2021

TRACKING INNOVATION

North Carolina Innovation Index

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

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NC DEPARTMENT of COMMERCE
SCIENCE, TECHNOLOGY & INNOVATION

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

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ROY COOPER
Governor

MACHELLE BAKER SANDERS
Secretary

DR. JOHN HARDIN
Executive Director

To the Citizens of North Carolina,

It is our pleasure to share with you the 2021 *Tracking Innovation* report, produced by the North Carolina Board of Science, Technology & Innovation and the North Carolina Department of Commerce. This periodic report tracks North Carolina's performance in the innovation economy across 39 measures and compares them to national trends. We are pleased to announce that the state maintains a strong position and has improved on several key measures.

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, advance national security, and drive future economic growth and well-being. Further, innovative regions are better equipped to resist and recover from economic shocks, such as those caused by the COVID-19 pandemic. 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.

In each of these areas, North Carolina has advanced to meet the national average and should continue to boost these three factors to further drive its future economic gains and prosperity. As shown in this latest report, North Carolina has the raw materials to continue to do just that.

As proof of its resilience, North Carolina grew to the 11th largest economy in the United States and maintained the 22nd largest in the world in 2020. 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.

Machelle Baker Sanders
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

EXECUTIVE SUMMARY

Overview

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

This 2021 report, the most extensive since the series' inception, measures the health of North Carolina's innovation economy. It tracks North Carolina's performance across 39 innovation measures weighed against that of the United States overall, six key comparison states (California, Massachusetts, Georgia, Virginia, Colorado, Washington), and 20 leading countries. These measures provide insights into the links between innovation, resources, and economic results in the North Carolina economy.

STATEWIDE SUMMARY FINDINGS

During the most recent time period for which data are available across the report's 39 measures, North Carolina's average rank among the 50 U.S. states is 20th based on these measures **[Statewide Summary Chart,** next page**]**.[2,3] Its highest single rank is 5th; its lowest single rank is 48th; its most common rank is 23rd. Additionally, on 17 of the 39 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 seven 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 28 measures it improved, on seven it declined, and on four it stayed the same or could not be measured over time.[4] Overall, North Carolina's statewide innovation ecosystem is moderately healthy, has improved since the early 2000s, and at a rate essentially the same as the U.S as a whole.

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 and not keeping pace with the national average. North Carolina's unemployment rate is consistent with the national average, and its poverty rate is above the national average.
- **Research & Development (R&D):** North Carolina excels at academic R&D, with a level well above the national average, but the total level of the state's R&D, particularly that performed by business, is slightly below the national average and positions the state in a moderately strong position to fuel and sustain economic growth. Both academic and business R&D have grown faster than the national average since 2000.
- **Commercialization:** North Carolina organizations, particularly its academic institutions, generate significant intellectual property. While university start-up company activity has improved to levels above the national average, other innovation commercialization activities remain below average and must be stronger to realize the full economic and social benefits of that intellectual property.
- **Innovative Organizations:** North Carolina has a higher concentration of high science, engineering and technology sector (SET) businesses, which are increasing in employment and have wages that are above the national average for all industries, but has average levels of entrepreneurial activity.
- **Education & Workforce:** North Carolina has a well-educated and well-trained science & engineering workforce, including at the more-advanced educational levels, similar to the national average, but its universities are graduating a lower proportion of science and engineering students. The overall educational attainment level of its residents is at the national average, buy will likely improve further as the state receives an influx of college-educated adults whose share of the total state population is above the national average.

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 though the benefits of innovation. Efforts to extend the benefits of innovation throughout the state should continue.

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[1] The NC Board of Science, Technology & Innovation has produced seven innovation indexes during the last 21 years, in 2000, 2003, 2008, 2013, 2015, 2017, and 2019.

[2] In the 2019 version of this report, North Carolina's average rank was 21st; in the 2017 and 2015 versions, North Carolina's average rank was 23rd; in the 2013 version North Carolina's average rank was 24th. However, one measure was removed in the current report and two were modified (measures 4.1 and 4.2), so caution should be taken when making comparisons to previous reports; due to changes in methodology, change in ranks cannot be positively attributed to changes in the economic conditions or structure of a state's economy. The rankings are for the state *overall*; for more detail on performance by NC county, which varies considerably across counties, 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.

[3] On a nominal basis, not adjusting measures for size or any other factor, North Carolina ranks 10th out of all 50 states, which is consistent with its population (9th largest) and GDP (11th).

[4] Historical data are unavailable for four of the 39 measures.

Statewide Summary of Measures

Statewide Summary Chart

MEASURE	N.C. RANK	N.C. % OF U.S. AVERAGE VALUE	PERFORMANCE OVER TIME[1] N.C.	PERFORMANCE OVER TIME[1] U.S.
ECONOMIC WELL-BEING & QUALITY OF LIFE	**30**			
Per Capita Gross Domestic Product, 2020	31	86%	↑	↑
Per Capita Income, 2020	40	85%	↑	↑
Median Household Income, 2019	39	87%	↑	↑
Average Annual Wage, 2020	23	88%	↑	↑
Unemployment Rate, 2020	26	90%	↑	↑
Percentage of Citizens in Poverty, 2019	39	111%	↓	↓
Population growth, 2000-2020	10	167%	↑	↑
RESEARCH & DEVELOPMENT	**14**			
Total R&D Expenditures as a Percentage of GDP, 2018	13	93%	↑	↑
Business-Performed R&D as a Percentage of Private-Industry Output, 2019	11	98%	↑	↑
Academic Science & Engineering R&D per $1,000 of State GDP, 2019	5	148%	↑	↑
Federal R&D Obligations per Employed Worker, 2019	23	57%	↑	↑
Academic S&E Article Output per 1,000 SEH Doctorate Holders in Academia, 2019	16	100%	↑	↑
COMMERCIALIZATION	**16**			
Average Annual SBIR & STTR Funding per $1 Million of GDP, 2016-18	16	109%	↑	↑
Academic Patents Awarded per 1,000 S&E Doctorate Holders in Academia, 2019	19	79%	↑	↑
Patents Awarded per 1,000 Individuals in S&E Occupations, 2020	24	71%	↑	↑
Venture Capital Dispersed per $1 Million of GDP, 2019	19	40%	↑	↑
Venture Capital Dispersed per Venture Capital Deal, 2019	19	66%	↑	↑
Academic License Inc. (Gross) as a Percentage of Academic R&D Expend., 2018-2019	12	61%	N/A	N/A
Academic License Inc. (Running) as a Percentage of Acad. S&E R&D Expend., 2018-2019	13	63%	↓	↓
Avg. Number of University Startups Formed per $1M of Academic S&E R&D Expenditures, 2018-2019	8	143%	↑	↑
INNOVATIVE ORGANIZATIONS	**21**			
High SET Employment Establishments as Percentage of All Business Establishments, 2020	10	121%	↑	↑
Employment in High SET Employment Establishments as a Percentage of Total Employment, 2020	14	101%	↑	↑
Average Monthly Number of Entrepreneurs per 100,000 People, 2018-2020	30	82%	↓	↑
Average Opportunity Share of New Entrepreneurs, 2018-2020	20	106%	↑	↓
Exports as a Percentage of GDP, 2020	32	71%	↓	↓
EDUCATION & WORKFORCE	**21**			
Individuals in S&E Occupations as a Percentage of the Workforce, 2020	16	101%	↑	↑
Employed SEH Doctorate Holders as a Percentage of the Workforce, 2019	17	98%	↑	↑
Engineers as a Percentage of All Occupations, 2019	26	86%	↑	↑
Bachelor's Degrees in S&E Conferred per 1,000 Individuals 18–24 Years Old, 2019	33	90%	↑	↑
Science & Engineering Degrees as a Percentage of Higher Education Degrees Conferred, 2019	14	105%	↑	↑
Educational Attainment of Residents Aged 25 and Over (Composite Score), 2019	23	99%	↑	↑
Average Years of Education Among In-Migrants, 2019	22	100%	↑	↑
In-Migration of College Educated Adults as a Percentage of Total State Population, 2019	18	124%	↑	↑
ENVIRONMENT & INFRASTRUCTURE	**20**			
Elementary & Secondary Public School Current Expend. as a Percentage of State GDP, 2018	48	81%	↓	↓
Approp. of State Tax Funds for Higher Education as a Percentage of State GDP, 2019	5	179%	↓	↓
Broadband Deployment at 25 Mbps/3 Mbps or Faster, 2019	28	100%	N/A	N/A
Broadband Adoption Rate 25 Mbps/3 Mbps or Faster, 2019	17	104%	N/A	N/A
Cost of Living Index, 2021	13	92%	N/A	N/A
Manufacturing GDP a Percentage of State GDP, 2020	7	150%	↓	↓
AVERAGE N.C. RANK ACROSS ALL MEASURES	**20[2]**			

↑ Improving ↓ Worsening[3]

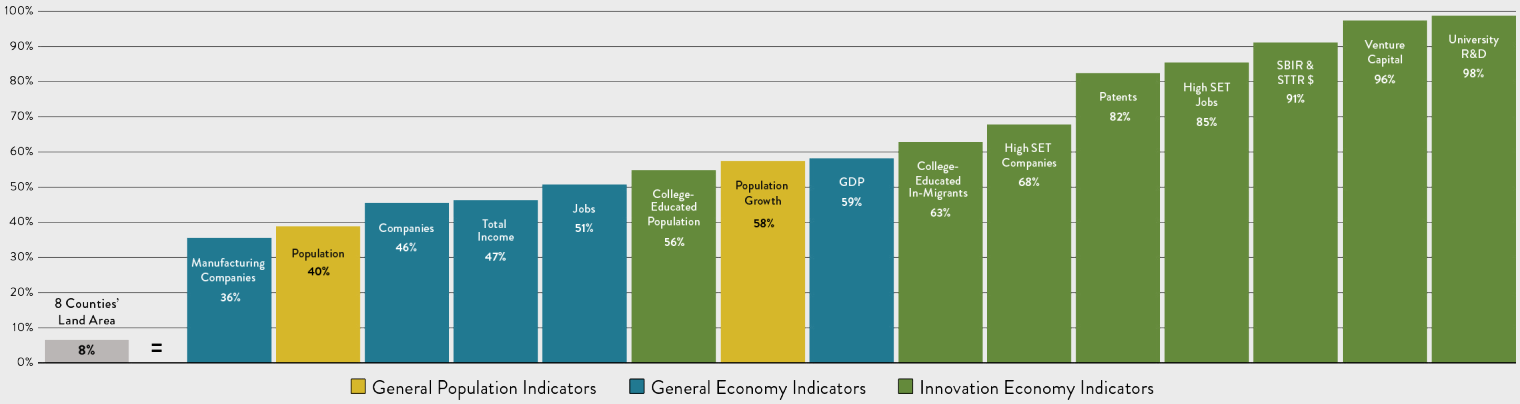
[1] For most measures, "over time" refers to the period between the year 2000 and the year listed to the right of the measure. In the rare cases when data were not available starting in 2000 for a measue, the starting year is typically few years after 2000.

[2] Assumes measures are weighted equally.

[3] For the Unemployment Rate and Percentage of Citizens in Poverty, increases represent worsening, while decreases represent improving.

County-Level Summary of Key Measures

County Summary Key Measures



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

At the county level, 15 key measures reveal differences important for further understanding North Carolina's overall performance and by local levels within the state **[County Summary Key Measures, *above*]**.[5] Specifically, among North Carolina's 100 counties, 8 that are highly populated and/or are home to major research universities (Wake, Mecklenburg, Guilford, Forsyth, Durham, Buncombe, New Hanover, and Orange) represent just 8 percent of the state's land area but account for disproportionally larger shares of the state's population, economy, and innovation assets and activities.[6]

In terms of *General Population*, those 8 counties represent 40 percent of the state's current population and 58 percent of the state's population growth between 2000 and 2020.[7] In terms of the General Economy, those 8 counties represent larger shares—they hold 36 percent of the state's manufacturing companies, 46 percent of the state's companies, 47 percent of the state's total income, 51 percent of its jobs, and 59 percent of its GDP. And in terms of the Innovation Economy, those 8 counties represent even larger shares—56 percent of the state's college-educated population, 63 percent of its college-educated in-migrants, 68 percent of the state's high SET companies, 82 percent of the state's patents, 85 percent of the state's high SET jobs, 91 percent of the state's SBIR/STTR grants, 96 percent of the state's venture capital, and 98 percent of the state's university R&D.

More specifically, 3 counties in the Research Triangle region (Wake, Durham, and Orange counties) account for an average of 42 percent of North Carolina's totals across all 15 key measures, and Wake is the only county with more than 5 percent share in each measure **[County Shares of Key Measures, *below*]**.

County Shares of Key Measures[8]

County	Mfg. Co.s	Pop.	Total Income	Co.s	Jobs	College-Ed. Pop.	Pop. Growth	GDP	College-Ed. In-migrants	High SET Co.s	Patents	High SET Jobs	SBIR & STTR $	Venture Capital	Univ. R&D	NC Total Share	NC Cumulative Share
Wake	8%	11%	14%	13%	13%	17%	21%	15%	18%	24%	42%	27%	23%	62%	16%	**22%**	**22%**
Mecklenburg	10%	11%	14%	14%	16%	15%	18%	20%	20%	20%	11%	29%	1%	13%	2%	**14%**	**36%**
Durham	2%	3%	3%	3%	5%	5%	4%	7%	7%	6%	9%	13%	37%	20%	37%	**11%**	**47%**
Orange	1%	1%	2%	1%	2%	2%	1%	2%	4%	3%	7%	1%	24%	1%	34%	**6%**	**52%**
Guilford	6%	5%	5%	5%	6%	6%	5%	6%	4%	5%	5%	6%	1%	0%	2%	**5%**	**57%**
Forsyth	3%	4%	4%	3%	4%	4%	3%	4%	3%	3%	5%	3%	2%	1%	7%	**4%**	**60%**
Buncombe	4%	3%	3%	3%	3%	3%	3%	3%	3%	4%	2%	2%	2%	0%	0%	**2%**	**63%**
New Hanover	2%	2%	2%	3%	3%	3%	3%	2%	3%	3%	2%	3%	0%	0%	1%	**2%**	**65%**
Total	**36%**	**40%**	**47%**	**46%**	**51%**	**56%**	**58%**	**59%**	**63%**	**68%**	**82%**	**85%**	**91%**	**96%**	**98%**		

General Population Indicators General Economy Indicators Innovation Economy Indicators

[5] Not all of the report's 39 indictors are available at the county level. The 15 key measures 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.

[6] 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. Each of the counties beyond those 8 accounts for less than 2 percent of the state's total value on those measures, with the majority of counties representing far less than 1 percent. The value of 2 percent was used as a breakpoint to determine which counties to include because 2 percent is twice the 1 percent share each county represents among the total number (100) of counties in the state.

[7] Between 2000 and 2030, the 8 counties combined are expected to represent as much as 54 percent of the state's population growth, suggesting the disproportionate findings by locale will continue and possibly increase over time.

[8] This table provides a county-level breakout of the eight counties whose aggregated values are presented in the County Summary chart above.

County-Level Summary of Key Measures

Counties Performing Above the U.S. Average on Key Measures

County	College-Educated In-migrants / Total State Population	College-Educated Population / Total State Population	High SET Emp. Estab.s / Total Estab.s	Median Household Income	University R&D / GDP	Patents / GDP	SBIR-STTR / GDP	Per Capita GDP	High SET Jobs	VC / GDP	Total Measures
Wake	■	■	■	▒	■	■	■	▒	■	■	10
Durham	■	■	■		■	▒	■	■	■	▒	9
Orange	■	■	■	▒	■	■	■				7
Mecklenburg	■	▒	▒	▒				■	▒		6
Union	▒	▒	▒	▒							4
Chatham		▒	▒	▒		■					4
Buncombe	■	▒	▒								3
New Hanover	▒	▒	▒								3
Iredell	▒		▒				■				3
Pitt	▒	▒			▒						3
Moore	■	▒									2
Currituck	▒			▒							2
Polk	▒					■					2
Transylvania	▒										2
Watauga	▒	▒									2
Dare	▒	▒									2
Guilford	▒	▒									2
Cabarrus		▒		▒							2
Forsyth		▒			■						2
Total Counties	16	16	9	7	5	5	4	3	3	2	19

■ At least 50% above the U.S. average ▒ Greater than 25% but less than 50% above the U.S. average ▒ Less than 25% greater than the U.S. average

General Population Indicators General Economy Indicators Innovation Economy Indicators

This region is notable for the high number of research universities, as indicated by academic R&D expenditures and federal funding for science and technology small businesses, many of which are university spinouts. Despite higher levels of academic R&D in Durham and Orange counties, more science and technology businesses are located in Wake County, where venture capital investments are highly concentrated (62 percent of state total) along with patenting activity (42 percent). Mecklenburg County maintains large shares of science and engineering firms, jobs, patent activity, venture capital, and the highest share of the state's economic activity, but has much less academic R&D and federal funding for commercialization of innovative technologies.

Relative to their populations, the Piedmont-Triad counties (Guilford and Forsyth), Buncombe County, and New Hanover County maintain high shares of SET establishments and employment, intellectual property generation, and an educated workforce. At the same time, these areas have less SBIR/STTR funding, venture capital investments, and academic research activities (with the notable exception of Wake Forest University in Forsyth County). The foundation exists in these emerging counties outside the Triangle to grow significant innovative, entrepreneurial ecosystems, however, and a focused, sustained effort to marshal their assets and address gaps has strong potential to broaden North Carolina's innovation strengths beyond the Research Triangle region.

When county performance is measured not solely by its share of the state total but instead relative to the U.S. average, a larger number of counties show strengths **[Counties Performing Above the U.S. Average on Key Measures,** *above***]**.[9] Specifically, 19 counties perform above the U.S. average on two or more key measures.

[9] All measures in this table are normalized (as ratios or percentages) by a factor, thus enabling an "apples to apples" comparison. Educational measures are normalized by county population; high SET companies and jobs are relative to total companies and jobs within a county, respectively, income is median household income; and the remainder of the measures are relative to county-level Gross Domestic Product.

County-Level Summary of Key Measures

As such, this listing expands beyond the top 8 counties to include those that may not hold the highest share of the state's resources but that perform above expectations (or have the potential to) given their size. This is a measure of how concentrated or strong certain factors are within each county.

In general, these additional counties are characterized by their proximity to metropolitan cores like Charlotte (Union, Iredell, Moore, and Cabarrus) and Durham-Chapel Hill (Chatham). While Moore and Cabarrus Counties are notable for their educated populations or higher-than-average income, Union and Iredell counties contain relatively high concentrations of technology-based businesses conducting research and development to drive their local innovation economies.

Smaller counties with a relatively large academic presence also show strengths, such as Pitt County, home to East Carolina University, and Watauga, home to Appalachian State University. A greater portion of Pitt County's local economic productivity is generated by academic research and development, because of ECU's size and medical school, whereas Watauga County has a relatively well-educated population but research and development activity below the U.S. average. Other counties with key measures above the U.S. average are primarily those with tourism-based economies and high levels of retirees, which contribute to higher educational attainment and income levels per household (e.g., Currituck, Dare, and Transylvania Counties).

Other counties perform above expectations (e.g., Iredell County in SBIR/STTR funding, and Chatham County in patent activity), but factors like high SET jobs and venture capital remain highly concentrated in the Research Triangle. These findings indicate that other regions with emerging innovation economies would benefit from a larger supply of high-SET workers and additional sources of capital to drive and sustain economic growth and resiliency.

Together, these county level differences reveal that North Carolina is a tale of two innovation economies: One economy is based primarily in 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. The more detailed 39 measures that follow in the body of this report provide a strong, multilevel basis for that understanding.

Implications & Priorities

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. Business-performed R&D in NC has accelerated faster than the U.S. average but has recently slowed down to a value just below average. One way North Carolina businesses could improve further 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.[10] 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, such as data science and data analytics. 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, and preferably greater than, 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 throughout the state.

[10] For example, the One North Carolina Small Business Program, administered by the North Carolina Board of Science, Technology & Innovation, awards state-funded Incentive or Matching grants to North Carolina Small Businesses that have applied for or won, respectively, highly competitive Phase I 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.[1] 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.[2] Put another way, between one-third to one-half of economic growth in the United States can be attributed to innovation.[3] 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.[4]

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.[5, 6] 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* 2021?

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.[7] 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.

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 1932

[1] For a review of these studies, see Tassey 2007, Chapter 3.

[2] Jones and Williams 1998, 2000.

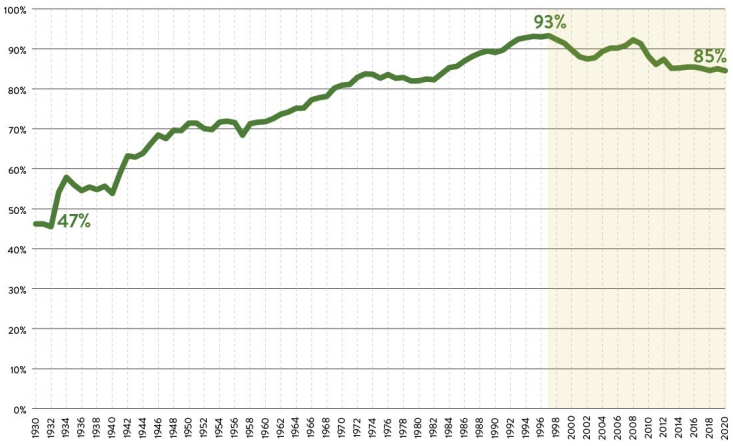
[3] U.S. Department of Commerce 2012.

[4] Hecker 2005.

[5] Atkinson and Ezell 2012.

[6] Atkinson and Foote 2020.

Figure 1 *N.C. Per Capita Income as share of U.S. Per Capita Income, 1930-2020*



Source: U.S. Bureau of Economic Analysis.

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% in 2020, the latest year for which data are available.

Thus, ensuring proper infrastructure and resources for innovation is important not just for sparking economic well-being 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* 2021?

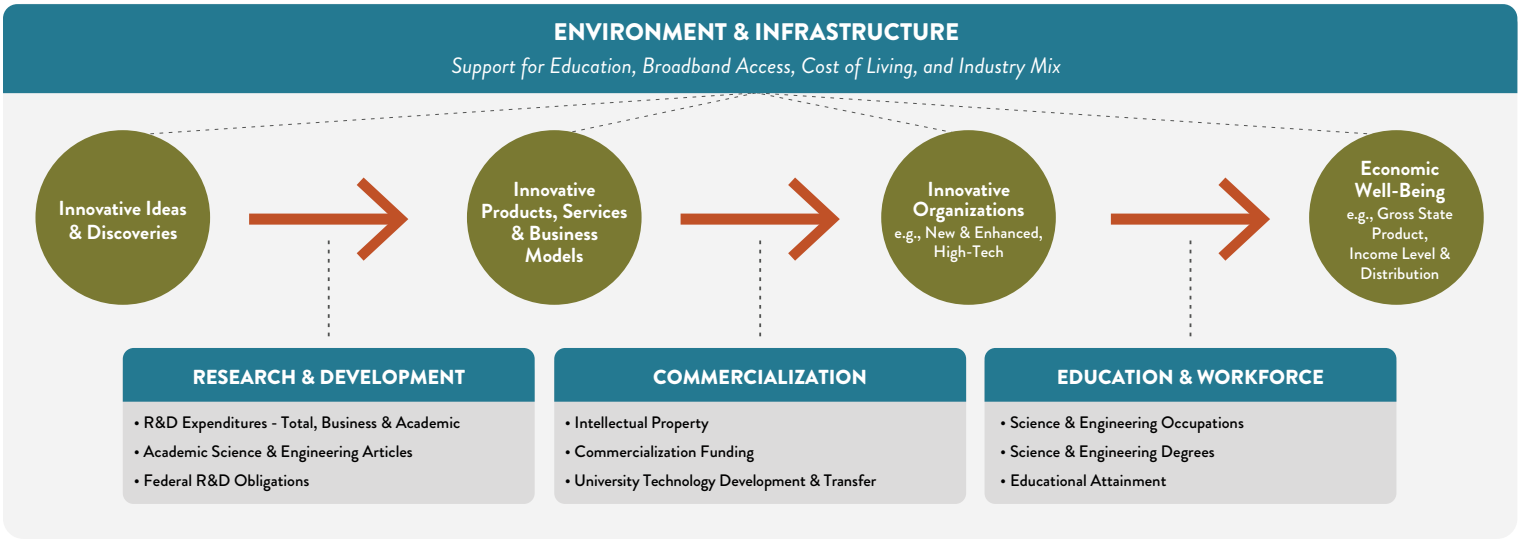
The goal of *Tracking Innovation 2021* is to provide that information in a systematic and accessible format, and therefore to help inform science, technology, and innovation planning and policy at all levels throughout the state. As a follow-up to previous reports tracking North Carolina's innovation performance,[7] 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 39 measures are summarized under 32 broad indicators of innovation, technology, and economic well-being. Each of the 39 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.

[7] The NC Board of Science, Technology & Innovation has produced seven innovation indexes during past 21 years, in 2000, 2003, 2008, 2013, 2015, 2017, and 2019. 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 2 *Innovation Ecosystem*



WHAT IS THE METHODOLOGY OF *TRACKING INNOVATION* 2021?

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.[8] It also compares these indicators on multiple dimensions—spatially & temporally[9]—to generate a rich and comprehensive understanding of the health of North Carolina's innovation ecosystem.[10]

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;[11]
- 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.

[8] This acknowledges the oft-cited aphorism that "Not everything that can be measured matters, and not everything that matters can be measured."

[9] 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 2018, 2019, or 2020. For virtually all the indicators, there is a one- to three-year lag time between the current year (2021) 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.

[10] 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.

[11] One state-level measure is a three-year average from 2016 to 2018, but all others are from 2018 or later. Some county-level measures use a five-year average from 2015 to 2019.

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)[12]

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.[13] 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.[14]

INTERNATIONAL & WITHIN-NORTH CAROLINA COMPARISONS

When available, international data (in the form of a selected set of 20 leading comparison countries)[15] 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.[16] 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.[17]

[12] 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.

[13] Line charts including all 50 states are too detailed to interpret meaningfully.

[14] 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).

[15] 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*.33)+(8*.33)+(1.5*.33)=3.5; similarly, China, for example, ranks 17th, with an average ranking of 23.5 across the three factors (2*.33)+(67*.33)+(1.5*.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.

[16] 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.

[17] 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.[18] 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 25 of the 39 measures), 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.

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

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ECONOMIC WELLBEING

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 9th 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 2020; since 2000, the per capita GDP of all but one of North Carolina's MSAs has increased at a rate slower than the U.S. average.

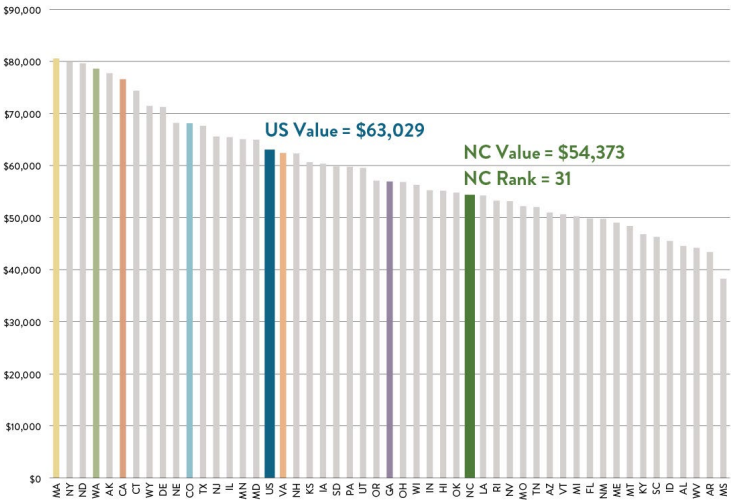
INDICATOR 1.1 OVERVIEW

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.[1] Although GDP is influenced by a wide range of factors—many of which are unrelated to the 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?

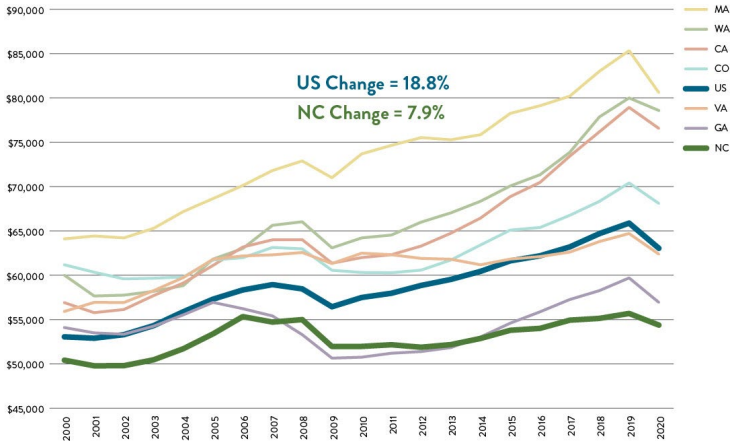
In 2020, North Carolina's per capita GDP of $54,373 was below the national average ($63,029) and below the midpoint of the individual state distribution, ranking 31st overall **[1.1A]**. All the comparison states except Georgia and Virginia had an average per capita GDP above the national average. Since 2000, inflation-adjusted per capita GDP has increased in North Carolina by 7.9 percent. This percentage increase is slower than the 18.8 percent growth rate for the nation **[1.1B]**. Indeed, North Carolina has fallen from the 21st-ranked state in per capita GDP in 2000 to 31st in 2020. Among the comparison states, Virginia (11.6 percent), Colorado (11.3 percent), and Georgia (5.2 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, 2020*



Source: U.S. Bureau of Economic Analysis.

1.1B *Per Capita Gross Domestic Product, Comparison States, 2000-2020*



Source: U.S. Bureau of Economic Analysis.

Note: Adjusted for Inflation (2020 Dollars).

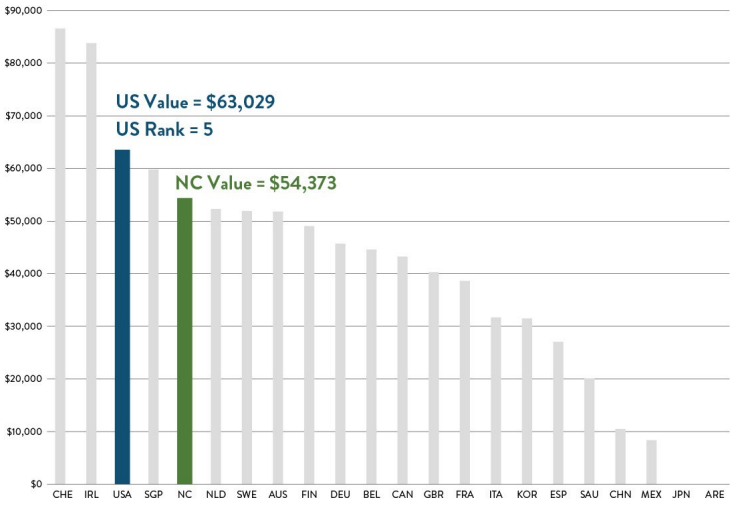
[1] For the purposes of this report, the term "gross domestic product (GDP)" is used as a general counterpart to the more specific terms "gross state product (GSP)" at the state level, "gross regional product (GRP)" at the regional level, and "gross metro product (GMP)" at the metropolitan statistical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

Indicator 1.1: Gross Domestic Product (GDP)

Internationally, U.S. per capita GDP was the 5th highest in the world in 2020 **[1.1C]**. Data for Japan and United Arab Emirates were unavailable at the of this report but have ranked behind the U.S. since at least 2006. The four countries ahead of the U.S. (Luxembourg, Switzerland, Ireland, and Norway) have unique economies (often heavily dependent on native natural resources or have small populations), however, which partially explains their higher per capita GDP levels. In comparison with top foreign countries, North Carolina's per capita GDP ranks approximately 9th overall, between that of the Netherlands and Iceland. While highly populated countries such as China and Mexico have large absolute GDPs, their per capita GDPs remain relatively small, ranking 53rd and 63rd, respectively.

Since 2000, 4 of the 18 comparison countries for which data were available had slower growth rates in per capita GDP than the U.S. (Mexico, Saudi Arabia, Italy, and the United Kingdom). The growth of all other comparison countries (87% on average) was much faster than the U.S. (20.2%) and N.C. (7.9%). **[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 2020 the per capita GDP of two countries (Switzerland and Ireland) had risen to be higher than both the U.S. and North Carolina's values, and the per-capita GDP of Singapore had risen to be below the U.S.'s but above North Carolina's. While most countries experienced downturns in per capita GDP between 2019 and 2020 (-6.2% on average), the U.S. and N.C. were relatively resilient with decreases of -3.8% and -2.4%, respectively. Switzerland, Ireland, and China all experienced growth between 2019 and 2020, with China's per capita GDP growing rapidly since 2000 at a rate of 470% overall.

