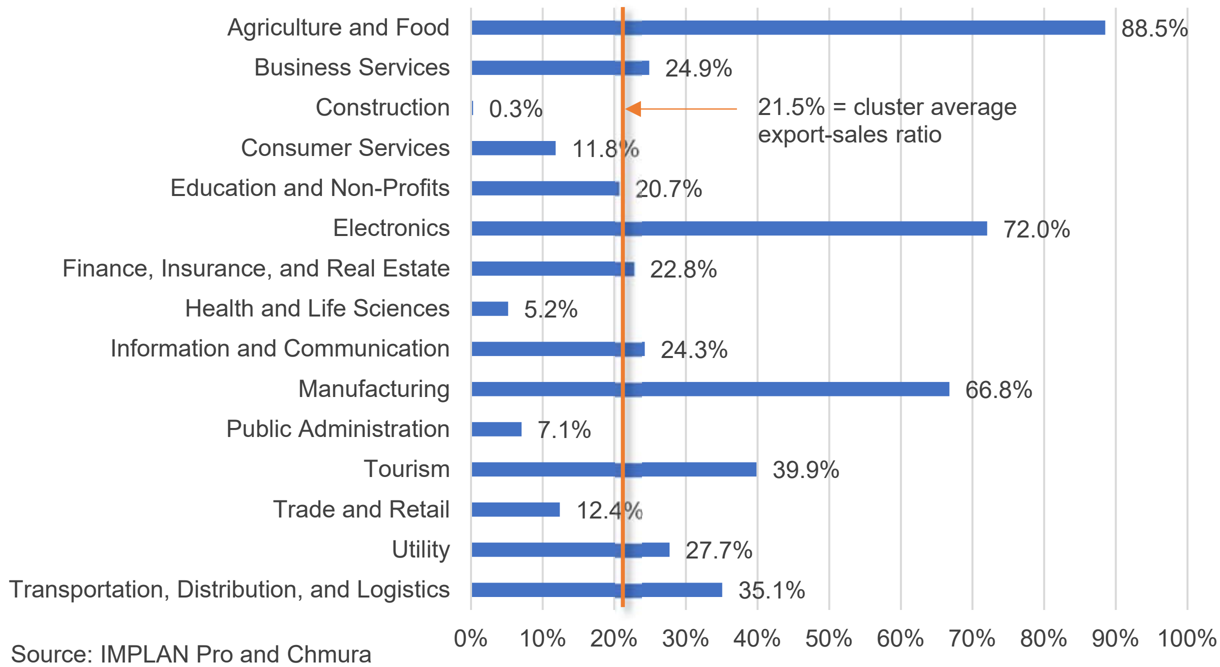
Wealth is also created when new dollars are brought into a region when a business exports its goods or services to customers outside the region. Through this export activity, economic expansion can occur when dollars from outside the region are further distributed through local purchases by area businesses, wages paid to employees, and local purchases supported by those earned wages.

The regional average export-to-sales ratio for all of the clusters is 21.5%, which means that 21.5% of all sales occur to customers that are outside the Fredericksburg Region.[17] The three clusters with the highest percentage of revenue

[17] The export-sales ratio was calculated using IMPLAN Pro software.

derived from outside the regional market are agriculture and food (88.5%), electronics (72.0%), and manufacturing (66.8%).

Figure 4.3: FRA Cluster Export-to-Sales Ratio



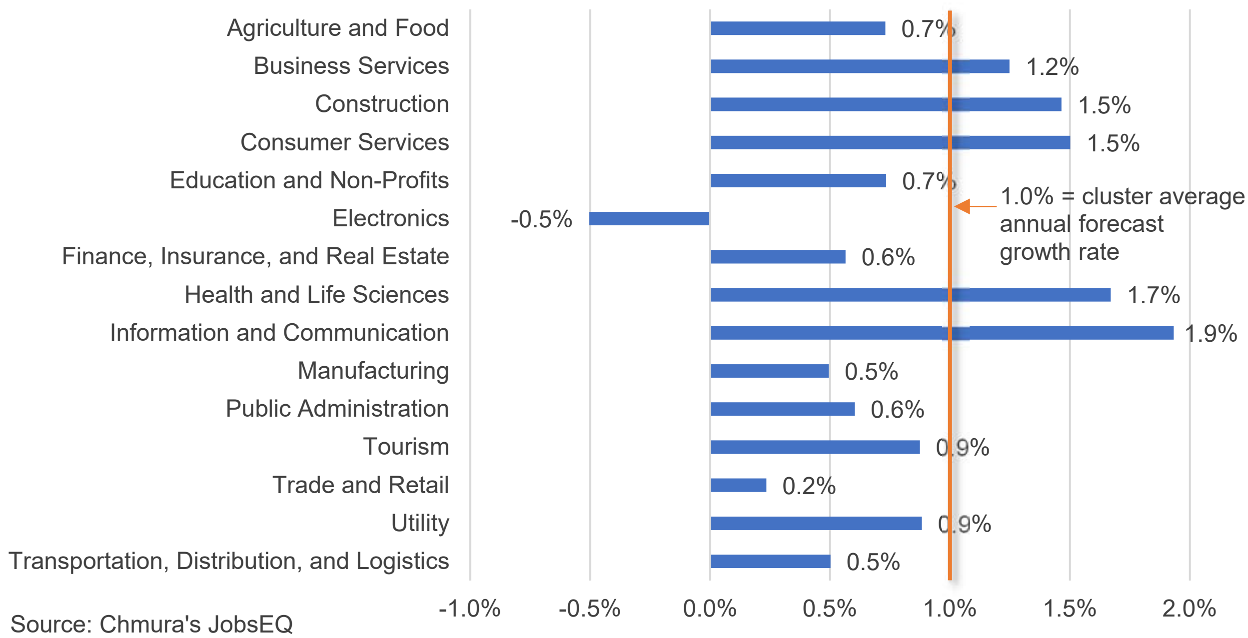
Source: IMPLAN Pro and Chmura

4.1.3 Employment Growth

Job growth is a primary objective of most economic development efforts. Job growth represents employment opportunities for residents in the region, and the prevalence of employment opportunities attracts new residents to the community. The Fredericksburg Region is fortunate that 14 of the 15 identified clusters are expected to experience positive growth over the next 10 years.

Growth can be measured in two ways: (1) growth rate, the percentage increase projected for a cluster over a period, and (2) absolute growth, meaning the net new jobs a cluster is expected to generate. Figure 4.4 shows the average annual growth rate projected for each cluster between 2020 and 2030. The average growth rate for all industries in the Fredericksburg Region is 1.0%. The annual average growth rate of the following five clusters is anticipated to exceed the average growth rate in the region: information and communication (1.9%), health and life sciences (1.7%), consumer services (1.5%), construction (1.5%), and business services (1.2%).

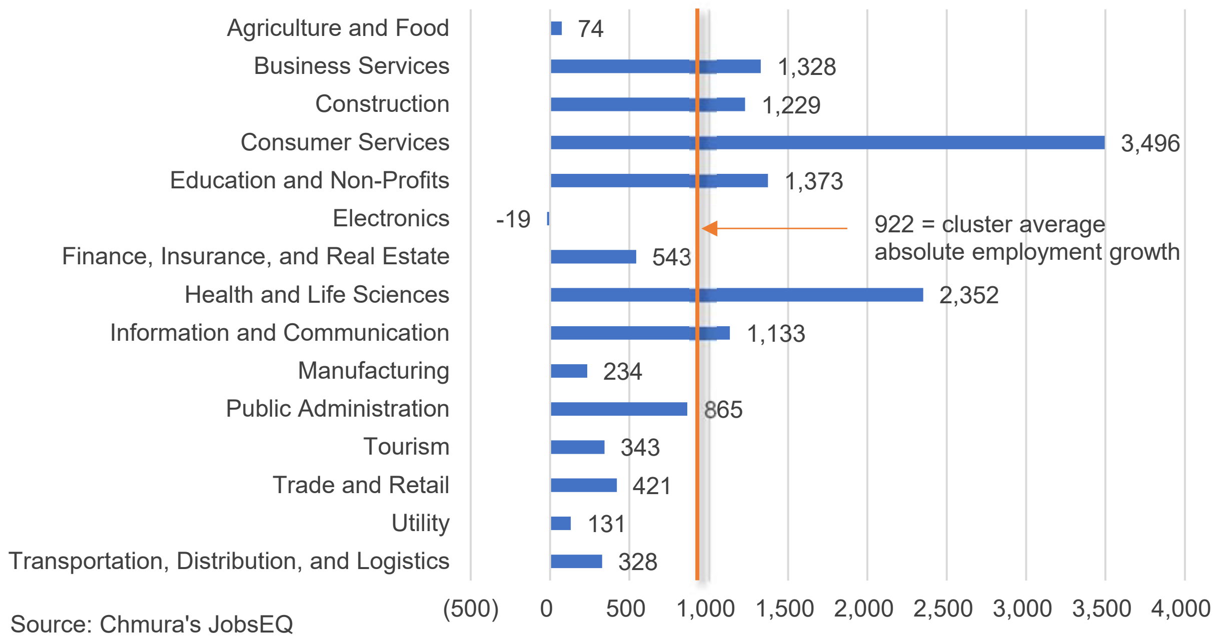
Figure 4.4: FRA Cluster Average Annual Employment Growth Forecast (%) 2020Q1-2030Q1



Source: Chmura's JobsEQ

The second measure of growth is the absolute number of new jobs the cluster is expected to create. Employers in the Fredericksburg Region are expected to create 13,831 net new jobs over the next ten years. The largest net increases are in the consumer services cluster, which is expected to add 3,496 jobs over that period. Figure 4.5 illustrates the forecast job growth for each cluster. In addition to consumer services, the five clusters expected to net more than 1,000 jobs are health and life sciences (2,352), education and non-profits (1,373), business services (1,328), construction (1,229), and information and communication (1,133).

Figure 4.5: FRA Cluster Absolute Employment Growth Forecast 2020Q1-2030Q1



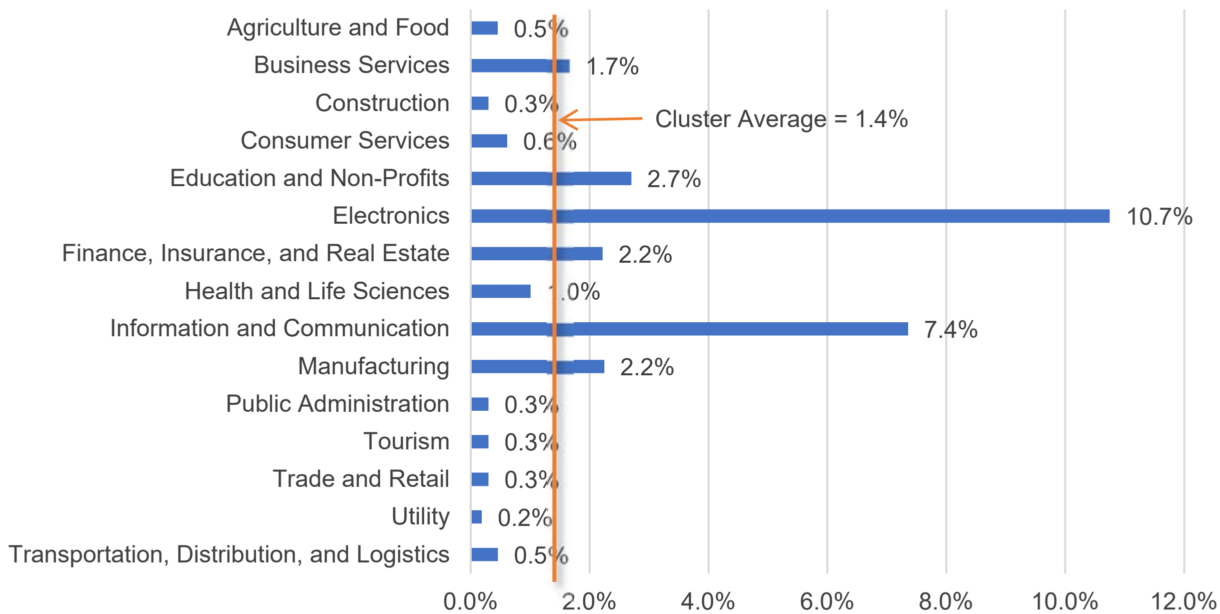
Source: Chmura's JobsEQ

4.1.4 Innovation - Research and Development

One measure of a cluster's capacity for future growth is the degree to which it invests in research and development (R&D) activities. R&D spending is not available at the regional level. For that reason, Chmura used R&D spending as a percentage of total sales at the national level as a measure of innovative capacity. This measure accounts for investment in new product development and technology advancement. Companies in clusters that dedicate a significant percentage of their revenue to research and development are invested in future growth and innovation.

Of the clusters, electronics has the highest level of dedicated spending to R&D activities (10.7%). Five other clusters invest at levels that meet or exceed the region's average. They include business services (1.7%), education and non-profits (2.7%), FIRE (2.2%), information and communication (7.4%), and manufacturing (2.2%).

