

# TRACKING INNOVATION

North Carolina Innovation Index

December 2019



# North Carolina Innovation Index 2019

# TRACKING INNOVATION



**NC DEPARTMENT**  
**of COMMERCE**  
SCIENCE, TECHNOLOGY  
& INNOVATION

North Carolina Department of Commerce  
Office of Science, Technology & Innovation

[nccommerce.com/sti](http://nccommerce.com/sti)

*On the Cover: Conceptual chart based on level of employment, growth, & concentration for various industries.  
See indicator 6.4 for North Carolina charts.*



ROY COOPER  
*Governor*

ANTHONY M. COPELAND  
*Secretary*

DR. JOHN HARDIN  
*Executive Director*

December 20, 2019

To the Citizens of North Carolina,

It is our pleasure to share with you the 2019 *Tracking Innovation* report, produced by the North Carolina Board of Science, Technology & Innovation. This periodic report tracks North Carolina's performance in the innovation economy across 40 measures and compares them to national trends. We are pleased to announce that North Carolina's national rank has improved, based on an assessment of all of the measures taken as a whole.

Innovation is a critical force multiplier that raises the standard of living of our citizens. It is also an accelerator that helps create new industries, keep existing ones globally competitive, and drive future economic growth and well-being. North Carolina's ability to thrive in an increasingly dynamic, global economy depends, fundamentally, on how much it infuses innovation throughout our citizens and this great state.

A detailed analysis of the data in previous *Tracking Innovation* reports found that leading states for output and compensation are strongly linked to high levels of the following three key innovation-related factors:

- Post-secondary educational attainment,
- Proportion of workers in science, engineering and technology establishments, and
- Proportion of workers in science and engineering occupations across the economy.

North Carolina should continue to boost these three factors to further drive its future economic gains and prosperity. As shown in this 2019 report, North Carolina has the raw materials to continue to do just that.

North Carolina has the 12<sup>th</sup> largest economy in the United States and the 22<sup>nd</sup> largest in the world. One of our strongest sources of innovation is our universities, which excel at research & development, generate significant intellectual capital, facilitate the creation of startup companies, and produce a well-educated and well-trained science & engineering workforce. North Carolina also has one of the fastest growing populations in the country, and the average years of education of its newest residents is above the U.S. average. Moreover, its science, engineering and technology enterprises are doing well, increasing in employment, and have wages well above the U.S. average for all establishments.

These strengths are not enough, however. To continue to increase the level of prosperity throughout the state, a larger share of the state's economy must transition to include and drive innovation. As this report illustrates, this transition will happen only if a broader cross section of the state's population has the education, training, resources, and infrastructure needed to start, grow, attract, participate in, and sustain companies and organizations that are innovative, entrepreneurial, and able to compete with the best in the world.

This report is, therefore, a call to action. North Carolina is known around the world for the farsighted investments that it has made in the past in support of its innovation-based future. We must continue to be vigilant and proactive about our investments in the innovation economy. Our future success will be determined by what we do now—the quality of our vision, how we invest, how we prioritize, and how we respond to the challenges of an evolving economy.

This report highlights key trends and themes that should be considered when undertaking these efforts, with the goal of generating informed decision making among North Carolina's policymakers, industries, academic institutions, and citizens.

We invite you to read the report and join in efforts to advance our state's innovation-based economy.

Anthony M. Copeland  
*Secretary, N.C. Department of Commerce*  
*Member, N.C. Board of Science, Technology & Innovation*

Michael R. Cunningham  
*Chair, N.C. Board of Science, Technology & Innovation*

## Overview

Innovation fuels the knowledge-based economy. A force multiplier, it creates new industries, makes existing ones globally competitive, and sustains economic growth. With this report, the seventh in a series of innovation indexes that began with *Tracking Innovation 2000*,<sup>1</sup> North Carolina is one of a handful of states that regularly monitor innovation assets, activities, and trends within their borders.

This 2019 report, the most extensive since the series' inception, measures the health of North Carolina's innovation economy. It tracks North Carolina's performance across 40 innovation measures weighed against that of the United States overall, six key comparison states (California, Massachusetts, Georgia, Virginia, Colorado, Washington), and leading 20 countries. These measures provide insights into the links between innovation, resources, and economic results in the North Carolina economy.

## SUMMARY FINDINGS

During the most recent time period for which data are available across the report's 40 measures, North Carolina's average rank among the 50 U.S. states is 21<sup>st</sup> based on these measures [**Statewide Summary, next page**].<sup>2</sup> Its highest single rank is 3<sup>rd</sup>; its lowest single rank is 49<sup>th</sup>; its most common rank is 20<sup>th</sup>. Additionally, on 15 of the 40 measures, North Carolina's "Percent of U.S. Average Value" is equal to or better than average, meaning the state matches or outperforms the nation as a whole on those measures.

Since the early 2000s, North Carolina's innovation economy has, on balance, advanced—on 28 measures it improved, on eight it declined, and on four it stayed the same or could not be measured over time. During that same period, the U.S. innovation economy, on balance, also advanced—on 30 measures it improved, on six it declined, and on four it stayed the same or could not be measured over time.<sup>3</sup> Overall, North Carolina's innovation ecosystem overall is moderately healthy and has improved since the early 2000s, but is lagging slightly behind the improvements of the nation overall.

## FINDINGS BY CATEGORY

- **Economic Well-Being:** North Carolina has one of the fastest-growing populations in the nation, but the productive capacity of its economy and the wages and incomes of its citizens are below the national average, its unemployment rate is consistent with the national average, and its poverty rate is above the national average.
- **Research & Development:** North Carolina excels at academic research & development, but the total level of the state's research & development, particularly that performed by business, is slightly below the national average and does not put the state in a strong position to fuel and sustain economic growth.

- **Commercialization:** North Carolina organizations, particularly its academic institutions, generate significant intellectual property, but the overall levels of the state's innovation commercialization activities are below the national average and must be stronger to realize the full economic and social benefits of that intellectual property.
- **Innovative Organizations:** North Carolina's high science, engineering and technology sectors (SET) are increasing in employment and have wages that are above the national average for all industries, but a higher-than-average share of the state's industries and employment is not high SET in nature and has average levels of entrepreneurial activity.
- **Education & Workforce:** North Carolina has a well-educated and well-trained science & engineering workforce at the more-advanced educational levels, but the overall educational attainment level of its residents is slightly below the national average; additionally, while the average years of education of its recent in-migrants and the in-migration of college educated adults as a percentage of the total state population are above the national average, they may not be sufficient to raise the state's overall educational attainment level significantly in the near term.

Across the state, these findings vary considerably by locale, with urban areas performing well above the U.S. average and having the greatest share of the assets and activities vital to creating, commercializing, and utilizing innovations. As in other states, rural areas fare less well and have the greatest need for improving their economic well-being and quality of life through the benefits of innovation.

<sup>1</sup> The NC Board of Science, Technology & Innovation has produced six innovation indexes during the last 19 years, in 2000, 2003, 2008, 2013, 2015, and 2017.

<sup>2</sup> In the 2017 and 2015 versions of this report, North Carolina's average rank was 23<sup>rd</sup>; in the 2013 version North Carolina's average rank was 24<sup>th</sup>. The rankings are for the state overall; for more detail on performance by NC county, see page iii of the Executive Summary and individual measures in the body of the report. All measures are expressed as ratios or percentages, which "normalizes" the data by controlling for "size" factors such as state population and Gross Domestic Product (GDP), thus enabling an "apples to apples" comparison. See the "Interpreting the Data" section of this report for additional insights on understanding the various values, rankings, and averages in the report.

<sup>3</sup> Historical data are unavailable for four of the 40 measures.

# EXECUTIVE SUMMARY

## Statewide Summary of Measures

MEASURE	N.C. RANK	N.C. % OF U.S. AVERAGE VALUE											PERFORMANCE OVER TIME <sup>1</sup>	
		0%	20%	40%	60%	80%	100%	120%	140%	160%	180%	200%	N.C.	U.S.
<b>ECONOMIC WELL-BEING &amp; QUALITY OF LIFE</b>	<b>29</b>													
Per Capita Gross Domestic Product, 2018	35	84%											↑	↑
Per Capita Income, 2018	38	85%											↑	↑
Median Household Income, 2017	38	87%											↑	↑
Average Annual Wage, 2018	24	89%											↑	↑
Unemployment Rate, 2018	26	100%											↑	↓
Percentage of Citizens in Poverty, 2017	37	110%											↓	↑
Population growth, 2000-18	8	179%											↑	↑
<b>RESEARCH &amp; DEVELOPMENT</b>	<b>13</b>													
Total R&D Expenditures as a Percentage of GDP, 2016	15	96%											↑	↑
Business-Performed R&D as a Percentage of Private-Industry Output, 2016	15	96%											↑	↑
Academic Science & Engineering R&D per \$1,000 of State GDP, 2017	3	146%											↑	↑
Federal R&D Obligations per Employed Worker, 2017	21	57%											↑	↑
Academic S&E Article Output per 1,000 SEH Doctorate Holders in Academia, 2017	12	107%											↑	↑
<b>COMMERCIALIZATION</b>	<b>18</b>													
Average Annual SBIR & STTR Funding per \$1 Million of GDP, 2014-16	19	92%											↑	↓
Academic Patents Awarded per 1,000 S&E Doctorate Holders in Academia, 2017	16	99%											↑	↑
Patents Awarded per 1,000 Individuals in S&E Occupations, 2017	20	82%											↑	↑
Venture Capital Dispersed per \$1 Million of GDP, 2017	14	39%											↓	↓
Venture Capital Deals as Percentage of High SET Employment Establishments, 2016	20	56%											↑	↑
Academic License Inc. (Gross) as a Percentage of Academic R&D Expend., 2015-17	21	45%											N/A	N/A
Academic License Inc. (Running) as a Percentage of Acad. S&E R&D Expend., 2015-17	16	50%											↓	↑
Avg. Number of University Startups Formed per \$1 Million of Academic S&E R&D Expenditures, 2015-17	20	97%											↑	↑
<b>INNOVATIVE ORGANIZATIONS</b>	<b>22</b>													
High SET Employment Establishments as Percentage of All Business Establishments, 2016	19	97%											↑	↑
Net high SET Employment Business Formations as a Percentage of All Business Establishments, 2016	19	108%											↓	↓
Employment in High SET Employment Establishments as a Percentage of Total Employment, 2016	24	92%											↑	↑
Average Annual Number of Entrepreneurs per 100,000 People, 2015-17	20	99%											↑	↑
Average Opportunity Share of New Entrepreneurs, 2015-17	21	100%											↑	↑
Exports as a Percentage of GDP, 2018	31	72%											↓	↑
<b>EDUCATION &amp; WORKFORCE</b>	<b>20</b>													
Individuals in S&E Occupations as a Percentage of the Workforce, 2017	17	100%											↑	↑
Employed SEH Doctorate Holders as a Percentage of the Workforce, 2017	15	104%											↑	↑
Engineers as a Percentage of All Occupations, 2018	27	83%											↑	↑
Bachelor's Degrees in Science and Engineering Conferred per 1,000 Individuals 18-24 Years Old, 2017	32	92%											↑	↑
Science and Engineering Degrees as a Percentage of Higher Education Degrees Conferred, 2017	15	105%											↑	↑
Educational Attainment of Residents Aged 25 and Over (Composite Score), 2017	24	98%											↑	↑
Average Years of Education Among In-Migrants, 2017	16	102%											↑	↑
In-Migration of College Educated Adults as a Percentage of Total State Population, 2017	16	119%											↑	↑
<b>ENVIRONMENT &amp; INFRASTRUCTURE</b>	<b>19</b>													
Elementary & Secondary Public School Current Expend. as a Percentage of State GDP, 2016	49	81%											↓	↑
Approp. of State Tax Funds for Higher Education as a Percentage of State GDP, 2017	7	170%											↓	↓
Broadband Deployment at 25 Mbps/3 Mbps or Faster, 2017	13	101%											N/A	N/A
Broadband Adoption Rate 25 Mbps/3 Mbps or Faster, 2017	20	99%											N/A	N/A
Cost of Living Index, 2018	12	92%											N/A	N/A
Manufacturing GDP a Percentage of State GDP, 2018	7	160%											↓	↓
<b>AVERAGE N.C. RANK ACROSS ALL MEASURES</b>	<b>21<sup>2</sup></b>													

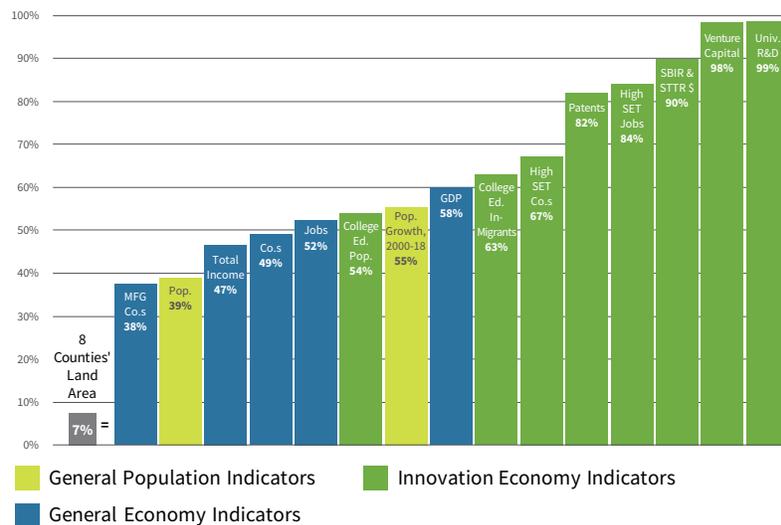
↑ Improving      ↓ Worsening<sup>3</sup>

<sup>1</sup> For most measures, "over time" refers to the period between the year 2000 and the year listed to the right of the measure. In the rare cases when data were not available starting in 2000 for a measure, the starting year is typically few years after 2000.

<sup>2</sup> Assumes measures are weighted equally.

<sup>3</sup> For the Unemployment Rate and Percentage of Citizens in Poverty, increases represent worsening, while decreases represent improving.

### LOCALE SUMMARY



8 North Carolina counties (Mecklenburg, Wake, Guilford, Forsyth, Durham, Buncombe, New Hanover, and Orange) represent 7% of the state's land area but disproportionately larger shares of state's population, economy, and innovation assets and activities.

### FINDINGS BY LOCALE

At the county level, 15 key measures reveal differences important for further understanding North Carolina's performance overall and by local levels within the state [**Locale Summary**].<sup>4</sup> Specifically, among North Carolina's 100 counties, 8 that are highly populated and/or are home to major research universities (Mecklenburg, Wake, Guilford, Forsyth, Durham, Buncombe, New Hanover, and Orange) represent just 7 percent of the state's land area but account for disproportionately larger shares of the state's population, economy, and innovation assets and activities.<sup>5</sup>

In terms of general population, those 8 counties represent 39 percent of the state's current population and 55 percent of the state's population growth between 2000 and 2018.<sup>6</sup> In terms of the general economy, those 8 counties represent larger shares—they hold 38 percent of the state's manufacturing companies, 47 percent of the state's total income, 49 percent of the state's companies, 52 percent of its jobs, and 58 percent of its GDP. And in terms of the innovation economy, those 8 counties represent even larger shares—54 percent of the state's

college educated population, 63 percent of its college educated in-migrants, 67 percent of the state's high SET companies, 82 percent of the state's patents, 84 percent of the state's high SET jobs, 90 percent of the state's SBIR/STTR grants, 98 percent of the state's venture capital, and 99 percent of the state's university R&D.

Together, these county level differences indicate that North Carolina is a tale of two innovation economies: One economy is based primarily in our more research-intensive areas, which have large populations that are growing rapidly and that have economic and innovation assets, activities, and outcomes well above the U.S. average; the other is based largely in less developed areas, which have much smaller populations that are stable or shrinking and that have economic outcomes well below the U.S. average.

Understanding the nature and performance of these two economies is critical for informed decision making and policies that improve the economic well-being and quality of life for all North Carolinians.

<sup>4</sup> Not all of the report's 40 measures are available at the county level. The 15 presented here are the ones that are both available at the county level and are most relevant to the state's population, general economy, or innovation economy. Detailed descriptions of each measure are available in the body of the report. See the Table of Contents for each measure's location in the report.

<sup>5</sup> Averaging across the 15 measures, each of the 8 counties accounts for at least 2 percent of the state total value on those measures within the state. Breakdown by county: Wake (21%), Mecklenburg (15%), Durham (11%), Orange (6%), Guilford (5%), Forsyth (4%), Buncombe (3%), New Hanover (2%); dates for measures: Mfg. Co.s (2018), Pop. (2018), Total Income (2018), Co.s (2018), Jobs (2018), College-Ed. Pop. (2013-2017, five year estimates), Pop. Growth (2000-2018), GDP (2018, chained 2012 dollars), College-Ed. In-migrants (2013-2017, five year estimates), High SET Co.s (2018), Patents (2016-2018 Average), High SET Jobs (2018), SBIR & STTR \$ (2016-2018 Average), Venture Capital (2016-2018 Average), Univ. R&D (2017).

<sup>6</sup> Between 2000 and 2030, the 8 counties are expected to represent as much as 58 percent of the state's population growth, suggesting the disproportionate findings by locale will continue or increase over time

These findings and trends paint a picture of North Carolina that is both rich with opportunities but also facing challenges. The degree to which North Carolina prospers in response to these challenges depends on how quickly and effectively it addresses them in tailored ways. Drawing on the findings of this report, the following priorities are crucial for growing and developing North Carolina's innovation-fueled economy statewide:

- Research & Development - Increase Volume and Intensity:** To grow its economy significantly in both the short term and long term, North Carolina must increase the volume and intensity of its research & development efforts—particularly those performed by business—relative to other U.S. states and to leading countries. In the near term it should, at a minimum, strive to be at parity with the U.S. average value. One way North Carolina businesses could achieve this is by closer and more frequent research & development partnerships with the state's universities, which have well-above-average research & development performance, and facilities, equipment, and expertise often beyond the scope of many of the state's businesses.
- Commercialization - Better Leverage Strong Asset Base:** To foster the start and growth of businesses developing and commercializing innovative technologies, North Carolina's universities should be incentivized and equipped to focus more on company and industry engagement, as well as technology commercialization. Additionally, the state must continue to support its programs focused on capturing and leveraging the benefits of federal grant programs, such as Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR), which provide working capital to small and emerging companies.<sup>7</sup> These steps will make North Carolina more attractive for later-stage commercialization resources such as venture capital, but they must also be leveraged further by strategic, proactive efforts to attract and develop investors and innovative businesses and market the state's innovative activities.
- Innovative Organizations - Boost Entrepreneurship and Business Linkages:** To advance the technology and innovation levels of its existing businesses and to start, grow, and attract new high-technology businesses, North Carolina must ensure that a greater share and range of its population has the training, resources, and support to be entrepreneurial. Similarly, it must enhance and extend programs focused on technology adoption and diffusion, particularly in rural regions with historically lower levels of innovation and that are struggling to fully participate in the benefits of the innovation economy. In addition, to remain competitive in

the global economy, the state must continue to explore new markets for the goods and services it produces, particularly by understanding how North Carolina industries fit within global commodity value chains, and deepening and expanding relationships with overseas trading partners.

- Education & Workforce - Emphasize STEM and Strengthen Fundamentals:** To intensify the innovation-relevant education and training levels of its workforce, North Carolina must grow the share of its community college and university-level students earning degrees in science, technology, engineering, and math (STEM) disciplines. One way to achieve this could entail industries, educators, and government regularly collaborating to develop a North Carolina innovation-focused technology workforce agenda and strategy. The strategy could organize education and workforce programs around broad clusters and skills, particularly ones the state has determined to be in its strategic interests. Additionally, North Carolina must raise the educational attainment of its citizens at all levels of the educational spectrum, to a level at least equal to the national average. Doing so would enhance efforts in the three priorities above and multiply their impacts.
- Environment & Infrastructure - Reinforce, Enhance, and Broaden:** To ensure that the greatest number and range of its citizens enjoy the economic and social benefits of science, technology, and innovation, North Carolina must continue to invest, throughout its regions, in basic infrastructure elements of its innovation economy, such as elementary, secondary, and higher education organizations; broadband deployment and adoption; and industries that use science and technology and a highly skilled workforce to develop, manufacture, distribute, and export products. Combined with North Carolina's low cost of living and high quality of life, these elements provide the richest and most fundamental foundation for starting, growing, and attracting businesses that improve our economic well-being and quality of life.

Efforts such as those above must be sufficiently long-term and well-funded to make a difference, and they must have the flexibility to respond to continually changing circumstances and to support different needs across regions and sectors. Moreover, decisions about their continuation and modification must be guided by clear benchmarks and performance criteria, such as those provided and explained in more detail throughout this report. With this information, key stakeholders—including policymakers, industries, academic institutions, nonprofits, and citizens—will have appropriate and timely baseline information on science, technology, and innovation in the state.

<sup>7</sup> For example, the One North Carolina Small Business Program, administered by the North Carolina Board of Science, Technology & Innovation, awards state-funded matching grants to North Carolina Small Businesses that have won highly competitive SBIR or STTR grants

## WHAT ARE SCIENCE, TECHNOLOGY & INNOVATION?

Innovation is the creation and adoption of new products, services, and business models to yield value. While innovation has many sources, science (systematic knowledge) and technology (the practical application of knowledge) are its fundamental elements. Throughout history, science, technology, and innovation have brought about the development of tools, products, processes, and services such as the wheel, sailing ships, the plow, agricultural irrigation systems, municipal water and sewer systems, the internal combustion engine, the telegraph, audio and video, accounting processes, medicines and medical technologies, and information and communications technologies. Each generation of civilization has built on the technological achievements of prior generations and used them to create new possibilities and wealth and security. In short, science and technology, and their practical advancement via innovation, are what have enabled humans to get—on an ongoing basis—more value out of the earth’s natural resources.

## WHY ARE SCIENCE, TECHNOLOGY & INNOVATION IMPORTANT FOR THE ECONOMY?

Through decades of empirical research, economists have documented the central role of science, technology, and innovation in long-term productivity, job growth, output growth, and higher incomes.<sup>1</sup> In terms of productivity and growth, economic studies have valued the return on research, development, and innovation to be four times the return on investment in physical capital.<sup>2</sup> Put another way, between one-third to one-half of economic growth in the United States can be attributed to innovation.<sup>3</sup> And in terms of income, U.S. Bureau of Labor Statistics (BLS) data show that in all but one of 71 technology oriented occupations, the median income exceeds the median for all occupations; moreover, in 57 of these occupations, the median income is 50 percent or more above the overall industry median.<sup>4</sup>

Two fundamental effects of science- and technology-based innovation drive these impacts:

- Innovation empowers product and productivity improvements in existing companies;
- Innovation spurs the dynamic creation of new companies that create new value.

Together, these effects lead to a virtuous cycle of expanding employment, as well as increased wages and lower prices, all of which expand domestic economic activity and create jobs.<sup>5,6</sup> A high-productivity, high-employment, high-income, growing economy must be a high-technology, innovation-driven economy. Other economies around the world, recognizing this and aspiring to the U.S. standard of living, have examined the technology-based economic growth process and are progressively evolving public-private asset growth models. The current global trends in investment and innovation are exceeding those in the U.S., and many economies across the globe are now establishing public-private research partnerships to pool risk, improve the efficiency of research and development (R&D), and diffuse innovation and new technology platforms more rapidly across and within domestic supply chains.

## WHY TRACKING INNOVATION 2019?

A major impediment to the proper design and implementation of policies and programs that help advance innovation is a lack of accurate, comprehensive, and up-to-date information on the various factors related to innovation—R&D performance, innovation rates, technology commercialization rates, trends in high-technology industries, education and training levels of the workforce, and how all these relate to overall economic performance.<sup>7</sup> Nearly all states and regions are grappling with this problem, including North Carolina. Critical questions concern the level of North Carolina’s innovative activity, as well as whether it has the proper infrastructure and resources in place to support innovation, as well as overall economic development, to its fullest extent.

<sup>1</sup> For a review of these studies, see Tassef 2007, Chapter 3.

<sup>2</sup> Jones and Williams 1998, 2000.

<sup>3</sup> U.S. Department of Commerce 2012.

<sup>4</sup> Hecker 2005.

<sup>5</sup> Atkinson and Ezell 2012.

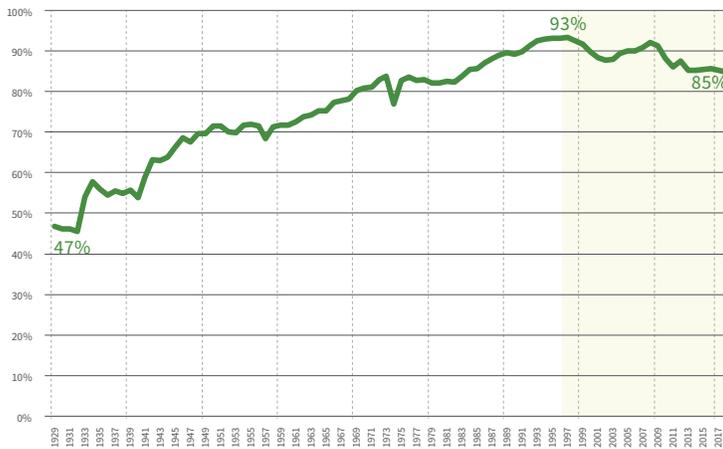
<sup>6</sup> Atkinson and Nager 2014.

<sup>7</sup> The NC Board of Science, Technology & Innovation has produced six innovation indexes during past 19 years, in 2000, 2003, 2008, 2013, 2015, and 2017.

See: <https://www.nccommerce.com/documents/innovation-reports>. While the 2008 report was titled “Advancing Innovation” rather than “Tracking Innovation,” it includes a detailed innovation index in “Chapter 2: North Carolina’s Innovation Performance.”

**FIGURE 1**

**N.C. PER CAPITA INCOME AS SHARE OF U.S. PER CAPITA INCOME, 1929-2018**



Source: U.S. Bureau of Economic Analysis.

For nearly a century, North Carolina has been transitioning from an agricultural and traditional manufacturing economy to a knowledge- and innovation-based economy fueled by science and technology. In the process, the state’s policymakers, businesses, educational institutions, and citizens have made strategic investments in infrastructure, institutions, and human capital. Because of these investments (and as illustrated later in this report), North Carolina has achieved a leading role in the “basic” and early-stage “applied” research that forms the foundation for breakthrough innovations. These innovations have helped North Carolina’s per capita income as a share of U.S. per capita income more than double during the last century, increasing steadily from a low of 47 percent in 1929 to a high of 93 percent in 1997 [Figure 1]. But while significant and impactful, these investments have not been sufficient to propel North Carolina’s per capita income to a level above the average per capita income for the nation as a whole. And since 1997, North Carolina’s per capita income as a share of U.S. per capita income has decreased significantly, currently at 85 percent in 2018, the latest year for which data are available.

Thus, ensuring proper infrastructure and resources for innovation is important not just for sparking economic wellbeing and prosperity, but also for sustaining them over time. At a minimum, finding answers regarding how to do so and to what extent requires appropriate and timely baseline information on science, technology, and innovation in the state. This, in turn, will help identify strengths and weaknesses, inform decisions and policy making, and establish benchmarks for measuring effectiveness.

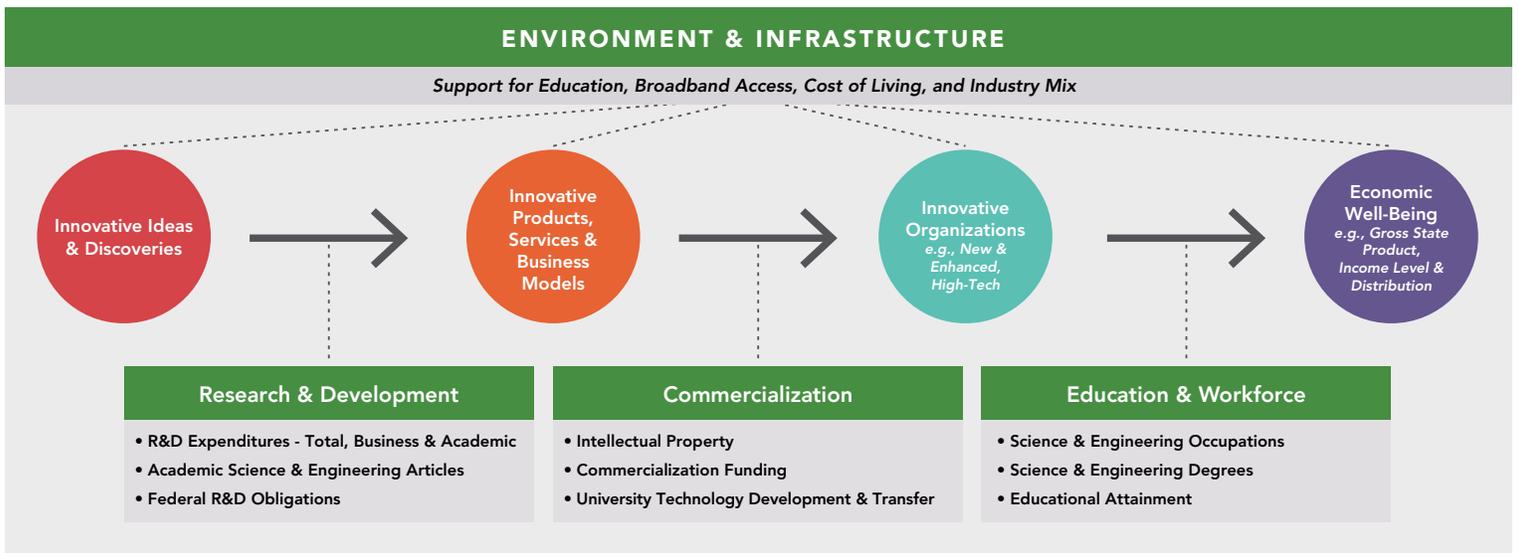
## WHAT IS TRACKING INNOVATION 2019?

The goal of *Tracking Innovation 2019* is to provide that information in a systematic and accessible format, and therefore to help inform science, technology, and innovation planning and policy at all levels throughout the state. As a follow-up to previous reports tracking North Carolina’s innovation performance,<sup>7</sup> this report enables North Carolina to join a growing number of states regularly monitoring innovation trends within and outside their borders. It assembles information from a wide variety of sources to document innovation-related activity in North Carolina, six comparison states, and the U.S. Its 40 measures are summarized under 32 broad indicators of innovation, technology, and economic well-being. Each of the 40 measures, in turn, falls into one of six general categories:

- **Economic Well-Being** (e.g., gross domestic product, income level and distribution)
- **Research & Development** (e.g., R&D expenditures, academic articles)
- **Commercialization** (e.g., intellectual property, commercialization funding)
- **Innovation Organizations** (e.g., high-technology establishments, entrepreneurs)
- **Education & Workforce** (e.g., science & engineering occupations, educational attainment)
- **Environment & Infrastructure** (e.g., support for education, broadband access)

The report does not make normative judgments regarding which of its measures are most important for plotting the course of science, technology, and innovation policy in North Carolina. Instead, the facts—as best they can be gathered from existing secondary sources—are presented as concisely and clearly as possible, leaving it primarily to the reader to gauge the significance of specific trends. Though every measure is insufficient in isolation, together they lend useful insight into the status of science, technology, and innovation activity in North Carolina.

**FIGURE 2** INNOVATION ECOSYSTEM



## WHAT IS THE METHODOLOGY OF TRACKING INNOVATION 2019?

### INNOVATION ECOSYSTEM

Innovation occurs in an “innovation ecosystem”—the complex and dynamic collection of people, organizations, cultures, policies, and programs that creates innovative ideas and discoveries, translates those ideas into innovative products, services and business models, and enhances existing organizations and builds new organizations to improve our economic well-being and quality of life [Figure 2]. Accordingly, any effort to measure innovation comprehensively, accurately, and effectively in North Carolina should:

1. Focus on multiple components of the state’s innovation ecosystem;
2. Include multiple indicators for each component.

The indicators included in this report meet these two goals while capturing, to the extent possible, the intersection of both what we want to measure and what we can measure using available data sources.<sup>8</sup> It also compares these indicators on multiple dimensions—spatially & temporally<sup>9</sup>—to generate a rich and comprehensive understanding of the health of North Carolina’s innovation ecosystem.<sup>10</sup>

### DATA SOURCES

The report relies primarily on existing secondary data sources (see detailed listing in the Sources section at the end of this report). In rare cases, and unless otherwise noted, no surveys or other forms of primary data collection were undertaken to assemble measures. Additionally, all measures are:

- As current and accurate as possible;<sup>11</sup>
- Derived from objective and reliable data sources;
- Easy to understand and compare across states; and
- Relevant and of interest to the public.

The measures included in this report are meant to serve as a baseline for decision making and further inquiry. To the extent possible, and when appropriate, future updates of the report will include additional data and measures.

<sup>8</sup> This acknowledges the oft-cited aphorism that “Not everything that can be measured matters, and not everything that matters can be measured.”

<sup>9</sup> The typical over-time period assessed in this report ranges from 2000 to the most recent year(s) for which current data are available, most often 2016, 2017, and 2018. For virtually all the indicators, there is a one- to three-year lag time between the current year (2019) and the most recent year for which data are available. This is because obtaining comprehensive (across all 50 states) data that are both reliable and accurate is labor intensive and time consuming and must be done with care and rigor.

<sup>10</sup> The index is analogous to the results of regular, comprehensive medical examination designed to evaluate and understand the health of a person. In this case, the health of North Carolina’s innovation ecosystem is being evaluated.

<sup>11</sup> For a small number of indicators, the most current data are from as far back as 2014, but data from these years are averaged with data from 2016 and 2017.

## STATE-BY-STATE COMPARISONS

For the point-in-time comparisons focused on the most recent periods possible, the report presents information for the U.S. average and each of the 50 states in bar-chart form. This enables a comprehensive and informative assessment of where North Carolina currently fares relative to the nation overall and to each of the 49 other states. In addition, to enable a more targeted assessment of North Carolina's performance relative to a handful of important states, the report highlights North Carolina's performance on each measure to that of the following six comparison states:

- Two leading technology states (California and Massachusetts)
- Two strong southeastern states (Georgia and Virginia)
- Two midrange but "up and coming" technology states (Colorado and Washington)<sup>12</sup>

For the over-time comparisons, the report presents information only for North Carolina, the U.S. average, and the six comparison states in line-chart form.<sup>13</sup> This enables an informative assessment of how North Carolina has fared relative to the nation overall and to each of the six comparison states over time, in particular the extent to which North Carolina is gaining ground, losing ground, or holding its own.<sup>14</sup>

## INTERNATIONAL & WITHIN-NORTH CAROLINA COMPARISONS

When available, international data (in the form of a selected set of 20 comparison countries)<sup>15</sup> and within-North Carolina data (most often in the form of county level data, but occasionally at other levels, such as ZIP code, city, Metropolitan Statistical Area (MSA), or university) are presented.<sup>16</sup> These additional levels of comparison provide deeper context for evaluating North Carolina's performance, particularly the within-North Carolina data, which provide a more nuanced understanding of the location and concentration of innovation-related factors throughout the state.<sup>17</sup>

<sup>12</sup> California and Massachusetts typically rank high on several indicators of science and technology. Georgia and Virginia are typically regarded as leading southeastern technology states with which North Carolina competes. Colorado and Washington often rank close to North Carolina on various innovation indicators and have improved their rankings significantly in recent years.

<sup>13</sup> Line charts including all 50 states are too detailed to interpret meaningfully.

<sup>14</sup> To facilitate a comparison of North Carolina's performance relative to that of the U.S. average and the six comparison states, the following color scheme is used on all charts: North Carolina (bold green), U.S. average (bold blue), California (pale red), Massachusetts (pale yellow), Georgia (pale purple), Virginia (pale orange), Colorado (pale blue), and Washington (pale green).

<sup>15</sup> The comparison countries were selected by computing, for each country, the average of its ranking on the following three factors: (1) the absolute size of its gross domestic product (GDP), (2) its per-capita GDP, and (3) the average of its ranking on the following two factors in the 2016 Global Manufacturing Competitiveness Index: (a) its "current competitiveness" ranking and (b) its "competitiveness in five years" ranking, as derived from 550 survey responses from senior manufacturing executives around the world. The top 20 countries were selected as the comparison countries. For example, using this methodology, the United States ranks first, with an average score of 3.5 across the three factors  $(1 \times .33) + (8 \times .33) + (1.5 \times .33) = 3.5$ ; similarly, China, for example, ranks 17<sup>th</sup>, with an average ranking of 23.5 across the three factors  $(2 \times .33) + (67 \times .33) + (1.5 \times .33) = 23.5$ . This average ranking is valuable because it includes both objective and subjective measures of each country's competitiveness. The above-referenced Index, produced by Deloitte Touche Tohmatsu Limited and the Council on Competitiveness, is available at: <https://www2.deloitte.com/global/en/pages/manufacturing/articles/global-manufacturing-competitiveness-index.html>.

<sup>16</sup> For each indicator, the decision regarding the level at which to display the data was determined by a combination of (a) the most precise level at which accurate and comprehensive data were available and (b) the level at which displaying the data proved most informative for the purposes of this report.

<sup>17</sup> Accurate and reliable international and within-North Carolina data are available much less often than are state-level data. Hence, not every indicator includes international and within-North Carolina data.

## INTERPRETING THE DATA

The data in this report are voluminous and can be overwhelming, and therefore must be interpreted appropriately and carefully. To that end, several points should be kept in mind:

- **Values for most indicators are expressed as ratios or percentages.** This “normalizes” the data by controlling for factors such as state population and gross domestic product, thus enabling an “apples to apples” comparison.
- **Small differences in rankings and changes in value over time are not significant.** Accordingly, for each indicator, tests of statistical significance were performed for North Carolina’s change over time relative to its history and relative to the U.S.’s change over time, respectively. In the text description accompanying each indicator, the words “significant” or “significantly” are used only when differences across rankings or values over time surpassed a minimum and commonly accepted level of significance—i.e., at least one standard deviation away from the mean value of the data. In some cases, what appears to be a large difference in percentages is not, in fact, a statistically significant difference. Care was taken not to overinterpret the data.
- **Broad patterns and trends matter most.** While it is tempting to draw conclusions based on a comparison of a small number of states or years (e.g., two or three), those conclusions are far less valid and compelling than ones based on a comparison of a larger number of states and years.
- **Interpretation of an indicator should not be made in isolation.** While each indicator, by itself, provides valuable information, that value increases dramatically when judged in light of the information provided by other indicators, as each is just one component of the larger interconnected innovation ecosystem. Moreover, whereas some indicators primarily reflect outcomes (e.g., gross state product, educational attainment, income levels, poverty levels), others primarily reflect causes or the broader environment and context (e.g., R&D expenditures, support for education, broadband access, industry mix). As such, each should be evaluated in light of its place in the ecosystem [Figure 2].
- **Data for states with smaller populations are less precise and may be misleading.** While the data for states with small populations are correct in that they reflect what is available, they should potentially be discounted because the smaller number of observations means their error level may be higher and their smaller magnitude may be less meaningful and impactful overall.

- **Rankings tend to divert attention from the actual value of a given measure, which often is more important.** On many indicators, there is very little statistically significant variation between state ranks, which simply are an ordinal-level measure.<sup>18</sup> This is most true for rankings with a low level of variation across the distribution, in which case the difference between the top-ranked state and the lowest-ranked state may be small and not particularly meaningful. Thus, in this report North Carolina’s actual value (a ratio or percentage) on each indicator is reported, in addition to its rank (which is revealed by default in each graphic), permitting more meaningful interpretation of the findings. When measuring North Carolina’s performance, it is better to know both its national rank and its percent of U.S. value. Each tells us something unique and helps us make sense of the other. Together, they provide more information than they would by themselves. The two numbers typically track together (e.g., when one is high, so is the other). When they don’t, it typically is when a small number of states dominate U.S. activity (e.g., see Venture Capital in indicator 3.4) or when there is little statistically significant difference between states.
- **Rankings are for the state as a whole.** Because the rankings are in summary form and reflect an average score for the entire state, they do not convey information about the performance of specific regions or areas (e.g., counties, cities, metropolitan statistical areas) within the state. Where such sub-state data are available (as they are for 26 of the 40 indicators), they are presented, typically in map form, to provide a more nuanced and explicit understanding of the location of innovation-related assets and the performance of those locations, which can vary considerably across the state.

We hope you find the data informative and useful.

<sup>18</sup> Ordinal-level measures allow only for the rank order [1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, etc.] by which data can be sorted, but do not allow for relative degree of difference between the data.

**EXECUTIVE SUMMARY ..... i**

**INTRODUCTION ..... v**

## Economic Well Being

### INDICATOR 1.1: GROSS DOMESTIC PRODUCT (GDP)

1.1A: Per Capita Gross Domestic Product, All U.S. States, 2018 ..... 1

1.1B: Per Capita Gross Domestic Product, Comparison States, 2000-2018 ..... 1

1.1C: Per Capita Gross Domestic Product, Comparison Countries, 2018 ..... 2

1.1D: Per Capita Gross Domestic Product, Comparison Countries, 2000-2018 ..... 2

1.1E: Per Capita Gross Domestic Product, N.C. MSAs, 2017 ..... 3

1.1F: Per Capita Gross Metro Product, N.C. MSAs, 2001-2017 ..... 3

1.1G: Per Capita Gross Metro Product, N.C. MSAs, 2017 ..... 3

1.1H: Total Gross Domestic Product, N.C. MSAs, 2001-2017 ..... 4

### INDICATOR 1.2: INCOME

1.2A: Per Capita Income, All U.S. States, 2018 ..... 5

1.2B: Per Capita Income, Comparison States, 2000-2018 ..... 5

1.2C: Median Household Income, All U.S. States, 2017 ..... 6

1.2D: Median Household Income, Comparison States, 2005-2017 ..... 6

1.2E: Median Household Income, N.C. Counties, 2013-2017 Average ..... 6

### INDICATOR 1.3: AVERAGE ANNUAL WAGE

1.3A: Average Annual Wage, All U.S. States, 2018 ..... 7

1.3B: Average Annual Wage, Comparison States, 2001-2018 ..... 7

1.3C: Average Annual Wage, High SET Employment Industries and All Industries, U.S. and N.C., 2001-2018 ..... 8

1.3D: Average Annual Wage, N.C. Counties, 2018 ..... 8

### INDICATOR 1.4: UNEMPLOYMENT

1.4A: Unemployment Rate, All U.S. States, 2018 ..... 9

1.4B: Unemployment Rate, Comparison States, 2000-2018 ..... 9

1.4C: Unemployment Rate, Comparison Countries, 2018 ..... 10

1.4D: Unemployment Rate, Comparison Countries, 2000-2018 ..... 10

1.4E: Unemployment Rate, N.C. Counties, 2018 ..... 11

### INDICATOR 1.5: POVERTY

1.5A: Percentage of Citizens in Poverty, All U.S. States, 2017 ..... 12

1.5B: Percentage of Citizens in Poverty, Comparison States, 2005-2017 ..... 12

1.5C: Percentage of Population Below Poverty Level, N.C. Counties, 2013-2017 Average ..... 13

### INDICATOR 1.6: POPULATION GROWTH

1.6A: Percentage Change in Population, All U.S. States, 2000-2018 ..... 14

1.6B: Estimated Location of Population in N.C., 2018 ..... 14

1.6C: Population Change, Percent of Total Change, N.C. Counties, 2000-2018 ..... 15

1.6D: Population Change, Percent of Total Change, N.C. Counties, 2000-2018 ..... 15

1.6E: Change in Population, N.C. Counties, 1930-2030 ..... 16

## Research & Development

### INDICATOR 2.1: TOTAL RESEARCH & DEVELOPMENT

2.1A: Total R&D Expenditures a Percentage of GDP, All U.S. States, 2016.....	17
2.1B: Total R&D Expenditures a Percentage of GDP, Comparison States, 2000-2016.....	17
2.1C: Total R&D Expenditures as a Percentage of GDP, Comparison Countries, 2015 .....	18
2.1D: Total R&D Expenditures as a Percentage of GDP, Comparison Countries, 2000-2015 .....	18
2.1E: Location of R&D Expenditures in N.C., 2018 .....	19

### INDICATOR 2.2: INDUSTRY RESEARCH & DEVELOPMENT

2.2A: Business-Performed R&D as a Percentage of Private-Industry Output, All U.S. States, 2016.....	20
2.2B: Business-Performed R&D as a Percentage of Private-Industry Output, Comparison States, 2000-2016 .....	20
2.2C: Location of Business-Performed R&D Expenditures in North Carolina, 2018 .....	21

### INDICATOR 2.3: ACADEMIC SCIENCE & ENGINEERING RESEARCH & DEVELOPMENT

2.3A: Academic R&D per \$1,000 of State GDP, All U.S. States, 2017 .....	22
2.3B: Academic R&D per \$1,000 of State GDP, Comparison States, 2003-2017 .....	23
2.3C: N.C. University R&D Expenditures, 2017.....	23
2.3D: N.C. University R&D Expenditures, 2017 .....	23
2.3E: University R&D Expenditures by Source of Funds, U.S. Average and N.C. Institutions, 2017 .....	24

### INDICATOR 2.4: FEDERAL RESEARCH & DEVELOPMENT

2.4A: Federal R&D Obligations per Employed Worker, All U.S States, 2017 .....	25
2.4B: Federal R&D Obligations per Employed Worker, Comparison States, 2000-2017 .....	25

### INDICATOR 2.5: ACADEMIC ARTICLES

2.5A: Academic S&E Article Output per 1,000 SE&H Doctorate Holders in Academia, All U.S. States, 2017 .....	27
2.5B: Academic S&E Article Output per 1,000 SE&H Doctorate Holders in Academia, Comparison States, 2003-2017 .....	28
2.5C: Location of Science & Engineering Articles Published, 2018 - 2019 Annual Average.....	28

## Commercialization

### INDICATOR 3.1: SMALL BUSINESS INNOVATION RESEARCH & SMALL BUSINESS TECHNOLOGY TRANSFER AWARDS

3.1A: Average Annual SBIR & STTR \$ per \$1 Million of Gross Domestic Product, All U.S. States, 2014-2016 .....	29
3.1B: Average Annual SBIR & STTR \$ per \$1 Million of Gross Domestic Product, Comparison States, 2000-2016.....	30
3.1C: Average Annual SBIR & STTR Awards, N.C. Cities, 2016-2018 .....	30
3.1D: Average Annual Amount of SBIR & STTR Awards, N.C. Counties, 2016–2018 .....	31

### INDICATOR 3.2: ACADEMIC PATENTS

3.2A: Academic Patents Awarded per 1,000 S&E Doctorate Holders in Academia, All U.S. States, 2017 .....	32
3.2B: Academic Patents Awarded per 1,000 S&E Doctorate Holders in Academia, Comparison States, 2001-2017 .....	32
3.2C: Average Annual Academic Patents Awarded to N.C. Universities, 2015-2017 .....	33
3.2D: Average Annual Academic Patents Awarded to N.C. Universities, 2015–2017 .....	33

### INDICATOR 3.3: PATENTS

3.3A: Patents Awarded per 1,000 Individuals In S&E Occupations, All U.S. States, 2017 .....	34
3.3B: Patents Awarded per 1,000 Individuals In S&E Occupations, Comparison States, 2003-2017 .....	34
3.3C: Grants for Direct Patent Applications Per Billion Dollars in GDP, Comparison Countries, 2018.....	35
3.3D: Grants for Direct Patent Applications Per Billion Dollars in GDP, Comparison Countries, 2000-2018.....	35
3.3E: Average Annual Number of Patents, Selected N.C. Counties, 2016-2018.....	36
3.3F: Average Annual Number of Patents, N.C. Counties, 2016–2018.....	36

### INDICATOR 3.4: VENTURE CAPITAL

3.4A: Venture Capital Dispersed per \$1 Million of GDP, All U.S. States, 2017 .....	37
3.4B: Venture Capital Dispersed per \$1 Million of GDP, Comparison States, 2000-2017 .....	37
3.4C: Venture Capital Deals as a Percentage of High SET Employment Establishments, All U.S. States, 2016 .....	38
3.4D: Venture Capital Deals as a Percentage of High SET Employment Establishments, Comparison States, 2003-2016.....	38
3.4E: Location of Venture Capital Investments in N.C., Average Annual Investments, 2016-2018 .....	39

### INDICATOR 3.5: TECHNOLOGY LICENSE INCOME

3.5A: Academic License Income (Gross Received) as % of Academic R&D Expenditures, All U.S. States, 2015-2017 Average.....	40
3.5B: Academic License Income (Running Royalties) as % of Academic R&D Expenditures, All U.S. States, 2015-2017 Average .....	41
3.5C: Academic License Income (Running Royalties) as % of Academic R&D Expenditures, Comparison States, Three-Year Avgs, 2003-2017 .....	41
3.5D: Average Annual Academic License Income, U.S. Average and N.C. Institutions, 2015-2017 .....	42
3.5E: Location of Academic License Income (Running Royalties) in N.C., Average Annual Income, 2015-2017.....	42

### INDICATOR 3.6: UNIVERSITY STARTUPS

3.6A: Average Number of University Startups Formed per \$1 Million of Academic R&D Expenditures, All U.S. States, 2015-2017 .....	43
3.6B: Average Number of University Startups Formed & Remaining in Home State per \$1 Million of Academic R&D Expenditures, All U.S. States, 2015-2017 .....	43
3.6C: Number of University Startups Formed per \$1 Million of Academic R&D Expenditures, Comparison States, 2003-2017.....	44
3.6D: Average Annual Number of University Startups Formed & Stayed in Home State, U.S. Average and N.C. Institutions, 2015-2017 .....	44