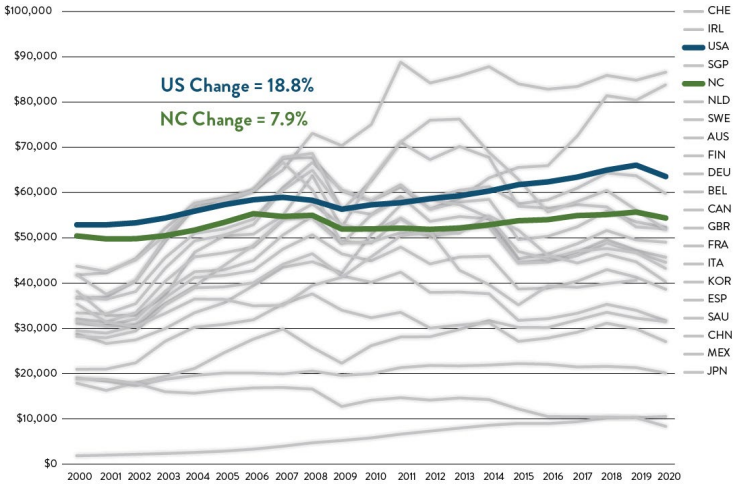
1.1C *Per Capita Gross Domestic Product, Comparison Countries, 2020*



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

Note: 2020 data for JPN and ARE not available.

1.1D *Per Capita Gross Domestic Product, Comparison Countries, 2000-2020*



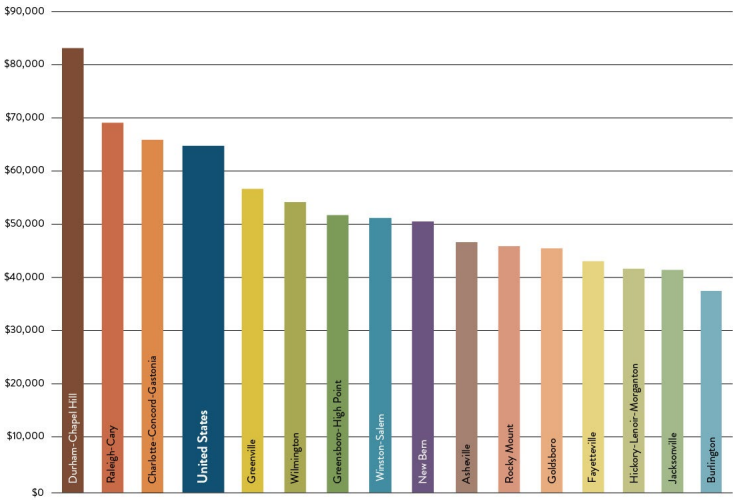
Source: World Bank, World Development Indicators, U.S. Bureau of Economic Analysis.

Note: Adjusted for inflation (2020 U.S. dollars). ARE historical data not included because GDP deflator was not available.

Indicator 1.1: Gross Domestic Product (GDP)

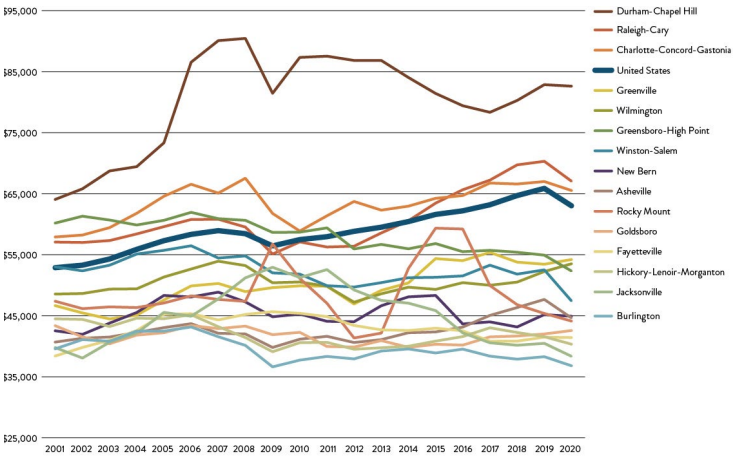
Within North Carolina, three Metropolitan Statistical Areas (MSAs)—Durham-Chapel Hill, Raleigh-Cary, and Charlotte-Concord-Gastonia—have higher per capita GDPs than the U.S. average in 2020 **[1.1E]**. GDP is even more concentrated than indicated by MSA-level data, as only three counties have a per capita GDP above the U.S. average: Durham, Mecklenburg and Wake **[1.1G]**. While three MSAs rank above the U.S. average value of per capita GDP, only the Durham-Chapel Hill MSA increased at a rate (29.0%) higher than the U.S. average (19.2%) between 2000 and 2020 **[1.1F]**. Other large North Carolina MSAs such as Raleigh-Cary and Charlotte-Concord-Gastonia increased by 17.5 percent and 13.1 percent, respectively. Greenville and Wilmington MSAs also experienced per capita GDP growth rates above 10 percent (16.2% and 10.2 %, respectively), but 7 out of 15 North Carolina MSAs decreased in per capita GDP over the same period.

1.1E *Per Capita Gross Domestic Product, N.C. MSAs, 2020*



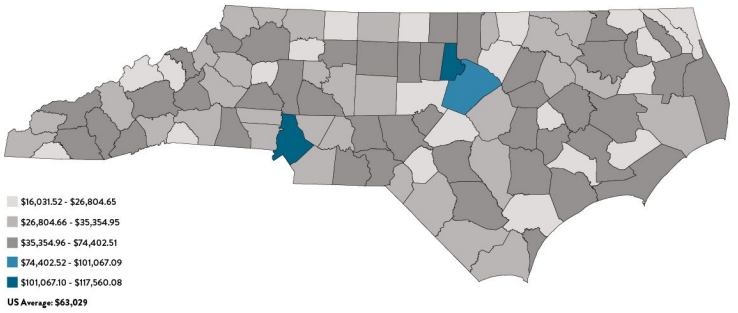
Source: U.S. Bureau of Economic Analysis, U.S. Census Bureau

1.1F *Per Capita Gross Metro Product, N.C. MSAs, 2001-2020*



Note: Adjusted for inflation (2020 dollars).

1.1G *Per Capita Gross Domestic Product, N.C. Counties, 2020*



Source: U.S. Bureau of Economic Analysis, U.S. Census Bureau.

Note: Adjusted for inflation (2020 dollars). Counties appearing in blue are above the U.S. average.

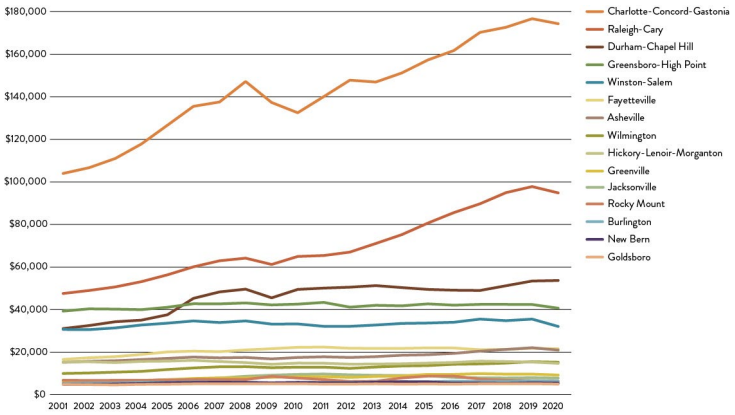
Indicator 1.1: Gross Domestic Product (GDP)

In terms of total GDP, two NC MSAs combined—Charlotte-Concord-Gastonia (34 percent) and Raleigh-Cary (19 percent)—account for more than half (53 percent) of the state's GDP accounted for by MSAs **[1.1H]**. The next three MSAs combined—Durham-Chapel Hill (11 percent), Greensboro-High Point (8 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: Fayetteville (4 percent), Asheville (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 95 percent. The remaining four MSAs (Rocky Mount, Burlington, New Bern, and Goldsboro) each account for 1 percent of the state's GDP accounted for by MSAs.

WHAT DOES THIS MEAN FOR NORTH CAROLINA?

Trends in per capita GDP in North Carolina are a cause for concern. As of 2020, 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, 2001-2020*



Note: Adjusted for inflation, 2020 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.

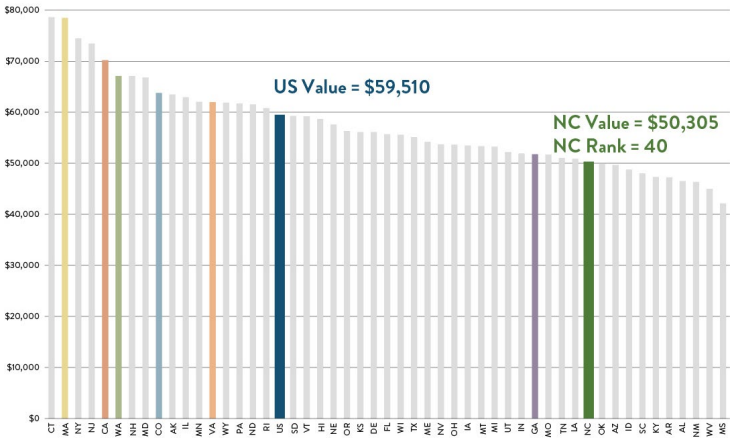
INDICATOR OVERVIEW

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.[1] 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?

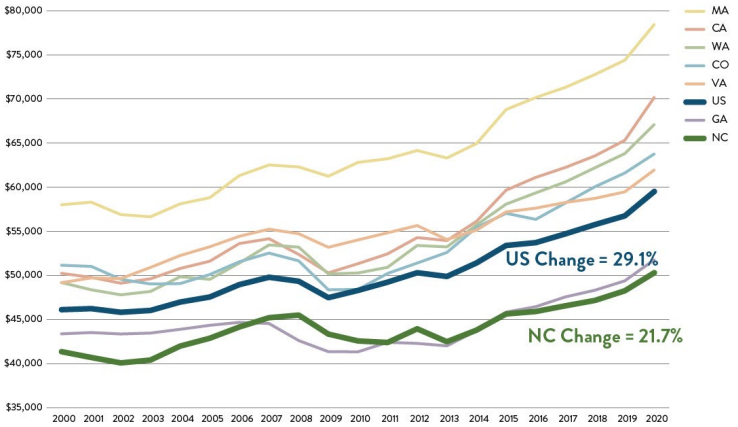
Per capita personal income in North Carolina was $50,305 in 2020 **[1.2A]**. This income is 85 percent of the national per capita personal income ($59,510) and places North Carolina as the 40th-highest performing state in the country. North Carolina's per capita personal income ranks below that of all the comparison states, having increased over the past 20 years but at a slower rate. Since 2000, the inflation-adjusted per capita personal income in North Carolina increased by 21.7 percent, while U.S. average per capita income increased by 29.1 percent **[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 California by 39.8%, Washington by 36.5 percent, and Massachusetts by 35.2 percent,. Georgia was the only comparison state for which the per capita income increased at a slower rate than North Carolina.

1.2A *Per Capita Income, All U.S. States, 2020*



Source: U.S. Bureau of Economic Analysis.

1.2B *Per Capita Income, Comparison States, 2000-2020*



Source: U.S. Bureau of Economic Analysis.
Note: Adjusted for inflation (2020 dollars).

[1] 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.

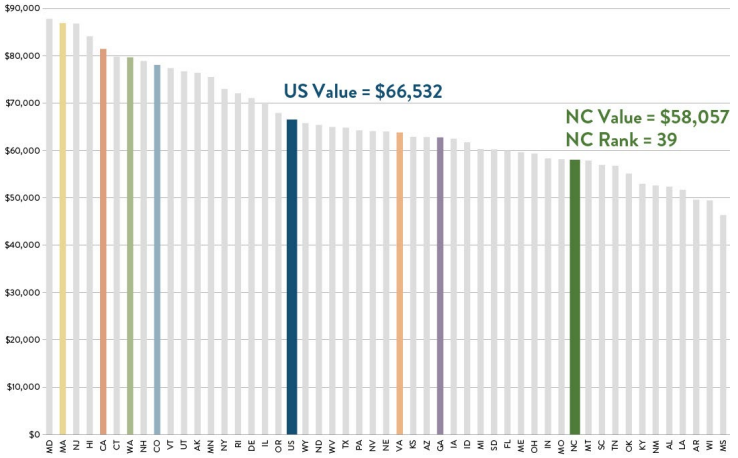
North Carolina's performance in median household income mirrors its performance in per capita income **[1.2C]**. With a median household income of $58,057 in 2019, North Carolina ranks 39th in the nation and has a median income that is 87 percent of the national average ($66,532). Furthermore, North Carolina had the lowest median household income among all comparison states. Again, only Georgia has experienced slower growth than North Carolina among the comparison states. Median household income for North Carolina increased at a slower rate from 2005 to 2019 (7.5 percent) than did the national median household income (8.5 percent) **[1.2D]**.

Within North Carolina, 14 counties have a per capita personal income higher than the state average, and four of those have a per capita personal income higher than the national average.[2] The low number of counties above the state average indicates that high-income counties like Orange and Chatham, with per capita personal incomes of $67,089 and $66,766, respectively, skew the distribution. Twenty-two counties had a median household income higher than the state average and eight counties had a median income higher than the U.S. median income in 2019 **[1.2E]**. Median household income ranged from $81,597 in Wake County to $35,413 in Robeson County.

WHAT DOES THIS MEAN FOR NORTH CAROLINA?

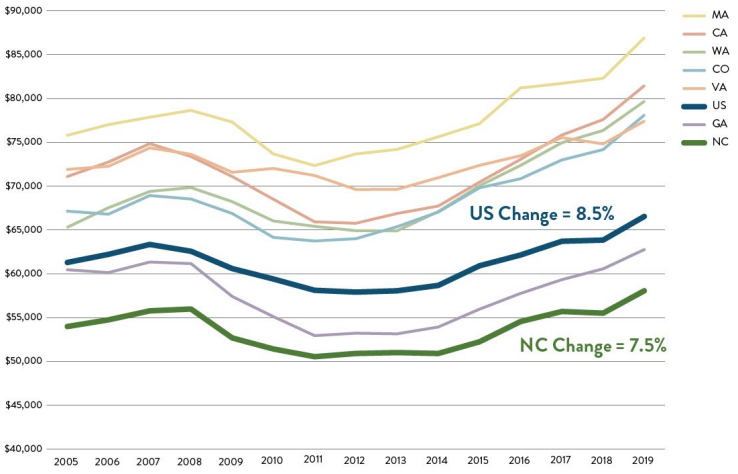
Per capita personal income and median household income in North Carolina compared unfavorably with the U.S. and comparison states in 2020 and 2019, respectively, the most recent years for which data were available for each indicator. Furthermore, historical data show that North Carolina's performance has been comparatively poor over time. Slow income growth indicates that the state economy may not be generating new opportunities for households to increase wealth and standards of living. Occupations in the innovation economy are often compensated with high incomes; to the extent that more individuals can enter the innovation economy, North Carolina income performance will improve. This may be accomplished through measures like improving education levels in the workforce and increasing the share of high science, engineering, and technology (SET) companies in the state's economy.

1.2C *Median Household Income, All U.S. States, 2019*



Source: U.S. Census Bureau.

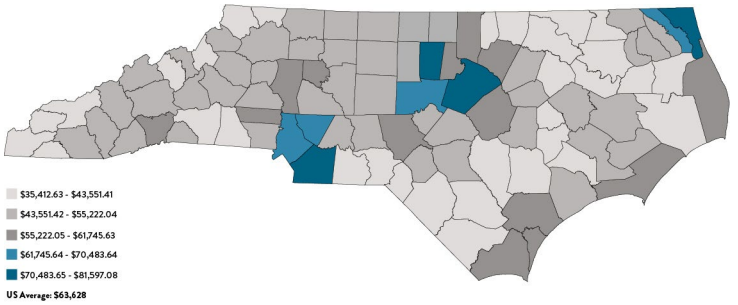
1.2D *Median Household Income, Comparison States, 2005-2019*



Source: U.S. Census Bureau.

Note: Adjusted for inflation (2020 dollars).

1.2E *Median Household Income, N.C. Counties, 2015-2019 Average*



Source: U.S. Census Bureau.

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

[2] U.S. Bureau of Economic Analysis, "Personal Income Summary, County," 2020.

Indicator 1.3: Average Annual Wage

KEY FINDINGS

- North Carolina's average annual wage in 2020 ranked considerably below the U.S. average and the average wages of all comparison states.
- Between 2001 and 2020, North Carolina's inflation-adjusted average wage increased at a rate slightly slower 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 four counties had average annual wages higher than the N.C. average in 2020. The same four counties also had higher average annual wages than the U.S. average even though the state ranked below the U.S. as a whole.

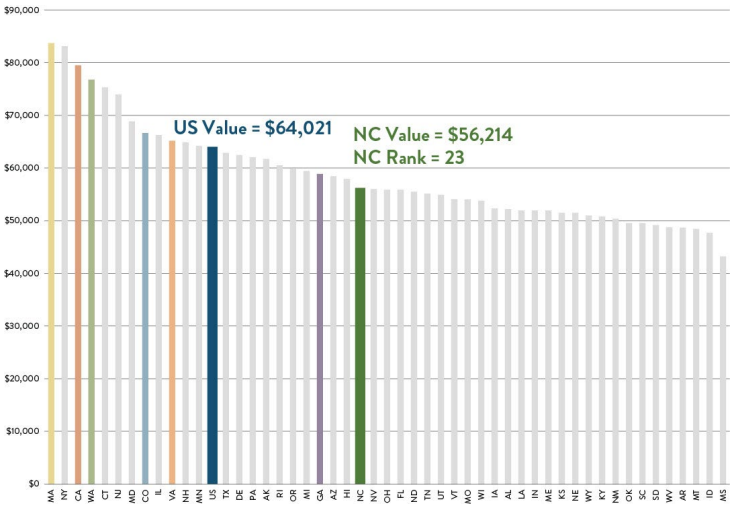
INDICATOR OVERVIEW

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?

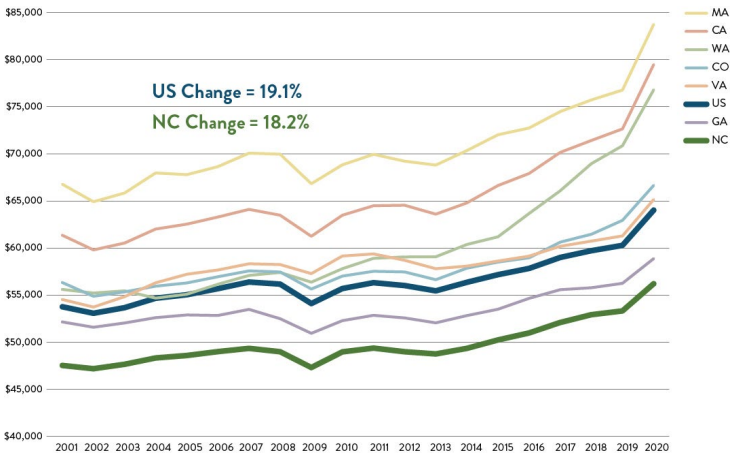
In 2020, the average annual wage in North Carolina was $56,214, ranking the state 23rd highest in the country and well below the national average of $64,021 **[1.3A]**. All six comparison states had higher average wages than North Carolina, and Georgia was the only other comparison state with an average 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, particularly in rural regions, the majority of the state. From 2001 to 2020, the inflation-adjusted average annual wage in North Carolina grew by 18.2 percent, which is slightly below the national growth rate (19.1 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, 2020*



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

1.3B *Average Annual Wage, Comparison States, 2001-2020*



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

Note: Adjusted for Inflation (2020 dollars).

Indicator 1.3: Average Annual Wage

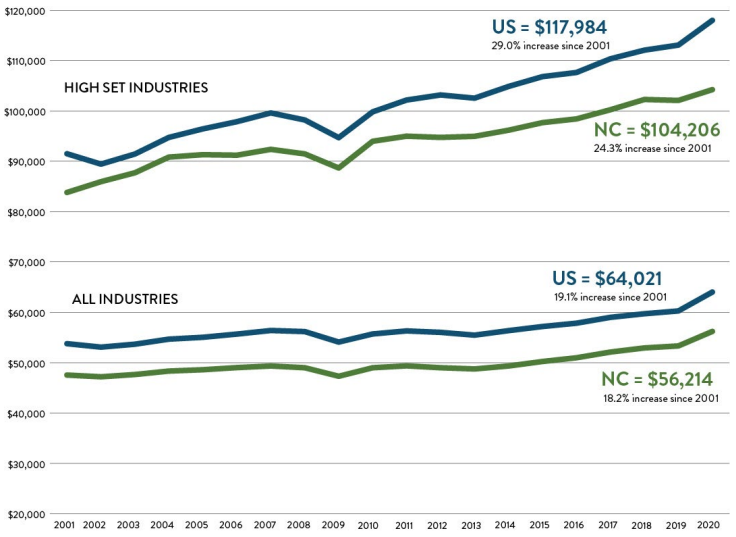
In 2020, the average annual wage for workers in high SET employment industries in North Carolina was $104,206, 85 percent greater than the average wage for workers in all industries in the state, $56,214 **[1.3C]**. This pattern reflects national patterns, in which the high SET employment average wage of $117,984 is nearly twice the average wage for all industries, $64,021.

Within North Carolina, the vast majority of counties have an average annual wage lower than the state average. Only four counties—Durham, Mecklenburg, Wake, and Orange—had a 2020 average wage higher than the state average; the same four counties had 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 2020 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 kept pace with 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., 2001-2020*

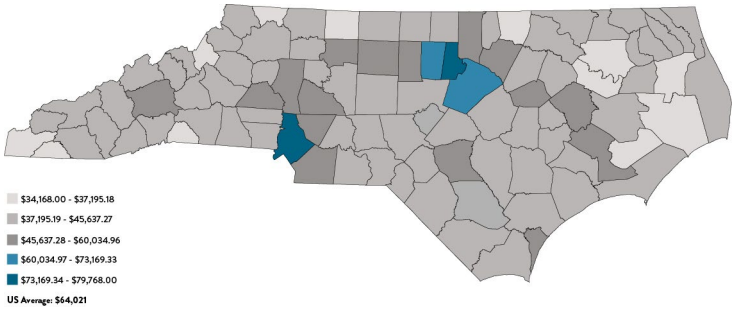


Source: Bureau of Labor Statistics, U.S. Department of Labor.

Note: Adjusted for Inflation (2020 dollars).

** 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. 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.*

1.3D *Average Annual Wage, N.C. Counties, 2020*



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 generally trended higher than the U.S. average since 2000, particularly during the 2007-2009 recession, but since 2014 has decreased to follow closely with the national average.
- In comparison with top foreign countries, North Carolina's unemployment rate ranked close to average for 2020.
- A majority of North Carolina counties had unemployment rates lower than the national (77 out of 100) and state (53 out of 100) averages in 2020.

INDICATOR OVERVIEW

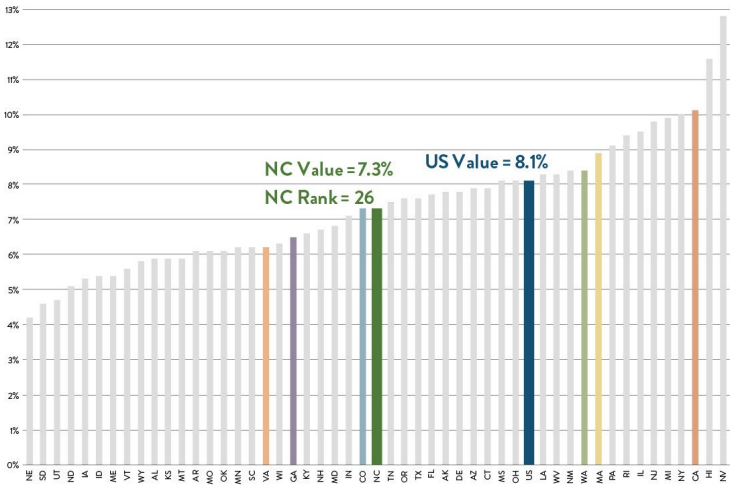
The unemployment rate is the percentage of labor force participants who are unemployed but actively seeking and available for work. Unemployment is generally viewed as a lagging indicator that reflects the performance of an economy. Unemployment rates indicate the degree to which an economy provides 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 2020 was 7.3 percent **[1.4A]**. This unemployment rate is lower than the national unemployment rate of 8.1 percent and is the 26th lowest rate of all states in the country. Among comparison states, North Carolina ranks in the middle of the pack, behind Virginia and Georgia, tied with Colorado, and ahead of Washington, Massachusetts, and California.

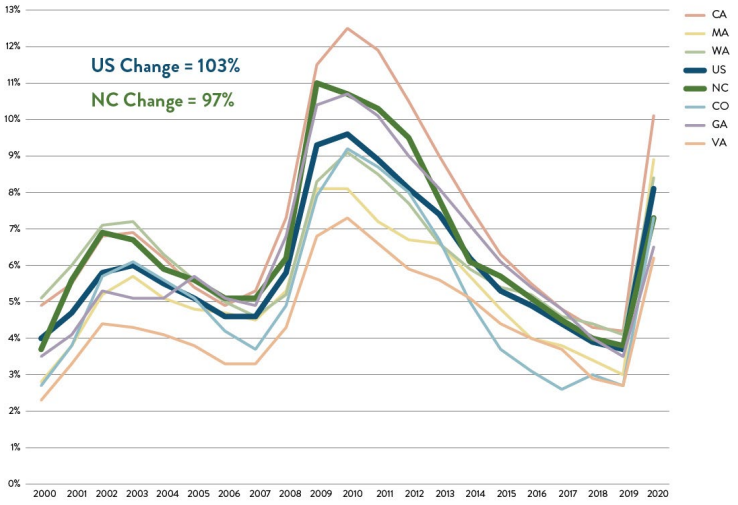
Between 2000 and 2019, North Carolina's unemployment rate rose slightly, whereas the national rate decreased **[1.4B]**. The recession beginning in late 2007 and early 2008 caused unemployment rates to spike in 2010 (particularly in North Carolina and California) but then to reverse and decrease steadily to pre-recession levels by 2018. Unemployment spiked again between 2019 and 2020 due to the COVID-19 pandemic, but North Carolina fared better than the U.S. average (92 percent increase versus 119 percent). The largest jumps in unemployment among comparison states between 2019 and 2020 were in Massachusetts (197 percent increase) and Colorado (170% increase).

1.4A *Unemployment Rate, All U.S. States, 2020*



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

1.4B *Unemployment Rate, Comparison States, 2000-2020*



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

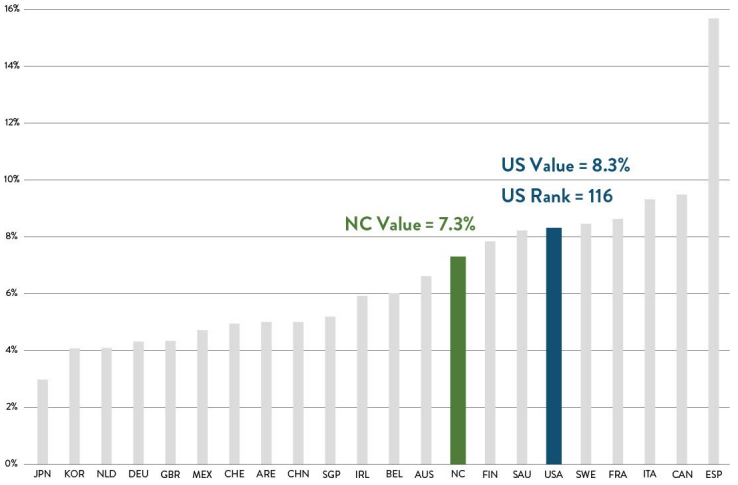
[1] NC is tied with Alabama, Georgia, Maryland, and Texas.

Indicator 1.4: Unemployment

Internationally, the U.S. dropped in ranking from the 67th lowest unemployment rate in 2018 to the 116th lowest in 2020 **[1.4C]**. Among the 20 comparison countries, only five countries had higher unemployment rates in 2020: Sweden, France, Italy, Canada, and Spain. North Carolina's unemployment rate, slightly below the U.S. unemployment rate, ranked between 103rd and 104th among global economies.

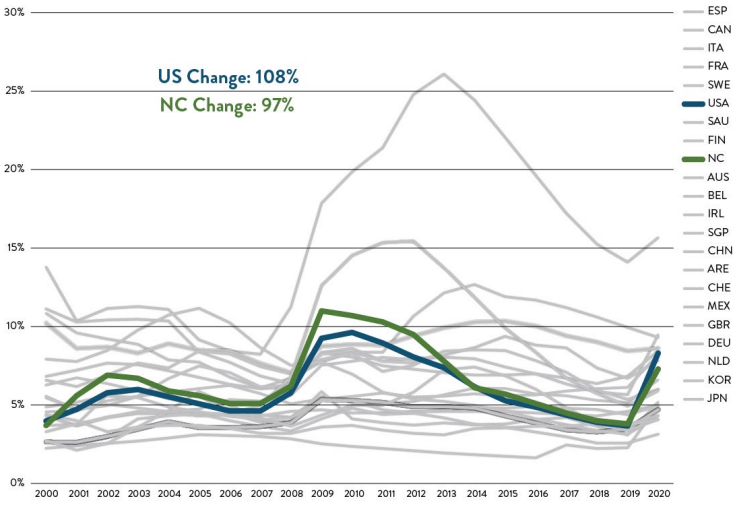
Since 2000, the unemployment rates in North Carolina and the U.S. have varied relatively consistently with the rates in nearly all the comparison countries, though the rate of increase was higher than the rates for most countries during the 2007-2009 recession. **[1.4D]**. The recession hit North Carolina 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. Among comparison countries, the increase in unemployment from 2019 to 2020 averaged 28 percent, which is much lower than the increase in North Carolina (92 percent).

1.4C *Unemployment Rate, Comparison Countries, 2020*



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

1.4D *Unemployment Rate, Comparison Countries, 2000-2020*



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

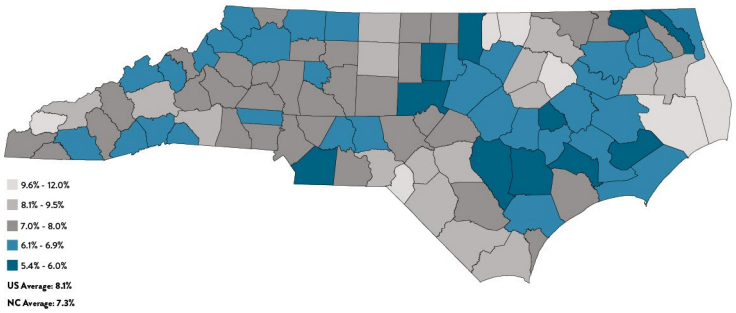
Indicator 1.4: Unemployment

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 53 counties, with 77 counties having rates below the U.S. average. At 5.4 percent, Chatham County had the lowest unemployment rate of all counties, whereas Scotland County, with unemployment at 12 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, 2020***



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

Note: Blue couties 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 from 8 percent to 28 percent; one-third of counties had poverty levels lower than the state average, and only 23 out of 100 had poverty levels lower than the U.S. average.

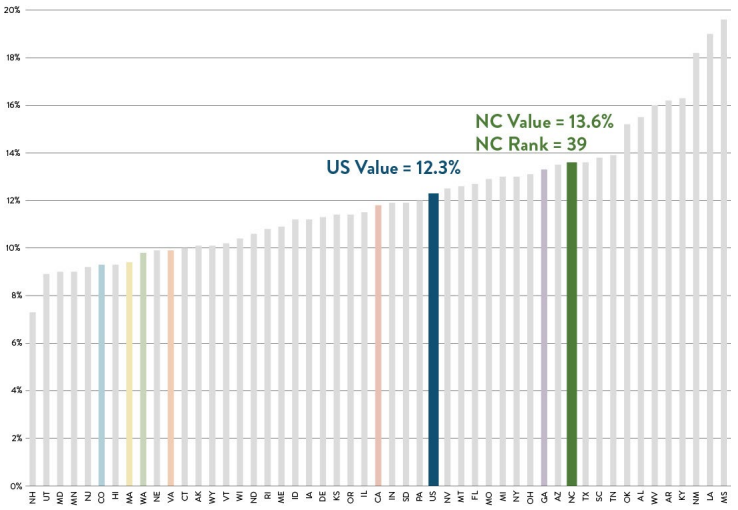
INDICATOR OVERVIEW

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 production and use. 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?

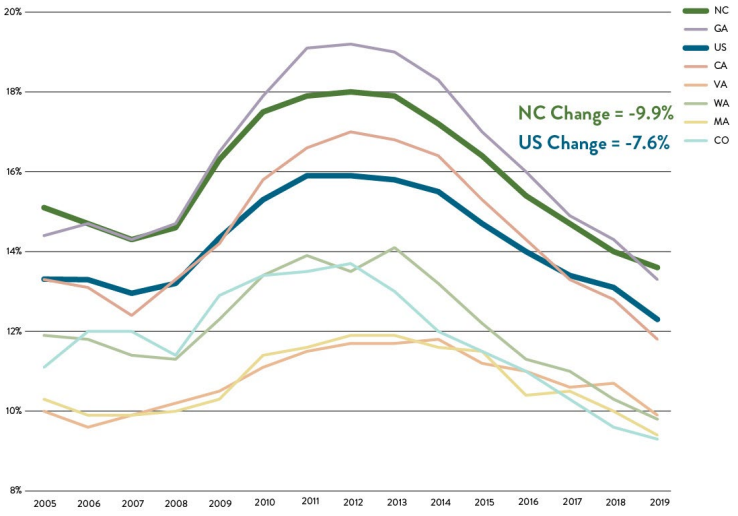
In 2019, 13.6 percent of North Carolinians lived in poverty **[1.5A]**. This is above the national poverty rate of 12.3 percent and ranks North Carolina 39th lowest in the country in terms of the share of its population in poverty. North Carolina's rank places it below all comparison states. All comparison states except Georgia had a poverty rate lower than the national average. Over time, North Carolina's poverty rate has decreased by 9.9 percent from 2005 to 2019 **[1.5B]**. This percentage decrease is more than the national decrease (7.6 percent) but less than the decreases in Washington, Colorado, and California (17.6, 16.2, and 11.3 percent, respectively).