Figure 4.6: FRA Cluster Research and Development Spending as Percentage of Total Sales



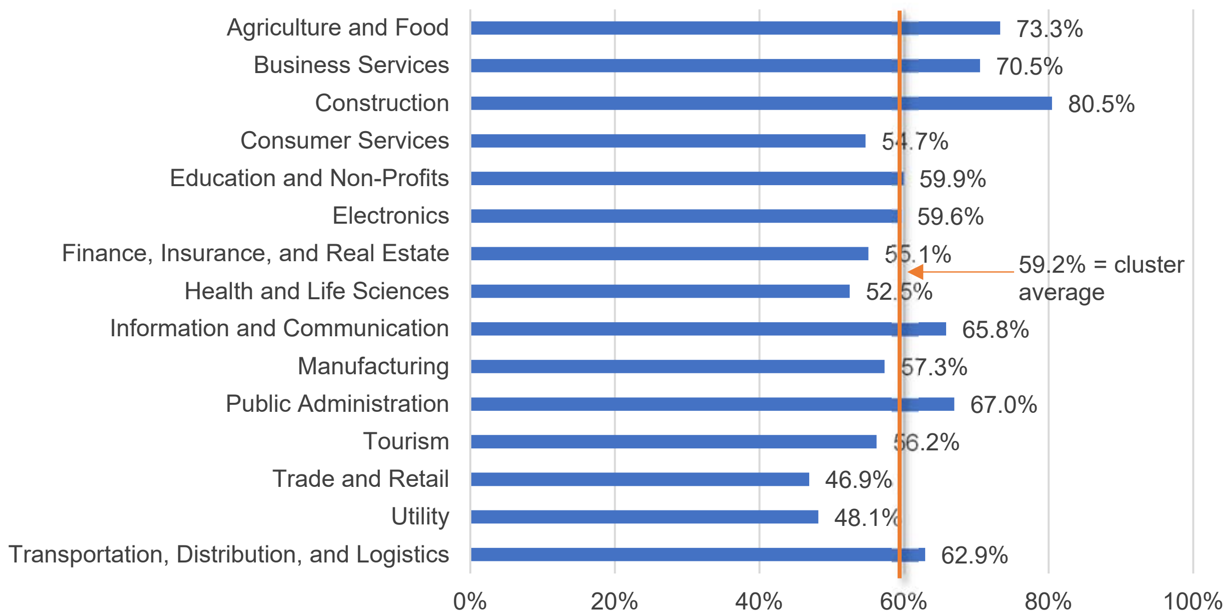
Source: National Science Foundation, Business R&D and Innovation Survey

4.1.5 Entrepreneurship

New business formation is an important indicator of the health of an industry cluster. A high percentage of small firms in a cluster suggests opportunities exist to innovate, collaborate, and leverage the talent base that may have supported larger firms. Small businesses can be significant contributors to job growth and innovation in a community.

A true measure of entrepreneurship would identify those small businesses that are growing at fast rates. Such a measure is not available from government sources. As a proxy, we identified the number of businesses with fewer than 10 employees in each cluster as a percentage of total firms. Fifty-nine percent of all cluster establishments meet this definition in the Fredericksburg Region. The highest percentage of small firms was found in the construction cluster where more than 80% of the firms meet the criterion for small businesses. As shown in Figure 4.7, a high proportion of regional businesses in the agriculture and food (73.3%), and business services (70.5%) clusters also are small businesses.

Figure 4.7: FRA Cluster Small Business (<10 Employees) as a Percentage of Total Firms 2020Q



Source: Chmura's JobsEQ, County Business Patterns, and Virginia Employment Commission

4.2 Ranking of Industry Cluster Targets

The Fredericksburg Regional Alliance has several viable industry clusters in its service area. While all the clusters present potential growth opportunities, some are more suitable targets for economic development efforts based on the region's goals.

4.2.1 Evaluation Model

To help rank and prioritize the clusters, Chmura created an evaluation model that weights each of the seven criteria detailed in the previous section of this report. The Fredericksburg Regional Alliance and its partners have endorsed and adopted the following weighting matrix.

Table 4.2.1 Priority Cluster Selection Criteria

Primary Indicator	Sub-Indicator	Weight
Wealth	*Average Wages*	20%
	Export Activity	20%
Employment Growth	*Job Growth #*	15%
	Forecast Employment Growth Rate	0%
Innovation	*Small Business (<10 employees) as Pct. of Total Firms*	15%
	Research and Development as Pct. of Total Sales	10%
Competitiveness	*Location Quotient*	20%
Total		**100%**

Based on these variable weights, and after discussion and input from the Fredericksburg Regional Alliance staff and stakeholder committee, Chmura recommends prioritizing the clusters in the following order:

1. Information and Communication
2. Public Administration
3. Finance, Insurance, and Real Estate
4. Education and Non-Profits
5. Business Services
6. Manufacturing
7. Electronics
8. Utility
9. Transportation, Distribution, and Logistics
10. Construction
11. Agriculture and Food
12. Health and Life Sciences
13. Consumer Services
14. Tourism
15. Trade and Retail

5. Attributes of Industry Cluster Targets

The following table provides a summary of the evaluated attributes of the industry cluster targets.

Table 5.1 Fredericksburg Region Industry Cluster Matrix Summary, Ranked by Priority

	2020Q1			Forecast 2020-2030 Annual Average Job Growth		R&D 2017	Small Businesses 2017
Cluster	**Location Quotient**	**Average Annual Wages 2020Q1**	**Sales-Export Ratio**	**Rate**	**Absolute Number**	**R&D as Percentage of Total Sales**	**Small Business as a Percentage of All Firms**
Information and Communication	1.07	$71,404	24.3%	1.9%	1,133	7.4%	65.8%
Public Administration	2.20	$99,475	7.1%	0.6%	865	0.3%	67.0%
Finance, Insurance, and Real Estate	1.23	$77,319	22.8%	0.6%	543	2.2%	55.1%
Education and Non-Profits	1.24	$37,696	20.7%	0.7%	1,373	2.7%	59.9%
Business Services	0.72	$56,930	24.9%	1.2%	1,328	1.7%	70.5%
Manufacturing	0.53	$75,430	66.8%	0.5%	234	2.2%	57.3%
Electronics	0.22	$74,929	72.0%	-0.5%	-19	10.7%	59.6%
Utility	1.30	$62,639	27.7%	0.9%	131	0.2%	48.1%
Transportation, Distribution, and Logistics	0.64	$54,286	35.1%	0.5%	328	0.5%	62.9%
Construction	1.01	$50,119	0.3%	1.5%	1,229	0.3%	80.5%
Agriculture and Food	0.29	$27,135	88.5%	0.7%	74	0.5%	73.3%
Health and Life Sciences	0.82	$61,277	5.2%	1.7%	2,352	1.0%	52.5%
Consumer Services	1.13	$25,895	11.8%	1.5%	3,496	0.6%	54.7%
Tourism	0.82	$20,470	39.9%	0.9%	343	0.3%	56.2%
Trade and Retail	1.29	$29,686	12.4%	0.2%	421	0.3%	46.9%

Source: Chmura Economics & Analytics, National Science Foundation, Business R&D Innovation Survey 2017, IMPLAN Pro

5.1 Information and Communications

The information and communications cluster currently employs 5,369 workers in the Fredericksburg Region. The largest industry in the cluster is computer system design and related services, which employs 3,122 highly-paid workers at an annual average wage of $90,961 in the first quarter of 2020. Other industries include activities related to advertising, data processing, and wired and wireless communication carriers.

Wages in this cluster are 43.2% higher than the regional average and the projected growth rate is 1.9% annually over the next ten years, the highest of all clusters. This cluster also has the second-highest rate of research and development spending as a percentage of total sales at 7.4%.

5.2 Public Administration

Public administration has the largest location quotient in the Fredericksburg Region. At 2.20, the region has over twice the employment concentration in public administration compared to the national average. This sector is defined as "establishments of federal, state, and local government agencies that administer, oversee, and manage public programs and have executive, legislative, or judicial authority over other institutions within a given area."[18] These establishments typically organize or produce public goods or services and derive their financial resources from taxes, fees, or other public funding sources.

The largest industry in the cluster is national security and international affairs, which employs 51% of the 13,954 people currently employed in this cluster. Individuals employed in this cluster also command the highest annual wages of all clusters at nearly twice the regional average ($99,475).

5.3 Finance, Insurance, and Real Estate

Insurance carriers make up 59.3% of this sector's total employment in the region with 5,560 workers. It also includes depository and nondepository credit intermediation, security brokerage and other financial investment activities, agencies and brokerages, insurance and employee benefit funds, commercial and real estate activities, and consumer and durable goods leasing.

Total employment in this cluster is 9,383 and average wages for all jobs in the cluster are $77,319 annually, the second highest of all 15 clusters. The cluster is expected to grow at an average rate of 0.6% over the next ten years, slower than the regional average for all industries. The nondepository credit intermediation industry is expected to grow at a faster rate (1.7%).

5.4 Education and Non-Profits

The education and non-profits cluster is one of the larger clusters in total employment, with 18,098 employed workers in the region. This cluster is primarily composed of elementary and secondary schools (63.4% of the cluster's employment). Religious organizations and child day care services make up another 9.2% and 6.7% of the cluster's employment, respectively. This cluster's employment is expected to grow by 1,373 over the next ten years.

5.5 Business Services

The business services cluster includes 17 different industries. As the name suggests, industries in this cluster deliver a variety of professional services to businesses including accounting, software design, consulting, management, office services, employment services, security, and commercial equipment repair.

Total employment in the business services cluster is 10,055 with the majority providing services to businesses and dwellings; management, scientific, and technical consulting services; and management of companies and enterprises. Management of companies and enterprises includes company headquarters.

[18] U.S. Census Bureau, 2017 North American Industrial Classification System

Wages in this cluster average $56,930 and job growth over the next ten years is forecast to be 1.2% annually, slightly faster than the average annual job growth rate for the region (1.0%). A high proportion (70.5%) of establishments in this cluster are small businesses.

5.6 Manufacturing

Manufacturing is one of the smaller clusters, employing 4,627 workers in the region. However, there are 57 industries in the cluster. The average wages are $75,430, and employment is forecast to grow at an average rate of 0.5% over the next ten years.

The largest industry in this cluster is architectural, engineering, and related services (employment 2,411), which are predominantly engineering services, testing laboratories, and surveying and mapping services. These firms provide an important input into the manufacturing process. Other related industries in this cluster include raw material extraction such as logging and mineral quarrying, and value-added manufacturing processes such as sawmills and other wood product manufacturing.

While manufacturing activity in the region is relatively small in scale, it has the potential to grow, especially in technical support areas, to serve a regional, mid-Atlantic market. The reshoring initiatives of the federal government may also lead to growth faster than forecast for this cluster. The cluster's high export-sales ratio (66.8%) offers further evidence of its potential to generate value for the region.

5.7 Electronics

Electronics is the smallest cluster in the region, employing 386 workers. This cluster pays a higher-than-average wage of $74,929. Its high export-to-sales ratio of 72.0% and high proportion of research and development funding as a percentage of total sales (10.7%) are evidence of this cluster's potential to generate wealth in the region.

The two largest industries in this cluster are semiconductor and other electronic component manufacturing (135 employed workers) and electronic and precision equipment repair and maintenance (105). These two industries are key suppliers of the manufacturing and public administration clusters, respectively. While small in scale, electronics has the potential to both bolster the region's supply chain and generate additional wealth for the region.

5.8 Utility

Utility is another small cluster in the region, employing 1,426 workers. It pays an above-average wage of $62,639 and has grown at a faster rate over the past five years than any other cluster (average 5.3% annually). Industries in this cluster include water and sewage systems; electric power generation, transmission, and distribution; and waste management, collection, treatment, and disposal.

5.9 Transportation, Distribution, and Logistics

The transportation, distribution, and logistics cluster employs 6,391 workers in the region at a slightly higher than average annual wage of $54,286. The top two industries in this cluster are general freight trucking and specialized freight trucking, accounting for 21.5% of the cluster's employment at 1,371 workers. Professional and commercial equipment and supplies merchant wholesalers is another large industry in this cluster. It pays nearly double the region's average annual wage at $98,064. Other key wholesaler industries in this cluster include machinery, electronic markets, and motor vehicles.

5.10 Construction

The construction cluster employs 7,853 workers in the region and pays an average wage of $50,119. This cluster is expected to grow an average 1.5% per year for the next ten years—higher than the regional average of 1.0%. Small businesses are prevalent in this clusters. Top industries include building equipment contractors, residential building construction, and building finishing contractors.

5.11 Agriculture and Food

While agriculture and food is one of the smallest clusters in the region at 980 workers and pays a low average wage of $27,135, its potential for wealth generation should not be overlooked. It has a high export-to-sales ratio of 88.5% and a high small business proportion of 73.3% of establishments. The top industries in this cluster include animal production, food manufacturing, beverage manufacturing, crop production, and greenhouse production.

5.12 Health and Life Sciences

Health and life sciences is one of the larger clusters in the region. It employs 13,056 individuals in the region in a variety of industry sectors. The largest is offices of physicians, followed by general medical and surgical hospitals. Non-direct patient care industries in this cluster include medical and diagnostic laboratories and medical equipment and supplies manufacturing. This cluster is expected to expand its employment base by an average annual 1.7% for the next ten years.