## Innovative Organizations

### INDICATOR 4.1: HIGH SCIENCE, ENGINEERING & TECHNOLOGY EMPLOYMENT ESTABLISHMENTS & FORMATIONS

4.1A: High SET Employment Establishments as a Percentage of all Business Establishments, All U.S. States, 2016.....	46
4.1B: High SET Employment Establishments as a Percentage of all Business Establishments, Comparison States, 2003-2016 .....	46
4.1C: Net High SET Employment Business Formations as a Percentage of all Business Establishments, All U.S. States, 2016 .....	47
4.1D: Net High SET Employment Business Formations as a Percentage of all Business Establishments, Comparison States, 2004-2016 .....	47
4.1E: High SET Establishments as a Percentage of Total Establishments, N.C. Counties, 2018 .....	48

### INDICATOR 4.2: HIGH SCIENCE, ENGINEERING & TECHNOLOGY EMPLOYMENT

4.2A: Employment in High SET Employment Establishments as a Percentage of Total Employment, All U.S. States, 2016 .....	49
4.2B: Employment in High SET Employment Establishments as a Percentage of Total Employment, Comparison States, 2003-2016 .....	49
4.2C: Employment in High SET Employment Establishments as a Percentage of Total Employment, N.C. Counties, 2018 .....	50

### INDICATOR 4.3: ENTREPRENEURIAL ACTIVITY

4.3A: Average Annual Number of Entrepreneurs Per 100,000 People, All U.S. States, 2015-2017.....	51
4.3B: Average Annual Number of Entrepreneurs Per 100,000 People, Comparison States, 2000-2017 .....	52
4.3C: Average Opportunity Share of New Entrepreneurs, All U.S. States, 2015-2017.....	52
4.3D: Average Opportunity Share of New Entrepreneurs, Comparison States, 2000-2017 .....	53

### INDICATOR 4.4: EXPORTS

4.4A: Exports as a Percentage of GDP, All U.S. States, 2018.....	54
4.4B: Exports as a Percentage of GDP, Comparison States, 2000-2018.....	54
4.4C: Exports as a Percentage of GDP, Comparison Countries, 2017 .....	55
4.4D: Exports as a Percentage of GDP, Comparison Countries, 2000-2017.....	55

## Education & Workforce

### INDICATOR 5.1: SCIENCE & ENGINEERING WORKFORCE

5.1A: Individuals in S&E Occupations as a Percentage of the Workforce, All U.S. States, 2017.....	56
5.1B: Individuals in S&E Occupations as a Percentage of the Workforce, Comparison States, 2003-2017 .....	56

### INDICATOR 5.2: EMPLOYED SCIENCE, ENGINEERING & HEALTH DOCTORATE HOLDERS

5.2A: Employed SEH Doctorate Holders as a Percentage of the Workforce, All U.S. States, 2017 .....	58
5.2B: Employed SEH Doctorate Holders as a Percentage of the Workforce, Comparison States, 2001-2017 .....	58

### INDICATOR 5.3: ENGINEERS AS A PERCENTAGE OF THE WORKFORCE

5.3A: Engineers as a Percentage of All Occupations, All U.S. States, 2018.....	60
5.3B: Engineers as a Percentage of All Occupations, Comparison States, 2003-2018.....	60

### INDICATOR 5.4: BACHELOR’S DEGREES IN SCIENCE, ENGINEERING & TECHNOLOGY

5.4A: Bachelor’s Degrees in S&E Conferred per 1,000 Individuals 18–24 Years Old, All U.S. States, 2017.....	62
5.4B: Bachelor’s Degrees in S&E Conferred per 1,000 Individuals 18–24 Years Old, Comparison States, 2000-2017.....	62

### INDICATOR 5.5: SCIENCE, ENGINEERING & TECHNOLOGY DEGREES

5.5A: S&E Degrees as Percentage of Higher Education Degrees Conferred, All U.S. States, 2017.....	64
5.5B: S&E Degrees as Percentage of Higher Education Degrees Conferred, Comparison States, 2000-2017.....	64

### INDICATOR 5.6: EDUCATIONAL ATTAINMENT

5.6A: Educational Attainment, All U.S. States, 2017 .....	65
5.6B: Educational Attainment, Comparison States, 2005–2017 .....	66
5.6C: Percentage of Residents 25 Years and Over Who Have Completed High School or More Education, N.C. Counties, 2013–2017 Estimate.....	66
5.6D: Percentage of Residents 25 Years and Over Who Have Completed a Bachelor’s Degree or More Education, N.C. Counties, 2013–2017 Estimate .....	66
5.6E: Weighted Measure (Composite Score) of the Education Attainment of Residents Aged 25 Years and Over, N.C. Counties, 2013–2017 Estimate..	67

### INDICATOR 5.7: EDUCATIONAL ATTAINMENT OF IN-MIGRANTS

5.7A: Average Years of Education Among In-Migrants, All U.S. States, 2017 .....	68
5.7B: Average Years of Education Among In-Migrants, Comparison States, 2005-2017.....	68
5.7C: In-Migration of College Educated Adults as a Percentage of Total State Population, All U.S. States, 2017.....	69
5.7D: In-Migration of College Educated Adults as Percentage of Total State Population, Comparison States, 2005-2017 .....	69
5.7E: In-Migration of College Educated Adults, Percent of State Total, N.C. Counties, 2017 .....	70

## Environment & Infrastructure

### INDICATOR 6.1: PUBLIC INVESTMENT IN EDUCATION

6.1A: Elementary and Secondary Public School Current Expenditures as a Percentage of State GDP, All U.S. States, 2016 .....	71
6.1B: Elementary and Secondary Public School Current Expenditures as a Percentage of State GDP, Comparison States, 2000-2016 .....	72
6.1C: Appropriations of State Tax Funds for Operating Expenses of Higher Education as a Percentage of State GDP, All U.S. States, 2017 .....	72
6.1D: Appropriations of State Tax Funds for Operating Expenses of Higher Education as a Percentage of State GDP, Comparison States, 2000-2017 .....	73
6.1E: Authorized Appropriations, University of North Carolina (UNC) Institutions, FY 2017-2019 Average .....	73

### INDICATOR 6.2: BROADBAND

6.2A: Percent of Population with Broadband Access (Deployment Rate) at 25 Mbps/3Mbps or Faster, All U.S. States, 2017 .....	74
6.2B: Percent of Fiber to the End User Connections of all Wireline Connections, All Reporting U.S. States, 2017 .....	75
6.2C: Broadband Adoption Rate 25 Mbps/3 Mbps or Faster, All U.S. States, 2017 .....	75
6.2D: Broadband Subscription Rates, N.C. Counties, 2017 .....	76
6.2E: MCNC Broadband Fiber Network Statewide, 2019 .....	76

### INDICATOR 6.3: COST OF LIVING INDEX

6.3A: Cost of Living Index, All U.S. States, 2018 .....	78
6.3B: Cost of Living Index, N.C. Counties, 2018 .....	79

### INDICATOR 6.4: INDUSTRY MIX

6.4A: Industry Employment, Annualized Employment Growth, and Concentration, All Industries, North Carolina, 2018 .....	80
6.4B: Sector Employment, Annualized Employment Growth, Concentration, and Average Wage, All N.C. Sectors .....	81
6.4C: Industry Employment, Annualized Employment Growth, and Concentration, High SET Employment Industries, North Carolina, 2018. ..	82
6.4D: Employment and Wages in High SET Employment Industries, N.C. ....	83
6.4E: Manufacturing GDP as a Percentage of State GDP, All U.S. States, 2018 .....	85
6.4F: High SET Manufacturing GDP as a Percentage of State GDP, All U.S. States, 2018 .....	85
6.4G: Manufacturing GDP as a Percentage of State GDP, Comparison States, 2007-2018 .....	85
6.4H: High SET Manufacturing GDP as a Percentage of State GDP, Comparison States, 2007-2018 .....	86

<b>APPENDIX</b> .....	<b>87</b>
-----------------------	-----------

<b>SOURCES</b> .....	<b>89</b>
----------------------	-----------

<b>ACKNOWLEDGEMENTS</b> .....	<b>97</b>
-------------------------------	-----------

<b>N.C. BOARD OF SCIENCE, TECHNOLOGY &amp; INNOVATION</b> .....	<b>98</b>
---	-----------

## Indicator 1.1: Gross Domestic Product (GDP)

### KEY FINDINGS

- North Carolina’s per capita GDP ranks below the U.S. average, has since at least 2000, and is increasing at a rate slower than the U.S. average.
- In comparison with top foreign countries, North Carolina’s per capita GDP ranks approximately 13<sup>th</sup> overall but is increasing at a much slower rate.
- Within North Carolina, three Metropolitan Statistical Areas (MSAs) had per capita GDPs higher than or equal to the national average for MSAs in 2017; since 2000, the per capita GDP of most of North Carolina’s MSAs has increased at a rate slower than the U.S. average.

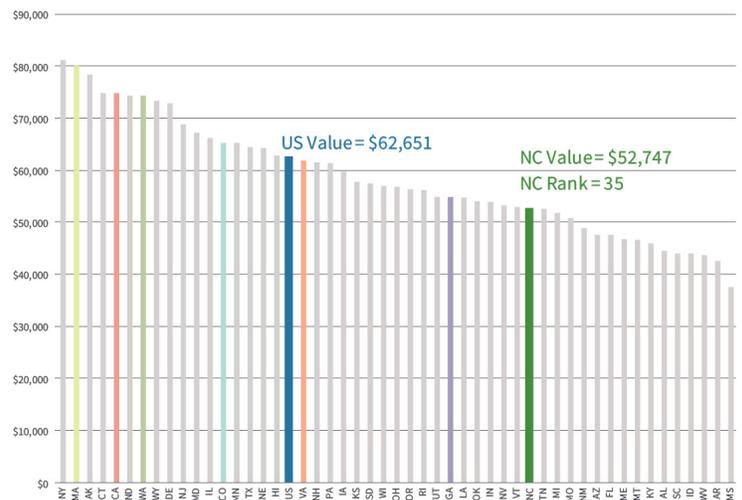
### INDICATOR OVERVIEW

Gross domestic product (GDP) per capita captures the overall economic performance of a locale (e.g., state, country, or region). GDP is a measure of the total value of goods and services produced by an economy; on a per capita basis, GDP provides a measure of the productive capacity of a locale’s workforce.<sup>1</sup> Although GDP is influenced by a wide range of factors—many of which are unrelated to a state’s innovation economy—one of the ultimate aims of fostering innovation is to increase per capita GDP and other related indicators of economic performance.

### HOW DOES NORTH CAROLINA PERFORM?

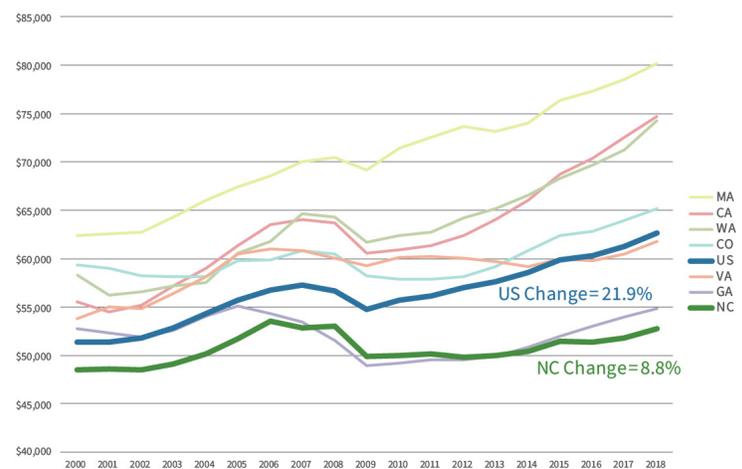
In 2018, North Carolina’s per capita GDP of \$52,747 was below the national average (\$62,651) and below the midpoint of the individual state distribution, ranking 35<sup>th</sup> overall **[1.1A]**. All the comparison states except Georgia and Virginia had an average per capita GDP above the national average. Since 2000, inflation-adjusted per capita GDP has increased in North Carolina by 8.8 percent. This percentage increase is slower than the 21.9 percent growth rate for the nation **[1.1B]**. Indeed, North Carolina has fallen from the 21<sup>st</sup>-ranked state in per capita GDP in 2000 to 35<sup>th</sup> in 2018. Among the comparison states, Colorado (9.8 percent), Georgia (3.9 percent), and Virginia (14.8 percent) also experienced lower-than-the-U.S.-average growth in per capita GDP since 2000.

### 1.1A PER CAPITA GROSS DOMESTIC PRODUCT, ALL U.S. STATES, 2018



Source: U.S. Bureau of Economic Analysis.

### 1.1B PER CAPITA GROSS DOMESTIC PRODUCT, COMPARISON STATES, 2000-2018



Source: U.S. Bureau of Economic Analysis.

Note: Adjusted for Inflation (2018 Dollars).

<sup>1</sup> For the purposes of this report, the term “gross domestic product (GDP)” is used as a general counterpart to the more specific terms “gross state product (GSP)” at the state level, “gross regional product (GRP)” at the regional level, and “gross metro product (GMP)” at the metropolitan statistical area level.

# ECONOMIC WELL BEING

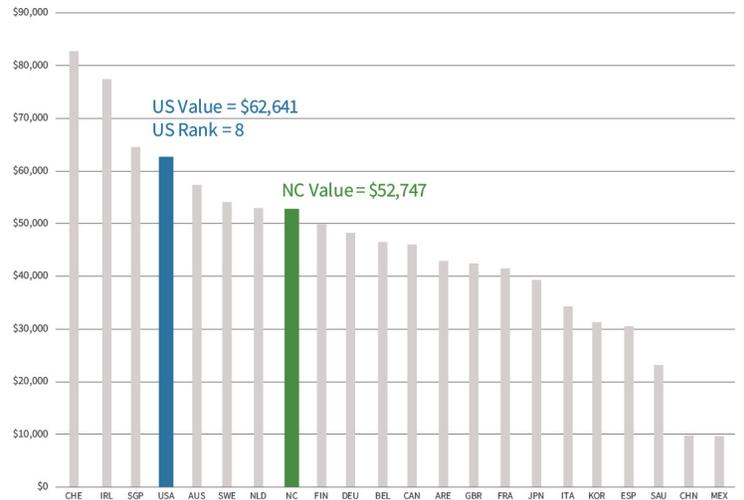
## Indicator 1.1: Gross Domestic Product (GDP)

Internationally, U.S. per capita GDP was the 8<sup>th</sup> highest in the world in 2018 [1.1C]. Many of the countries ahead of the U.S. have unique economies (often heavily dependent on native natural resources) and small populations, however, which explains their higher per capita GDP levels. In comparison with top foreign countries, North Carolina's per capita GDP ranks approximately 13<sup>th</sup> overall, between that of the Netherlands and Finland. While highly populated countries such as China and Mexico have large absolute GDPs, their per capita GDPs remain relatively small, ranking 66<sup>th</sup> and 67<sup>th</sup>, respectively.

Since 2000, the per capita GDP of each of the 20 comparison countries except Japan, Saudi Arabia, the United Kingdom, the United Arab Emirates, and Mexico has risen at a much faster rate (an average of 90 percent across the countries) than that of the U.S. (21.9 percent) and North Carolina (8.8 percent) [1.1D]. Additionally, while the per capita GDPs of most of the 20 comparison countries were relatively lower than that of the U.S. and North Carolina in 2000, by 2018 the per capita GDP of three countries (Switzerland, Ireland, and Singapore) had risen to be higher than both the U.S. and North Carolina's values, and the per-capita GDP in another three countries (Australia, Sweden, and the Netherlands) had risen to be below the U.S.'s but above North Carolina's. While the per-capita GDP in the remaining comparison countries remained relatively low between 2000 and 2018, their average growth rate was 57.6 percent, with China's GDP growing especially rapidly at 448.9 percent.

### 1.1C

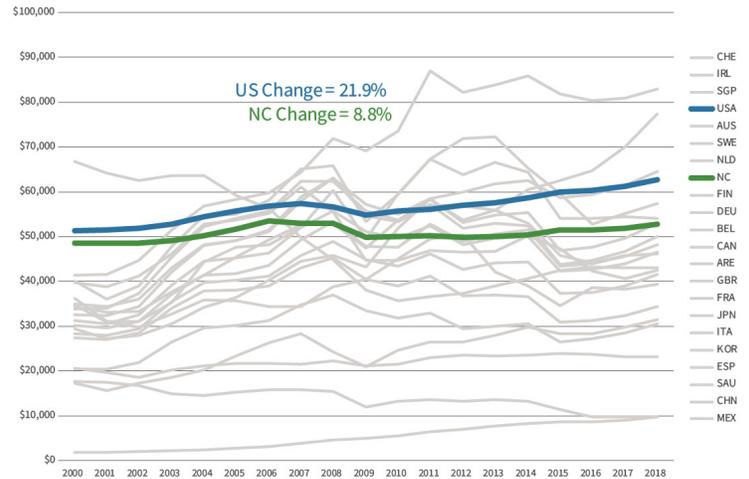
#### PER CAPITA GROSS DOMESTIC PRODUCT, COMPARISON COUNTRIES, 2018



Source: World Bank, World Development Indicators, U.S. Bureau of Economic Analysis.

### 1.1D

#### PER CAPITA GROSS DOMESTIC PRODUCT, COMPARISON COUNTRIES, 2000-2018



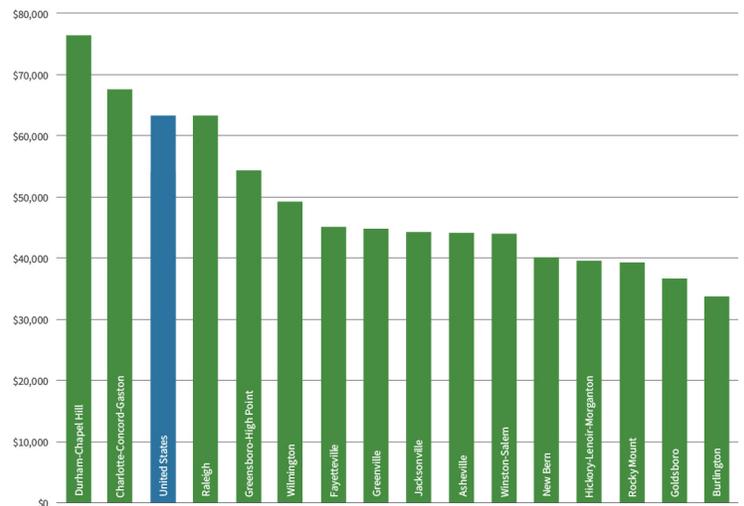
Source: World Bank, World Development Indicators, U.S. Bureau of Economic Analysis.

## Indicator 1.1: Gross Domestic Product (GDP)

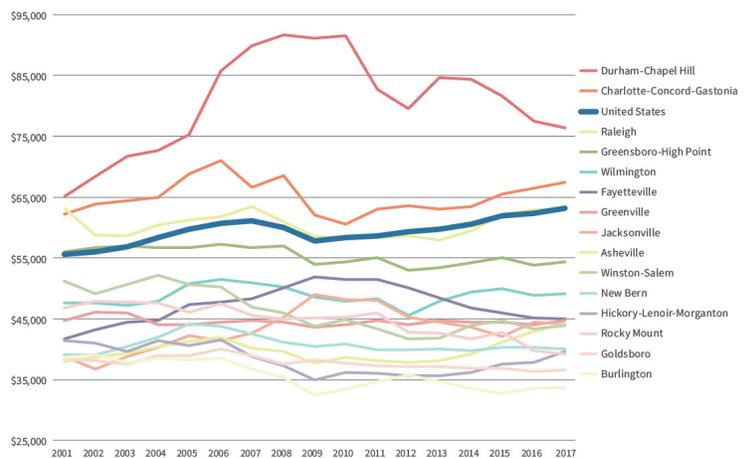
Within North Carolina, two Metropolitan Statistical Areas (MSAs)—Durham-Chapel Hill and Charlotte-Concord-Gastonia—had higher per capita GDPs than the U.S. average in 2017, while the Raleigh MSA’s GDP is essentially equal with the U.S. average [1.1E, 1.1G].<sup>2</sup> The remaining 12 metro areas rank below the U.S. average. The Durham-Chapel Hill MSA accelerated between 2000 and 2017, increasing its per capita GDP by 17 percent [1.1F]. Over the same time period, the U.S. average increased by 14 percent, and other large North Carolina MSAs such as Charlotte-Concord-Gastonia and Raleigh increased by 8 percent and 0 percent, respectively. Among the other North Carolina MSAs, Jacksonville (14%) and Asheville (16%) grew at rates equal to or above the U.S average, whereas the remaining North Carolina MSAs grew at a slower rate than the U.S. average or declined overall.

In terms of total GDP, two NC MSAs combined—Charlotte-Concord-Gastonia (36 percent) and Raleigh (18 percent)—account for more than half (54 percent) of all the state’s GDP accounted for by MSAs [1.1H]. The next three MSAs combined—Durham-Chapel Hill (9 percent), Greensboro-High Point (9 percent), and Winston-Salem (6 percent)—account for another 25 percent of the state’s GDP accounted for by MSAs. This means that five of the state’s 15 MSA’s account for 78 percent of the state’s GDP accounted for by MSAs. The next six MSAs combined—Asheville (4 percent), Fayetteville (4 percent), Hickory-Lenoir-Morganton (3 percent), Wilmington (3 percent), Jacksonville (2 percent), and Greenville (2 percent)—account for another 18 percent of the state’s GDP accounted for by MSAs, bringing the total accounted for by the preceding MSAs to 96 percent. Each of the remaining four MSAs combined—Rocky Mount, Burlington, New Bern, and Goldsboro—accounts for 1 percent of the state’s GDP accounted for by MSAs.

**1.1E PER CAPITA GROSS DOMESTIC PRODUCT, N.C. MSAS, 2017**

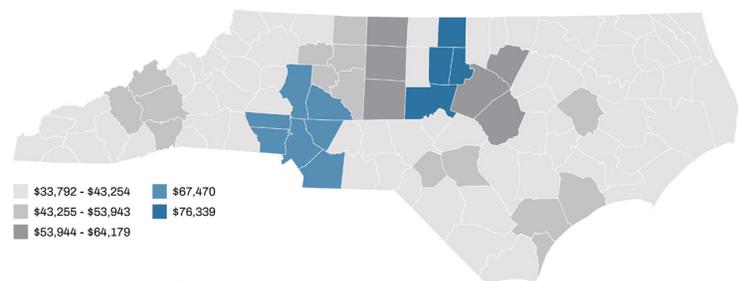


**1.1F PER CAPITA GROSS METRO PRODUCT, N.C. MSAS, 2001-2017**



Note: Adjusted for Inflation (2018 Dollars)

**1.1G PER CAPITA GROSS METRO PRODUCT, N.C. MSAS, 2017**



Source: U.S. Bureau of Economic Analysis.

Note: Adjusted for inflation (2018 dollars). MSAs appearing in blue rank above the U.S. average.

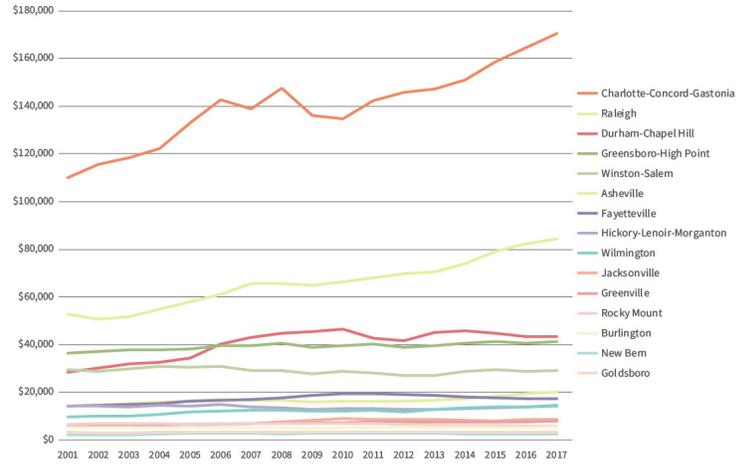
<sup>2</sup> In December 2018, the U.S. Bureau of Economic Analysis released prototype statistics for GDP by county for 2012-2015. Because those statistics are a prototype and not current, they are not used here.

## Indicator 1.1: Gross Domestic Product (GDP)

### WHAT DOES THIS MEAN FOR NORTH CAROLINA?

Trends in per capita GDP in North Carolina are a cause for concern. As of 2018, the state performed well below average in comparison with all U.S. states. Additionally, North Carolina's per capita GDP value has grown more slowly since 2000 than has the national value and those of several comparison countries. Because per capita GDP measures the ability of the state economy to support residents and weather economic turbulence, it is important that North Carolina improve this statistic by taking smart, strategic steps to grow the economy. Fostering innovation is one such step; the value added by innovation can improve productivity and is often compensated with increasing jobs, income, and profit.

### 1.1H TOTAL GROSS DOMESTIC PRODUCT, N.C. MSAS, 2001-2017



Note: Adjusted for Inflation, 2018 Dollars (Millions of Dollars)

## Indicator 1.2: Income

### KEY FINDINGS

- North Carolina’s per capita income ranks below the U.S. average, has since at least 2000, and, adjusted for inflation, is increasing more slowly than the U.S. per capita income is increasing.
- North Carolina’s median household income ranks below the U.S. average, has since at least 2005, and, adjusted for inflation, is increasing more slowly than the U.S. median household income is increasing.
- Within North Carolina, county per capita income and median household income vary considerably. On both income measures, most North Carolina counties have incomes well below the state average and the U.S. average.

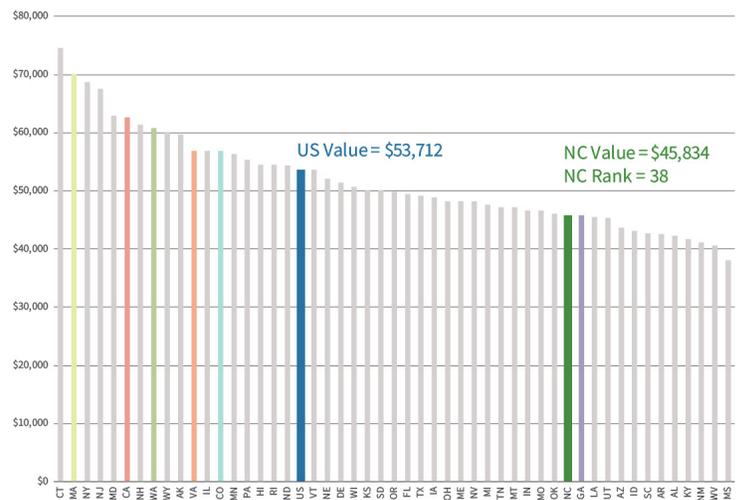
### INDICATOR OVERVIEW

The two measures of income examined within this indicator—per capita income and median household income—can be used to approximate economic prosperity and the ability of the economy to generate improved standards of living for its citizens.<sup>1</sup> Per capita personal income is the total income received from all sources divided by the total population; it measures the amount of wealth generated by an economy from wages and salaries, transfer payments, dividends, interest, rents and proprietor’s income for each person in that economy. Per capita income may, however, obscure differences in income distribution, as it depends somewhat on demographics, such as the share of a state’s population that is of working age. Thus, to add more clarity to North Carolina’s income picture, median household income—the income amount at which half of all households fall above and half of all households fall below—is included here as a second measure of income. Median household income provides insight into changes in economic conditions for middle-income households.

### HOW DOES NORTH CAROLINA PERFORM?

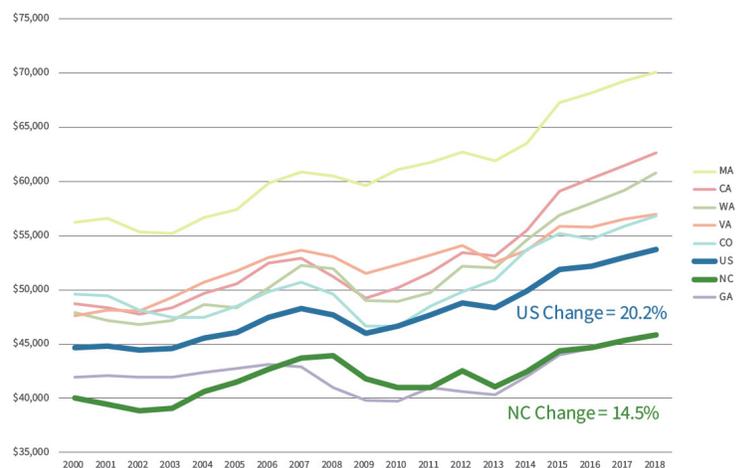
Per capita personal income in North Carolina was \$45,834 in 2018 [1.2A]. This income is 85 percent of the national per capita personal income (\$53,712) and places North Carolina as the 38<sup>th</sup>-highest performing state in the country. North Carolina’s per capita personal income ranks below that of all the comparison states except Georgia. Since 2000, the inflation-adjusted per capita personal income in North Carolina increased by 14.5 percent while per capita income increased by 20.2 percent for the country as a whole [1.2B]. Over the same period, per capita income in some comparison states has increased faster than the national average; for example, per capita income increased in Massachusetts by 24.6 percent and in Virginia by 19.6 percent.

#### 1.2A PER CAPITA INCOME, ALL U.S. STATES, 2018



Source: U.S. Bureau of Economic Analysis.

#### 1.2B PER CAPITA INCOME, COMPARISON STATES, 2000-2018



Source: U.S. Bureau of Economic Analysis.

Note: Adjusted for Inflation (2018 Dollars).

<sup>1</sup> Income measures in this indicator do not account for differences in cost of living. Thus, the income earned in one state may provide a citizen in that state with more or less purchasing power than the same income provides a citizen in a different state. See indicator 6.3 for cost of living comparisons.



## Indicator 1.3: Average Annual Wage

### KEY FINDINGS

- North Carolina’s average annual wage in 2018 ranked considerably below the U.S. average and the average wages of all comparison states.
- Between 2001 and 2018, North Carolina’s inflation-adjusted average wage increased at a rate slightly faster than the rate of increase in the U.S. average wage. Average annual wages for workers in high science, engineering, and technology (SET) employment industries, in both North Carolina and the U.S. overall, are consistently much higher than the average annual wages for workers in all industries.
- Within North Carolina, only three counties had average annual wages higher than the U.S. average annual wage in 2018; only five counties had average annual wages higher than the N.C. average.

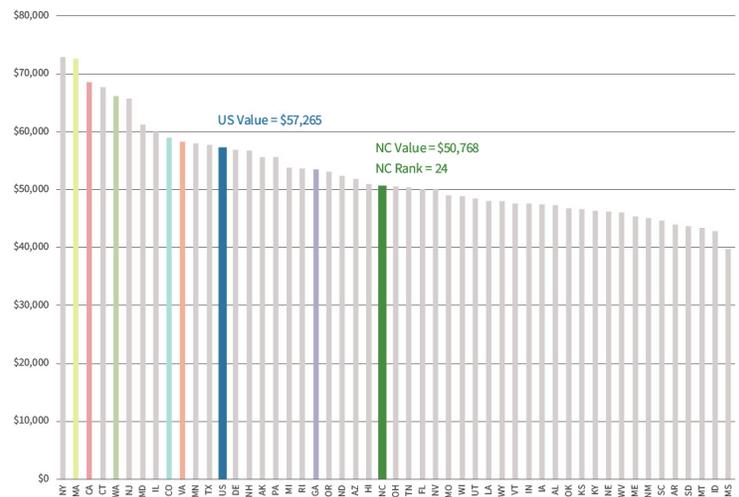
### INDICATOR OVERVIEW

An economy’s average annual wage reflects and provides insight into its mix of jobs. Low average annual wages typically indicate that an economy has a high percentage of low-wage jobs that may be in low-technology and labor-intensive economic sectors. High average annual wages typically indicate that a state’s industry mix provides a larger share of middle- and high-wage jobs and generates relatively high standards of living. Enhancing North Carolina’s innovation-based economy, fueled by industries with high science, engineering, and technology (SET) employment, can lead to higher average annual wages, ultimately leading to greater economic well-being and quality of life.

### HOW DOES NORTH CAROLINA PERFORM?

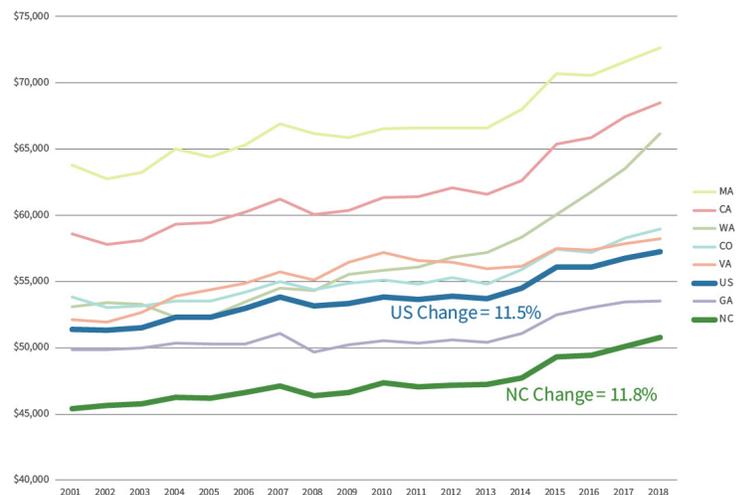
In 2018, the average annual wage in North Carolina was \$50,768, ranking the state 24<sup>th</sup> highest in the country and well below the national average of \$57,265 [1.3A]. All six comparison states had higher average wages than North Carolina, and Georgia is the only other comparison state with an average wage lower than the national average. North Carolina’s modest performance relates to the industry mix of its economy, which continues to depend—more than many other states do—on low-technology industries that are sensitive to labor costs (see indicator 4.1). From 2001 to 2018, the inflation-adjusted average annual wage in North Carolina grew by 11.8 percent, which is slightly higher than the national growth rate (11.5 percent) and in the middle of the pack among the comparison states—behind Washington, California, and Massachusetts, equal to Virginia, and ahead of Colorado and Georgia [1.3B].

### 1.3A AVERAGE ANNUAL WAGE, ALL U.S. STATES, 2018



Source: Bureau of Labor Statistics, U.S. Department of Labor.

### 1.3B AVERAGE ANNUAL WAGE, COMPARISON STATES, 2001-2018



Source: Bureau of Labor Statistics, U.S. Department of Labor.  
Note: Adjusted for Inflation (2018 Dollars).

## Indicator 1.3: Average Annual Wage

In 2018, the average annual wage for workers in high SET employment industries in North Carolina was \$98,058, more than \$47,000 (or nearly 100 percent) greater than the average wage for workers in all industries in the state, \$50,768 [1.3C]. This pattern reflects national patterns, in which the high SET employment average wage of \$112,065 is nearly twice the average wage for all industries, \$57,265.

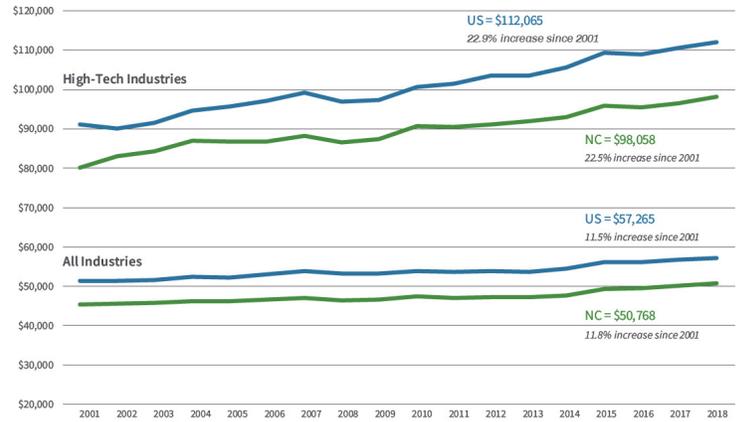
Within North Carolina, the vast majority of counties have an average annual wage lower than the state average. Only five counties—Durham, Mecklenburg, Wake, Orange, and Forsyth—had a 2018 average wage higher than the state average; only three counties—Durham, Mecklenburg, and Wake—had a 2018 average wage higher than the U.S. average [1.3D]. This pattern reflects the fact that high-wage, innovation-based jobs typically are concentrated in a few, typically urban, counties (see indicators 4.1 and 4.2).

### WHAT DOES THIS MEAN FOR NORTH CAROLINA?

North Carolina's average annual wage in 2018 was below the average annual wage for the nation as a whole and for all comparison states. However, average wages in North Carolina have increased over time, and this increase has been slightly higher than the growth experienced by the country as a whole. Overall, the wage picture in North Carolina is improving somewhat but is still lower than it should be. A key way to increase wages is to increase the number of workers employed in high SET industries and other knowledge-based industries. Growth in these occupations will lead to higher standards of living for North Carolinians, increased consumer spending, and economic growth across the state.

1.3C

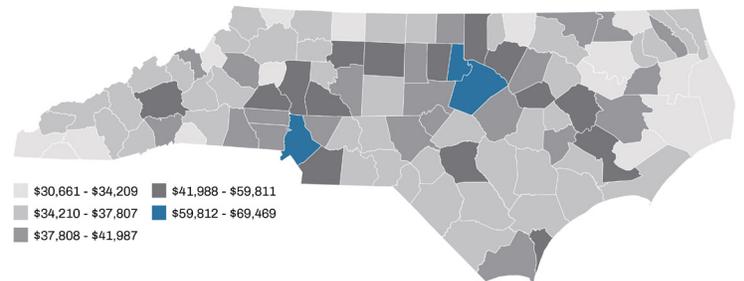
### AVERAGE ANNUAL WAGE, HIGH SET EMPLOYMENT INDUSTRIES AND ALL INDUSTRIES, U.S. AND N.C., 2001-2018



Source: Bureau of Labor Statistics, U.S. Department of Labor.  
Note: Adjusted for Inflation (2018 Dollars).

1.3D

### AVERAGE ANNUAL WAGE, N.C. COUNTIES, 2018



Source: Bureau of Labor Statistics, U.S. Department of Labor.  
Note: Blue counties rank above the U.S. average.

## Indicator 1.4: Unemployment

### KEY FINDINGS

- North Carolina's unemployment rate is equal to the U.S. average but has risen at a rate faster than the national rate since 2000, particularly during the 2007-2009 recession.
- In comparison with top foreign countries, North Carolina's unemployment rate ranks better than average.
- A majority of North Carolina counties have unemployment rates higher than the state average and national average.

### INDICATOR OVERVIEW

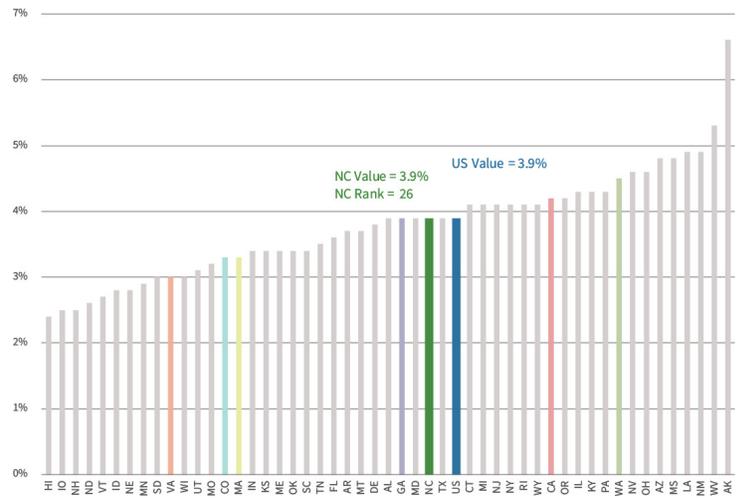
The unemployment rate is the percentage of labor force participants who are unemployed but actively seeking and available for work. Unemployment is generally viewed as a lagging indicator that reflects the performance of an economy. Unemployment rates indicate the degree to which an economy provides sufficient jobs to its labor force; higher rates show a relative inability to generate job opportunities.

### HOW DOES NORTH CAROLINA PERFORM?

The average unemployment rate for North Carolina in 2018 was 3.9 percent **[1.4A]**. This unemployment rate is identical to the national unemployment rate of 3.9 percent and is the 26<sup>th</sup> lowest rate of all states in the country.<sup>1</sup> Among comparison states, North Carolina ranks in the middle of the pack, behind California, Georgia, and Washington, but ahead of Massachusetts, Virginia, and Colorado.

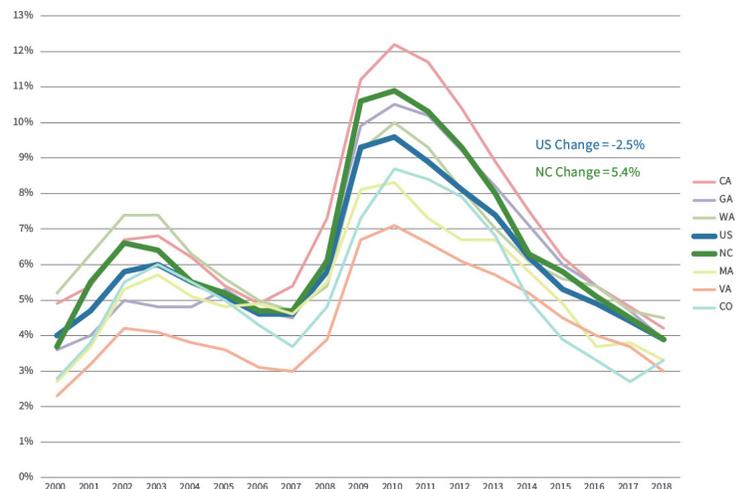
Between 2000 and 2018, North Carolina's unemployment rate rose, whereas the national rate decreased; specifically, North Carolina's unemployment rate increased by 5.4 percent, while the U.S. unemployment rate decreased by 2.5 percent **[1.4B]**. North Carolina's increase was smaller than the increase in four of the comparison states (Colorado, Georgia, Massachusetts, Virginia). The recession beginning in late 2007 and early 2008 caused unemployment rates to spike in 2010 (particularly in North Carolina and California) but then to reverse and decrease steadily to pre-recession levels by 2018.

### 1.4A UNEMPLOYMENT RATE, ALL U.S. STATES, 2018



Source: Bureau of Labor Statistics, U.S. Department of Labor.

### 1.4B UNEMPLOYMENT RATE, COMPARISON STATES, 2000-2018



Source: Bureau of Labor Statistics, U.S. Department of Labor.

<sup>1</sup> NC is tied with Alabama, Georgia, Maryland, and Texas.

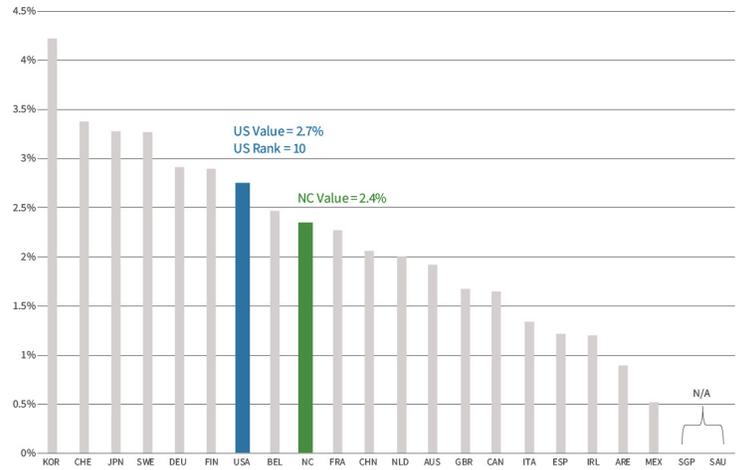
## Indicator 1.4: Unemployment

Internationally, the U.S. had the 67<sup>th</sup> lowest unemployment rate in the world in 2018 [1.4C]. Among the 20 comparison countries, Japan, the United Arab Emirates, Mexico, Germany, Singapore, the Republic of Korea, and the Netherlands all have lower unemployment rates in 2018. North Carolina's unemployment rate, consistent with the U.S. unemployment rate, is higher than the rates of these countries.

Since 2000, the unemployment rates in North Carolina and the U.S. have varied relatively consistently with the rates in nearly all the comparison countries, though the rate of their increase was higher than the rates for most countries during the 2007-2009 recession. [1.4D]. The recession hit North Carolina especially hard, due primarily to its disproportionate unemployment impact on sectors such as financial services and low-skill, low-tech manufacturing, in which North Carolina has had a higher-than-average presence.

1.4C

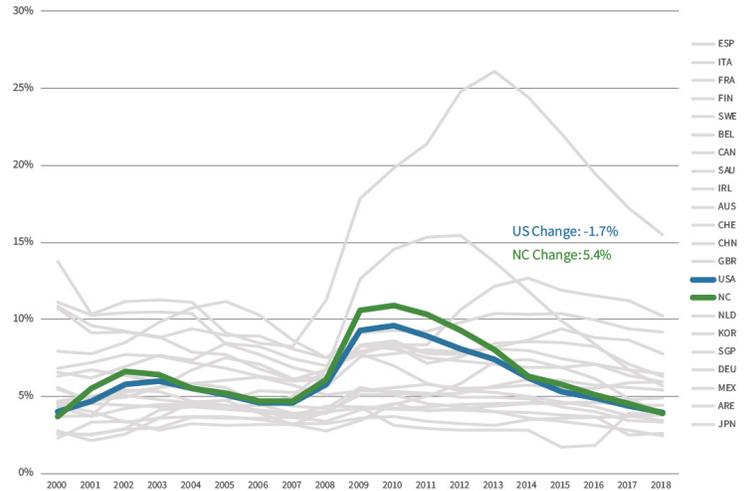
### UNEMPLOYMENT RATE, COMPARISON COUNTRIES, 2018



Source: World Bank World Development Indicators, Bureau of Labor Statistics, U.S. Department of Labor.

1.4D

### UNEMPLOYMENT RATE, COMPARISON COUNTRIES, 2000-2018



Source: World Bank World Development Indicators, Bureau of Labor Statistics, U.S. Department of Labor.

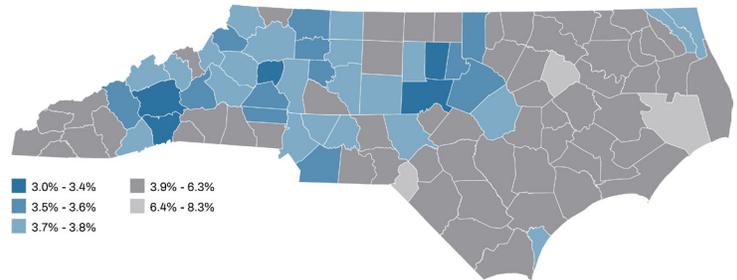
## Indicator 1.4: Unemployment

There is significant variability in unemployment rates across North Carolina [1.4E]. In 2018, unemployment rates were lower than or equal to the state average and U.S. average in 44 counties, with 56 counties having rates above the state and U.S. average. At 3.0 percent, Buncombe County had the lowest unemployment rate of all counties, whereas Hyde County, with unemployment at 8.3 percent, had the highest unemployment in the state.

### WHAT DOES THIS MEAN FOR NORTH CAROLINA?

In terms of unemployment, North Carolina is in the middle of the pack compared to other states and better than average relative to the comparison countries. North Carolina's higher than average unemployment increase during the 2007-2009 recession resulted primarily from the disproportionate unemployment impact on sectors such as financial services and low-skill, low-tech manufacturing, in which North Carolina has had a higher-than-average presence. Though North Carolina's employment rate has since converged with the U.S. average, growing the state's innovation economy would serve to increase employment in STEM (science, technology, engineering, and math) fields and would have strong multiplier effects in industries seemingly unrelated to technology and innovation. These developments would help insulate the state's unemployment rate further from recessionary impacts. As the North Carolina economy continues to shift to higher-skill jobs, the job creation potential of the innovation economy could help the state to replace jobs in declining industries.

### 1.4E UNEMPLOYMENT RATE, N.C. COUNTIES, 2018



Source: World Bank World Development Indicators, Bureau of Labor Statistics, U.S. Department of Labor.

Note: Blue counties rank below the U.S. average.

## Indicator 1.5: Poverty

### KEY FINDINGS

- The percentage of North Carolinians in poverty is above the U.S. average and has been since at least 2005, but is decreasing at a rate slightly faster than the U.S. average.
- Within North Carolina, the percentage of the population living in poverty varies greatly; while the majority of counties had poverty levels lower than the state average, only a small minority have poverty levels lower than the U.S. average.

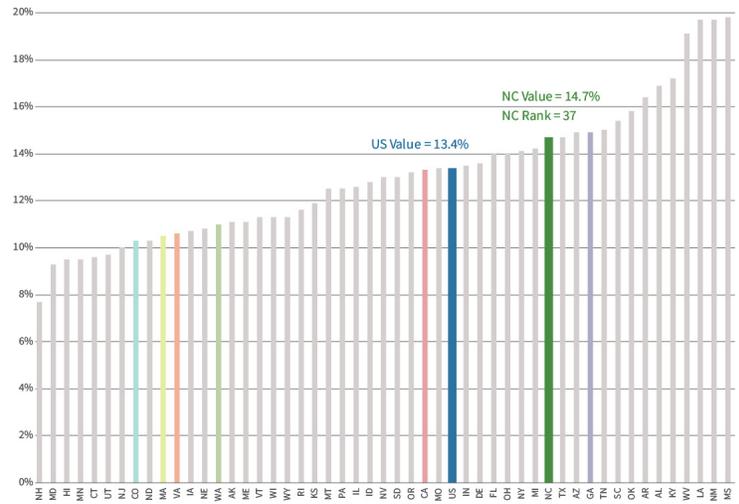
### INDICATOR OVERVIEW

This indicator explores the extent to which the North Carolina innovation economy provides opportunities for the entire state workforce. Monitoring poverty is important for examining the effects of the state economic shift from a low-skill manufacturing-based economy to one based on knowledge use and production. High or widespread poverty levels indicate that advances in the innovation economy are failing to translate into greater opportunity for all North Carolinians. On the other hand, low or decreasing poverty levels may suggest that the high-wage jobs associated with the knowledge-based economy are leading to the improved economic standing of all North Carolinians.