1.5A *Percentage of Citizens in Poverty, All U.S. States, 2019*



Source: U.S. Census Bureau.

1.5B *Percentage of Citizens in Poverty, Comparison States, 2005-2019*



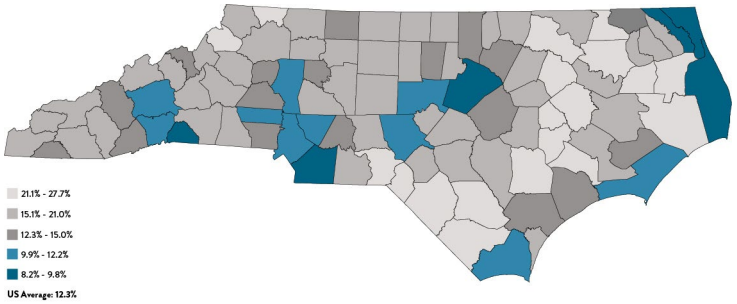
Source: U.S. Census Bureau.

Five-year average poverty within North Carolina (2015–2019) ranged from a low of 8.2 percent in Union County to 27.7 percent in Robeson County, with a state average of 14.7 percent **[1.5C]**. Sixty-six counties had an average poverty level higher than the state five-year average, and seventy-seven 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, 2015-2019 Average***



Source: U.S. Census Bureau.

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

Indicator 1.6: Population Growth

KEY FINDINGS

- Between 2000 and 2020, North Carolina moved from the 11th to the 9th most populous state, growing at a rate 67 percent faster than the U.S. average.
- Within North Carolina, the location and growth of the population are highly concentrated in a very small number of counties; 10 counties (out of 100) accounted for 70 percent of the change in population between 2000 and 2020.

INDICATOR OVERVIEW

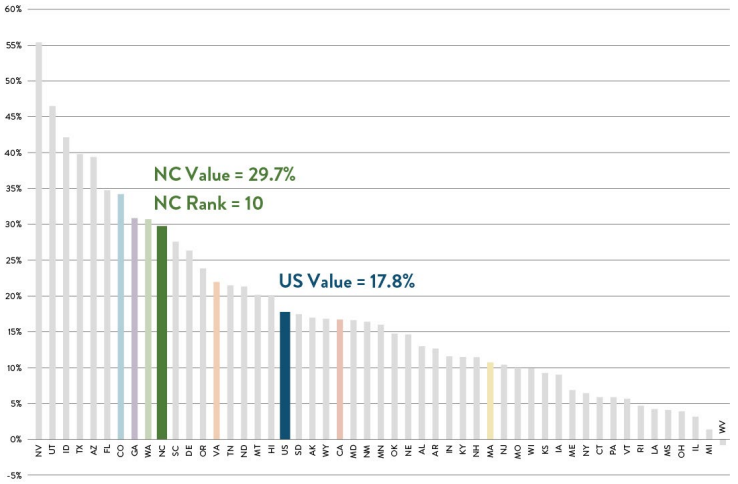
This indicator measures the extent to which North Carolina's total population is growing over time. For a given state, three components make up population growth: (1) natural growth—the excess of births over deaths; (2) in-migration—the movement of people from another state; and (3) immigration—the movement 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 2020, North Carolina ranked as the 9th most populous state in the country, with a total resident population of 10,439,388, according to the 2020 decennial census. In terms of percentage change in population between 2000 and 2020, North Carolina ranked 10th in the nation, with a growth rate that was 67 percent faster than the U.S. average and 46 percent slower than the fastest growing state, Nevada **[1.6A]**. Among the comparison states, North Carolina ranked in the middle, ahead of Virginia, California, and Massachusetts Colorado, Georgia, Washington, and North Carolina all had similar growth rates and were the 7th, 8th, 9th, and 10th fastest growing states, respectively, over the 20-year period. The populations of California and Massachusetts increased slower than the national average during the same period.

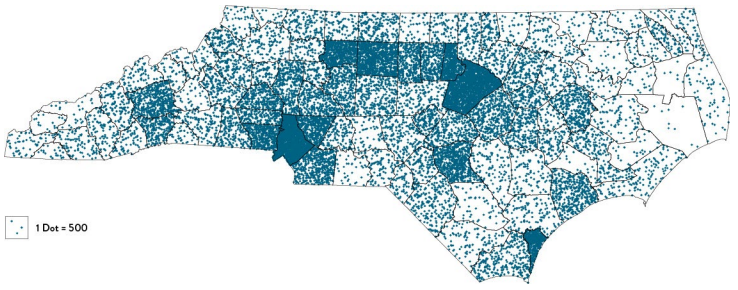
Within North Carolina, the location and growth of the population are highly concentrated in a small number of counties **[1.6B]**. In terms of location, the state's three most populous counties account for more than 26.7 percent of the state's population—Wake (10.8 percent), Mecklenburg (10.7 percent), , and Guilford (5.2 percent). Together, the 10 next most populous counties—Forsyth (3.7 percent), Cumberland (3.2 percent), Durham (3.1 percent), Buncombe (2.6 percent), Union (2.3 percent), Gaston (2.2 percent), Cabarrus (2.2 percent), New Hanover (2.2 percent), Johnston (2.1 percent), and Onslow (2.0 percent)—account for 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.

1.6A *Percentage Change in Population, All U.S. States, 2000-2020*



Source: U.S. Census Bureau.

1.6B *Estimated Location of Population in N.C., 2020*



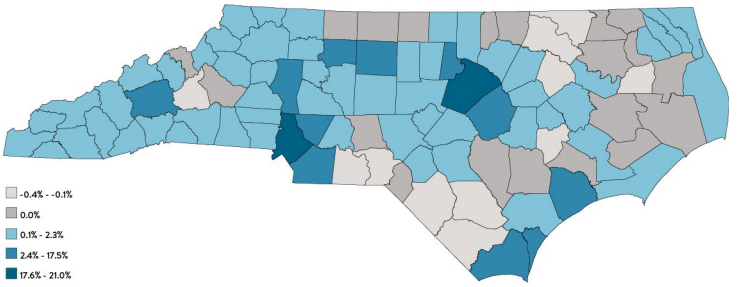
Source: U.S. Census Bureau.

Indicator 1.6: Population Growth

Each of the 13 next most populous counties—Iredell, Alamance, Pitt, Davidson, Catawba, Orange, Rowan, Randolph, Brunswick, Harnett, Wayne, Robeson, and Henderson—has between 1.8 and 1.1 percent of the state's population, a percentage slightly greater than 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 1 percent or less of the state's total population, and together they account for 30 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 38.6 percent of the population growth between 2000 and 2020—Wake (21.0 percent) and Mecklenburg (17.6 percent). Together, the next three counties—Guilford (5.0 percent), Union (4.8 percent), and Durham (4.2 percent)—account for another 14.1 percent of the state's population growth. In total, this means that five of the state's 100 counties account for more than half the state's population growth since 2000. To reach over 75 percent of the state's population growth, only 8 more counties (for a total of 13) are needed— Cabarrus (4.0 percent), Johnston (3.9 percent), Forsyth (3.2 percent), New Hanover (2.7 percent), Iredell (2.7 percent), Brunswick (2.7 percent), Buncombe (2.6 percent), Onslow (2.3 percent),. Another nine counties—Harnett, Alamance, Gaston, Pitt, Cumberland, Orange, Henderson, Chatham, and Moore—each account for between 1.8 and 1.0 percent of the state's population growth between 2000 and 2020. Each of the remaining 78 counties comprise approximately one percent or less of the state's total population growth, and together they account for 10.8 percent of the state's total population growth.

1.6C *Population Change, Percent of Total Change, N.C. Counties, 2000-2020*



Source: U.S. Census Bureau.

Note: Blue counties are increasing in population.

1.6D *Population Change, North Carolina Counties, 2000-2020*

County	Population 2000	Population 2020	Absolute Change 2000-2020	% of Total Change	Cumulative % of Total Change
Wake	627,846	1,129,410	501,564	21.0%	21.0%
Mecklenburg	695,454	1,115,482	420,028	17.6%	38.6%
Guilford	421,048	541,299	120,251	5.0%	43.6%
Union	123,677	238,267	114,590	4.8%	48.4%
Durham	223,314	324,833	101,519	4.2%	52.6%
Cabarrus	131,063	225,804	94,741	4.0%	56.6%
Johnston	121,965	215,999	94,034	3.9%	60.5%
Forsyth	306,067	382,590	76,523	3.2%	63.7%
New Hanover	160,307	225,702	65,395	2.7%	66.5%
Iredell	122,660	186,693	64,033	2.7%	69.1%
Brunswick	73,143	136,693	63,550	2.7%	71.8%
Buncombe	206,330	269,452	63,122	2.6%	74.4%
Onslow	150,355	204,576	54,221	2.3%	76.7%
Harnett	91,025	133,568	42,543	1.8%	78.5%
Alamance	130,800	171,415	40,615	1.7%	80.2%
Gaston	190,365	227,943	37,578	1.6%	81.8%
Pitt	133,798	170,243	36,445	1.5%	83.3%
Cumberland	302,963	334,728	31,765	1.3%	84.6%
Orange	118,227	148,696	30,469	1.3%	85.9%
Henderson	89,173	116,281	27,108	1.1%	87.0%
Chatham	49,329	76,285	26,956	1.1%	88.2%
Moore	74769	99,727	24,958	1.0%	89.2%
78 Other	3,505,635	3,763,702	258,067	10.8%	100.0%
Total	**8,049,313**	**10,439,388**	**2,390,075**	**100.0%**	**100.0%**

**Listed counties each accounted for >1% of the population change between 2000 and 2020*

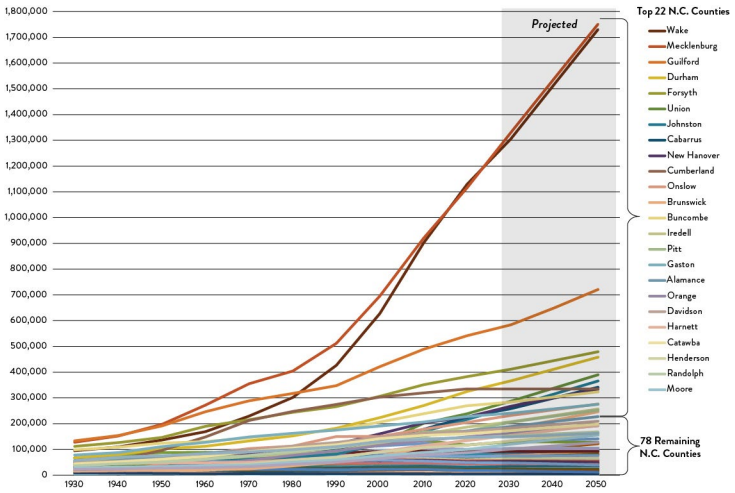
Indicator 1.6: Population Growth

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 2050 the respective county populations are projected to differ considerably **[1.6E]**. Specifically, in 1930 the most populous county (Guilford: 133,010) had 26 times more people than the least populous county (Tyrrell: 5,164), but in 2050 the most populous county (Mecklenburg: 1,750,805) is projected to have more than 485 times as many people as the least populous county (Tyrrell: 3,608). Between 1930 and 2050, two highly populated counties, Wake and Mecklenburg, are projected by grow by 1,726 percent and 1,268 percent, respectively, while the projected average growth rate across all other counties for that period is 236 percent. Moreover, the top 22 counties in terms of growth rate between 1930 and 2050 account for 89 percent of the change in the state's population during that period, whereas the other 78 counties account for 11 percent of the change in the state's population during that period. And each of top 22 counties accounts for at least 1 percent of the change in the state's population between 1930 and 2050, whereas each of the other 78 counties accounts for less than 1 percent of the change in the state's population between during that period; of those 78 counties, 17 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, 1930-2050*



Note: 22 counties each accounted for >1% of the population change between 2000 and 2020.

Indicator 2.1: Total Research & Development

KEY FINDINGS

- North Carolina's total 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 12th 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 business-performed R&D is most concentrated in metropolitan regions; two-thirds of business-performed R&D occurs in the Research Triangle region, along with 86 percent of the state's university R&D.

INDICATOR OVERVIEW

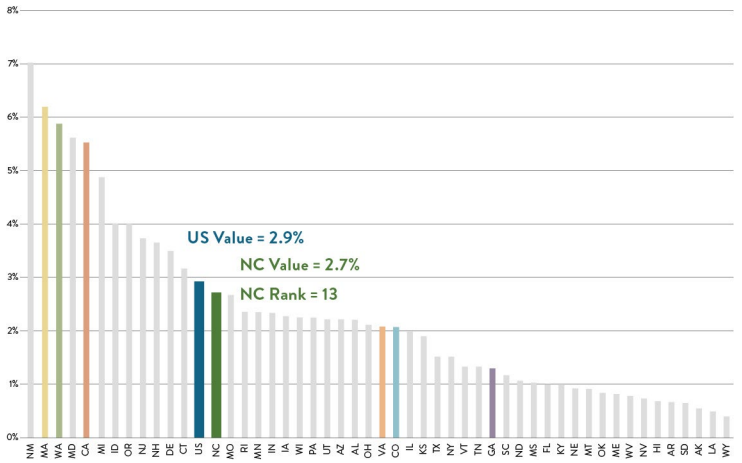
This indicator represents the extent to which R&D plays a role in a state's economy. R&D expenditures refer to R&D activities performed by businesses, universities, nonprofit organizations, and federal and state agencies.[1] R&D is the driving force behind innovation and sustained economic growth. Organizations 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 13th in the nation, with a level that is 93 percent of the U.S. value **[2.1A]**. In other words, the ratio of R&D to GDP in North Carolina is 93 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.[2]

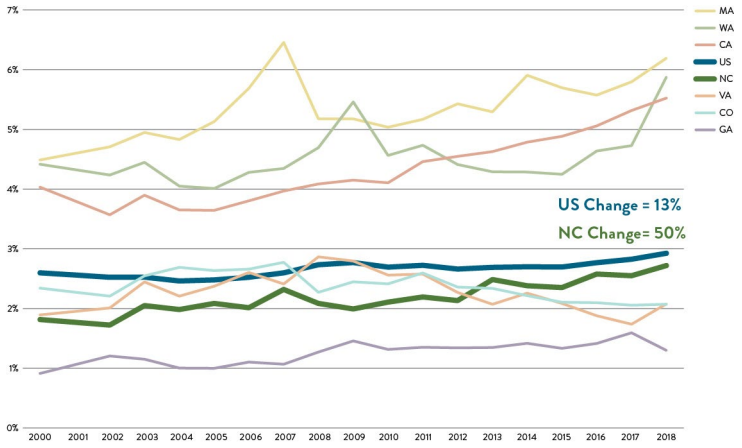
This ranking reflects the relative distribution of academic R&D to industry R&D within North Carolina and nationally. Specifically, North Carolina's academic R&D level per state GDP (see indicator 2.3) is 148 percent of the U.S. level, while its industry R&D level per industry output (see indicator 2.2) is 98 percent of the U.S. level and 37 percent of the leading state's (Washington). Nationwide and in North Carolina, industry R&D accounts for approximately 76 percent of total R&D,[3] 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 almost four 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, 2018*



Source: National Science Board.

2.1B *Total R&D Expenditures a Percentage of GDP Comparison States, 2000-2018*



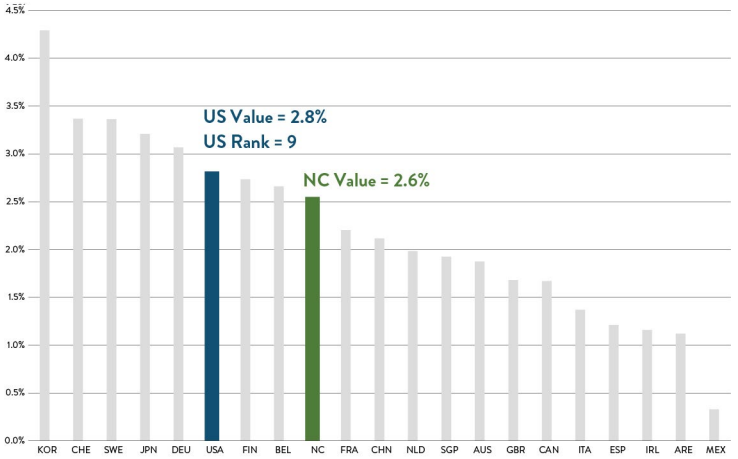
Source: National Science Board.

[1] 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.
[2] 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.
[3] National Science Board, Science and Engineering Indicators 2020, Chapter 4, "U.S. R&D Performance and Funding," pp. 10-11.

Indicator 2.1: Total Research & Development

Internationally, the U.S. was the 9th most R&D-intensive country in 2017, at 65 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 12th overall, between that of Belgium and France. Since 2000, the R&D intensity of many of the most R&D-intensive countries (those with R&D expenditures as a percentage of GDP greater than two percent) has risen steadily and often at a much higher rate than in the U.S.—35% average growth among the top countries, compared to 7 percent in the U.S. The top countries' growth is more consistent with North Carolina's rate of increase **[2.1D]**. The People's Republic of China and the Republic of Korea have made increasingly higher investments in R&D to fuel their economies relative to other countries; R&D intensity more than doubled in these two countries between 2000 and 2017.

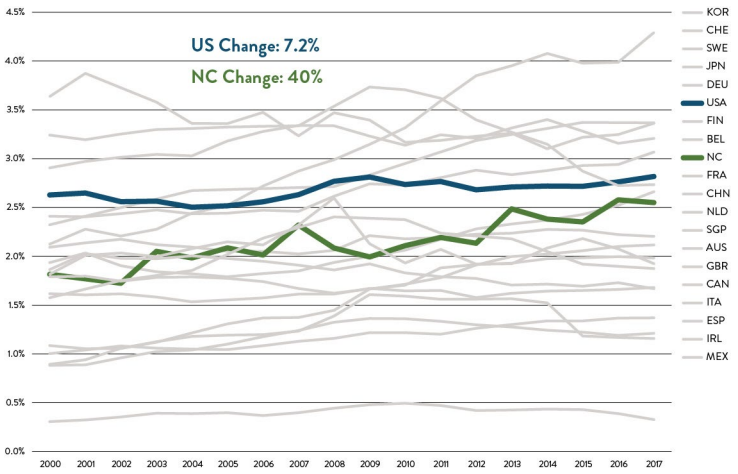
2.1C *Total R&D Expenditures as a Percentage of GDP, Comparison Countries, 2017*



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

Note: Insufficient data to include Saudi Arabia.

2.1D *Total R&D Expenditures as a Percentage of GDP, Comparison Countries, 2000-2017*



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

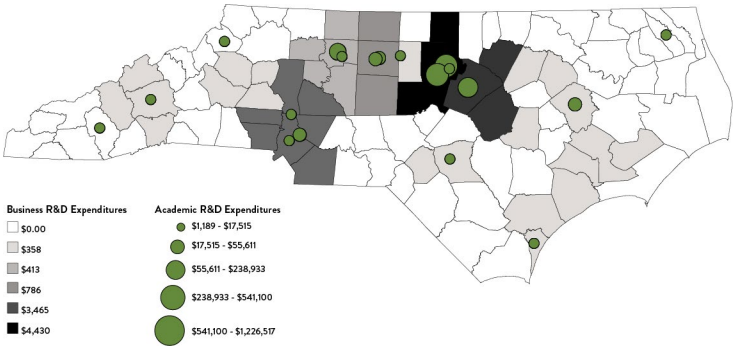
Note: Insufficient data to include Saudi Arabia.

Within North Carolina, R&D is highly concentrated in a pattern that reflects the location of the state's population and research universities **[2.1E]**. While it is reasonable to assume more balanced rates of R&D across the state's industries, the rate of R&D across universities is not equal, with nearly 86 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, where companies have access to the talent needed to conduct R&D activities.

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 North Carolina, 2018-2019**



Sources: National Science Foundation and U.S. Census Bureau.

Note: Business R&D Expenditures are given in millions of dollars. Academic R&D Expenditures are given in thousands of dollars. Business establishments perform 76% of R&D in NC; universities perform 24% of R&D.

**Business R&D from 2018 survey and Academic R&D from 2019.*

[4] The extent to which this approximation is accurate depends on the size of the businesses and the industry mix across the state. 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 360 billion, or 82%, of domestic business R&D performance in 2018: 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 Research and Development Survey, 2018).

Indicator 2.2: Industry Research & Development

KEY FINDINGS

- North Carolina's business-performed R&D as a percentage of private-industry output ranks slightly 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 the three largest metropolitan regions of the state.
- Relative to the U.S. average business R&D pattern, business R&D within North Carolina is more concentrated in the pharmaceutical, computer and electronic products, and software publishing sectors.

INDICATOR OVERVIEW

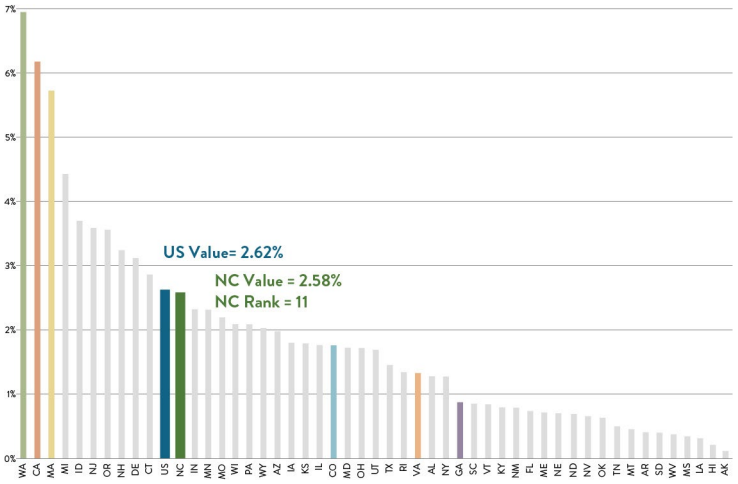
The business sector is the largest performer of U.S. R&D. Nationwide, business-performed R&D accounts for 57 percent of all U.S. applied research and more than 90 percent of all development.[1] For a given state, a high value for this indicator shows that businesses within the state are making a large 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 11th in the nation, with a level that is 98 percent of the U.S. value **[2.2A]**. However, this value is only 37 percent of the value of the top-ranking state, Washington.

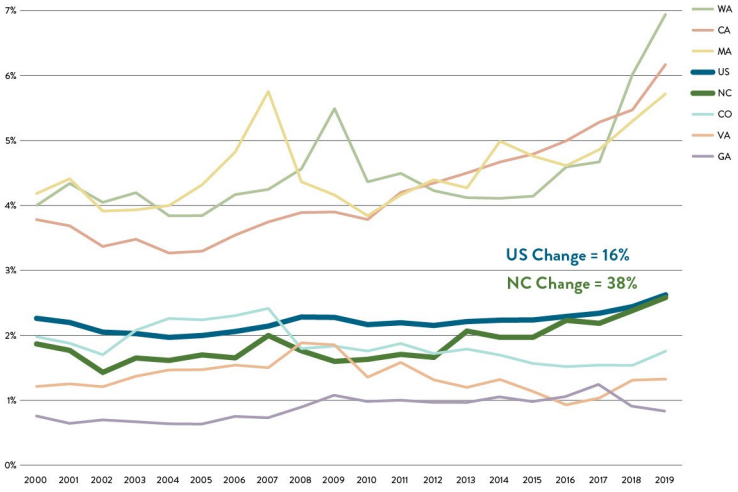
This ranking reflects North Carolina's economic history, which is heavily based in agricultural, industrial, and branch-plant operations. Because of this, historically, comparatively few companies within the state have had significant research operations, which typically locate at or near company headquarters, often located outside of North Carolina. This is changing over time, however, as North Carolina's business-performed R&D rate has increased nearly 38 percent since 2000, more than twice the rate for the U.S. overall at 16 percent **[2.2B]**. The top three comparison states (Washington, California, and Massachusetts) are also the top three states nationally. Furthermore, they each have a much higher percentage of private-industry output devoted to business-performed R&D than North Carolina and have increased this value as fast or faster since 2000.

2.2A *Business-Performed R&D as a Percentage of Private-Industry Output, All U.S. States, 2019*



Source: National Science Board.

2.2B *Business-Performed R&D as a Percentage of Private-Industry Output, Comparison States, 2000-2019*



Source: National Science Board.

[1] National Science Board, Science and Engineering Indicators 2020, Chapter 4, "U.S. R&D Performance and Funding," pp. 10-11.

2.2C *Business-Performed R&D Expenditures by Industry, U.S. and N.C, 2018*

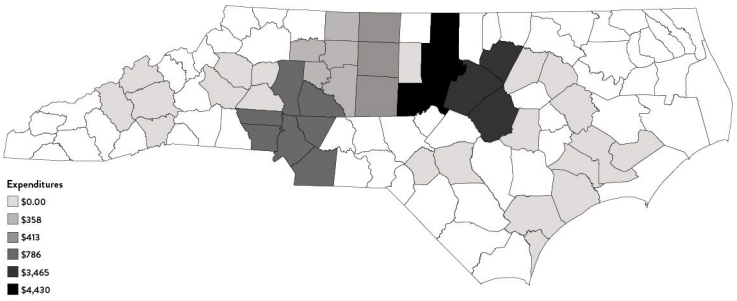
SUBSECTOR	NAICS CODE	UNITED STATES		NORTH CAROLINA	
		Expenditures *In Millions*	% of All Industries	Expenditures *In Millions*	% of All Industries
All Industries	**21–23, 31–33, 42–81**	**$377,806**	**-**	**$7,790**	**-**
Chemicals	325	$73,584	19%	$1,955	25%
Computer and electronic products	334	$73,922	20%	$1,791	23%
Publishing	511	$32,281	8.5%	$881	11%
Professional, scientific, and technical services	541	$22,374	5.9%	$815	10%
Data processing, hosting, and related services	518	$23,115	6.1%	$511	6.6%
Machinery	333	$13,765	3.6%	$316	4.1%
Transportation equipment	336	$35,894	9.5%	$254	3.3%
Miscellaneous	339	$16,807	4.4%	$211	2.7%
Electrical equipment, appliances, and components	335	$4,222	1.1%	$170	2.2%
Beverage and tobacco products	312	$1,004	0.3%	$80	1.0%
Subtotal		**$296,968**	**79%**	**$6,984**	**90%**

Note: Expenditures by company, not including expenditures by others for R&D performed by company. Source: National Center for Science and Engineering Statistics and U.S. Census Bureau.

Following national trends, 65 percent of R&D is performed in manufacturing sectors.[2] Almost all North Carolina business-performed and paid R&D occurs in 10 subsectors **[2.2C]**. R&D expenditures were more highly concentrated than the U.S. average in six of those subsectors (chemicals, computer and electronic products, publishing, professional services, data processing and hosting, and machinery). 92% of chemical subsector R&D is performed by the pharmaceuticals and medicines industry (NAICS code 3254), 100% of publishing subsector expenditures are by the software publishing industry (5112), and 84% of miscellaneous is attributed to the medical equipment and supplies industry (3391). While not a large portion of total expenditures, North Carolina businesses are much more heavily involved in beverage and tobacco product R&D than would be expected based on the U.S. average. This is likely a result of North Carolina's historical involvement in the tobacco and agricultural industries whose businesses are innovating beyond traditional products.

Within North Carolina, business-performed R&D is highly concentrated in three regions **[2.2D, 2.2E]**. Two-thirds of business R&D was performed in the Durham-Chapel Hill and Raleigh-Cary metropolitan statistical areas (MSAs). Another 12 percent was conducted by companies in the Charlotte metro area, and 13 percent within the Piedmont Triad region (Greensboro-High Point, Winston-Salem, and Burlington MSAs). Research and development operations require a highly skilled workforce and proximity to leading research universities in these three regions likely explains this trend.

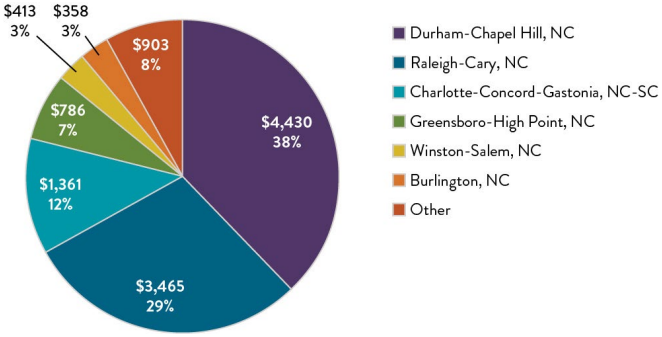
2.2D *Location of Business-Performed R&D Expenditures, North Carolina Counties, 2018*



Source: National Center for Science and Engineering Statistics and U.S. Census Bureau.

Note: Dollars in Millions. 7.7% of North Carolina business-performed R&D expenditures were not attributed to a particular area by the U.S. Census Bureau's Business Research and Development Survey

2.2E *Location of Business-Performed R&D Expenditures, North Carolina Core-Based Statistical Areas, 2018*



Source: National Center for Science and Engineering Statistics and U.S. Census Bureau.

Note: Dollars in Millions

[2] National Center for Science and Engineering Statistics and U.S. Census Bureau, Business Research and Development Survey, 2018.

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 industrial structure, 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.

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 institutions perform nearly half of basic research and 13 percent of all R&D conducted in the United States.[1] While industry performs 76 percent of all U.S. R&D, academic R&D serves as a valuable foundation for industry R&D and future economic development.[1]

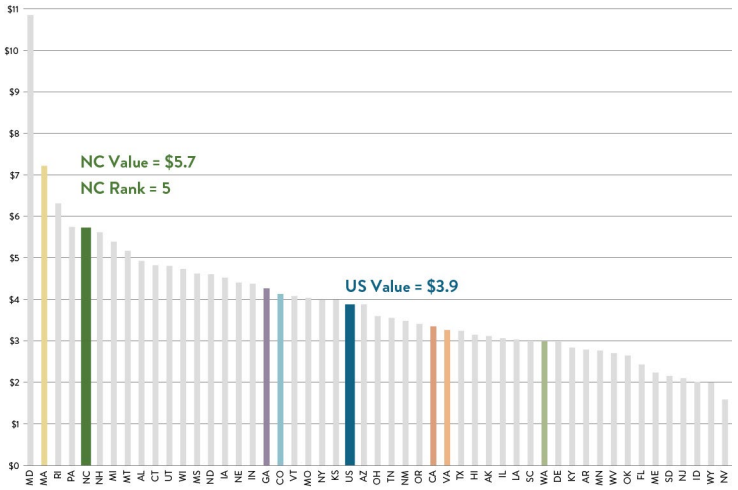
HOW DOES NORTH CAROLINA PERFORM?

In terms of the level of North Carolina's academic R&D expenditures relative to the size of its economy, North Carolina ranks fifth in the nation and is 49 percent higher than the U.S. average **[2.3A]**.[2] North Carolina's academic R&D intensity is 148 percent of the U.S. value, meaning that the amount of academic R&D in North Carolina is 48 percent higher than what we would expect based on the levels of academic R&D in all other states. As with business R&D (indicator 2.2), the top states far exceed the rest of the country, and North Carolina's academic R&D intensity is half of the top-performing state, Maryland.

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.

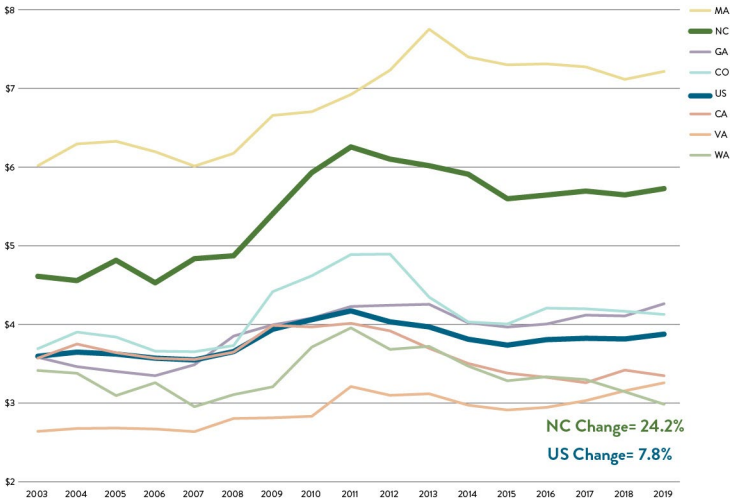
Since 2003, North Carolina's academic R&D intensity has been growing at a rate more than three times faster than the U.S. rate, further increasing the gap between the two **[2.3B]**. This rate of increase is also faster than the rate of increase in any of the comparison states. Only Massachusetts has higher academic R&D intensity among comparison states, and North Carolina has a 34% higher value than the next highest comparison state, Georgia.

2.3A *Academic R&D per $1,000 of State GDP, All U.S. States, 2019*



Source: National Science Board.

2.3B *Academic R&D per $1,000 of State GDP, Comparison States, 2003-2019*



Source: National Science Board.