Wages in this cluster exceed the regional average, paying $61,277; however, there is a broad range of wages paid by industries within this cluster. The lowest-paid jobs are in retirement and assisted living facilities for the elderly ($29,918). The highest-average annual wages are earned in the offices of physicians ($85,758). Many of the industries in this cluster primarily serve the local market; however, there are opportunities to position the Fredericksburg region as a center for destination medical services and export-oriented life science services, such as medical and diagnostic laboratories.

5.13 Consumer Services

Employment in the consumer services cluster has grown the most over the past five years and is expected to grow the most out of any cluster over the next ten years. With 21,753 employed individuals, it is the largest cluster based on employment. Restaurants and other eating places are the primary industries in this cluster. Despite its proven growth potential, the wealth generation in this cluster is relatively low as wages (average of $25,895[19]) and export-to-sales is low (11.8%). The two industries in this cluster that pay an above-average wage are legal services ($69,157) and other professional, scientific, and technical services ($50,576).

5.14 Tourism

Tourism employs 3,770 workers in the region, mostly in amusement and recreation industries and traveler accommodations. The region also employs 278 workers at museums and historical sites and 217 independent artists, writers, and performers. While Fredericksburg's tourism cluster has a higher wealth generation potential as measured by the export-to-sales ratio (39.9%) compared to consumer services (11.8%), it pays an even lower average annual wage ($20,470).

[19] Part of the reason the wages are low is that many workers are part-time.

5.15 Trade and Retail

The trade and retail cluster mainly serves Fredericksburg Region residents at general stores, grocery stores, automobile dealers, gas stations, department stores, and building material and supplies dealers. This cluster employs 17,784 workers in the region and pays an annual average wage of $29,686. While trade and retail typically does not generate wealth for the region on its own, the location quotient of 1.29 indicates Fredericksburg stores draw in shoppers from outside the region.

6. Industry Cluster Climate-Capability Matrix

6.1 Industry Selection

The Fredericksburg Regional Alliance will have the most success in attracting clusters that have the greatest potential for growth given national and global trends, as measured by the External Climate Index; and in light of the strengths and specialization of the region's industries, as measured by the Capabilities Index. This analysis is performed at the four-digit NAICS code level to identify specific industries in the clusters that should be targeted.

All four-digit industries with employment of at least 100 workers in the Fredericksburg Region were considered for the climate-capability index. One purpose of this analysis is to identify wealth generation industries prime for business attraction. For that reason, non-traded industries that serve only the local market such as waste collection, dentist offices, and dry cleaners are excluded. This resulting list of 77 industries are mapped based on their regional capabilities and national climate.

All clusters identified have varying degrees of potential for growth and promise as targets for economic development. The climate-capability matrix identifies specific industries and helps to incorporate external factors that could influence the long-term viability of industries within their broader cluster.

6.2 Data Collection

Data were compiled from the following sources to analyze the national climate as well as regional capabilities in the Fredericksburg Region:

1. Chmura's JobsEQ software provided past industry and wage growth and industry competitiveness.
2. National output forecasts are from the Bureau of Labor Statistics.
3. Research and development spending by industry are from the National Science Foundation.
4. Venture Capital investment data by industry were purchased from Reuters Refinitiv.
5. National, historical export growth was obtained from the IMPLAN Pro software.
6. Patents were obtained from Patentsview, based on data from the U.S. Patent and Trademark Office (USPTO).
7. Federal contract spending was obtained from Chmura's Federal Spending by Time of Performance (FedSpendTOP) database.[20]

6.3 Index Methodology

An index is created for both the external climate and the Fredericksburg Region's capabilities based on data compiled at the four-digit NAICS level. Both the external climate index and FRA capability index are calculated by first ranking each individual component of those indexes. The index is standardized to be between 1 and 100, with the higher number indicating a more favorable external climate or higher Fredericksburg capabilities. Intersecting those two indexes allows

[20] The FPDS (Federal Procurement Data System) and FSRS (Federal Subaward Reporting System, together USAspending.gov) are the official source of contract award data for federal contracts. However, U.S. Government Accountability Office (GAO) studies have found inaccuracies in the FPDS and have recommended actions to improve the data. In light of these shortcomings, Chmura created processes and proprietary algorithms to improve the accuracy of USAspending.gov. The resulting database, FedSpendTOP (FEDeral SPENDing by Time of Performance), adjusts contract work performed by both time and place. The values of the awards are adjusted by contract length to more accurately depict the value of work performed during contracts spanning multiple fiscal years. FedSpendTOP data also capture the effects of subcontract work being performed in places different from the prime awards.

Chmura to identify industries whose targeting is most likely to result in economic gains for the region. This is due to strong capabilities in the Fredericksburg Region as well as a favorable national and international climate for future growth.

6.4 External Climate, United States

National and global trends provide a more favorable climate for some regional industries than for others and it is important to examine the capacity for growth of Fredericksburg's priority cluster industry targets within this context. The external climate represents a potential environment for growth in both the nation and internationally. The national outlook for growth in industrial output provides a good indicator of the future market for an industry's goods or services. The export growth trend indicates the market potential from global markets. Data on research and development spending show the innovation potential of current industries, while data on value-added and industry multipliers indicate how effective investment in those industries will be in supporting other industries in the nation.

Specifically, the External Climate Index includes:

- Historical export growth (2007 to 2017),
- Projected national output growth (2019 to 2029),
- Research and development spending as a percentage of total sales (2017),
- Industry output multipliers (2020), and
- Federal research and development contract spending (2019).

6.5 Fredericksburg Region Capabilities

The Fredericksburg Region's clusters differ in their positioning to take advantage of a favorable external climate or, conversely, they differ in their ability to compensate for an unfavorable external climate. The relative strengths and weaknesses of the Fredericksburg Region's industry clusters are referred to as "capabilities." As with the eternal climate indicators, the region's capabilities provide measures to evaluate potential industries in terms of economic performance, innovative potential, and value added.

Economic performance considers each cluster's competitiveness relative to the nation and its recent growth based on the assumption that firms in clusters that already perform well in the region are in the best position for continued growth if the external environment is positive. Innovation potential is comprised of leading indicators that point to future development such as research contracts. The industry multiplier, or value added by an industry, identifies the extent to which the industry will create additional income and jobs for other industries in the Fredericksburg Region.

Specifically, the FRA Capabilities Index includes:

- Location quotient (2020),
- Change in location quotient (2010 to 2020),
- Annual average employment growth (2010 to 2020),
- Relative wages (2020),
- Average annual wage growth (2010 to 2020),
- Federal research and development contract spending (2019),
- Patents (2015-2020), and
- Fredericksburg Region's industry multipliers (2020).

Figure 6.5: Fredericksburg Region Climate-Capability Matrix

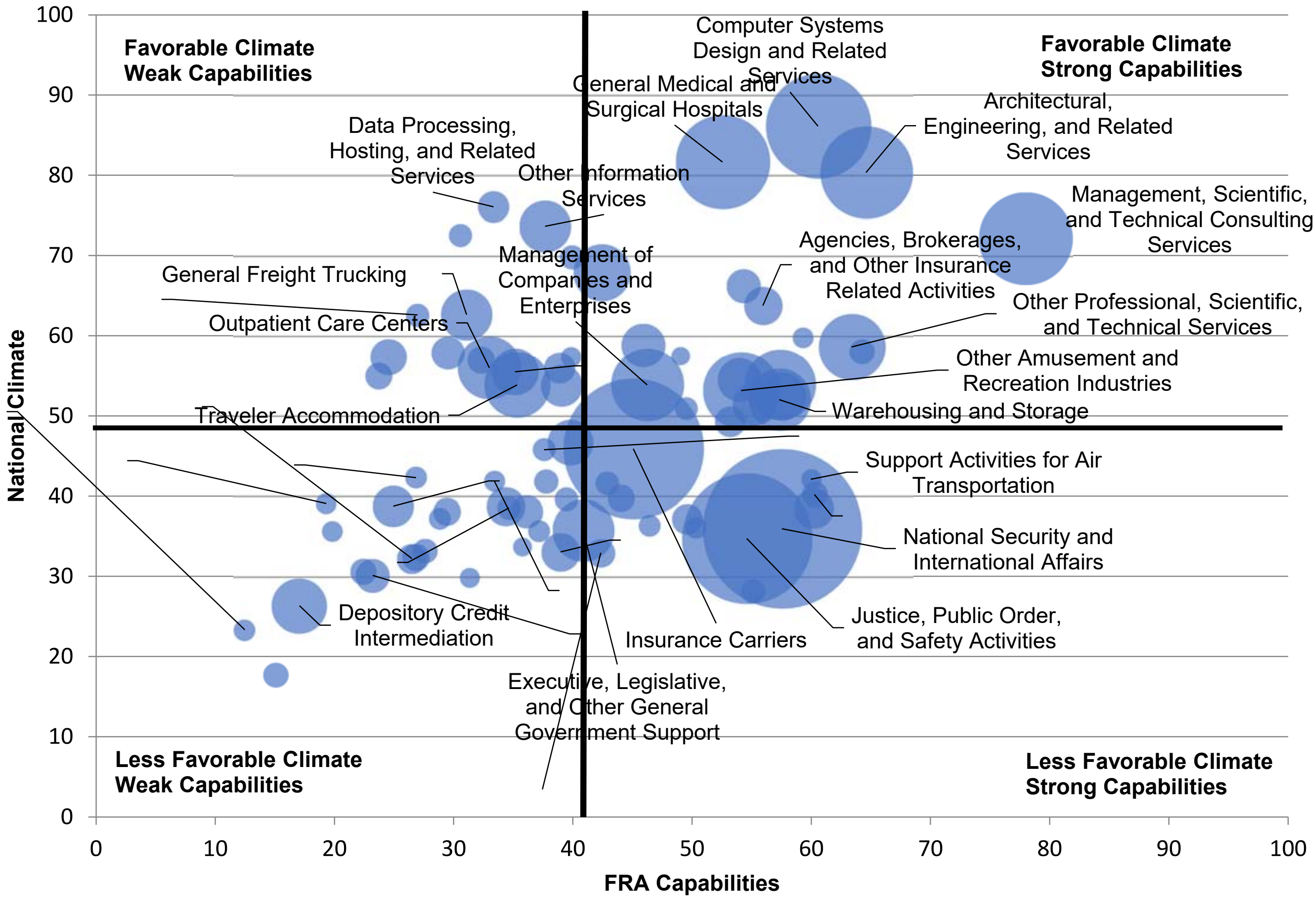


Figure 6.5 shows the relative competitive position for each industry in the priority industry clusters. The size of each industry's circle represents its relative employment. For example, national security and international affairs is the largest circle because its employment (7,295 workers in the Fredericksburg Region) is larger than that of the 76 other industries included in the matrix. Each quadrant is unique, and within each industry there may be individual firms that have capabilities that make them competitive and well-positioned for future growth (or conversely, poorly positioned). The following sections describe general industry trends at the national and regional level for each quadrant and provide guidance for the economic development strategy in the Fredericksburg Region.

6.6 Favorable External Climate – Strong Local Capabilities

Firms in the upper right quadrant of Figure 6.5 have both a favorable external business climate and represent sectors in which the Fredericksburg region has an existing competency. Strategies that target these firms for business attraction and ensure the growth of existing firms are most likely to succeed and have the potential to produce near-term outcomes (job creation and capital investment) for FRA and its partners. This quadrant includes several industries in the business services, education and non-profits, manufacturing, and consumer services clusters. The list below is rank-ordered by industries with the most favorable ranking at the top.

5416 Management, Scientific, and Technical Consulting Services
5415 Computer Systems Design and Related Services
5413 Architectural, Engineering, and Related Services
6221 General Medical and Surgical Hospitals
5231 Securities and Commodity Contracts Intermediation and Brokerage
5419 Other Professional, Scientific, and Technical Services
6114 Business Schools and Computer and Management Training
5242 Agencies, Brokerages, and Other Insurance Related Activities
6115 Technical and Trade Schools
4931 Warehousing and Storage
6113 Colleges, Universities, and Professional Schools
7223 Special Food Services
5613 Employment Services
6112 Junior Colleges
7139 Other Amusement and Recreation Industries
5614 Business Support Services
3399 Other Miscellaneous Manufacturing
6116 Other Schools and Instruction
5616 Investigation and Security Services
3219 Other Wood Product Manufacturing
5511 Management of Companies and Enterprises

6.7 Favorable External Climate – Weak Local Capabilities

Firms in the upper left quadrant of the chart have a favorable national business climate but weak capabilities locally. Firms in this group have the potential to be viable attraction targets as they have exhibited past growth in exports and are projected to increase output over the next ten years. Additionally, these industries have high multipliers, and their attraction could thus have a high leveraged impact on the regional economy.

Locally, these industries have performed relatively weakly. Bolstering the performance of existing firms and ensuring that they have access to the resources they need to be successful in a global marketplace could improve the local capabilities of firms in this quadrant, support growth from within the region, and create a more favorable environment for attracted firms. Despite low current capabilities in the region for these industries, many of them are still well-suited for business attraction. For example, the data processing, hosting, and related services industry often brings a wealth of capital expenditure to a region, and Fredericksburg is well-positioned to expand this industry. Located one hour from the worldwide internet hub in Ashburn and two hours from the transatlantic fiberoptic cable port in Virginia Beach, Fredericksburg offers a cost-efficient and central location for prospective data centers.