### HOW DOES NORTH CAROLINA PERFORM?

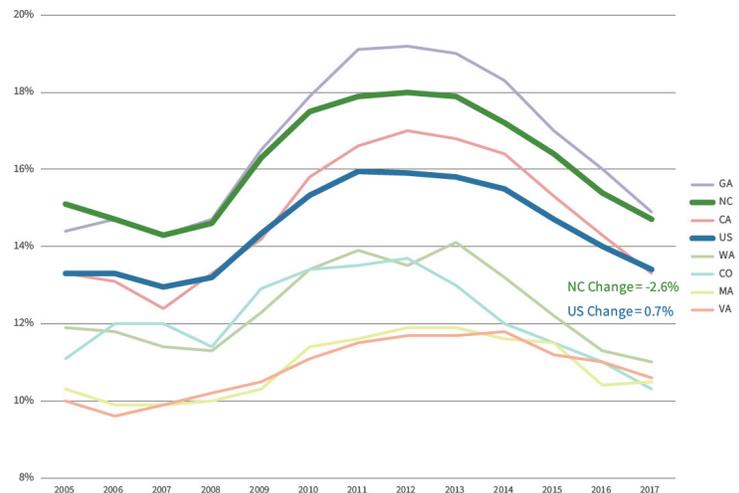
In 2017, 14.7 percent of North Carolinians lived in poverty **[1.5A]**. This is above the national poverty rate of 13.4 percent and ranks North Carolina 37<sup>th</sup> lowest in the country in terms of the share of its population in poverty. North Carolina's rank places it below all comparison states except Georgia. The majority of comparison states had a poverty rate lower than the national average. Over time, North Carolina's poverty rate has decreased by 2.6 percent from 2005 to 2017 **[1.5B]**. This percentage decrease is more than the national decrease (.7 percent) but less than the decreases in Washington and Colorado (7.6 and 7.2 percent, respectively). The poverty rate in California did not change between 2005 and 2017, whereas the rates in Massachusetts, Virginia, and Georgia all increased (1.9, 3.5, and 6.0 percent, respectively).

### 1.5A PERCENTAGE OF CITIZENS IN POVERTY, ALL U.S. STATES, 2017



Source: U.S. Census Bureau.

### 1.5B PERCENTAGE OF CITIZENS IN POVERTY, COMPARISON STATES, 2005-2017



Source: U.S. Census Bureau.

## Indicator 1.5: Poverty

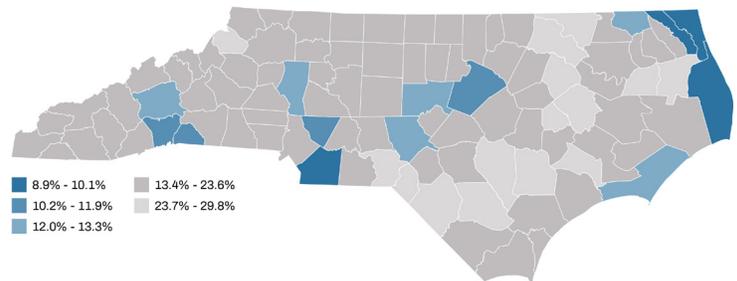
Five-year average poverty within North Carolina (2013–2017) ranged from a low of 8.9 percent in Dare County to 29.8 percent in Scotland County, with a state average of 18.3 percent **[1.5C]**. Fifty-five counties had an average poverty level lower than the state five-year average, and 14 had a poverty level lower than the U.S. average during that five-year period. Forty-five counties had an average poverty level higher than the state five-year average, and 86 had a poverty level higher than the U.S. average.

### WHAT DOES THIS MEAN FOR NORTH CAROLINA?

Current levels of poverty in North Carolina are not favorable when compared to national levels, though over-time trends are improving slightly. As the North Carolina economy becomes increasingly reliant on knowledge-based jobs, it will be vitally important that no segment of the population be isolated without means of generating income. The high and widespread poverty levels across the state indicate that advances in the innovation economy are failing to translate into greater opportunity for all North Carolinians. To the extent the state has low or improving poverty levels, they are concentrated in a small minority of counties. North Carolina policy should seek to reduce poverty, and income inequality more generally, to ensure that the economy of the future—highly reliant on innovation and knowledge production—generates economic opportunities for all citizens.

1.5C

### PERCENTAGE OF POPULATION BELOW POVERTY LEVEL, N.C. COUNTIES, 2013-2017 AVERAGE



Source: U.S. Census Bureau.

Note: Blue counties rank below the U.S. average.

## Indicator 1.6: Population Growth

### KEY FINDINGS

- Since 2000, North Carolina’s population has grown nearly twice as fast as the U.S. average.
- Within North Carolina, the location and growth of the population are highly concentrated in a very small number of counties.

### INDICATOR OVERVIEW

This indicator measures the extent to which North Carolina’s total population is growing over time. For a given state, three components make up population growth: (1) natural growth—the excess of births over deaths; (2) in-migration—the movement of people from another state; and (3) immigration—the movement of people from outside the country to the state. Changes in population have social and economic implications that influence business location decisions, infrastructure demands, and service requirements. Population growth is also considered an indicator of economic and social opportunities, as people often move to regions where there are job opportunities or a high quality of life.

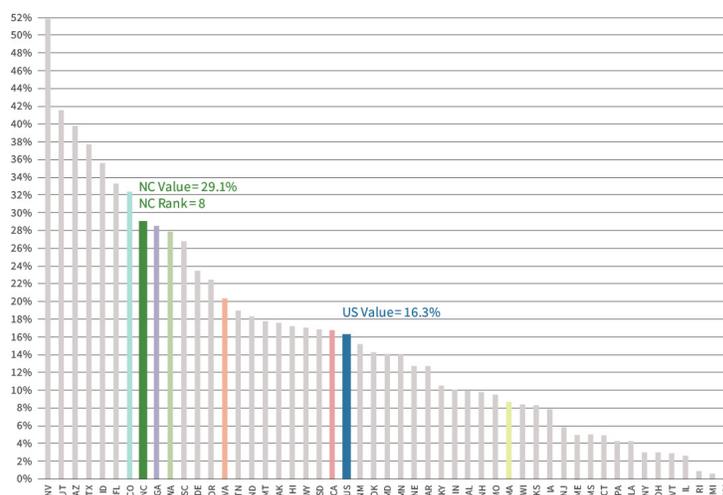
### HOW DOES NORTH CAROLINA PERFORM?

In 2018, North Carolina ranked as the 9<sup>th</sup> most populous state in the country, with a total resident population of 10,383,620. In terms of percentage change in population between 2000 and 2018, North Carolina ranks 8<sup>th</sup> in the nation, with a value that is 179 percent of the U.S. value and 56 percent of the value of the top-ranking state, Nevada [1.6A]. Among the comparison states, North Carolina ranks second, slightly behind Colorado, slightly ahead of Georgia and Washington, and well ahead of Virginia, and California, all of which are growing faster than the U.S. average. Massachusetts is the only comparison state whose rate of population growth is below the U.S. average.

Within North Carolina, the location and growth of the population are highly concentrated in a small number of counties [1.6B]. In terms of location, the state’s three most populous counties account for more than 26.2 percent of the state’s population—Mecklenburg (10.5 percent), Wake (10.5 percent), and Guilford (5.1 percent). Together, the 10 next most populous counties—Forsyth (3.7 percent), Cumberland (3.2 percent), Durham (3.1 percent), Buncombe (2.5 percent), Union (2.3 percent), New Hanover (2.2 percent), Gaston (2.1 percent), Cabarrus (2.0 percent), Johnston (2.0 percent), and Onslow (1.9 percent)—account for nearly 25 percent of the state’s population. In total, this means that 13 of the state’s 100 counties account for slightly more than half the state’s population.

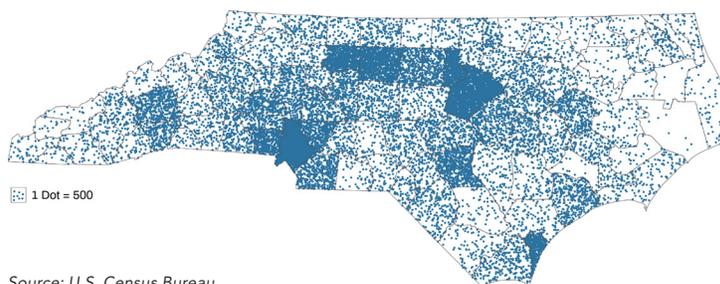
Each of the 13 next most populous counties—Pitt, Iredell, Davidson, Alamance, Catawba, Orange, Randolph, Rowan, Brunswick, Harnett, Robeson, Wayne, and Henderson—has

### 1.6A PERCENTAGE CHANGE IN POPULATION, ALL U.S. STATES, 2000-2018



Source: U.S. Census Bureau.

### 1.6B ESTIMATED LOCATION OF POPULATION IN N.C., 2018



Source: U.S. Census Bureau.

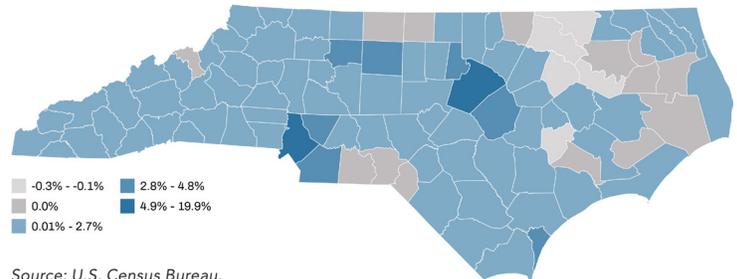
## Indicator 1.6: Population Growth

between 1.8 and 1.0 percent of the state’s population, a percentage slightly greater than or equal to each county’s respective share (1 percent) of the total number of counties (100). These 13 counties, plus the 13 more populous ones, account for 70 percent, or nearly three-fourths of the state’s total population. Each of the remaining 74 counties has less than one percent of the state’s total population, and together they account for 30.0 percent of the state’s total population.

In terms of growth, the level of concentration is even greater than the distribution of population [1.6C, 1.6D]. Two counties account for 36.1 percent of the population growth between 2000 and 2018—Wake (19.4 percent) and Mecklenburg (16.7 percent). Together, the next three counties—Guilford (4.7 percent), Union (4.7 percent), and Durham (3.9 percent)—account for another 13.3 percent of the state’s population growth. In total, this means that five of the state’s 100 counties account for nearly half the state’s population growth since 2000. To reach over 75 percent of the state’s population growth, only 10 more counties (for a total of 15) are needed—Johnston (3.4 percent), Cabarrus (3.4 percent), Forsyth (3.1 percent), New Hanover (3.0 percent), Brunswick (2.7 percent), Iredell (2.3 percent), Buncombe (2.2 percent), Onslow (2.2 percent), Pitt (1.9 percent), and Harnett (1.8 percent). Another seven counties—Alamance, Gaston, Cumberland, Orange, Henderson, Moore, and Chatham—each accounts for between 1.8 and 1.0 percent of the state’s population growth between 2000 and 2018. Each of the remaining 78 counties has approximately one percent or less of the state’s total population growth, and together they account for 16.6 percent of the state’s total population growth.

### 1.6C

#### POPULATION CHANGE, PERCENT OF TOTAL CHANGE, N.C. COUNTIES, 2000-2018



Source: U.S. Census Bureau.

Note: Blue counties are increasing in population.

### 1.6D

#### POPULATION CHANGE, PERCENT OF TOTAL CHANGE, N.C. COUNTIES, 2000-2018

County	Population 2000	Population 2018	Absolute Change 2000-2018	Percent of Total Change	Cumulative Percent of Total Change
Wake	627,846	1,092,305	464,459	19.4%	19.4%
Mecklenburg	695,454	1,093,901	398,447	16.7%	36.1%
Guilford	421,048	533,670	112,622	4.7%	40.8%
Union	123,677	235,908	112,231	4.7%	45.5%
Durham	223,314	316,739	93,425	3.9%	49.4%
Johnston	121,965	202,675	80,710	3.4%	52.7%
Cabarrus	131,063	211,342	80,279	3.4%	56.1%
Forsyth	306,067	379,099	73,032	3.1%	59.1%
New Hanover	160,307	232,274	71,967	3.0%	62.2%
Brunswick	73,143	136,744	63,601	2.7%	64.8%
Iredell	122,660	178,435	55,775	2.3%	67.1%
Buncombe	206,330	259,103	52,773	2.2%	69.4%
Onslow	150,355	197,683	47,328	2.0%	71.3%
Pitt	133,798	179,914	46,116	1.9%	73.3%
Harnett	91,025	134,214	43,189	1.8%	75.1%
Alamance	130,800	166,436	35,636	1.5%	76.6%
Gaston	190,365	222,846	32,481	1.4%	77.9%
Cumberland	302,963	332,330	29,367	1.2%	79.1%
Orange	118,227	146,027	27,800	1.2%	80.3%
Henderson	89,173	116,748	27,575	1.2%	81.5%
Moore	74,769	98,682	23,913	1.0%	82.4%
Chatham	49,329	73,139	23,810	1.0%	83.4%
78 Other	3,260,206	3,656,310	396,104	16.6%	100.0%
<b>Total</b>	<b>7,803,884</b>	<b>10,196,524</b>	<b>2,392,640</b>	<b>100.0%</b>	<b>100.0%</b>

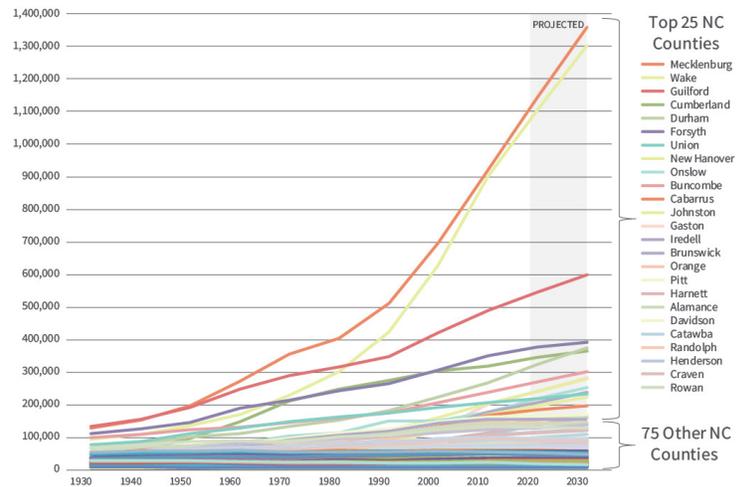
## Indicator 1.6: Population Growth

These recent population growth trends reflect longer-term population growth trends. Whereas in 1930 the respective populations of each of North Carolina’s 100 counties were relatively similar, by 2030 the respective county populations are projected to differ considerably [1.6E]. Specifically, in 1930 the most populous county (Guilford: 33,010) had 27 times more people than the least populous county (Tyrrell: 5,164), but in 2030 the most populous county (Mecklenburg: 1,360,319) is projected to have more than 369 times as many people as the least populous county (Tyrrell: 3,686). Between 1930 and 2030, two highly populated counties, Wake and Mecklenburg, are projected to grow by 1,275 percent and 963 percent, respectively, while the projected average growth rate across all other counties for that time period is 205 percent. Moreover, the top 25 counties in terms of growth rate between 1930 and 2030 account for 80 percent of the change in the state’s population during that time period, whereas the other 75 counties account for 20 percent of the change in the state’s population during that period. And each of top 25 counties accounts for at least 1 percent of the change in the state’s population between 1930 and 2030, whereas each of the other 75 counties accounts for less than 1 percent of the change in the state’s population between during that period; of those 75 counties, eight are decreasing in population. Overall, the pattern is for more populated counties to grow faster than less populated counties.

### WHAT DOES THIS MEAN FOR NORTH CAROLINA?

The relationship between population growth and economic well-being is strong and positive, as evidenced by high rates of population growth in counties and regions ranking high on the indicators of economic well-being (see indicators 1.1–1.5). North Carolina will continue to experience population growth from in-migrants and immigrants into those locales having high economic output, employment opportunities, and high wages. To the extent state leaders want that growth to continue, and to the extent that it actually does continue, the need to enhance and grow infrastructure (schools, utilities, roads/transit, broadband, water/sewer, etc.) will increase as well.

**1.6E** CHANGE IN POPULATION, N.C. COUNTIES, 1930-2030



## Indicator 2.1: Total Research & Development

### KEY FINDINGS

- North Carolina's total Research and Development (R&D) expenditures as a percentage of gross domestic product (GDP) ranks below the U.S. average and has since at least the early 2000s, but is increasing at a rate faster than the U.S. average.
- In comparison with top foreign countries, North Carolina's total R&D expenditures as a percentage of GDP ranks approximately 17<sup>th</sup> overall and is increasing at rate consistent with many of the most R&D-intensive countries.
- Businesses perform three-fourths of the R&D in North Carolina and are most concentrated in metropolitan regions; nearly 89 percent of the state's university R&D is concentrated in the Research Triangle region.

### INDICATOR OVERVIEW

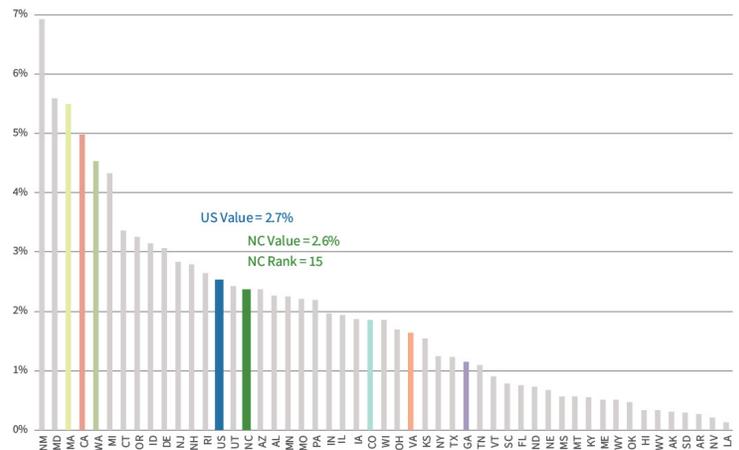
This indicator represents the extent to which R&D plays a role in a state's economy. R&D expenditures refer to R&D activities performed by businesses, universities, nonprofit organizations, and federal and state agencies.<sup>1</sup> R&D is the driving force behind innovation and sustained economic growth. Organizations performing R&D create new product or process innovations, thus expanding markets and sales, stimulating investment, and ultimately creating jobs. Companies located near R&D centers benefit from shared knowledge and expertise and are often the first to adopt new product and production technologies.

### HOW DOES NORTH CAROLINA PERFORM?

In terms of total R&D (industry + academic + all other) as a percentage of GDP, North Carolina's value ranks 15<sup>th</sup> in the nation, with a level that is 96 percent of the U.S. value [2.1A]. In other words, the ratio of R&D to GDP in North Carolina is 96 percent of what we would expect based on the national ratio of R&D to GDP. Moreover, the ratio of North Carolina's total R&D to GDP is just over one-third the value of the top-ranking state, New Mexico.<sup>2</sup>

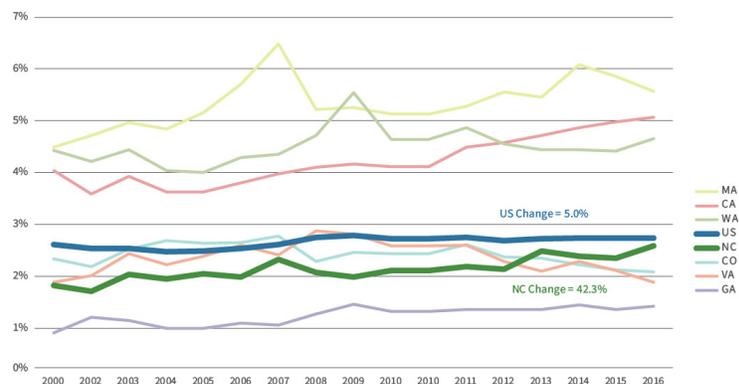
This ranking reflects the relative distribution of academic R&D to industry R&D within North Carolina and nationally. Specifically, North Carolina's academic R&D level per state GDP (see indicator 2.3) is 146 percent of the U.S. level, while its industry R&D level per industry output (see indicator 2.2) is 96 percent of the U.S. level and 43 percent of the leading state's (California). Nationwide and in North Carolina, industry R&D accounts for approximately 75 percent of total R&D,<sup>3</sup> meaning that North Carolina's lower-than-average rate of industry R&D puts it at a competitive disadvantage in total R&D. Since 2000, however, North Carolina's total R&D rate has been growing more than eight times faster than the U.S. rate, narrowing the gap between the two [2.1B].

### 2.1A TOTAL R&D EXPENDITURES AS A PERCENTAGE OF GDP, ALL U.S. STATES, 2016



Source: National Science Board.

### 2.1B TOTAL R&D EXPENDITURES A PERCENTAGE OF GDP, COMPARISON STATES, 2000-2016



Source: National Science Board.

<sup>1</sup> R&D-performing organizations either fund their own R&D activities or receive funding from other organizations. For example, a considerable portion of academic R&D performance is funded by the federal government.

<sup>2</sup> New Mexico commonly has the greatest value for this indicator by a significant margin due to the high concentration of R&D activities at two national laboratories in the state, combined with the state's relatively small gross domestic product.

<sup>3</sup> National Science Foundation, National Center for Science and Engineering Statistics, National Patterns of R&D Resources (annual series).

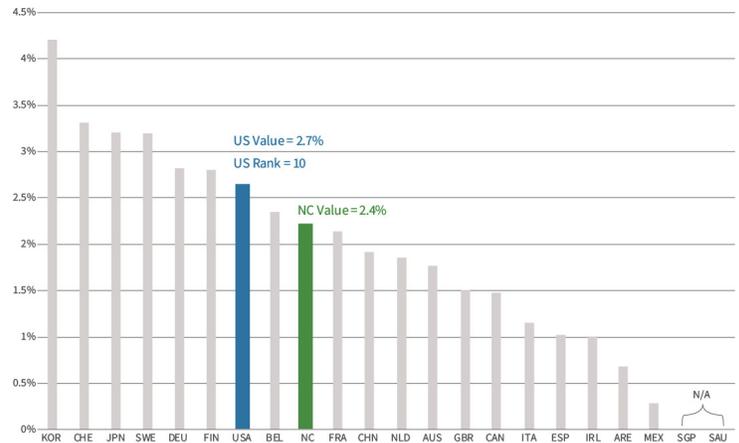
## Indicator 2.1: Total Research & Development

Internationally, the U.S. was the 10<sup>th</sup> most R&D-intensive country in 2015, at 64 percent of the intensity of the leading country, the Republic of Korea [2.1C]. In comparison with top foreign countries, North Carolina's R&D intensity ranks approximately 17<sup>th</sup> overall, between that of Belgium and France. Since 2000, the R&D intensity of many of the most R&D-intensive countries (particularly the Republic of Korea and Switzerland) has risen steadily, and often at a much higher rate than in the U.S. but more consistent with North Carolina's rate of increase [2.1D]. These other countries increasingly are making larger investments in R&D to fuel their economies.

Within North Carolina, R&D is highly concentrated in a pattern that reflects the location of the state's population and research universities. Data indicating the location and level of all R&D within North Carolina are not available,<sup>4</sup> but mapping the location of all manufacturing businesses (which conduct approximately 64 percent of all industry R&D)<sup>5</sup> and universities in North Carolina provides a rough approximation [2.1E]. While it is reasonable to assume more balanced rates of R&D across industries,<sup>6</sup> the rate of R&D across universities is not equal, with nearly 89 percent occurring in the Research Triangle Region. In general, this pattern suggests that R&D is most concentrated in metropolitan regions, particularly those with major research universities.

### 2.1C

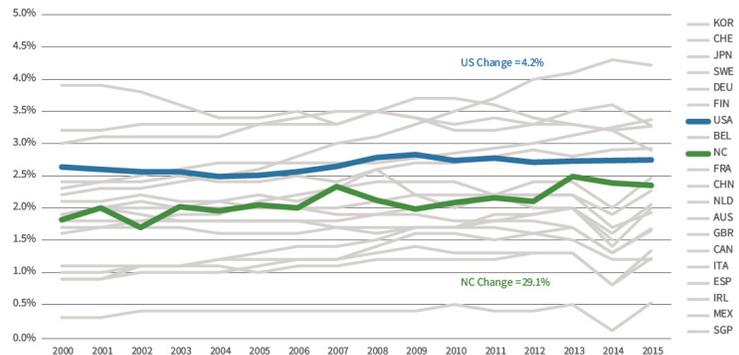
#### TOTAL R&D EXPENDITURES AS A PERCENTAGE OF GDP, COMPARISON COUNTRIES, 2015



Sources: World Bank, World Development Indicators, Bureau of Economic Analysis.

### 2.1D

#### TOTAL R&D EXPENDITURES AS A PERCENTAGE OF GDP, COMPARISON COUNTRIES, 2000-2015



Sources: World Bank, World Development Indicators, Bureau of Economic Analysis.

<sup>4</sup> Business-performed R&D information is proprietary to the businesses and not currently available in a systematic, accurate form below the state level.

<sup>5</sup> National Center for Science and Engineering Statistics, National Science Foundation, and U.S. Census Bureau, Business Research and Development Survey, 2017.

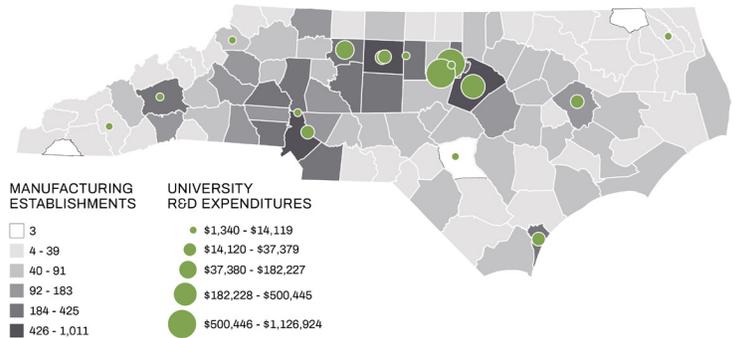
<sup>6</sup> The extent to which this approximation is accurate depends on the size of the businesses and the industry mix across the states. In general, large companies conduct more research than small companies do. Moreover, National Science Foundation data indicate that trends in U.S. business R&D performance are driven by five industries that together accounted for 296.7 billion, or 83%, of domestic business R&D performance in 2015: chemicals manufacturing; computer and electronic products manufacturing; transportation equipment manufacturing; information; and professional, scientific, and technical (PST) services (National Science Foundation, National Center for Science and Engineering Statistics, Business R&D and Innovation Survey, 2015).

## Indicator 2.1: Total Research & Development

### WHAT DOES THIS MEAN FOR NORTH CAROLINA?

For North Carolina to grow its economy significantly in both the short term and long term, it needs to increase the volume and intensity of its R&D efforts relative to other U.S. states and to leading R&D-intensive countries. In the near term it should, at a minimum, strive to be at parity with the U.S. value. Given the R&D strengths of its universities, an efficient and effective way NC industry could achieve this goal is by tighter and more frequent R&D partnerships with the state's universities, which have above-average research expenditures.

### 2.1E LOCATION OF R&D EXPENDITURES IN N.C., 2018



Sources: Quarterly Census of Employment and Wages, Labor & Economic Analysis Division, NC Department of Commerce; National Science Foundation.

Note: Business establishments perform 75% of R&D in NC; of that, manufacturing establishments perform 64%; universities perform 22% of R&D.

## Indicator 2.2: Industry Research & Development

### KEY FINDINGS

- North Carolina’s business-performed R&D as a percentage of private-industry output ranks below the U.S. average and has since at least the early 2000s, but is increasing at a rate faster than the U.S. average.
- Within North Carolina, business-performed R&D is highly concentrated in a pattern that reflects the location of the state’s population.

### INDICATOR OVERVIEW

The business sector is the largest performer of U.S. R&D. Nationwide, business-performed R&D accounts for 58 percent of all U.S. applied research and more than 88 percent of all development.<sup>1</sup> For a given state, a high value for this indicator shows that businesses within the state are making a large investment in their R&D activities. Across states, this indicator reflects state differences in industrial structure as well as the behavior or priorities of individual businesses. Private-industry output, against which the level of business-performed R&D is normalized for this indicator, is the portion of state gross domestic product contributed by state businesses.

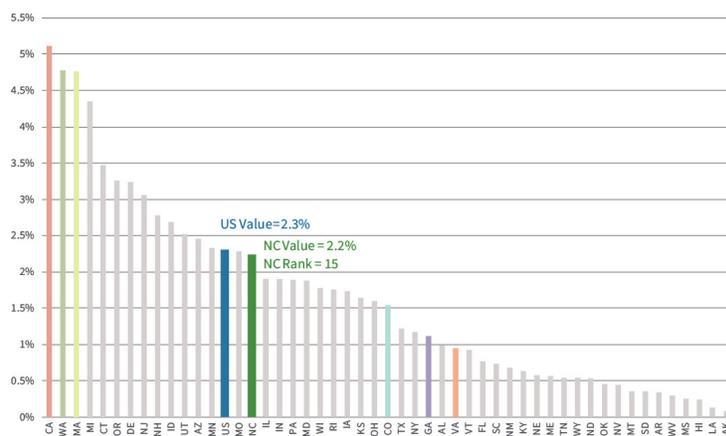
### HOW DOES NORTH CAROLINA PERFORM?

In terms of business-performed R&D as a percentage of private-industry output, North Carolina’s value ranks 15<sup>th</sup> in the nation, with a level that is 96 percent of the U.S. value [2.2A]. Moreover, the value of North Carolina’s business-performed R&D as a percentage of private-industry output is 43 percent of the value of the top-ranking state, California.

This ranking reflects North Carolina’s economic history, which is heavily based in agricultural, industrial, and branch-plant operations. Because of this, historically, comparatively few companies within the state have had significant research operations, which typically locate at or near company headquarters, often located outside of North Carolina. This is changing over time, however, as North Carolina’s business-performed R&D rate has increased nearly 20 percent since 2000, much faster than the rate for the U.S. overall, just over two percent [2.2B].

### 2.2A

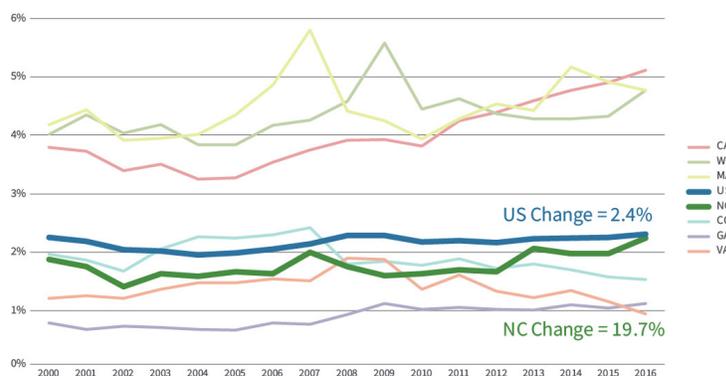
### BUSINESS-PERFORMED R&D AS A PERCENTAGE OF PRIVATE-INDUSTRY OUTPUT, ALL U.S. STATES, 2016



Source: National Science Board.

### 2.2B

### BUSINESS-PERFORMED R&D AS A PERCENTAGE OF PRIVATE-INDUSTRY OUTPUT, COMPARISON STATES, 2000-2016



Source: National Science Board.

<sup>1</sup> National Science Board, *Science and Engineering Indicators 2018*, Chapter 4, “Research and Development: National Trends and International Comparisons.”

## Indicator 2.2: Industry Research & Development

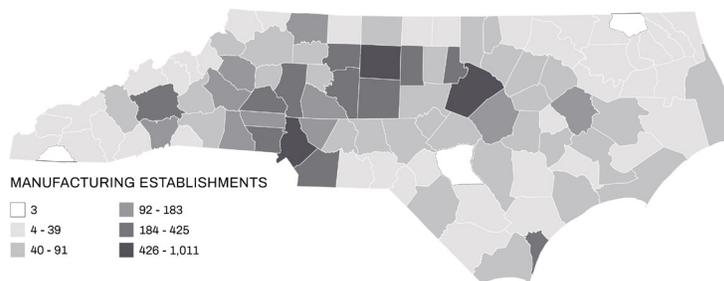
Within North Carolina, business-performed R&D is highly concentrated in a pattern that reflects the location of the state's population [2.2C]. Data indicating the location and level of business-performed R&D within North Carolina are not available,<sup>2</sup> but mapping the location of all manufacturing businesses (which conduct approximately 64 percent of all business-performed R&D)<sup>3</sup> in North Carolina provides a fair approximation. Assuming roughly equal rates of R&D across the businesses, the distribution of manufacturing businesses across the state gives an approximation of the distribution of industry R&D across the state.<sup>4</sup> In general, the pattern suggests that business-performed R&D is most concentrated in metropolitan regions, which are home to the majority of the state's manufacturing businesses.

### WHAT DOES THIS MEAN FOR NORTH CAROLINA?

For North Carolina to grow its economy significantly in both the short term and long term, it needs to increase the level and intensity of business-performed R&D relative to that in other U.S. states. In the short term, an efficient and effective way the state's businesses could achieve this goal is by tighter and more frequent R&D partnerships with the state's universities, which have above-average R&D expenditures and can serve as strong R&D partners with the businesses. This approach may also prove useful in the longer term, as trends over the past several decades reveal that businesses increasingly partner with universities to conduct R&D, which often requires facilities, equipment, and expertise beyond the scope and budgets of most businesses. The largest determinant of North Carolina's level of business-performed R&D is its industry mix, which currently exhibits a lower share of high-tech establishments nationally and relative to comparison states (see, e.g., indicators 4.1–4.3 and 6.4). For North Carolina to increase its business-performed R&D, it will need to increase the share of high science, engineering and technology (SET), innovation-focused businesses in its economy.

2.2C

### LOCATION OF BUSINESS-PERFORMED R&D EXPENDITURES IN NORTH CAROLINA, 2018



Source: Quarterly Census of Employment and Wages, Labor & Economic Analysis Division, NC Department of Commerce.

Note: Business establishments perform 75% of R&D in NC; of that, Mfg. establishments perform 64%.

<sup>2</sup> Business-performed R&D information is proprietary to the businesses and not currently available in a systematic, accurate form.

<sup>3</sup> National Center for Science and Engineering Statistics, National Science Foundation, and U.S. Census Bureau, Business Research and Development Survey, 2017.

<sup>4</sup> The extent to which this approximation is accurate depends on the size of the businesses and the industry mix across the states. In general, large companies conduct more research than small companies do. Moreover, National Science Foundation data indicate that trends in U.S. business R&D performance are driven by five industries that together accounted for 296.7 billion, or 83%, of domestic business R&D performance in 2015: chemicals manufacturing; computer and electronic products manufacturing; transportation equipment manufacturing; information; and professional, scientific, and technical (PST) services (National Science Foundation, National Center for Science and Engineering Statistics, Business R&D and Innovation Survey, 2015).

## Indicator 2.3: Academic Science & Engineering Research & Development

### KEY FINDINGS

- North Carolina’s academic R&D spending as a share of state GDP ranks well above the U.S. average, has since at least the early 2000s, and is increasing at a rate faster than the U.S. average.
- North Carolina’s academic R&D is highly concentrated in a small number of universities located primarily in the Research Triangle region.
- The federal government funds the majority of North Carolina’s academic R&D, but some universities also receive significant funding from state and local government and business.

### INDICATOR OVERVIEW

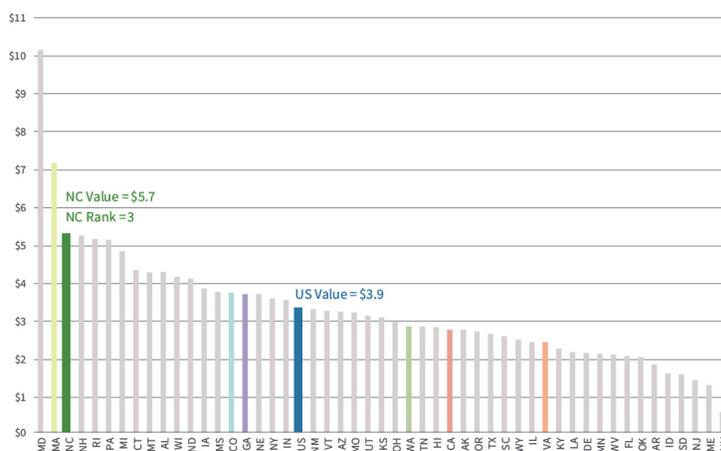
R&D is the driving force behind innovation and sustained economic growth. The ratio of R&D expenditures at a state’s colleges and universities relative to the size of the state’s economy measures the intensity of the state’s academic R&D. Across the U.S., academic R&D performers account for slightly more than half of basic research, about one-third of total research (basic plus applied), and roughly 15% of all R&D conducted in the United States.<sup>2</sup> While industry performs 75 percent of all U.S. R&D, academic R&D serves as a valuable foundation for industry R&D and future economic development.<sup>2</sup>

### HOW DOES NORTH CAROLINA PERFORM?

In terms of the level of North Carolina’s academic R&D expenditures relative to the size of its economy, North Carolina ranks third in the nation, behind only Maryland and Massachusetts **[2.3A]**.<sup>3</sup> North Carolina’s academic R&D intensity is 146 percent of the U.S. value, meaning that the amount of academic R&D in North Carolina is 46 percent higher than what we would expect based on the levels of academic R&D in all other states.

This strong ranking reflects a long-standing pattern in North Carolina: The core strength of North Carolina’s R&D activities is in its colleges and universities. North Carolina has a comparatively large number of colleges and universities for its population, and several are national leaders in the sciences and engineering. Thus, a large proportion of research conducted in North Carolina is basic in nature and, therefore, not heavily focused on industry requirements or direct economic outcomes. This fact underlies North Carolina’s lower-than-expected performance on some of the commercially focused indicators discussed elsewhere in this report.

### 2.3A ACADEMIC R&D PER \$1,000 OF STATE GDP, ALL U.S. STATES, 2017



Source: National Science Board.

<sup>1</sup> National Center for Science and Engineering Statistics, National Science Foundation, Higher Education Research and Development Survey (various years).

<sup>2</sup> National Science Foundation, National Center for Science and Engineering Statistics, National Patterns of R&D Resources (annual series).

<sup>3</sup> Academic R&D is reported for institutions with R&D more than \$150,000.

## Indicator 2.3: Academic Science & Engineering Research & Development

Since 2003, North Carolina's academic R&D intensity has been growing at a rate more than three times faster than the U.S. rate, further increasing the gap between the two [2.3B]. This rate of increase is also faster than the rate of increase in any of the comparison states.

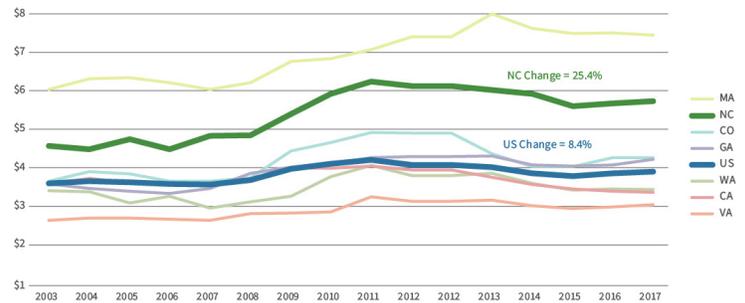
Within North Carolina, academic R&D is highly concentrated in the Research Triangle region. The three largest universities located in that region—Duke University, UNC-Chapel Hill, and North Carolina State University—account for 89 percent of all academic R&D expenditures within the state [2.3C and 2.3D]. Wake Forest University in Winston-Salem also has significant academic R&D (six percent of the state total), while 14 other public and private universities conduct the state's remaining academic R&D across the state.

The source of funds for academic R&D reflects, to some extent, the nature of the R&D, and varies considerably across the U.S. and North Carolina's academic institutions [2.3E]. Nationwide and across North Carolina, the federal government is the largest supporter of academic R&D, in most cases funding a significant majority of that R&D. Within North Carolina, North Carolina State University is the only academic institution that receives less than 50 percent of its academic R&D funding from the federal government, although the federal government remains the university's largest source of funding. This lower share of federal funding reflects the fact that, as a land-grant university with a historical focus on agricultural and mechanical arts, as well as material science, NC State University receives a significant and much higher than average share (20 percent) of its funding from state and local government.

While business also funds a substantial share of academic R&D, for most institutions that share is 11 percent or less, with the exception in North Carolina being Duke University, which receives 21 percent of its funding from business. This larger-than-average share results from the activities of the Duke Clinical Research Institute (DCRI), which conducts medically focused clinical trials for industry.

### 2.3B

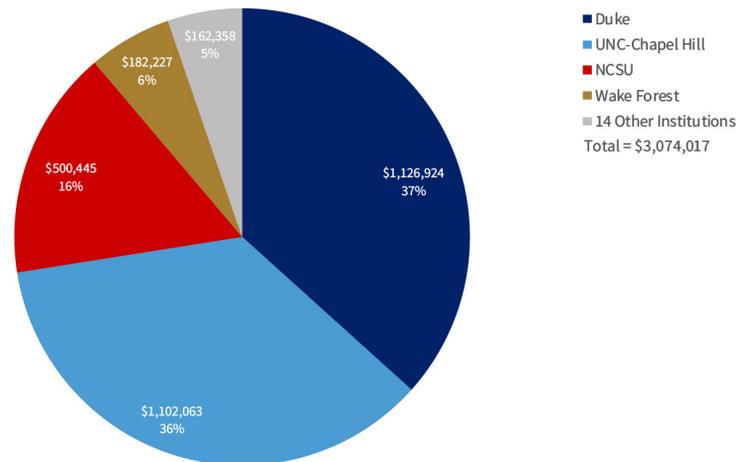
#### ACADEMIC R&D PER \$1,000 OF STATE GDP, COMPARISON STATES, 2003-2017



Source: National Science Board.

### 2.3C

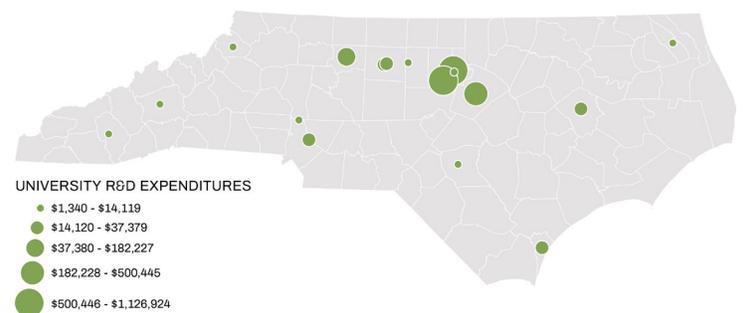
#### N.C. UNIVERSITY R&D EXPENDITURES (DOLLARS IN THOUSANDS), 2017



Source: National Science Foundation.

### 2.3D

#### N.C. UNIVERSITY R&D EXPENDITURES (DOLLARS IN THOUSANDS), 2017



Source: National Science Foundation.

Note: Universities perform 22% of R&D in NC.

### WHAT DOES THIS MEAN FOR NORTH CAROLINA?

North Carolina’s academic research, the majority of which focuses on basic fundamental science, is important for producing new knowledge and scientific stature. Industry R&D is more often the engine that translates the basic research discoveries into commercial products. This suggests that attention should be given to continuing to strengthen both academic R&D and academic-industry collaborative R&D. Strengths in both, particularly across a wider range of North Carolina’s geography, will help improve the economic well-being and quality of life across the state.

2.3E

### UNIVERSITY R&D EXPENDITURES BY SOURCE OF FUNDS, U.S. AVERAGE AND N.C. INSTITUTIONS, 2017

Higher Education Institution	Source of Funds				
	Federal Government	State & Local Government	Business/ Industry	Institution Funds	Nonprofits
US Average	54%	6%	6%	25%	7%
Duke	55%	0%	21%	13%	9%
UNC-Chapel Hill	61%	2%	4%	25%	6%
NC State University	44%	20%	11%	24%	1%
Wake Forest	81%	5%	7%	1%	5%
14 Other NC Institutions	63%	5%	6%	22%	4%

Source: National Science Foundation.

## Indicator 2.4: Federal Research & Development

### KEY FINDINGS

- North Carolina’s ratio of federal R&D obligations per employed worker ranks well below the U.S. average.
- North Carolina’s ratio of federal R&D obligations to employed worker has increased significantly since 2000, at a rate faster than the rate of the U.S. ratio overall and is in the middle among comparison states.

### INDICATOR OVERVIEW

This indicator represents how federal R&D obligations are disbursed geographically relative to the size of a state’s employed civilian workforce. Federal R&D obligations are a binding financial commitment in a congressional budget appropriation and include contracts, staff employment, and purchases of goods and services. For the purposes of this indicator, federal R&D obligations are attributed to the states in which the prime recipients of federal obligations are located.<sup>1</sup> While this funding comes from 11 federal agencies, the Department of Defense (DoD) disburses the most funding, approximately 50 percent of the total.<sup>2</sup> A high value on this indicator may indicate the existence of many large prime contractors or major federally funded R&D facilities in a state. Higher values for this indicator occur in the states surrounding the District of Columbia and in less populated states with national laboratories or federal facilities.

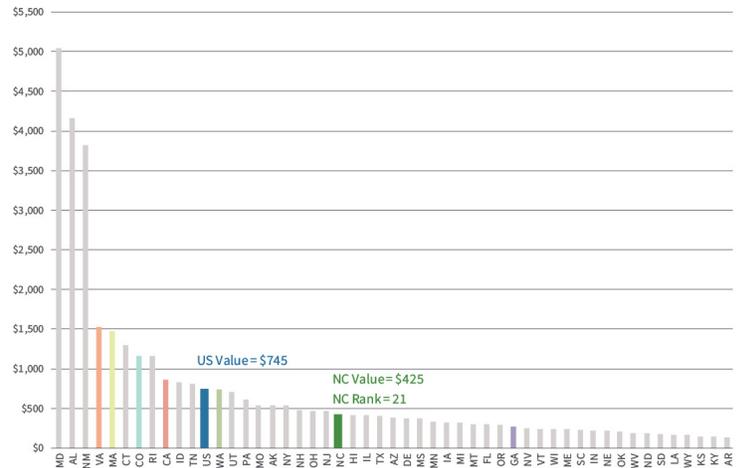
### HOW DOES NORTH CAROLINA PERFORM?

The value of North Carolina’s federal R&D obligations per employed worker ranks 21<sup>st</sup> in the nation, with a level that is 57 percent of the U.S. value and 8 percent of the value of the top-ranking state, Maryland [2.4A]. North Carolina’s ranking reflects the fact that it has a relatively small number of federal prime contractors and federally funded R&D centers.

Since 2000, North Carolina’s federal R&D obligations per employed worker have risen significantly, at a rate of 59 percent [2.4B], faster the rate of increase for the U.S. overall (38 percent). Among the comparison states, North Carolina’s increase in federal R&D obligations per employed worker ranks considerably below Washington and Colorado, but above Massachusetts, Virginia, California, and Georgia.

#### 2.4A

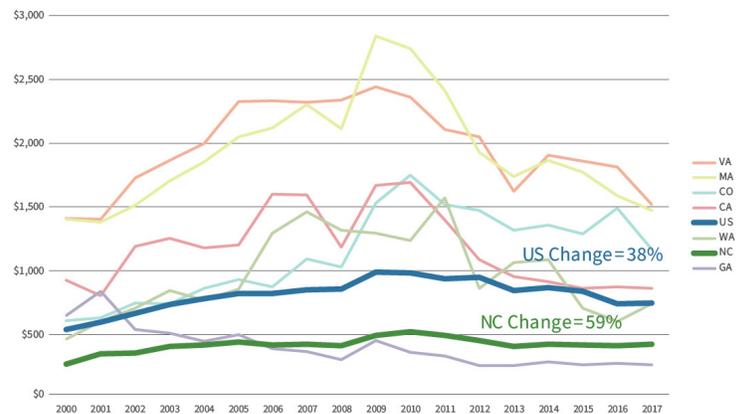
### FEDERAL R&D OBLIGATIONS PER EMPLOYED WORKER, ALL U.S. STATES, 2017



Source: National Science Board.

#### 2.4B

### FEDERAL R&D OBLIGATIONS PER EMPLOYED WORKER, COMPARISON STATES, 2000-2017



Source: National Science Board.

<sup>1</sup> Tracking federal R&D obligations below the prime contractor level is beyond the scope of the data sources used in this report.

<sup>2</sup> National Science Board. 2018. "Federal R&D Obligations per Employed Worker" and "Business-Performed R&D as a Percentage of Private-Industry Output." Science and Engineering Indicators 2018, State Indicators.

### WHAT DOES THIS MEAN FOR NORTH CAROLINA?

Federal R&D obligations to all U.S. states amounted to nearly \$115 billion in 2017. Although this amount represents less than one-third the amount of industry R&D in 2016 (\$374 billion), it is substantial and drives a considerable amount of innovation.<sup>3</sup> In 2017, only 11 states exceeded the national average of \$745 in federal R&D obligations per worker, meaning that these states received the majority of federal R&D obligations. North Carolina should strive to remain competitive on this front by working to increase its number of prime federal contractors. It should also work to increase its number of subcontractors to prime federal contractors.<sup>4</sup>

<sup>3</sup> National Science Board. 2018. "Federal R&D Obligations per Employed Worker." *Science and Engineering Indicators 2018, State Indicators*.