[1] National Science Board, Science and Engineering Indicators 2020, Chapter 4, "U.S. R&D Performance and Funding," pp. 10-11.
[2] Academic R&D is reported for institutions with R&D more than $150,000.

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 86 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 (seven percent of the state total), while 15 other public and private universities conduct the state's remaining 7 percent academic R&D across the state.

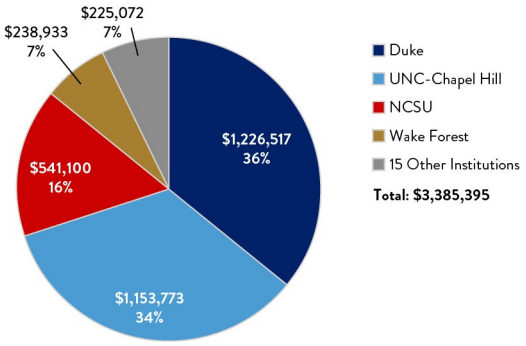
The source of funds for academic R&D reflects, to some extent, the nature of the R&D, and varies considerably across the U.S. and North Carolina's academic institutions **[2.3E]**. Nationwide and across North Carolina, the federal government is the largest supporter of academic R&D, in most cases funding 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 (more than 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 less than 10 percent, with the exception in North Carolina being Duke University, which receives 19 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.

WHAT DOES THIS MEAN FOR NORTH CAROLINA?

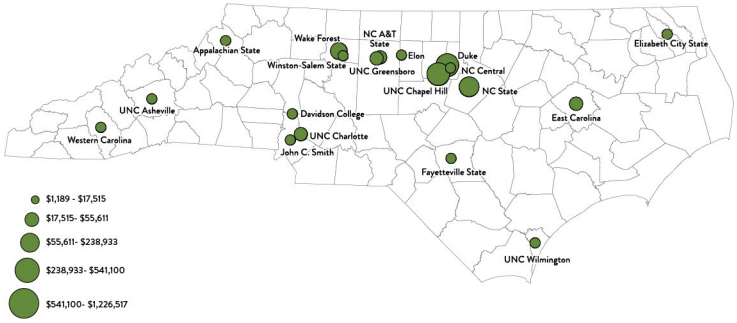
North Carolina's academic research, the majority of which focuses on basic fundamental science, is important for producing new knowledge and scientific stature. Industry R&D is more often the engine that translates the basic research discoveries into commercial products. This suggests that attention 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.

2.3C *N.C. University R&D Expenditures, 2019*



Source: National Science Foundation.

2.3D *N.C. University R&D Expenditures, 2019*



Source: National Science Foundation.

Note: Dollars in Thousands. Universities perform 24% of R&D in NC.

2.3E *University R&D Expenditures by Source of Funds, U.S. Average and N.C. Institutions, 2019*

HIGHER EDUCATION INSTITUTION	SOURCE OF FUNDS				
	Federal Government	State & Local Government	Business/ Industry	Institution Funds	Nonprofits
US Average	**53%**	**5%**	**6%**	**25%**	**7%**
Duke	58%	0%	19%	13%	9%
UNC-Chapel Hill	62%	1%	4%	25%	6%
NC State University	42%	23%	10%	24%	1%
Wake Forest	69%	6%	6%	9%	6%
15 Other NC Institutions	54%	4%	4%	32%	5%

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

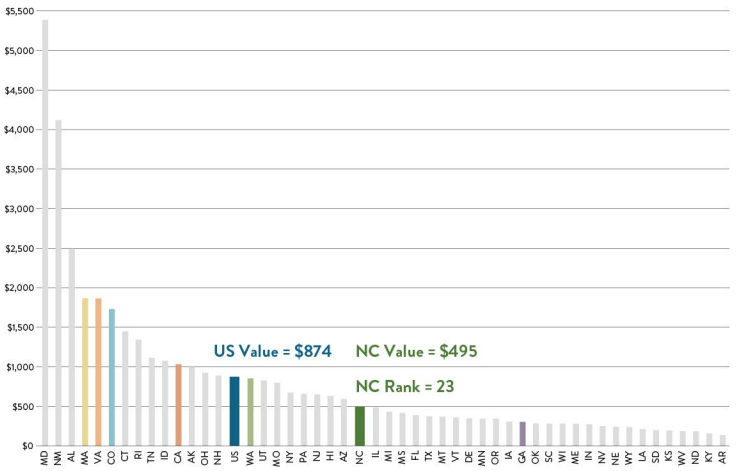
This indicator represents how federal R&D obligations are disbursed geographically relative to the size of a state's employed civilian workforce. Federal R&D obligations are a binding financial commitment in a congressional budget appropriation and include contracts, staff employment, and purchases of 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 and are provided in current dollars (not adjusted for inflation).[1] While this funding comes from 11 federal agencies, the Department of Defense (DoD) disburses the most funding, approximately 44 percent of the total.[2] 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 23rd in the nation, with a level that is 57 percent of the U.S. value and 9 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.

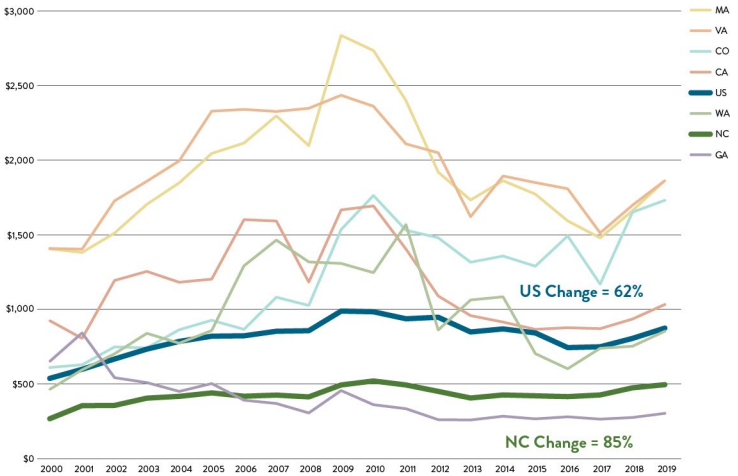
Between 2000 and 2019, North Carolina's federal R&D obligations per employed worker increased by 85 percent in current dollars **[2.4B]**, faster the rate of increase for the U.S. overall (62 percent). Among the comparison states, North Carolina's level of increase in federal R&D obligations per employed worker ranks second only to Colorado, though considerably so; Colorado had an increase of 184 percent in federal R&D obligations per employed worker over the same period.

2.4A *Federal R&D Obligations per Employed Worker, All U.S States, 2019*



Source: National Science Board.

2.4B *Federal R&D Obligations per Employed Worker, Comparison States, 2000-2019*



Source: National Science Board.

[1] Tracking federal R&D obligations below the prime contractor level is beyond the scope of the data sources used in this report.

[2] National Science Board. 2020. "U.S. R&D Performance and Funding." Science and Engineering Indicators 2020.

WHAT DOES THIS MEAN FOR NORTH CAROLINA?

Federal R&D obligations to all U.S. states amounted to nearly $121 billion in 2017. Although this amount represents less than one-third the amount of industry R&D in 2017 ($381 billion), it is substantial and drives a considerable amount of innovation.[3] In 2019, only 14 states exceeded the national average of $874 in federal R&D obligations per worker, meaning that these states received more federal R&D obligations than expected based on the size of their workforce. 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.[4]

[3] National Science Board. 2020. "U.S. R&D Performance and Funding." Science and Engineering Indicators 2020.

[4] 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 is similar to the U.S. average, and since 2000 has increased at a rate slightly 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

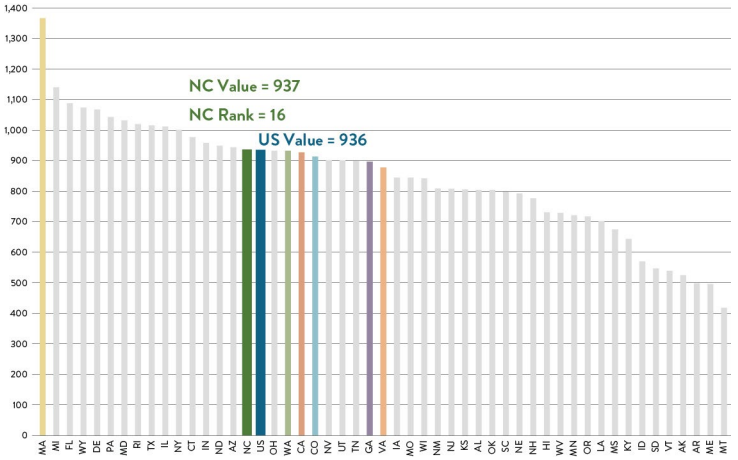
The volume of peer-reviewed articles published per 1,000 academic SEH doctorate holders is an approximate measure of their contribution to scientific knowledge, which includes, among other outputs, research & development (R&D) activities and funding (see indicator 2.3); patents (see indicator 3.2); and 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.[1] SEH doctorates include those in computer sciences; mathematics; the biological, agricultural, or environmental life sciences; physical sciences; social sciences; psychology; engineering; and health fields.[2]

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 16th in the nation, a level that is very similar to the U.S. value and 69 percent of the value of the top-ranking state, Massachusetts **[2.5A]**. Among the comparison states, Massachusetts was the only state that outranked North Carolina on this indicator in 2019. North Carolina and the remaining comparison states all compared similarly to the U.S. average. 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.

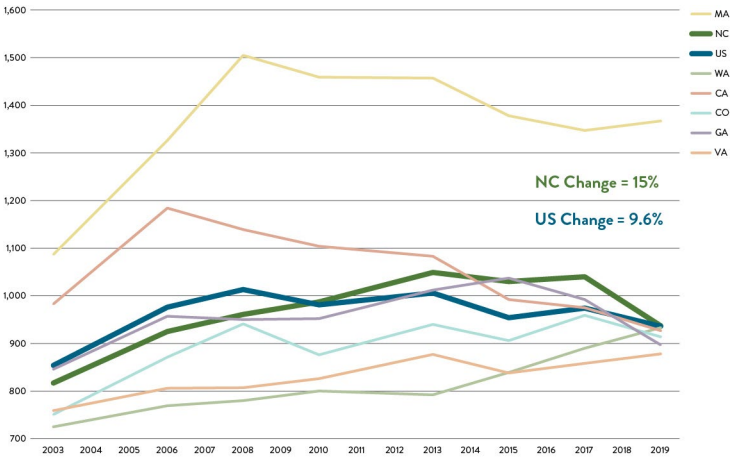
Since 2003, North Carolina's S&E article output per 1,000 SEH doctorate holders in academia has increased by 14.7 percent, a rate that is 50% higher than the U.S. rate, 9.6 percent **[2.5B]**. North Carolina ranks second to Massachusetts among comparison states in terms of article output, however North Carolina's rate of increase is lower than that of Virginia, Colorado, Massachusetts, and Washington.

2.5A *Academic Science and Engineering Article Output per 1,000 Science, Engineering, and Health Doctorate Holders in Academia, All U.S. States, 2019*



Source: National Science Board.

2.5B *Academic Science and Engineering Article Output per 1,000 Science, Engineering, and Health Doctorate Holders in Academia, 2003-2019*



Source: National Science Board.

[1] 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. 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.

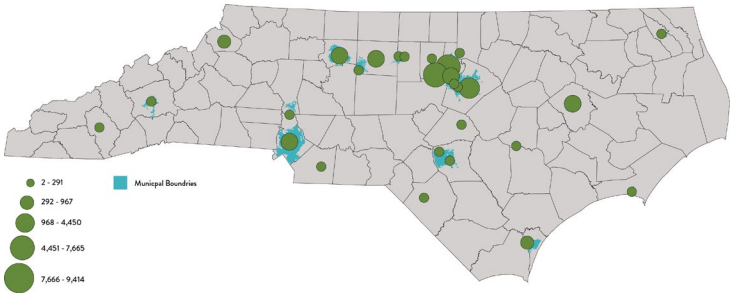
[2] SEH doctorate data are estimates and exclude those with doctorates from foreign institutions and those older than the age of 75. Data for SEH doctorate holders in academia are presented by employment location, regardless of residence. Estimates for states with smaller populations of SEH doctorate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

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.

2.5C *Location of Science & Engineering Articles Published, 2018 - 2019 Annual Average*



Source: Scopus, Elsevier.

Indicator 3.1: SBIR & STTR Awards

KEY FINDINGS

- For the years 2016 to 2018, North Carolina's SBIR/STTR funding as a share of state GDP surpassed the U.S. average for the first time, having increased considerably faster than the U.S. average since 2000.
- North Carolina's SBIR/STTR funding is highly concentrated in a small number of cities and regions in the state.

INDICATOR OVERVIEW

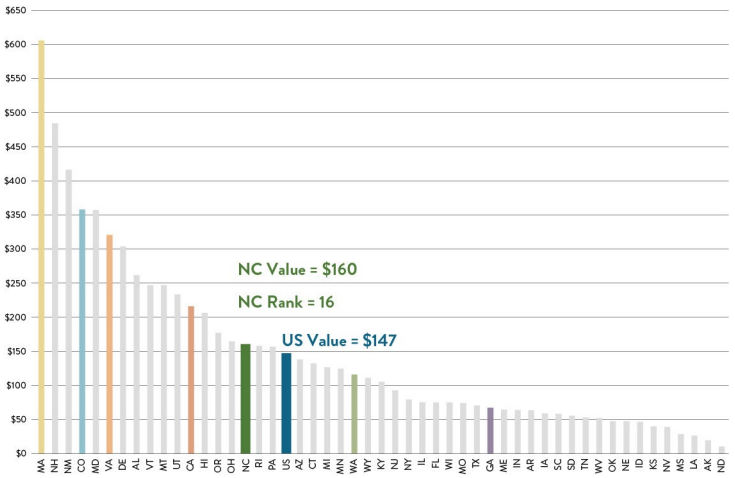
Funds awarded through the highly competitive federal Small Business Innovation Research (SBIR) grant program support technological innovation in companies with 500 or fewer employees. The awards enable the small businesses to evaluate the feasibility and scientific merit of new technology (Phase I up to approximately $275,000) and to develop the technology to a point where it can be commercialized (Phase II up to approximately $1,800,000).[1] 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.[2]

SBIR and STTR grants are the single largest source of early-stage technology development and commercialization funding for small businesses (more than $3.7 billion in 2019). 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.[3] The amount of SBIR/STTR funding in a state strongly correlates with successful technology-based economic development.

HOW DOES NORTH CAROLINA PERFORM?[4]

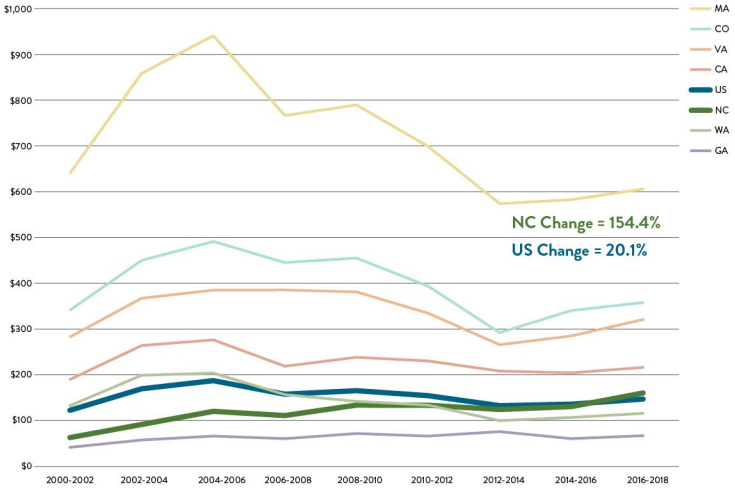
In terms of the level of SBIR/STTR funding relative to the size of its economy, North Carolina ranks 16th in the nation and above the U.S. average **[3.1A]**.[5] Specifically, the ratio of North Carolina's SBIR/STTR funding relative to the size of its total GDP is 9 percent higher than the U.S. value, meaning that the amount of SBIR/ STTR funding in North Carolina is about 9 percent higher than what we would expect based on the levels of such funding in all other states. However, its per-GDP level of SBIR/STTR funding is only 26 percent of the leading state's (Massachusetts) level. These levels of early-stage funding suggest that North Carolina is capitalizing on opportunities to fund and commercialize its innovative discoveries but still has room to improve given the disproportionate amount that goes to the top-performing states.

3.1A *Average Annual SBIR & STTR $ per $1 Million of Gross Domestic Product, All U.S. States, 2016-2018*



Source: National Science Board.

3.1B *Average Annual SBIR & STTR $ per $1 Million of Gross Domestic Product, Comparison States, 2000-2018*



Source: National Science Board.

[1] Amounts federal agencies may award without approval as of November 2021 retrieved from www.sbir.gov/about.
[2] Eleven federal agencies participate in the SBIR program and five in the STTR program.
[3] See, e.g., National Research Council. 2008. An Assessment of the SBIR Program. Washington, DC: The National Academies Press.
[4] The total award dollars reported here include both Phase I and Phase II SBIR/STTR awards.
[5] 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.
[6] Other steps include increased focus on SBIR/STTR grants by universities in the state, as well as by entrepreneur and innovation-support organizations in the state.

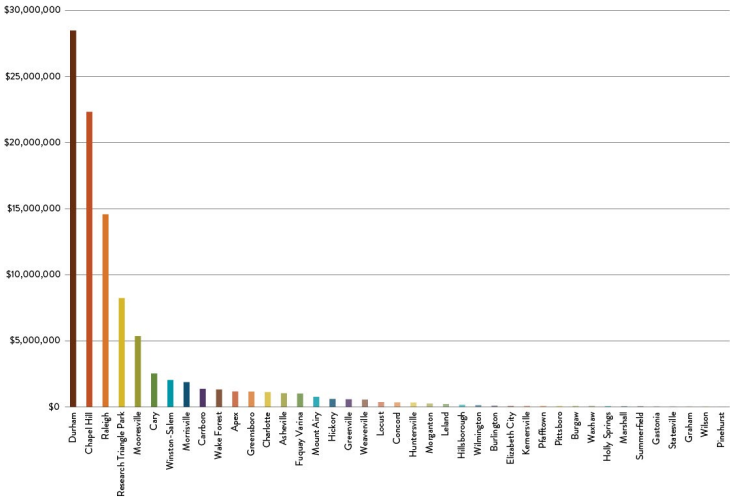
Indicator 3.1: SBIR & STTR Awards

It is important to note that a large percentage of the small tech-based businesses in North Carolina focus on the life sciences and medical technology sectors, which are among the state's strengths. Those businesses, in fact, have a high success rate in receiving SBIR/STTR grants from the Department of Health and Human Services. However, the interests of other large SBIR/STTR-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 154 percent, compared to the 20.1 percent increase for the U.S. overall **[3.1B]**. In contrast, the ratio of SBIR/STTR funding to GDP has increased 12.6 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, administered by the North Carolina Board of Science, Technology & Innovation (BSTI).[6] 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.

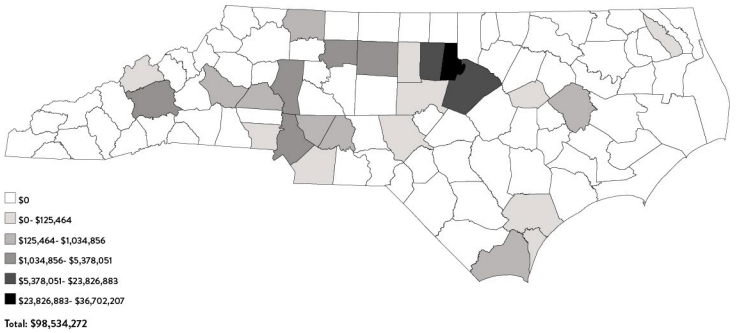
Within North Carolina, SBIR/STTR funding is highly concentrated in the Triangle region of the state, which contains the cities of Durham, Chapel Hill, the Research Triangle Park region, and Raleigh **[3.1C and 3.1D]**. Combined, these four locales receive 75 percent of the state's SBIR/STTR funding. The next 18 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 7 percent is dispersed across 28 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.

3.1C *Average Annual SBIR & STTR Awards, NC Cities, 2018-2020*



Source: SBIR.gov

3.1D *Average Annual Amount of SBIR & STTR Awards, N.C. Counties, 2018–2020*



Source: SBIR.gov

WHAT DOES THIS MEAN FOR NORTH CAROLINA?

North Carolina's strong 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 further improving the state's position in this category. Continued funding for the One North Carolina Small Business Program, which provides state grants to incentivize and match the SBIR/STTR grants, is critical on this front.[7] 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.

[7] This program was started after the BSTI's 2003 Tracking Innovation in NC report (available at: http://www.nccommerce.com/scitech/resources/innovationreports) indicated that NC ranked 34th 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 and John W. Hardin, David J. Kaiser and Albert N. Link (2020), "Public Support of Private Innovation: An Initial Assessment of the North Carolina SBIR/STTR Phase I Matching Funds Program", Annals of Science and Technology Policy: Vol. 4: No. 1, pp 1-79 (https://www.nowpublishers.com/article/Details/ASTP-015).

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 below 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

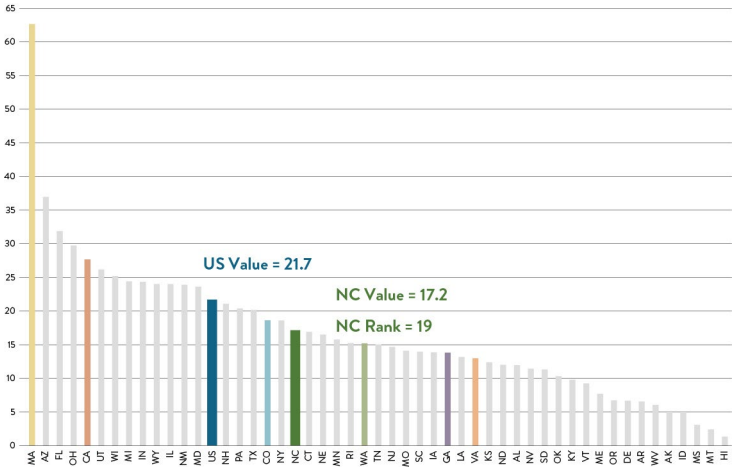
This indicator relates the number of academic-owned utility patents to the size of the doctoral science & engineering (S&E) workforce in academia. Academia includes two-year colleges, four-year colleges and universities, medical schools, and university-affiliated research centers. S&E doctorates include those in computer sciences; mathematics; biological, agricultural, or environmental life sciences; physical sciences; social sciences; psychology; engineering; and health fields.[1] 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.[2] As such, academic patents are one approximate measure of the degree to which the doctoral academic workforce generates results with perceived economic value.[3]

HOW DOES NORTH CAROLINA PERFORM?

The value of North Carolina's academic patents per 1,000 S&E doctorate holders in academia ranks 19th in the nation, with a level that is 79 percent of the U.S. value and 27 percent of the value of the top-ranking state, Massachusetts **[3.2A]**. North Carolina's below-average ranking may indicate that North Carolina has potential to increase patent productivity, given the relatively high academic R&D activity within the state (see Indicator 2.3) and that many universities have offices dedicated to commercialization.[4] Another explanation for the recent decrease in patents per 1,000 S&E doctorate holders may be the above-normal recent increase in North Carolinians who hold a doctorate. Between 1997 and 2017 the number of doctorate holders in North Carolina increased at an average annual rate of 2.3 percent, but between 2017 and 2019 the annual rate was 7.5 percent. This jump may have diluted the value for 2019 and may suggest increased patent productivity during the coming years.

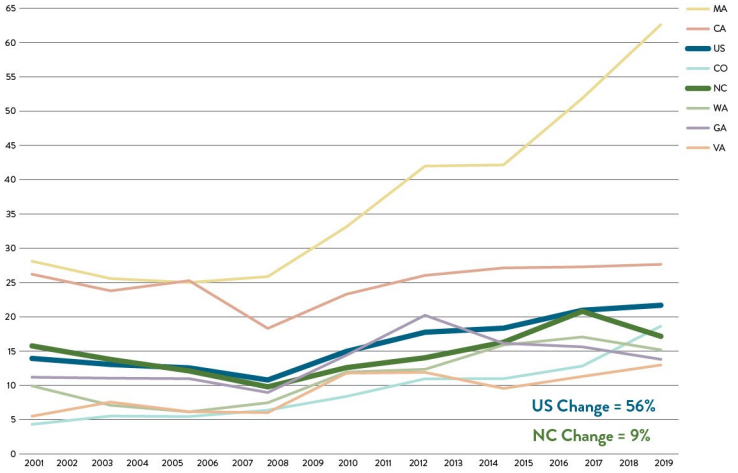
Between 2001 and 2017, the ratio of North Carolina's academic patents relative to S&E doctorate holders in academia increased at a rate of 32 percent and largely tracked the U.S. average **[3.2B]**. Including the recent decline in 2019, however, North Carolina's ratio is only 9 percent higher than in 2001, whereas the ratio for the U.S. overall increased by 56 percent. All comparison states except California have increased more than North Carolina in terms of academic patents per 1,000 S&E doctorate holders.

3.2A *Academic Patents Awarded per 1,000 Science & Engineering Doctorate Holders in Academia, All U.S. States, 2019*



Source: National Science Board

3.2B *Academic Patents Awarded per 1,000 Science & Engineering Doctorate Holders in Academia, Comparison States, 2001-2019*



Source: National Science Board

[1] S&E doctorate data exclude those with doctorates from foreign institutions and those above the age of 75.

[2] 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.

[3] 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.

[4] 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

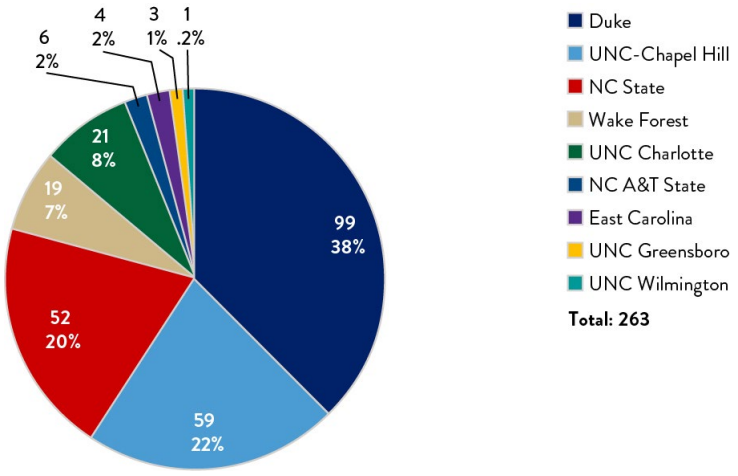
Within North Carolina, academic patenting activity is highly concentrated in the Research Triangle region and reflects both the nature and size of that region's universities' R&D activities, as well as the resources devoted to their patenting offices **[3.2C and 3.2D]**. The three largest universities in that region—Duke University, the University of North Carolina at Chapel Hill, and North Carolina State University—account for 80 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). UNC-Charlotte and Wake Forest University in Winston-Salem also have significant academic patenting activity, receiving 8 percent and 7 percent of the state total, respectively. North Carolina A&T State University, East Carolina University, UNC Greensboro, and UNC Wilmington account for 2 percent, 1 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 of states 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 19th place ranking on academic patenting puts it in the upper middle 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.

To continue making improvements, 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.[5] 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.[6] 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.

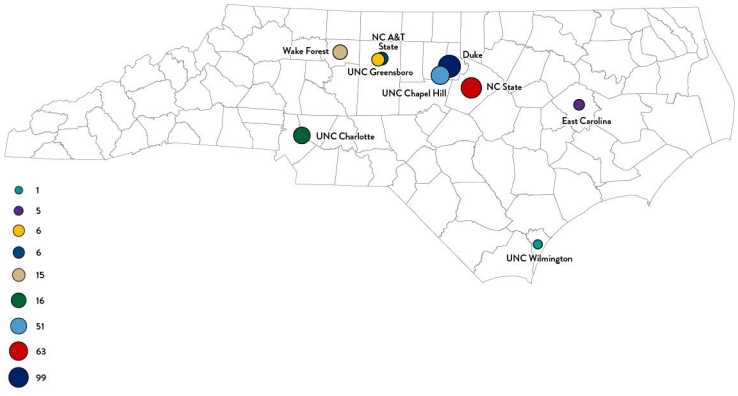
3.2C *Average Annual Academic Patents Awarded to N.C. Universities, 2018-2020*



Source: Association of University Technology Managers.

Note: Data not available for NC A&T State University FY2018 and UNC Wilmington FY2020 and were not included in the average.

3.2D *Average Annual Academic Patents Awarded to N.C., Universities, 2018-2020*



Source: Association of University Technology Managers

[5] *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.

[6] Recommendations of the Governor's Innovation-to-Jobs Working Group. March 2015. Available at: https://www.nccommerce.com/Portals/6/Documents/Resources/I2J%20Recommendations%20Final.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, and since the early 2000's has been increasing at a rate lower 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

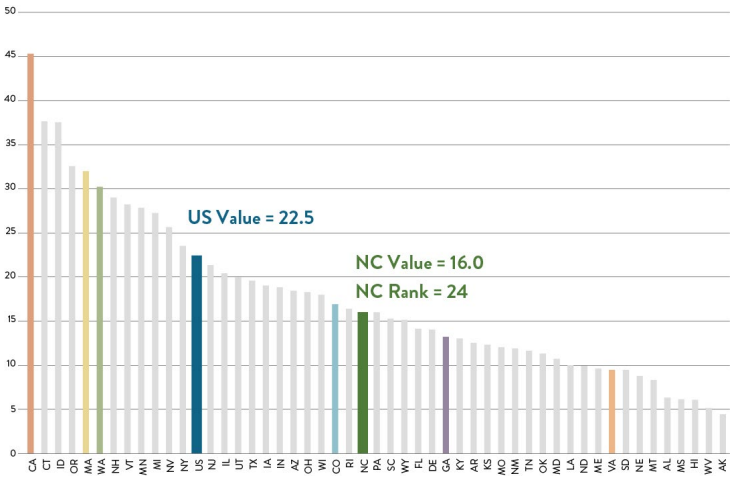
This indicator represents state patent activity normalized to the size of a locale's science & engineering workforce and its economy. For the state-by-state charts (3.3A and 3.3B), utility patents—commonly known as patents for inventions—are presented.[1] The science & engineering workforce includes engineers and computer, mathematical, life, physical, and social scientists.[2] 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.[3] 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?

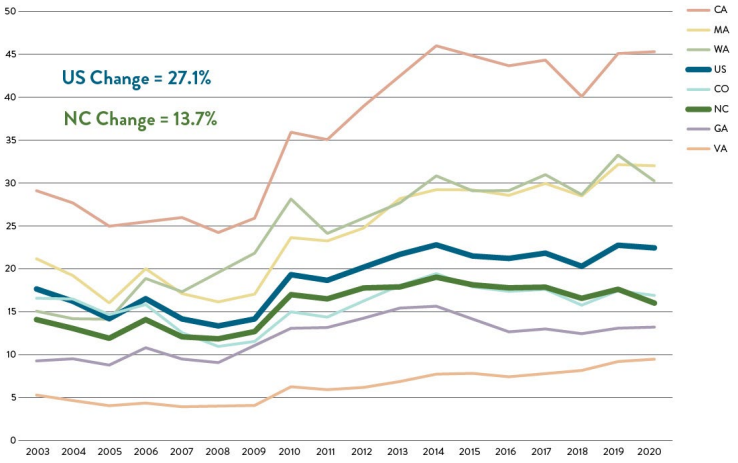
The value of North Carolina's patents per 1,000 individuals in science and engineering occupations ranks 24th in the nation, with a level that is 71 percent of the U.S. value and 35 percent of the value of the highest-ranking state, California **[3.3A]**. Among the comparison states, North Carolina's rate of patenting ranks ahead of its neighbors, Virginia, and Georgia but behind California, Washington, and Massachusetts, and Colorado. Overall, North Carolina's rate of patents compares less favorably than its rate of academic patents, reflecting, in part, its lower industry R&D ranking (see indicator 2.2) relative to academic R&D (see indicator 2.3). As a broad indicator of nonacademic innovative activity within a state, this indicator suggests that North Carolina's nonacademic private sector is not as strong as its academic sector at initial discovery and protection of innovative ideas. From 2003 to 2015, the ratio of North Carolina's patents to individuals in science & engineering occupations increased at a rate similar to the U.S. but since 2015 has lagged behind, growing at an overall rate of 13.7% compared to the national average of 27.1% **[3.3B]**.