This quadrant includes many firms in the health and life sciences; information and communication; transportation, distribution, and logistics; and tourism clusters.

5191 Other Information Services
6223 Specialty (except Psychiatric and Substance Abuse) Hospitals
5182 Data Processing, Hosting, and Related Services
6222 Psychiatric and Substance Abuse Hospitals
3379 Other Furniture Related Product Manufacturing
7121 Museums, Historical Sites, and Similar Institutions
4841 General Freight Trucking
5412 Accounting, Tax Preparation, Bookkeeping, and Payroll Services
4842 Specialized Freight Trucking
3119 Other Food Manufacturing
6219 Other Ambulatory Health Care Services
7211 Traveler Accommodation
6214 Outpatient Care Centers
6215 Medical and Diagnostic Laboratories
5418 Advertising, Public Relations, and Related Services
3231 Printing and Related Support Activities

6.8 Less Favorable External Climate - Weak Local Capabilities

The lower left quadrant of Figure 6.5 contains industries that have less favorable growth prospects due to poor past performance, less than robust national growth projections, or low levels of investment in research and development. Many of these industries also have low multipliers, suggesting that their ripple impact on the regional economy is limited.

Firms in this quadrant could be strategically targeted for economic development purposes; however, they may not present the most viable long-term prospects. Individual firms within this segment could have performance that exceeds their peers in their industry. An attraction strategy should evaluate targets to ensure they have they have a viable business strategy and adequate resources to execute.

Existing firms in this quadrant would benefit from support, possibly to diversify their customer base into more growth-oriented markets or to pursue technological advances that may make them more competitive and profitable.

The transportation, distribution, and logistics cluster dominates industries in this quadrant. The manufacturing; agriculture and food; finance, insurance, and real estate; information and communication; and tourism clusters also have at least two industries in this quadrant.

4234 Professional and Commercial Equipment and Supplies Merchant Wholesalers
3121 Beverage Manufacturing
3273 Cement and Concrete Product Manufacturing
4239 Miscellaneous Durable Goods Merchant Wholesalers
9211 Executive, Legislative, and Other General Government Support
3261 Plastics Product Manufacturing
4921 Couriers and Express Delivery Services
3212 Veneer, Plywood, and Engineered Wood Product Manufacturing

5411 Legal Services
7111 Performing Arts Companies
4251 Wholesale Electronic Markets and Agents and Brokers
4237 Hardware, and Plumbing and Heating Equipment and Supplies Merchant Wholesalers
5321 Automotive Equipment Rental and Leasing
7115 Independent Artists, Writers, and Performers
4249 Miscellaneous Nondurable Goods Merchant Wholesalers
4238 Machinery, Equipment, and Supplies Merchant Wholesalers
4859 Other Transit and Ground Passenger Transportation
4233 Lumber and Other Construction Materials Merchant Wholesalers
4244 Grocery and Related Product Merchant Wholesalers
5173 Wired and Wireless Telecommunications Carriers
5111 Newspaper, Periodical, Book, and Directory Publishers
4248 Beer, Wine, and Distilled Alcoholic Beverage Merchant Wholesalers
4231 Motor Vehicle and Motor Vehicle Parts and Supplies Merchant Wholesalers
2123 Nonmetallic Mineral Mining and Quarrying
5221 Depository Credit Intermediatio`n
1110 Crop Production (Proprietors)
1120 Animal Production (Proprietors)

6.9 Less Favorable External Climate – Strong Local Capabilities

Industries in the lower right quadrant of Figure 7.5 have a relatively strong position locally, but nationally or internationally may be facing significant challenges. Firms in this quadrant are found in the public administration; transportation, distribution, and logistics; finance, insurance, and real estate; and manufacturing clusters.

While the region is currently home to a large number of individuals employed in the public administration cluster and the Fredericksburg area has benefitted from the expansion of federal activities over the past decade, the national climate indicators do not support future growth. Likely scenarios include reduced employment and lower levels of spending in this area as federal employment contracts. An economic development strategy that addresses these realities should include an effective business retention strategy to ensure existing agencies/firms stay in the region. Additionally, cost pressures will likely drive agency consolidations. The Fredericksburg Region is well positioned to capitalize on these conditions, but should acknowledge that the political and fiscal environment in which these firms operate may make this segment volatile in the near-term.

Individual firms within other industries in this quadrant could be appropriate targets for attraction, especially if they are developing new technology or employing innovative processes that will make them more competitive. The region is home to a number of firms in this quadrant, and efforts should be made to ensure they remain viable and stay in the region.

4881 Support Activities for Air Transportation
3211 Sawmills and Wood Preservation
9261 Administration of Economic Program
9281 National Security and International Affairs
5241 Insurance Carriers
9221 Justice, Public Order, and Safety Activities
9231 Administration of Human Resource Programs

3344	Semiconductor and Other Electronic Component Manufacturing
5222	Nondepository Credit Intermediation
4821	Rail Transportation
9241	Administration of Environmental Quality Programs
7112	Spectator Sports
4884	Support Activities for Road Transportation

7. COVID-19 Impact and Recovery

This section analyzes the impact of the COVID-19 pandemic on both employment and gross domestic product (GDP) of the industries in the FRA region, as well as the potential recovery paths for regional industries.

7.1. COVID-19 Impact on FRA Industries

7.1.1. Overall Impact on Regional Industries

Total employment in the Fredericksburg Regional Alliance region was 132,971 as of the first quarter of 2020.[21] Based on the two-digit North American Industry Classification System (NAICS), the largest sector in the region was retail, employing 17,531 workers. The next-largest sectors were healthcare and social assistance (17,196 workers), public administration (14,306 workers), and educational services (12,871). Many residents of the Fredericksburg Region work outside of the region, with a large number traveling north to Fairfax, Arlington, and Washington, D.C.

To estimate the impact of the pandemic on the Fredericksburg Region, Chmura first estimated the potential impact of COVID-19 on the national labor market based on its potential impact on different industry sectors, recent releases of unemployment claims, and the latest news reports of business closures and layoffs. Chmura also classified industries by different levels of exposure to the pandemic based on a study by Moody's Investors Service, which categorizes industries into low, moderate, and high levels of exposure.[22]

After estimating national trends, Chmura incorporated information related to the COVID-19 impact that is specific to the state of Virginia and the Fredericksburg Region. One of the most significant factors in this evaluation is the state "stay-at-home" order and reopening schedules. On March 12, Virginia Governor Ralph Northam declared a State of Emergency to address COVID-19 pandemic.[23] Throughout March, the governor ordered closure of schools and put in restrictions on business and social gatherings. On March 23, Governor Northam issued executive order 53, closing all non-essential businesses.[24] On March 30, Governor Northam issued a statewide "stay-at-home" order, effective until June 10.[25] Under the "stay-at-home" order, only essential services (such as grocery stores and pharmacists) and critical infrastructure such as food supply or healthcare remained in operation. All schools, entertainment, and recreation venues, such as bars/nightclubs; gyms/fitness centers; theaters/performance venues; and amusement parks were to be closed. In the Fredericksburg Region, many of the counties and the city of Fredericksburg declared local states of emergency in response to the pandemic during the month of March. The University of Mary Washington shifted to online instruction on March 16 with the declaration of the local state of emergency.[26] Students were strongly encouraged to return home for the remained of the semester.[27]

As the spread of COVID-19 slowed in May, Virginia started its gradual reopening process. In early May, Governor Northam outlined a three-phase plan to ease restrictions in Virginia. Phase One of reopening for the state began on May 15, with the

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21 This employment number is based on the place of work, not the place of residence. This is un-seasonally adjusted quarterly data with a manual adjustment to unclassified employment.

22 Source: https://www.moodys.com/newsandevents/topics/Coronavirus-Credit-Effects-007054.

23 Source: https://www.governor.virginia.gov/media/governorvirginiagov/governor-of-virginia/pdf/eo/EO-51-Declaration-of-a-State-of-Emergency-Due-to-Novel-Coronavirus-(COVID-19).pdf

24 Source: https://www.governor.virginia.gov/newsroom/all-releases/2020/march/headline-855292-en.html

25 Source: https://www.governor.virginia.gov/media/governorvirginiagov/executive-actions/EO-55-Temporary-Stay-at-Home-Order-Due-to-Novel-Coronavirus-(COVID-19).pdf

26 Source: https://www.umw.edu/advisories/external-advisory/career-center-update-covid-19/

27 Source: https://www.umw.edu/advisories/2020/03/11/covid-19-impact-on-residential-students/

exceptions of localities in Northern Virginia and the city of Richmond.[28] Phase Two of reopening started on June 5 while all localities entered Phase Three of reopening on July 1.[29] In Phase Three, social distancing and teleworking are still recommended, and individuals are required to wear face coverings in indoor public settings. The maximum number of individuals allowed in social gatherings was 250 people. All businesses were told to continue following physical distancing guidelines, frequently clean and sanitize high contact surfaces, and keep enhanced workplace safety measures in place. Restaurant and beverage establishments were required to maintain six feet of distance between tables, fitness centers were permitted to open indoor areas at 75 percent occupancy, and recreation and entertainment venues were permitted to operate at 50 percent occupancy, or a maximum of 1,000 persons.

At the time of this report, Virginia remains in the Phase Three of reopening, and the state government implemented new policies to help communities reopen. On October 8th, Governor Northam announced that $220 million in CARES Act funding would be made available to Virginia's schools, with each district receiving at least $100,000 to help with resources and the statewide recovery process.[30] On October 21st, Governor Northam signed eight new laws to support the state's COVID-19 response, including new protocols with the Board of Health, providing clarity with the Virginia Department of Health with disease outbreak data, and a formal program for the purchase and distribution of personal protective equipment during a public health threat.[31]

As infection rates continued to climb in Virginia, Governor Northam issued executive orders lowering the indoor and outdoor public gathering limit from 250 people to 25 (November) and 10 (December).

Of the above state and local measures, the stay-at-home order had a significant impact on regional employment in the second quarter of 2020, while the phased reopening of businesses facilitated the economic recovery in the third quarter of 2020. However, the uptick in COVID-19 cases as well as the new restrictions are expected to slow the pace of economic growth that occurred in the third quarter.

Table 7.1 summarizes the employment and GDP impact of the COVID-19 pandemic in the FRA region at the two-digit NAICS level. It is estimated that 12,491 jobs based in the region were lost in the second quarter from April to June 2020, equivalent to 9.4% of the regional workforce.[32] This represents an estimated loss of $198.8 million of the regional GDP. It is also estimated that during the month of April, when the stay-at-home order was in effect in Virginia, as many as 14,573 jobs based in the region could have been lost. This is equivalent to 11.0% of the workforce and represents a loss of $73.1 million of GDP for the month of April. The gradual reopening of the economy in May and June and the Paycheck Protection Program (PPP) brought some jobs back, and the average job loss for the second quarter of 2020 remains smaller than the peak job loss in April.

Table 7.1: Estimated Employment and GDP Impact from COVID-19 in the Fredericksburg Region

	Employment Impact (Average April-June Job Losses)	GDP Impact (Cumulative April-June $Million)	Employment Impact (Peak April Job Losses)	GDP Impact (April $Million)
Accommodation and Food Services	-4,254	-$43.1	-5,279	-$17.3
Health Care and Social Assistance	-2,685	-$40.7	-2,983	-$15.8
Retail Trade	-1,590	-$23.2	-1,975	-$9.8

[28] Source: https://www.governor.virginia.gov/newsroom/all-releases/2020/may/headline-856681-en.html
[29] Source: https://www.governor.virginia.gov/newsroom/all-releases/2020/june/headline-858266-en.html
[30] https://www.governor.virginia.gov/newsroom/all-releases/2020/october/headline-860767-en.html
[31] https://www.governor.virginia.gov/newsroom/all-releases/2020/october/headline-860965-en.html
[32] Please note that employment figures in this section slightly differ from what is shown in Chmura's JobsEQ software. Figures in this report are based on a more up-to-date COVID-19 model with region-specific adjustments based on additional qualitative and quantitative research.