<sup>4</sup> While this will not explicitly improve North Carolina's performance on this particular indicator, it may be a more likely means by which the state can continue to advance innovation with federal support.

## Indicator 2.5: Academic Articles

### KEY FINDINGS

- North Carolina’s academic science & engineering (S&E) article output per 1,000 science, engineering, and health (SEH) doctorate holders in academia ranks above the U.S. average, and since 2000 has increased at a rate faster than the U.S average rate.
- North Carolina’s academic S&E articles are highly concentrated in a small number of cities located primarily in the Research Triangle region, though cities outside that region also produce a significant number of articles.

### INDICATOR OVERVIEW

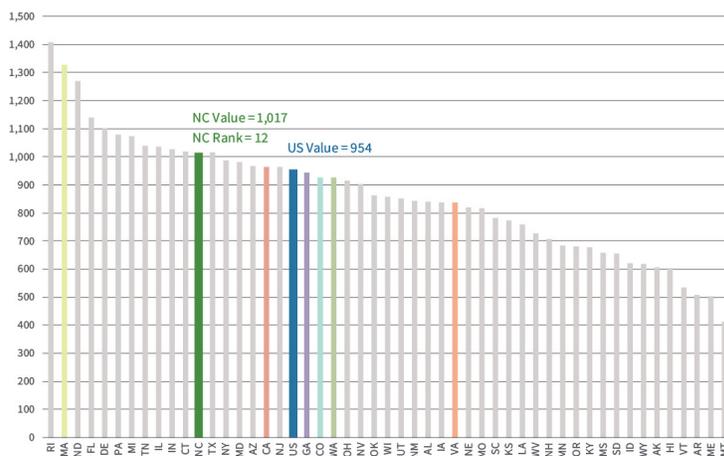
The volume of peer-reviewed articles published per 1,000 academic SEH doctorate holders is an approximate measure of their contribution to scientific knowledge, which includes, among other outputs, research & development (R&D) activities and funding (see indicator 2.3); patents (see indicator 3.2); and trademarks, copyrights, and licenses (see indicator 3.5). The volume of peer-reviewed S&E articles per 1,000 academic SEH doctorate holders is an approximate measure of their contribution to scientific knowledge. A high value on this indicator shows that the SEH faculties in a state’s academic institutions are generating a high volume of publications relative to the number of SEH doctorate holders employed at academic institutions in the state. Academic institutions include 2-year colleges, 4-year colleges and universities, medical schools, and university-affiliated research centers.<sup>1</sup> SEH doctorates include those in computer sciences; mathematics; the biological, agricultural, or environmental life sciences; physical sciences; social sciences; psychology; engineering; and health fields.<sup>2</sup>

### HOW DOES NORTH CAROLINA PERFORM?

The value of North Carolina’s academic S&E article output per 1,000 SEH doctorate holders in academia ranks 12<sup>th</sup> in the nation, a level that is 107 percent of the U.S. value and 68 percent of the value of the top-ranking state, Massachusetts [2.5A]. Among the comparison states, Massachusetts is the only state that tops North Carolina on this indicator in 2017, and North Carolina ranks well above the remaining five comparison states. As with S&E R&D (see indicator 2.3), this strong ranking reflects a longstanding pattern in North Carolina: The core strength of North Carolina’s innovation ecosystem is its colleges and universities.

2.5A

### ACADEMIC SCIENCE AND ENGINEERING ARTICLE OUTPUT PER 1,000 SCIENCE, ENGINEERING, AND HEALTH DOCTORATE HOLDERS IN ACADEMIA, ALL U.S. STATES, 2017



Source: National Science Board.

<sup>1</sup> Research is more central to the mission of some of these institutions than others. As used in this indicator, publication counts are based on the number of articles that appear in a set of journals tracked by Elsevier’s Scopus database as of December 2016. The journal set consists of S&E publications (including publications on the natural sciences, applied sciences, medical sciences, and social sciences but excluding the arts and humanities). Only documents published in refereed scientific journals were counted (mostly articles, reviews, and conference proceedings), as these documents were reviewed by peers prior to being accepted for publication. The peer-review process is designed to ensure that the research is of good quality and constitutes an original contribution to scientific knowledge. Fractional counting at the level of researchers is used to ensure that a single paper is not counted several times. For example, if two of three authors are in state A and the third author is in state B, then two-thirds of the publication is attributed to state A, and one-third is attributed to state B.

<sup>2</sup> SEH doctorate data are estimates and exclude those with doctorates from foreign institutions and those older than the age of 75. Data for SEH doctorate holders in academia are presented by employment location, regardless of residence. Estimates for states with smaller populations of SEH doctorate holders are generally less precise than estimates for states with larger populations.

## Indicator 2.5: Academic Articles

Since 2000, North Carolina’s S&E article output per 1,000 SEH doctorate holders in academia has increased by 27 percent, a rate that is nearly twice the U.S. rate of increase, 13.9 percent [2.5B]. Among the comparison states, North Carolina’s rate ranks higher than all comparison states except Colorado and Washington.

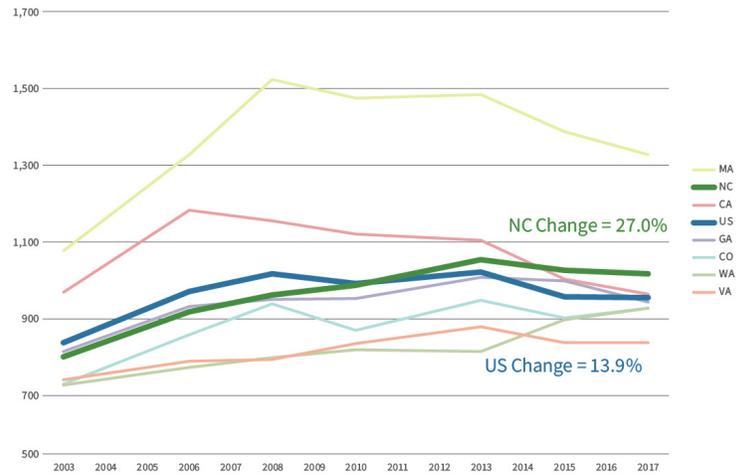
Within North Carolina, the production of S&E articles is highly concentrated in the Research Triangle region. Together, three cities in that region—Durham (31.6 percent), Chapel Hill (20.3 percent), and Raleigh (9.2 percent)—account for 61 percent of all S&E articles produced within the state [2.5C]. Research Triangle Park, located between those three cities, also accounts for a significant share of articles (4.6 percent), bringing the Triangle’s regional total to nearly 2/3 of the state total. Outside the Triangle region, Winston-Salem accounts for a significant share of the state’s S&E articles (12.6 percent), as does, Charlotte (5.9 percent), Greenville (4.5 percent), Wilmington (2.1 percent), Greensboro (2.0 percent), Boone (1.5 percent), and Fayetteville (1.1 percent). The remaining four percent of the state’s S&E articles is spread across 14 other cities, none of which produces more than one percent of the state’s S&E articles.

### WHAT DOES THIS MEAN FOR NORTH CAROLINA?

North Carolina has considerable strengths in academic S&E, as evidenced by its higher-than-average performance on academic S&E articles per 1,000 SEH doctorate holders in academia. These strengths, however, are highly concentrated in a small number of universities and other R&D-focused organizations located primarily in the Research Triangle region and other metropolitan areas, such as the Piedmont Triad. As evidenced in the Economic Well-Being indicators in Section 1 and the Innovative Organizations indicators in Section 4, these academic S&E strengths are benefiting a less-than-optimal share and geographic distribution of North Carolina’s citizens and companies. North Carolina’s academic, corporate, and policy leaders should increase their efforts designed to spread the benefits of the state’s academic S&E strengths throughout all regions of the state.

### 2.5B

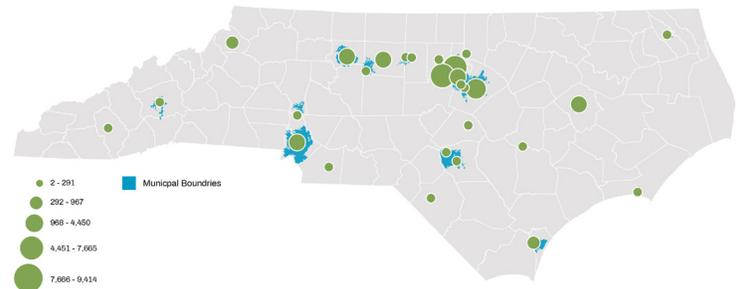
### ACADEMIC SCIENCE AND ENGINEERING ARTICLE OUTPUT PER 1,000 SCIENCE, ENGINEERING, AND HEALTH DOCTORATE HOLDERS IN ACADEMIA, COMPARISON STATES, 2003-2017



Source: National Science Board.

### 2.5C

### LOCATION OF SCIENCE & ENGINEERING ARTICLES PUBLISHED, 2018 - 2019 ANNUAL AVERAGE



Source: Scopus, Elsevier.

## Indicator 3.1: SBIR & STTR Awards

### KEY FINDINGS

- North Carolina's SBIR/STTR funding as a share of state GDP ranks below the U.S. average and has since at least the early 2000s, but is increasing considerably faster than the U.S. average.
- North Carolina's SBIR/STTR funding is highly concentrated in a small number of cities and regions in the state.

### INDICATOR OVERVIEW

Funds awarded through the highly competitive federal Small Business Innovation Research (SBIR) grant program support technological innovation in companies with 500 or fewer employees. The awards enable the small businesses to evaluate the feasibility and scientific merit of new technology (Phase I ~ \$150,000) and to develop the technology to a point where it can be commercialized (Phase II ~ up to \$1,000,000). Small Business Technology Transfer (STTR) is a similar but smaller program; its unique feature is the requirement for the small business to collaborate with a nonprofit research institution.<sup>1</sup>

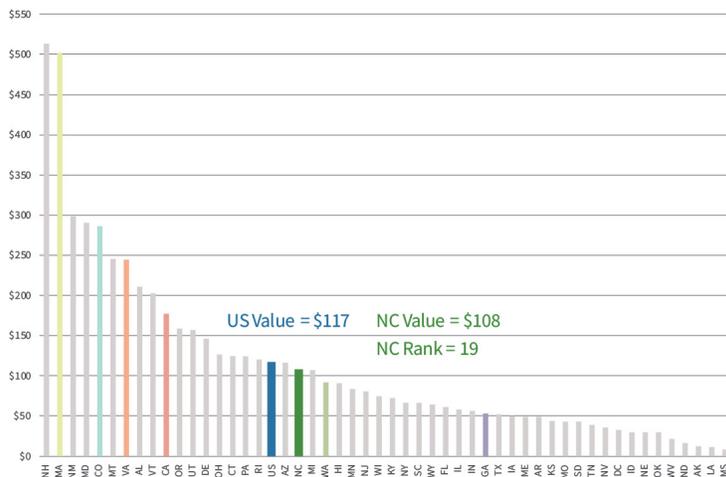
SBIR and STTR grants are the single largest source of early-stage technology development and commercialization funding for small businesses (more than \$2.6 billion in 2017). Success in the SBIR/STTR programs attracts additional outside capital investment, and companies that receive SBIR Phase II funding typically outperform similar companies that do not receive such support.<sup>2</sup> The amount of SBIR/STTR funding in a state strongly correlates with successful technology-based economic development.

### HOW DOES NORTH CAROLINA PERFORM?<sup>3</sup>

In terms of the level of SBIR/STTR funding relative to the size of its economy, North Carolina ranks 19<sup>th</sup> in the nation and below the U.S. average [3.1A].<sup>4</sup> Specifically, the ratio of North Carolina's SBIR/STTR funding relative to the size of its total GDP is 92 percent of the U.S. value, meaning that the amount of SBIR/STTR funding in North Carolina is about eight percent lower than what we would expect based on the levels of such funding in all other states. Moreover, its per-GDP level of SBIR/STTR funding is only 21 percent of the leading state's (New Hampshire) level. This below-average level of early stage funding suggests that North Carolina is potentially missing out on opportunities to fund and commercialize its innovative discoveries.

3.1A

### AVERAGE ANNUAL SBIR & STTR \$ PER \$1 MILLION OF GROSS DOMESTIC PRODUCT, ALL U.S. STATES, 2014-2016



Source: National Science Board.

<sup>1</sup> Eleven federal agencies participate in the SBIR program and five in the STTR program.

<sup>2</sup> See, e.g., National Research Council. 2008. *An Assessment of the SBIR Program*. Washington, DC: The National Academies Press.

<sup>3</sup> The total award dollars reported here include both Phase I and Phase II SBIR/STTR awards.

<sup>4</sup> The high average U.S. value results primarily from the high concentration of SBIR/STTR awards in MA, which has well-recognized academic research institutions from which innovative small businesses have emerged. In addition, many of the states with the highest rankings on this indicator are locations of federal laboratories.

## Indicator 3.1: SBIR & STTR Awards

It is important to note, however, that a large percentage of the small tech-based businesses in North Carolina focus on the pharmaceuticals and medical technology sectors, which are among the state's strengths. Those businesses, in fact, have a high success rate in receiving SBIR grants from the National Institutes of Health. However, the interests of other large SBIR-granting agencies—such as the Department of Defense, the National Aeronautics and Space Administration, and the Department of Energy—either do not align as well with the majority of North Carolina businesses' commercialization interests, or companies lack knowledge about these other agencies and the goals they are trying to achieve.

Since 2000, the ratio of North Carolina's SBIR & STTR funding relative to its GDP has increased by 72.1 percent, compared to the 4.9 percent decrease for the U.S. overall [3.1B]. In contrast, the ratio of SBIR/STTR funding to GDP has seen a decrease of nearly 10 percent in all the comparison states combined. During this time period North Carolina experienced the largest increase compared to the U.S. and any of the comparison states. This is due, in part, to two steps taken to improve North Carolina's SBIR/STTR award rate: (1) the creation in 2001 of an SBIR program specialist position at the North Carolina Small Business and Technology Development Center (STBDC) and (2) the creation in 2006 of the state's SBIR/STTR matching fund program, the One North Carolina Small Business Program. The former provides assistance to small businesses to help them identify and apply for SBIR/STTR proposal opportunities; the latter awards matching grants to small businesses in North Carolina that have received SBIR/STTR grants. These state matching grants supplement and leverage the federal grants and make North Carolina small businesses better investment opportunities in the eyes of federal funding agencies.

Within North Carolina, SBIR/STTR funding is highly concentrated in the Triangle region of the state, which contains the cities of Durham, Chapel Hill, the Research Triangle Park region, and Raleigh [3.1C and 3.1D]. Combined, these four locales receive 70 percent of the state's SBIR/STTR funding. The next 20 percent goes primarily to cities in the Piedmont Triad (e.g., Greensboro and Winston-Salem), Charlotte region (e.g., Charlotte and Mooresville), and the cities of Cary and Morrisville (within the Triangle region). The remaining 10 percent is dispersed across 30 other cities across the state. Overall, this highly concentrated SBIR/STTR award activity reflects the level of concentration in North Carolina's R&D activity, particularly its academic R&D, as well as its population.

### 3.1B

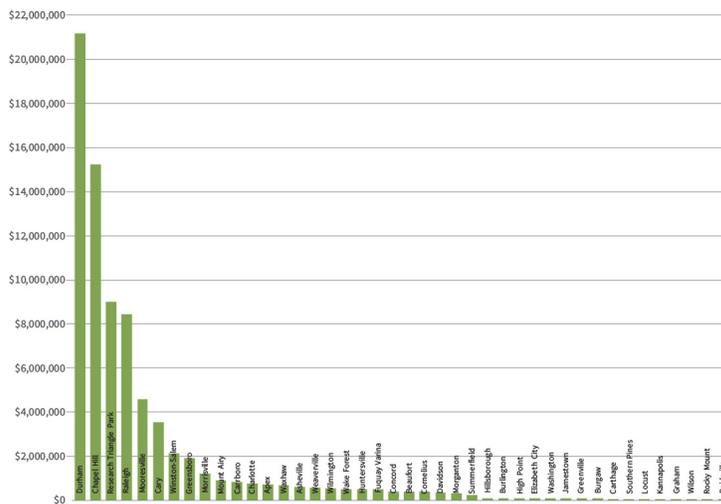
### AVERAGE ANNUAL SBIR & STTR \$ PER \$1 MILLION OF GROSS DOMESTIC PRODUCT, COMPARISON STATES, 2000-2016



Source: National Science Board.

### 3.1C

### AVERAGE ANNUAL SBIR & STTR AWARDS, N.C. CITIES, 2016-2018



Source: SBIR.gov

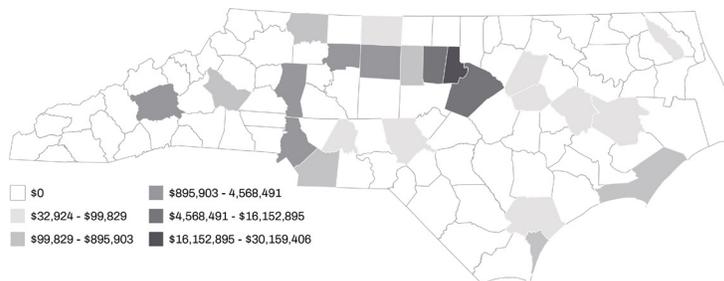
### WHAT DOES THIS MEAN FOR NORTH CAROLINA?

North Carolina's funding under the SBIR/STTR programs indicates both how aggressive the state's small businesses are in pursuing federal support for innovation activity, as well as their competitiveness in developing and commercializing innovative ideas, technologies, and products.

Given the importance of such funding, emphasis should be placed on improving the state's position in this category. Continued funding for the One North Carolina Small Business Program, which provides state grants to match the SBIR/STTR grants, is critical on this front.<sup>5</sup> Additionally, proposal opportunity identification and counseling services, such as those provided by North Carolina's Small Business and Technology Development Center (SBTDC), should be continued and enhanced to ensure that North Carolina businesses are maximizing their ability to receive SBIR/STTR grants.

3.1D

### AVERAGE ANNUAL AMOUNT OF SBIR & STTR AWARDS, N.C. COUNTIES, 2016-2018



Source: SBIR.gov

<sup>5</sup> This program was started after the 2003 Tracking Innovation in NC report (available at: <http://www.nccommerce.com/scitech/resources/innovationreports>) indicated that NC ranked 34<sup>th</sup> in terms of SBIR funding per capita and had a value 41 percent of the U.S. value. While all of the top-performing states were increasing in the 2000-2004 timeframe, only NC continued to increase in the latter part of the decade. This coincides with the One NC Small Business Program beginning in 2006. For additional evidence of the program's impacts, see <https://www.nccommerce.com/grants-incentives/technology-funds/one-north-carolina-small-business-program#program-impacts-&success-stories>.

## Indicator 3.2: Academic Patents

### KEY FINDINGS

- The ratio of North Carolina’s academic patents per 1,000 science & engineering doctorate holders in academia ranks roughly equal to the U.S. average and is increasing at a rate slower than the U.S. average.
- North Carolina’s academic patenting activity is highly concentrated in a small number of universities located primarily in the Research Triangle region.

### INDICATOR OVERVIEW

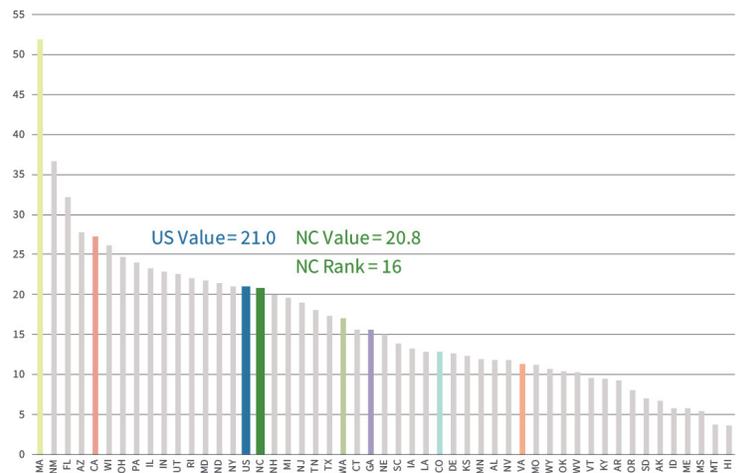
This indicator relates the number of academic-owned utility patents to the size of the doctoral science & engineering (S&E) workforce in academia. Academia includes two-year colleges, four-year colleges and universities, medical schools, and university-affiliated research centers. S&E doctorates include those in computer sciences; mathematics; biological, agricultural, or environmental life sciences; physical sciences; social sciences; psychology; engineering; and health fields.<sup>1</sup> Utility patents, commonly known as patents for inventions, include any new, useful, or improved method, process, machine, device, manufactured item, or chemical compound, and represent a key measure of intellectual property.<sup>2</sup> As such, academic patents are one approximate measure of the degree to which the doctoral academic workforce generates results with perceived economic value.<sup>3</sup>

### HOW DOES NORTH CAROLINA PERFORM?

The value of North Carolina’s academic patents per 1,000 S&E doctorate holders in academia ranks 16<sup>th</sup> in the nation, with a level that is 99 percent of the U.S. value and 40 percent of the value of the top-ranking state, Massachusetts [3.2A]. North Carolina’s upper-mid range ranking reflects the fact that it has stronger-than-average academic institutions, many of which have offices dedicated to patenting.<sup>4</sup>

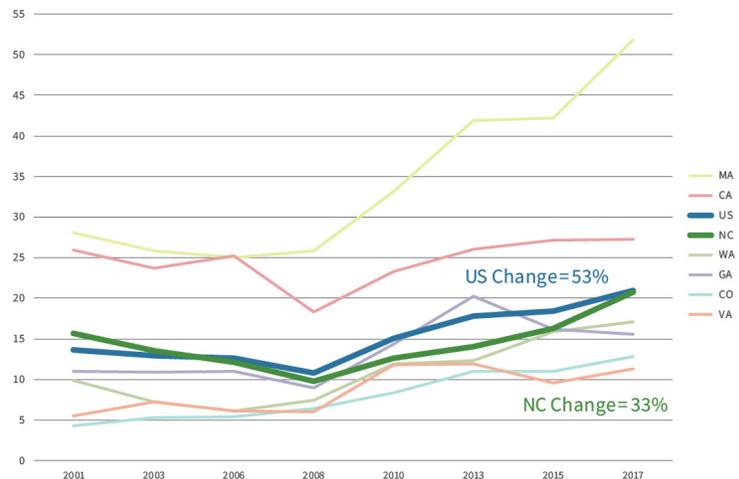
Since 2000, the ratio of North Carolina’s academic patents relative to S&E doctorate holders in academia has increased at a rate of 33 percent and largely tracked the U.S. average. Additionally, the ratio for the U.S. overall increased by 53 percent [3.2B] over that time period. Among the comparison states, all states had increases in their rates over time, and Colorado, Virginia, Massachusetts, and Washington had greater rates of increase than North Carolina.

### 3.2A ACADEMIC PATENTS AWARDED PER 1,000 SCIENCE & ENGINEERING DOCTORATE HOLDERS IN ACADEMIA, ALL U.S. STATES, 2017



Source: National Science Board

### 3.2B ACADEMIC PATENTS AWARDED PER 1,000 SCIENCE & ENGINEERING DOCTORATE HOLDERS IN ACADEMIA, COMPARISON STATES, 2001-2017



Source: National Science Board

<sup>1</sup> S&E doctorate data exclude those with doctorates from foreign institutions and those above the age of 75.

<sup>2</sup> Patent assignments are made on the basis of the address of their original assignee(s). For patents with multiple U.S. university assignees from different U.S. states, the data credit each participating U.S. state as owning one patent.

<sup>3</sup> Another measure of academic economic value is the actual or expected revenue derived from academic patents. However, because actual revenue accrues over time and expected revenue is difficult to estimate with a reasonable level of accuracy, revenue data are not presented for this indicator. License income, which depends heavily on patent activity, is presented in indicator 3.5.

<sup>4</sup> The offices go by different names (e.g. Office of Technology Transfer; Office of Technology Commercialization) at different institutions, but all have patenting academic discoveries as one of their primary activities.

## Indicator 3.2: Academic Patents

Within North Carolina, academic patenting activity is highly concentrated in the Research Triangle region and reflects both the nature and size of that region’s universities’ R&D activities, as well as the resources devoted to their patenting offices [3.2C and 3.2D]. The three largest universities in that region—Duke University, the University of North Carolina at Chapel Hill, and North Carolina State University—account for 79 percent of all academic patenting activity within the state, a pattern very similar to the pattern for academic R&D expenditures (see indicator 2.3). Wake Forest University in Winston- Salem also has significant academic patenting activity (11 percent of the state total), while UNC-Charlotte, East Carolina University, UNC Greensboro, and UNC Wilmington account for 6 percent, 3 percent, 1 percent, and less than 1 percent of the state total, respectively.

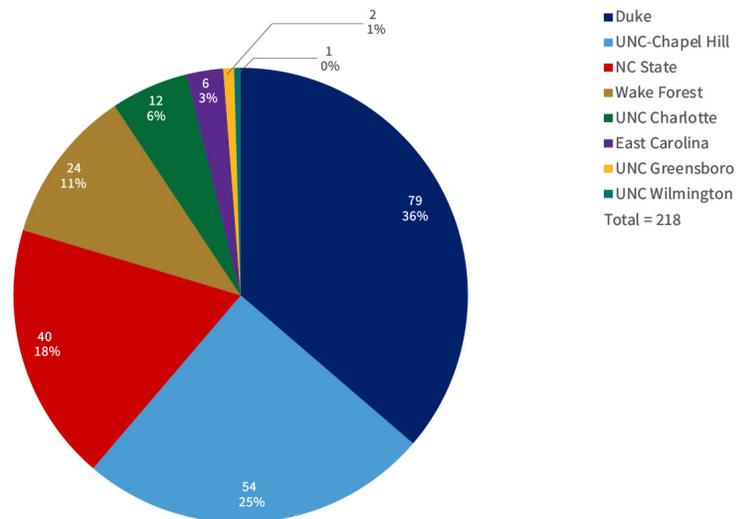
### WHAT DOES THIS MEAN FOR NORTH CAROLINA?

While one of North Carolina’s innovation-related strengths is its academic R&D (see indicator 2.3, on which NC ranks in the top 10 percent and has a value significantly greater than the U.S. value), it fares less well on academic patenting, one of the key measures of the economic value of its academic discoveries. Its 16<sup>th</sup> place ranking on academic patenting puts it ahead of two thirds of the U.S. states, but the ratio of its academic patenting activity relative to S&E doctorate holders in academia ranks slightly lower than the U.S. average ratio. While improving over time, North Carolina’s academic patenting activity relative to that of the comparison states and the U.S. average can improve.

For this to happen, North Carolina’s universities should focus their attention on their offices and activities that generate patents. For example, the University of North Carolina’s 2013–2018 strategic directions include establishing and supporting a “scout team” and core support staff that any campus could utilize for market assessment, legal assistance, new venture services, and other operational support, such as patenting for commercialization.<sup>5</sup> Additionally, in 2014 the Governor’s Innovation-to-Jobs Working group recommended that the state’s public and private universities create a University Innovation Commercialization Council, which would define best practices for innovation commercialization at the state’s universities, promote inter-university cooperation and standardization where possible, and catalyze transformation in culture to encourage technology commercialization.<sup>6</sup> Initiatives such as these and others focused on increasing the commercial impact of academic discoveries should be a high priority for state and university policy makers.

3.2C

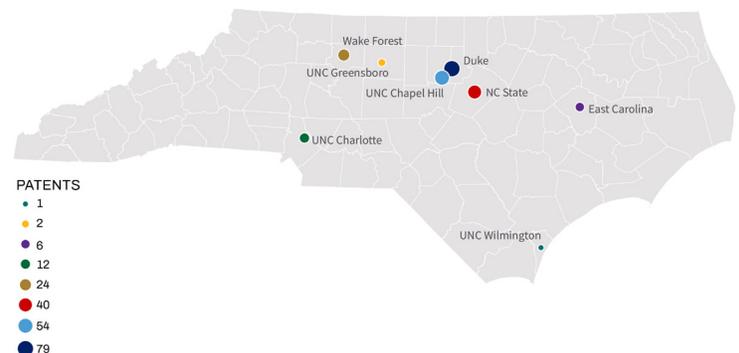
### AVERAGE ANNUAL ACADEMIC PATENTS AWARDED TO N.C. UNIVERSITIES, 2015-2017



Source: Association of University Technology Managers.

3.2D

### AVERAGE ANNUAL ACADEMIC PATENTS AWARDED TO N.C. UNIVERSITIES, 2015-2017



Source: Association of University Technology Managers

Note: 2016-2017 data for Wake Forest were not available; values for those years were extrapolated based on 2000-2015 data.

<sup>5</sup> *Our Time, Our Future: The UNC Compact with North Carolina, Strategic Directions 2013-2018*, available at [https://www.northcarolina.edu/sites/default/files/strategic\\_directions\\_2013-2018\\_0.pdf](https://www.northcarolina.edu/sites/default/files/strategic_directions_2013-2018_0.pdf).

<sup>6</sup> *Recommendations of the Governor’s Innovation-to-Jobs Working Group, March 2015*. Available at: [https://files.nc.gov/nccommerce/documents/files/Governors\\_Innovation-to-Jobs\\_Working\\_Group\\_Recommendations\\_March\\_2015.pdf](https://files.nc.gov/nccommerce/documents/files/Governors_Innovation-to-Jobs_Working_Group_Recommendations_March_2015.pdf).

## Indicator 3.3: Patents

### KEY FINDINGS

- The ratio of North Carolina’s patents awarded per 1,000 individuals in science & engineering occupations ranks below the U.S. average, but since 2000 has been increasing at a rate greater than the U.S. average.
- North Carolina’s patenting activity ranks above that of most comparison countries but well behind that of leading countries.
- North Carolina’s patenting activity is highly concentrated in a small number of counties located primarily in the Research Triangle region.

### INDICATOR OVERVIEW

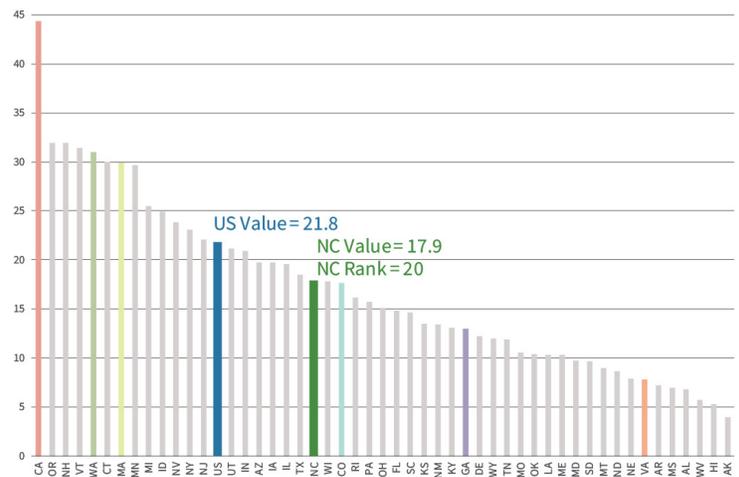
This indicator represents state patent activity normalized to the size of a locale’s science & engineering workforce and its economy. For the state-by-state charts (3.3A and 3.3B), utility patents—commonly known as patents for inventions—are presented.<sup>1</sup> The science & engineering workforce includes engineers and computer, mathematical, life, physical, and social scientists.<sup>2</sup> For the comparison country charts (3.3C and 3.3D), grants for direct patent applications are presented. These grants are conferred by a country’s intellectual property office to applicants who apply directly to that office.<sup>3</sup> Gross domestic product (GDP) is a measure of the total value of goods and services produced by an economy.

Patents are the leading form of legal codification and ownership of innovative thinking and its application. As such, they are a key indicator of the rate of new product and process innovation. There are considerable differences in the propensity of different industries to patent new ideas, and thus the industry mix partially explains differences in patenting rates across locales. Patents are particularly important for companies whose success depends on their ability to protect their innovative products.

### HOW DOES NORTH CAROLINA PERFORM?

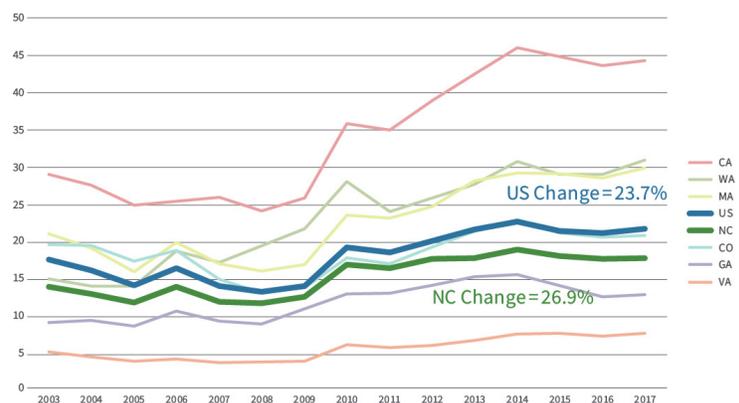
The value of North Carolina’s patents per 1,000 individuals in science & engineering occupations ranks 20<sup>th</sup> in the nation, with a level that is 82 percent of the U.S. value and 40 percent of the value of the highest-ranking state, California [3.3A]. Among the comparison states, North Carolina’s rate of patenting ranks in the middle of the pack, ahead of Colorado, Georgia and Virginia, but behind California, Washington, and Massachusetts. Overall, North Carolina’s rate of patents compares less favorably than its rate of academic patents, reflecting, in part, its lower level of industry R&D (see indicator 2.2) as well as its relatively low number of high-tech business establishments (see indicator 4.1). As a broad indicator of nonacademic innovative activity within a state, this indicator suggests that North Carolina’s

### 3.3A PATENTS AWARDED PER 1,000 INDIVIDUALS IN SCIENCE AND ENGINEERING OCCUPATIONS, ALL U.S. STATES, 2017



Source: National Science Board

### 3.3B PATENTS AWARDED PER 1,000 INDIVIDUALS IN SCIENCE AND ENGINEERING OCCUPATIONS, COMPARISON STATES, 2003-2017



Source: National Science Board

<sup>1</sup> See indicator 3.2 for a more detailed description of utility patents. The U.S. Patent and Trademark Office (USPTO) classifies patents geographically according to the residence of the first-named inventor. Only U.S.-origin patents are included.

<sup>2</sup> Managers, technicians, elementary and secondary schoolteachers, and medical personnel are not included.

<sup>3</sup> Direct applications exclude Patent Cooperation Treaty (PCT) applications and are therefore most comparable to the National Science Foundation data used for charts 3.3A and 3.3B. PCT, an international treaty administered by the World Intellectual Property Organization, facilitates the acquisition of patent rights in a large number of jurisdictions.

## Indicator 3.3: Patents

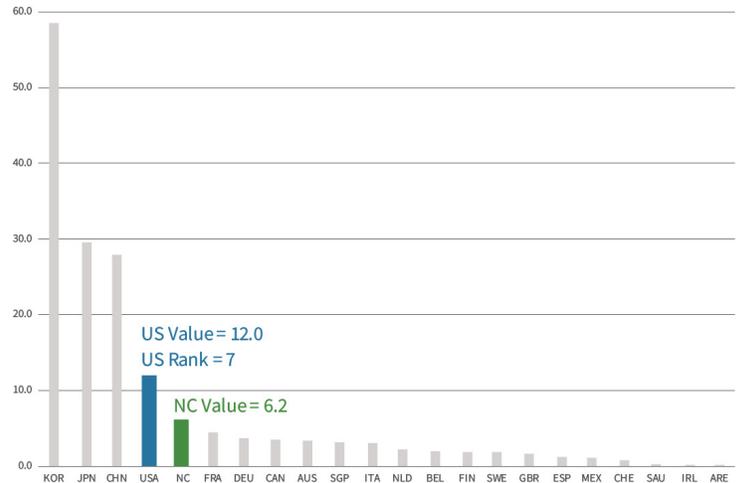
nonacademic private sector is not as strong as its academic sector at initial discovery and protection of innovative ideas. Since 2003, however, the ratio of North Carolina's patents to individuals in science & engineering occupations increased at a rate of 26.9 percent, which is slightly higher than the 23.7 percent rate of increase for the U.S. overall **[3.3B]**. Among the comparison states, North Carolina's rate of increase is ahead of Colorado's rate, but behind Washington, California, Virginia, Massachusetts, and Georgia. Combined, the comparison states' patenting activity increased 49 percent, which is significantly higher than North Carolina's increase.

While ranking the U.S. patent activity internationally among all countries isn't possible due to data limitations, among the comparison countries, the U.S. ranks 7<sup>th</sup> but well behind the leading countries, South Korea, Japan, and China **[3.3C]**. The United States also significantly more ahead of France, Germany, Canada, and the rest of the other comparison countries. Since 2000, the patent activity of China has risen considerably (197 percent) and much faster than the rate for all other comparison countries, whose combined average is -33 percent and much closer to the rates for the U.S. and North Carolina **[3.3D]**. Fifteen of the comparison countries decreased their rate of patenting activity over time.<sup>4</sup>

Within North Carolina, patenting activity is highly concentrated in a small number of counties, with nearly 80 percent of all patents being awarded in six counties **[3.3E and 3.3F]**. Wake County, with 44 percent of all the state's patents, has the largest share, followed by Mecklenburg (10 percent), Durham (9 percent), Orange (8 percent), Guilford (4 percent) and Forsyth (4 percent). The next 13 counties, ranging between .5 and 2 percent of all the state's patents, account for 13 percent of the state's patents overall, while the remaining 81 counties account for the final 8 percent of the state's patents. This high concentration of patents reflects a combination of the state's population (see indicator 1.6), the location and mix of its companies (see indicators 4.1, 4.2, and 6.4), the location and mix of its academic and business R&D (see indicator 2.2 and 3.1), the location of its academic patents (see indicator 3.2), and the educational attainment levels of its citizens (see indicator 5.6).

### 3.3C

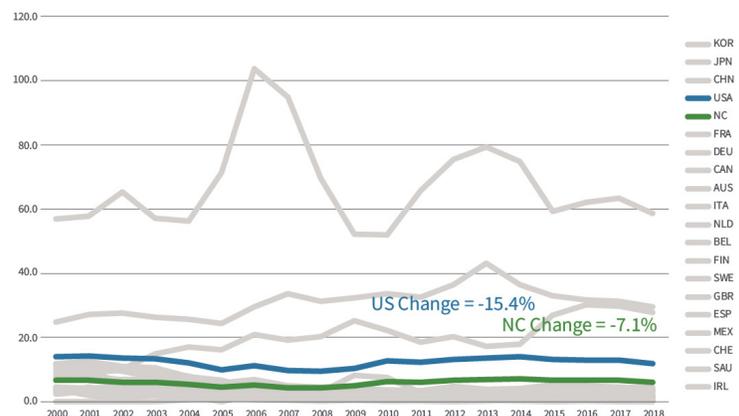
#### GRANTS FOR DIRECT PATENT APPLICATIONS PER BILLION DOLLARS IN GDP, COMPARISON COUNTRIES, 2018



Source: World Bank, World Development Indicators; World Intellectual Property Organization; U.S. Bureau of Economic Analysis; United States Patent and Trademark Office.

### 3.3D

#### GRANTS FOR DIRECT PATENT APPLICATIONS PER BILLION DOLLARS IN GDP, COMPARISON COUNTRIES, 2000-2018



Source: World Bank, World Development Indicators; World Intellectual Property Organization; U.S. Bureau of Economic Analysis; United States Patent and Trademark Office.

Note: Time series data for Singapore and the United Arab Emirates are unavailable.

<sup>4</sup> While difficult to see in chart 3.3D, the raw data indicate that all but four of the comparison countries decreased over time.

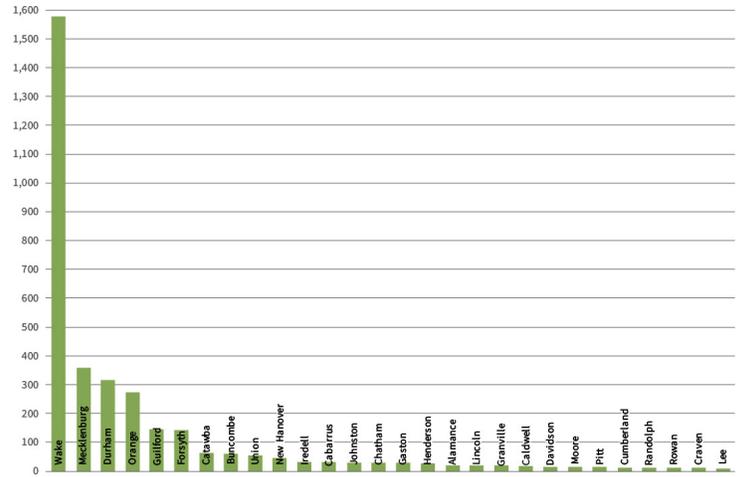
## Indicator 3.3: Patents

### WHAT DOES THIS MEAN FOR NORTH CAROLINA?

Academic institutions own less than 10 percent of North Carolina’s patents,<sup>5</sup> meaning businesses and individuals hold the vast majority of legally protected intellectual property in the state. Although North Carolina’s patenting rate ranks slightly below the U.S. average, its rate is above that of most states and is growing slightly faster than the U.S. average. Together, these facts suggest that North Carolina has a considerable and growing amount of intellectual property with the potential to yield new, as well as enhanced, products and services to improve the economic well-being and quality of life of its citizens. The extent to which that potential is realized ultimately depends on the ability of the state’s businesses and individuals to capitalize on their intellectual property in ways that allow them to appropriate economic and social value from it. The state should work to enhance the conditions that facilitate the commercialization of intellectual property.

### 3.3E

### AVERAGE ANNUAL NUMBER OF PATENTS, SELECTED N.C. COUNTIES, 2016-2018

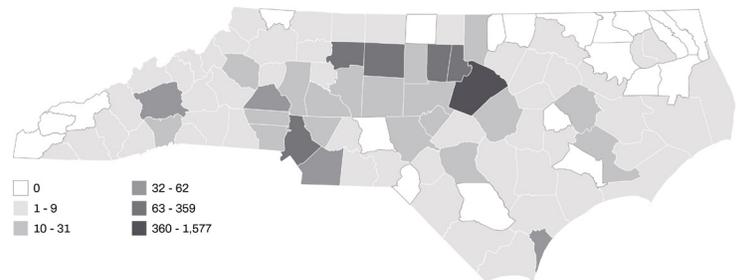


Source: U.S. Patent and Trademark Office, via Neo IP Intellectual Property Law Firm and Magic Number, Inc. software.

Note: Counties with 10 or more patents are included.

### 3.3F

### AVERAGE ANNUAL NUMBER OF PATENTS, N.C. COUNTIES, 2016-2018



Source: U.S. Patent and Trademark Office, via Neo IP Intellectual Property Law Firm and Magic Number, Inc. software.

<sup>5</sup> This percentage is derived from National Science Foundation data, specifically by dividing the total number of patents by the number of academic patents for recent years for which both total patent and academic patent data were available.

## Indicator 3.4: Venture Capital

### KEY FINDINGS

- The ratio of North Carolina’s venture capital dollars to state GDP ranks well below the U.S. average, decreasing significantly since 2000, similar to the trend for the U.S. overall.
- The number of North Carolina’s venture capital deals as a percentage of high-technology business establishments ranks below the U.S. average but has increased since 2003.
- North Carolina’s venture capital investments are highly concentrated in a small number of urban counties and counties containing major universities.

### INDICATOR OVERVIEW

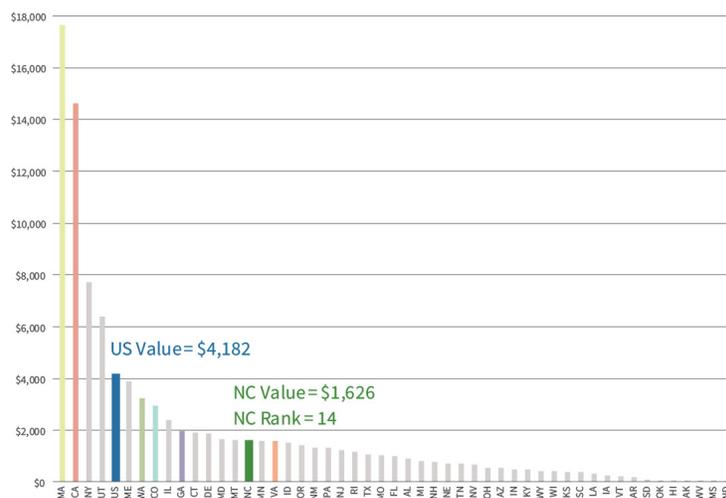
Venture capital dollars disbursed per \$1,000 in state gross domestic product (GDP) is a measure of the magnitude of venture capital investment, adjusting for the size of a state economy. Venture capital is financial capital provided to early-stage, high-potential, high-risk, growth startup companies. The typical venture capital investment occurs as growth funding after the seed funding round in the interest of generating a return through an event, such as an initial public offering or sale of the company. Venture capital is especially important to startup companies in the early stages of development; these companies often need financing to get a project off the ground but are unable to access traditional financing because of an insufficient cash flow history. States that rank well in this measure possess companies that have been successful in attracting venture capital investment. Positive trends in this measure may be predictors of new products and services, job creation, and revenue growth.

### HOW DOES NORTH CAROLINA PERFORM?

In terms of venture capital investment adjusted for state economy size, North Carolina ranks 14<sup>th</sup> in the nation, with a value that is 39 percent of the U.S. value [3.4A]. This below-the-national average value reflects the very high concentrations of venture capital investment in Massachusetts and California, which skew the national average upward. More than 61 percent of all venture capital disbursements are made in Massachusetts and California alone, and only two other states (New York and Utah) possess averages higher than the national average.

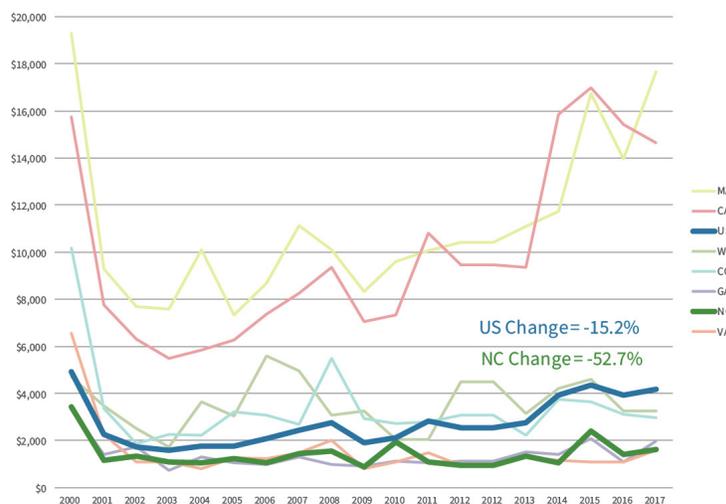
Between 2000 and 2017, venture capital investment in North Carolina firms decreased by 52.7 percent [3.4B]. Although this decline is significant, it mostly parallels declines across the nation. Over the same period, the U.S. average decreased by 15.2 percent, and all comparison states experienced similar declines. This across-the-board decline is explained by high venture capital investment in 2000—all states had their highest venture capital values in that year, the peak of the dot-com bubble and the first year in this analysis. Since 2001, North Carolina venture capital per \$1,000 GDP has fluctuated between \$3.44 and \$0.89.

### 3.4A VENTURE CAPITAL DISPENSED PER \$1 MILLION OF GDP, ALL U.S. STATES, 2017



Source: National Science Board.

### 3.4B VENTURE CAPITAL DISPENSED PER \$1 MILLION OF GDP, COMPARISON STATES, 2000-2017



Source: National Science Board.



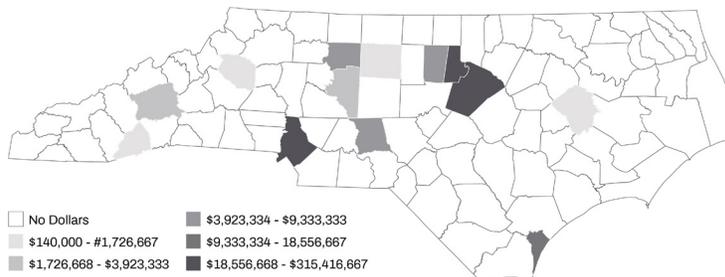
## Indicator 3.4: Venture Capital

### WHAT DOES THIS MEAN FOR NORTH CAROLINA?

Innovative companies often need venture capital to realize their growth potential. If they are unable to access venture capital in North Carolina, entrepreneurs may need to relocate to venture capital-rich parts of the country—for example, Silicon Valley in California and the Boston metro area—in order to develop and expand. To the extent that venture capital investments in North Carolina are able to retain innovative companies spun off from North Carolina businesses, universities, and innovation infrastructure, the state will receive benefits such as job growth and income increases. Increasing access to venture capital is vitally important, but the direct impact of increased venture capital in North Carolina may not be uniformly felt across the state.

3.4E

### LOCATION OF VENTURE CAPITAL INVESTMENTS IN N.C., AVERAGE ANNUAL INVESTMENTS, 2016-2018



Source: PitchBook Data Inc.

## Indicator 3.5: Technology License Income

### KEY FINDINGS

- North Carolina’s gross income received from technology licenses ranks below the U.S average.
- North Carolina’s running royalties received from technology licenses ranks below the U.S average and has decreased since the early 2000s.
- Within North Carolina, at least seven universities have significant technology license income.