3.3A *Patents Awarded per 1,000 Individuals In Science and Engineering Occupations, All U.S. States, 2020*



Source: National Science Board

3.3B *Patents Awarded per 1,000 Individuals In Science and Engineering Occupations, Comparison States, 2003-2020*



Source: National Science Board

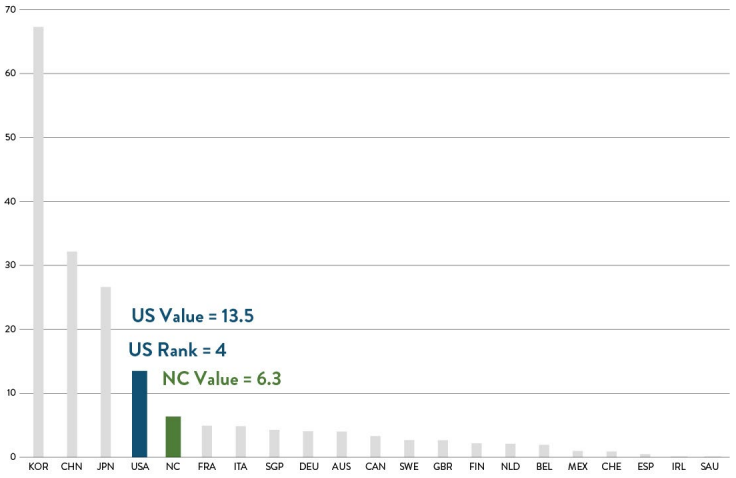
[1] See indictor 3.2 for a more detailed description of utility patents. The U.S. Patent and Trademark Office (USPTO) classifies patents geographically according to the residence of the first-named inventor. Only U.S.-origin patents are included.
[2] Managers, technicians, elementary and secondary schoolteachers, and medical personnel are not included.
[3] 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

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 55 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 and relative to each nation's GDP, the U.S. ranks 4th but well behind the leading countries, South Korea, China, and Japan **[3.3C]**. Still, the United States is significantly ahead of France, Italy, Spain, and the rest of the other comparison countries. Since 2000, the patent activity of China has risen considerably (242 percent) and much faster than the rate for all other comparison countries, whose combined average actually fell by 43 percent over the same period **[3.3D]**. Fifteen of the comparison countries decreased their rate of patenting activity over time.[4] U.S. grants for direct patent applications as a function of GDP is near the 2000 value, while North Carolina's value increased by 40 percent.

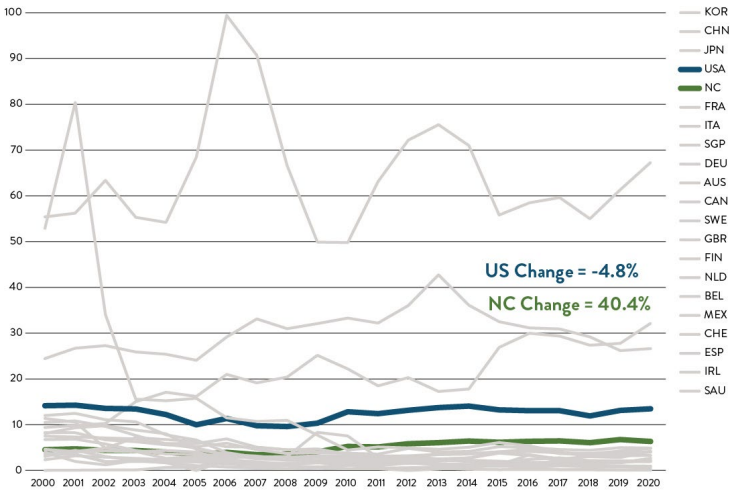
3.3C *Grants for Direct Patent Applications Per Billion Dollars in GDP, Comparison Countries, 2020*



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

Note: 2020 data for the United Arab Emirates is unavailable.

3.3D *Grants for Direct Patent Applications Per Billion Dollars in GDP, Comparison Countries, 2000-2020*



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

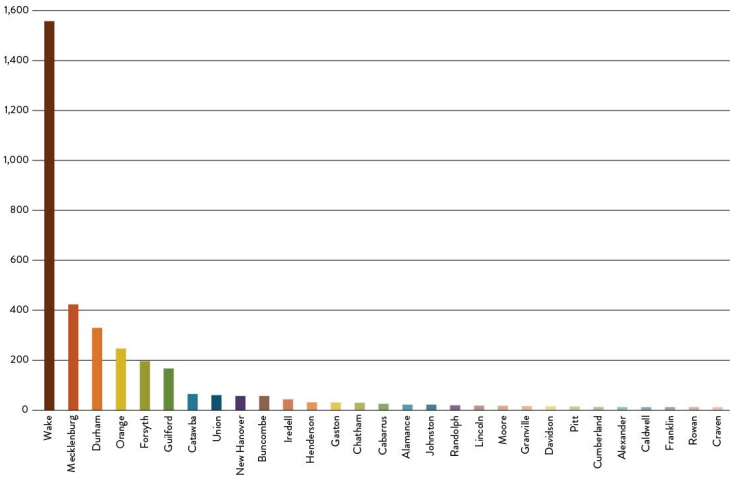
Note: Time series data for the United Arab Emirates is unavailable.

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 42 percent of all the state's patents, has the largest share, followed by Mecklenburg (11 percent), Durham (9 percent), Orange (7 percent), Forsyth (5 percent) and Guilford (5 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).

WHAT DOES THIS MEAN FOR NORTH CAROLINA?

Academic institutions own less than 10 percent of North Carolina's patents,[5] 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.

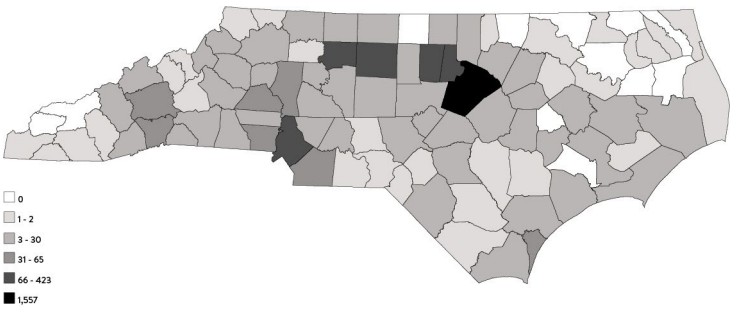
3.3E *Average Annual Number of Patents, Selected N.C. Counties, 2018-2020*



Source: U.S. Patent and Trademark Office, via Neo IP Intellectual Property Law Firm and Magic Number, Inc. d/b/a Patent Forecast.

Note: Counties with 10 or more patents are included.

3.3F *Average Annual Number of Patents, N.C. Counties, 2018–2020*



Source: U.S. Patent and Trademark Office, via Neo IP Intellectual Property Law Firm and Magic Number, Inc. d/b/a Patent Forecast.

[4] While difficult to see in chart 3.3D, the raw data indicate that all but five of the comparison countries decreased over time.

[5] 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 and is increasing slower than the U.S. average.
- The average size of North Carolina's venture capital deals ranks below the U.S. average and is increasing slower than the U.S. average.
- North Carolina's venture capital investments are highly concentrated in a small number of urban counties and counties containing major universities.

INDICATOR OVERVIEW

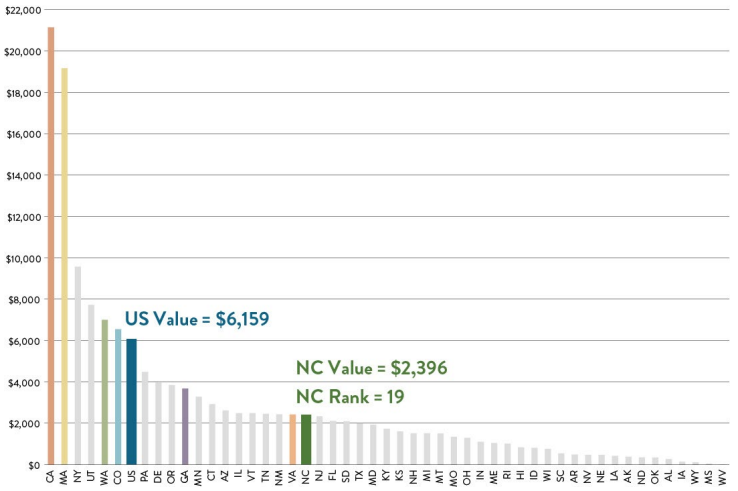
Venture capital dollars disbursed per $1,000 in state Gross Domestic Product (GDP) is a measure of the magnitude of venture capital investment, adjusting for the size of a state economy. Venture capital is financial capital provided to early-stage, high-potential, high-risk, growth startup companies. 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 19th 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 relative to state domestic product in Massachusetts and California, which skew the national average upward. Nearly 50 percent of all U.S. venture capital disbursements were made in California in 2019. New York and Massachusetts companies received 12.5 percent and 8.6 percent, respectively, of all venture capital investments, and no other state received more than 5 percent.

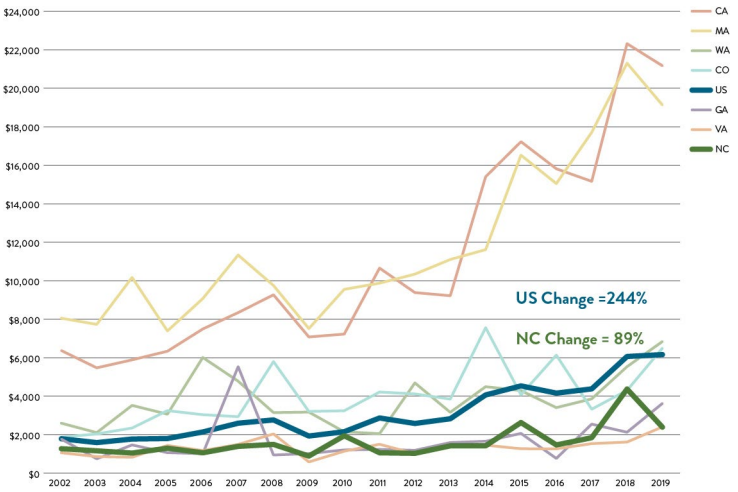
Venture capital investment within the U.S. increased relative to GDP by 244 percent from 2002 to 2019 **[3.4B]**. Investments in North Carolina firms also rose over the same period but at a considerably lower rate of 89 percent. North Carolina ranked last among comparison states in 2019, behind its two regional neighbors Georgia and Virginia, which all ranked below the U.S. average. Recent trends suggest there is potential for North Carolina to improve its standing, as San Francisco and New York-based venture capital firms increasingly divert their funding away from the Bay Area, New York, and Boston.[1] Further, venture capital firms have increased their physical presence in the Southeastern U.S., with venture capital establishments up 30 percent between 2019 and 2021.[2] It is

3.4A *Venture Capital Dispersed per $1 Million of GDP, All U.S. States, 2019*



Source: National Science Board, Pitchbook.

3.4B *Venture Capital Dispersed per $1 Million of GDP, Comparison States, 2002-2019*



Source: National Science Board, Pitchbook.

[1] Revolution and PitchBook, "Beyond Silicon Valley: Coastal Dollars and Local Investors Accelerate Early-Stage Startup Funding Across the US", 2021.
[2] Embarc Collective, "Southeast Capital Landscape Report", 2021.

important that the start-up communities across North Carolina are poised to take advantage of this shift.

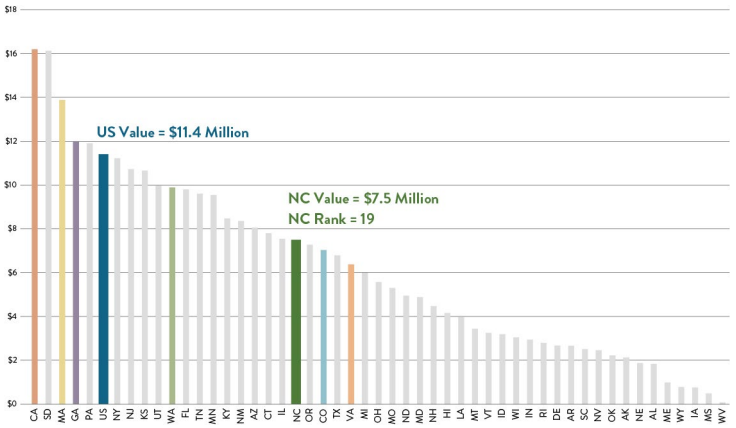
The average funding amount per deal is another indicator of venture capital activity, though it can vary widely year-to-year, especially in states with low number of deals. For example, in 2019 South Dakota ranked second in venture capital disbursed per deal among all states but was ranked last in 2017. North Carolina ranked 19th in 2019, with a value that was 66 percent of the U.S. average.**[3.4C]**. Between 2002 and 2019, North Carolina's performance on this measure increased by 9.1 percent, compared to the U.S. rate of 26.2 percent **[3.4D]**. It should be noted that these dollar amounts are not adjusted for inflation, which increased by 42 percent over the same period meaning the purchasing power of the average deal has decreased.[3] Among comparison states, the average deal size within North Carolina was higher than in Colorado and Virginia in 2019. Only Massachusetts and California average deal sizes have matched the rate of inflation.

From 2018 to 2020, a total of $6.4 billion worth of venture capital investments were made in North Carolina. However, 94 percent of this investment was made in three urban counties (Wake, Durham, and Mecklenburg) **[3.4E]**. Overall, 62 percent of all venture capital investments took place in Wake County, followed by Durham (19.7 percent) and Mecklenburg (12.6 percent) over this timeframe. Venture capital investments took place in thirteen other counties, which had a combined total of 6 percent of North Carolinas' remaining investment activity.

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 or the New York and Boston metro areas—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.

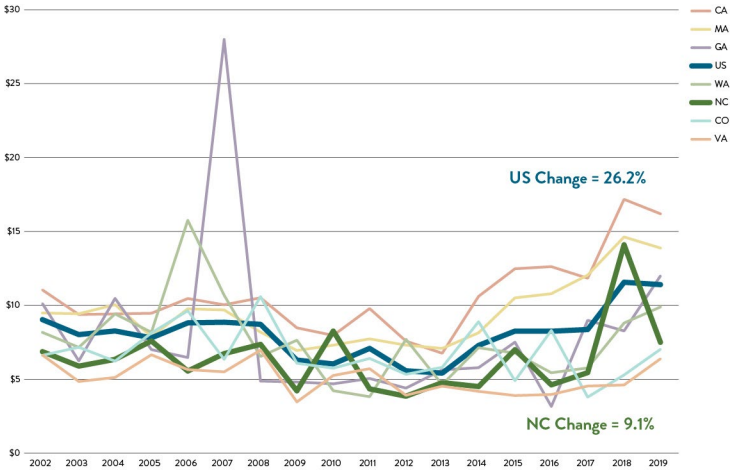
3.4C *Venture Capital Disbursed per Deal, All U.S. States, 2019*



Source: National Science Board, Pitchbook.

Note: Current Dollars in Millions (not adjusted for inflation).

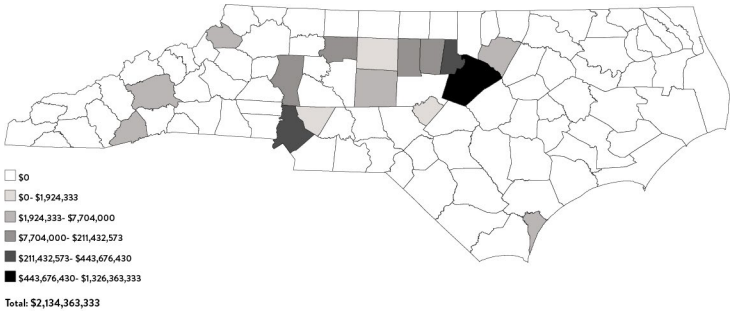
3.4D *Venture Capital Disbursed per Deal, Comparison States, 2002-2019*



Source: National Science Board.

Note: Current Dollars in Millions (not adjusted for inflation).

3.4E *Location of Venture Capital Investments in N.C., Average Annual Investments, 2018-2020*



Source: PitchBook Data Inc.

[3] U.S. Bureau of Labor Statistics, Consumer Price Index for All Urban Consumers (CPI-U)

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.

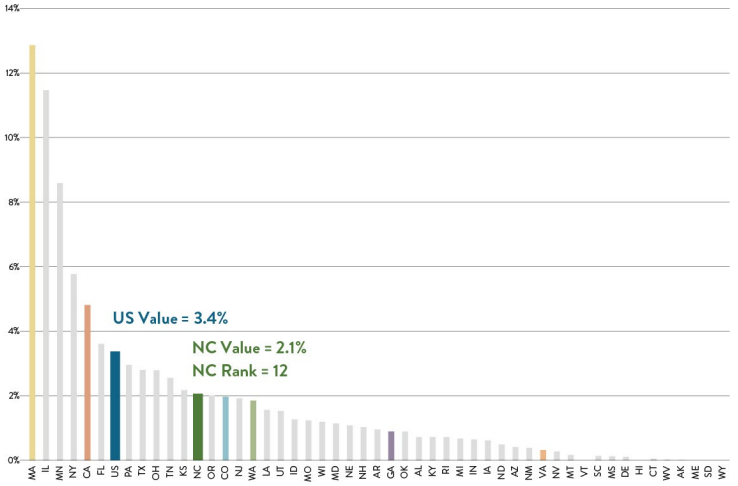
This indicator measures technology license income two ways: 1) gross income received and 2) running royalties received, with each measured as a percentage of academic science & engineering R&D expenditures. Gross income is the more inclusive measure, and it includes license issue fees, payments under 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 12th in the nation, with a value that is 61 percent of the U.S. value and 16 percent of the value of the top-ranking state, Massachusetts **[3.5A]**. Among the comparison states, North Carolina ranks behind Massachusetts and California, but ahead of Washington, Georgia, Virginia, and Colorado.

North Carolina fares similarly for running royalties as a percentage of academic science & engineering R&D expenditures, ranking 13th in the nation, with a value that is 63 percent of the U.S. value and 11 percent of the value of the top-ranking state, Illinois **[3.5B]**.

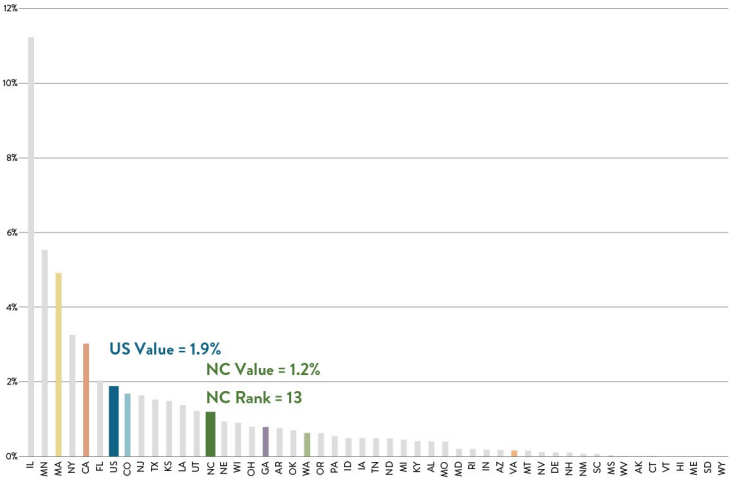
3.5A *Academic License Income (Gross Received) as a Percentage of Academic R&D Expenditures, All U.S. States, 2018-2019 Average*



Sources: Association of University Technology Managers and National Science Foundation

Note: Values for Wake Forest University were extrapolated based on historical data.

3.5B *Academic License Income (Running Royalties) as a Percentage of Academic R&D Expenditures, All U.S. States, 2018-2019 Average*



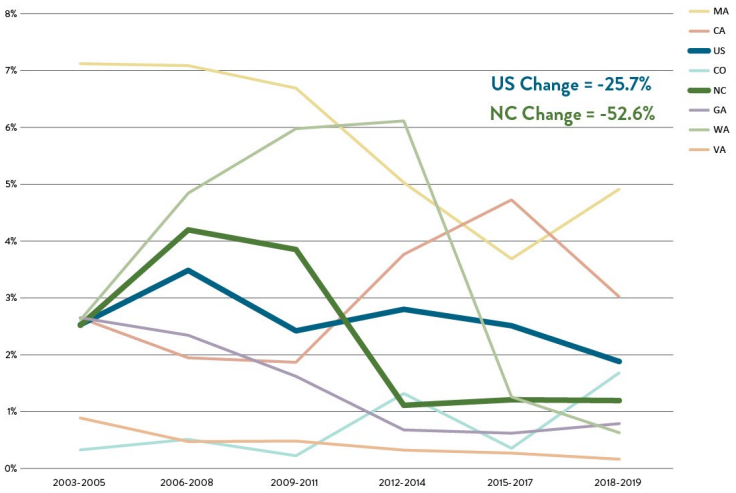
Sources: Association of University Technology Managers and National Science Foundation.

Note: Values for Wake Forest University were extrapolated based on historical data.

Indicator 3.5: Technology License Income

Among the comparison states, North Carolina ranks behind California, Massachusetts, and Colorado, but ahead of Georgia, Washington, and Virginia. Since 2000, North Carolina's running royalties as a percentage of academic science & engineering R&D expenditures have decreased by 52.6 percent. The U.S. average has also decreased over the same period but to a lesser extent, with a decrease of 25.7%. California and Colorado are the only two comparison states whose universities and nonprofit research institutions have increased their running royalties as a percentage of academic R&D over time **[3.5C]**.[1]

3.5C *Academic License Income (Running Royalties) as a Percentage of Academic R&D Expenditures, Comparison States, Three-Year Averages, 2003-2019*



Sources: Association of University Technology Managers and National Science Foundation.

Note: Values for Wake Forest University were extrapolated based on historical data. Because Academic R&D Expenditures were not available for 2020, a two-year average (2018-2019) was used.

[1] A small number of technologies at a small number of universities often account for a large majority of a state's running royalties. In North Carolina, a handful of medical devices and diagnostics generated large royalties between 2002 and 2012. When those royalties ended, North Carolina's total royalties decreased.

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]**.[2] During 2018 and 2019, together the universities received, on average, more than $39 million in licensing income, compared to a high of more than $107 between 2009 and 2010.[3]

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.[4] 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.[5] 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.

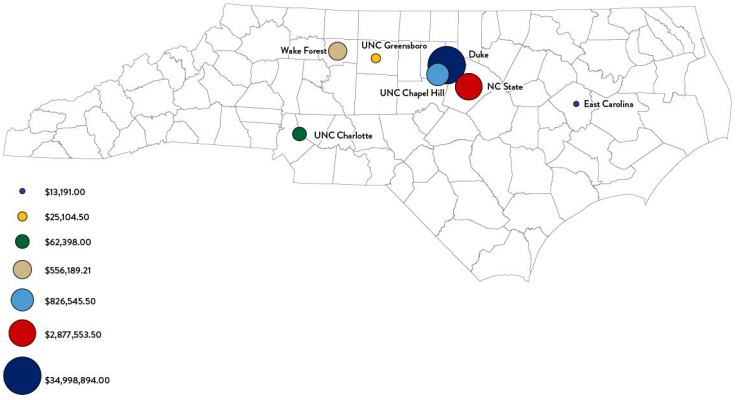
3.5D *Average Annual Academic License Income, U.S. Average and N.C. Institutions, 2018-2019*

HIGHER EDUCATION INSTITUTION	GROSS RECEIVED	RUNNING ROYALTIES
US Average	**$15,148,304**	**$9,208,368**
Duke	$54,449,487	$34,998,894
East Carolina	$25,960	$13,191
NC State	$5,385,678	$2,877,554
UNC-Chapel Hill	$7,477,655	$826,546
UNC-Charlotte	$138,526	$62,398
UNC Greensboro	N/A	$25,105
Wake Forest	$592,952	$556,189

Source: Association of University Technology Managers.

Note: UNC-Greensboro did not report gross income during this period. Values for Wake Forest were projected based on historical data.

3.5E *Location of Academic License Income (Running Royalties) in N.C., Average Annual Income, 2018-2019*



Source: Association of University Technology Managers.

Note: Values for Wake Forest University were projected based on historical data.

[2] These seven universities have offices focusing on technology patenting and commercialization. North Carolina A&T State University and UNC Wilmington have dedicated technology transfer offices, but these institutions have not historically reported gross income and have never reported running royalties. All data are self-reported by the universities to the Association of University Technology Managers (AUTM) via its Annual Licensing Survey. While it is possible that some NC universities have technology license income not reported to AUTM, the likelihood and amount are very low and not likely to change the findings presented here significantly.

[3] Duke is the only North Carolina university with running royalties considerably higher than the U.S. average. The remaining six universities have running royalties significantly lower than the U.S. average.

[4] *Our Time, Our Future: The UNC Compact with North Carolina, Strategic Directions 2013-2018.*

[5] Recommendations of the Governor's Innovation-to-Jobs Working Group. March 2015. Available at: https://files.nc.gov/nccommerce/documents/files/I2J_Recommendations.pdf

Indicator 3.6: University Startups

KEY FINDINGS

- North Carolina's average number of university startups formed per $1 million of academic science and engineering R&D expenditures ranks above the U.S average.
- North Carolina's average number of startups formed & remaining in home state per $1 million of academic science and engineering R&D expenditures ranks above the U.S. average.
- 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 since 2000, particularly since 2011.
- Within North Carolina, eight universities produced startups during 2018 and 2019, three of them at a rate higher than the national average.

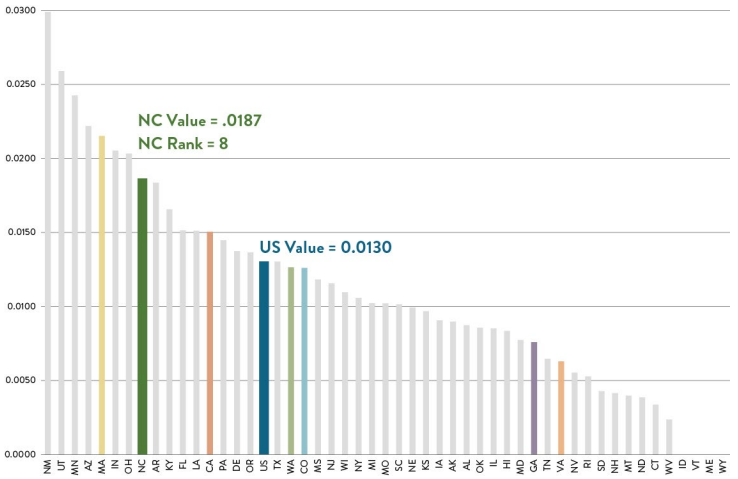
INDICATOR OVERVIEW

Startup companies that originate within universities, also commonly known as spinoffs, are companies founded to commercialize technologies that were developed through university research and development (R&D). Often, universities claim the intellectual property (IP) rights to these technologies, which results in the creation of licenses to this IP for the university and patents for new companies. Most, but not all, university startups remain within the state in which they were founded, providing significant development and income gains to those local economies. This indicator measures university startups in two ways: 1) the average number of university startups formed per $1 million of academic science and engineering R&D expenditures, and 2) the average number of university startups formed *and stayed in their home state* per $1 million of academic science and engineering R&D expenditures.

HOW DOES NORTH CAROLINA PERFORM?

In terms of the number of university startups formed per $1 million of academic science and engineering R&D expenditures, North Carolina ranks 8th in the nation, with a rate just below that of the national average **[3.6A]**. North Carolina also ranks above all comparison states and has a value that is 62 percent of the rate of the highest-ranking state, New Mexico. Similarly, when measured against university startups that remained within their home state, North Carolina ranks 7th in the nation and is 55 percent above the national average **[3.6B]**. North Carolina ranks ahead of all comparison states for the number of start-ups remaining in-state, though Massachusetts has a value that is only slightly lower. Although in the top ten, North Carolina's value on this measure is half the value of New Mexico.

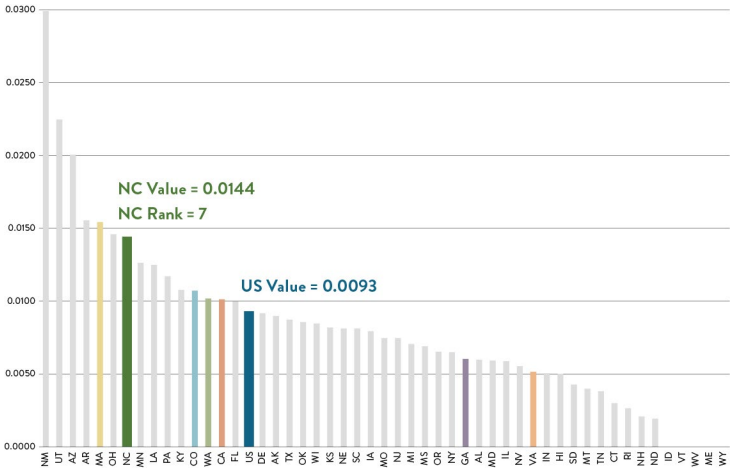
3.6A *Average Number of University Startups Formed per $1 Million of Academic R&D Expenditures, All U.S. States, 2018-2019*



Source: Association of University Technology Managers and National Science Foundation.

Note: Values for Wake Forest University were projected based on historical data.

3.6B *Average Number of University Startups Formed & Remaining in Home State per $1 Million of Academic R&D Expenditures, All U.S. States, 2018-2019*



Source: Association of University Technology Managers and National Science Foundation.

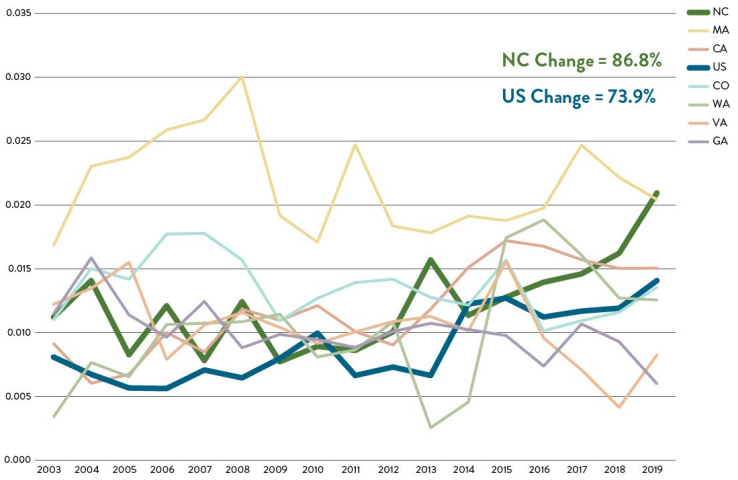
Note: Values for Wake Forest University were projected based on historical data.

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.[1] While quite variable over this time fame, North Carolina experienced an increase of 86.8 percent from 2000 to 2019 **[3.6C]**. Meanwhile, the U.S. experienced a positive trend of 73.9 percent. North Carolina has improved more than all other comparison states, except for Washington, which has increased by 269 percent since 2000 but started at a low value. The rate of start-up formation has accelerated in North Carolina over the past few years across multiple universities. The trend is important, because no single institution is driving the change, however this indicator is sensitive to yearly variations.

From 2018-2019, eight North Carolina universities reported having formed university startups—Duke University, ECU, North Carolina State University, the University of North Carolina at Chapel Hill, the University of North Carolina at Charlotte, the University of North Carolina at Greensboro, the University of North Carolina at Wilmington, 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, 2003-2019*



Source: Association of University Technology Managers and National Science Foundation.

Note: Values for Wake Forest University were projected based on historical data.

3.6D *Average Annual Number of University Startups Formed & Stayed in Home State, U.S. Average and N.C. Institutions, 2018-2019*

HIGHER EDUCATION INSTITUTION	AVERAGE ANNUAL NUMBER OF UNIVERSITY STARTUPS FORMED	AVERAGE ANNUAL NUMBER OF UNIVERSITY STARTUPS FORMED & STAYED IN HOME STATE
U.S. Total	**6**	**4**
Duke	16	15
ECU	2	2
NC State	21	17
UNC-Chapel Hill	8	7
UNC-Charlotte	3	3
UNC-Greensboro	6	N/A
UNC-Wilmington	1	1
Wake Forest	5	3

Source: Association of University Technology Managers.

Note: UNC-Greensboro did not report number of startups that stayed in home state for this period.

[1] 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?

North Carolina improved from 20th to 8th in university start-ups formed as a percentage of academic R&D spending compared to the 2015-2017 average. 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. All else equal, a top 5 ranking in start-up formation could be expected given the level of R&D expenditures at North Carolina's universities. However, the translation of research and science to commercialize technology does not happen passively, as evident from the previous ranking of 20th when academic R&D spending was 3rd nationally. This upward trend is likely attributable to several factors, but there has been a concerted effort by policy makers and universities to maximize the value generated by universities to generate economic growth. 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.[2] 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.[3] Initiatives such as these and others focused on increasing the commercial impact of academic discoveries should continue to be a high priority for state and university policy makers.

[2] *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.

[3] Recommendations of the Governor's Innovation-to-Jobs Working Group. March 2015. Available at: https://www.nccommerce.com/Portals/6/Documents/Resources/I2J%20Recommendations%20Final.pdf

Indicator 4.1: High SET Employment Establishments & Formations

KEY FINDINGS

- The percentage of North Carolina's business establishments classified as having high SET employment ranks above the U.S. average and increased at a rate twice that of the U.S. average between 2000 and 2020.
- North Carolina's high SET employment establishments are highly concentrated in a small number of urban counties.

INDICATOR OVERVIEW

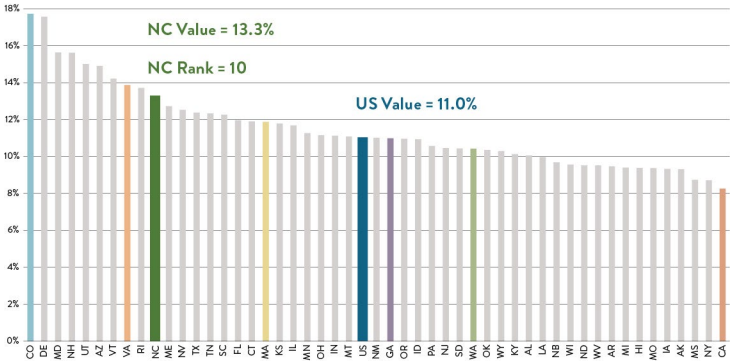
This indicator measures high SET employment establishments as the percentage of a state's business establishments that are classified as being part of high SET employment industries.[1] High SET employment industries are defined as those in which the proportion of employees in technology-oriented occupations 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.[2]

States often consider high SET employment industries desirable, in part because they typically compensate workers better than other industries do (see indicator 1.3C). Moreover, because the business base of a state is constantly changing as new businesses form and others cease to function, a high percentage of high SET employment business formations indicates an increasingly prominent role for these industries.