Table 7.1: Estimated Employment and GDP Impact from COVID-19 in the Fredericksburg Region

	Employment Impact (Average April-June Job Losses)	GDP Impact (Cumulative April-June $Million)	Employment Impact (Peak April Job Losses)	GDP Impact (April $Million)
Educational Services	-1,464	-$31.0	-1,492	-$10.5
Other Services (except Public Administration)	-918	-$10.0	-1,204	-$4.7
Arts, Entertainment, and Recreation	-754	-$7.8	-785	-$2.6
Public Administration	-435	-$18.5	-126	-$1.4
Manufacturing	-212	-$7.7	-253	-$2.9
Professional, Scientific, and Technical Services	-150	-$4.2	-175	-$1.7
Transportation and Warehousing	-149	-$2.5	-156	-$0.8
Real Estate and Rental and Leasing	-112	-$23.8	-114	-$8.3
Information	-76	-$2.1	-62	-$0.6
Construction	-73	-$1.9	-368	-$3.0
Administrative and Support and Waste Management and Remediation Services	-51	-$0.6	-59	-$0.2
Finance and Insurance	-36	-$1.0	-25	-$0.2
Mining, Quarrying, and Oil and Gas Extraction	-14	-$0.7	-14	-$0.2
Utilities	29	$6.3	32	$2.2
Agriculture, Forestry, Fishing and Hunting	79	$1.9	76	$0.6
Wholesale Trade	125	$4.2	127	$1.4
Management of Companies and Enterprises	130	$4.0	141	$1.5
Unclassified	120	$3.4	120	$1.1
Total	**-12,491**	**-$198.8**	**-14,573**	**-$73.1**

Source: Chmura and JobsEQ by Chmura

The industry impacted the most in terms of employment is accommodation and food services, with an estimated job loss of 4,254 in the second quarter of 2020, or 33% of regional workforce in this industry. Healthcare and social assistance is estimated to have lost 2,685 jobs. Other industries such as retail trade; educational services; and other services (excluding public administration) are estimated to have lost a significant number of jobs.

On the other hand, some industries are expected to see a limited impact or even experience an increase in the employment during the pandemic. For example, utilities; agriculture, forestry, fishing, and hunting; wholesale trade; and management of companies and enterprises are expected to add jobs in this quarter.

7.1.2. Clusters Most Impacted by COVID-19

Chmura also analyzed the impact of COVID-19 on the Fredericksburg Region by cluster. The consumer services cluster was the most impacted, with an estimated job loss of 5,097 in the second quarter of 2020, or 24% of the cluster's employment. The job loss in this cluster accounts for 40% of the total job loss in the Fredericksburg Region. The region's tourism cluster is estimated to have lost over one in three (36%) of its jobs in the second quarter, accounting for 10% of all job losses in the region. Estimated job losses in the education and non-profits cluster (2,153), health and life sciences cluster (1,630), and trade and retail cluster (1,590) are also significant in the region.

Four of the 15 clusters in the Fredericksburg Region are estimated to have modestly gained jobs in the second quarter of 2020. The electronics and agriculture clusters both are estimated to have increased their employment base by 5% over the second quarter, and employment in the utility cluster is similarly estimated to have increased 4% from the first quarter. The transportation, distribution, and logistics cluster has a large employment base, making the net gain of 28 jobs relatively modest (+0.4% from the first quarter). The agriculture and food cluster consists of many industries that are considered essential, which are less impacted by the “stay-at-home” policy. For the transportation and distribution sector, employment rose as consumers increasingly rely on online shopping during the pandemic.

Table 7.2: Impact of COVID-19 by Cluster in the Fredericksburg Region

	Employment Impact (Average April-June Job Losses)	GDP Impact (Cumulative April-June 3 $Million)	Employment Impact (Peak April Job Losses)	GDP Impact (April $Million)
Consumer Services	-5,097	-$50.1	-6,494	-$21.4
Education and Non-Profits	-2,153	-$34.5	-2,182	-$11.7
Health and Life Sciences	-1,630	-$32.5	-1,908	-$13.0
Trade and Retail	-1,590	-$23.2	-1,975	-$9.8
Tourism	-1,240	-$16.4	-1,227	-$5.2
Public Administration	-435	-$18.5	-126	-$1.4
Manufacturing	-244	-$8.5	-275	-$3.0
Finance, Insurance, and Real Estate	-148	-$24.8	-138	-$8.5
Business Services	-113	-$1.5	-123	-$0.6
Construction	-73	-$1.9	-368	-$3.0
Information and Communication	-27	$0.1	-26	$0.1
Electronics	21	$0.7	17	$0.2
Transportation, Distribution, and Logistics	28	$3.1	44	$1.1
Agriculture and Food	42	-$1.1	36	-$0.5
Utility	48	$6.8	53	$2.4

Source: Chmura and JobsEQ by Chmura

7.1.3. Specific Industries Most Impacted by COVID-19

Chmura further analyzed industries at the four-digit NAICS code level that are impacted the most by COVID-19. The 20 most-impacted industries are presented in Table 7.3. In total, the estimated number of jobs lost in the second quarter for these industries reached 10,228, or 81.9% of all jobs lost in the Fredericksburg Region.

Table 7.3: Twenty Industries Impacted Most by COVID-19 in the Fredericksburg Region, Four-Digit NAICS

	Employment Impact (Average April-June Job Losses)	GDP Impact (Cumulative April-June 3 $Million)	Employment Impact (Peak April Job Losses)	GDP Impact (April $Million)
Restaurants and Other Eating Places	-3,426	-$29.2	-4,440	-$12.6
Elementary and Secondary Schools	-1,134	-$23.5	-1,157	-$8.0
Other Amusement and Recreation Industries	-604	-$5.5	-674	-$2.1

Table 7.3: Twenty Industries Impacted Most by COVID-19 in the Fredericksburg Region, Four-Digit NAICS

	Employment Impact (Average April-June Job Losses)	GDP Impact (Cumulative April-June 3 $Million)	Employment Impact (Peak April Job Losses)	GDP Impact (April $Million)
Individual and Family Services	-549	-$4.6	-562	-$1.6
Traveler Accommodation	-509	-$8.9	-463	-$2.7
Child Day Care Services	-417	-$2.7	-423	-$0.9
Personal Care Services	-400	-$5.3	-519	-$2.3
Clothing Stores	-383	-$3.7	-413	-$1.3
Offices of Dentists	-321	-$6.2	-364	-$2.4
Special Food Services	-315	-$4.8	-375	-$1.9
Offices of Physicians	-288	-$8.6	-417	-$4.1
Civic and Social Organizations	-287	-$1.3	-285	-$0.4
Department Stores	-239	-$2.7	-278	-$1.1
Outpatient Care Centers	-225	-$4.5	-276	-$1.8
Offices of Other Health Practitioners	-221	-$4.5	-266	-$1.8
Automobile Dealers	-210	-$6.4	-261	-$2.7
Health and Personal Care Stores	-198	-$3.4	-169	-$1.0
Gasoline Stations	-188	-$2.2	-182	-$0.7
National Security and International Affairs	-158	-$8.3	3	$0.0
Justice, Public Order, and Safety Activities	-155	-$6.7	-50	-$0.7
Top 20 Total	**-10,228**	**-$143.2**	**-11,573**	**-$50.1**
Percent of Top 20 in Region Total	**81.9%**	**72.0%**	**79.4%**	**68.5%**

Source: Chmura and JobsEQ by Chmura

At the four-digit industry level, restaurants are estimated to have lost 3,426 jobs in the second quarter of 2020, or 31% of the regional workforce in that industry. These numbers are consistent with major layoff notices from Virginia Employment Commission. Since March 2020, major restaurant chains like Outback Steakhouse, Carrabba's Italian Grill, Bonefish Grill, and Hooters laid off over one thousand restaurant workers in the Fredericksburg Region.[33]

Outside food services, elementary and secondary schools are estimated to have suffered 1,134 job losses, or 11% of the industry's workforce. Other amusement and recreation industries may have lost 604 jobs, or 43% of its workforce. The top 20 list also includes multiple retail industries, represented by clothing stores, department stores, automobile dealers, health stores, and gas stations. Healthcare and social assistance industries are also prevalent in the top 20, with individual and family services, child day care services, offices of dentists, offices of physicians, outpatient care centers, and offices of other health practitioners all losing hundreds of jobs.

[33] Source: WARN Notices, Virginia Employment Commission. https://www.vec.virginia.gov/warn-notices

7.2. The Fredericksburg Region's Path to Recovery

Chmura conducted research using various studies and industry expert reports to understand the recovery paths for various industries. The development of a vaccine and/or effective treatment for COVID-19 is the determining factors in achieving a full economic recovery. Without a medical breakthrough, social distancing policies will remain in place. Consumers will be cautious about traveling and visiting establishments, such as food service and entertainment venues.

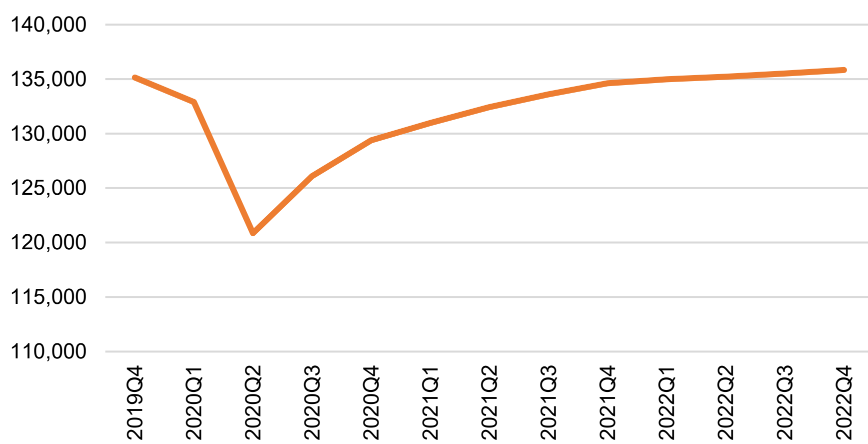
Although many health specialists speculated that the timetable for an effective vaccine would be one to two years,[34] the development of the COVID-19 vaccine was on an accelerated schedule with the federal government investing billions of dollars. The Pfizer and Moderna vaccines received Food and Drug Administration (FDA) approval in December, and high-priority individuals (primarily healthcare workers and nursing home residents) have begun receiving vaccinations. Several additional vaccines are in the final phase of clinical trial in the winter of 2020. Chmura assumes effective vaccines will be widely distributed in the United States in the second quarter of 2021.

Industries will recover at different paces from this COVID-induced recession. Chmura expects construction and manufacturing to be among the first to recover. They require fewer person-to-person interactions, making it easier to maintain social distancing. Outside manufacturing and construction, industries such as finance and insurance and professional and business services, are expected to experience smaller job losses and relatively faster recoveries as they are able to maintain their operations via remote work.[35] Some reports also found that the healthcare industry will enjoy a fast recovery.[36]

7.2.1. Broad Recovery

Employment in other industries, such as hospitality, food service, entertainment, and personal services, will likely be on a slower recovery path. Each of these industries involves close contact with customers. The recovery of the retail industry is in the middle, between those fast-recovering industries like manufacturing and slow-recovering industries like hospitality. Some essential retail such as grocery stores and drug stores are not impacted by the pandemic, but non-essential retail such as clothing or furniture stores will experience a slow recovery.

Figure 7.1: Fredericksburg Region Employment Recovery



Source: Chmura

From the long-term perspective, there will be some permanent changes in national and regional economies in the post-pandemic period. Some studies predict retail industries will be permanently changed. Based on a McKinsey report,[37] the pandemic has accelerated the trend of consumers choosing e-commerce over brick-and-mortar establishments. Some of the behaviors that consumers develop during the pandemic will persist, and this will affect retail

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[34] Source: https://www.cnbc.com/2020/05/20/accelerating-the-timeline-for-covid-19-vaccine-will-take-collaboration.html.

[35] Source: https://www.inquirer.com/business/recovery-economy-zandi-moodys-virus-covid-19-jobs-prediction-20200423.html.

[36] Source: Moody's Analytics. https://www.moodysanalytics.com/-/media/article/2020/this-week-in-covid-crisis-april-19-2020.pdf.

[37] Source: McKinsey.https://www.mckinsey.com/business-functions/organization/our-insights/to-emerge-stronger-from-the-covid-19-crisis-companies-should-start-reskilling-their-workforces-now

and food service businesses after the pandemic is over. During the pandemic, tens of thousands of retail stores and restaurants closed, and many of them will not come back after the pandemic.[38] The stimulus bill passed by Congress and signed by President Trump in the last few days of 2020 may lessen some of these losses.

On the other hand, the McKinsey report indicated there will be some permanent benefits for manufacturing industries with some manufacturing capacity moving back to the United States to be close to the consumer markets. Specifically, the McKinsey report identified automobile and electronic manufacturing as two industries where companies may shift manufacturing operations closer to points of sale. With a well-educated and competitive workforce, the Fredericksburg Region is well-positioned to take advantage of this potential supply chain shift.