### INDICATOR OVERVIEW

Universities and nonprofit research organizations use technology license agreements to transfer codified knowledge in the form of innovative intellectual property (IP) to companies and entrepreneurs seeking to commercialize the technology. The income generated from license agreements is a key measure of the value of that IP. In addition, net licensing income can be used to support subsequent research and development (R&D) and education activities, as well as patenting and other commercialization-related costs.

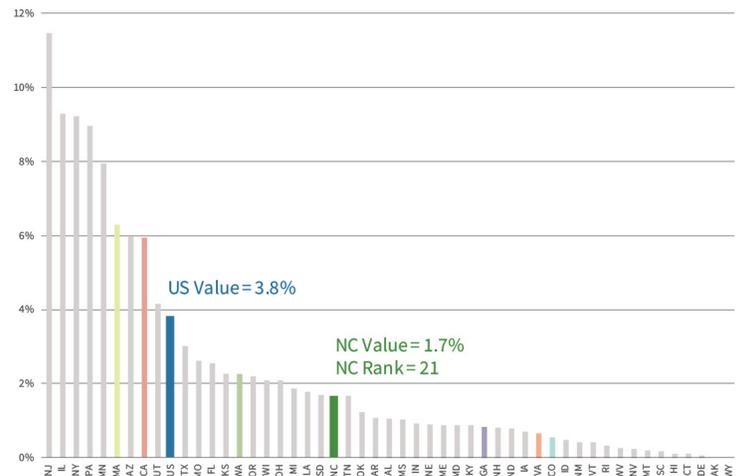
This indicator measures technology license income two ways: 1) gross income received and 2) running royalties received, with each measured as a percentage of academic science & engineering R&D expenditures. Gross income is the more inclusive measure, and it includes license issue fees, payments under options, annual minimums, running royalties, termination payments, the amount of equity received when cashed-in, and software and biological material end-user license fees equal to \$1,000 or more. Running royalties, a subset of the more inclusive gross income measure, are usage-based payments made by the licensee to the licensor for ongoing use of an asset or IP right. As such, running royalties are evidence of the perceived value of IP in the marketplace or the achievement of milestones on the path toward commercialization.

### HOW DOES NORTH CAROLINA PERFORM?

In terms of gross income received as a percentage of academic science & engineering R&D expenditures, North Carolina ranks 21<sup>st</sup> in the nation, with a value that is 45 percent of the U.S. value and 15 percent of the value of the top-ranking state, New Jersey [3.5A]. Among the comparison states, North Carolina ranks behind Massachusetts, California, and Washington, but ahead of Georgia, Virginia, and Colorado.

3.5A

### ACADEMIC LICENSE INCOME (GROSS RECEIVED) AS A PERCENTAGE OF ACADEMIC R&D EXPENDITURES, ALL U.S. STATES, 2015-2017 AVERAGE

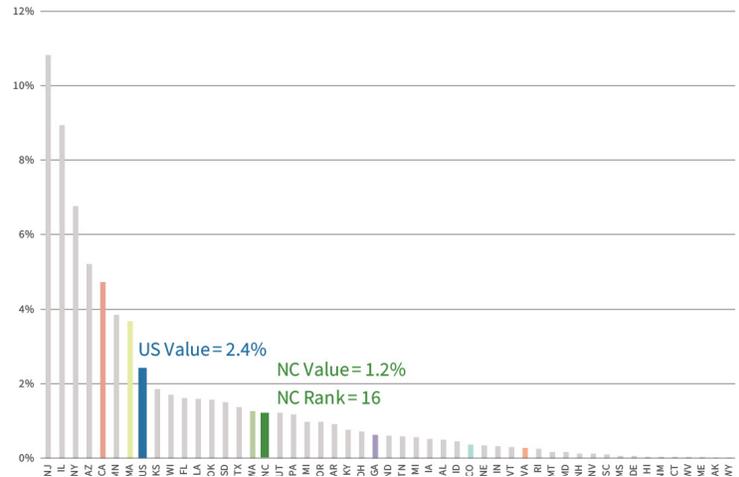


Sources: Association of University Technology Managers and National Science Foundation  
 Note: 2016-2017 data for Wake Forest were not available; values for those years were extrapolated based on 2012-2015 data.

## Indicator 3.5: Technology License Income

North Carolina fares similarly for running royalties as a percentage of academic science & engineering R&D expenditures, ranking 16<sup>th</sup> in the nation, with a value that is 50 percent of the U.S. value and 11 percent of the value of the top-ranking state, New Jersey [3.5B]. Among the comparison states, and similar to the gross income measure, North Carolina ranks behind California, Massachusetts, and Washington, but ahead of Georgia, Colorado, and Virginia. Since 2000, North Carolina's running royalties as a percentage of academic science & engineering R&D expenditures have decreased by 51.8 percent, which is opposite the trends for the U.S. as well as California, and Colorado, among the comparison states [3.5C].<sup>1</sup>

### 3.5B ACADEMIC LICENSE INCOME (RUNNING ROYALTIES) AS A PERCENTAGE OF ACADEMIC R&D EXPENDITURES, ALL U.S. STATES, 2015-2017 AVERAGE



## Indicator 3.5: Technology License Income

Within North Carolina, seven universities report significant technology license income—Duke University, ECU, North Carolina State University, the University of North Carolina at Charlotte, the University of North Carolina at Greensboro, the University of North Carolina at Chapel Hill, and Wake Forest University [3.5D and 3.5E].<sup>2</sup> Between 2013 and 2015, together the universities received, on average, more than \$49 million in licensing income.<sup>3</sup>

### WHAT DOES THIS MEAN FOR NORTH CAROLINA?

One of North Carolina’s core innovation-related strengths is its academic R&D (see indicator 2.3), which suggests the state could rank better on income from university technology license agreements as a percentage of academic science & engineering R&D expenditures. The level of license income varies considerably across the state’s universities and is concentrated in a relatively small number of universities overall. To maximize the value of the state’s strong academic R&D, a larger number of North Carolina’s universities should focus increased attention on their offices and activities that generate patents and other forms of IP that can be licensed. This would not necessarily entail a large increase in resources. For example, the University of North Carolina’s 2013–2018 strategic directions include establishing and supporting a “scout team” and core support staff that any campus could utilize for market assessment, legal assistance, new venture services, and other operational support, such as patenting and copyrighting, for commercialization.<sup>4</sup> Additionally, in fall 2014, the Governor’s Innovation-to-Jobs Working Group recommended that the state’s universities—public and private—form an Innovation Commercialization Council to develop and share best practices and elevate the importance of commercializing university innovations.<sup>5</sup> Initiatives such as these and others focused on increasing the commercial impact of academic discoveries should be a high priority for state and university policy makers.

### 3.5D

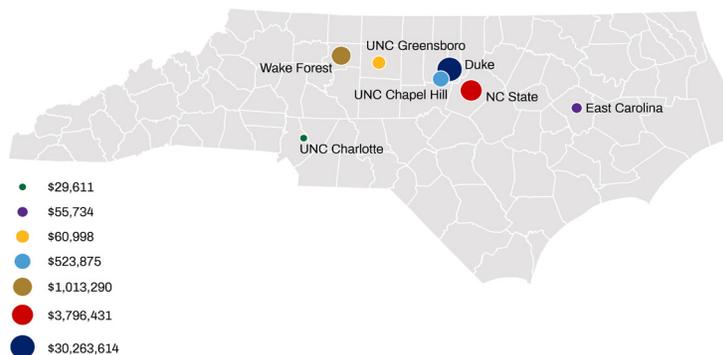
### AVERAGE ANNUAL ACADEMIC LICENSE INCOME, U.S. AVERAGE AND N.C. INSTITUTIONS, 2015-2017

Higher Education Institution	Gross Received	Running Royalties
US Average	\$15,207,263	\$10,169,253
Duke	\$38,512,774	\$30,263,614
East Carolina	\$235,053	\$55,734
NC State	\$5,297,122	\$3,796,431
UNC Charlotte	\$70,547	\$29,611
UNC Greensboro	\$60,998	\$60,998
UNC-Chapel Hill	\$3,871,131	\$523,875
Wake Forest	\$1,199,013	\$1,013,290

Source: Association of University Technology Managers.  
 Note: 2016-2017 data for Wake Forest were not available; values for those years were extrapolated based on 2012-2015 data.

### 3.5E

### LOCATION OF ACADEMIC LICENSE INCOME (RUNNING ROYALTIES) IN N.C., AVERAGE ANNUAL INCOME, 2015-2017



Source: Association of University Technology Managers.  
 Note: 2016-2017 data for Wake Forest were not available; values for those years were extrapolated based on 2012-2015 data.

<sup>4</sup> Our Time, Our Future: The UNC Compact with North Carolina, Strategic Directions 2013-2018, available at [https://www.northcarolina.edu/sites/default/files/strategic\\_directions\\_2013-2018\\_0.pdf](https://www.northcarolina.edu/sites/default/files/strategic_directions_2013-2018_0.pdf).

<sup>5</sup> Recommendations of the Governor’s Innovation-to-Jobs Working Group. March 2015. Available at: [https://files.nc.gov/nccommerce/documents/files/Governors\\_Innovation-to-Jobs\\_Working\\_Group\\_Recommendations\\_March\\_2015.pdf](https://files.nc.gov/nccommerce/documents/files/Governors_Innovation-to-Jobs_Working_Group_Recommendations_March_2015.pdf)

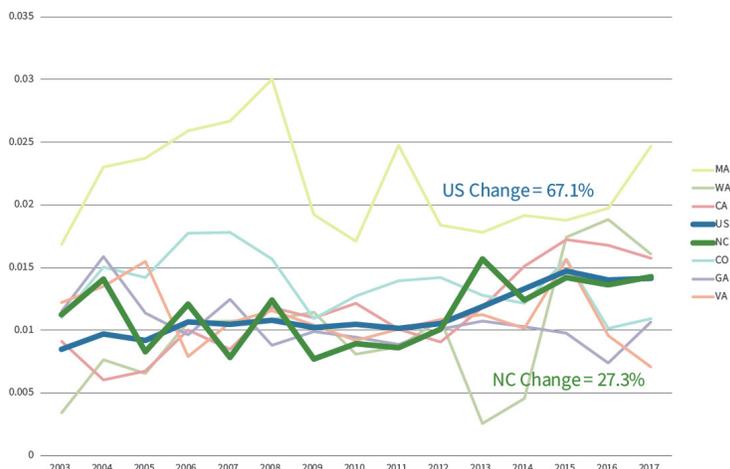


## Indicator 3.6: University Startups

Since 2000, North Carolina has experienced an upward trend in the number of university startups formed per \$1 million of academic science and engineering R&D expenditures.<sup>1</sup> While quite variable over this time frame, North Carolina experienced an increase of 27.3 percent from 2000 to 2017 [3.6C]. Meanwhile, the U.S. experienced a positive trend of 67.1 percent. Relative to comparison states, North Carolina ranks in the middle, behind Massachusetts, Washington, and California, which had larger increases, but ahead of Colorado, Georgia, and Virginia, which decreased.

From 2015-2017, seven North Carolina universities reported having formed university startups—Duke University, ECU, North Carolina State University, the University of North Carolina at Charlotte, the University of North Carolina at Greensboro, the University of North Carolina at Chapel Hill, and Wake Forest University. Among all universities within the state, North Carolina State University had highest average number of startups formed during this time period, and also had the highest average number of startups formed that remained in the state [3.6D]. North Carolina State University, Duke University, and the University of North Carolina at Chapel Hill were the only universities whose averages were higher than the U.S. average for both the average number of university startups formed and those that stayed in the home state.

### 3.6C NUMBER OF UNIVERSITY STARTUPS FORMED PER \$1 MILLION OF ACADEMIC R&D EXPENDITURES, COMPARISON STATES, 2003-2017



Source: Association of University Technology Managers and National Science Foundation. Note: 2016-2017 data for Wake Forest were not available; values for those years were extrapolated based on 2000-2015 data.

### 3.6D AVERAGE ANNUAL NUMBER OF UNIVERSITY STARTUPS FORMED & STAYED IN HOME STATE, U.S. AVERAGE AND N.C. INSTITUTIONS, 2015-2017

Higher Education Institution	Average Annual Number of University Startups Formed	Average Annual Number of University Startups Formed & Stayed in Home State
US	6	4
Duke	9	6
ECU	2	1
NC State	13	12
UNC Charlotte	4	4
UNC Greensboro	1	1
UNC-Chapel Hill	9	7
Wake Forest	3	2

Source: Association of University Technology Managers. Note: 2016-2017 data for Wake Forest were not available; values for those years were extrapolated based on 2000-2015 data.

<sup>1</sup> Though not presented in chart form here, the data indicate a slight downward trend in the average number of university startups formed and stayed in their home state per \$1 million of academic science and engineering R&D expenditures.

## WHAT DOES THIS MEAN FOR NORTH CAROLINA?

Because North Carolina's innovation- and research-related strengths are derived heavily from academic institutions (see indicators 2.3 and 2.5), it is not surprising that several of the state's universities produce startup companies. Additionally, based on raw numbers alone, North Carolina ranks 7<sup>th</sup> and 6<sup>th</sup> overall in the number of university startups (as well as those that remained in the state), respectively.<sup>2</sup> When these numbers are normalized to account for science and engineering R&D expenditures, North Carolina ranks considerably lower nationally, primarily because the state ranks particularly high on academic R&D expenditures—3<sup>rd</sup> nationally and well above the U.S. average (see indicator 2.3). To maximize the value of the state's strong academic R&D, a larger number of North Carolina's universities should focus increased attention on their offices and activities that generate patents and other forms of IP that form the basis of a startup company. This would not necessarily entail a large increase in resources. For example, the University of North Carolina's 2013–2018 strategic directions include establishing and supporting a "scout team" and core support staff that any campus could utilize for market assessment, legal assistance, new venture services, and other operational support, such as patenting and copyrighting, for commercialization.<sup>3</sup> Additionally, in fall 2014, the Governor's Innovation-to-Jobs Working Group recommended that the state's universities—public and private—form an Innovation Commercialization Council to develop and share best practices and elevate the importance of commercializing university innovations.<sup>4</sup> Initiatives such as these and others focused on increasing the commercial impact of academic discoveries should be a high priority for state and university policy makers.

<sup>2</sup> These estimates are not presented in the charts.

<sup>3</sup> *Our Time, Our Future: The UNC Compact with North Carolina, Strategic Directions 2013-2018*, available at [https://www.northcarolina.edu/sites/default/files/strategic\\_directions\\_2013-2018\\_0.pdf](https://www.northcarolina.edu/sites/default/files/strategic_directions_2013-2018_0.pdf).

<sup>4</sup> *Recommendations of the Governor's Innovation-to-Jobs Working Group. March 2015*. Available at: [https://files.nc.gov/nccommerce/documents/files/Governors\\_Innovation-to-Jobs\\_Working\\_Group\\_Recommendations\\_March\\_2015.pdf](https://files.nc.gov/nccommerce/documents/files/Governors_Innovation-to-Jobs_Working_Group_Recommendations_March_2015.pdf)



## Indicator 4.1: High SET Employment Establishments & Formations

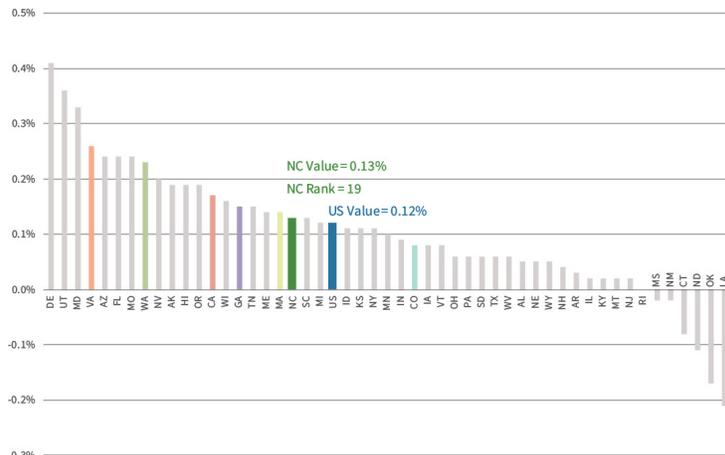
comparison states, which average 16 percent [4.1B].

In terms of high SET employment business formations as a percentage of all business establishments, North Carolina's value of .13 percent is larger than the U.S. value of .12 percent, but nearly one third of the value of the highest state, Delaware [4.1C]. Among comparison states, North Carolina is behind all states except Colorado (.08 percent). The percentage of high SET employment business formations in North Carolina has decreased by 46.3 percent since 2004. This rate of decrease is nearly double the rate of decrease for the U.S., -23.8 percent, and the average rate for the comparison states, -11.2 percent [4.1D]. Notably, most of this decrease results from the 2008-2009 recession, which caused a sharp downturn in the rate of high SET employment business formations. Since 2009, the rate has increased significantly for North Carolina, the U.S. overall, and for all the comparison states.

Although high SET employment establishments are located in each of North Carolina's 100 counties, nearly half (49.4 percent) of those establishments are located in just three counties—Wake (23.4 percent), Mecklenburg (20.4 percent), and Durham (5.6 percent) [4.1E]. The next six counties combined—Guilford (4.9 percent), Buncombe (3.8 percent), New Hanover (3.3 percent), Forsyth (3.2 percent), Orange (2.5 percent), and Union (2.5 percent)—account for another 20.2 percent of the state's high SET employment establishments. This means that nine of the state's 100 counties contain more than two-thirds of the state's high SET employment establishments. These nine counties plus seven others—Chatham, Iredell, Lincoln, Cabarrus, Transylvania, Moore, and Franklin—are the only ones in the state whose high SET employment establishments as a percentage of total establishments is higher than the U.S. average. Of the remaining 84, three counties account for between one and two percent of the state's high SET employment establishments each, whereas each of the remaining 81 counties has less than one percent of the state's high SET employment establishments.

### 4.1C

#### NET HIGH SET EMPLOYMENT BUSINESS FORMATIONS AS A PERCENTAGE OF ALL BUSINESS ESTABLISHMENTS, ALL U.S. STATES, 2016



Source: National Science Board

### 4.1D

#### NET HIGH SET EMPLOYMENT BUSINESS FORMATIONS AS A PERCENTAGE OF ALL BUSINESS ESTABLISHMENTS, COMPARISON STATES, 2004-2016



Source: National Science Board

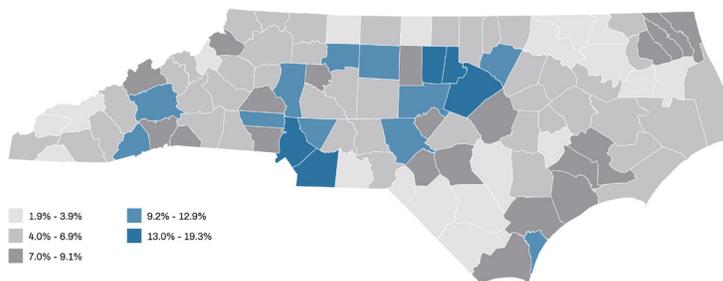
## Indicator 4.1: High SET Employment Establishments & Formations

### WHAT DOES THIS MEAN FOR NORTH CAROLINA?

Together, North Carolina's below-average level of high SET employment establishments but above-average rate of high SET employment establishment formations reflect the facts that, while a large proportion of North Carolina currently remains rural in nature and has a higher-than-average share of establishments in lower-technology manufacturing industries and agriculture, a larger share of the state's economy is becoming high tech at a rate faster than in the U.S. overall. In the innovation-driven economy, the presence and formation of high SET employment establishments indicates the degree to which a state's economy is dynamic, innovative, and a positive environment for economic growth and job creation. To compete favorably in this economy, North Carolina must continue to increase the technology levels of its existing establishments and to start and grow new high SET employment establishments at a faster-than-average rate, particularly in more rural regions.

4.1E

### HIGH SET ESTABLISHMENTS AS A PERCENTAGE OF TOTAL ESTABLISHMENTS, N.C. COUNTIES, 2018



Source: Quarterly Census of Employment and Wages, Labor and Economic Analysis Division, NC Department of Commerce.

Note: Blue counties rank above the U.S. average.

## Indicator 4.2: High SET Employment

### KEY FINDINGS

- The percentage of North Carolina’s workforce employed in high science, engineering and technology (SET) employment establishments ranks below the U.S. average and has since at least the early 2000s, but is increasing at a rate faster than the U.S. average.
- North Carolina’s employment in high SET employment establishments is highly concentrated in a very small number of urban counties.

### INDICATOR OVERVIEW

This indicator represents the extent to which a state’s workforce is employed in industries with high employment in science, engineering, and technology (SET) occupations.<sup>1</sup> High SET employment industries are defined as those in which the proportion of employees in technology-oriented occupations is at least twice the average proportion for all industries. SET occupations include scientific, engineering, and technician occupations that employ workers who generally possess in-depth knowledge of the theories and principles of science, engineering, and mathematics at a postsecondary level.<sup>2</sup>

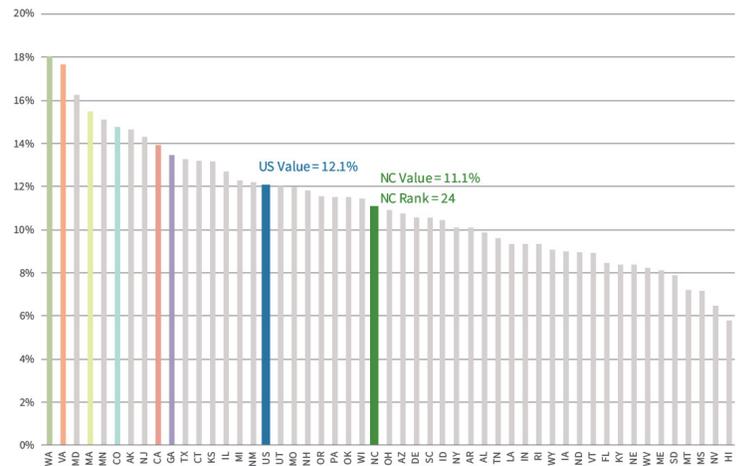
States often consider such industries desirable, in part because they tend to compensate workers better than other industries do (see indicator 1.3). High SET occupations tend to be managerial, professional and technical positions held by individuals with at least two years of college education. Skilled and educated workers are the core drivers of states’ most important industries, from research and development, to high value-added manufacturing, to high-wage traded services.

### HOW DOES NORTH CAROLINA PERFORM?

North Carolina’s employment in high SET employment establishments is 11.1 percent of the state’s total employment, a value that ranks 24<sup>th</sup> in the nation and is 92 percent of the U.S. average value and 61 percent of the value of the top-ranking state, Washington [4.2A]. Among the comparison states, North Carolina’s employment in high SET employment establishments as a percentage of total employment ranks last, over two percentage points lower than the next highest state, Georgia. The percentage of North Carolina’s employment in high SET employment establishments has increased by 6.1 percent since 2003. This rate of increase is higher than the 1.0 percent rate of increase for the U.S., lower than the rates of increase for Virginia and Georgia (12.8 and 10.4, respectively), but above the rates for Washington, California, Colorado, and Massachusetts, whose values ranged between -0.1 and 3.2 percent [4.2B].

#### 4.2A

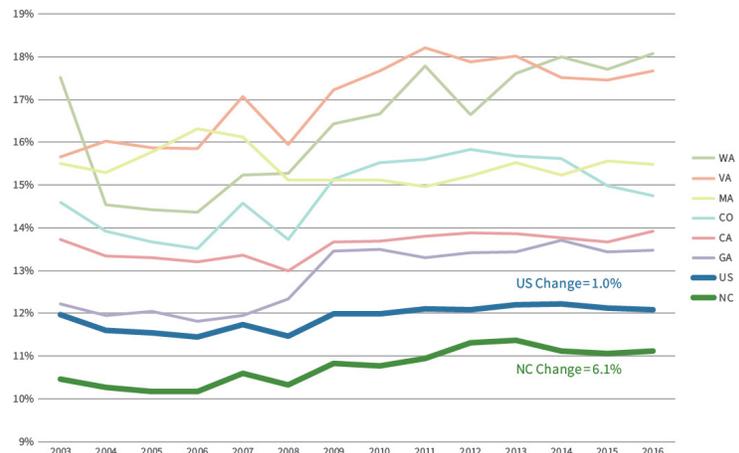
### EMPLOYMENT IN HIGH SET EMPLOYMENT ESTABLISHMENTS AS A PERCENTAGE OF TOTAL EMPLOYMENT, ALL U.S. STATES, 2016



Source: National Science Board

#### 4.2B

### EMPLOYMENT IN HIGH SET EMPLOYMENT ESTABLISHMENTS AS A PERCENTAGE OF TOTAL EMPLOYMENT, COMPARISON STATES, 2003-2016



Source: National Science Board

<sup>1</sup> Total employment refers to all U.S. business establishments with paid employees but does not include crop and animal production, rail transportation, the postal service, public administration, or most government employees.

<sup>2</sup> The data on business establishments in high SET employment industries for the years 2003–08 are based on the establishments’ classification according to the 2002 edition of the North American Industry Classification System (NAICS). The data for the years 2009–12 are based on classification according to the 2007 edition of NAICS, and subsequent years use 2012 NAICS codes. See the Appendix for a list of the 48 industries (by 4-digit NAICS code) that are defined as having high SET employment. Data on total employment and NAICS industry establishment employment are provided by the Census Bureau and differ from workforce data provided by the Bureau of Labor Statistics.

## Indicator 4.2: High SET Employment

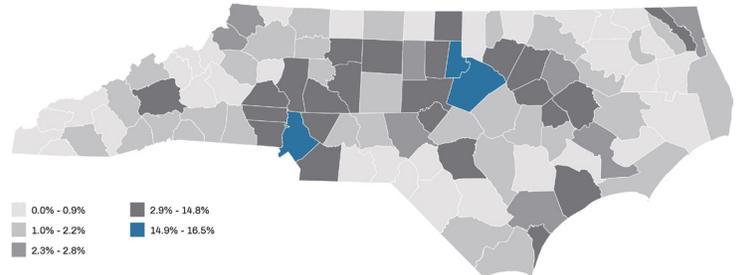
Although high SET employment establishments employ workers in nearly all of North Carolina’s 100 counties, over two-thirds (68.3 percent) of those employees work in just three urban counties—Mecklenburg (30.7 percent), Wake (27.6 percent), and Durham (10.0 percent) [4.2C]. Moreover, those three counties are the only ones in the state whose employment in high SET employment establishments as a percentage of total county employment is greater than or equal to than the U.S. average (12.1 percent). Establishments located in each of the next nine counties—Guilford (6.4 percent), Forsyth (3.4 percent), Buncombe (2.5 percent), New Hanover (2.4 percent), Catawba (1.4 percent), Cumberland (1.4 percent), Iredell (1.1 percent), Pitt (1.1 percent), and Orange (1.0 percent)—account for just over twenty percent of the state’s high SET workers. This means that establishments located in only 12 percent of the state’s counties employ nearly 90 percent of the state’s high SET workers. Each of the remaining 88 counties has less than one percent of the state’s high SET employment.

### WHAT DOES THIS MEAN FOR NORTH CAROLINA?

As with high SET employment establishments (see indicator 4.1), North Carolina’s below-average level of employment in high SET employment establishments reflects the dual facts that a large proportion of North Carolina remains rural in nature and has a higher-than-average share of companies in lower-technology manufacturing industries and agriculture. Moreover, looking across the state, the distribution of high SET workers is more concentrated than the distribution of high SET employment establishments. This pattern of geographically concentrated high SET employment establishments and high SET workers is considerably more concentrated than the state’s population (see indicator 1.6). Together, these patterns suggest that more factors than just the location of the state’s population influence where people work and the types of establishments in which they work. These other factors include, among others, the location of research and development assets and activities (see indicators in Section 2) and the education attainment levels of the population across the state (see indicator 5.6). For North Carolina to increase the percentage of its workforce in high SET employment establishments, it must not only increase the technology levels of its existing companies and start and grow new high SET employment companies. It must also ensure that a greater share and range of its population has the educational requirements and training to work in high SET employment establishments.

4.2C

### EMPLOYMENT IN HIGH SET EMPLOYMENT ESTABLISHMENTS AS A PERCENTAGE OF TOTAL EMPLOYMENT, N.C. COUNTIES, 2018



Source: Quarterly Census of Employment and Wages, Labor and Economic Analysis Division, NC Department of Commerce.

Note: Blue counties rank above the U.S. average.

## Indicator 4.3: Entrepreneurial Activity

### KEY FINDINGS

- North Carolina’s monthly rate of new business creation ranks slightly behind the U.S. average.
- While North Carolina’s monthly rate of new business creation has increased since 2000, it is not keeping pace with the U.S. rate overall.
- North Carolina’s average opportunity share of new entrepreneurs ranks equal to the U.S. average.
- North Carolina’s average opportunity share of new entrepreneurs has increased moderately since 2000 at a rate slower than the U.S. average.

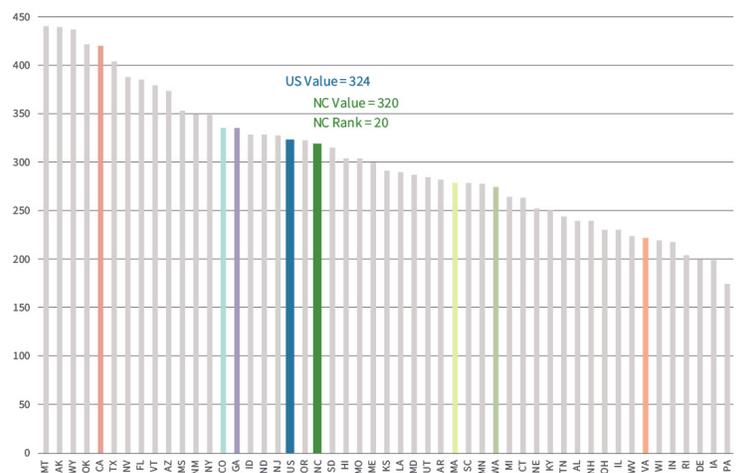
### INDICATOR OVERVIEW

This indicator measures the state of entrepreneurial activity in North Carolina. Entrepreneurs provide expertise in transforming innovative ideas into valuable innovations. Strong entrepreneurial activity will help advance North Carolina’s transition to a knowledge-based, technology-driven economy and also create new jobs for the state workforce. Data for entrepreneurial activity are drawn from the Kauffman Foundation, which measures entrepreneurial activity two ways presented here. First, it uses the Current Population Survey to measure the monthly rate of business creation to approximate entrepreneurial activity.<sup>1</sup> Second, it measures the average opportunity share of new entrepreneurs using a proxy indicator of the percent of new entrepreneurs starting businesses because they saw market opportunities. Specifically, it measures the percent of new entrepreneurs who were not unemployed before starting their businesses.

### HOW DOES NORTH CAROLINA PERFORM?

North Carolina’s monthly rate of business creation ranks 20<sup>th</sup> in the nation, with a level that is just below the U.S. value and 73 percent of the value of the top-ranking state, Montana<sup>2</sup> [4.3A]. Specifically, North Carolina’s monthly rate of business creation is 0.3 percent; in other words, entrepreneurs in North Carolina started 320 businesses each month for every 100,000 adults living in the state. Among comparison states, North Carolina’s monthly rate is in the middle of the pack—lower than California, Colorado, and Georgia, but higher than Massachusetts, Washington, and Virginia.

**4.3A** AVERAGE ANNUAL NUMBER OF ENTREPRENEURS PER 100,000 PEOPLE, ALL U.S. STATES, 2015-2017



Source: Kauffman Foundation.

<sup>1</sup> The Kauffman Index of Entrepreneurial Activity (Kauffman Index) measures the rate of business creation at the individual owner level. Presenting the percentage of the adult, non-business owner population that starts a business each month, the Kauffman Index captures all new business owners, including those who own incorporated or unincorporated businesses, and those who are employers or nonemployers. The Kauffman Index is calculated from matched data from the Current Population Survey, a monthly survey conducted by the U.S. Bureau of the Census and the Bureau of Labor Statistics. For more information, see <https://indicators.kauffman.org/data-table>.

<sup>2</sup> To increase sample sizes and precision, monthly entrepreneurial activity rates for each state are averaged over a three-year period to calculate an average monthly estimate for the period. Year-to-year estimates are not presented here because of the lack of precision in entrepreneurship rates, especially for smaller states.

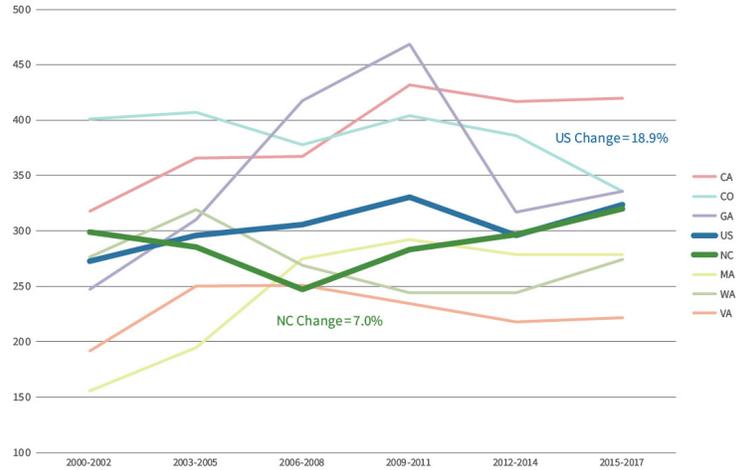
## Indicator 4.3: Entrepreneurial Activity

Since 2000, North Carolina's three-year entrepreneurship index average has remained fairly constant in growth, dipping only during the 2006–2008 period [4.3B]. Overall, North Carolina's index increased by 7.0 percent, and the U.S. index increased by 18.9 percent from 2000–2017. Four of the comparison states—Massachusetts, California, Georgia, and Virginia—experienced significant increases over time and grew faster than the North Carolina average. Two states—Colorado and Washington—experienced declines in entrepreneurship from 2000–2017.

In terms of the average opportunity share of new entrepreneurs, North Carolina ranks 21<sup>st</sup> in the nation, with a level that is equal to the U.S. value and 92 percent of the value of the top-ranking state, Iowa [4.3C]. Specifically, North Carolina's average opportunity share of new entrepreneurs is 84.5 percent, meaning nearly 85 percent of North Carolina's new entrepreneurs were not unemployed before starting their businesses. Among comparison states, North Carolina's opportunity share of new entrepreneurs is below Washington and Colorado, but ahead of Georgia, Massachusetts, California, and Virginia.

### 4.3B

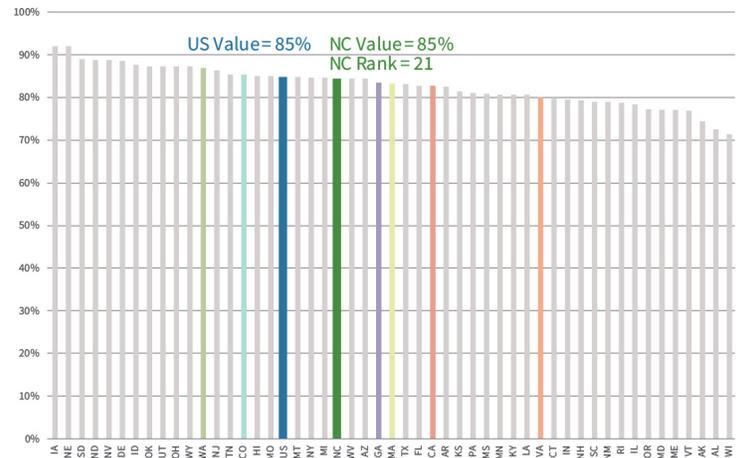
#### AVERAGE ANNUAL NUMBER OF ENTREPRENEURS PER 100,000 PEOPLE, COMPARISON STATES, 2000-2017



Source: Kauffman Foundation.

### 4.3C

#### AVERAGE OPPORTUNITY SHARE OF NEW ENTREPRENEURS, ALL U.S. STATES, 2015-2017



Source: Kauffman Foundation.

## Indicator 4.3: Entrepreneurial Activity

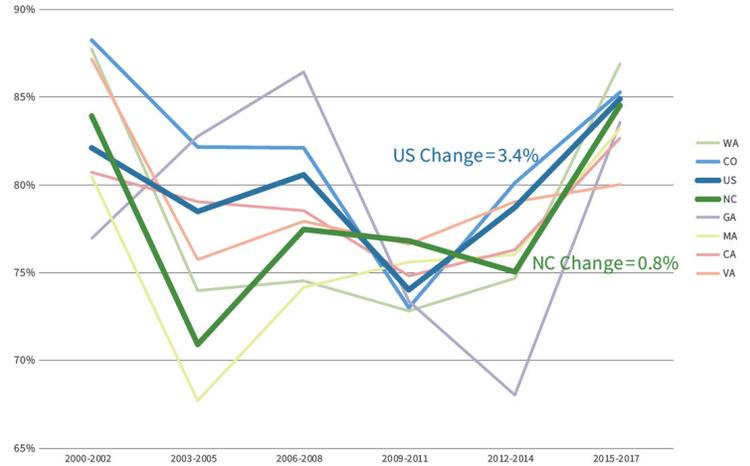
Since 2000, North Carolina's average opportunity share of new entrepreneurs has increased by 0.8 percent [4.3D]. During that same period of time, the opportunity share of new entrepreneurs in the U.S. overall increased by 3.4 percent. In three of the comparison states, the opportunity share of new entrepreneurs also increased—Georgia, Massachusetts, and California Colorado—and at rates that were faster than North Carolina's rate of change. Virginia, Colorado, and Washington had negative rates of change.

### WHAT DOES THIS MEAN FOR NORTH CAROLINA?

Several factors—such as economic and labor market conditions, industry mix, education, and culture—affect rates of entrepreneurship across states. Thus, while it is difficult to pinpoint causes of the different business creation rate scores across states, this indicator provides important insight into how quickly North Carolina's economy is changing to provide new opportunities and employment in economic sectors of the future. In general, North Carolina's performance is at or slightly below the national average; more can be done to improve state conditions for, and levels of, entrepreneurial activities.

4.3D

### AVERAGE OPPORTUNITY SHARE OF NEW ENTREPRENEURS, COMPARISON STATES, 2000-2017



Source: Kauffman Foundation.

## Indicator 4.4: Exports

### KEY FINDINGS

- The value of North Carolina’s exports as a percentage of state Gross Domestic Product (GDP)<sup>1</sup> ranks below the U.S. average, has since at least the early 2000s, and is decreasing while the U.S. value is increasing.
- In comparison with top foreign countries, the value of North Carolina’s exports as a percentage of GDP ranks low and has remained relatively constant since the early 2000s.

### INDICATOR OVERVIEW

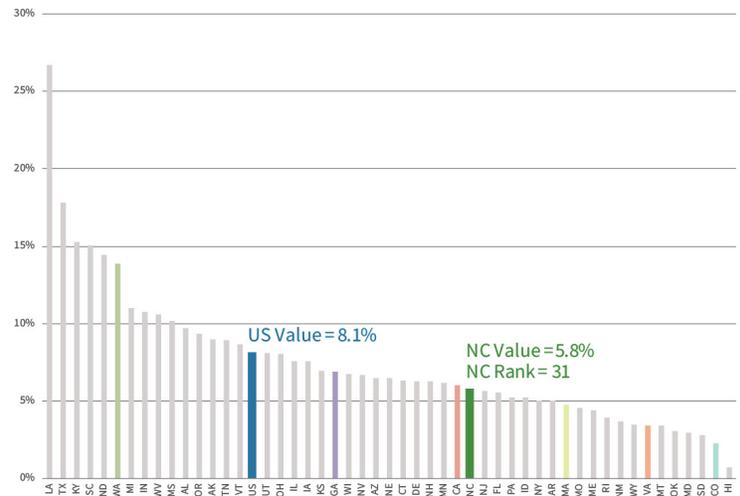
This indicator measures the dollar value of each state’s international exports as a percentage of its GDP. Export statistics are based on the state from which goods start their journey to the port of export; that is, the data reflect the transportation origin of exports.<sup>2</sup> Exports are an important indicator of a state’s potential for generating income and increasing the competitiveness of businesses in the state. More than 95 percent of the world’s population lives outside the U.S., and money brought into the state from export businesses allows for the purchase of local goods and services and thus improves the state’s local economy.<sup>3</sup> Export-based companies also are frequently required to adapt products in unique ways for foreign consumers. They may be called upon to negotiate trade restrictions and certification requirements, work with foreign suppliers, and/or manage expansive distribution channels, all of which create the flexibility and determination that result in greater competitiveness for home markets.

### HOW DOES NORTH CAROLINA PERFORM?

In terms of exports as a percentage of state GDP, North Carolina ranks 31<sup>st</sup> in the nation, with a value that is 72 percent of the U.S. value and 22 percent of the value of the top-ranking state, Louisiana [4.4A]. Among the comparison states, North Carolina’s exports as a percentage of state GDP ranks behind Washington, Georgia, and California, but ahead of Massachusetts, Virginia and Colorado. Between 2000 and 2018, North Carolina’s exports as a percentage of state GDP decreased by 11.0 percent, a rate below the 6.8 percent increase for the U.S. [4.4B]. While North Carolina’s decrease ranks behind Georgia and Washington, whose exports as a percentage of state GDP increased, its rate of decrease is slightly less than the rates for Virginia, California, Massachusetts, and Colorado.<sup>4</sup>

#### 4.4A

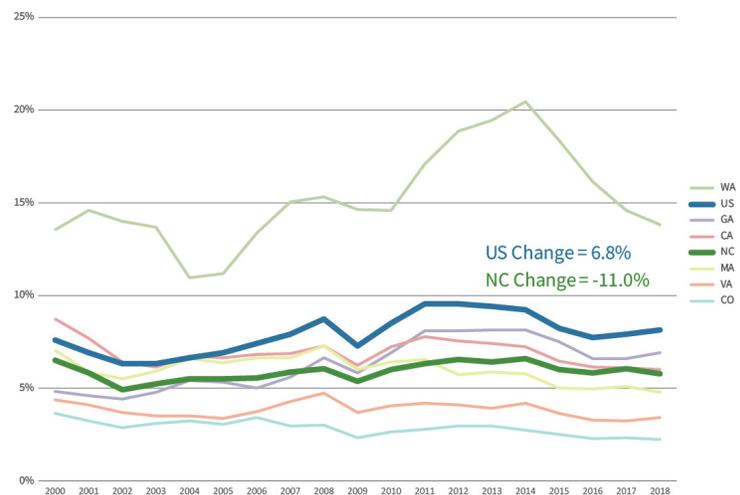
### EXPORTS AS A PERCENTAGE OF GDP, ALL U.S. STATES, 2018



Source: WISERTrade and U.S. Bureau of Economic Analysis.

#### 4.4B

### EXPORTS AS A PERCENTAGE OF GDP, COMPARISON STATES, 2000-2018



Source: WISERTrade and U.S. Bureau of Economic Analysis.

<sup>1</sup> When used in the context of states, “domestic” refers to the state level. When used as the context of nations, “domestic” refers to the national level.

<sup>2</sup> The data come from the Origin of Movement (OM) series, available since 1987 from the U.S. Census Bureau, Foreign Trade Division. OM data cover exports of goods only; there are no comparable statistics for exports of services at the state level.

<sup>3</sup> Export income is considered “new” money introduced into a state’s economy. This “new” money can be spent on local goods and services, resulting in an income multiplier effect.

<sup>4</sup> As evidenced by the trends for the U.S., N.C., and the comparison states in chart 4.4B, much of the decrease resulted from the global recession that began in 2008 and negatively impacted economic and trade activity in 2009 and 2010. Since 2010, export levels for the U.S., N.C., and the comparison states have trended upward.

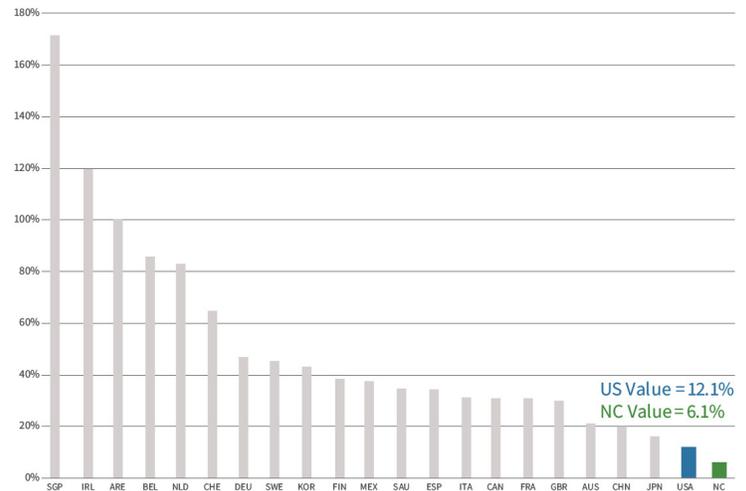
Internationally, the U.S. ranks as the 215<sup>th</sup> most export-intensive country in 2017, making its export intensity 12 percent of the rate of the most export-intensive country, Luxembourg [4.4C].<sup>5</sup> North Carolina's export intensity ranks behind that of all the comparison countries. Since 2000, the export intensity of most of the comparison countries has risen at roughly the same rate as the U.S. rate or, in some cases, at a considerably higher rate (e.g., United Arab Emirates at 104.2 percent, Japan at 53.0 percent, and Germany at 52.6 percent) [4.4D]. A small number of countries saw their export intensities decrease (e.g., Canada at -29.7 percent, Saudi Arabia at -19.7 percent, Singapore at -9.4 percent, Finland at -8.5 percent, and China at -6.0 percent).

### WHAT DOES THIS MEAN FOR NORTH CAROLINA?

Exports continue to be one of the key drivers for North Carolina's economic development. In 2018, for example, North Carolina exported more than \$32.8 billion in products and services to international markets.<sup>6</sup> Exporting helps companies in North Carolina diversify their business portfolios and become more profitable and resilient in the global market. Furthermore, much of the 9 percent reduction in the trade deficit from 2011 to 2016 can be attributed to the 20 percent growth in services exports over the same period, and specifically, strong growth in information and communication technologies (ICT)-enabled service exports.<sup>7</sup> For North Carolina to remain competitive in the global economy, it must continue to explore new markets for the goods and services it produces. Such efforts require focus in strengthening and expanding relationships with overseas trading partners and understanding how North Carolina industries fit within global commodity value chains. Infrastructure investment in highways, inland terminals, and port facilities is needed to improve the ability to efficiently move goods. Enhanced export assistance and increased availability of financial credits to small and medium-sized companies seeking to export are crucial in connecting businesses to the global economy.<sup>8</sup>

#### 4.4C

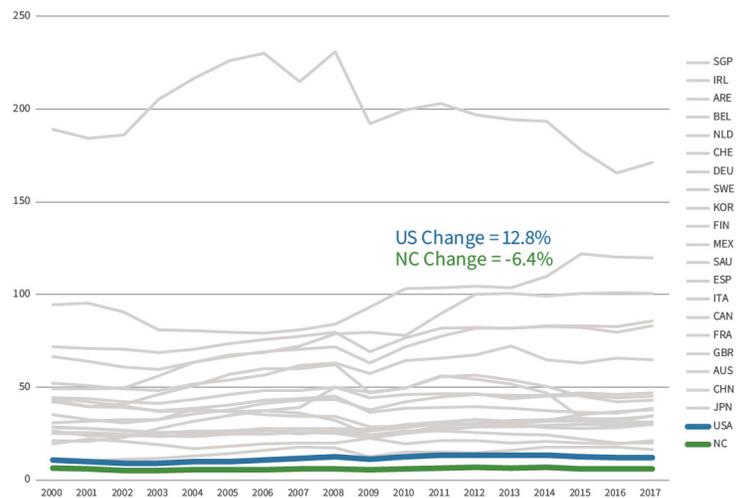
### EXPORTS AS A PERCENTAGE OF GDP, COMPARISON COUNTRIES, 2017



Source: World Bank World Development Indicators, WISERTrade, and U.S. Bureau of Economic Analysis.

#### 4.4D

### EXPORTS AS A PERCENTAGE OF GDP, COMPARISON COUNTRIES, 2000-2017



Source: World Bank World Development Indicators, WISERTrade, and U.S. Bureau of Economic Analysis.

<sup>5</sup> Countries with especially high export intensities have highly developed trade-oriented economies and high capacity ports (e.g., Singapore), are large producers and exporters of widely used high-tech products like semiconductor devices, electrical goods, and information and communication technology products (e.g., China), or have abundant supplies of natural resources, such as natural gas, that comprise a large share of their exports (e.g., Netherlands).

<sup>6</sup> WISERTrade: State Exports by SIC & HS Database.

<sup>7</sup> See Atkinson, R. D. & Wu, J. J. (November 2017). *The 2017 State New Economy Index: Benchmarking Economic Transformation in the States*. Information Technology & Innovation Foundation. Available at: <https://itif.org/publications/2017/11/06/2017-state-new-economy-index>; U.S. Census Bureau, *Foreign Trade Historical Series (Annual goods (BOP basis), services, and total balance, exports and imports, 1960 – present*; accessed May 18, 2017), <https://www.census.gov/foreign-trade/statistics/historical/index.html>.

<sup>8</sup> In addition to the U.S. Department of Commerce's presence across the globe, the International Trade Division of the Economic Development Partnership of North Carolina has staff in the state and in six locations around the globe to facilitate export growth.

## Indicator 5.1: Science & Engineering Workforce

### KEY FINDINGS

- The percentage of North Carolina's workforce in science & engineering (S&E) occupations ranks equal to the U.S. average and is increasing at a rate faster than the U.S. average.