HOW DOES NORTH CAROLINA PERFORM?

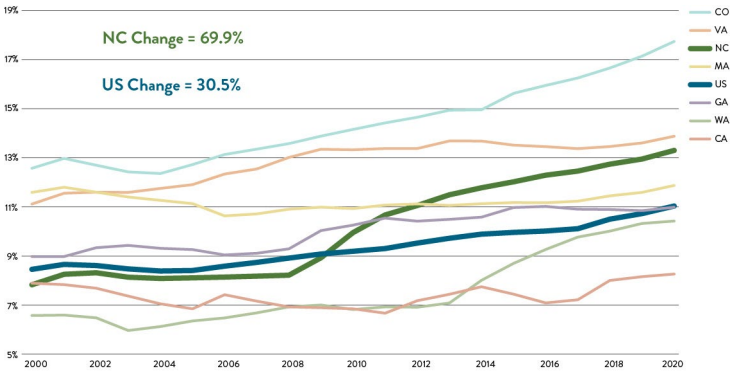
North Carolina's high SET employment establishments represent 13 percent of all business establishments in the state, with a value that ranks 10th in the nation and is 121 percent of the U.S. value and 75 percent of the value of the top-ranking state, Colorado **[4.1A]**. Among the comparison states, North Carolina's percentage of high SET employment establishments ranks behind Colorado and Virginia but is increasing at a faster rate. The percentage of high SET employment business establishments in North Carolina has increased by 69.9 percent since 2000, however, a rate almost twice the rate for the U.S., 30.5 percent, and faster than the rates of all comparison states, which average 25.7 percent **[4.1B]**. Notably, after 2008 the percentage of high SET employment establishments started to increase at a faster rate in North Carolina. This was more likely due to closures of low SET establishments than an increase in high SET business formations, which would indicate their benefit to the economic resiliency of a region.

4.1A *High SET Employment Establishments as a Percentage of All Business Establishments, All U.S. States, 2020*



Source: U.S. Bureau of Labor Statistics

4.1B *High SET Employment Establishments as a Percentage of All Business Establishments, Comparison States, 2000 - 2020*



Source: U.S. Bureau of Labor Statistics

[1] Data for the current report was taken from the U.S. Bureau of Labor Statistics Quarterly Census of Employment and Wages. Previous reports used U.S. Census Bureau Census Business Information Tracking Series, which has been discontinued. The two datasets provide the same insights but cannot be directly compared.

[2] See the Appendix for a list of the 48 industries (by 4-digit NAICS code) that are defined as having high SET employment.

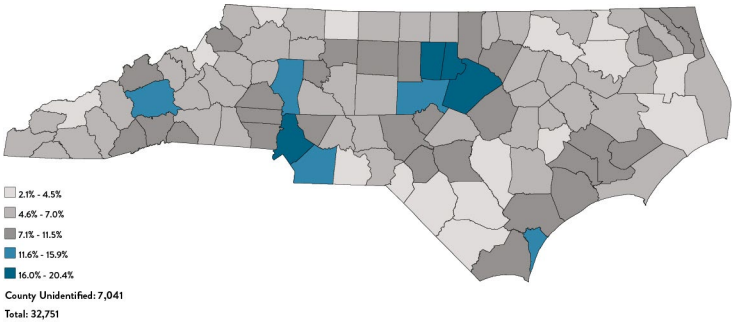
Indicator 4.1: High SET Employment Establishments & Formations

Although high SET employment establishments are located in each of North Carolina's 100 counties, half (50.2 percent) of those establishments are located in just three counties—Wake (24.2 percent), Mecklenburg (20.5percent), and Durham (5.5percent) **[4.1C]**. The next six counties combined—Guilford (4.7 percent), Buncombe (3.9 percent), New Hanover (3.4 percent), Forsyth (3.1 percent), Orange (2.5 percent), and Union (2.5 percent)—account for another 20.1 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. Seven of these top nine counties also have a higher concentration of high SET employment establishments compared to the U.S. average (Guilford and Forsyth counties have lower than average values). Two additional counties, Iredell and Chatham, also have higher than national average concentrations. Of the remaining 86 counties, each has less than one percent of the state's high SET employment establishments.

WHAT DOES THIS MEAN FOR NORTH CAROLINA?

North Carolina's economy has historically been driven by lower-technology manufacturing industries, but since 2010 has achieved an above-average level of high SET employment establishments. 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.

4.1C *High SET Establishments as a Percentage of Total Establishments, N.C. Counties, 2020*



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 ranked below the U.S. average in the early 2000s, but increased at a faster rate and now is similar to 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

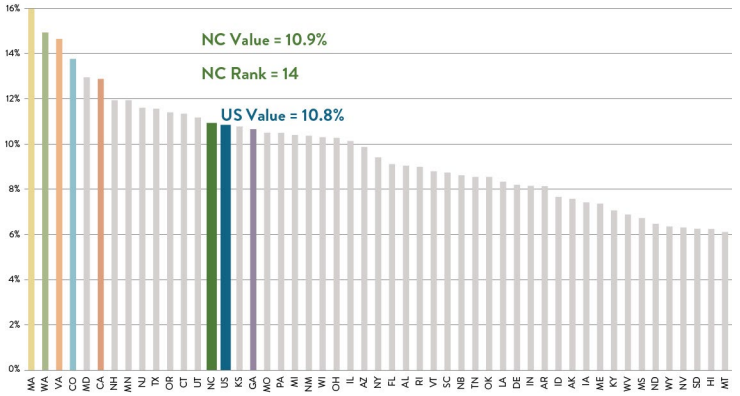
This indicator represents the extent to which a state's workforce is employed in industries with high employment in science, engineering, and technology (SET) occupations.[1] High SET employment industries are defined as those in which the proportion of employees in technology-oriented occupations is 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.[2]

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?

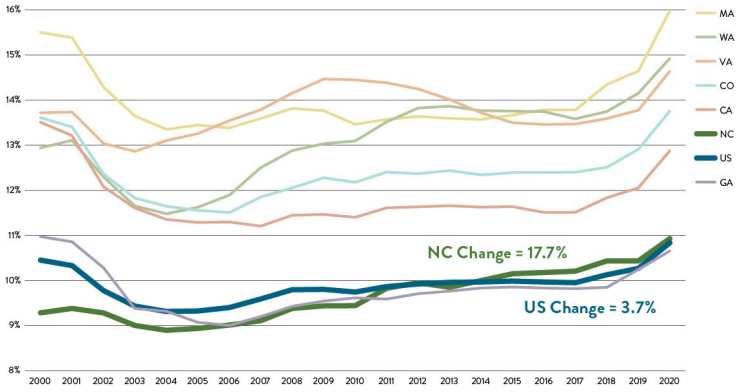
10.9 percent of North Carolina employees work in high SET employment establishments, a value that ranks 14th in the nation and is just above the U.S. average value and 68 percent of the value of the top-ranking state, Massachusetts **[4.2A]**. Among the comparison states, North Carolina's employment in high SET employment establishments as a percentage of total employment ranks second to last, but is just above, Georgia, which has a value of 10.7 percent. The percentage of North Carolina's employment in high SET employment establishments has increased by 17.7 percent since 2000. This rate of increase is higher than the 3.7 percent rate of increase for the U.S. and higher than the rates of all other comparison states **[4.2B]**.

4.2A *Employment in High SET Employment Establishments as a Percentage of Total Employment, All U.S. States, 2020*



Source: U.S. Bureau of Labor Statistics

4.2B *Employment in High SET Employment Establishments as a Percentage of Total Employment, Comparison States, 2000 - 2020*



Source: U.S. Bureau of Labor Statistics

[1] Data for the current report was taken from the U.S. Bureau of Labor Statistics Quarterly Census of Employment and Wages. Previous reports used U.S. Census Bureau Census Business Information Tracking Series, which has been discontinued. The two datasets provide the same insights but cannot be directly compared.

[2] See the Appendix for a list of the 48 industries (by 4-digit NAICS code) that are defined as having high SET employment.

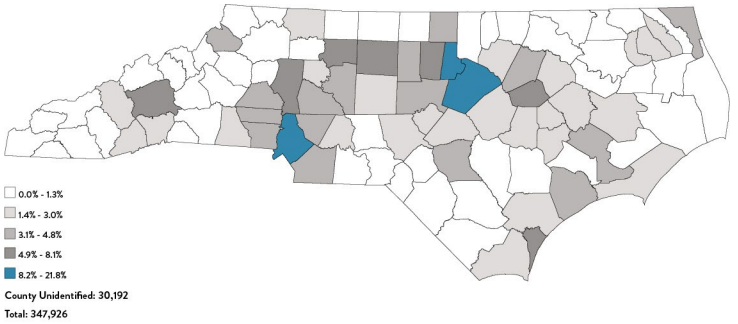
Indicator 4.2: High SET Employment

Although high SET employment establishments employ workers in nearly all of North Carolina's 100 counties, over two-thirds (69.5 percent) of those employees work in just three urban counties—Mecklenburg (29.4 percent), Wake (26.8 percent), and Durham (13.3 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 (10.8 percent). Establishments located in each of the next eight counties—Guilford (6.2 percent), Forsyth (3.1 percent), New Hanover (2.6 percent), Buncombe (2.4 percent), Cumberland (1.2percent), Iredell (1.2 percent), Orange (1.1 percent), and Catawba (1.1 percent)—account for 19 percent of the state's high SET workers. This means that establishments located in only 11 percent of the state's counties employ 88 percent of the state's high SET workers. Each of the remaining 89 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 above-average level of employment in high SET employment establishments reflects the recent growth in high SET industries forming within and locating to the state despite the facts that a large proportion of North Carolina remains rural in nature and has historically had 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, 2020***



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 behind the U.S. average.
- North Carolina's monthly rate of new business creation has decreased since 2000, while the U.S. average has increased.
- North Carolina's average opportunity share of new entrepreneurs ranks above the U.S. average.
- North Carolina's average opportunity share of new entrepreneurs has increased moderately since 2000, at a rate slightly faster than the U.S. average.

INDICATOR OVERVIEW

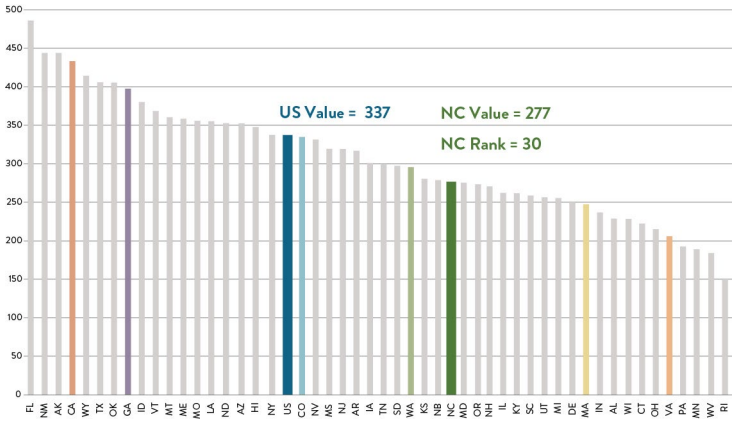
This indicator measures the state of entrepreneurial activity in North Carolina. Entrepreneurs provide expertise in transforming innovative ideas into valuable innovations. Strong entrepreneurial activity will help advance North Carolina's transition to a knowledge-based, technology-driven economy and 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.[1] 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 30th in the nation, with a level that is 82 percent of the U.S. value and 57 percent of the value of the top-ranking state, Florida[2] **[4.3A]**. Specifically, North Carolina's monthly rate of business creation is 0.28 percent; in other words, entrepreneurs in North Carolina started 280 businesses each month for every 100,000 adults living in the state. Among comparison states, North Carolina's monthly rate is in the bottom half—lower than California, Georgia, Colorado, and Washington but higher than Massachusetts and Virginia.

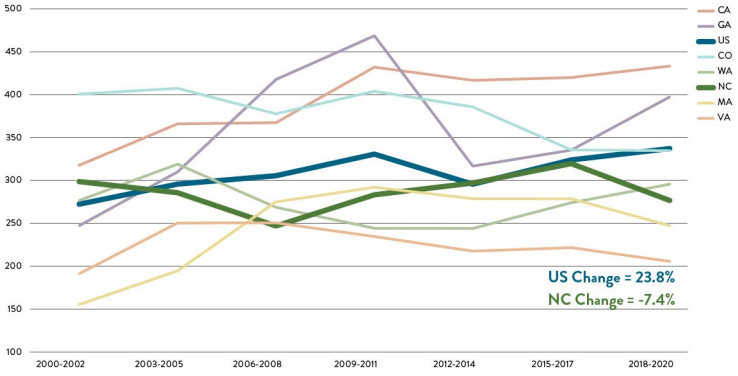
Since 2000, North Carolina's three-year entrepreneurship index average has remained fairly constant, while the U.S. average has steadily increased **[4.3B]**. In fact, North Carolina's current 3-year average (2018-2020) is 7.4 percent lower than its 2000-2002 value, and the U.S. index is 23.8 percent higher. Three of the comparison states—Massachusetts, California, and Georgia—experienced significant increases over time and grew faster than the North Carolina and U.S. averages. Colorado experienced declines in entrepreneurship from 2000-2020.

4.3A *Average Monthly Number of New Entrepreneurs Per 100,000 People, All U.S. States, 2018-2020*



Source: Kauffman Foundation.

4.3B *Average Monthly Number of Entrepreneurs Per 100,000 People, Comparison States, 2000-2020*



Source: Kauffman Foundation.

[1] 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.

[2] 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

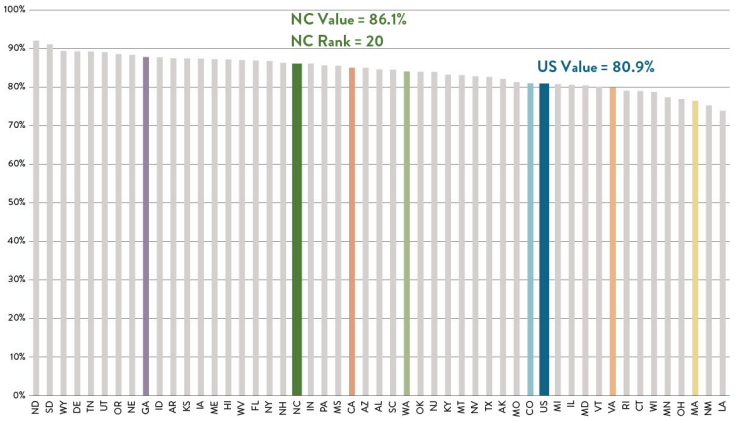
In terms of the average opportunity share of new entrepreneurs, North Carolina's ranks 20th in the nation, with a level that is 6 percent above the U.S. value and 94 percent of the value of the top-ranking state, North Dakota **[4.3C]**. Specifically, North Carolina's average opportunity share of new entrepreneurs averaged 86 percent between 2018 and 2020, meaning 86 percent of North Carolina's new entrepreneurs were not unemployed before starting their businesses. North Carolina's opportunity share of new entrepreneurs is higher than all comparison states except Georgia.

Since 2000, North Carolina's average opportunity share of new entrepreneurs has increased by 2.6 percent **[4.3D]**. During that same period of time, the opportunity share of new entrepreneurs in the U.S. overall decreased by 1.4 percent. In three of the comparison states, the opportunity share of new entrepreneurs also increased—Georgia and California—and at rates that were faster than North Carolina's rate of change. Massachusetts, Virginia, Colorado, and Washington had negative rates of change.

WHAT DOES THIS MEAN FOR NORTH CAROLINA?

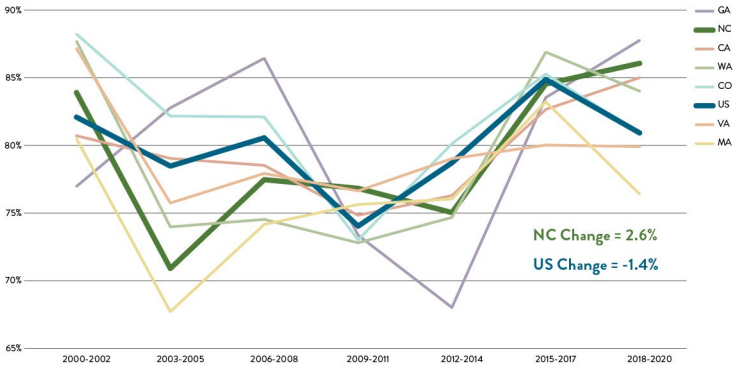
Several factors—such as economic and labor market conditions, industry mix, education, and culture—affect rates of entrepreneurship across states. Thus, while it is difficult to pinpoint causes of the different business creation rate scores across states, this indicator provides important insight into 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.

4.3C *Average Opportunity Share of New Entrepreneurs, All U.S. States, 2018-2020*



Source: Kauffman Foundation.

4.3D *Average Opportunity Share of New Entrepreneurs, Comparison States, 2000-2020*



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)[1] ranks below the U.S. average and has since at least the early 2000s.
- North Carolina and U.S. exports as a percentage of GDP have decreased from 20-year highs in the early 2010s but have now fallen to at or near 20-year lows.
- 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.

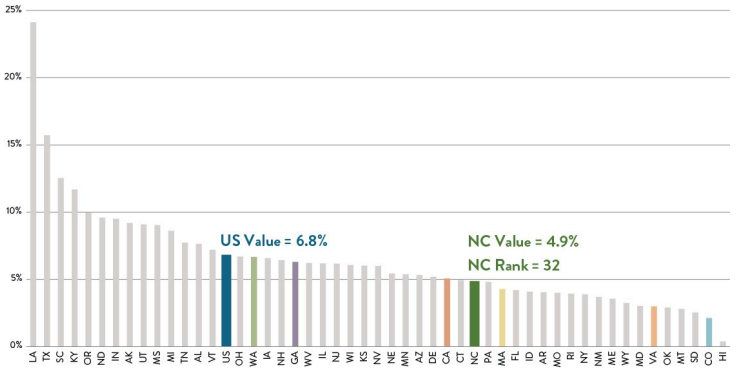
INDICATOR OVERVIEW

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.[2] 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., 80 percent of the world's buying power and lies 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.[3] 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?

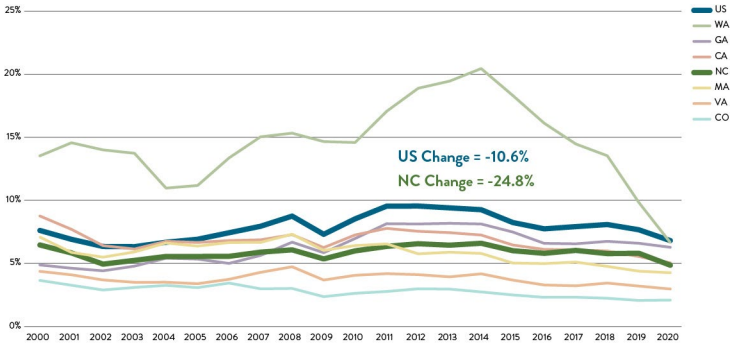
In terms of exports as a percentage of state GDP, North Carolina ranks 32nd in the nation, with a value that is 71 percent of the U.S. value and 20 percent of the value of the top-ranking state, Louisiana **[4.4A]**. Among the comparison states, North Carolina's exports as a percentage of state GDP ranks behind Washington, Georgia, and California, but ahead of Massachusetts, Virginia and Colorado. Between 2000 and 2020, North Carolina's exports as a percentage of state GDP decreased by 24.8 percent, a rate below the 10.6 percent increase for the U.S. average **[4.4B]**. While North Carolina's decrease ranks behind Georgia, whose exports as a percentage of state GDP increased, its rate of decrease is less than the rates for all other comparison states.[4]

4.4A *Exports as a Percentage of GDP, All U.S. States, 2020*



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

4.4B *Exports as a Percentage of GDP, Comparison States, 2000-2020*



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

[1] 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.

[2] 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.

[3] 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.

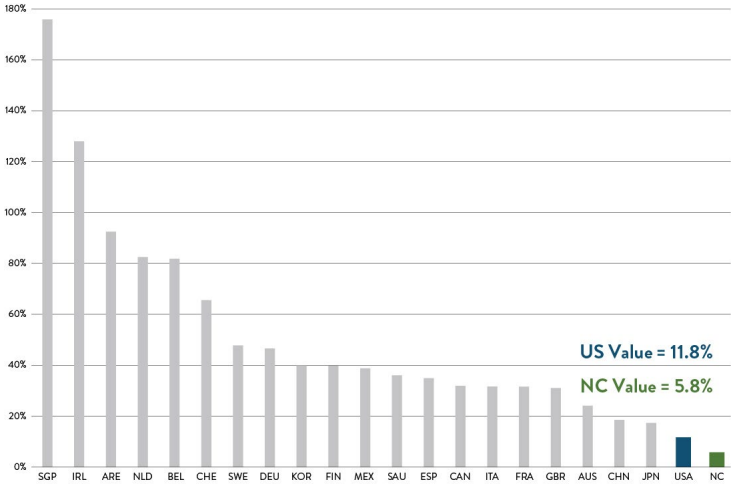
[4] After the 2008 global recession that negatively impacted economic and trade activity in 2009 and 2010, a quick recovery over the next 5 years resulted in 20-year highs in export levels, which have since declined and have dropped further following the global pandemic that started in early 2020.

Internationally, the U.S. ranks as the 169th most export-intensive country out of the 176 global economies for which data was available in 2019, making its export intensity 5.6 percent of the rate of the most export-intensive country, Luxembourg **[4.4C]**.[5] 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 88 percent, Japan at 66 percent, Mexico at 53 percent, and Germany at 51 percent) **[4.4D]**. A small number of countries saw their export intensities decrease (e.g., Canada at -28 percent, Saudi Arabia at -17percent, Singapore at -6.6 percent, Finland at -5.2 percent, and China at -11 percent).

WHAT DOES THIS MEAN FOR NORTH CAROLINA?

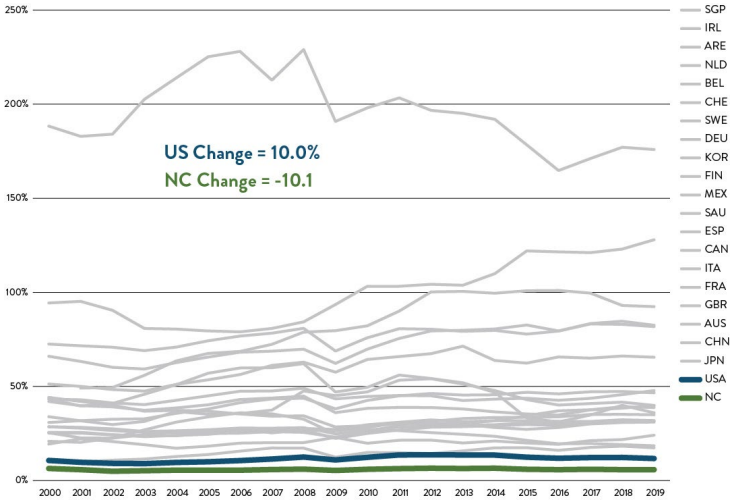
Exports continue to be one of the key drivers for North Carolina's economic development. In 2020, for example, North Carolina exported more than $28.4 billion in products and services to international markets.[6] Exporting helps companies in North Carolina diversify their business portfolios and become 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.[7] 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.[8]

4.4C *Exports as a Percentage of GDP, Comparison Countries, 2019*



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

4.4D *Exports as a Percentage of GDP, Comparison Countries, 2000-2019*



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

[5] 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).

[6] WISERTrade: State Exports by SIC & HS Database.

[7] 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.

[8] 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 (EDPNC) has staff in the state and in 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

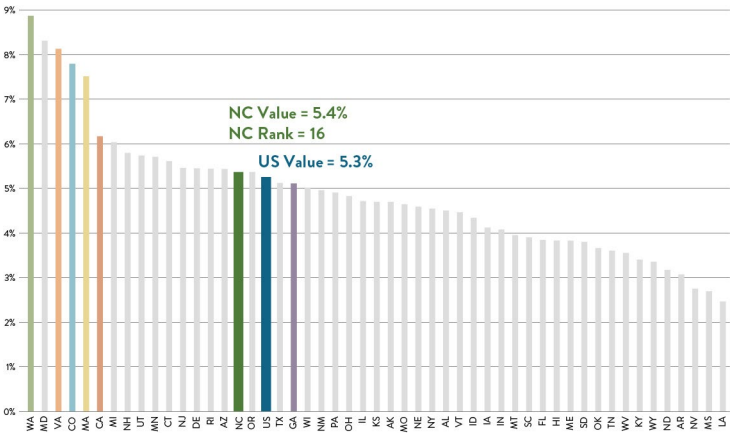
This indicator represents the extent to which a state's workforce is employed in S&E occupations. A high value indicates that a state's economy has a high percentage of technical jobs relative to other states. As such, it reflects the labor pool's interests, its level of skill development, and the nature 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 21st-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[1] 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.[2]

HOW DOES NORTH CAROLINA PERFORM?

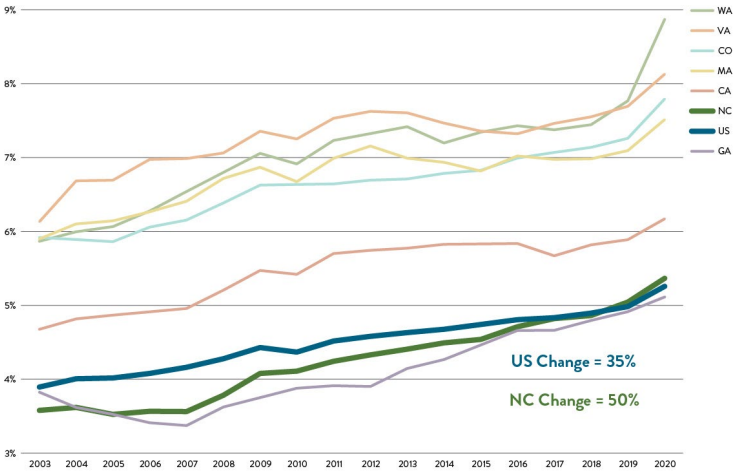
In terms of individuals in S&E occupations as a percentage of the workforce, North Carolina ranks 16th in the nation, with a level that is one tenth of a percent higher than the U.S. average value and 60 percent of the value of the top-ranking state, Washington **[5.1A]**. Apart from Georgia, all comparison states rank well ahead of North Carolina and are within the top 6 among all states. From 2003 to 2020, the percentage of North Carolina's workforce in S&E occupations increased significantly, by 50 percent. This rate is faster than the rate of increase for the U.S. overall (35 percent) and ahead of the rate for all comparison states expect Washington **[5.1B]**.

5.1A *Individuals in Science & Engineering Occupations as a Percentage of the Worksforce, All U.S. States, 2020*



Source: National Science Board.

5.1B *Individuals in Science & Engineering Occupations as a Percentage of the Workforce, Comparison States, 2003-2020*



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 interpolated from proximal years' data.

[1] 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.

[2] 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 at or above average among all states and 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 SEH Doctorate Holders

KEY FINDINGS

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

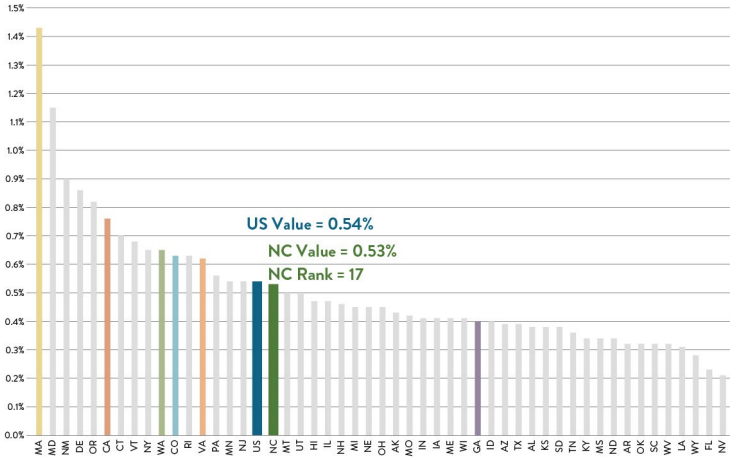
INDICATOR OVERVIEW

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.[1]

HOW DOES NORTH CAROLINA PERFORM?

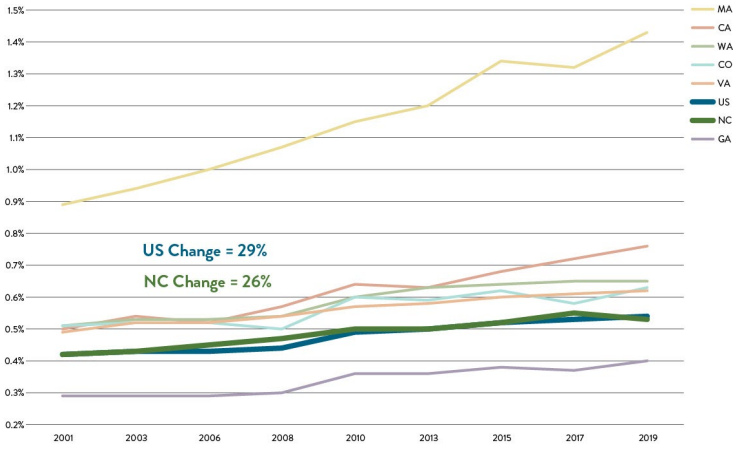
In terms of employed SEH doctorate holders as a percentage of the workforce, North Carolina ranks 17th in the nation, with a level that is 98 percent of the U.S. average value and 37 percent of the value of the top-ranking state, Massachusetts **[5.2A]**.[2] With the exception of Georgia, all the comparison states rank ahead of North Carolina, and three (Massachusetts, California, and Washington) rank in the top 10 among all states. From 2001 to 2019, employed S&E doctorate holders as a percentage of the workforce in North Carolina increased significantly, by 26 percent. However, this rate is slower than the U.S. average (29 percent) and slower than all comparison states except for Colorado **[5.2B]**.

5.2A *Employed Science, Engineering & Health Doctorate Holders as a Percentage of the Workforce, All U.S. States, 2019*



Source: National Science Board.

5.2B *Employed Science, Engineering & Health Doctorate Holders as a Percentage of the Workforce, Comparison States, 2001-2019*



Source: National Science Board.

Note: Data interpolated between years listed on x-axis.

[1] 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.

[2] 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 at or above average among all states and 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 continue 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.

Indicator 5.3: Engineers as a Percentage of the Workforce

KEY FINDINGS

- The percentage of trained engineers in North Carolina's workforce 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.

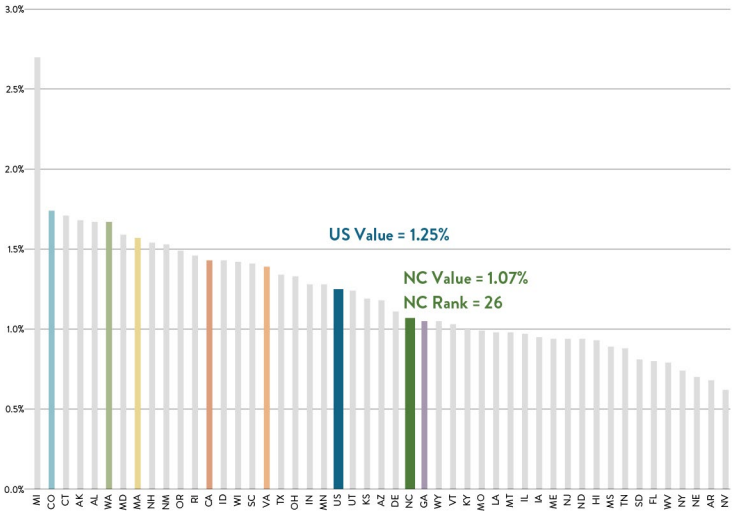
INDICATOR OVERVIEW

This indicator represents the percentage of trained engineers in a state's workforce. Engineers design and operate production processes and create new products and services. This indicator includes the Standard Occupational Classification (SOC) codes for engineering fields:[1] aerospace, agricultural, biomedical, chemical, civil, computer hardware, electrical and electronics, environmental, industrial, marine and naval architectural, materials, mechanical, mining and geological, nuclear, and petroleum.[2] Occupations also include postsecondary teachers in these fields.

HOW DOES NORTH CAROLINA PERFORM?

In terms of the percentage of trained engineers in a state's workforce, North Carolina ranks 26th in the nation, with a level that is 86 percent of the U.S. average value and 40 percent of the value of the top-ranking state, Michigan **[5.3A]**. All comparison states rank ahead of North Carolina, except Georgia, which has maintained a similar percentage of engineers as NC over time **[5.3B]**. Three comparison states (Colorado, Washington, and Massachusetts) are within the top 10 among all states. From 2003 to 2019, the percentage of trained engineers in North Carolina's workforce increased by 27.4 percent, higher than the rate of increase for the U.S. overall (8.7 percent). This rate is slightly slower than the rate of increase for Georgia, but much faster than the rate of increase for the other comparison states.