Table 7.4: Projected Employment by Industry in the Fredericksburg Region (2020-2022)

	2019Q4-Actual	2020Q2	2020Q4	2021Q2	2021Q4	2022Q2	2022Q4	%Change 2019Q4-2022Q4
Accommodation and Food Services	13,185	8,556	12,249	12,473	12,606	12,689	12,824	-2.7%
Administrative and Support and Waste Management and Remediation Services	5,604	5,423	5,312	5,523	5,649	5,658	5,667	1.1%
Agriculture, Forestry, Fishing and Hunting	650	682	654	652	653	653	654	0.5%
Arts, Entertainment, and Recreation	2,282	1,449	1,622	1,815	2,031	2,172	2,303	0.9%
Construction	8,036	7,645	7,770	8,025	8,149	8,194	8,239	2.5%
Educational Services	13,457	11,408	12,731	13,218	13,524	13,551	13,578	0.9%
Finance and Insurance	7,388	7,619	7,372	7,379	7,414	7,426	7,438	0.7%
Health Care and Social Assistance	17,266	14,511	16,472	16,936	17,520	17,774	18,028	4.4%
Information	1,515	1,366	1,451	1,496	1,520	1,521	1,522	0.5%
Management of Companies and Enterprises	1,499	1,676	1,462	1,487	1,507	1,510	1,513	0.9%
Manufacturing	2,550	2,354	2,461	2,553	2,595	2,588	2,581	1.2%
Mining, Quarrying, and Oil and Gas Extraction	189	180	188	190	190	190	190	0.6%
Other Services (except Public Administration)	7,043	6,028	6,322	6,682	7,043	7,045	7,054	0.1%
Professional, Scientific, and Technical Services	10,801	10,881	10,460	10,686	10,933	10,989	11,046	2.3%
Public Administration	14,042	13,871	14,245	14,245	14,158	14,114	14,070	0.2%
Real Estate and Rental and Leasing	2,041	1,871	1,945	2,010	2,054	2,059	2,064	1.1%
Retail Trade	18,345	15,942	17,482	17,770	17,794	17,803	17,776	-3.1%
Transportation and Warehousing	5,059	4,659	4,872	5,007	5,091	5,098	5,105	0.9%
Unclassified	315	421	513	413	317	317	318	1.0%
Utilities	716	690	711	716	716	716	715	-0.2%
Wholesale Trade	3,072	3,249	2,939	3,027	3,065	3,061	3,058	-0.4%
Total	**135,056**	**120,480**	**129,232**	**132,304**	**134,527**	**135,128**	**135,745**	**0.5%**

Source: Chmura and JobsEQ by Chmura

[38] For example, please see the following articles from the USA Today: https://www.usatoday.com/story/money/2020/07/14/coronavirus-closings-retail-mall-closures-shopping-changes/5400200002/ https://www.usatoday.com/picture-gallery/money/business/2020/08/13/covid-19-closings-35-most-popular-restaurants-not-reopening/3359490001/

Figure 7.1 and Table 7.4 present the projected employment recovery for the Fredericksburg Region from 2020 to 2022. For overall regional employment, the lowest expected level is in the second quarter of 2020, at 89.2% of the pre-pandemic level of the 4th quarter of 2019.[39] Some jobs are expected to be added starting in the third quarter of 2020, led by manufacturing, and healthcare and social assistance. However, the growth of retail and hospitality industries are still expected to be constrained, even as those industries will experience some level of recovery. It is estimated that 35.9% of lost jobs in the region can be recovered in the third quarter. By the fourth quarter of 2020, the region is projected to recover 60.4% of lost jobs, with total employment reaching 129,232. While holiday retail sales data are not yet available, there is currently no sign indicating a sharp reduction this holiday shopping season.[40] By mid-year 2021, the region is projected to recover 81.1% of lost jobs, as other consumer-driven industries including retail, food service, and recreation will be on a path to recovery, with a vaccine becoming available. By the second quarter of 2022, regional employment is expected to reach its pre-pandemic level, and start to grow again. However, even at that time, employment in sectors such as retail and food services is still expected to remain below its pre-pandemic levels, while industries such as healthcare and social assistance, professional, scientific, and technical services, and construction are on an expansionary trajectory.

7.2.2. Recovery by Cluster

Table 7.5 presents the projected employment recovery for the Fredericksburg Region from 2020 to 2022 by cluster. The tourism and consumer services clusters are expected to have the deepest declines from their pre-COVID peaks. The five hardest hit clusters (tourism, consumer services, education and non-profits, trade and retail, and health and life sciences) are all expected to significantly rebound in the second half of 2020. The education and health clusters are projected to reach new peaks in employment in the second half of 2021. Tourism, trade and retail, and consumer services are expected to recover at the slowest pace, not returning to their pre-COVID peak until after 2022.

Table 7.5: Projected Employment by Cluster in the Fredericksburg Region (2020-2022)

	2019Q4-Actual	2020Q2	2020Q4	2021Q2	2021Q4	2022Q2	2022Q4	%Change 2019Q4-2019Q4
Agriculture and Food	932	928	927	925	937	938	939	0.8%
Business Services	9,932	9,788	9,461	9,773	10,009	10,042	10,073	1.4%
Construction	8,036	7,645	7,770	8,025	8,149	8,194	8,239	2.5%
Consumer Services	21,739	16,367	20,289	20,834	21,315	21,431	21,597	-0.7%
Education and Non-Profits	17,585	14,782	16,388	17,083	17,618	17,690	17,765	1.0%
Electronics	401	432	397	402	404	404	404	0.8%
Finance, Insurance, and Real Estate	9,430	9,490	9,317	9,390	9,468	9,485	9,503	0.8%
Health and Life Sciences	13,227	11,428	12,718	13,044	13,454	13,632	13,811	4.4%
Information and Communication	5,229	5,299	5,075	5,195	5,290	5,305	5,319	1.7%
Manufacturing	4,545	4,310	4,418	4,542	4,614	4,619	4,623	1.7%
Public Administration	14,042	13,871	14,245	14,245	14,158	14,114	14,070	0.2%
Tourism	3,533	2,157	2,770	2,991	3,217	3,369	3,519	-0.4%
Trade and Retail	18,345	15,942	17,482	17,770	17,794	17,803	17,776	-3.1%
Transportation, Distribution, and Logistics	6,476	6,355	6,190	6,385	6,488	6,491	6,493	0.3%
Utility	1,285	1,262	1,268	1,285	1,291	1,291	1,290	0.4%
Unclassified	319	425	516	417	321	321	322	1.0%
Total	**135,056**	**120,480**	**129,232**	**132,304**	**134,527**	**135,128**	**135,745**	**0.5%**

Source: Chmura and JobsEQ by Chmura. Note: numbers may not sum due to rounding

[39] Please note that job losses started in March, the first quarter of 2020.
[40] Chmura's projection did not consider such second wave and possible restrictions.

7.2.3. Supply Chain Implications of COVID

The COVID-19 pandemic has highlighted supply chain issues that have resulted from offshoring production to foreign countries in pursuit of lower cost labor or products. Shortages of personal protective equipment, pharmaceuticals, and other products at the beginning of the pandemic is one example. The shortages extend beyond health care with disruptions ranging from food to equipment. Accenture recently reported that "94% of Fortune 1000 companies are seeing supply chain disruptions from COVID-19."

Some analysts predict that the vulnerabilities highlighted during the COVID-19 pandemic will cause manufacturers of all types the increase domestic production and grow employment in the United States. Federal regulations to produce sensitive supplies for defense products in the United States is also requiring some manufacturing to reshore. Specifically, the CHIPS for America Act "establishes investment and incentives to support U.S. semiconductor manufacturing, research and development, and supply chain security." Although not yet law, the bill is said to provide more than $22.8 billion in aid.

Both trends together provide an opportunity for economic developers to highlight the competitive advantage of their regional industries along with their proximity to consumers and businesses that need their products and services.

Although only 1.9% of the Fredericksburg Region's employment is in manufacturing, the three prominent military installations in the region (Fort A.P. Hill, Naval Support Facility Dahlgren, and Quantico) are magnets for expanding firms that benefit from the CHIPS for America Act. Semiconductor and other electronic component manufacturers employed 145 people in the region in the first quarter of 2020. If the Fredericksburg Region labor shed is expanded to a 45-minute drivetime, the attractiveness of the region is much greater. Semiconductor and other electronic component manufacturers employed 1,817 people in the labor shied in the first quarter of 2020.

8. Conclusion

Cluster prioritization in the Fredericksburg region can guide the employment growth, wealth generation, and overall success of the region. While many retailers in the region benefit from its proximity to the nation's capital, many of the region's residents commute north for higher-paying jobs. The attraction of living in the Fredericksburg Region is validated by its population growing an annual average 1.5% over the past 10 years—double that of the state and nation where annual average population increases were both 0.7% over the same period. Population growth in the Fredericksburg Region is forecast to continue to outpace the state and the nation, and it may further accelerate if work-from-home policies enforced during the COVID-recession are maintained after a vaccine is widely distributed.

Employment in the region also outpaced that of the state and the nation over the last ten years. From the first quarter of 2010 through the first quarter of 2020, employment in the Fredericksburg Region increased an annual average 1.7% compared with 0.8% in the state and 1.1% in the nation over the same period. Over the past 10 years, the Fredericksburg economy has added more than 21,000 jobs. The largest sector gains have been in the public administration and health care and social services.

The COVID-19 pandemic looms large in the foreground of this study. It continues to have a profound impact causing social, healthcare, and economic issues throughout the country and the Fredericksburg Region. The region is typically less sensitive to recessions than the state and nation. Such has also been the case in the COVID-led recession that began in February 2020. The pre-COVID seasonally adjusted unemployment rate of 4.1% in February 2020 jumped to 7.8% in June and has since fallen to 5.5% in October.

Chmura rank-ordered target clusters for the region based on several weighted metrics using pre-COVID data. To help rank and prioritize the clusters, Chmura created an evaluation model that weights each of the seven criteria detailed in the table below based on their contribution to wealth, employment growth, innovation, and competitiveness.

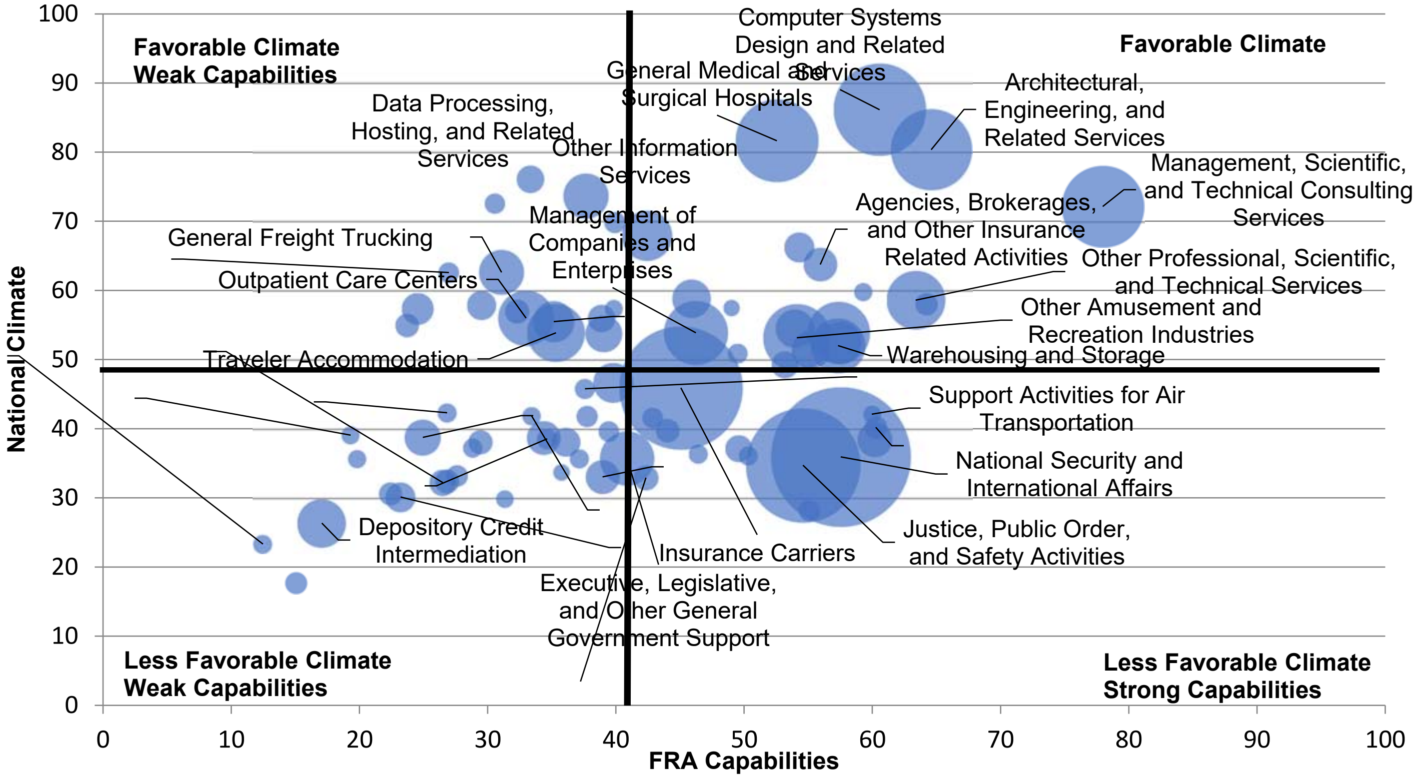
Table 8.1 Fredericksburg Region Industry Cluster Matrix Summary

	2020Q1			Forecast 2020-2030 Annual Average Job Growth		R&D 2017	Small Businesses 2017
Cluster	Location Quotient	Average Annual Wages 2020Q1	Sales-Export Ratio	Rate	Absolute Number	R&D as Percentage of Total Sales	Small Business as a Percentage of All Firms
Information and Communication	1.07	$71,404	24.3%	1.9%	1,133	7.4%	65.8%
Public Administration	2.20	$99,475	7.1%	0.6%	865	0.3%	67.0%
Finance, Insurance, and Real Estate	1.23	$77,319	22.8%	0.6%	543	2.2%	55.1%
Education and Non-Profits	1.24	$37,696	20.7%	0.7%	1,373	2.7%	59.9%
Business Services	0.72	$56,930	24.9%	1.2%	1,328	1.7%	70.5%
Manufacturing	0.53	$75,430	66.8%	0.5%	234	2.2%	57.3%
Electronics	0.22	$74,929	72.0%	-0.5%	-19	10.7%	59.6%
Utility	1.30	$62,639	27.7%	0.9%	131	0.2%	48.1%
Transportation, Distribution, Logistics	0.64	$54,286	35.1%	0.5%	328	0.5%	62.9%
Construction	1.01	$50,119	0.3%	1.5%	1,229	0.3%	80.5%
Agriculture and Food	0.29	$27,135	88.5%	0.7%	74	0.5%	73.3%
Health and Life Sciences	0.82	$61,277	5.2%	1.7%	2,352	1.0%	52.5%
Consumer Services	1.13	$25,895	11.8%	1.5%	3,496	0.6%	54.7%
Tourism	0.82	$20,470	39.9%	0.9%	343	0.3%	56.2%
Trade and Retail	1.29	$29,686	12.4%	0.2%	421	0.3%	46.9%

Source: Chmura Economics & Analytics, National Science Foundation, Business R&D Innovation Survey 2017, IMPLAN Pro

The top three weighed industry clusters for economic development targeting are information and communications; public administration; and finance, insurance, and real estate. The Fredericksburg Regional Alliance will have the most success in attracting clusters that have the greatest potential for growth given favorable national and regional trends, as measured by the External Climate Index and Regional Capabilities Index, respectively. The figure below shows the relative competitive position of each 4-digit North American Industry Classification System (NAICS) codes that was analyzed for this report. The size of each industry's circle represents its relative employment. Each quadrant is unique, and within each industry there may be individual firms that have capabilities that make them competitive and well-positioned for future growth (or conversely, poorly positioned).