### INDICATOR OVERVIEW

This indicator represents the extent to which a state's workforce is employed in S&E occupations. A high value indicates that a state's economy has a high percentage of technical jobs relative to other states. As such, it reflects the labor pool's interests, its level of skill development, and the nature of the employment opportunities in the state. Policymakers and scholars consistently emphasize innovation based on S&E research and development as a vehicle for economic growth and competitiveness. In the increasingly interconnected 21<sup>st</sup>-century world, workers with S&E expertise are integral to a nation's and state's innovative capacity because of their high skill level, their creative ideas, and their ability not only to advance basic scientific knowledge but also to transform advances in fundamental knowledge into tangible and useful products and services.

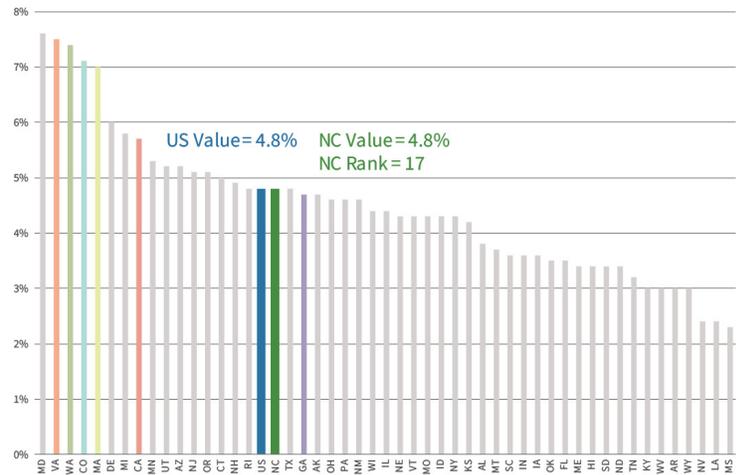
Occupations for S&E are defined by Standard Occupational Classification (SOC) codes<sup>1</sup> and include engineers and computer, mathematical, life, physical, and social scientists. Managers, technicians, elementary and secondary schoolteachers, faculty teaching in S&E fields, and medical personnel are not included.<sup>2</sup>

### HOW DOES NORTH CAROLINA PERFORM?

In terms of individuals in S&E occupations as a percentage of the workforce, North Carolina ranks 17<sup>th</sup> in the nation, with a level that is 100 percent of the U.S. average value and 63 percent of the value of the top-ranking state, Maryland [5.1A]. With the exception of Georgia, all of the comparison states rank well ahead of North Carolina and are within the top 10 among all states. From 2003 to 2017, the percentage of North Carolina's workforce in S&E occupations increased significantly, by 34.8 percent. This rate is faster than the rate of increase for the U.S. overall and ahead of the rate for all of the comparison states [5.1B].

#### 5.1A

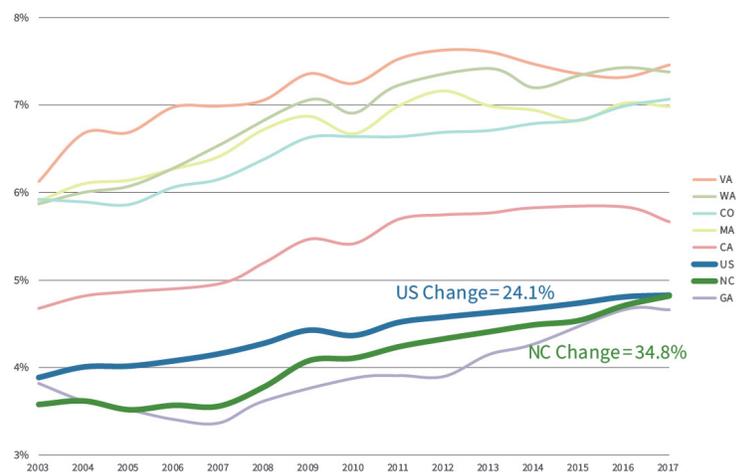
### INDIVIDUALS IN SCIENCE & ENGINEERING OCCUPATIONS AS A PERCENTAGE OF THE WORKFORCE, ALL U.S. STATES, 2017



Source: National Science Board.

#### 5.1B

### INDIVIDUALS IN SCIENCE & ENGINEERING OCCUPATIONS AS A PERCENTAGE OF THE WORKFORCE, COMPARISON STATES, 2003-2017



Source: National Science Board.

Note: Data were not available for Washington in 2008 and 2012, and were not available for California in 2006 and 2015, and Georgia in 2009 and 2015. Lines for those years were extrapolated from other years' data.

<sup>1</sup> The SOC system is used by federal statistical agencies to classify workers into occupational categories for the purpose of collecting, calculating, or disseminating data. All workers are classified into one of 867 detailed occupations according to their occupational definition.

<sup>2</sup> Data on individuals in S&E occupations come from a survey of workplaces that assigns workers to a state based on where they work. Estimates do not include self-employed persons and are developed by the U.S. Bureau of Labor Statistics (BLS) from data provided by state workforce agencies. Data on the size of the workforce are BLS estimates and represent the employed component of the civilian labor force. In these estimates, workers are assigned to a state based on where they live.

### WHAT DOES THIS MEAN FOR NORTH CAROLINA?

North Carolina's high rate of growth in S&E occupations indicates that it is gaining relative to the U.S. overall. The share of the state's workers in S&E occupations reflects the share of its establishments composed of high science, engineering and technology (SET) employment establishments (see indicator 4.1) and the share of its employment that works in high SET employment establishments (see indicator 4.2). On both these measures, North Carolina ranks slightly below average and close to the median among all states but is increasing faster than the U.S. average. For North Carolina to exceed the comparison states and rise above the U.S. average on S&E employment, it would likely also need to continue to increase the technology levels of its existing companies and to start and grow new high SET companies. The concentrated geographic distribution and employment of the state's high SET establishments suggest that broadening the distribution of such establishments across North Carolina, as well as deepening the existing concentrations of such establishments, would help increase the share of the state's employment in S&E occupations.

## Indicator 5.2: Employed Science, Engineering & Health Doctorate Holders

### KEY FINDINGS

- The percentage of North Carolina’s workforce holding science, engineering, and health (SEH) doctorates ranks just above the U.S. average and has been roughly equal to or slightly above the U.S. average since the early 2000s.
- Since 2001, the percentage of North Carolina’s workforce holding SEH doctorates has increased slightly faster than the U.S. average.

### INDICATOR OVERVIEW

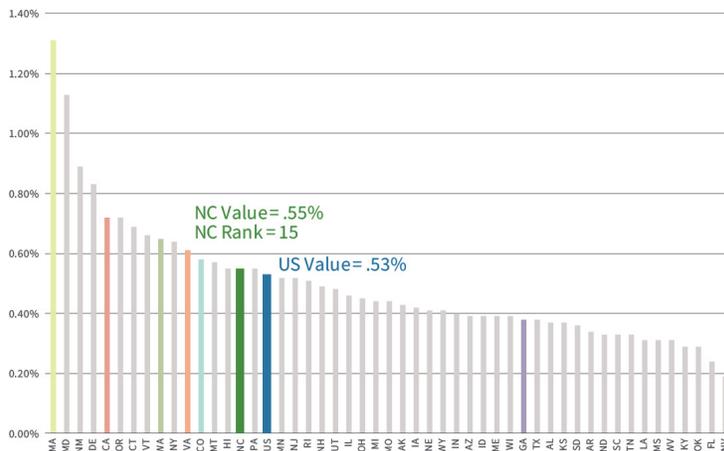
This indicator represents a state’s ability to attract, retain and grow highly trained scientists, engineers, and healthcare (SEH) professionals. These individuals often conduct R&D, manage R&D activities, or are otherwise engaged in knowledge-intensive activities. As such, this indicator reflects the labor pool’s interests, its level of skill development, and the nature of the employment opportunities in the state. A high value for this indicator in a state suggests employment opportunities for individuals with highly advanced training in SEH fields. Data on employed SEH doctorate holders include those with doctoral degrees in computer and mathematical sciences; the biological, agricultural, or environmental life sciences; physical sciences; social sciences; psychology; engineering; and health fields. SEH doctorate data exclude individuals with doctorates from foreign institutions and those above the age of 75.<sup>1</sup>

### HOW DOES NORTH CAROLINA PERFORM?

In terms of employed SEH doctorate holders as a percentage of the workforce, North Carolina ranks 15<sup>th</sup> in the nation, with a level that is 104 percent of the U.S. average value and 42 percent of the value of the top-ranking state, Massachusetts [5.2A].<sup>2</sup> With the exception of Georgia, all the comparison states rank ahead of North Carolina, and three (Massachusetts, California, and Washington) rank in the top 10 among all states. From 2001 to 2017, employed S&E doctorate holders as a percentage of the workforce in North Carolina increased significantly, by 30.2 percent. This rate is slower than the rate of increase for Massachusetts and California, but above the rate for the U.S. overall, as well as the remaining comparison states (Georgia, Washington, Virginia, and Colorado) [5.2B].

#### 5.2A

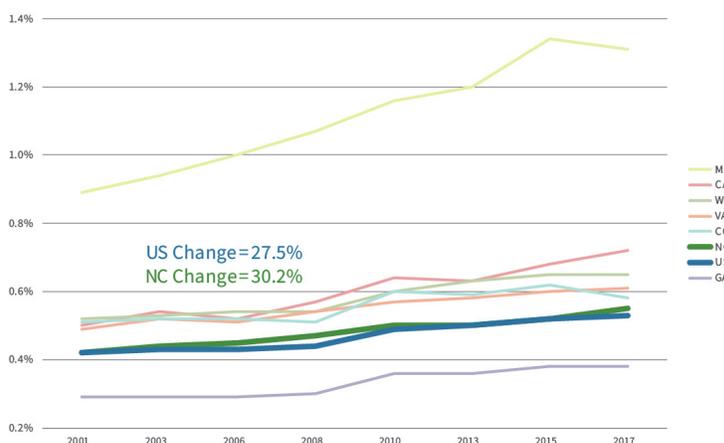
### EMPLOYED SCIENCE, ENGINEERING & HEALTH DOCTORATE HOLDERS AS A PERCENTAGE OF THE WORKFORCE, ALL U.S. STATES, 2017



Source: National Science Board.

#### 5.2B

### EMPLOYED SCIENCE, ENGINEERING & HEALTH DOCTORATE HOLDERS AS A PERCENTAGE OF THE WORKFORCE, COMPARISON STATES, 2001-2017



Source: National Science Board.

Note: Data not available for 2002, 2004, 2005, 2007, 2009, 2011, 2012, and 2014.

<sup>1</sup> Employed workforce data are developed by the U.S. Bureau of Labor Statistics (BLS), which assigns workers to a state based on where they live. Workforce data represent annual estimates of the employed civilian labor force; estimates are not seasonally adjusted.

<sup>2</sup> States in the top quartile for this indicator tend to have high concentrations of major research laboratories, research universities, or research-intensive industries.

### WHAT DOES THIS MEAN FOR NORTH CAROLINA?

North Carolina's relatively high rate of growth in SEH doctorate holders indicates that it is keeping pace relative the U.S. overall but is slightly behind leading comparison states. As with science & engineering occupations as a percentage of the workforce (see indicator 5.1), the share of the state's workers holding SEH doctorates reflects the share of its establishments composed of high science, engineering and technology (SET) employment establishments (see indicator 4.1) and the share of its employment that works in high SET employment establishments (see indicator 4.2). On both these measures, North Carolina ranks slightly below average and close to the median among all states but is increasing faster than the U.S. average. For North Carolina to outpace the comparison states and rise above the U.S. average on employed SEH doctorate holders, it would likely also need to increase the technology levels of its existing companies, start and grow new high SET companies, or increase its number of other research-intensive organizations. The concentrated geographic distribution and employment of the state's high SET establishments suggest that broadening the distribution of such establishments across North Carolina, as well as deepening the existing concentrations of such establishments, would help increase the share of the state's employees holding SEH doctorates.



### WHAT DOES THIS MEAN FOR NORTH CAROLINA?

In general, the states with the highest percentage of engineers in their workforce are centers of automobile and aircraft manufacturing, such as Michigan and Washington, or states that rank high on employment in high science, engineering and technology establishments as share of total employment, such as Washington, Virginia, and California (see indicator 4.2). The relatively low percentage of trained engineers in North Carolina's workforce is a cause for concern, because regions with a high concentration of engineers have a greater capacity for innovation and often lead in key industries.<sup>3</sup> For North Carolina to outpace the comparison states and rise above the U.S. average on the percentage of trained engineers in its workforce, it would also need to continue to increase the technology levels of its existing companies and to start and grow new high science, engineering and technology companies. The concentrated geographic distribution and employment of the state's high science, engineering and technology employment establishments suggest that broadening the distribution of such establishments across North Carolina, as well as deepening the existing concentrations of such establishments, would help increase the share of the state's employees trained as engineers.

<sup>3</sup> Notably, San Jose/Silicon Valley's ratio of 45 engineers per 1,000 employees is twice as high as any other big metro area, which is a key reason it is one of the nation's most affluent metro areas.

## Indicator 5.4: Bachelor's Degrees in Science, Engineering & Technology

### KEY FINDINGS

- The ratio of S&E bachelor's degrees to the population aged 18–24 years in North Carolina ranks slightly below the U.S. average, has since at least the early 2000s, and in recent years has been increasing at a rate slightly below the U.S. average.

### INDICATOR OVERVIEW

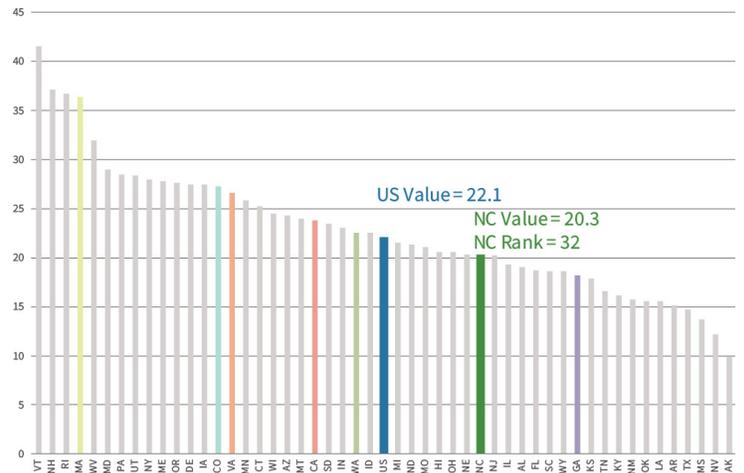
This indicator is the ratio of new S&E bachelor's degrees to the population ages 18–24 years and represents the extent to which a state prepares young people to enter technology-intensive occupations that are fundamental to a knowledge-based, technology-driven economy. S&E fields include the physical, life, earth, ocean, atmospheric, computer and social sciences; mathematics; engineering; psychology; science technologies; and engineering technologies. They do not include medical fields or technologies.<sup>1</sup>

### HOW DOES NORTH CAROLINA PERFORM?

In terms of the ratio of new S&E bachelor's degrees to the population ages 18–24 years, North Carolina ranks 32<sup>nd</sup> in the nation, with a level that is 91 percent of the U.S. average value and 49 percent of the value of the top-ranking state, Vermont [5.4A]. Relative to the comparison states, North Carolina ranks above only Georgia. From 2000 to 2017, North Carolina's ratio of new S&E bachelor's degrees to the population ages 18–24 years increased by 37.6 percent, a rate lower than the rate of increase for the U.S. overall (53.9 percent). North Carolina's rate of increase is also slower than that of all other comparison states except for Colorado and Massachusetts [5.4B].

5.4A

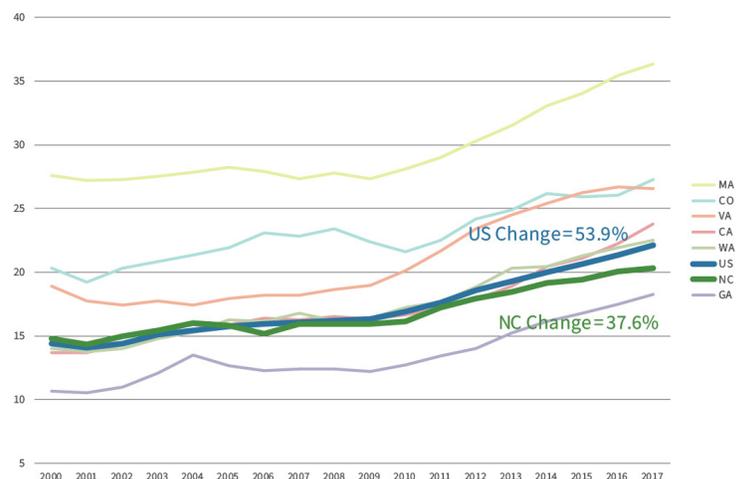
### BACHELOR'S DEGREES IN SCIENCE AND ENGINEERING CONFERRED PER 1,000 INDIVIDUALS 18–24 YEARS OLD, ALL U.S. STATES, 2017



Source: National Science Board.

5.4B

### BACHELOR'S DEGREES IN SCIENCE AND ENGINEERING CONFERRED PER 1,000 INDIVIDUALS 18–24 YEARS OLD, COMPARISON STATES, 2000-2017



Source: National Science Board.

<sup>1</sup> The number of bachelor's degrees awarded in S&E fields is an actual count provided by the National Center for Education Statistics. Estimates of the population aged 18–24 years old are provided by the U.S. Census Bureau. A high value for this indicator may suggest the successful provision of undergraduate training in S&E fields. Because students often relocate after graduation, this measure does not directly indicate the qualifications of a state's future workforce. A state's value for this indicator may also be high when its higher education system draws a large percentage of out-of-state students, a situation that sometimes occurs in states with small resident populations and the District of Columbia.

**WHAT DOES THIS MEAN FOR NORTH CAROLINA?**

Educational attainment in an S&E field gives people greater opportunities to work in higher-paying technical jobs than are generally available to those in other fields of study. Earning a bachelor's degree in an S&E field also prepares an individual for advanced technical education. A high value for this indicator indicates the successful provision of undergraduate training in S&E fields. North Carolina's slightly below average performance on this indicator suggests room for improvement. While the ratio of new S&E bachelor's degrees to the population ages 18–24 years in North Carolina is increasing over time, this rate is slower than the rate for the U.S. overall. For North Carolina to have the skilled workforce necessary to drive the innovation economy, it should work to increase the share of its college-age population earning degrees in S&E fields. Relocating companies are likely to gravitate to North Carolina if it has the required workforce pool available, and companies already located in North Carolina are more likely to remain here if it has a strong pool of S&E workers.

## Indicator 5.5: Science, Engineering & Technology Degrees

### KEY FINDINGS

- The percentage of higher education degrees conferred in S&E fields in North Carolina ranks above the U.S average and has since at least the early 2000s, but is increasing slower than the U.S. average.

### INDICATOR OVERVIEW

This indicator represents the extent to which a state's higher education programs are concentrated in S&E fields. S&E fields include the physical, life, earth, ocean, atmospheric, computer, and social sciences; mathematics; engineering; and psychology. They do not include medical fields or technologies. Counts of both S&E degrees and higher education degrees conferred include bachelor's, master's, and doctoral degrees; associate's degrees and professional degrees are not included.

### HOW DOES NORTH CAROLINA PERFORM?

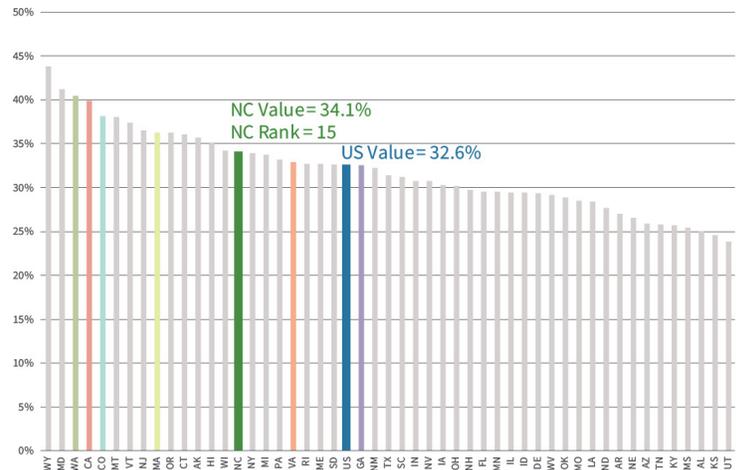
In terms of S&E degrees as a percentage of higher education degrees conferred, North Carolina ranks 15<sup>th</sup> in the nation, with a level that is 105 percent of the U.S. average value and 78 percent of the value of the top-ranking state, Wyoming [5.5A]. Relative to the comparison states, North Carolina ranks below all the comparison states except Virginia and Georgia. From 2000 to 2017, S&E degrees as a percentage of higher education degrees conferred in North Carolina increased by 7.3 percent [5.5B], a rate slightly lower than the rate of increase for the U.S. overall (10.2 percent). North Carolina's rate of increase is less than the rates of increase for Washington, Georgia, Massachusetts, and California, but higher than the rates of increase for Colorado and Virginia, the latter of whose rate decreased.<sup>1</sup>

### WHAT DOES THIS MEAN FOR NORTH CAROLINA?

Irrespective of degree level, educational attainment in S&E fields gives people greater opportunities to work in higher-paying technical jobs than are generally available to those in other fields of study. A high value for this indicator suggests the successful provision of higher education training in S&E fields at both the undergraduate and graduate levels. North Carolina's above-average performance on this indicator but below-average performance on bachelor's degrees in S&E fields (see indicator 5.4) suggests that North Carolina's provision of S&E degrees is stronger at the master's and doctoral level than at the bachelor's level. The percentage of higher education degrees overall that were conferred in S&E fields in North Carolina is increasing over time, and this rate of increase is just behind the rate of increase for the U.S. overall. However, for North Carolina to have the skilled workforce necessary to drive the innovation economy, it should work to increase the share of its undergraduate-level students earning degrees in S&E fields.

#### 5.5A

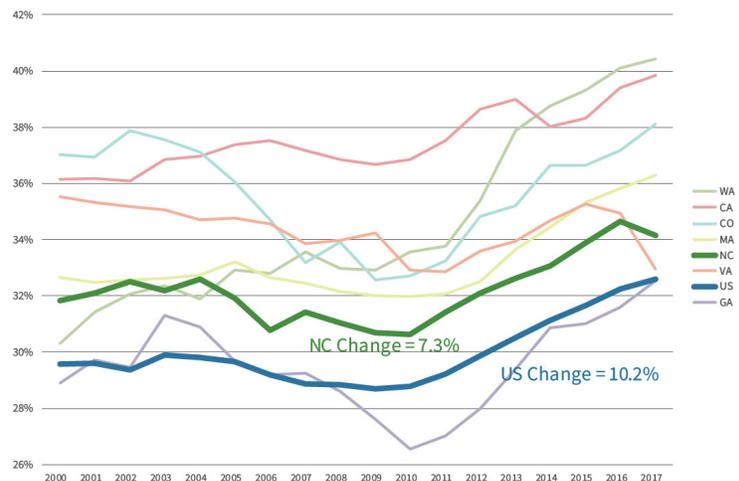
### SCIENCE & ENGINEERING DEGREES AS PERCENTAGE OF HIGHER EDUCATION DEGREES CONFERRED, ALL U.S. STATES, 2017



Source: National Science Board.

#### 5.5B

### SCIENCE & ENGINEERING DEGREES AS PERCENTAGE OF HIGHER EDUCATION DEGREES CONFERRED, COMPARISON STATES, 2000-2017



Source: National Science Board.

<sup>1</sup> Degree data reflect the location of the degree-granting institution, not the state where degree-earning students permanently reside. The year indicates the end date of the academic year. For example, data for 2017 represent degrees conferred during the 2016-17 academic year. All degree data are actual counts.

## Indicator 5.6: Educational Attainment

### KEY FINDINGS

- North Carolina’s educational attainment composite score ranks below the U.S. average and has since at least the early 2000s, but is increasing at a rate slightly faster than the U.S. average.
- Within North Carolina, educational attainment levels vary considerably; only 15 counties, the majority of which are urban, have an educational composite score higher than the U.S. average composite score.

### INDICATOR OVERVIEW

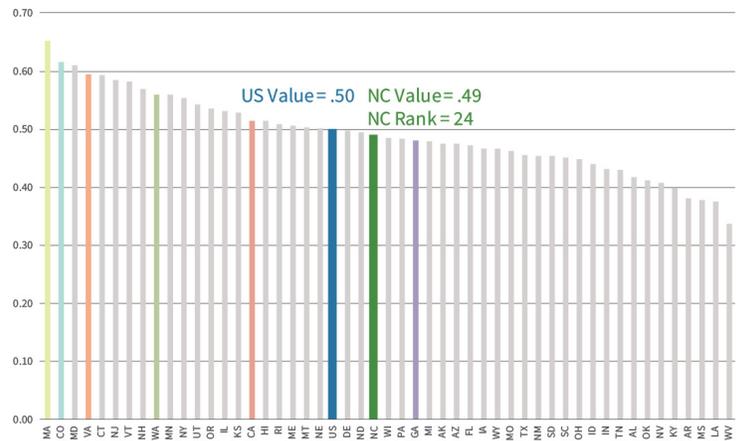
Regardless of industry or occupation, a well-educated, skilled workforce is a prerequisite for success in the innovation economy. The educational attainment of the workforce—measured here as an aggregate using a composite score (see “Methodological Note,” on the last page of this indicator)—is a fundamental determinant of how well a state can generate and support economic growth centered on innovation. Moreover, the greater the share of well-educated workers within a state, the less the state has to rely on in-migration (see indicator 5.7) to sustain its pool of workers. North Carolina’s ability to compete in the innovation economy is heavily dependent on its ability to produce and maintain a well-educated workforce.

### HOW DOES NORTH CAROLINA PERFORM?

In terms of its educational attainment composite score, North Carolina’s value ranks 24<sup>th</sup> in in the nation, with a level that is 98 percent of the U.S. value and 75 percent of the value of the top-ranking state, Massachusetts [5.6A]. This composite score derives from the following statistics:<sup>1</sup> 12.2 percent of North Carolina citizens over 25 years of age have not completed high school, 25.8 percent completed their education with a high school degree, 21.3 percent completed with a high school degree and have some college experience, 9.4 percent completed with an associate degree, 20.1 percent completed with a bachelor’s degree, and 11.2 percent completed with a graduate or professional degree.

As a group, these statistics indicate that, compared to the U.S. average, North Carolina has a higher percentage of its citizens without a high school diploma, with some college, with an associate’s degree, or with a bachelor’s degree. In all the other educational attainment categories—high school degree, graduate or professional degree, or doctorate degree—North Carolina’s percentage is equal to or lower than the U.S average. And with the exception of Georgia, all comparison states had a higher educational attainment composite score than North Carolina’s score.

### 5.6A EDUCATIONAL ATTAINMENT, ALL U.S. STATES, 2017



Source: U.S. Census Bureau.

Note: Weighted measure (composite score) of the education attainment of residents aged 25 years and over.

<sup>1</sup> Using these statistics and the weighted measure methodology described on the last page of this indicator, North Carolina’s composite score for 2017 is calculated as follows:  $.122(-.05) + .258(0) + .213(.25) + .094(.5) + .201(1) + .112(1.75) = .491$  (as shown in charts 5.6a and 5.6b).

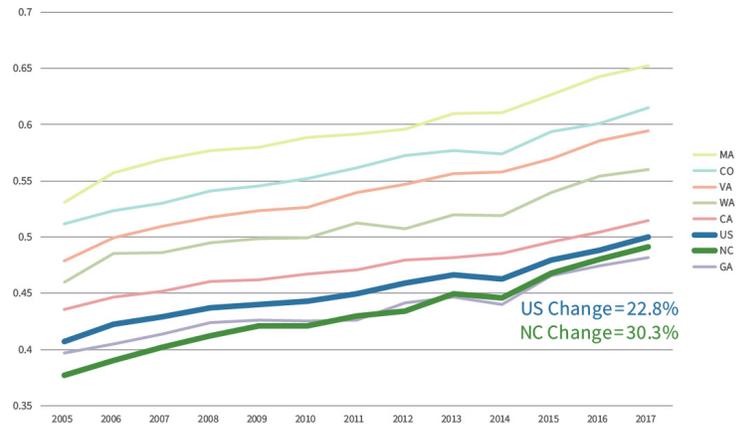
## Indicator 5.6: Educational Attainment

From 2005 to 2017, North Carolina’s composite score increased by 30.3 percent, which was greater than the increase for the U.S. average composite score (22.8 percent) and the average of the composite scores for the comparison states (20.7 percent) **[5.5B]**. It was also greater than the increase for any of the comparison states individually.

Within North Carolina, educational attainment is considerably higher in urban counties (e.g., Mecklenburg, Wake, Guilford, Forsyth, Durham, etc.) and counties with high numbers of retirees (e.g., Moore, Buncombe, Dare, New Hanover), military personnel (e.g., Craven, Cumberland), or universities (e.g., Orange, Pitt, Watauga) **[5.6C and 5.6D]**. Of the state’s 100 counties, only 28 have, for residents 25 years and older, a high-school completion rate higher than the U.S. average, 87.3 percent. In terms of the percentage of residents 25 years and over who have completed a bachelor’s degree or more education, only 16 counties have a rate higher than the U.S. average, 30.0 percent. For the educational attainment composite score, the pattern is similar but considerably more concentrated **[5.6E]**. This is because the composite score includes higher levels of educational attainment and places greater weight on those higher attainment levels.

Thus, the overall pattern across North Carolina is that a majority of counties have relatively low educational attainment levels (85 have an educational composite score below the U.S. average composite score) and typically are in rural regions. Of the 15 counties that have an educational composite score higher than the U.S. average composite score, 8 counties are among the top 10 most populous counties in the state; the other half are in less populous counties that are the home to universities or have a large number of retirees or military personnel.

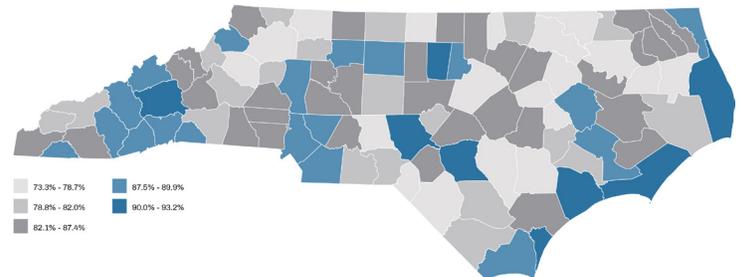
### 5.6B EDUCATIONAL ATTAINMENT, COMPARISON STATES, 2005–2017



Source: U.S. Census Bureau.

Note: Weighted measure (composite score) of the education attainment of residents aged 25 years and over.

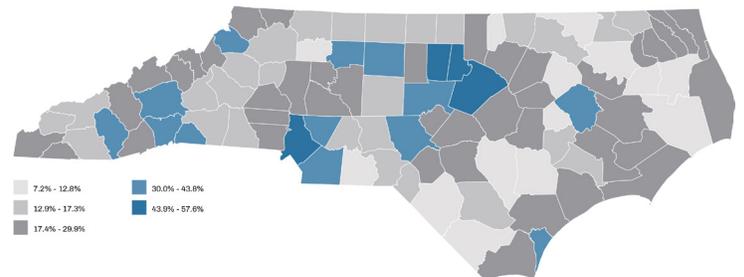
### 5.6C PERCENTAGE OF RESIDENTS 25 YEARS AND OVER WHO HAVE COMPLETED HIGH SCHOOL OR MORE EDUCATION, N.C. COUNTIES, 2013–2017 ESTIMATE



Source: U.S. Census Bureau.

Note: Blue counties rank above the U.S. average.

### 5.6D PERCENTAGE OF RESIDENTS 25 YEARS AND OVER WHO HAVE COMPLETED A BACHELOR’S DEGREE OR MORE EDUCATION, N.C. COUNTIES, 2013–2017 ESTIMATE



Source: U.S. Census Bureau.

Note: Blue counties rank above the U.S. average.

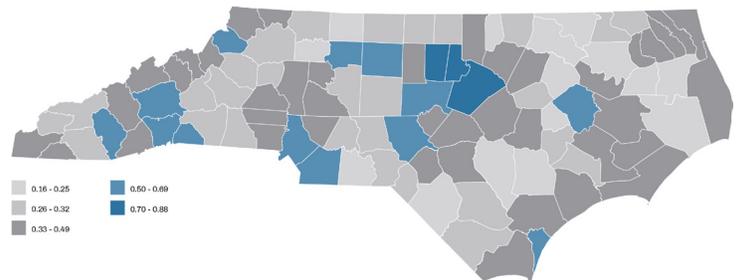
## Indicator 5.6: Educational Attainment

### WHAT DOES THIS MEAN FOR NORTH CAROLINA?

The 2011 State of the North Carolina Workforce report highlighted four key facts focused on educational attainment: (1) individuals with a baccalaureate degree were half as likely to be unemployed as the average worker, while individuals without a high school degree were twice as likely as the average worker to be unemployed; (2) workers with a baccalaureate degree can expect to earn \$1.5 million more over a 30-year career than a high school dropout; (3) nearly half of the new jobs being created in North Carolina will require, at a minimum, some postsecondary education, many in science, technology, engineering and math (STEM) disciplines; (4) STEM jobs will constitute an increasing share of higher- and medium-wage jobs, creating significant barriers to employment for unprepared young adults and existing workers. These facts, combined with the educational attainment findings presented above, make it clear that North Carolina must improve the educational attainment levels of its citizens in order to generate innovative ideas, to support the expansion of a knowledge-based economy, and to increase the economic well-being and quality of life of its citizens.

5.6E

### WEIGHTED MEASURE (COMPOSITE SCORE) OF THE EDUCATION ATTAINMENT OF RESIDENTS AGED 25 YEARS AND OVER, N.C. COUNTIES, 2013–2017 ESTIMATE



Source: U.S. Census Bureau.

Note: Blue counties rank above the U.S. average.

#### METHODOLOGICAL NOTE

The weighted measure (composite score) used in charts 5.5A and 5.5B and map 5.5E is virtually identical to the one developed and used by the Information Technology & Innovation Foundation (ITIF) in its 2017 *State New Economy Index*. Specifically, it uses U.S. Census Bureau data to determine, for each state, the share of the state's population aged 25 years and over with the following six educational attainments: no high school diploma, high school diploma, some college (1 or more years, no degree), associate's degree, bachelor's degree, graduate or professional school degree, and doctorate degree. It then assigns each degree class a weight, as follows:

- -0.05 for no high school diploma
- 0.0 for a high school diploma
- 0.25 for some college
- 0.50 for associate's degree
- 1.00 for bachelor's degree
- 1.75 for graduate or professional degree

Each share is multiplied by its respective weight and the products are summed to arrive at the final score. This composite score is valuable for at least two reasons:

1. It includes, in a single measure, the full spectrum of relevant degree classes, and
2. It assigns greater weight to higher-level degrees.

Accordingly, it provides an efficient and effective measure of the general educational attainment level of each state.

## Indicator 5.7: Educational Attainment of In-Migrants

### KEY FINDINGS

- North Carolina’s average years of education among in-migrants ranks slightly above the U.S. average, has more often than not since at least the mid 2000s, and is increasing at a rate faster than the U.S. average.
- North Carolina’s in-migration of college-educated adults as a percentage of total state population ranks slightly above the U.S. average, has more often than not since at least the mid 2000s, and is increasing at a rate similar to the U.S. average.
- Within North Carolina, the in-migration of individuals with a bachelor’s degree or higher is very concentrated in a small number of counties.

### INDICATOR OVERVIEW

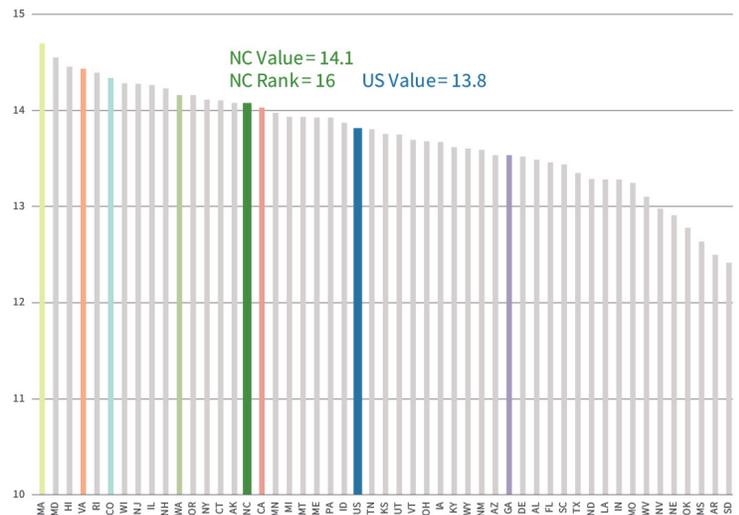
The ability of a state to successfully attract well-educated, skilled individuals to relocate from other states and countries enhances that state’s ability to foster an innovation economy. This indicator measures the education attainment of in-migrants in two ways: average years of education among in-migrants, and in-migration of college-educated adults as a percentage of total state population. The first measure is a more comprehensive indicator of the educational attainment of in-migrants, whereas the second measure is a more targeted indicator of the higher-level educational attainment of in-migrants. States better able to attract educated and skilled workers provide organizations in the innovation economy with the skill sets necessary to compete in knowledge-intensive production. Furthermore, attracting outside talent enhances a state’s ability to generate new innovative ideas that may have economic impacts in the future.

### HOW DOES NORTH CAROLINA PERFORM?

In terms of average years of education among in-migrants, North Carolina ranks 16<sup>th</sup> in the nation, with a value that is 102 percent of the U.S. average value, and 96 percent of the value of the top-ranking state, Massachusetts [5.7A]. Among the comparison states, California and Georgia rank lower than North Carolina on this measure. From 2005–2017, the average years of education among in-migrants in North Carolina increased by 11.1 percent, which is faster than the 7.9 percent increase for the U.S. overall [5.7B]. North Carolina’s rate of increase is slightly less than the rate of increase for California, and slightly faster than the rates for Georgia, Virginia, Massachusetts, Colorado, and Washington.

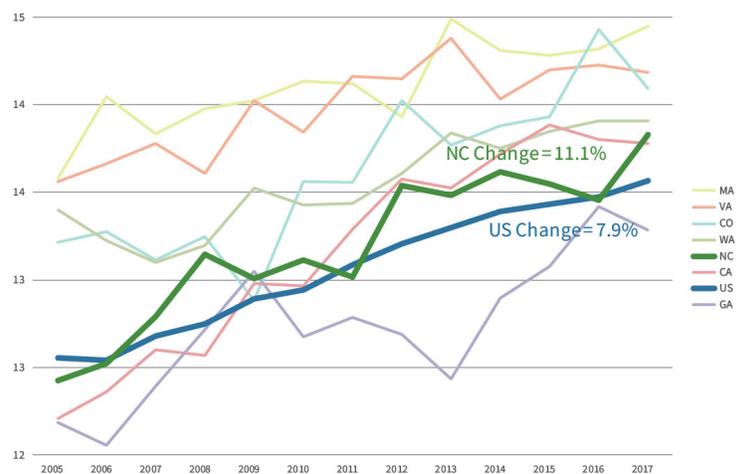
In terms of in-migration of college-educated adults as a percentage of total state population, North Carolina ranks 16<sup>th</sup> in the nation, with a value that is 119 percent of the U.S. average value, and 68 percent of the value of the top-ranking state, Colorado [5.7C]. Among the comparison states, California and Georgia rank lower than North Carolina on this measure.

### 5.7A AVERAGE YEARS OF EDUCATION AMONG IN-MIGRANTS, ALL U.S. STATES, 2017



Source: U.S. Census Bureau.

### 5.7B AVERAGE YEARS OF EDUCATION AMONG IN-MIGRANTS, COMPARISON STATES, 2005-2017



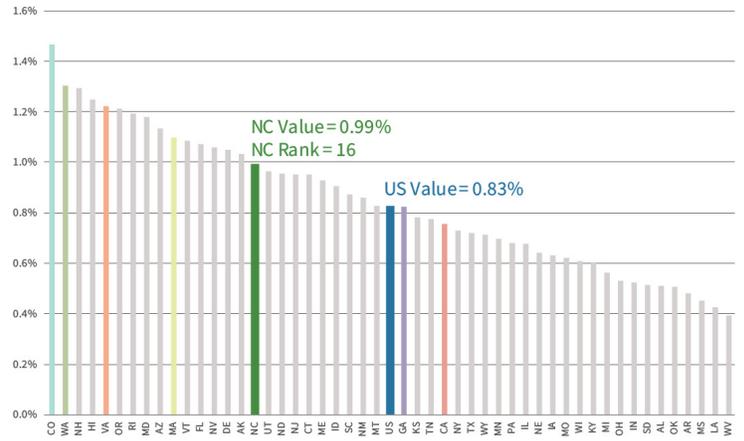
Source: U.S. Census Bureau.

Indicator 5.7: Educational Attainment of In-Migrants

From 2005–2017, the in-migration of college-educated adults as a percentage of total state population increased by 20.7 percent, whereas the percentage for the U.S. overall increased by 21.0 percent [5.7D]. Relative to the comparison states, North Carolina’s rate of increase is higher than those of Colorado, Washington, Virginia, and Georgia.

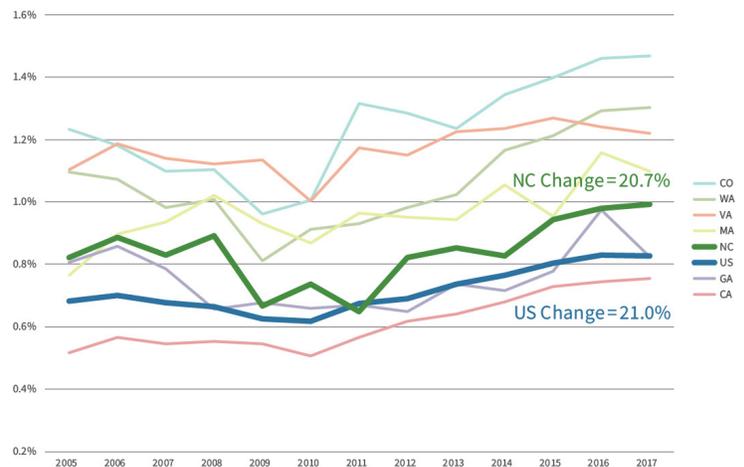
Within North Carolina, the in-migration of individuals with a bachelor’s degree or higher is very concentrated in a small number of counties [5.7E].<sup>1</sup> Two counties combined account for 39.1 percent of the state’s in-migrants with a bachelor’s degree or higher between 2013–2017—Mecklenburg (20.7%) and Wake (18.4%). The next nine counties combined—Durham (6.8%), Cumberland (4.6%), Orange (4.2%), Guilford (3.8%), Buncombe (3.6%), Forsyth (3.2%), Onslow (2.7%), New Hanover (2.2%), and Union (2.0%)—account for one third (32.9%) of the state’s in-migrants with a bachelor’s degree or higher during 2017. In total, this means that 11 of the state’s 100 counties account for 72% of the state’s in-migrants with a bachelor’s degree or higher between 2013–2017. The following next 8 counties combined—Brunswick (1.9%), Moore (1.7%), Henderson (1.7%), Iredell (1.7%), Cabarrus (1.6%), Harnett (1.4%), Pitt (1.2%), and Craven (1.0%)—account for another 12.3 percent of the state’s in-migrants with a bachelor’s degree or higher between 2013–2017. Each of the remaining 81 counties accounts for less than one percent of the state’s in-migrants with a bachelor’s degree or higher between 2013–2017, and together they account for 15.8 percent of that in-migration.

**5.7C** IN-MIGRATION OF COLLEGE EDUCATED ADULTS AS A PERCENTAGE OF TOTAL STATE POPULATION, ALL U.S. STATES, 2017



Source: U.S. Census Bureau.

**5.7D** IN-MIGRATION OF COLLEGE EDUCATED ADULTS AS PERCENTAGE OF TOTAL STATE POPULATION, COMPARISON STATES, 2005-2017



Source: U.S. Census Bureau.

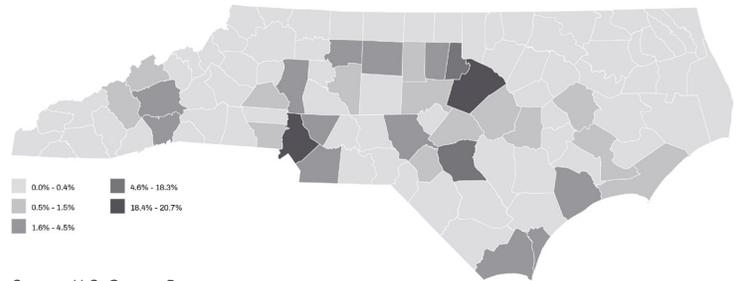
<sup>1</sup> The percentages presented here are based, for a given county, on the number of in-migrants that have a bachelor’s degree or higher and that relocated from another county within the state, a different state, or from a different country between 2013–2017. The trends illustrated in map 5.7E are highly correlated with trends illustrated in map 1.6B and chart 1.6C.

**WHAT DOES THIS MEAN FOR NORTH CAROLINA?**

The ability of the state to attract highly educated individuals is a key factor that influences the generation of innovative ideas and strengthens a knowledge-based economy. Strong influxes of highly educated workers strengthen the innovation economy labor pool by providing diverse and highly demanded skill sets. North Carolina’s performance on this factor—slightly above the middle of the U.S. state distribution—suggests that the state can continue to do more to attract highly educated individuals to relocate here. Additionally, a small number of counties accounts for the majority of the state’s in-migration of individuals with a bachelor’s degree or higher. These findings suggest that the state should work to increase the opportunities for highly educated individuals to relocate from other states and countries. This holds especially true for counties with a low percentage of college-educated in-migrants.

5.7E

**IN-MIGRATION OF COLLEGE EDUCATED ADULTS, PERCENT OF STATE TOTAL, N.C. COUNTIES, 2017**



Source: U.S. Census Bureau.  
 Note: The 2018 1-year estimates do not include all NC counties. 2015 ACS 5-year estimates were used for several counties.

## Indicator 6.1: Public Investment in Education

### KEY FINDINGS

- North Carolina’s elementary and secondary public school current expenditures as a percentage of state gross domestic product (GDP) rank well below the U.S. average, have since at least the early 2000s, and are decreasing over time.
- North Carolina’s appropriations of state tax funds for operating expenses of higher education as a percentage of state GDP rank well above the U.S. average, have since at least the early 2000s, but are decreasing over time.
- Within North Carolina, authorized appropriations for the University of North Carolina (UNC) institutions are highly correlated with the size of the institutions.

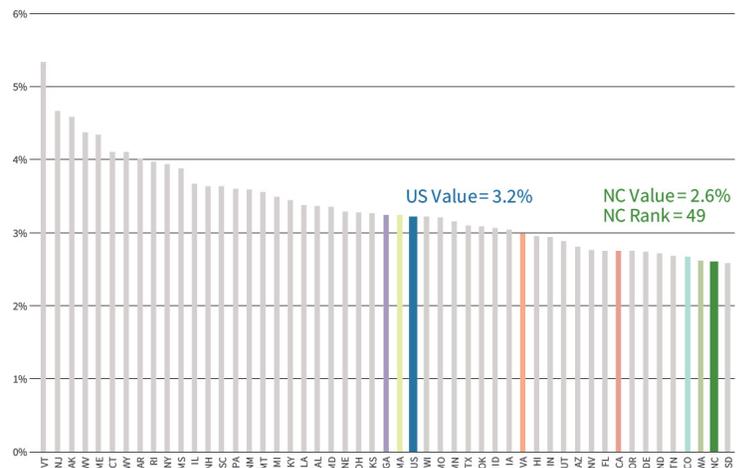
### INDICATOR OVERVIEW

This indicator measures public investment in education two ways: 1) elementary and secondary public school current expenditures, and 2) appropriations of state tax funds for operating expenses of higher education, each as a percentage of state GDP. The first measure represents the relative amount of resources that state governments expend to support public education in pre-kindergarten through grade 12. Current expenditures include instruction and instruction-related costs, student support services, administration, and operations; they exclude funds for school construction and other capital outlays, debt service, and programs outside of public elementary and secondary education. State and local support are the largest sources of funding for elementary and secondary education.<sup>1</sup> The second measure represents the relative amount of resources that state governments expend to support higher education operating expenses.<sup>2</sup>

For each measure, a higher value indicates that a state has made financial support of the respective education level more of a priority.<sup>3</sup> Investments in public pre-kindergarten through grade 12 are important for preparing a broadly educated and innovation-capable workforce. Investments in public postsecondary education are critical to increase the ability of public academic institutions to prepare students for skilled and well-paying employment. Well-regarded public higher education programs enhance a state’s ability to attract students from around the globe, many whom choose to remain and work in the state after graduation.

### 6.1A

### ELEMENTARY AND SECONDARY PUBLIC SCHOOL CURRENT EXPENDITURES AS A PERCENTAGE OF STATE GDP, ALL U.S. STATES, 2016



Source: National Science Board.

<sup>1</sup> Current expenditures are expressed in actual dollars and their data year is the end date of the academic year. GDP data refer to the 2016 calendar year in current dollars.

<sup>2</sup> Because of decreases in state tax collections in FY 2009–11 during the Great Recession, state monies allocated to higher education decreased in many states. This decrease was offset to a degree by federal stimulus funds that were used to restore the level of state support for public higher education. Nationally, state financial support of higher education operating expenses relative to GDP has experienced a downward trend since the early 2000s. The state monies used to calculate this indicator do not include federal stimulus funds for education stabilization or federal, state, or local government funds for the modernization, renovation, or repair of higher education facilities.

<sup>3</sup> This does not assume that more spending necessarily leads to improved educational outcomes.