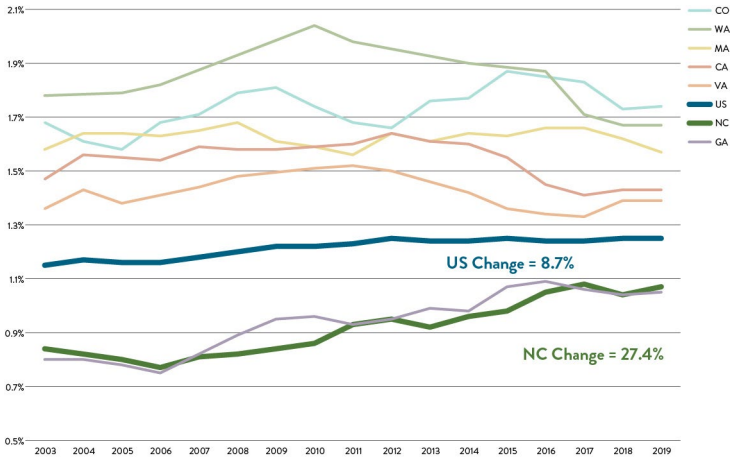
5.3A *Engineers as a Percentage of All Occupations, All U.S. States, 2019*



Source: National Science Board.

Note: 2019 data not available for Oklahoma and Pennsylvania.

5.3B *Engineers as a Percentage of All Occupations, Comparison States, 2003-2019*



Source: National Science Board.

Note: Data not available for Washington for 2004, 2007, 2009, 2012, 2013, and 2015; Virginia for 2009. Lines for missing years were interpolated using other years' data.

[1] 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.

[2] 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?

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.[3] 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.

[3] Notably, San Jose/Silicon Valley's ratio of 47 engineers and architects per 1,000 employees is a key reason it is one of the nation's most affluent metro areas. The Detroit MSA has a concentration of 43 engineers and architects per 1,000, while Raleigh has 25 per 1,000. (Bureau of Labor Statistics, "May 2020 Occupational Employment and Wage Statistics Survey," accessed February 21, 2022 at https://www.bls.gov/oes/#data).

Indicator 5.4: Bachelor's Degrees in Science & Engineering

KEY FINDINGS

- The ratio of S&E bachelor's degrees to the population aged 18–24 years in North Carolina ranks below the U.S average, has been similar to the U.S. average for nearly twenty years, 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.[1]

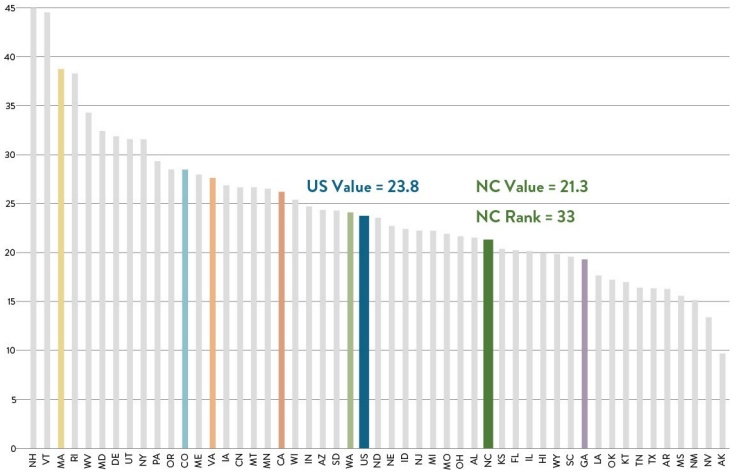
HOW DOES NORTH CAROLINA PERFORM?

In terms of the ratio of new S&E bachelor's degrees to the population ages 18–24 years, North Carolina ranks 33rd in the nation, with a level that is 90 percent of the U.S. average value and 44 percent of the value of the top-ranking state, New Hampshire **[5.4A]**. Relative to the comparison states, North Carolina ranks above only Georgia. From 2000 to 2019, North Carolina's ratio of new S&E bachelor's degrees to the population ages 18–24 years increased by 44 percent, a rate lower than the rate of increase for the U.S. overall (65 percent). North Carolina's rate of increase is also slower than that of all other comparison states except for Colorado and Massachusetts **[5.4B]**.

WHAT DOES THIS MEAN FOR NORTH CAROLINA?

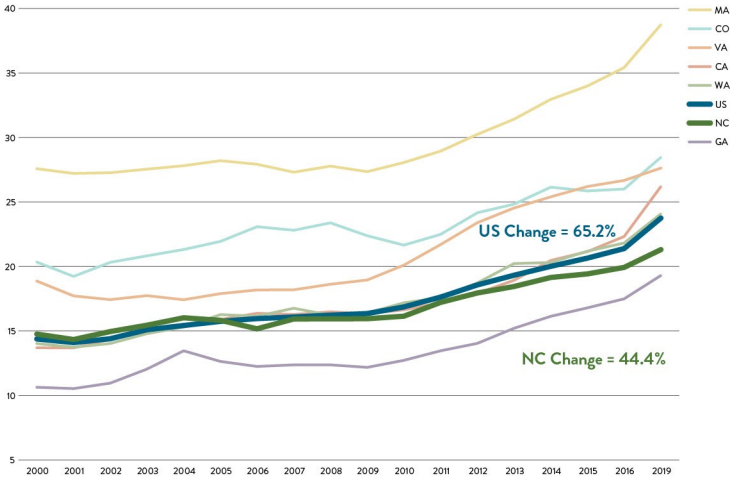
Educational attainment in an S&E field gives people greater opportunities to work in higher-paying technical jobs than are generally available to those in other fields of study. Earning a bachelor's degree in an S&E field also prepares an individual for advanced technical education. A high value for 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 of 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.

5.4A *Bachelor's Degrees in Science & Engineering Conferred per 1,000 Individuals 18–24 Years Old, All US States, 2019*



Source: National Science Board.

5.4B *Bachelor's Degrees in Science & Engineering Conferred per 1,000 Individuals 18–24 Years Old, Comparison States, 2000-2019*



Source: National Science Board.

[1] 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.

Indicator 5.5: Science & Engineering 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.

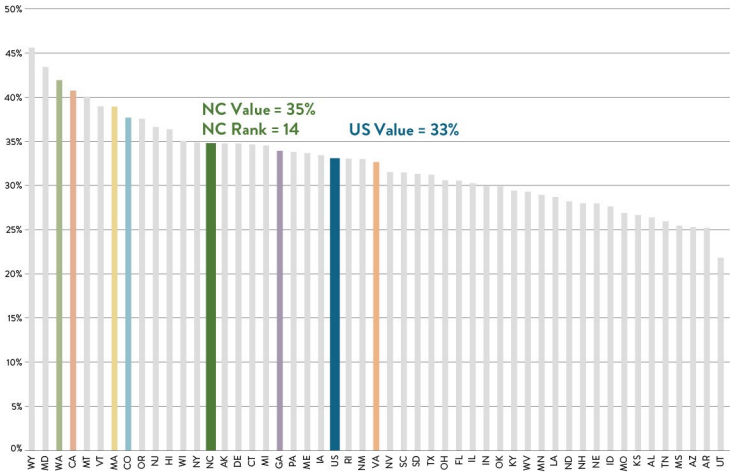
HOW DOES NORTH CAROLINA PERFORM?

In terms of S&E degrees as a percentage of higher education degrees conferred, North Carolina ranks 14th in the nation, with a level that is 105 percent of the U.S. average value and 76 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 2019, S&E degrees as a percentage of higher education degrees conferred in North Carolina increased by 9 percent, a rate slightly lower than the rate of increase for the U.S. overall (11.8 percent) **[5.5B]**. 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.[1]

WHAT DOES THIS MEAN FOR NORTH CAROLINA?

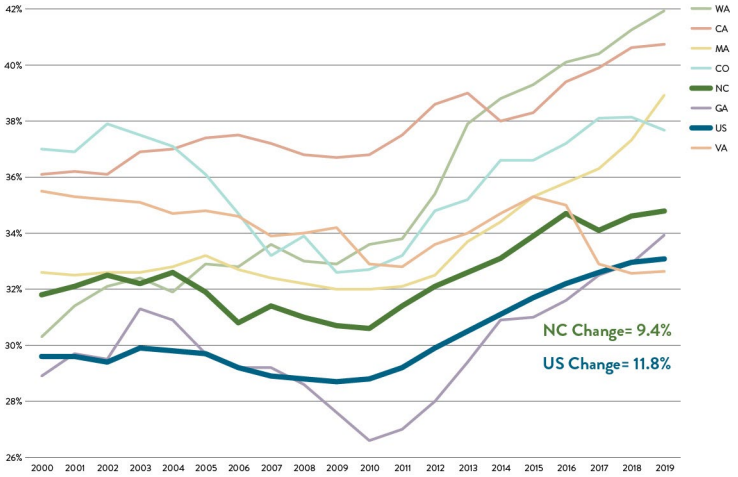
Irrespective of degree level, educational attainment in S&E fields gives people greater opportunities to work in higher-paying technical jobs than are generally available to those in other fields of study. A high value for this indicator suggests the successful provision of higher education training 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, 2019*



Source: National Science Board.

5.5B *Science & Engineering Degrees as Percentage of Higher Education Degrees Conferred, Comparison States, 2000-2019*



Source: National Science Board.

[1] 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 2019 represent degrees conferred during the 2018–19 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; 18 counties, the majority of which are urban, have an educational composite score higher than the U.S. average composite score.

INDICATOR OVERVIEW

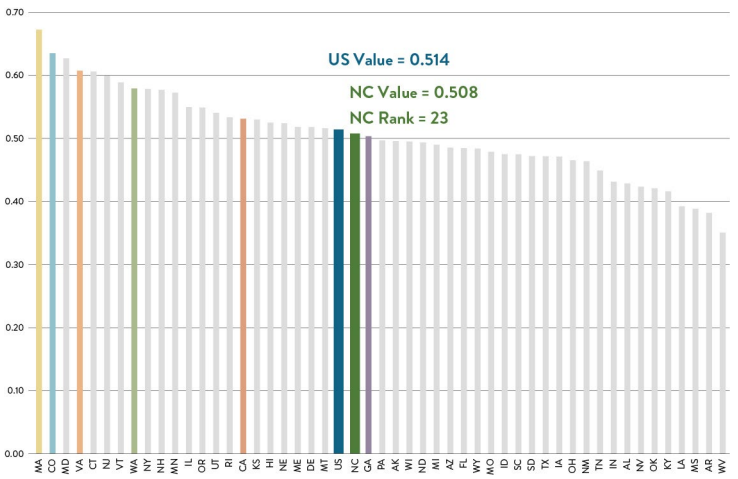
Regardless of industry or occupation, a well-educated, skilled workforce is a prerequisite for success in the innovation economy. The educational attainment of the workforce—measured here as an aggregate using a composite score (see "Methodological Note," on the last page of this indicator)—is a fundamental 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 23rd in in the nation, with a level that is 99 percent of the U.S. value and 76 percent of the value of the top-ranking state, Massachusetts **[5.6A]**. This composite score derives from the following statistics:[1] 11.4 percent of North Carolina citizens over 25 years of age have not completed high school, 25.6 percent completed their education with a high school degree, 20.6 percent completed with a high school degree and have some college experience, 10.1 percent completed with an associate degree, 20.5 percent completed with a bachelor's degree, and 11.8 percent completed with a graduate or professional degree. North Carolina compares closely with the U.S. average in each individual educational attainment category with two exceptions: the percentage of citizens with an associate degree is higher in N.C. than average, and the percentage of graduate degree holders is lower than average.

All comparison states have a higher educational attainment composite score than North Carolina, apart from Georgia. From 2005 to 2019, North Carolina's composite score increased by 35 percent, which was greater than the increase for the U.S. average composite score (26 percent) and the average of the composite scores for the comparison states (25 percent) **[5.6B]**. It was also greater than the increase for any of the comparison states individually.

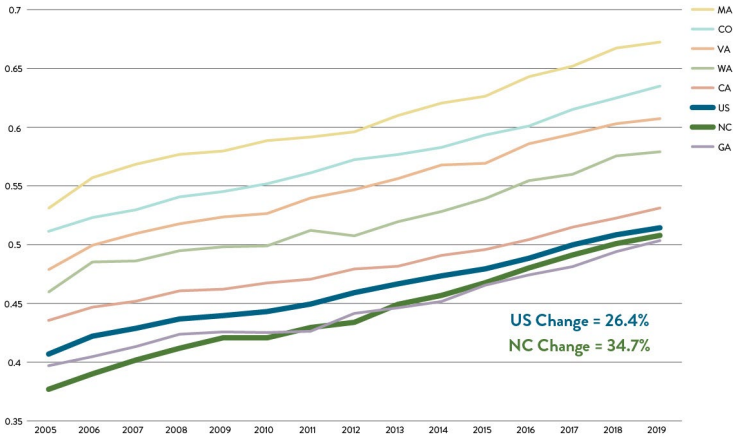
5.6A *Educational Attainment, All U.S. States, 2019*



Source: U.S. Census Bureau.

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

5.6B *Educational Attainment, Comparison States, 2005–2019*



Source: U.S. Census Bureau.

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

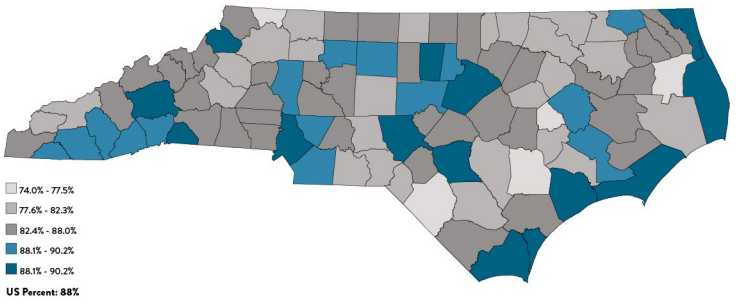
[1] Using these statistics and the weighted measure methodology described on the last page of this indicator, North Carolina's composite score for 2017 is calculated as follows 0.114(-0.05) + 0.256(0) + 0.206(0.25) + 0.10.1(0.5) + 0.205(1) + 0.118(1.75) = 0.508 (as shown in charts 5.6a and 5.6b).

Indicator 5.6: Educational Attainment

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 29 have, for residents 25 years and older, a high-school completion rate higher than the U.S. average, 88 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, 32 percent. The educational attainment composite score follows a similar pattern but adds two more counties, Jackson and Henderson, for a total of 18 counties above the national average **[5.6E]**.

Thus, the overall pattern across North Carolina is that a majority of counties have relatively low educational attainment levels (82 have an educational composite score below the U.S. average composite score) and typically are in rural regions. Of the 18 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 remainder are less populous counties that are the home to universities or have a large number of retirees or military personnel.

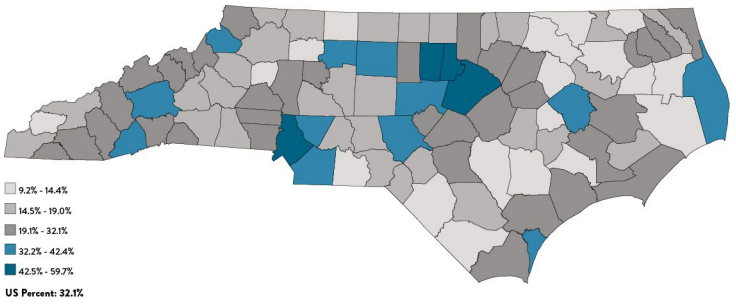
5.6C *Percentage of Residents 25 Years and Over Who Have Completed High School or More Education, N.C. Counties, 2015–2019 Estimate*



Source: U.S. Census Bureau.

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

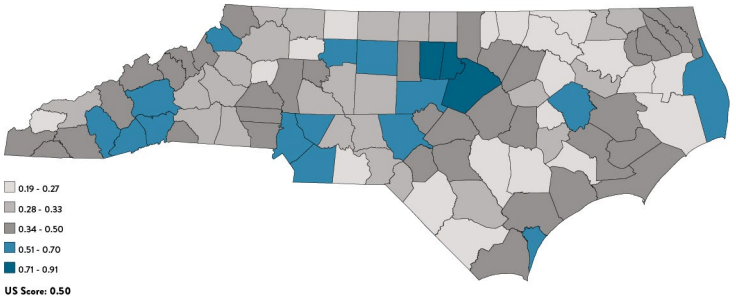
5.6D *Percentage of Residents 25 Years and Over Who Have Completed a Bachelor's Degree or More Education, N.C. Counties, 2015–2019 Estimate*



Source: U.S. Census Bureau.

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

5.6E *Weighted Measure (composite score) of the Education Attainment of Residents Aged 25 Years and Over, N.C. Counties, 2015–2019 Estimate*



Source: U.S. Census Bureau.

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

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.

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 similar to the U.S. average.
- North Carolina's in-migration of college-educated adults as a percentage of total state population ranks above the U.S. average, has more often than not since at least the mid-2000s, and is increasing at a rate above 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.

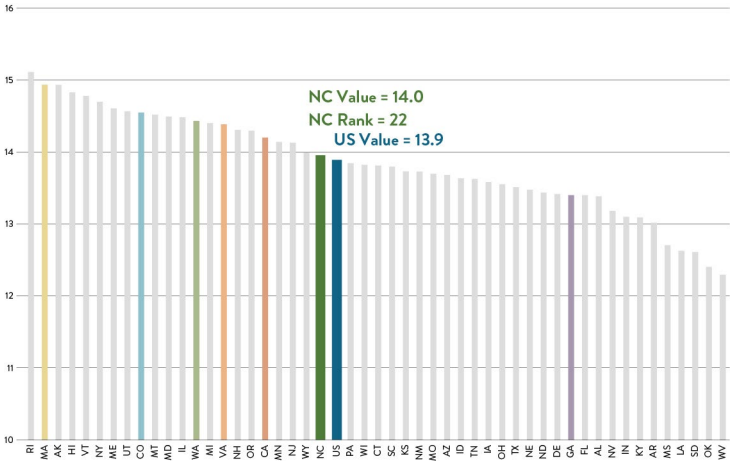
INDICATOR OVERVIEW

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?

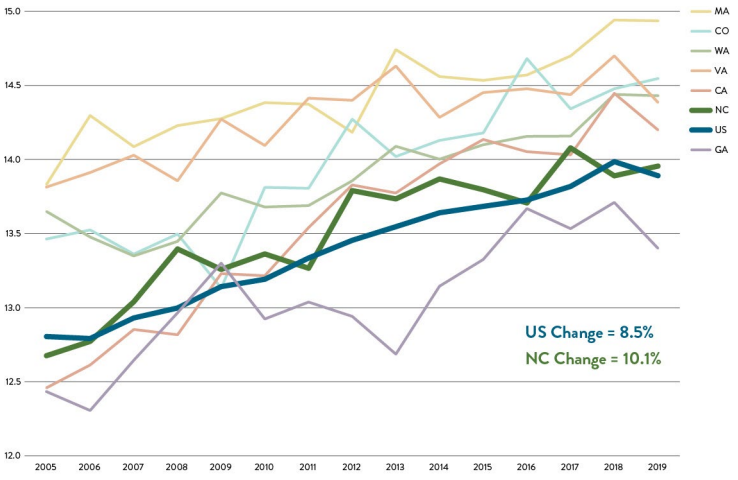
In terms of average years of education among in-migrants, North Carolina ranks 22nd in the nation, with a value just above the U.S. average (14.0 years versus 13.9 years), and 92 percent of the value of the top-ranking state, Rhode Island (15.1 years) **[5.7A]**. Among the comparison states, North Carolina ranks above Georgia and below all other comparison states on this measure. Massachusetts ranks in the top 5 among all states historically, and California has improved by the greatest amount since 2005 among comparison states. From 2005–2019, the average years of education among in-migrants in North Carolina increased by 10.1 percent, which is faster than the 8.5 percent increase for the U.S. overall and the average of all comparison states (7.9 percent) **[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.

5.7A *Average Years of Education Among In-Migrants, All U.S. States, 2019*



Source: U.S. Census Bureau.

5.7B *Average Years of Education Among In-Migrants, Comparison States, 2005-2019*



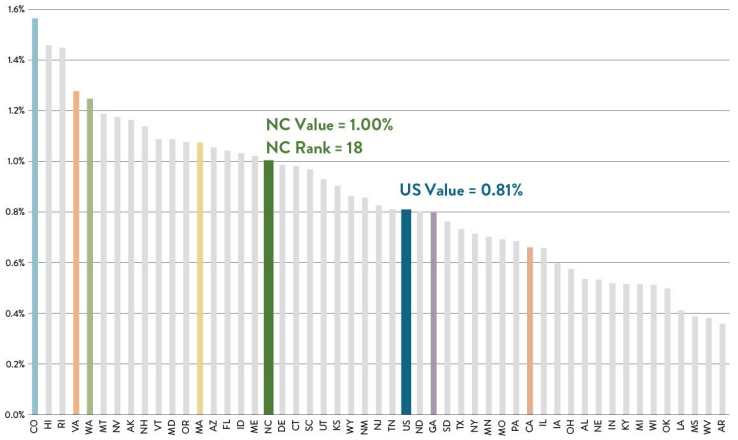
Source: U.S. Census Bureau.

Indicator 5.7: Educational Attainment of In-Migrants

College-educated adult in-migrants account for 1.0 percent of North Carolina's population. North Carolina's value ranks 18th in the nation, 24 percent above the U.S. average value, and 64 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. From 2005–2019, North Carolina in-migration of college-educated adults as a percentage of total state population increased by 22.3 percent, whereas the percentage for the U.S. overall increased by 18.6 percent **[5.7D]**. Relative to the comparison states, North Carolina's rate of increase is higher than those of Washington, Virginia, and Georgia.

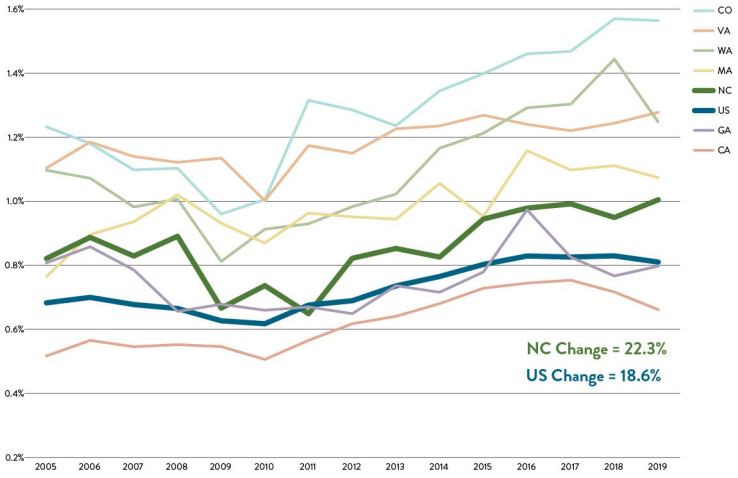
Within North Carolina, the in-migration of individuals with a bachelor's degree or higher is very concentrated in a small number of counties **[5.7E]**.[1] Two counties combined accounted for 38.4 percent of the state's in-migrants with a bachelor's degree or higher between 2015 and 2019—Mecklenburg (20.5%) and Wake (18.0%). Another third of college-educated in-migrants moved to nine counties—Durham (7.0%), Cumberland (4.5%), Guilford (4.5%), Orange (3.9%), Buncombe (3.4%), Forsyth (3.0%), New Hanover (2.6%), Onslow (2.5%), and Union (2.0%). 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 2015 and 2019. The next 9 counties combined— Iredell (1.9%), Brunswick (1.7%), Pitt (1.6%), Moore (1.4%), Cabarrus (1.3%), Harnett (1.2%), Henderson (1.2%), Johnston (1.1%), and Craven (1.0%)—account for another 12.4 percent of the state's in-migrants with a bachelor's degree or higher over the same period. Each of the remaining 80 counties accounts for less than one percent of the state's in-migrants with a bachelor's degree or higher between 2015 and 2019, and together they account for 15.6 percent of that in-migration.

5.7C *In-Migration of College Educated Adults as a Percentage of Total State Population, All U.S. States, 2019*



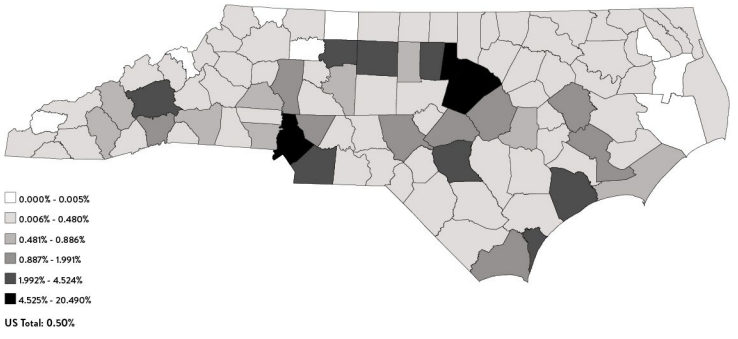
Source: U.S. Census Bureau.

5.7D *In-Migration of College Educated Adults as Percentage of Total State Population, Comparison States, 2005-2019*



Source: U.S. Census Bureau.

5.7E *In-Migration of College Educated Adults, Percent of State Total, N.C. Counties, 2015-2019*



Source: U.S. Census Bureau.

[1] 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 2015 and 2019. 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.

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

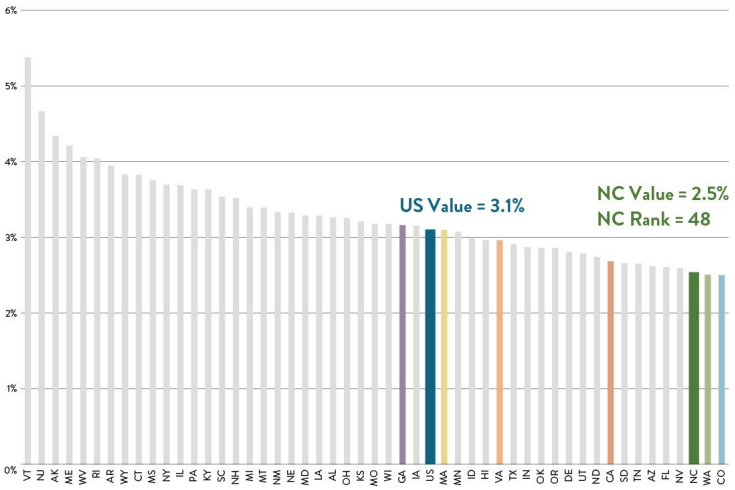
This indicator measures public investment in education two ways: 1) elementary and secondary public school current expenditures, and 2) appropriations of state tax funds for operating expenses of higher education, each as a percentage of state GDP. The first measure represents the relative amount of 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.[1] The second measure represents the relative amount of resources that state governments expend to support higher education operating expenses.[2]

For each measure, a higher value indicates that a state has made financial support of the respective education level more of a priority.[3] 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.

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 48th in the nation, with a level that is 81 percent of the U.S. average value and 47 percent of the value of the state with the highest value, Vermont **[6.1A]**. Among comparison states, North Carolina expends more on primary and secondary public schools than Washington and Colorado relative to their state domestic products. Between 2000 and 2018, U.S. average elementary and secondary public

6.1A *Elementary and Secondary Public School Current Expenditures as a Percentage of State GDP, All U.S. States, 2018*



Source: National Science Board.

[1] 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.

[2] 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.

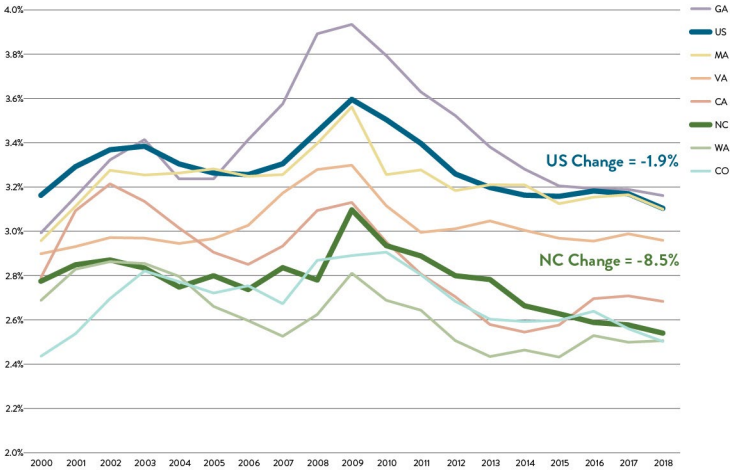
[3] This does not assume that more spending necessarily leads to improved educational outcomes.

school current expenditures as a percentage of state GDP decreased by 1.9 percent, whereas North Carolina's percentage decreased by 8.5 percent. **[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 5th in the nation, with a level that is 79 percent greater than the U.S. average and 79 percent of the value of the state with the highest value, Wyoming **[6.1C]**. North Carolina ranks well 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 2019, North Carolina's appropriations of state tax funds for operating expenses of higher education as a percentage of state GDP decreased by 10.8 percent, which is smaller than the 18 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 27 percent), and all were larger decreases that the decrease in North Carolina.

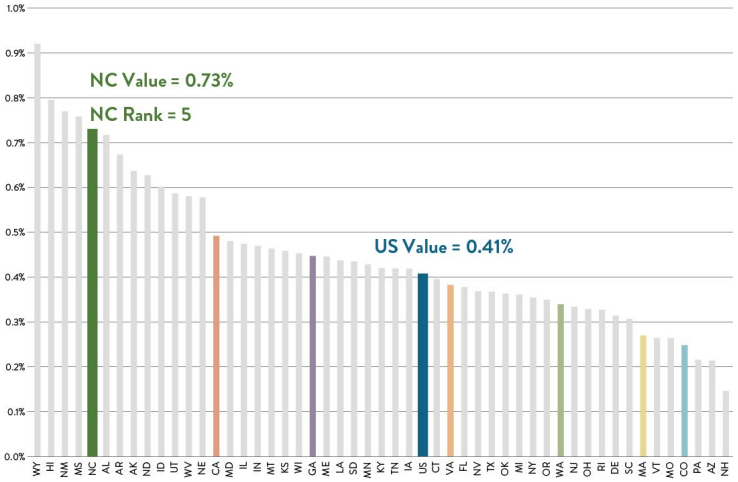
Within North Carolina, the pattern of authorized appropriations for the University of North Carolina (UNC) institutions is highly correlated with the size of the institutions **[6.1E]**.[4] For example, the three largest institutions together account for nearly 42 percent of total appropriations to UNC institutions—NC State University (18.3 percent), UNC-Chapel Hill (12.0 percent), and UNC-Charlotte (11.2 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 (1.4 percent), and NC School of Science and Mathematics (1.1 percent).

6.1B *Elementary and Secondary Public School Current Expenditures as a Percentage of State GDP, Comparison States, 2000-2018*



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, 2019*



Source: National Science Board.

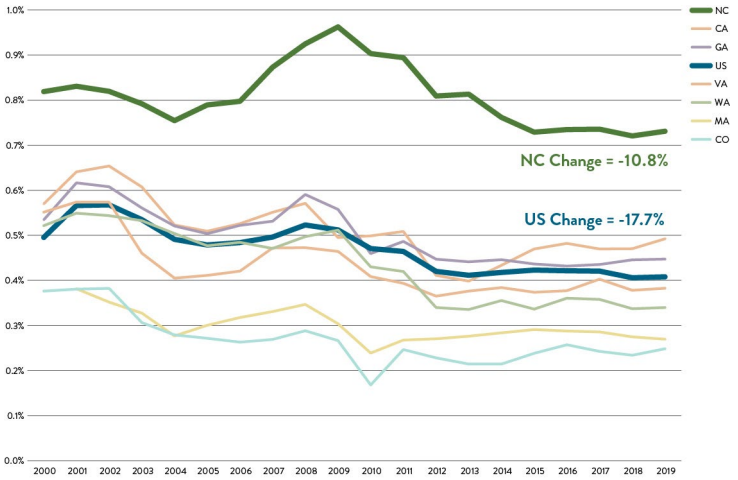
[4] FY2020-2021 appropriations (NC Office of State Budget and Management). Size is the total headcount enrollment in Fall 2020 (UNC System).. This pattern of appropriations is more correlated with institution size than are other measures of university activity, such as academic science & engineering research & development (see indicator 2.3), academic patents (see indicator 3.2), and academic license income (see indicator 3.5).

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 average for employment in high-tech establishments as a percentage of total employment (see indicator 4.2).[5] 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) and science, engineering & technology degrees as percentage of total higher education degrees conferred (see indicator 5.5).

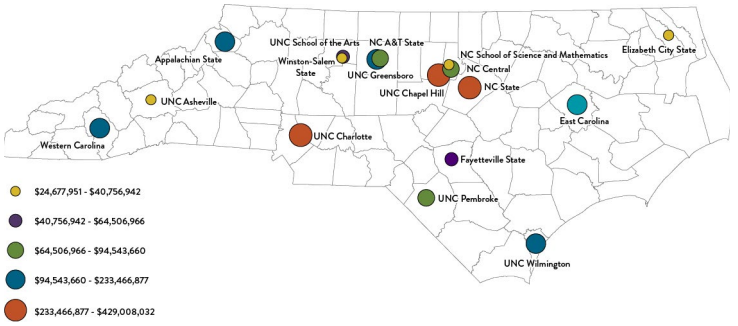
North Carolina's ability to compete in a knowledge- and innovation-driven economy depends critically on the education and training of its workforce at all levels. Given the link between investment in education and related measures of success in education, it is clear that North Carolina should continue 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, 2000-2019*



Source: National Science Board.