Fredericksburg Region Climate-Capability Matrix



The top ten industries with the most favorable external climate and strong local capabilities are:

1. Management, Scientific, and Technical Consulting Services
2. Computer Systems Design and Related Services
3. Architectural, Engineering, and Related Services
4. General Medical and Surgical Hospitals
5. Securities and Commodity Contracts Intermediation and Brokerage
6. Other Professional, Scientific, and Technical Services
7. Business Schools and Computer and Management Training
8. Agencies, Brokerages, and Other Insurance Related Activities
9. Technical and Trade Schools
10. Warehousing and Storage

Appendix

A1. Cluster Definitions

NAICS	Industry	Cluster
1110	Crop Production (Proprietors)	Agriculture and Food
1111	Oilseed and Grain Farming	Agriculture and Food
1112	Vegetable and Melon Farming	Agriculture and Food
1113	Fruit and Tree Nut Farming	Agriculture and Food
1114	Greenhouse, Nursery, and Floriculture Production	Agriculture and Food
1119	Other Crop Farming	Agriculture and Food
1120	Animal Production (Proprietors)	Agriculture and Food
1121	Cattle Ranching and Farming	Agriculture and Food
1129	Other Animal Production	Agriculture and Food
1141	Fishing	Agriculture and Food
1142	Hunting and Trapping	Agriculture and Food
1151	Support Activities for Crop Production	Agriculture and Food
1152	Support Activities for Animal Production	Agriculture and Food
1153	Support Activities for Forestry	Agriculture and Food
3111	Animal Food Manufacturing	Agriculture and Food
3112	Grain and Oilseed Milling	Agriculture and Food
3113	Sugar and Confectionery Product Manufacturing	Agriculture and Food
3114	Fruit and Vegetable Preserving and Specialty Food Manufacturing	Agriculture and Food
3115	Dairy Product Manufacturing	Agriculture and Food
3116	Animal Slaughtering and Processing	Agriculture and Food
3117	Seafood Product Preparation and Packaging	Agriculture and Food
3118	Bakeries and Tortilla Manufacturing	Agriculture and Food
3119	Other Food Manufacturing	Agriculture and Food
3121	Beverage Manufacturing	Agriculture and Food
3253	Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	Agriculture and Food
5412	Accounting, Tax Preparation, Bookkeeping, and Payroll Services	Business Services
5414	Specialized Design Services	Business Services
5416	Management, Scientific, and Technical Consulting Services	Business Services
5417	Scientific Research and Development Services	Business Services
5511	Management of Companies and Enterprises	Business Services
5611	Office Administrative Services	Business Services
5612	Facilities Support Services	Business Services
5613	Employment Services	Business Services
5614	Business Support Services	Business Services
5616	Investigation and Security Services	Business Services

NAICS	Industry	Cluster
1110	Crop Production (Proprietors)	Agriculture and Food
1111	Oilseed and Grain Farming	Agriculture and Food
1112	Vegetable and Melon Farming	Agriculture and Food
1113	Fruit and Tree Nut Farming	Agriculture and Food
1114	Greenhouse, Nursery, and Floriculture Production	Agriculture and Food
1119	Other Crop Farming	Agriculture and Food
1120	Animal Production (Proprietors)	Agriculture and Food
1121	Cattle Ranching and Farming	Agriculture and Food
1129	Other Animal Production	Agriculture and Food
1141	Fishing	Agriculture and Food
5617	Services to Buildings and Dwellings	Business Services
5619	Other Support Services	Business Services
7113	Promoters of Performing Arts, Sports, and Similar Events	Business Services
7114	Agents and Managers for Artists, Athletes, Entertainers, and Other Public Figures	Business Services
8113	Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance	Business Services
8114	Personal and Household Goods Repair and Maintenance	Business Services
7213	Rooming and Boarding Houses	Business Services
2361	Residential Building Construction	Construction
2362	Nonresidential Building Construction	Construction
2371	Utility System Construction	Construction
2372	Land Subdivision	Construction
2373	Highway, Street, and Bridge Construction	Construction
2379	Other Heavy and Civil Engineering Construction	Construction
2381	Foundation, Structure, and Building Exterior Contractors	Construction
2382	Building Equipment Contractors	Construction
2383	Building Finishing Contractors	Construction
2389	Other Specialty Trade Contractors	Construction
4931	Warehousing and Storage	Consumer Services
5411	Legal Services	Consumer Services
5419	Other Professional, Scientific, and Technical Services	Consumer Services
6241	Individual and Family Services	Consumer Services
6242	Community Food and Housing, and Emergency and Other Relief Services	Consumer Services
6243	Vocational Rehabilitation Services	Consumer Services
7223	Special Food Services	Consumer Services
7224	Drinking Places (Alcoholic Beverages)	Consumer Services
7225	Restaurants and Other Eating Places	Consumer Services
8111	Automotive Repair and Maintenance	Consumer Services
8121	Personal Care Services	Consumer Services
8122	Death Care Services	Consumer Services

NAICS	Industry	Cluster
1110	Crop Production (Proprietors)	Agriculture and Food
1111	Oilseed and Grain Farming	Agriculture and Food
1112	Vegetable and Melon Farming	Agriculture and Food
1113	Fruit and Tree Nut Farming	Agriculture and Food
1114	Greenhouse, Nursery, and Floriculture Production	Agriculture and Food
1119	Other Crop Farming	Agriculture and Food
1120	Animal Production (Proprietors)	Agriculture and Food
1121	Cattle Ranching and Farming	Agriculture and Food
1129	Other Animal Production	Agriculture and Food
1141	Fishing	Agriculture and Food
8123	Drycleaning and Laundry Services	Consumer Services
8129	Other Personal Services	Consumer Services
8141	Private Households	Consumer Services
6111	Elementary and Secondary Schools	Education and Non-Profits
6112	Junior Colleges	Education and Non-Profits
6113	Colleges, Universities, and Professional Schools	Education and Non-Profits
6114	Business Schools and Computer and Management Training	Education and Non-Profits
6115	Technical and Trade Schools	Education and Non-Profits
6116	Other Schools and Instruction	Education and Non-Profits
6117	Educational Support Services	Education and Non-Profits
6244	Child Day Care Services	Education and Non-Profits
8131	Religious Organizations	Education and Non-Profits
8132	Grantmaking and Giving Services	Education and Non-Profits
8133	Social Advocacy Organizations	Education and Non-Profits
8134	Civic and Social Organizations	Education and Non-Profits
8139	Business, Professional, Labor, Political, and Similar Organizations	Education and Non-Profits
3341	Computer and Peripheral Equipment Manufacturing	Electronics
3342	Communications Equipment Manufacturing	Electronics
3343	Audio and Video Equipment Manufacturing	Electronics
3344	Semiconductor and Other Electronic Component Manufacturing	Electronics
3345	Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	Electronics
3346	Manufacturing and Reproducing Magnetic and Optical Media	Electronics
3351	Electric Lighting Equipment Manufacturing	Electronics
3352	Household Appliance Manufacturing	Electronics
3353	Electrical Equipment Manufacturing	Electronics
3359	Other Electrical Equipment and Component Manufacturing	Electronics
5112	Software Publishers	Electronics
8112	Electronic and Precision Equipment Repair and Maintenance	Electronics
5221	Depository Credit Intermediation	Finance, Insurance, and Real Estate

NAICS	Industry	Cluster
1110	Crop Production (Proprietors)	Agriculture and Food
1111	Oilseed and Grain Farming	Agriculture and Food
1112	Vegetable and Melon Farming	Agriculture and Food
1113	Fruit and Tree Nut Farming	Agriculture and Food
1114	Greenhouse, Nursery, and Floriculture Production	Agriculture and Food
1119	Other Crop Farming	Agriculture and Food
1120	Animal Production (Proprietors)	Agriculture and Food
1121	Cattle Ranching and Farming	Agriculture and Food
1129	Other Animal Production	Agriculture and Food
1141	Fishing	Agriculture and Food
5222	Nondepository Credit Intermediation	Finance, Insurance, and Real Estate
5223	Activities Related to Credit Intermediation	Finance, Insurance, and Real Estate
5231	Securities and Commodity Contracts Intermediation and Brokerage	Finance, Insurance, and Real Estate
5239	Other Financial Investment Activities	Finance, Insurance, and Real Estate
5241	Insurance Carriers	Finance, Insurance, and Real Estate
5242	Agencies, Brokerages, and Other Insurance Related Activities	Finance, Insurance, and Real Estate
5311	Lessors of Real Estate	Finance, Insurance, and Real Estate
5312	Offices of Real Estate Agents and Brokers	Finance, Insurance, and Real Estate
5313	Activities Related to Real Estate	Finance, Insurance, and Real Estate
5321	Automotive Equipment Rental and Leasing	Finance, Insurance, and Real Estate
5322	Consumer Goods Rental	Finance, Insurance, and Real Estate
5323	General Rental Centers	Finance, Insurance, and Real Estate
5324	Commercial and Industrial Machinery and Equipment Rental and Leasing	Finance, Insurance, and Real Estate
5331	Lessors of Nonfinancial Intangible Assets (except Copyrighted Works)	Finance, Insurance, and Real Estate
1133	Logging	Manufacturing
2111	Oil and Gas Extraction	Manufacturing
2123	Nonmetallic Mineral Mining and Quarrying	Manufacturing
2131	Support Activities for Mining	Manufacturing
3141	Textile Furnishings Mills	Manufacturing
3149	Other Textile Product Mills	Manufacturing
3152	Cut and Sew Apparel Manufacturing	Manufacturing
3159	Apparel Accessories and Other Apparel Manufacturing	Manufacturing
3169	Other Leather and Allied Product Manufacturing	Manufacturing
3211	Sawmills and Wood Preservation	Manufacturing
3212	Veneer, Plywood, and Engineered Wood Product Manufacturing	Manufacturing
3219	Other Wood Product Manufacturing	Manufacturing
3222	Converted Paper Product Manufacturing	Manufacturing
3241	Petroleum and Coal Products Manufacturing	Manufacturing
3252	Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments Manufacturing	Manufacturing