## Indicator 6.1: Public Investment in Education

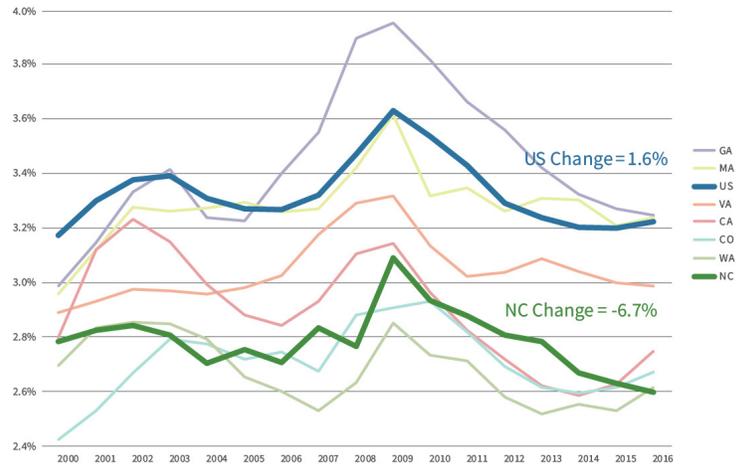
### HOW DOES NORTH CAROLINA PERFORM?

In terms of the elementary and secondary public school current expenditures as a percentage of state GDP, North Carolina ranks 49<sup>th</sup> in the nation, with a level that is 81 percent of the U.S. average value and 49 percent of the value of the state with the highest value, Vermont [6.1A]. Relative to the comparison states, North Carolina has the lowest percentage of its state GDP for elementary and secondary public school current expenses. From 2000 to 2016, North Carolina's elementary and secondary public school current expenditures as a percentage of state GDP decreased -6.7 percent, compared to a 1.6 percent increase for the U.S. overall [6.1B]. Over this same period, two comparison states (California and Washington) also had decreasing rates in the percentage of their state GDP on elementary and secondary public school current expenses, though their rates of decrease were smaller than the rate for North Carolina.

In terms of appropriations of state tax funds for operating expenses of higher education as a percentage of state GDP, North Carolina ranks 7<sup>th</sup> in the nation, with a level that is 170 percent of the U.S. average value and 80 percent of the value of the state with the highest value, Mississippi [6.1C]. North Carolina ranks above all of the comparison states, of which only two—California and Georgia—have percentages above the U.S. average. Each of the four other comparison states—Virginia, Washington, Massachusetts, and Colorado—has a percentage below the U.S. average. From 2000 to 2017, North Carolina's appropriations of state tax funds for operating expenses of higher education as a percentage of state GDP decreased by 10.4 percent, which is smaller than the 13 percent decrease for the U.S. overall [6.1D]. Over this same period, each of the comparison states had a decrease in the percentage of its GDP appropriated for operating expenses of higher education (an average of 24 percent), and all were larger decreases than the decrease in North Carolina.

### 6.1B

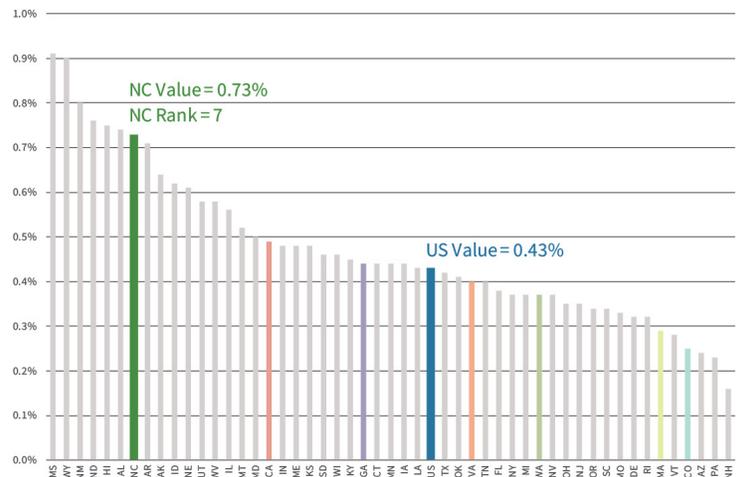
### ELEMENTARY AND SECONDARY PUBLIC SCHOOL CURRENT EXPENDITURES AS A PERCENTAGE OF STATE GDP, COMPARISON STATES, 2000-2016



Source: National Science Board.

### 6.1C

### APPROPRIATIONS OF STATE TAX FUNDS FOR OPERATING EXPENSES OF HIGHER EDUCATION AS A PERCENTAGE OF STATE GDP, ALL U.S. STATES, 2017



Source: National Science Board.

## Indicator 6.1: Public Investment in Education

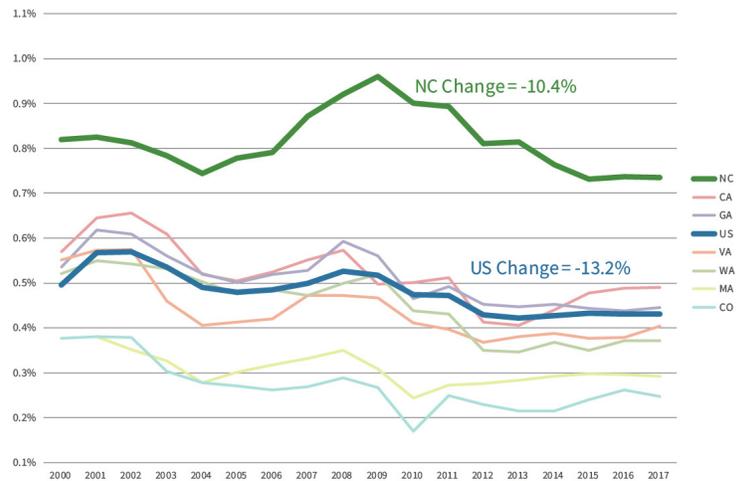
Within North Carolina, the pattern of authorized appropriations for the University of North Carolina (UNC) institutions is highly correlated with the size of the institutions [6.1E].<sup>4</sup> For example, the three largest institutions together account for nearly 42 percent of total appropriations to UNC institutions—NC State University (18.7 percent), UNC-Chapel Hill (12.2 percent), and UNC-Charlotte (11.3 percent). In contrast, the three smallest institutions together account for 4 percent of total appropriations to UNC institutions—Elizabeth City State University (1.6 percent), NC School of the Arts (1.5 percent), and NC School of Science and Mathematics (1.0 percent).

### WHAT DOES THIS MEAN FOR NORTH CAROLINA?

In general, North Carolina’s public investment in education correlates highly with its performance in the other education-related indicators tracked in this report. Specifically, given the state’s low ranking on elementary and secondary public school current expenditures as a percentage of state GDP, it isn’t surprising that the state ranks below average in terms of the educational attainment of its residents age 25 and older (see indicator 5.6) and its employment in high-tech establishments as a percentage of total employment (see indicator 4.2).<sup>5</sup> Conversely, given the state’s near-top ranking on appropriations of state tax funds for operating expenses of higher education as a percentage of state GDP, it isn’t surprising that the state ranks similarly high in terms of academic science & engineering (S&E) research and development as a percentage of State GDP (see indicator 2.3), employed S&E doctorate holders as a percentage of the workforce (see indicator 5.2), and science, engineering & technology degrees as percentage of total higher education degrees conferred (see indicator 5.5).

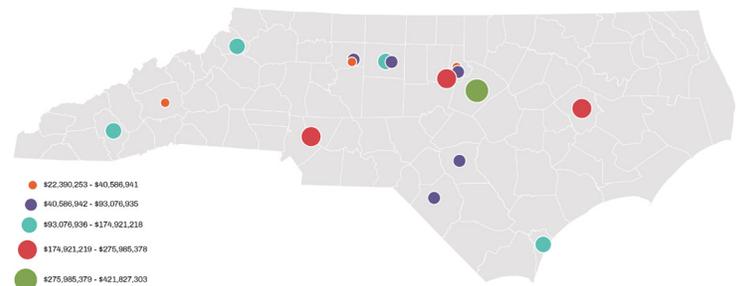
North Carolina’s ability to compete in a knowledge- and innovation-driven economy depends critically on the education and training of its workforce at all levels. Given the link between investment in education and related measures of success in education, it is clear that North Carolina should continue its strong levels of investment in higher education and significantly increase its levels of investment in elementary and secondary education.

### 6.1D APPROPRIATIONS OF STATE TAX FUNDS FOR OPERATING EXPENSES OF HIGHER EDUCATION AS A PERCENTAGE OF STATE GDP, COMPARISON STATES, 2000-2017



Source: National Science Board.

### 6.1E AUTHORIZED APPROPRIATIONS, UNIVERSITY OF NORTH CAROLINA (UNC) INSTITUTIONS, FY 2017-2019 AVERAGE



Source: N.C. Office of State Budget and Management.

Note: These data include only General Fund appropriations, not other funding sources that comprise the UNC system budget. Additionally, the data include only FY 2017-2019 average appropriations for each institution’s Academic Affairs functions, not for other functions, such as Health Affairs and Area Health Education Centers at UNC-Chapel Hill, Agricultural Research Service and Cooperative Extension at NC State, and Health Services at East Carolina.

<sup>4</sup> Here size is measured by the headcount enrollment in 2017. This pattern of appropriations is more correlated with institution size than are other measures of university activity, such as academic science & engineering research & development (see indicator 2.3), academic patents (see indicator 3.2), and academic license income (see indicator 3.5).

<sup>5</sup> North Carolina has similar low rankings on other measures of educational achievement not tracked in this report, such as eighth-grade science performance and high school graduates among individuals 25-44 years old. For more information, see: National Science Board. 2018. Science and Engineering Indicators 2018.

## Indicator 6.2: Broadband

### KEY FINDINGS

- North Carolina’s broadband deployment rate ranks slightly above the U.S. average.
- North Carolina’s fiber deployment rate ranks well below the U.S. average.
- North Carolina’s broadband adoption rate ranks slightly below the U.S. average.
- Across North Carolina, broadband subscription rates vary considerably by county, with more populous counties generally having the highest rates.
- North Carolina has significant and unique middle-mile assets that can be leveraged to increase speeds and capacity in last-mile deployments and help leverage solutions for serving some of the unserved areas in the state.

### INDICATOR OVERVIEW

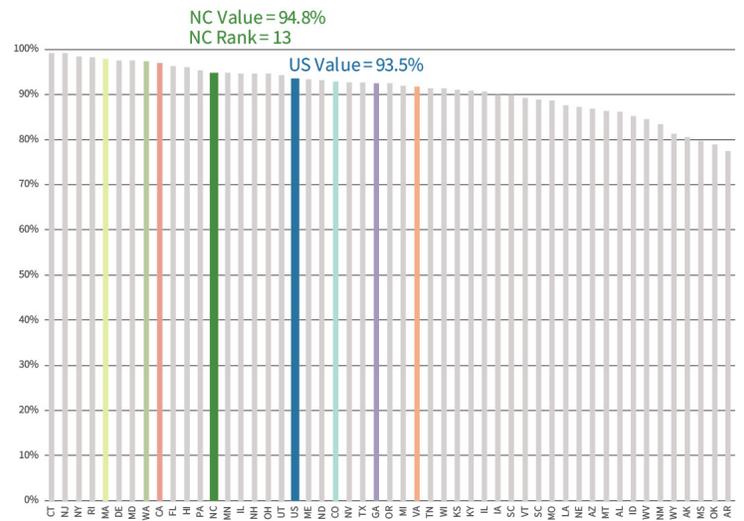
The term “broadband” refers to a range of technologies (e.g., fiber, coax cable, copper, and wireless technologies) that allow for higher capacity and faster data transmission with the Internet. Broadband is a platform for innovation, in that using broadband technologies can foster and enable innovation in all sectors by increasing business productivity, improving health care and education, and enabling the creation and use of new technologies.

Broadband is examined here at the state level in three ways: (1) deployment rate, (2) percent of fiber connections, and (3) household adoption rates. Deployment rate measures the basic “supply” level of broadband using the ratio of the population with access to fixed broadband at 25 Mbps (download)/3 Mbps (upload), the Federal Communication Commission’s (FCC) recommended speed threshold. Fiber connections to the end user are presented as a more refined, higher-level measure of the deployment rate, as fiber technology is a scalable and ‘future proof’ technology. Fiber deployment is measured here as a percent of all wireline connections—to the home and businesses. Finally, the broadband adoption rate measures the demand for broadband by calculating the number of households with broadband subscriptions divided by the number of homes where broadband subscriptions are available.<sup>1</sup>

### HOW DOES NORTH CAROLINA PERFORM?<sup>2</sup>

At the speed examined, North Carolina’s broadband deployment rate (94.8 percent) ranks 13<sup>th</sup> in the nation<sup>3</sup> and is 101 percent of the U.S. average and 96 percent of the rate of the top-ranking state, Connecticut [6.2A].<sup>4</sup> Among the comparison states, North Carolina’s rate is ahead of those of Colorado, Georgia, and Virginia, but behind those of Massachusetts, Washington, and California.

### 6.2A PERCENT OF POPULATION WITH BROADBAND ACCESS (DEPLOYMENT RATE) AT 25 MBPS/3MBPS OR FASTER, ALL U.S. STATES, 2017



Source: Federal Communications Commission.

<sup>1</sup> This measure is slightly different than the measure used to gauge demand for broadband in Tracking Innovation 2017 (broadband subscription rate), which was calculated as the number of households with internet subscriptions divided by the total number of households/population.

<sup>2</sup> Over-time data are not presented here because broadband delivery technology is changing so rapidly that consistent, accurate over-time data are not available.

<sup>3</sup> Deployment data are often overstated because the data submitted by service providers indicate an entire census block has access to broadband even if only one household in the census block has access.

<sup>4</sup> Source: Data provided to the North Carolina Broadband Infrastructure Office from the Federal Communication’s Commission, September 2019.

<sup>5</sup> Massachusetts, as well as Delaware, Hawaii, Maryland, New Jersey, New York, Pennsylvania, and Rhode Island withhold data for confidentiality reasons.

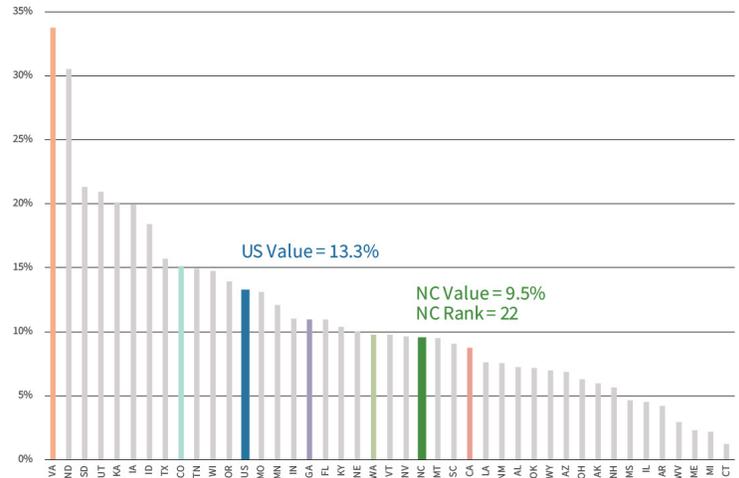
## Indicator 6.2: Broadband

In terms of fiber to the end-user connections as a percentage of all wireline connections, North Carolina ranks considerably lower than the U.S. average and five of the comparison states—Virginia, Colorado, Georgia, and Washington [6.2B].<sup>5</sup> The number of fiber-to-the-end user connections has more than doubled since 2017, at 329,000 fiber-to-the-end user connections, or 9.5 percent. Moreover, the technology has grown as a percent of all wireline connections, and North Carolina now ranks 22<sup>nd</sup> nationally, with a value that is 71 percent of the U.S. value. Notably, though, North Carolina’s peer and northern neighbor, Virginia, ranks first in the nation on this measure, with 33.8 percent of its wireline connections being fiber connections.

North Carolina’s adoption rate, 59.4 percent at the examined speed threshold, indicates that just over half of North Carolina’s households purchase broadband in their homes [6.2C]. The adoption rate is useful in that it gives a clear picture of the number of households with and without service in their homes. On this measure North Carolina ranks 20<sup>th</sup> nationally, with a value that is 99 percent of the U.S. average and 71 percent of the value of the to-ranking state, Delaware. North Carolina also ranks lower than all comparison states except for Georgia.<sup>6</sup>

### 6.2B

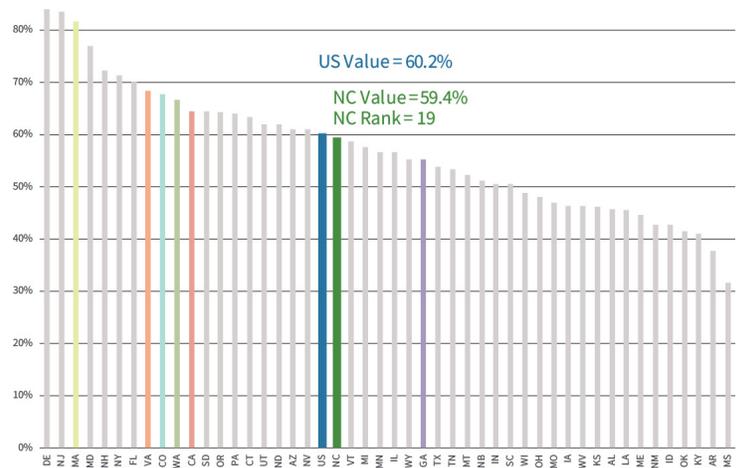
#### PERCENT OF FIBER TO THE END USER CONNECTIONS OF ALL WIRELINE CONNECTIONS, ALL REPORTING U.S. STATES\*, 2017



Source: Federal Communications Commission.  
\*42 U.S. States reported.

### 6.2C

#### BROADBAND ADOPTION RATE 25 MBPS/3 MBPS OR FASTER, ALL U.S. STATES\*, 2017



Source: Federal Communications Commission.  
\*Alaska, Hawaii, and Rhode Island subscription rates not reported.

<sup>6</sup> Many states share the same subscription rate and thus are “tied.” In addition, three states did not report their subscription rates at the reported speed threshold: Alaska, Hawaii, and Rhode Island.

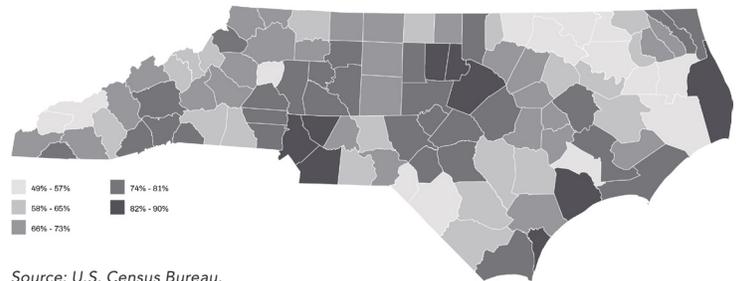
## Indicator 6.2: Broadband

In 2017, within North Carolina, 44 of the 100 counties have a household broadband deployment rate at the download speed examined, equal to or above the U.S. average of 94.8 percent, and 24 counties equaled or surpassed the state’s average of 75.8 percent adoption when considering all speeds **[maps not provided]**.<sup>7</sup> In 2017-2019, the subscription rate (see definition in footnote 1) varied considerably, with nine counties having rates between 82 and 90 percent, 29 counties having rates between 74 and 81 percent, 29 having rates between 66 and 73 percent, 20 having rates between 58 and 65 percent, and 13 having rates between 49 and 57 percent **[6.2D]**. In general, more populous counties had higher broadband subscription rates.

The connections to the end-user are made possible through “middle-mile” assets, which are the backbone of the networks, and of which North Carolina is well provisioned. While standard metrics for middle-mile are difficult to obtain, North Carolina has over 100 broadband providers who have significant middle-mile assets. In addition, the MCNC network, a 2,600-mile-long, contiguous open access middle-mile network that touches 82 of North Carolina’s counties and provides service to community anchor institutions and opportunities to private sector providers to lease **[6.2E]**. The significance of these assets must be considered when looking at North Carolina’s opportunities for innovation.

### 6.2D

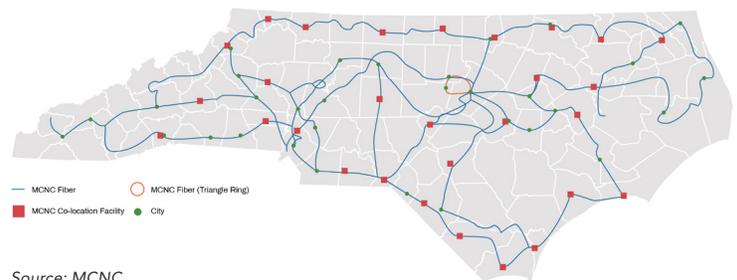
#### BROADBAND SUBSCRIPTION RATES, N.C. COUNTIES, 2017



Source: U.S. Census Bureau.

### 6.2E

#### MCNC BROADBAND FIBER NETWORK STATEWIDE, 2019



Source: MCNC.

<sup>7</sup> Source: American Community Survey 5 Year Estimates, 2013-2017. Map available only for subscription rates.

### WHAT DOES THIS MEAN FOR NORTH CAROLINA?

Deployment rates show that much of North Carolina has access to basic broadband. However, roughly 537,000 North Carolinians continue to lack service—97 percent of which live in the state’s rural areas. These sparsely populated areas generally lack a traditional business case for private sector providers to serve them, and as the last unserved areas in the state, are the hardest and most expensive to serve. Moreover, as speeds increase, availability of broadband drops, which can hinder innovation as data trends suggest the need and demand for faster broadband speeds is growing and will continue to increase.

For these reasons, the North Carolina Broadband Infrastructure Office, a division of the Department of Information and Technology seeks to accomplish its vision that every North Carolinian should be able to access affordable high-speed internet anywhere, at any time. The office works to achieve this vision through the design of programs, policies and tools all aimed to close the digital divide in North Carolina.

The chief obstacles to effectively harnessing broadband’s power as an innovation enabler are the remaining unserved households throughout the state, the state’s low adoption rate, and the ever-increasing need for higher speeds. Broadband adoption is a complex challenge, with many factors impacting the subscription of wired broadband at home, such as the cost of the service and the device, literacy and digital literacy, availability of other public internet access (such as libraries), and relevancy. But through North Carolina’s strong private sector broadband providers, it’s unique middle-mile asset in MCNC, and the State’s dedication to broadband expansion, North Carolina is well positioned to remain innovative in expanding broadband deployments, adoption and use.

## Indicator 6.3: Cost of Living Index

### KEY FINDINGS

- North Carolina’s Cost of Living Index ranks below the U.S. average.
- Within North Carolina, the cost of living varies, but only moderately compared to variations nationwide. Nearly one-third of North Carolina counties have Cost of Living Index values slightly lower than or moderately higher than the U.S. average. More than two-thirds of the counties have Cost of Living Index values that are more than five percent lower than the U.S. average.

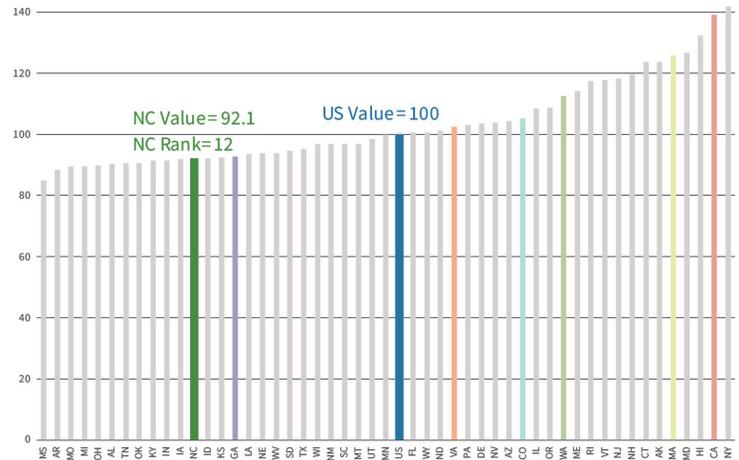
### INDICATOR OVERVIEW

This indicator is a price index that compares cost of living differences among urban areas based on the price of consumer goods and services. Specifically, it uses the Cost of Living Index produced quarterly by the Council for Community and Economic Research (C2ER).<sup>1</sup> The Cost of Living Index assumes that prices collected at a specified time, in strict conformance with standard specifications, provide a sound basis for constructing a reasonably accurate gauge of relative differences in the cost of consumer goods and services. The average for all participating areas, both metropolitan and nonmetropolitan, equals 100, and each participant’s index is read as a percentage of the average for all areas combined, i.e., the U.S. average.<sup>2</sup> Assessments of quality of life, of which cost of living is a major component, influence states’ and regions’ ability to attract and retain talented people. A reasonable and affordable cost of living can attract people to an area, thus facilitating businesses’ ability to fill open positions and fuel expansion in the area.<sup>3</sup>

### HOW DOES NORTH CAROLINA PERFORM?

In terms of the Cost of Living Index, North Carolina ranks 12<sup>th</sup> in the nation, with a level that is 92.1 percent of the U.S. average value and 109 percent of the value of the state with the lowest Cost of Living Index value, Mississippi [6.3A]. Among the comparison states, North Carolina has the lowest Cost of Living Index value as of 2018. Furthermore, of the comparison states, only Georgia has a Cost of Living value lower than the U.S. average. The Cost of Living Index value for Colorado and Virginia are slightly above the U.S. average, while the values for California, Massachusetts, and Washington are considerably above the U.S. average and among the top-15 most expensive states.

**6.3A COST OF LIVING INDEX, ALL U.S. STATES, 2018**



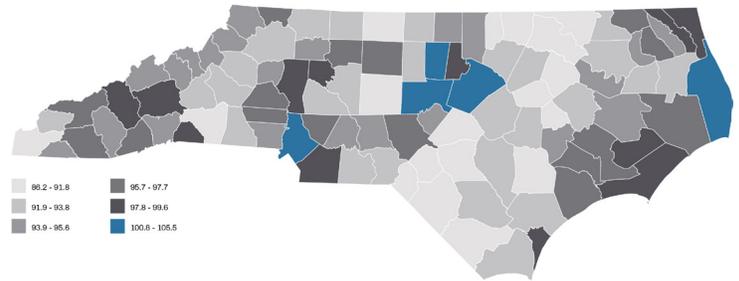
## Indicator 6.3: Cost of Living Index

Within North Carolina, the Cost of Living index varies by county, but only moderately when compared to the variance across all counties nationwide [6.3B]. The NC county indexes range from a high of 105.4 (Mecklenburg county) to a low of 86.2 (Robeson County). In 2018, county values nationwide range widely, from as high as 304.0 in New York County, New York to as low as 78.5 in Magoffin County, Kentucky.<sup>4</sup> In total, five (Mecklenburg, Orange, Wake, Chatham, and Dare) of North Carolina’s 100 counties have a cost of living higher than the U.S. average, whereas another 26 have a cost of living slightly lower than the U.S. average. The 69 remaining North Carolina counties have a cost of living that is five percent or more lower than the U.S. average.

### WHAT DOES THIS MEAN FOR NORTH CAROLINA?

In general, independent of other factors, an affordable, close-to-average cost of living is an advantage for a state or region. A cost of living that is notably higher than the U.S. average could be unattractive to both employers and employees, as costs for employers could be excessive, and workers may prefer to live in lower-cost areas. Alternatively, a cost of living that is notably lower than the U.S. average could also be unattractive to both employers and employees, potentially indicating the area has fewer amenities and infrastructure. On average, North Carolina’s cost of living is neither excessively high nor overly low. In general, counties with a cost of living slightly above or slightly below the U.S. average are more likely to be the targets for innovative activity, as they are relatively affordable and more likely to possess a good mix of infrastructure, amenities, goods, and services. Those counties with a cost of living that is notably lower than the U.S. average, while more affordable, may have a less suitable mix of infrastructure, amenities, goods, and services. To the extent that is the case, efforts may be needed to increase those factors in order to increase the innovative activity and economic growth of those areas.

### 6.3B COST OF LIVING INDEX, N.C. COUNTIES, 2018



Source: Council for Community and Economic Research (C2ER).  
Blue counties rank above the U.S. average.

<sup>4</sup> The standard deviation of the 2018 Cost of Living Index across all U.S. counties is 11.97, and approximately 84% of all U.S. counties fall within one standard deviation from the mean (mean = 100.0). Only one NC county (Robeson County) falls outside of the standard deviation, suggesting its cost living is notably different from the U.S. average.

## Indicator 6.4: Industry Mix

### KEY FINDINGS

- North Carolina’s industry mix does not position the state, overall, to be a leader in innovation.
- A large portion of the state’s industries and employment is not high science, engineering, and technology (SET) in nature and, therefore, is less likely to produce the types of innovations that drive growth, employment, and higher wages in the economy.
- Among the small number of sectors that are high SET, virtually all have wages well above the U.S. average for all sectors, and slightly more than half are increasing in employment.
- North Carolina’s manufacturing GDP as a percentage of state GDP ranks above the U.S. average, has since at least the early 2000s, and is decreasing at a rate slightly faster than the U.S. average.

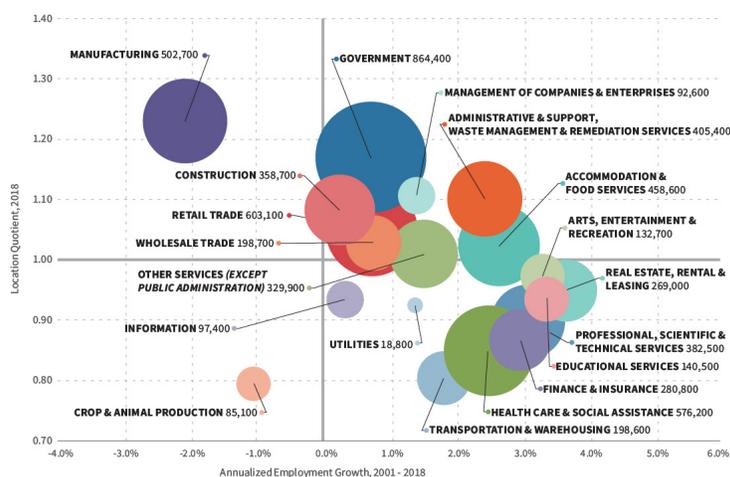
### INDICATOR OVERVIEW

This indicator measures North Carolina’s industry mix (i.e., the basic industry composition and patterns of North Carolina’s economy) in three ways. Industry mix is measured first by detailing—for each major economic sector—four factors:<sup>1</sup> the level of employment, employment change (2001-2018), relative concentration (see Methodological Note, next page), and average wage. The second measure details—for high science, engineering & technology (SET) employment industries only<sup>2</sup>—the same four factors. The third measures manufacturing GDP as a percentage of state GDP. Together, these measures provide useful context for interpreting and explaining many of the other indicators in this report, particularly the ones focused on industry activity (e.g., Innovative Organizations in Section 4) and Employment (e.g., Workforce in Section 5).<sup>3</sup>

### HOW DOES NORTH CAROLINA PERFORM?<sup>4</sup>

In terms of major economic sectors, half of North Carolina’s employment is in five major economic sectors—Government (14.4%),<sup>5</sup> Retail Trade (10.0%), Health Care and Social Assistance (9.6%), Manufacturing (8.4%),<sup>6</sup> and Accommodation and Food Services (7.6%) [6.4A and 6.4B].<sup>7</sup>

### 6.4A INDUSTRY EMPLOYMENT, ANNUALIZED EMPLOYMENT GROWTH, AND CONCENTRATION, ALL INDUSTRIES, NORTH CAROLINA, 2018



Notes: Employment numbers rounded to the nearest hundreds; excludes NAICS codes 99 (Unclassified Industry) and 21 (Mining, Quarrying, & Oil & Gas Extraction). Industry Employment is depicted by the size of the bubble (which corresponds to the number for each bubble), annualized employment growth is depicted on the horizontal axis, and industry concentration is depicted on the vertical axis.

<sup>1</sup> Economic sectors are defined by 2-digit North American Industry Classification System (NAICS) codes. NAICS is the standard used by federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy. NAICS is a 2- through 6-digit hierarchical classification system, offering five levels of detail. Each digit in the code is part of a series of progressively narrower categories, and more digits in the code signify greater classification detail. The first two digits designate the economic sector, the third digit designates the subsector, the fourth digit designates the industry group, the fifth digit designates the NAICS industry, and the sixth digit designates the national industry. For more information about NAICS codes, see [www.census.gov/eos/www/naics](http://www.census.gov/eos/www/naics).

<sup>2</sup> The data pertaining to establishments are based on their classification according to the 2017 edition of the North American Industry Classification System (NAICS). See Appendix for a list of the 48 industries (by 4-digit NAICS code) that are defined having high science, engineering & technology (SET) employment. Also see indicator 6.4 for more description of the EMSI data used for this particular indicator.

<sup>3</sup> This indicator does not present a “cluster” analysis. A cluster is a group of businesses and industries that are related through presence in a common product chain, dependence on similar labor skills, or utilization of similar or complementary.

<sup>4</sup> The measures reported here are for the state overall, not just the small number of much-acclaimed, very well-performing regions such as the Research Triangle and Charlotte.

<sup>5</sup> Government excludes federal military.

<sup>6</sup> Manufacturing industries are defined as those industries whose 2-digit NAICS code ranges from 31–33.

<sup>7</sup> The data in table 6.4B are the source for the graphics in chart 6.4A, which simply provides a summary-level pictorial representation of the data, from which it is easier to discern patterns.

<sup>8</sup> “Wage” includes wages, salaries, commissions, tips, overtime pay, hazard pay, bonuses, stock options, and severance pay. It does not include supplements, such as employer contributions to 401(k) plans, pensions, insurance funds, and government social insurance (FIA/FUTA). The 2018 average wage in North Carolina is \$50,768 (see indicator 1.3).

## Indicator 6.4: Industry Mix

### 6.4B SECTOR EMPLOYMENT, ANNUALIZED EMPLOYMENT GROWTH, CONCENTRATION, & AVERAGE WAGE, ALL N.C. SECTORS (SORTED IN DESCENDING ORDER OF EMPLOYMENT)

2-Digit NAICS Code	Industry	Employment					
		Total 2018	Share of Total 2018	Cumulative Share of Total 2018	Annualized Growth Rate (Compound Annual Growth Rate) 2001-2018	Location Quotient 2018	Average Wage 2019
90	Government	864,400	14.4%	14.4%	0.7%	1.17	\$65,200
44	Retail Trade	603,100	10.0%	24.4%	0.7%	1.05	\$31,700
62	Health Care and Social Assistance	576,200	9.6%	34.0%	2.5%	0.85	\$55,900
31	Manufacturing	502,700	8.4%	42.4%	-2.1%	1.23	\$71,700
72	Accommodation and Food Services	458,600	7.6%	50.0%	2.7%	1.02	\$20,900
56	Administrative and Support and Waste Management and Remediation Services	405,400	6.7%	56.8%	2.4%	1.10	\$36,400
54	Professional, Scientific, and Technical Services	382,500	6.4%	63.2%	3.1%	0.90	\$77,800
23	Construction	358,700	6.0%	69.1%	0.3%	1.08	\$52,300
81	Other Services (except Public Administration)	329,900	5.5%	74.6%	1.5%	1.01	\$27,000
52	Finance and Insurance	280,800	4.7%	79.3%	3.0%	0.87	\$99,500
53	Real Estate and Rental and Leasing	269,000	4.5%	83.8%	3.7%	0.95	\$33,900
42	Wholesale Trade	198,700	3.3%	87.1%	0.8%	1.03	\$83,300
48	Transportation and Warehousing	198,600	3.3%	90.4%	1.8%	0.80	\$49,500
61	Educational Services	140,500	2.3%	92.7%	3.4%	0.94	\$42,800
71	Arts, Entertainment, and Recreation	132,700	2.2%	94.9%	3.3%	0.97	\$26,900
51	Information	97,400	1.6%	96.6%	0.3%	0.93	\$88,800
55	Management of Companies and Enterprises	92,600	1.5%	98.1%	1.4%	1.11	\$119,000
11	Crop and Animal Production	85,100	1.4%	99.5%	-1.0%	0.79	\$39,100
22	Utilities	18,800	0.3%	99.8%	1.4%	0.92	\$121,200
21	Mining, Quarrying, and Oil and Gas Extraction	10,300	0.2%	100.0%	2.7%	0.21	\$29,500
	<b>Total</b>	<b>6,006,000</b>	<b>100.0%</b>		<b>1.3%</b>		<b>\$54,000</b>

Source: QCEW Employees, Non-QCEW Employees, Self-Employed & Extended Proprietors - EMSI 2019.4 Class of Worker

Note: Sorted in descending order by employment. Excludes NAICS code 99 (Unclassified Industry); average wage and employment numbers rounded to the nearest hundreds.

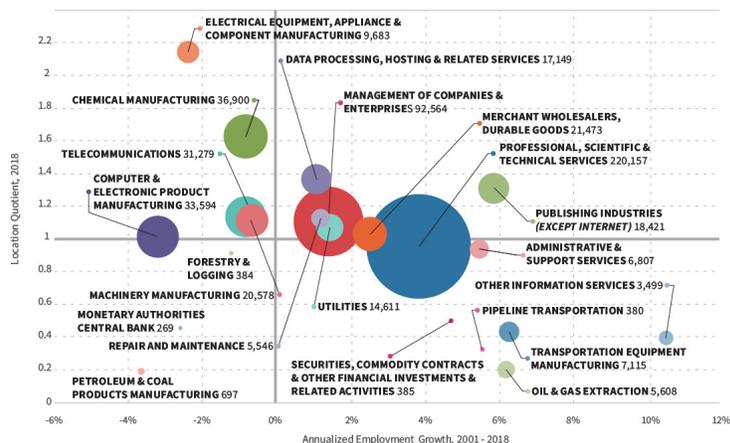
## Indicator 6.4: Industry Mix

Of these, three—Government, Health Care and Social Assistance, and Manufacturing—have wages above the North Carolina average (see indicator 1.3),<sup>8</sup> and only Manufacturing has a substantial share of high SET employment industries and employment [6.4C and 6.4D].<sup>9</sup> The next four sectors—Administrative and Support and Waste Management and Remediation (6.7%), Professional, Scientific, and Technical Services (6.4%), Construction (6.0%), and Other Services (5.5%)—together account for another almost one quarter of all of North Carolina’s employment. Of these, Professional, Scientific, and Technical Services and Construction have above-average wages, and Professional, Scientific, and Technical Services has a substantial share of high SET employment industries and employment. The remaining 25 percent of North Carolina’s employment is spread across 11 additional sectors, of which only a small minority consists of high SET employment industries. In general, the average wages (\$48,976) of the nine sectors comprising approximately three-fourths of North Carolina’s employment are lower than the average wages (\$66,682) of the 11 sectors comprising approximately one-fourth of North Carolina’s employment.

In terms of the sectors’ relative concentration, as measured by location quotients, there are four sectors in which North Carolina has a larger share of activity in the industry than we would expect based on national trends—Manufacturing, Government, Management of Companies and Enterprises, and Administrative and Support and Waste Management and Remediation Services. Of these, two sectors—Management of Companies and Enterprises and Manufacturing—have above-average wages and a substantial share of high SET employment industries.<sup>10</sup> The first of these sectors is growing in employment over time, whereas the other is shrinking in employment over time. Of the sectors in which North Carolina has a smaller share of activity in the industry than we would expect based on national trends, there are two that have above-average wages and a substantial share of high SET employment industries and employment—Professional, Scientific, and Technical Services; and Finance and Insurance; both of which are growing in employment over time.

### 6.4C

## INDUSTRY EMPLOYMENT, ANNUALIZED EMPLOYMENT GROWTH, AND CONCENTRATION, HIGH SET EMPLOYMENT INDUSTRIES, NORTH CAROLINA, 2018



Notes: Employment numbers rounded to the nearest hundreds. Industry Employment is depicted by the size of the bubble (which corresponds to the number for each bubble), annualized employment growth is depicted on the horizontal axis, and industry concentration is depicted on the vertical axis.

In terms of high SET employment industries, more than half (56.2%) of North Carolina’s high SET employment is in industries within two subsectors—Professional, Scientific and Technical Services (40.2%) and Management of Companies and Enterprises (16.9%) [6.4C and 6.4D].<sup>11</sup> In the first subsector—Professional, Scientific and Technical Services—North Carolina has a slightly smaller share of activity than we would expect based on national trends; within that subsector, Management, Scientific, and Technical Consulting Services and Scientific Research and Development Services are the two industries in which North Carolina’s share of activity is equal to or above the national average. In the second subsector—Management of Companies and Enterprises—North Carolina has a larger share of activity than we would expect based on national trends. Each subsector is growing in employment and has average wages well above the U.S. average wage for all industries.

<sup>9</sup> Each sector consists of a large number of subsectors and an even larger number of industries, of which only a minority (48) is classified as having high science, engineering & technology employment (SET). See the Appendix for a list of the 48 industries.

<sup>10</sup> The Government sector also has above-average wages, but does not have any share of the high SET employment industries.

<sup>11</sup> Employment numbers, location quotients, and average wages are reported only for those industry (4-digit NAICS codes) that are identified as a SET employment industry. Accordingly, the subsector data reported here at the 3-digit NAICS code level do not match similar data for the entire subsector defined at the 3-digit NAICS level. Moreover, the data in chart 6.4C are presented at the 3-digit level because the four-digit level is too detailed for graphic presentation purposes.

## Indicator 6.4: Industry Mix

6.4D

### EMPLOYMENT & WAGES IN HIGH SET EMPLOYMENT INDUSTRIES, N.C. (SORTED BY DESCENDING ORDER OF EMPLOYMENT)

NAICS Code	High-Technology Industry	Employment					
		Total 2018	Share of Total 2018	Cumulative Share of Total 2018	Annualized Growth Rate (Compound Annual Growth Rate) 2001-2018	Location Quotient 2018	Average Wage 2019
<b>541</b>	<b>Professional, Scientific, &amp; Technical Services</b>	<b>220,200</b>	<b>40.2%</b>	<b>40.2%</b>	<b>3.9%</b>	<b>0.95</b>	<b>\$96,900</b>
5416	Management, Scientific, & Technical Consulting Services	77,500	14.2%		5.5%	1.00	\$75,500
5415	Computer Systems Design & Related Services	67,600	12.4%		3.8%	0.88	\$118,300
5413	Architectural, Engineering, & Related Services	48,000	8.8%		1.6%	0.90	\$81,700
5417	Scientific Research & Development Services	27,000	4.9%		4.9%	1.19	\$131,600
<b>551</b>	<b>Management of Companies &amp; Enterprises</b>	<b>92,600</b>	<b>16.9%</b>	<b>57.2%</b>	<b>1.4%</b>	<b>1.11</b>	<b>\$119,000</b>
5511	Management of Companies & Enterprises	92,600	16.9%		1.4%	1.11	\$119,000
<b>325</b>	<b>Chemical Manufacturing</b>	<b>36,900</b>	<b>6.7%</b>	<b>63.9%</b>	<b>-0.8%</b>	<b>1.63</b>	<b>\$115,000</b>
3254	Pharmaceutical & Medicine Manufacturing	22,000	4.0%		0.9%	2.42	\$127,700
3252	Resin, Synthetic Rubber, & Artificial Synthetic Fibers & Filaments Manufacturing	3,700	0.7%		-5.5%	1.30	\$92,000
3259	Other Chemical Product & Preparation Manufacturing	3,300	0.6%		-1.2%	1.19	\$80,300
3251	Basic Chemical Manufacturing	3,100	0.6%		-1.7%	0.67	\$102,500
3255	Paint, Coating, & Adhesive Manufacturing	2,500	0.5%		0.7%	1.18	\$84,400
3253	Pesticide, Fertilizer, & Other Agricultural Chemical Manufacturing	2,200	0.4%		-2.3%	1.91	\$132,100
<b>334</b>	<b>Computer &amp; Electronic Product Manufacturing</b>	<b>33,600</b>	<b>6.1%</b>	<b>70.0%</b>	<b>-3.2%</b>	<b>1.01</b>	<b>\$137,600</b>
3345	Navigational, Measuring, Electromedical, & Control Instruments Manufacturing	12,100	2.2%		1.3%	0.94	\$133,800
3341	Computer & Peripheral Equipment Manufacturing	9,800	1.8%		-3.8%	1.99	\$163,400
3344	Semiconductor & Other Electronic Component Manufacturing	7,300	1.3%		-5.8%	0.64	\$115,600
3342	Communications Equipment Manufacturing	3,100	0.6%		-2.3%	1.13	\$133,200
3346	Manufacturing & Reproducing Magnetic & Optical Media	500	0.1%		-11.3%	1.14	\$151,000
3343	Audio & Video Equipment Manufacturing	700	0.1%		-1.2%	1.07	\$83,400
<b>517</b>	<b>Telecommunications</b>	<b>31,300</b>	<b>5.7%</b>	<b>75.8%</b>	<b>-0.8%</b>	<b>1.13</b>	<b>\$84,700</b>
517311	Wired Telecommunications Carriers	19,800	3.6%		-0.4%	1.02	\$86,500
517312	Wireless Telecommunications Carriers (except Satellite)	6,500	1.2%		0.2%	1.43	\$68,200
5179	Other Telecommunications	4,900	0.9%		-3.3%	1.48	\$100,300
5174	Satellite Telecommunications	200	0.0%		3.0%	0.57	\$59,000
<b>423</b>	<b>Merchant Wholesalers, Durable Goods</b>	<b>21,500</b>	<b>3.9%</b>	<b>79.7%</b>	<b>2.6%</b>	<b>1.03</b>	<b>\$123,100</b>
4234	Professional & Commercial Equipment & Supplies Merchant Wholesalers	21,500	3.9%		2.6%	1.03	\$123,100
<b>333</b>	<b>Machinery Manufacturing</b>	<b>20,600</b>	<b>3.8%</b>	<b>83.5%</b>	<b>-0.7%</b>	<b>1.11</b>	<b>\$85,000</b>
3339	Other General Purpose Machinery Manufacturing	9,100	1.7%		-1.2%	1.06	\$89,800
3336	Engine, Turbine, & Power Transmission Equipment Manufacturing	4,500	0.8%		0.9%	1.49	\$94,200
3332	Industrial Machinery Manufacturing	4,400	0.8%		-2.2%	1.13	\$70,100
3333	Commercial & Service Industry Machinery Manufacturing	2,600	0.5%		2.3%	0.87	\$77,000
<b>511</b>	<b>Publishing Industries (except Internet)</b>	<b>18,400</b>	<b>3.4%</b>	<b>86.8%</b>	<b>5.9%</b>	<b>1.31</b>	<b>\$138,900</b>
5112	Software Publishers	18,400	3.4%		5.9%	1.31	\$138,900
<b>518</b>	<b>Data Processing, Hosting, &amp; Related Services</b>	<b>17,100</b>	<b>3.1%</b>	<b>89.9%</b>	<b>1.1%</b>	<b>1.36</b>	<b>\$101,600</b>
5182	Data Processing, Hosting, & Related Services	17,100	3.1%		1.1%	1.36	\$101,600
<b>221</b>	<b>Utilities</b>	<b>14,600</b>	<b>2.7%</b>	<b>92.6%</b>	<b>1.5%</b>	<b>1.07</b>	<b>\$133,600</b>
2211	Electric Power Generation, Transmission & Distribution	14,600	2.7%		1.5%	1.07	\$133,600

Source: QCEW Employees, Non-QCEW Employees, Self-Employed & Extended Proprietors - EMSI 2019.4 Class of Worker

Note: Average wage and employment numbers rounded to the nearest hundreds.

\*Data not shared due to quality concerns.

## Indicator 6.4: Industry Mix

### 6.4D EMPLOYMENT & WAGES IN HIGH SET EMPLOYMENT INDUSTRIES, N.C. (SORTED BY DESCENDING ORDER OF EMPLOYMENT), CONTINUED

NAICS Code	High-Technology Industry	Employment					
		Total 2018	Share of Total 2018	Cumulative Share of Total 2018	Annualized Growth Rate (Compound Annual Growth Rate) 2001-2018	Location Quotient 2018	Average Wage 2019
335	Electrical Equipment, Appliance, & Component Manufacturing	9,700	1.8%	94.4%	-2.4%	2.14	\$91,200
3353	Electrical Equipment Manufacturing	9,700	1.8%		-2.4%	2.14	\$91,200
336	Transportation Equipment Manufacturing	7,100	1.3%	95.7%	6.3%	0.43	\$117,100
3364	Aerospace Product & Parts Manufacturing	6,400	1.2%		6.1%	0.41	\$122,300
3369	Other Transportation Equipment Manufacturing	800	0.1%		8.1%	0.64	\$74,000
561	Administrative & Support Services	6,800	1.2%	96.9%	5.5%	0.94	\$60,600
5612	Facilities Support Services	4,600	0.8%		5.9%	0.81	\$51,600
561312	Executive Search Services	2,200	0.4%		4.7%	1.42	\$78,800
211	Oil & Gas Extraction	5,600	1.0%	98.0%	6.2%	0.20	*
2111	Oil & Gas Extraction	5,600	1.0%		6.2%	0.20	*
811	Repair & Maintenance	5,500	1.0%	99.0%	1.2%	1.13	\$70,400
8112	Electronic & Precision Equipment Repair & Maintenance	5,500	1.0%		1.2%	1.13	\$70,400
519	Other Information Services	3,500	0.6%	99.6%	10.5%	0.39	\$79,200
519130	Internet Publishing & Broadcasting & Web Search Portals	3,500	0.6%		10.5%	0.39	\$79,200
324	Petroleum & Coal Products Manufacturing	700	0.1%	99.7%	-3.7%	0.19	\$100,100
3241	Petroleum & Coal Products Manufacturing	700	0.1%		-3.7%	0.19	\$100,100
113	Forestry & Logging	400	0.1%	99.8%	-1.2%	0.91	\$70,400
1131	Timber Tract Operations	200	0.0%		-1.4%	0.79	\$74,200
1132	Forest Nurseries & Gathering of Forest Products	200	0.0%		-0.9%	1.15	\$65,500
523	Securities, Commodity Contracts, & Other Financial Investments & Related Activities	400	0.1%	99.9%	4.7%	0.50	*
5232	Securities and Commodity Exchanges	400	0.1%		4.7%	0.50	*
486	Pipeline Transportation	400	0.1%	99.9%	5.6%	0.32	\$109,500
4869	Other Pipeline Transportation	300	0.1%		5.5%	1.07	\$105,700
4862	Pipeline Transportation of Natural Gas	100	0.0%		5.8%	0.11	\$119,600
4861	Pipeline Transportation of Crude Oil	<10			--	--	--
521	Monetary Authorities-Central Bank	300	0.1%	100.0%	-2.6%	0.45	\$129,900
5211	Monetary Authorities-Central Bank	300	0.1%		-2.6%	0.45	\$129,900
	<b>Total</b>	<b>\$547,201</b>	<b>100%</b>		<b>2%</b>		<b>\$98,190</b>

Source: QCEW Employees, Non-QCEW Employees, Self-Employed & Extended Proprietors - EMSI 2019.4 Class of Worker

Note: Average wage and employment numbers rounded to the nearest hundreds.

\*Data not shared due to quality concerns.

The next two subsectors, both focused on manufacturing, together account for 12.8 percent of North Carolina's high SET employment—Chemical Manufacturing (6.7%) and Computer and Electronic Product Manufacturing (6.1%). In each subsector, North Carolina has a larger or slightly larger share of activity than we would expect based on national trends and average wages well above the U.S. average wage for all industries, but employment levels that are decreasing. Within the first subsector—Chemical Manufacturing—North Carolina

has a relatively high degree of concentration in all high SET employment industries except Basic Chemical Manufacturing; in the latter subsector—Computer and Electronic Product Manufacturing—North Carolina has a relatively high degree of concentration in all of the high SET employment industries except for Semiconductor and Other Electronic Components Manufacturing. Together, these first four subsectors account for more than two-thirds (70.0%) of North Carolina's high SET industry employment.<sup>12</sup>

<sup>12</sup> Although North Carolina is well known for having a strong financial services and banking sector, major portions of those sectors do not appear here because this analysis includes only the portions defined as having high SET employment. Additionally, a considerable portion of those jobs are classified in other sectors, such as Management of Companies and Enterprises, which does appear here and in which North Carolina performs well.

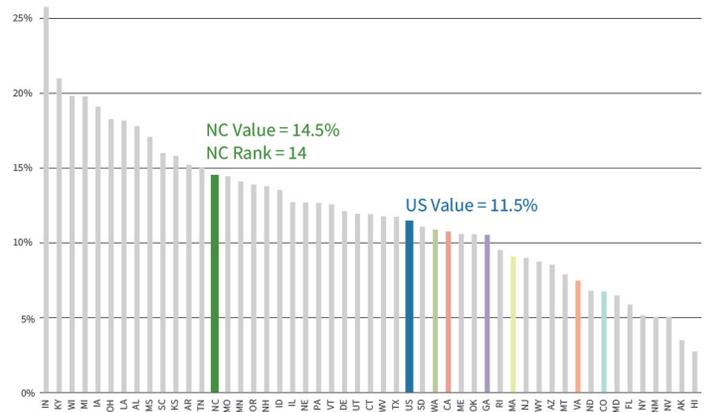
## Indicator 6.4: Industry Mix

Adding the next three subsectors brings the total to 83.5 percent of North Carolina’s high SET industry employment—Telecommunications (5.7%), Merchant Wholesalers, Durable Goods (3.9%), and Machinery Manufacturing (3.8%). North Carolina’s share of activity for two subsectors—Telecommunications and Machinery Manufacturing, is more concentrated than what we would expect based on national patterns. Average wages are well above the U.S. average wage for all industries. Two of the subsectors—Telecommunications and Machinery Manufacturing—have decreasing employment levels, whereas the Merchant Wholesalers, Durable Goods subsector has increasing employment levels. Within the first subsector—Telecommunications—North Carolina has a relatively high degree of concentration in all the high SET employment industries except Satellite Telecommunications. Within the second subsector—Merchant Wholesalers, Durable Goods—North Carolina’s activity level is slightly above the U.S. level. Within the third subsector—Machinery Manufacturing—North Carolina has relatively high degrees of concentration in all industries except Commercial and Service Industry Machinery Manufacturing. The 14 remaining subsectors together account for 16.5 percent of North Carolina’s high SET industry employment.

In terms of manufacturing GDP as a percentage of state GDP, North Carolina ranks 14<sup>th</sup> in the nation, with a level that is 126 percent of the U.S. average value and 56 percent of the value of the state with the highest value, Indiana [6.4E]. North Carolina ranks well ahead of all the comparison states, all of which have values lower than the U.S. average. However, in relation to High SET manufacturing as a percentage of state GDP, North Carolina ranks 36<sup>th</sup> in the nation, at a level that is 38.5 percent of the U.S. average value [6.4F]. North Carolina ranks low among the comparison states, with the exception of Virginia at 49<sup>th</sup>. From 2007 to 2018, the percentage of North Carolina’s GDP accounted for by manufacturing decreased significantly, by 22.4 percent, which is greater than the decrease for the U.S. overall, 12.1 percent, and for all comparison states except Massachusetts [6.4G]. Over the same period, the percentage of North Carolina’s GDP accounted for by High SET manufacturing remained almost constant, with a minimal increase of 2.4 percent, which is greater than the 15.3 percent decrease for the U.S. overall [6.4H]. North Carolina has historically been a strong manufacturing state, but these findings indicate that the state is losing a significant share of the state’s manufacturing as a percentage of GDP, mostly in low-skilled, low-technology industries in manufacturing.

### 6.4E

#### MANUFACTURING GDP AS A PERCENTAGE OF STATE GDP, ALL U.S. STATES, 2018

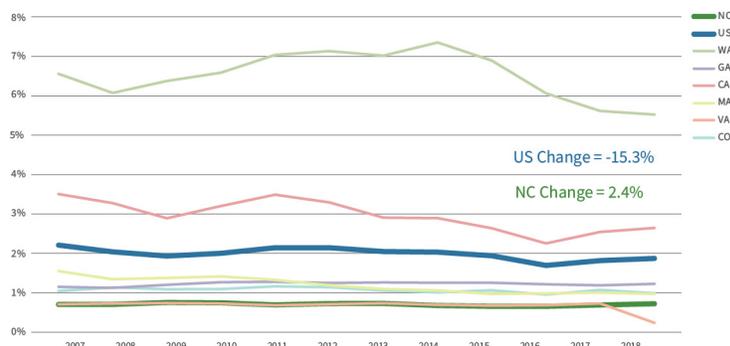


### WHAT DOES THIS MEAN FOR NORTH CAROLINA?

North Carolina's industry mix does not position the state, overall, to be a leader in innovation. Specifically, as summarized in indicators 4.1 (High SET Employment Establishments) and 4.2 (Employment in High SET Establishments) and illustrated in more detail here, a large portion of the state's industries and employment is not high SET in nature and, therefore, less likely to produce the types of innovations that drive growth, employment, and higher wages in the economy. Among the small number of sectors that are defined as having SET employment, however, virtually all have wages well above the U.S. average for all sectors, and slightly more than half are increasing in employment.<sup>13</sup>

While North Carolina has lost several manufacturing jobs since 2001, it is notable that most of those job losses have been in low-technology, low-skill industries, while productivity and job gains have been the case in high SET employment, high-skill industries. Overall in North Carolina, manufacturing wages are higher than the U.S. average, and for high SET employment manufacturing industries, the average wages are even higher. In general, manufacturing (particularly technology-based advanced manufacturing) remains the key source of U.S. traded-sector strength.<sup>14</sup> This is important because traded-sector establishments provide the economic foundation upon which the rest of the economy grows. Manufacturing jobs also have large employment multiplier effects (nationally, each manufacturing job supports as many as 2.9 other jobs in the rest of the economy).<sup>15</sup>

### 6.4H HIGH SET MANUFACTURING GDP AS A PERCENTAGE OF STATE GDP, COMPARISON STATES, 2007-2018



Source: EMSI Analysis

Within North Carolina, only 22 percent of the manufacturing jobs are currently in high SET employment industries.<sup>16</sup> Given the importance and impact of high SET manufacturing, and given that manufacturing establishments perform 64 percent of industry R&D (see indicator 2.2, Industry R&D), North Carolina should work to ensure that new high SET employment manufacturing industries are forming in or relocating to the state. North Carolina should also work to ensure that existing manufacturing industries are innovating and incorporating new technologies to increase their productivity. Similar efforts should also be devoted to high SET employment industries not in the manufacturing sector, such as Professional, Scientific, and Technical Services. Such efforts would expand innovation in North Carolina, thereby improving the economic well-being and quality of life of all its citizens.

#### METHODOLOGICAL NOTE

Relative concentration is measured using a simple descriptive measure called a location quotient. For a given industry, the location quotient is the ratio of the industry's share of employment in North Carolina to its share of employment in the U.S. as a whole. A location quotient equal to 1.0 indicates that the industry's share in North Carolina matches the comparable share for the U.S. as a whole. A location quotient significantly above 1.0 (i.e., more than 10 percent higher) signifies state specialization, i.e., the state has a larger share of activity (more concentration) in the industry than we would expect based on national trends. Conversely, a location quotient significantly below 1.0 (i.e., more than 10 percent lower) signifies state lack of specialization, i.e., the state has a smaller share of activity (less concentration) in the industry than we would expect based on national trends. The formula for computing a location quotient is as follows:

$$\frac{\text{EMPLOYMENT INDUSTRY } i, \text{ NC}}{(\text{TOTAL EMPLOYMENT, NC})} \div \frac{\text{EMPLOYMENT INDUSTRY } i, \text{ US}}{(\text{TOTAL EMPLOYMENT, US})}$$

<sup>13</sup> A more detailed analysis, not presented here, shows three relevant findings. First, Massachusetts and California have significantly higher location quotients in Professional, Scientific and Technical Services and in Information; together, these two sectors account for much of the industrial activity that is popularly thought of as high SET. Second, Massachusetts and California have significantly higher location quotients for the Computer and Electronic Product Manufacturing subsector. Third, each of these two states has more subsectors with very high location quotients, compared to North Carolina, where high SET employment appears to be more evenly distributed.

<sup>14</sup> The traded sector comprises those industries and establishments that produce goods and services (e.g. electronics, management consulting, advertising) that have a high potential to be consumed outside the region of production. The non-traded sector comprises local-serving industries (e.g., construction, personal services, real estate).

<sup>15</sup> For more information, see Ezell, Stephen and Robert D. Atkinson. 2011. *The Case for a National Manufacturing Strategy*. Information Technology and Innovation Foundation (<http://www.itif.org/publications/case-nationalmanufacturing-strategy>).

<sup>16</sup> This percentage results from dividing the number of high SET manufacturing jobs (i.e., those with 3-digit NAICS codes within the 2-digit range 31–33) in table 6.4D (108,600) by the total number of manufacturing jobs (502,700) in table 6.4B.

## High Science, Engineering, and Technology (SET) Employment Industries

To define high science, engineering, and technology (SET) employment industries, this report uses a modification of the approach employed by the Bureau of Labor Statistics (BLS; Hecker 2005). BLS's approach is based on the intensity of high SET employment within an industry.

High SET employment occupations include scientific, engineering, and technician occupations. These occupations employ workers who possess an in-depth knowledge of the theories and principles of science, engineering, and mathematics, which is generally acquired through postsecondary education in some field of technology. An industry is considered a high SET employment industry if employment in technology-oriented occupations accounts for a proportion of that industry's total employment that is at least twice the average for all industries (i.e., 9.8% or higher in 2002, the data that Hecker used).

In this report, the category "high SET employment industries" refers only to private sector businesses. Each industry is defined by a four-digit code that is based on the North American Industry Classification System (NAICS). The NAICS classifications are periodically revised, thereby affecting the trend data presented in the tables. Relevant NAICS codes were used for the appropriate years of data presented (so in trend analyses, multiple versions of the NAICS codes were used.) The list of high SET employment industries used in this report includes the 48 four-digit codes from the 2002, 2007, 2012, and 2017 NAICS listing below.

### NAICS CODES THAT CONSTITUTE HIGH SET EMPLOYMENT INDUSTRIES

2002 NAICS Code	2007 NAICS Code	2012 NAICS Code	2017 NAICS Code	Industry
1131	1131	1131	1131	Timber track operations
1132	1132	1132	1132	Forest nurseries and gathering of forest products
2111	2111	2111	2111	Oil and gas extraction
2211	2211	2211	2211	Electric power generation, transmission, and distribution
3241	3241	3241	3241	Petroleum and coal products manufacturing
3251	3251	3251	3251	Basic chemical manufacturing
3252	3252	3252	3252	Resin, synthetic rubber, and artificial synthetic fibers and filaments manufacturing
3253	3253	3253	3253	Pesticide, fertilizer, and other agricultural chemical manufacturing
3254	3254	3254	3254	Pharmaceutical and medicine manufacturing
3255	3255	3255	3255	Paint, coating, and adhesive manufacturing
3259	3259	3259	3259	Other chemical product and preparation manufacturing
3332	3332	3332	3332	Industrial machinery manufacturing
3333	3333	3333	3333	Commercial and service industry machinery manufacturing
3336	3336	3336	3336	Engine, turbine, and power transmission equipment manufacturing
3339	3339	3339	3339	Other general-purpose machinery manufacturing
3341	3341	3341	3341	Computer and peripheral equipment manufacturing
3342	3342	3342	3342	Communications equipment manufacturing
3343	3343	3343	3343	Audio and video equipment manufacturing
3344	3344	3344	3344	Semiconductor and other electronic component manufacturing
3345	3345	3345	3345	Navigational, measuring, electromedical, and control instruments manufacturing
3346	3346	3346	3346	Manufacturing and reproducing magnetic and optical media
3353	3353	3353	3353	Electrical equipment manufacturing
3364	3364	3364	3364	Aerospace product and parts manufacturing
3369	3369	3369	3369	Other transportation equipment manufacturing
4234	4234	4234	4234	Professional and commercial equipment and supplies, merchant wholesalers
4861	4861	4861	4861	Pipeline transportation of crude oil
4862	4862	4862	4862	Pipeline transportation of natural gas

### NAICS CODES THAT CONSTITUTE HIGH SET EMPLOYMENT INDUSTRIES, CONTINUED

2002 NAICS Code	2007 NAICS Code	2012 NAICS Code	2017 NAICS Code	Industry
4869	4869	4869	4869	Other pipeline transportation
5112	5112	5112	5112	Software publishers
5161	NA	NA	NA	Internet publishing and broadcasting
NA	519130	519130	519130	Internet publishing and broadcasting and Web search portals
5171	5171	5171	NA	Wired telecommunications carriers
5172	5172	5172	NA	Wireless telecommunications carriers (except satellite)
5173	NA	NA	5173	Telecommunications resellers
5174	5174	5174	5174	Satellite telecommunications
5179	5179	5179	5179	Other telecommunications
5181	NA	NA	NA	Internet service providers and Web search portals
5182	5182	5182	5182	Data processing, hosting, and related services
5211	5211	5211	5211	Monetary authorities, central bank
5232	5232	5232	5232	Securities and commodity exchanges
5413	5413	5413	5413	Architectural, engineering, and related services
5415	5415	5415	5415	Computer systems design and related services
5416	5416	5416	5416	Management, scientific, and technical consulting services
5417	5417	5417	5417	Scientific research and development services
5511	5511	5511	5511	Management of companies and enterprises
5612	5612	5612	5612	Facilities support services
NA	561312	561312	561312	Executive search services
8112	8112	8112	8112	Electronic and precision equipment repair and maintenance

na = not applicable.

## INTRODUCTION

“2016 Global Manufacturing Competitiveness Index.” Deloitte. Accessed July 9, 2019. <https://www2.deloitte.com/global/en/pages/manufacturing/articles/global-manufacturing-competitiveness-index.html>.

Atkinson, Robert D., and John Wu. 2017. *The 2017 State New Economy Index: Benchmarking Economic Transformation in the States*. Washington, D.C.: Information Technology & Innovation Foundation. <https://itif.org/publications/2017/11/06/2017-state-new-economy-index>.

Atkinson, Robert D., and Stephen J. Ezell. 2012. *Innovation Economics: The Race for Global Advantage*. New Haven, Conn.: Yale University Press.

Hecker, Daniel E. 2005. “High-Technology Employment: A NAICS-Based Update.” *Monthly Labor Review*. July: 57–72.

Jones, Charles I. and Williams, John C. 2000. “Too Much of a Good Thing? The Economics of Investment in R&D.” *Journal of Economic Growth*. 5: 65–85.

Jones, Charles I., and John C. Williams. 1998. “Measuring the Social Return to R&D.” *The Quarterly Journal of Economics*. 113, No. 4: 1119-135.

Tassey, Gregory. 2007. *The Technology Imperative*. Cheltenham, UK: Edward Elgar.

United States Department of Commerce. 2012. *The Competitiveness and Innovative Capacity of the United States*. Washington, D.C.: U.S. Dept. of Commerce.

## INDICATORS

The indicators in this report were compiled using existing secondary data sources. The specific measures within the various indicators typically required reconfiguration of existing datasets. Because the measures were derived from a wide range of sources, there are variations in the time frames used and in the specific data that define the indicators being measured. The information below provides detailed notes on data sources used for each indicator. When available, website addresses are provided. Where relevant for an indicator, the citations of publications referenced in the indicator explanation are also presented.

### 1.1: GROSS DOMESTIC PRODUCT (GDP)

State-level GDP data are from the Per Capita Real GDP by State dataset, U.S. Bureau of Economic Analysis (BEA), U.S. Department of Commerce, accessed August 1, 2019, [https://www.bea.gov/iTable/index\\_regional.cfm](https://www.bea.gov/iTable/index_regional.cfm). National-level GDP data are from the World Bank, GDP Per Capita dataset, accessed July 30, 2019, <https://databank.worldbank.org/source/world-development-indicators>. MSA-level GDP data are from the Per Capita Real GDP by Metro Area dataset, U.S. Bureau of Economic Analysis (BEA), U.S. Department of Commerce, accessed August 7, 2019, [https://www.bea.gov/iTable/index\\_regional.cfm](https://www.bea.gov/iTable/index_regional.cfm). Over-time data are adjusted for inflation using the BEA’s GDP deflator.

### 1.2: INCOME

State-level per-capita income data are from the U.S. Bureau of Economic Analysis (BEA), U.S. Department of Commerce, Per Capita Personal Income dataset, accessed August 5, 2019, [http://www.bea.gov/iTable/index\\_regional.cfm](http://www.bea.gov/iTable/index_regional.cfm). State-level median household income data are from the U.S. Census Bureau, American Community Survey, Median Income in the Last 12 Months dataset, 1-Year Estimates, accessed August 5, 2019, <https://www.census.gov/programs-surveys/acs/>. County-level median household income data are from the U.S. Census Bureau, American Community Survey, Median Income in the Last 12 Months dataset, 5-Year Estimates, accessed August 16, 2019, <https://www.census.gov/programs-surveys/acs/>. Over-time data are adjusted for inflation using the Bureau of Labor Statistics (BLS), U.S. Department of Labor, Consumer Price Index (CPI), accessed August 2, 2019, <https://www.bls.gov/cpi/>.

**1.3: AVERAGE ANNUAL WAGE**

State and county-level average annual wage data are from the Bureau of Labor Statistics (BLS), U.S. Department of Labor, Quarterly Census of Employment and Wages program, accessed August 2, 2019, <https://www.bls.gov/cew/downloadable-data-files.htm>. Overtime data are adjusted for inflation using the Bureau of Labor Statistics (BLS), U.S. Department of Labor, Consumer Price Index (CPI), accessed August 2, 2019, <https://www.bls.gov/cpi/>.

**1.4: UNEMPLOYMENT**

State and county-level unemployment data are from the Bureau of Labor Statistics (BLS), U.S. Department of Labor, Local Area Unemployment Statistics, Multi-Screen Data Search, Unemployment Rates, accessed August 12, 2019, <http://data.bls.gov/cgi-bin/dsrv?la>. National-level unemployment data are from the International Labour Organization, Key Indicators of the Labour Market database, Unemployment, total (% of total labor force) (modeled ILO estimate), as provided by the World Bank, accessed July 29, 2019, <https://databank.worldbank.org/source/world-development-indicators>. County-level unemployment data are from the Bureau of Labor Statistics (BLS), U.S. Department of Labor, Local Area Unemployment Statistics, accessed August 19, 2019, <https://www.bls.gov/lau/#tables>.

**1.5: POVERTY**

State-level poverty data are from the U.S. Census Bureau, American Community Survey, S1701: Poverty Status in the Last 12 Months dataset, 1-Year Estimates, accessed August 12, 2019, <http://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml>. County-level poverty data are from the U.S. Census Bureau, American Community Survey, S1701: Poverty Status in the Last 12 Months dataset, 5-Year Estimates, accessed August 19, 2019, <http://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml>.

**1.6: POPULATION GROWTH**

State-level 2018 population data are from the U.S. Census Bureau, Population Division, Current Estimates Data, Annual Estimates of the Resident Population for the United States, Regions, States, and Puerto Rico: April 1, 2010 to July 1, 2018, accessed July 12, 2019, <https://www.census.gov/data/datasets/time-series/demo/popest/2010s-state-total.html>. State-level 2000 population data are from the U.S. Census Bureau, Resident Population of the 50 States, the District of Columbia, and Puerto Rico: Census 2000, accessed July 12, 2019, <https://www.census.gov/data/tables/time-series/demo/popest/intercensal-2000-2010-state.html>. County-level 2000-2018 population data are from the U.S. Census Bureau, accessed August 2, 2019, <https://www2.census.gov/programs-surveys/popest/datasets/2010-2018/counties/totals/co-est2018-alldata.csv>. Historical total population data are from the U.S. Census Bureau, via Carolina Demography, accessed December 1, 2019, <https://www.ncdemography.org/>. Total population projections are from the North Carolina Office of State Budget and Management, Demographic and Economic Analysis Section, via Carolina Demography, accessed December 1, 2019, <https://www.ncdemography.org/>.

**2.1: TOTAL RESEARCH & DEVELOPMENT (R&D)**

State-level total R&D data are from the National Science Board, *Science and Engineering Indicators 2018*, State Indicator S-41: R&D as a Percentage of Gross Domestic Product (Percent) dataset, accessed October 29, 2019, <https://www.nsf.gov/statistics/state-indicators/indicator/rd-performance-to-state-gdp>. National-level total R&D data are from the World Bank, Research & Development Expenditure (% of GDP) dataset, accessed July 30, 2019, <https://databank.worldbank.org/source/world-development-indicators>. Business-level R&D data are an approximation based on mapping the location of all manufacturing establishments in North Carolina, as provided by the Bureau of Labor Statistics (BLS), U.S. Department of Labor, Quarterly Census of Employment and Wages dataset, as provided by the Demand Driven Data Delivery (D4) System, North American Industry Classification (NAICS) codes 31-33 (Manufacturing), Annual by County, accessed October 14, 2019, <https://d4.nccommerce.com/QCEWSelection.aspx?q=524>. University-level R&D data are from the National Science Foundation, National Center for Science and Engineering Statistics, Higher Education R&D Expenditures by Source of Funds dataset, Table 5, accessed June 14, 2019, [https://ncesdata.nsf.gov/herd/2017/html/herd2017\\_dst\\_05.html](https://ncesdata.nsf.gov/herd/2017/html/herd2017_dst_05.html).

National Science Foundation, National Center for Science and Engineering Statistics, National Patterns of R&D Resources, U.S. R&D expenditures, by state, performing sector, and source of funds: 2016, <https://nces.nsf.gov/pubs/nsf19309/assets/data-tables/tables/np17-dst-tab010.xlsx>.

## 2.2: BUSINESS-PERFORMED R&D

State-level business-performed R&D data are from the National Science Board, *Science and Engineering Indicators 2018*, State Indicator S-45: Business-Performed R&D as a Percentage of Private-Industry Output (Percent) dataset, accessed June 14, 2019, <https://www.nsf.gov/statistics/state-indicators/indicator/business-performed-rd-to-private-industry-output>. Business-level R&D data are an approximation based on mapping the location of all manufacturing establishments in North Carolina, as provided by the Bureau of Labor Statistics (BLS), U.S. Department of Labor, Quarterly Census of Employment and Wages dataset, as provided by the Demand Driven Data Delivery (D4) System, North American Industry Classification (NAICS) codes 31-33 (Manufacturing), Annual by County, accessed October 14, 2019, <https://d4.nccommerce.com/QCEWSelection.aspx?q=524>.

National Science Board, *Science and Engineering Indicators 2018*, Chapter 4, "Research and Development: National Trends and International Comparisons," <https://www.nsf.gov/statistics/2018/nsb20181/report/sections/research-and-development-u-s-trends-and-international-comparisons/highlights>.

## 2.3: ACADEMIC SCIENCE & ENGINEERING R&D

State-level academic science & engineering R&D data are from the National Science Board, *Science and Engineering Indicators 2018*, State Indicator S-46: Academic Science and Engineering R&D per \$1,000 of Gross Domestic Product (Dollars) dataset, accessed June 19, 2019, <https://www.nsf.gov/statistics/state-indicators/indicator/academic-rd-per-1000-state-gdp>. University-level R&D data are from the National Science Foundation, National Center for Science and Engineering Statistics, Higher Education R&D Expenditures by Source of Funds dataset, Table 5, accessed June 14, 2019, [https://ncesdata.nsf.gov/herd/2017/html/herd2017\\_dst\\_05.html](https://ncesdata.nsf.gov/herd/2017/html/herd2017_dst_05.html).

National Science Foundation, National Center for Science and Engineering Statistics, National Patterns of R&D Resources, U.S. R&D expenditures, by state, performing sector, and source of funds: 2016, <https://nces.nsf.gov/pubs/nsf19309/assets/data-tables/tables/np17-dst-tab010.xlsx>.

## 2.4: FEDERAL R&D

State-level federal R&D obligations data are from the National Science Board, *Science and Engineering Indicators 2018*, State Indicator S-42: Federal R&D Obligations per Employed Worker (Dollars) dataset, accessed October 29, 2019, <https://www.nsf.gov/statistics/state-indicators/indicator/federal-rd-obligations-per-employed-worker>.

## 2.5: ACADEMIC ARTICLES

State-level academic articles data are from the National Science Board, *Science and Engineering Indicators 2018*, State Indicator S-48: Academic Science and Engineering Article Output per 1,000 Science, Engineering, and Health Doctorate Holders in Academia (Articles) dataset, accessed October 29, 2019, <https://www.nsf.gov/statistics/state-indicators/indicator/academic-se-articles-per-1000-seh-doctorate-holders-in-academia>. County-level academic articles data are from Scopus, Elsevier, accessed November 27, 2019, via special request to Elsevier staff.

## 3.1: SBIR & STTR FUNDING

State-level SBIR data are from the National Science Board, *Science and Engineering Indicators 2018*, State Indicator S-55: Average Annual Federal Small Business Innovation Research and Small Business Technology Transfer Funding per \$1 Million of Gross Domestic Product (Dollars) dataset, accessed October 26, 2019, <https://www.nsf.gov/statistics/state-indicators/indicator/ave-sbir-and-sttr-funding-per-1-million-state-gdp>. City, county, and ZIP Code-level SBIR and STTR data are from SBIR.gov, Awards Search, accessed June 14, 2019, <https://www.sbir.gov/sbirsearch/award/all>.

National Research Council. 2008. *An Assessment of the SBIR Program*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/11989>.

### 3.2: ACADEMIC PATENTS

State-level academic patents data are from the National Science Board, *Science and Engineering Indicators 2018*, State Indicator S-50: Academic Patents Awarded per 1,000 Science, Engineering, and Health Doctorate Holders in Academia (Patents) dataset, accessed November 11, 2019, <https://www.nsf.gov/statistics/state-indicators/indicator/academic-patents-per-1000-seh-doctorate-holders-in-academia>. University-level academic patents data are from the Association of University Technology Managers (AUTM), FY 2017 Licensing Survey, accessed August 27, 2019, <https://autm.net/surveys-and-tools/surveys/licensing-survey/>.

Office of Science, Technology & Innovation. March 2015. Recommendation of the Governor's Innovation-to-Jobs Working Group. The North Carolina Department of Commerce. Available at: <https://www.nccommerce.com/documents/innovation-reports>.

The University of North Carolina. 2013. *Our Time, Our Future: The UNC Compact with North Carolina*. Strategic Directions 2013-2018. Available at [https://www.northcarolina.edu/sites/default/files/strategic\\_directions\\_2013-2018\\_0.pdf](https://www.northcarolina.edu/sites/default/files/strategic_directions_2013-2018_0.pdf).

### 3.3: PATENTS

State-level patents data are from the National Science Board, *Science and Engineering Indicators 2018*, State Indicator S-51: Patents Awarded per 1,000 Individuals in Science and Engineering Occupations (Patents) dataset, accessed August 2, 2019, <https://www.nsf.gov/statistics/state-indicators/indicator/patents-per-1000-se-occupation-holders>. National-level patents data are from the World Intellectual Property Organization (WIPO) IP Statistics Data Center, 2a - Grant for Direct Applications, accessed November 24, 2019, <https://www3.wipo.int/ipstats/index.htm?tab=patent>. National-level GDP data are from the World Bank, GDP (Current, US\$) dataset, accessed November 14, 2019, <https://databank.worldbank.org/source/world-development-indicators>. State-level GDP data are from the Gross Domestic Product by State dataset, U.S. Bureau of Economic Analysis (BEA), U.S. Department of Commerce, accessed November 15, 2019, <https://www.bea.gov/data/gdp/gdp-state>. National-level GDP data are from the World Bank, GDP Per Capita dataset, accessed July 30, 2019, <https://databank.worldbank.org/source/world-development-indicators>. County-level patents data are from the U.S. Patent and Trademark Office (USPTO), Source: U.S. Patent and Trademark Office, via Neo IP Intellectual Property Law Firm and Magic Number, Inc. software., accessed October 28, 2019, <http://neoipassets.com> and <http://magicnumberip.com>.

### 3.4: VENTURE CAPITAL

State-level venture capital data are from the National Science Board, *Science and Engineering Indicators 2018*, State Indicator S-58: Venture Capital Disbursed per \$1 Million of Gross Domestic Product (Dollars) dataset, accessed April 5, 2019, <https://www.nsf.gov/statistics/state-indicators/indicator/venture-capital-per-1-million-state-gdp> and State Indicator S-59: Venture Capital Deals as a Percentage of High Science, Engineering, and Technology Employment Establishments (Percent) dataset, accessed November 11, 2019, <https://www.nsf.gov/statistics/state-indicators/indicator/venture-capital-deals-per-high-set-establishments>. ZIP Code-level venture capital data are from PitchBook Data, Inc., accessed June 18, 2019, <http://pitchbook.com/>.

### 3.5: TECHNOLOGY LICENSE INCOME

State and university-level license income data are from the Association of University Technology Managers (AUTM), FY 2017 Licensing Survey, accessed August 27, 2019, <https://autm.net/surveys-and-tools/surveys/licensing-survey/>. Academic science & engineering R&D data are from the National Science Board, *Science and Engineering Indicators 2018*, State Indicator S-46: Academic Science and Engineering R&D per \$1,000 of Gross Domestic Product dataset, accessed September 13, 2019, <https://www.nsf.gov/statistics/state-indicators/indicator/academic-rd-per-1000-state-gdp>.

Office of Science, Technology & Innovation. March 2015. Recommendation of the Governor's Innovation-to-Jobs Working Group. The North Carolina Department of Commerce. Available at: <https://www.nccommerce.com/documents/innovation-reports>.

The University of North Carolina. 2013. *Our Time, Our Future: The UNC Compact with North Carolina*. Strategic Directions 2013-2018. Available at [https://www.northcarolina.edu/sites/default/files/strategic\\_directions\\_2013-2018\\_0.pdf](https://www.northcarolina.edu/sites/default/files/strategic_directions_2013-2018_0.pdf).

### 3.6: UNIVERSITY STARTUPS

University startup data are from the Association of Association of University Technology Managers (AUTM), FY 2017 Licensing Survey, accessed August 27, 2019, <https://autm.net/surveys-and-tools/surveys/licensing-survey/>. State-level academic science & engineering R&D data are from the National Science Board, *Science and Engineering Indicators 2018*, State Indicator S-46: Academic R&D per \$1,000 of Gross Domestic Product (Dollars) dataset, accessed June 19, 2019, <https://www.nsf.gov/statistics/state-indicators/indicator/academic-rd-per-1000-state-gdp>.

Office of Science, Technology & Innovation. March 2015. *Recommendation of the Governor's Innovation-to-Jobs Working Group*. The North Carolina Department of Commerce. Available at: <https://www.nccommerce.com/documents/innovation-reports>.

The University of North Carolina. 2013. *Our Time, Our Future: The UNC Compact with North Carolina. Strategic Directions 2013-2018*. Available at [https://www.northcarolina.edu/sites/default/files/strategic\\_directions\\_2013-2018\\_0.pdf](https://www.northcarolina.edu/sites/default/files/strategic_directions_2013-2018_0.pdf).

### 4.1: HIGH SCIENCE, ENGINEERING AND TECHNOLOGY (SET) EMPLOYMENT ESTABLISHMENTS AND FORMATIONS

State-level high SET employment establishments data are from the National Science Board, *Science and Engineering Indicators 2018*, State Indicator S-52: High Science, Engineering, and Technology Employment Establishments as a Percentage of All Business Establishments (Percent) dataset, accessed November 3, 2019, <https://www.nsf.gov/statistics/state-indicators/indicator/high-set-to-all-business-establishments>. State-level high SET Employment Business Formations data are from the National Science Board, *Science and Engineering Indicators 2018*, State Indicator S-53: Net Formations of High Science, Engineering, and Technology Employment Establishments as a Percentage of All Business Establishments (Percent) dataset, accessed November 3, 2019, <https://www.nsf.gov/statistics/state-indicators/indicator/high-set-formations-to-all-business-establishments>. High SET employment business establishments by state and county data are from the Bureau of Labor Statistics (BLS), U.S. Department of Labor, Quarterly Census of Employment and Wages program, accessed September 23, 2019, <http://www.bls.gov/cew/datatoc.htm>. The data pertaining to establishments are based on their classification according to the 2017 edition of the North American Industry Classification System (NAICS). See the Appendix for a list of the 48 industries (by 4-digit NAICS code) that are defined as having high SET employment.

### 4.2: HIGH SET EMPLOYMENT

State-level high SET employment data are from the National Science Board, *Science and Engineering Indicators 2018*, State Indicator S-54: Employment in High Science, Engineering, and Technology Employment Establishments as a Percentage of Total Employment (Percent) dataset, accessed November 3, 2019, <https://www.nsf.gov/statistics/state-indicators/indicator/high-set-employment-to-total-employment>. High SET business employment by state and county data are from the Bureau of Labor Statistics (BLS), U.S. Department of Labor, Quarterly Census of Employment and Wages program, accessed September 23, 2019, <http://www.bls.gov/cew/datatoc.htm>. The data pertaining to establishments are based on their classification according to the 2017 edition of the North American Industry Classification System (NAICS). See the Appendix for a list of the 48 industries (by 4-digit NAICS code) that are defined as having high SET employment.

### 4.3: ENTREPRENEURIAL ACTIVITY

State-level entrepreneurial activity data are from the Kauffman Foundation, Kauffman Indicators of Entrepreneurship, accessed March 28, 2019, <https://indicators.kauffman.org/data-table>. State-level opportunity share of new entrepreneurs data are from the Kauffman Foundation, Kauffman Indicators of Entrepreneurship, accessed April 2, 2019, <https://indicators.kauffman.org/data-table>.

#### 4.4: EXPORTS

State-level export data are from the World Institute for Strategic Economic Research (WISER), WISERTrade, State Exports by NAICS database, purchased on July 24, 2019, <http://www.wisertrade.org/home/portal/index.jsp>. State-level GDP data are from the Gross Domestic Product by State dataset, U.S. Bureau of Economic Analysis (BEA), U.S. Department of Commerce, accessed August 7, 2019, <https://www.bea.gov/data/gdp/gdp-state>. National-level export data are from the World Bank, Exports of Goods and Services (% of GDP) dataset, accessed July 30, 2019, <https://databank.worldbank.org/source/world-development-indicators>.

Atkinson, R. D. & Wu, J. J. (November 2017.) *The 2017 State New Economy Index: Benchmarking Economic Transformation in the States*. Information Technology & Innovation Foundation. Available at: <https://itif.org/publications/2017/11/06/2017-state-new-economy-index>.

United States Census Bureau, Foreign Trade Historical Series (Annual goods (BOP basis), services, and total balance, exports and imports, 1960 – present; accessed May 18, 2017), <https://www.census.gov/foreign-trade/statistics/historical/index.html>.

#### 5.1: SCIENCE & ENGINEERING WORKFORCE

State-level science & engineering workforce data are from the National Science Board, *Science and Engineering Indicators 2018*, State Indicator S-32: Individuals in Science and Engineering Occupations as a Percentage of All Occupations (Percent) dataset, accessed November 3, 2019, <https://www.nsf.gov/statistics/state-indicators/indicator/se-occupations-to-all-occupations>.

#### 5.2: EMPLOYED SCIENCE, ENGINEERING AND HEALTH DOCTORATE HOLDERS

State-level employed science, engineering and health doctorate holders data are from the National Science Board, *Science and Engineering Indicators 2018*, State Indicator S-33: Employed Science, Engineering, and Health Doctorate Holders as a Percentage of the Workforce (Percent) dataset, accessed November 3, 2019, <https://www.nsf.gov/statistics/state-indicators/indicator/seh-doctorate-holders-in-workforce>.

#### 5.3: ENGINEERS AS A PERCENTAGE OF ALL OCCUPATIONS

State-level engineers as a percentage of all occupations data are from the National Science Board, *Science and Engineering Indicators 2018*, State Indicator S-38: Engineers as a Percentage of All Occupations (Percent) dataset, accessed November 3, 2019, <https://www.nsf.gov/statistics/state-indicators/indicator/engineers-to-all-occupations>.

#### 5.4: BACHELOR'S DEGREES IN SCIENCE, ENGINEERING AND TECHNOLOGY

State-level bachelor's degrees in science, engineering and technology data are from the National Science Board, *Science and Engineering Indicators 2018*, State Indicator S-19: Bachelor's Degrees in Science and Engineering Conferred per 1,000 Individuals 18–24 Years Old (Degrees) dataset, accessed March 20, 2019, <https://www.nsf.gov/statistics/state-indicators/indicator/se-bachelors-degrees-per-1000-18-24-year-olds>.

#### 5.5: SCIENCE, ENGINEERING, AND TECHNOLOGY DEGREES

State-level science, engineering, and technology degree data are from the National Science Board, *Science and Engineering Indicators 2018*, State Indicator S-20: Science and Engineering Degrees as a Percentage of Higher Education Degrees Conferred (Percent) dataset, accessed March 12, 2019, <https://www.nsf.gov/statistics/state-indicators/indicator/se-degrees-to-all-higher-education-degrees>.

#### 5.6: EDUCATIONAL ATTAINMENT

State-level educational attainment data are from the U.S. Census Bureau, American Community Survey, S1501: Educational Attainment for the Population 25 Years and Over, American Community Survey 1-Year Estimates datasets, accessed May 7, 2019, <http://www.census.gov/programs-surveys/acs/>. County-level educational attainment data are from the U.S. Census Bureau, American Community Survey, S1501 Educational Attainment; North Carolina and all Counties, 2013-2017 American Community Survey 5-Year Estimates dataset, accessed June 19, 2019, <https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml>.

### 5.7: EDUCATIONAL ATTAINMENT OF IN-MIGRANTS

State-level educational attainment of in-migrants data are from the U.S. Census Bureau, American Community Survey, Geographic Mobility in the Past Year by Educational Attainment for Current Residence in the United States, Population 25 Years and Over in the United States, American Community Survey 1-Year Estimates dataset, Table B07009, accessed June 19, 2019, [https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS\\_17\\_1YR\\_B07009&prodType=table](https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_17_1YR_B07009&prodType=table). County-level educational attainment data are from the U.S. Census Bureau, American Community Survey, Geographic Mobility in the Past Year by Educational Attainment for Current Residence in the United States, Population 25 Years and Over in the United States, 2013-2017 American Community Survey 5-Year Estimates dataset, Table B07009, accessed June 19, 2019, [https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS\\_17\\_5YR\\_B07009&prodType=table](https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_17_5YR_B07009&prodType=table).

### 6.1: PUBLIC INVESTMENT IN EDUCATION

State-level elementary and secondary public school current expenditures data are from the National Science Board, *Science and Engineering Indicators 2018*, State Indicator S-10: Elementary and Secondary Public School Expenditures as a Percentage of Gross Domestic Product (Percent) dataset, accessed March 12, 2019, <https://www.nsf.gov/statistics/state-indicators/indicator/public-school-expenditures-to-state-gdp>. State-level appropriations of state tax funds for operating expenses of higher education data are from the National Science Board, *Science and Engineering Indicators 2018*, State Indicator S-26: Appropriations of State Tax Funds for Higher Education as a Percentage of Gross Domestic Product (Percent) dataset, accessed October 14, 2019, <https://www.nsf.gov/statistics/state-indicators/indicator/state-tax-appropriations-for-higher-ed-operations-to-state-gdp>. Authorized appropriations data to University of North Carolina (UNC) institutions are from the NC Office of State Budget and Management, via special request, November 11, 2019.

### 6.2: BROADBAND

State-level data for broadband deployment, fiber to end user connections, and adoption rate are from the Federal Communications Commission, received via special request from the Broadband Infrastructure Office, North Carolina Department of Information Technology on September 25, 2019. County-level broadband subscription rates are from the 2017 American Community Survey, processed by the North Carolina Center for Geographic Information and Analysis for the North Carolina Broadband Infrastructure Office in September 2019. MCNC Broadband Fiber network map obtained from MCNC's website on November 27, 2019, <https://www.mcnc.org/about/ncren-footprint>.

### 6.3: COST OF LIVING INDEX

State-level Cost of Living Index data are from the Council for Community and Economic Research (C2ER), via the AccessNC online data portal operated by the North Carolina Department of Commerce, accessed May 24, 2019, <https://accessnc.opendatasoft.com/explore/?q=cost+of+living&sort=modified>. County-level Cost of Living Index data are from C2ER, County Cost of Living Index, provided by C2ER staff on September 12, 2019, <http://www.coli.org/>.

#### 6.4: INDUSTRY MIX

Industry mix data are from the Economic Modeling Specialists, Inc. (EMSI), <http://www.economicmodeling.com>, accessed on October 11, 2019 by the Labor and Economic Analysis Division at the North Carolina Department of Commerce. EMSI derives its industry employment data by combining covered employment data from the Quarterly Census of Employment and Wages (QCEW) produced by the Bureau of Labor Statistics (BLS) with supplemental estimates from County Business Patterns produced by the U.S. Census Bureau (Census). Non-QCEW employees are based on multiple sources including QCEW, Current Employment Statistics, County Business Patterns, Bureau of Economic Analysis (BEA) State and Local Personal Income Reports, the National Industry-Occupation Employment Matrix, the American Community Survey (ACS) (Census), and Railroad Retirement Board statistics. Self-Employed and Extended Proprietor classes of worker data are primarily based on the ACS, Non-employer Statistics, and BEA State and Local Personal Income Reports. Data from the fourth quarter of 2019 were used to produce the estimates provided in indicator 6.4. Projections for QCEW and Non-QCEW Employees are informed by the National Industry-Occupation Employment Matrix and long-term industry projections provided by individual states. EMSI has a detailed methodology for estimates, including changes to standard QCEW data, such as moving public school employees from the Educational Services sector into Government. Information from EMSI is provided as part of a paid subscription service. The average earnings, also called “Current Total Earnings,” is the total industry earnings for a region divided by number of jobs. It includes wages, salaries, supplements (additional employee benefits), and proprietor income.

Manufacturing industries are defined as those industries whose 2-digit NAICS code ranges from 31-33. The National Science Foundation defines “high science, engineering and technology (SET) employment” industries at the 4-digit NAICS level according to the 2007 NAICS coding scheme. EMSI employment data are reported according to the 2017 NAICS coding scheme. Industries considered “high SET” in this analysis follow the NSF’s classification method, except where adjusted to account for differences between the 2007 and 2017 NAICS coding scheme. State-industry combinations whose employment data are reported as “<10” were adjusted to 0. Job counts, average wages, and location quotients are reported only for those subcategories of each industry that are identified as a “high SET employment” industry. Accordingly, the data reported here at the 3-digit NAICS level may not match similar data for the entire industry defined at the 3-digit NAICS level.

Ezell, S. J. and Atkinson, R. D. April 2011. “The Case for a National Manufacturing Strategy.” Washington, DC: The Information Technology & Innovation Foundation. Available at: <http://www2.itif.org/2011-national-manufacturing-strategy.pdf>.

# ACKNOWLEDGEMENTS

This report is the product of the work, insights, and expertise of the following people:

## PROJECT DIRECTOR

**John Hardin** *Executive Director, NC Board of Science, Technology & Innovation, NC Department of Commerce*

## LEAD RESEARCHERS & AUTHORS

**David Kaiser** *Deputy Director, NC Board of Science, Technology & Innovation, NC Department of Commerce*

**Daniel Smith** *Research Associate, NC Board of Science, Technology & Innovation, NC Department of Commerce*

## CONTRIBUTING RESEARCHERS

**Andrew Berger-Gross** *Senior Economist; Manager, Labor & Economic Analysis Division, NC Department of Commerce*

**Jeff DeBellis** *Director of Economic & Policy Analysis, Labor & Economic Analysis Division, NC Department of Commerce*

**Amy Huffman** *Digital Inclusion and Policy Manager, Broadband Infrastructure Office of the NC Department of Information Technology*

**Joshua Klein** *Research Intern, NC Board of Science, Technology & Innovation, NC Department of Commerce & Undergraduate, Georgetown University*

**Elizabeth Mitchell** *Research Intern, NC Board of Science, Technology & Innovation, NC Department of Commerce & Undergraduate, University of North Carolina at Chapel Hill*

**Tammy Roy Kechout** *Data Analyst, AccessNC, Labor & Economic Analysis Division, NC Department of Commerce*

**Jeffrey Rosenthal** *Senior Workforce Analyst, Labor & Economic Analysis Division, NC Department of Commerce*

**Thomas Slade** *Research Intern, NC Board of Science, Technology & Innovation, NC Department of Commerce & Undergraduate, University of North Carolina at Chapel Hill*

## GRAPHIC DESIGN

**Laura Murray** *Graphic Designer, NC Department of Commerce*

## GEOGRAPHIC INFORMATION SYSTEMS

**Nicole Kennedy** *Applications Technician II, Labor & Economic Analysis Division, NC Department of Commerce*



## NC DEPARTMENT of COMMERCE SCIENCE, TECHNOLOGY & INNOVATION

The mission of the North Carolina Board of Science, Technology & Innovation is to improve the economic well-being and quality of life of all North Carolinians through advancing science, technology, and innovation. Established by statute in 1963, the Board is the longest-operating state-level board of its kind in the nation. The Board works with the North Carolina Governor, General Assembly, and other institutions and organizations to put into place the infrastructure, policies, and programs that keep North Carolina on the cutting edge of science, technology, and innovation.

### MEMBERS

**The Honorable Roy Cooper**, *Governor of the State of North Carolina*

**The Honorable Tony Copeland**, *North Carolina Secretary of Commerce*

**Michael Cunningham**, *Chair, NC Board of Science, Technology & Innovation*

**George Abercrombie**, *Adjunct Professor, Fuqua School of Business, Duke University & former President and Chief Executive Officer, Hoffmann-La Roche, Inc.*

**Ravi Bellamkonda**, *Vinik Dean of the Pratt School of Engineering, Duke University*

**Jason Botts**, *Vice President, Information Technology, Chiltern International*

**Eric Boyette**, *Secretary and State Chief Information Officer, NC Department of Information Technology*

**Bill Brown**, *Co-Founder, 8 Rivers Capital & CEO, NET Power*

**Patricia Brown**, *Executive Vice President and Chief Legal Officer, SAS*

**Judith Cone**, *Vice Chancellor for Innovation, Entrepreneurship & Economic Development, UNC-Chapel Hill*

**Alston Gardner**, *Co-Founder and Member of the Advisory Board, Fulcrum Equity Partners*

**Algie Gatewood**, *President, Alamance Community College*

**Catherine Horne**, *President and CEO at Discovery Place, Inc.*

**Jeff Kaplan**, *Director, Venture Asheville*

**Olga Pierrakos**, *Founding Chair and Professor, Department of Engineering, Wake Forest University*

**Michael Quillen**, *Vice President of Academic Programs, Rowan-Cabarrus Community College*

**Sean Patrick Tario**, *CEO, Open Spectrum, Inc.*

**Claudia Walker**, *Teacher, Murphey Traditional Academy, Guilford County Schools*

**Rick Webb**, *Managing Director, Health and Public Services, Accenture*

### EXECUTIVE STAFF

**John Hardin**, *Executive Director*

**David Kaiser**, *Deputy Director*

**Ruth Maitz**, *Executive Assistant*

<https://www.nccommerce.com/sti>