NAICS	Industry	Cluster
1110	Crop Production (Proprietors)	Agriculture and Food
1111	Oilseed and Grain Farming	Agriculture and Food
1112	Vegetable and Melon Farming	Agriculture and Food
1113	Fruit and Tree Nut Farming	Agriculture and Food
1114	Greenhouse, Nursery, and Floriculture Production	Agriculture and Food
1119	Other Crop Farming	Agriculture and Food
1120	Animal Production (Proprietors)	Agriculture and Food
1121	Cattle Ranching and Farming	Agriculture and Food
1129	Other Animal Production	Agriculture and Food
1141	Fishing	Agriculture and Food
3256	Soap, Cleaning Compound, and Toilet Preparation Manufacturing	Manufacturing
3261	Plastics Product Manufacturing	Manufacturing
3271	Clay Product and Refractory Manufacturing	Manufacturing
3273	Cement and Concrete Product Manufacturing	Manufacturing
3274	Lime and Gypsum Product Manufacturing	Manufacturing
3279	Other Nonmetallic Mineral Product Manufacturing	Manufacturing
3323	Architectural and Structural Metals Manufacturing	Manufacturing
3324	Boiler, Tank, and Shipping Container Manufacturing	Manufacturing
3325	Hardware Manufacturing	Manufacturing
3326	Spring and Wire Product Manufacturing	Manufacturing
3327	Machine Shops; Turned Product; and Screw, Nut, and Bolt Manufacturing	Manufacturing
3328	Coating, Engraving, Heat Treating, and Allied Activities	Manufacturing
3329	Other Fabricated Metal Product Manufacturing	Manufacturing
3331	Agriculture, Construction, and Mining Machinery Manufacturing	Manufacturing
3332	Industrial Machinery Manufacturing	Manufacturing
3333	Commercial and Service Industry Machinery Manufacturing	Manufacturing
3339	Other General Purpose Machinery Manufacturing	Manufacturing
3363	Motor Vehicle Parts Manufacturing	Manufacturing
3371	Household and Institutional Furniture and Kitchen Cabinet Manufacturing	Manufacturing
3372	Office Furniture (including Fixtures) Manufacturing	Manufacturing
3399	Other Miscellaneous Manufacturing	Manufacturing
4821	Rail Transportation	Manufacturing
5413	Architectural, Engineering, and Related Services	Manufacturing
3364	Aerospace Product and Parts Manufacturing	Manufacturing
3251	Basic Chemical Manufacturing	Manufacturing
3322	Cutlery and Handtool Manufacturing	Manufacturing
1132	Forest Nurseries and Gathering of Forest Products	Manufacturing
3315	Foundries	Manufacturing
3272	Glass and Glass Product Manufacturing	Manufacturing
3161	Leather and Hide Tanning and Finishing	Manufacturing

NAICS	Industry	Cluster
1110	Crop Production (Proprietors)	Agriculture and Food
1111	Oilseed and Grain Farming	Agriculture and Food
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1121	Cattle Ranching and Farming	Agriculture and Food
1129	Other Animal Production	Agriculture and Food
1141	Fishing	Agriculture and Food
3335	Metalworking Machinery Manufacturing	Manufacturing
3362	Motor Vehicle Body and Trailer Manufacturing	Manufacturing
3314	Nonferrous Metal (except Aluminum) Production and Processing	Manufacturing
3259	Other Chemical Product and Preparation Manufacturing	Manufacturing
3379	Other Furniture Related Product Manufacturing	Manufacturing
3369	Other Transportation Equipment Manufacturing	Manufacturing
3255	Paint, Coating, and Adhesive Manufacturing	Manufacturing
3254	Pharmaceutical and Medicine Manufacturing	Manufacturing
3366	Ship and Boat Building	Manufacturing
3133	Textile and Fabric Finishing and Fabric Coating Mills	Manufacturing
1131	Timber Tract Operations	Manufacturing
3334	Ventilation, Heating, Air-Conditioning, and Commercial Refrigeration Equipment Manufacturing	Manufacturing
9211	Executive, Legislative, and Other General Government Support	Public Administration
9221	Justice, Public Order, and Safety Activities	Public Administration
9231	Administration of Human Resource Programs	Public Administration
9241	Administration of Environmental Quality Programs	Public Administration
9251	Administration of Housing Programs, Urban Planning, and Community Development	Public Administration
9261	Administration of Economic Program	Public Administration
9281	National Security and International Affairs	Public Administration
3391	Medical Equipment and Supplies Manufacturing	Health and Life Sciences
6211	Offices of Physicians	Health and Life Sciences
6212	Offices of Dentists	Health and Life Sciences
6213	Offices of Other Health Practitioners	Health and Life Sciences
6214	Outpatient Care Centers	Health and Life Sciences
6215	Medical and Diagnostic Laboratories	Health and Life Sciences
6216	Home Health Care Services	Health and Life Sciences
6219	Other Ambulatory Health Care Services	Health and Life Sciences
6221	General Medical and Surgical Hospitals	Health and Life Sciences
6222	Psychiatric and Substance Abuse Hospitals	Health and Life Sciences

NAICS	Industry	Cluster
1110	Crop Production (Proprietors)	Agriculture and Food
1111	Oilseed and Grain Farming	Agriculture and Food
1112	Vegetable and Melon Farming	Agriculture and Food
1113	Fruit and Tree Nut Farming	Agriculture and Food
1114	Greenhouse, Nursery, and Floriculture Production	Agriculture and Food
1119	Other Crop Farming	Agriculture and Food
1120	Animal Production (Proprietors)	Agriculture and Food
1121	Cattle Ranching and Farming	Agriculture and Food
1129	Other Animal Production	Agriculture and Food
1141	Fishing	Agriculture and Food
6223	Specialty (except Psychiatric and Substance Abuse) Hospitals	Health and Life Sciences
6231	Nursing Care Facilities (Skilled Nursing Facilities)	Health and Life Sciences
6232	Residential Intellectual and Developmental Disability, Mental Health, and Substance Abuse Facilities	Health and Life Sciences
6233	Continuing Care Retirement Communities and Assisted Living Facilities for the Elderly	Health and Life Sciences
6239	Other Residential Care Facilities	Health and Life Sciences
3231	Printing and Related Support Activities	Information and Communication
5111	Newspaper, Periodical, Book, and Directory Publishers	Information and Communication
5121	Motion Picture and Video Industries	Information and Communication
5122	Sound Recording Industries	Information and Communication
5151	Radio and Television Broadcasting	Information and Communication
5152	Cable and Other Subscription Programming	Information and Communication
5173	Wired and Wireless Telecommunications Carriers	Information and Communication
5174	Satellite Telecommunications	Information and Communication
5179	Other Telecommunications	Information and Communication
5182	Data Processing, Hosting, and Related Services	Information and Communication
5191	Other Information Services	Information and Communication
5415	Computer Systems Design and Related Services	Information and Communication
5418	Advertising, Public Relations, and Related Services	Information and Communication
5615	Travel Arrangement and Reservation Services	Tourism
7111	Performing Arts Companies	Tourism
7112	Spectator Sports	Tourism
7115	Independent Artists, Writers, and Performers	Tourism
7121	Museums, Historical Sites, and Similar Institutions	Tourism
7131	Amusement Parks and Arcades	Tourism
7132	Gambling Industries	Tourism
7139	Other Amusement and Recreation Industries	Tourism
7211	Traveler Accommodation	Tourism
7212	RV (Recreational Vehicle) Parks and Recreational Camps	Tourism
4411	Automobile Dealers	Trade and Retail

NAICS	Industry	Cluster
1110	Crop Production (Proprietors)	Agriculture and Food
1111	Oilseed and Grain Farming	Agriculture and Food
1112	Vegetable and Melon Farming	Agriculture and Food
1113	Fruit and Tree Nut Farming	Agriculture and Food
1114	Greenhouse, Nursery, and Floriculture Production	Agriculture and Food
1119	Other Crop Farming	Agriculture and Food
1120	Animal Production (Proprietors)	Agriculture and Food
1121	Cattle Ranching and Farming	Agriculture and Food
1129	Other Animal Production	Agriculture and Food
1141	Fishing	Agriculture and Food
4412	Other Motor Vehicle Dealers	Trade and Retail
4413	Automotive Parts, Accessories, and Tire Stores	Trade and Retail
4421	Furniture Stores	Trade and Retail
4422	Home Furnishings Stores	Trade and Retail
4431	Electronics and Appliance Stores	Trade and Retail
4441	Building Material and Supplies Dealers	Trade and Retail
4442	Lawn and Garden Equipment and Supplies Stores	Trade and Retail
4451	Grocery Stores	Trade and Retail
4452	Specialty Food Stores	Trade and Retail
4453	Beer, Wine, and Liquor Stores	Trade and Retail
4461	Health and Personal Care Stores	Trade and Retail
4471	Gasoline Stations	Trade and Retail
4481	Clothing Stores	Trade and Retail
4482	Shoe Stores	Trade and Retail
4483	Jewelry, Luggage, and Leather Goods Stores	Trade and Retail
4511	Sporting Goods, Hobby, and Musical Instrument Stores	Trade and Retail
4512	Book Stores and News Dealers	Trade and Retail
4522	Department Stores	Trade and Retail
4523	General Merchandise Stores, including Warehouse Clubs and Supercenters	Trade and Retail
4531	Florists	Trade and Retail
4532	Office Supplies, Stationery, and Gift Stores	Trade and Retail
4533	Used Merchandise Stores	Trade and Retail
4539	Other Miscellaneous Store Retailers	Trade and Retail
4541	Electronic Shopping and Mail-Order Houses	Trade and Retail
4542	Vending Machine Operators	Trade and Retail
4543	Direct Selling Establishments	Trade and Retail
4811	Scheduled Air Transportation	Transportation, Distribution, and Logistics
4812	Nonscheduled Air Transportation	Transportation, Distribution, and Logistics

NAICS	Industry	Cluster
1110	Crop Production (Proprietors)	Agriculture and Food
1111	Oilseed and Grain Farming	Agriculture and Food
1112	Vegetable and Melon Farming	Agriculture and Food
1113	Fruit and Tree Nut Farming	Agriculture and Food
1114	Greenhouse, Nursery, and Floriculture Production	Agriculture and Food
1119	Other Crop Farming	Agriculture and Food
1120	Animal Production (Proprietors)	Agriculture and Food
1121	Cattle Ranching and Farming	Agriculture and Food
1129	Other Animal Production	Agriculture and Food
1141	Fishing	Agriculture and Food
4831	Deep Sea, Coastal, and Great Lakes Water Transportation	Transportation, Distribution, and Logistics
4841	General Freight Trucking	Transportation, Distribution, and Logistics
4842	Specialized Freight Trucking	Transportation, Distribution, and Logistics
4851	Urban Transit Systems	Transportation, Distribution, and Logistics
4853	Taxi and Limousine Service	Transportation, Distribution, and Logistics
4854	School and Employee Bus Transportation	Transportation, Distribution, and Logistics
4855	Charter Bus Industry	Transportation, Distribution, and Logistics
4859	Other Transit and Ground Passenger Transportation	Transportation, Distribution, and Logistics
4871	Scenic and Sightseeing Transportation, Land	Transportation, Distribution, and Logistics
4872	Scenic and Sightseeing Transportation, Water	Transportation, Distribution, and Logistics
4881	Support Activities for Air Transportation	Transportation, Distribution, and Logistics
4882	Support Activities for Rail Transportation	Transportation, Distribution, and Logistics
4883	Support Activities for Water Transportation	Transportation, Distribution, and Logistics
4884	Support Activities for Road Transportation	Transportation, Distribution, and Logistics
4885	Freight Transportation Arrangement	Transportation, Distribution, and Logistics
4889	Other Support Activities for Transportation	Transportation, Distribution, and Logistics
4911	Postal Service	Transportation, Distribution, and Logistics
4921	Couriers and Express Delivery Services	Transportation, Distribution, and Logistics
4922	Local Messengers and Local Delivery	Transportation, Distribution, and Logistics
4231	Motor Vehicle and Motor Vehicle Parts and Supplies Merchant Wholesalers	Transportation, Distribution, and Logistics
4232	Furniture and Home Furnishing Merchant Wholesalers	Transportation, Distribution, and Logistics

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1121	Cattle Ranching and Farming	Agriculture and Food
1129	Other Animal Production	Agriculture and Food
1141	Fishing	Agriculture and Food
4233	Lumber and Other Construction Materials Merchant Wholesalers	Transportation, Distribution, and Logistics
4234	Professional and Commercial Equipment and Supplies Merchant Wholesalers	Transportation, Distribution, and Logistics
4235	Metal and Mineral (except Petroleum) Merchant Wholesalers	Transportation, Distribution, and Logistics
4236	Household Appliances and Electrical and Electronic Goods Merchant Wholesalers	Transportation, Distribution, and Logistics
4237	Hardware, and Plumbing and Heating Equipment and Supplies Merchant Wholesalers	Transportation, Distribution, and Logistics
4238	Machinery, Equipment, and Supplies Merchant Wholesalers	Transportation, Distribution, and Logistics
4239	Miscellaneous Durable Goods Merchant Wholesalers	Transportation, Distribution, and Logistics
4241	Paper and Paper Product Merchant Wholesalers	Transportation, Distribution, and Logistics
4242	Drugs and Druggists' Sundries Merchant Wholesalers	Transportation, Distribution, and Logistics
4243	Apparel, Piece Goods, and Notions Merchant Wholesalers	Transportation, Distribution, and Logistics
4244	Grocery and Related Product Merchant Wholesalers	Transportation, Distribution, and Logistics
4245	Farm Product Raw Material Merchant Wholesalers	Transportation, Distribution, and Logistics
4246	Chemical and Allied Products Merchant Wholesalers	Transportation, Distribution, and Logistics
4247	Petroleum and Petroleum Products Merchant Wholesalers	Transportation, Distribution, and Logistics
4248	Beer, Wine, and Distilled Alcoholic Beverage Merchant Wholesalers	Transportation, Distribution, and Logistics
4249	Miscellaneous Nondurable Goods Merchant Wholesalers	Transportation, Distribution, and Logistics
4251	Wholesale Electronic Markets and Agents and Brokers	Transportation, Distribution, and Logistics
2211	Electric Power Generation, Transmission and Distribution	Utility
2212	Natural Gas Distribution	Utility
2213	Water, Sewage and Other Systems	Utility
5621	Waste Collection	Utility
5622	Waste Treatment and Disposal	Utility
5629	Remediation and Other Waste Management Services	Utility