6.1E *Authorized Appropriations, University of North Carolina (UNC) Institutions, FY 2019-2021 Average*



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

These data include only General Fund appropriations, not other funding sources that comprise the UNC system budget. Additionally, the data include only FY 2019-2021 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.

[5] 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 is similar to the U.S. average.
- North Carolina's fiber deployment rate ranks 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 prosperous 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

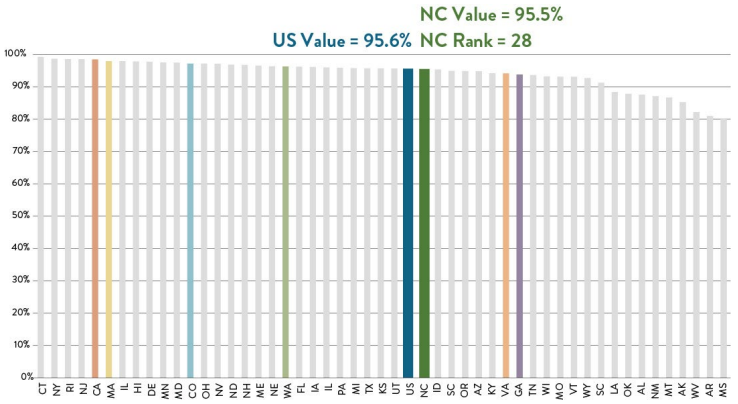
The term "broadband" refers to a range of technologies (e.g., fiber, coax cable, copper, and wireless technologies) that allow for higher capacity and faster data transmission with the Internet. Broadband is a platform for innovation, in that using broadband technologies can foster and enable innovation 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.[1]

HOW DOES NORTH CAROLINA PERFORM?[2]

At the speed examined, North Carolina's broadband deployment rate (95.5 percent) ranks 28th in the nation[3], which is similar to the U.S. average of 95.6 percent and 96 percent of the rate of the top–ranking state, Connecticut **[6.2A]**.[4] Among the comparison states, North Carolina's rate is ahead of those of Georgia and Virginia, but behind those of Colorado, Massachusetts, Washington, and California.

6.2A *Percent of Population with Broadband Access (Depolyment Rate) at 25 Mbps/3 Mbps or Faster, All U.S. States, 2019*



Source: Federal Communications Commission.

[1] 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.

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

[3] 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.

[4] Source: Data provided to the North Carolina Broadband Infrastructure Office from the Federal Communication's Commission, December 2019.

Indicator 6.2: Broadband

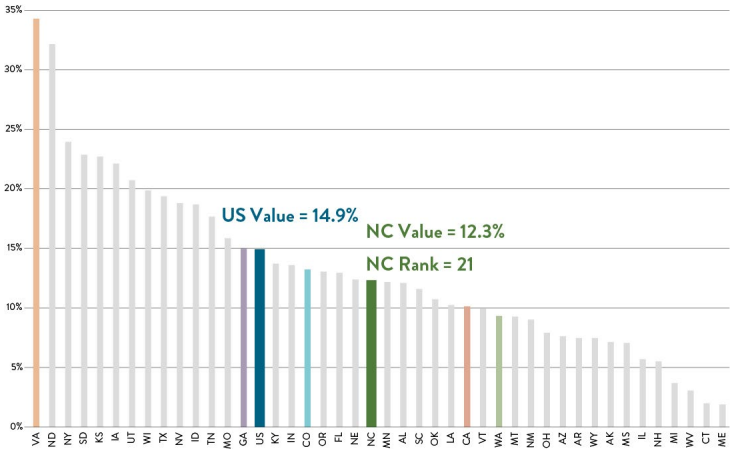
In terms of fiber to the end-user connections as a percentage of all wireline connections, North Carolina ranks lower than the U.S. average and three of the comparison states that reported data– Virginia, Colorado, and Georgia **[6.2B]**.[5] The percentage of fiber-to-the-end user connections almost tripled between 2016 and 2018 from 4.2 percent to 12.3 percent. North Carolina now ranks 21st nationally, with a value that is 83 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 34.3 percent of its wireline connections being fiber connections.

Broadband adoption rate gives a clear picture of the number of households with and without service in their homes. North Carolina's adoption rate at the examined speed threshold (71.4 percent) is just above the U.S. average of 68.9 percent **[6.2C]**. North Carolina ranks 17th nationally, but is well behind the top-ranking state of Delaware that has an adoption rate of 90 percent. North Carolina also ranks lower than all comparison states except for Georgia.[6]

Within North Carolina, in 2015-2019 the subscription rate (see definition in footnote 1) varied considerably, with 13 counties having rates between 85 and 91 percent, 33 counties having rates between 77 and 84 percent, 34 having rates between 69 and 76 percent, 11 having rates between 61 and 68 percent, and 9 having rates less than 60 percent **[6.2D]**. In general, more prosperous counties had higher broadbands 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, an open access middle-mile network with over 4,400 miles of fiber optic infrastructure that maintains 99.99% uptime and spans all 100 counties in North Carolina **[6.2E]**. The significance of these assets must be considered when looking at North Carolina's opportunities for innovation.

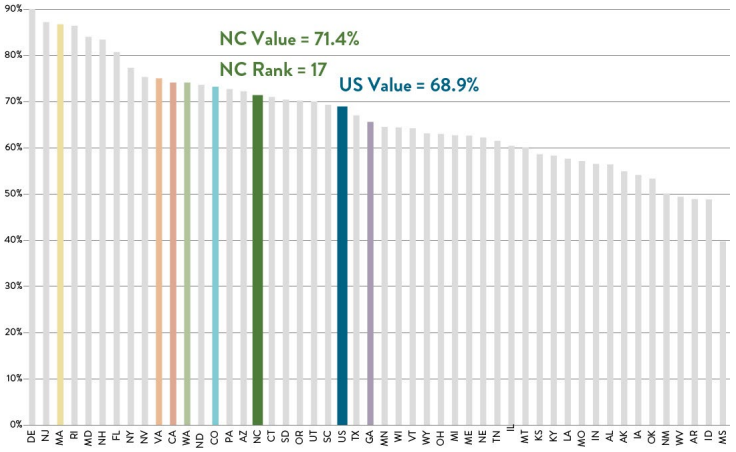
6.2B *Percent of Fiber to the End User Connections of all Wireline Connections, All Reporting U.S. States*, 2018*



Source: Federal Communications Commission.

**43 U.S. States reported.*

6.2C *Broadband Adoption Rate 25 Mbps/3 Mbps or Faster, All Reporting U.S. States*, 2019*



Source: Federal Communications Commission.

**Hawaii rate was not reported.*

[5] Massachusetts, as well as Delaware, Hawaii, Maryland, New Jersey, Pennsylvania, and Rhode Island withhold data for confidentiality reasons.

[6] Many states share the same subscription rate and thus are "tied." In addition, Hawaii did not report their subscription rate at the reported speed threshold.

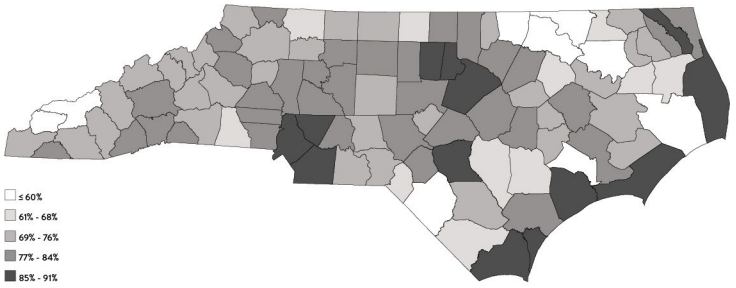
WHAT DOES THIS MEAN FOR NORTH CAROLINA?

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.

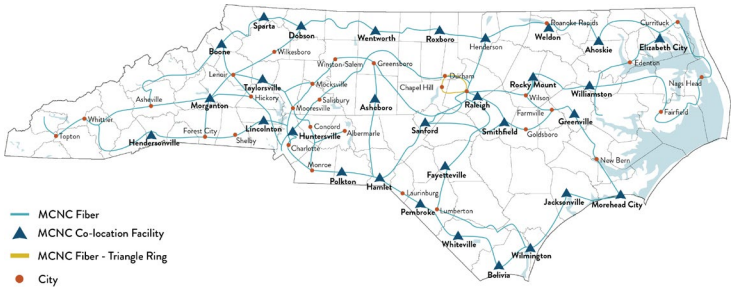
The chief obstacles to effectively harnessing broadband's power as an innovation enabler are the remaining unserved households throughout the state, the state's low adoption rate, and the ever-increasing need for higher speeds. Broadband adoption is a complex challenge, with many factors impacting the 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.

6.2D *Broadband Subscription Rates, NC Counties, 2015-2019*



Source: US Census Bureau, American Community Survey 5 year data.

6.2E *MCNC Broadband Fiber Network Statewide, 2021*



Source: MCNC.

Indicator 6.3: Cost of Living Index

KEY FINDINGS

- North Carolina's Cost of Living Index is below the U.S. average.
- Within North Carolina, the cost of living varies, but only moderately compared to variations nationwide. More than half of North Carolina counties have a Cost of Living Index plus or minus five percent of the U.S. average, and the remainder are below the U.S. average.

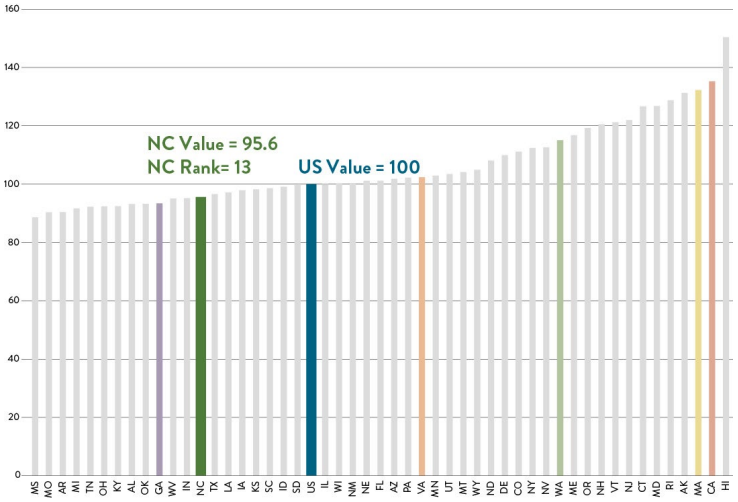
INDICATOR OVERVIEW

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).[1] 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.[2] 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.[3]

HOW DOES NORTH CAROLINA PERFORM?

In terms of the Cost of Living Index, North Carolina ranks 13th in the nation, with a level that is 95.6 percent of the U.S. average value and 108 percent of the value of the state with the lowest Cost of Living Index value, Mississippi **[6.3A]**. Among the comparison states, only Georgia has a Cost of Living Index lower than North Carolina, and they are the only two comparison states to have values lower than the U.S. average. The Cost of Living Index value for Virginia is slightly above the U.S. average, while the values for California, Massachusetts, Washington, and Colorado are considerably above the U.S. average and among the top-16 most expensive states with Colorado ranking 16th.

6.3A *Cost of Living Index, All U.S. States, 2021*



Source: Council for Community and Economic Research (C2ER).

[1] For more detail on the Cost of Living Index and C2ER, see http://www.coli. org/. In general, the Cost of Living Index is intended to measure differences among urban areas; however, C2ER has developed a county-level Cost of Living Index based on an econometric model that identifies key determinants of an area's cost of living. Data using that model appear in map 6.3B.

[2] For example, if City A has an index of 98.3, the cost of living in that city is approximately 1.7 percent less than the U.S. average cost of living. If City B has a composite index of 128.5, the cost of living in that city is approximately 28.5 percent higher than the U.S. average. Thus, if a worker lives in City A and is contemplating a job offer in City B, that worker would need a 30.72 percent increase in after-tax income to remain at his/her City A lifestyle once moving to City B (30.72% = 100*[(128.5 - 98.3)/98.3]). Conversely, if the same worker were considering a move from City B to City A, that worker could sustain a 23.5 percent decrease in after-tax income without reducing his/her lifestyle (23.5% = 100*[(98.3 – 128.5)/128.5]).

[3] For the purposes of this report, a Cost of Living Index slightly above or slightly below the U.S. average is advantageous, as it indicates that an area's cost of living is reasonably affordable, but not so extreme as to suggest that the area is excessively expensive (in the case of a high index value) or has low-quality infrastructure, amenities, goods, and services (in the case of a low index value).

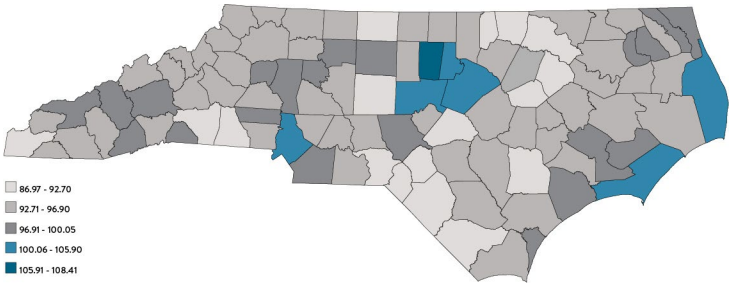
Indicator 6.3: Cost of Living Index

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 108.4 (Orange county) to a low of 87.0 (Robeson County). In 2021, county values nationwide ranged widely from as high as 283.8 in New York County, New York to as low as 77.5 in Oglala Lakota County, South Dakota. In total, seven (Orange, Mecklenburg, Wake, Chatham, Dare, Durham, and Carteret) of North Carolina's 100 counties have a cost of living higher than the U.S. average, whereas another 49 have a cost of living slightly lower than the U.S. average. The 44 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, and sources of, 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, 2021*



Source: Council for Community and Economic Research.

Blue counties rank above the U.S. average.

[4] The standard deviation of the 2021 Cost of Living Index across all U.S counties is 11.82, and approximately 83% 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 positions the state, overall, to be an innovation leader in only a small number of industries.
- 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. Slightly less than half are increasing in employment, but overall high SET employment as a percentage of total employment is increasing.
- 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.

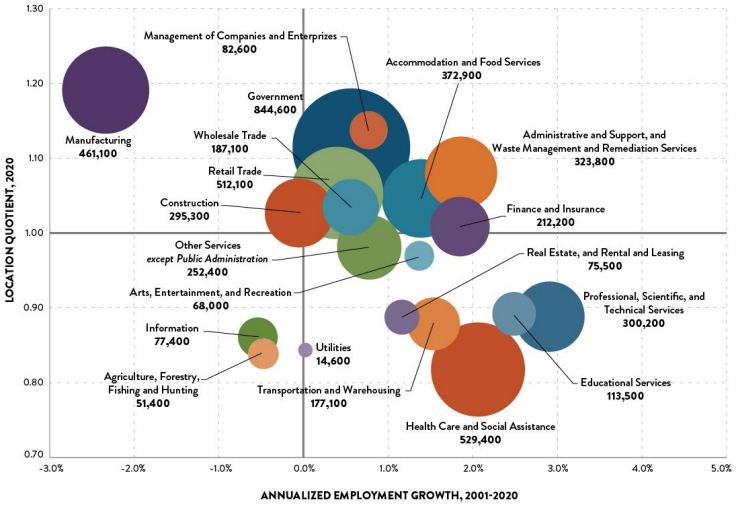
INDICATOR OVERVIEW

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:[1] the level of employment, employment change (2001-2020), relative concentration (see Methodological Note, next page), and average wage. The second measure details—for high science, engineering & technology (SET) employment industries only[2] —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., 2.2 - Industry R&D and Innovative Organizations in Section 4) and Employment (e.g., Workforce in Section 5).[3]

HOW DOES NORTH CAROLINA PERFORM?[4]

In terms of major economic sectors, half of North Carolina's employment is in five major economic sectors—Government (17.0%)[5], Health Care and Social Assistance (10.7%), Retail Trade (10.3%), Manufacturing (9.3%),[6] and Accommodation and Food Services (7.5%) **[6.4A and 6.4B]**.[7]

6.4A *Industry Employment, Annualized Employment Growth, and Concentration (Location Quotient), All NC Industries, 2020*



Note: Employment numbers rounded to the nearest hundreds; excludes NAICS codes 99 (Unclassified Industry) and 21 (Mining, Quarrying, & Oil & Gas Extraction).

[1] 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.

[2] 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 the Source information for indicator 6.4 at the end of this report for more description of the EMSI data used for this particular indicator.

[3] 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.

[4] 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.

[5] Government excludes federal military.

[6] Manufacturing industries are defined as those industries whose 2-digit NAICS code ranges from 31–33.

[7] 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.

6.4B *Sector Employment, Annualized Employment Growth, Concentration (Location Quotient), and Average Wage, All N.C. Sectors*

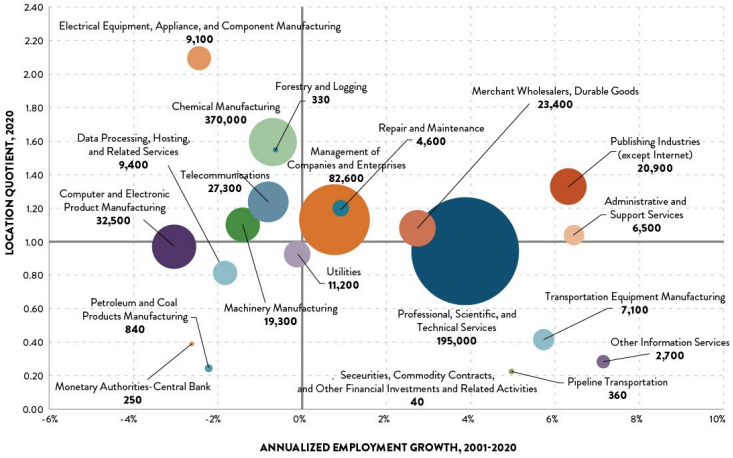
2-DIGIT NAICS CODE	INDUSTRY	EMPLOYMENT					
		Total 2020 *rounded*	Share of Total 2020	Cumulative Share of Total 2020	Annualized Growth Rate (*Compound Annual Growth Rate*) 2001-2020	Location Quotient 2020	2020 Average Earnings *rounded*
90	Government	844,600	17.0%	17.0%	0.6%	1.12	$71,200
62	Health Care and Social Assistance	529,400	10.7%	27.7%	2.1%	0.82	$63,000
44	Retail Trade	512,100	10.3%	38.1%	0.4%	1.05	$38,800
31	Manufacturing	461,100	9.3%	47.4%	-2.3%	1.19	$77,400
72	Accommodation and Food Services	372,900	7.5%	54.9%	1.4%	1.05	$22,100
56	Administrative and Support and Waste Management and Remediation Services	323,800	6.5%	61.4%	1.9%	1.08	$47,600
54	Professional, Scientific, and Technical Services	300,200	6.1%	67.5%	2.9%	0.89	$99,700
23	Construction	295,300	6.0%	73.5%	0.0%	1.03	$62,800
81	Other Services (except Public Administration)	252,400	5.1%	78.6%	0.8%	0.98	$31,600
52	Finance and Insurance	212,200	4.3%	82.8%	1.8%	1.01	$124,900
42	Wholesale Trade	187,100	3.8%	86.6%	0.6%	1.03	$94,000
48	Transportation and Warehousing	177,100	3.6%	90.2%	1.5%	0.88	$60,200
61	Educational Services	113,500	2.3%	92.5%	2.5%	0.89	$54,500
55	Management of Companies and Enterprises	82,600	1.7%	94.1%	0.8%	1.14	$138,500
51	Information	77,400	1.6%	95.7%	-0.5%	0.86	$110,800
53	Real Estate and Rental and Leasing	75,500	1.5%	97.2%	1.2%	0.89	$62,600
71	Arts, Entertainment, and Recreation	68,000	1.4%	98.6%	1.4%	0.97	$42,400
11	Agriculture, Forestry, Fishing and Hunting	51,400	1.0%	99.6%	-0.5%	0.84	$40,100
22	Utilities	14,600	0.3%	99.9%	0.0%	0.84	$134,000
21	Mining, Quarrying, and Oil and Gas Extraction	3,200	0.1%	100.0%	-1.9%	0.18	$80,300
	Total	**4,954,200**	**100.0%**		**0.6%**		**$65,000**

Source: CEW Employees, Non-QCEW Employees, Self-Employed & Extended Proprietors - EMSI 2021.3 Class of Worker
Note: Sorted in decending order by employment. Excludes NAICS code 99 (Unclassified Industry); average wage and employment numbers rounded to the nearest hundreds.

Of these, three—Government, Health Care and Social Assistance, and Manufacturing—have wages above the North Carolina average (see indicator 1.3),[8] and only Manufacturing has a substantial share of high SET employment industries and employment **[6.4C and 6.4D]**.[9] The next four sectors—Administrative and Support and Waste Management and Remediation (6.5%), Professional, Scientific, and Technical Services (6.1%), Construction (6.0%), and Other Services (5.1%)—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 ($58,878) of the nine sectors comprising approximately three-fourths of North Carolina's employment are lower than the average wages ($87,355) of the 11 sectors comprising approximately one-fourth of North Carolina's employment. To increase North Carolina's average wage, it is necessary to start, grow, and attract companies in these higher-wage sectors and train the workforce for them.

In terms of the sectors' relative concentration, as measured by location quotients, there are three sectors in which North Carolina has a larger share of activity sector than we would expect based on national trends—Manufacturing, Government, and Management of Companies and Enterprises. While all three sectors have wages above the state average, only Manufacturing and Management of Companies and Enterprises have a substantial share of high SET employment industries. The Manufacturing sector has decreased, whereas Management of Companies and Enterprises has grown in employment over time. Of the sectors in which North Carolina has a smaller share of activity than we would expect based on national trends, there are two that have above-average wages and a substantial share of high SET employment—Professional, Scientific, and Technical Services and Information. These two sectors contain industries that account for 52.2% of high SET industry employment in North Carolina. The former has grown over time (2.9% AGR), while the latter has shrunk (-0.5% AGR).

6.4C ***Industry Employment, Annualized Employment Growth, and Concentration (Location Quotient), High SET Employment Industries, North Carolina, 2020***



Notes: Employment numbers rounded.

In terms of high SET employment industries, the top two subsectors comprise more than half (56.6%) of North Carolina's high SET employment—Professional, Scientific and Technical Services (39.8%) and Management of Companies and Enterprises (16.8%) **[6.4C and 6.4D]**.[10] 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.

[8] "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 2020 average wage in North Carolina is $56,214 (see indicator 1.3).

[9] 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.

[10] 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.

6.4D *Employment & Wages in High SET Employment Industries, N.C.*

NAICS CODE	HIGH-TECHNOLOGY INDUSTRY	EMPLOYMENT					
		Total 2020	Share of Total 2020	Cumulative Share of Total 2020	Annualized Growth Rate *Compound Annual Growth Rate* 2001-2020	Location Quotient 2020	Average Earnings 2020
541	**Professional, Scientific, and Technical Services**	**195,000**	**39.8%**	**39.8%**	**3.9%**	**0.94**	**$110,400**
5416	Management, Scientific, and Technical Consulting Services	58,700	12.0%		5.3%	1.01	$95,500
5415	Computer Systems Design and Related Services	64,200	13.1%		4.2%	0.87	$127,400
5413	Architectural, Engineering, and Related Services	43,300	8.8%		1.6%	0.86	$93,800
5417	Scientific Research and Development Services	28,800	5.9%		5.0%	1.17	$141,300
551	**Management of Companies and Enterprises**	**82,600**	**16.8%**	**56.6%**	**0.8%**	**1.14**	**$138,500**
5511	Management of Companies and Enterprises	82,600	16.8%		0.8%	1.14	$138,500
325	**Chemical Manufacturing**	**37,000**	**7.5%**	**64.2%**	**-0.7%**	**1.60**	**$132,100**
3254	Pharmaceutical and Medicine Manufacturing	23,300	4.8%		1.1%	2.35	$132,200
3252	Resin, Synthetic Rubber, and Artificial and Synthetic Fibers and Filaments Manufacturing	3,700	0.8%		-4.9%	1.29	$155,900
3251	Basic Chemical Manufacturing	3,000	0.6%		-1.7%	0.64	$115,500
3259	Other Chemical Product and Preparation Manufacturing	2,500	0.5%		-2.4%	0.99	$112,100
3253	Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	2,200	0.4%		-2.2%	1.86	$137,500
3255	Paint, Coating, and Adhesive Manufacturing	2,300	0.5%		0.3%	1.15	$83,900
334	**Computer and Electronic Product Manufacturing**	**32,500**	**6.6%**	**70.8%**	**-3.0%**	**0.97**	**$165,200**
3345	Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	12,600	2.6%		1.7%	0.96	$141,200
3341	Computer and Peripheral Equipment Manufacturing	9,600	2.0%		-3.5%	1.92	$186,300
3344	Semiconductor and Other Electronic Component Manufacturing	7,000	1.4%		-5.4%	0.60	$135,000
3342	Communications Equipment Manufacturing	2,400	0.5%		-4.0%	0.87	$149,300
3346	Manufacturing and Reproducing Magnetic and Optical Media	200	0.0%		-14.1%	0.62	$297,600
3343	Audio and Video Equipment Manufacturing	700	0.1%		-0.4%	1.09	$96,800
517	**Telecommunications**	**27,300**	**5.6%**	**76.3%**	**-0.8%**	**1.24**	**$101,700**
517311	Wired Telecommunications Carriers	18,800	3.8%		0.0%	1.18	$99,800
517312	Wireless Telecommunications Carriers (except Satellite)	4,200	0.9%		-1.0%	1.29	$92,500
5179	Other Telecommunications	4,200	0.9%		-3.3%	1.58	$111,800
5174	Satellite Telecommunications	100	0.0%		4.9%	0.30	$73,600
423	**Merchant Wholesalers, Durable Goods**	**23,400**	**4.8%**	**81.1%**	**2.7%**	**1.08**	**$131,900**
4234	Professional and Commercial Equipment and Supplies Merchant Wholesalers	23,400	4.8%		2.7%	1.08	$131,900
511	**Publishing Industries (except Internet)**	**20,900**	**4.3%**	**85.4%**	**6.3%**	**1.33**	**$152,700**
5112	Software Publishers	20,900	4.3%		6.3%	1.33	$152,700

Source: QCEW Employees, Non-QCEW Employees, Self-Employed & Extended Proprietors - EMSI 2021.3 Class of Worker.
Note: Average wage and employment numbers rounded to the nearest hundreds. Sorted in decending order by number of employees. 3-digit Industrial information for frequency and wages are solely based on the High-Tech 4- and 6-digit portions of the industry. Some data not shared due to quality concerns.

6.4D *Employment & Wages in High SET Employment Industries, N.C.*

NAICS CODE	HIGH-TECHNOLOGY INDUSTRY	EMPLOYMENT					
		Total 2020	Share of Total 2020	Cumulative Share of Total 2020	Annualized Growth Rate *Compound Annual Growth Rate* 2001-2020	Location Quotient 2020	Average Earnings 2020
333	**Machinery Manufacturing**	**19,300**	**3.9%**	**89.3%**	**-1.4%**	**1.10**	**$83,200**
3339	Other General Purpose Machinery Manufacturing	8,400	1.7%		-1.9%	1.02	$86,500
3336	Engine, Turbine, and Power Transmission Equipment Manufacturing	4,600	0.9%		0.3%	1.60	$91,300
3332	Industrial Machinery Manufacturing	4,000	0.8%		-2.8%	1.10	$71,800
3333	Commercial and Service Industry Machinery Manufacturing	2,200	0.4%		0.9%	0.82	$84,900
221	**Utilities**	**11,200**	**2.3%**	**91.6%**	**-0.1%**	**0.93**	**$145,800**
2211	Electric Power Generation, Transmission and Distribution	11,200	2.3%		-0.1%	0.93	$145,800
518	**Data Processing, Hosting, and Related Services**	**9,400**	**1.9%**	**93.5%**	**-1.8%**	**0.81**	**$131,000**
5182	Data Processing, Hosting, and Related Services	9,400	1.9%		-1.8%	0.81	$131,000
335	**Electrical Equipment, Appliance, and Component Manufacturing**	**9,100**	**1.9%**	**95.4%**	**-2.4%**	**2.09**	**$94,200**
3353	Electrical Equipment Manufacturing	9,100	1.9%		-2.4%	2.09	$94,200
336	**Transportation Equipment Manufacturing**	**7,100**	**1.4%**	**96.8%**	**5.7%**	**0.42**	**$106,700**
3364	Aerospace Product and Parts Manufacturing	6,300	1.3%		5.5%	0.40	$108,700
3369	Other Transportation Equipment Manufacturing	800	0.2%		8.8%	0.68	$77,400
561	**Administrative and Support Services**	**6,500**	**1.3%**	**98.1%**	**6.4%**	**1.04**	**$72,300**
5612	Facilities Support Services	4,700	1.0%		8.9%	0.96	$49,100
561312	Executive Search Services	1,700	0.3%		2.7%	1.30	$93,000
811	**Repair and Maintenance**	**4,600**	**0.9%**	**99.1%**	**0.9%**	**1.19**	**$87,100**
8112	Electronic and Precision Equipment Repair and Maintenance	4,600	0.9%		0.9%	1.19	$87,100
519	**Other Information Services**	**2,700**	**0.6%**	**99.6%**	**7.1%**	**0.28**	**$115,800**
519130	Internet Publishing and Broadcasting and Web Search Portals	2,700	0.6%		7.1%	0.28	$115,800
324	**Petroleum and Coal Products Manufacturing**	**840**	**0.2%**	**99.8%**	**-2.2%**	**0.24**	**$93,300**
3241	Petroleum and Coal Products Manufacturing	840	0.2%		-2.2%	0.24	$93,300
486	**Pipeline Transportation**	**360**	**0.1%**	**99.9%**	**5.0%**	**0.22**	**$116,600**
4869	Other Pipeline Transportation	270	0.1%		5.1%	1.04	$112,600
4862	Pipeline Transportation of Natural Gas	90	0.0%		4.7%	0.09	$128,300
4861	Pipeline Transportation of Crude Oil		0.0%				
113	**Forestry and Logging**	**330**	**0.1%**	**99.9%**	**-0.6%**	**1.55**	**$74,400**
1131	Timber Tract Operations	190	0.0%		-0.2%	1.45	$79,600
1132	Forest Nurseries and Gathering of Forest Products	140	0.0%		-1.2%	1.70	$68,600
521	**Monetary Authorities-Central Bank**	**250**	**0.1%**	**100.0%**	**-2.6%**	**0.39**	**$147,600**
5211	Monetary Authorities-Central Bank	250	0.1%		-2.6%	0.39	$147,600
523	**Securities, Commodity Contracts, and Other Financial Investments and Related Activities**	**40**	**0.0%**	**100.0%**	**0.7%**	**0.18**	**$112,000**
5232	Securities and Commodity Exchanges	40	0.0%		0.7%	0.18	112000
211	**Oil and Gas Extraction**	**30**	**0.0%**	**100.0%**	**-14.6%**	**0.01**	**$120,600**
2111	Oil and Gas Extraction	30	0.0%		-14.6%	0.01	$120,600

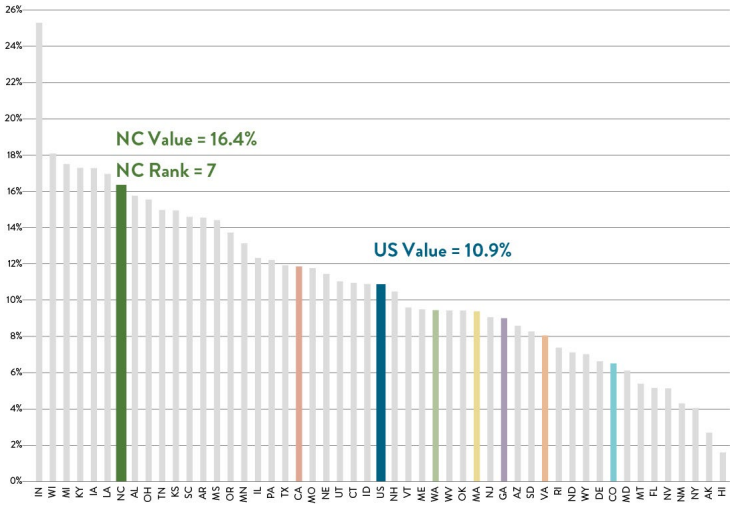
Source: QCEW Employees, Non-QCEW Employees, Self-Employed & Extended Proprietors - EMSI 2021.3 Class of Worker.
Note: Average wage and employment numbers rounded to the nearest hundreds. Sorted in decending order by number of employees. 3-digit Industrial information for frequency and wages are solely based on the High-Tech 4- and 6-digit portions of the industry. Some data not shared due to quality concerns.

The next two subsectors, both focused on manufacturing, together account for 14.1 percent of North Carolina's high SET employment—Chemical Manufacturing (7.5%) and Computer and Electronic Product Manufacturing (6.6%). North Carolina has a larger share of activity than we would expect based on national trends in the Chemical subsector, and slightly lower than expected in Computer and Electronic Products. Both have average wages well above the U.S. average wage for all industries, but employment levels 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 the high SET employment industries except for Manufacturing and Reproducing Magnetic and Optical Media and Semiconductor and Other Electronic Components Manufacturing. Together, these first four subsectors account for more than two-thirds (70.8%) of North Carolina's high SET industry employment.[11]

Adding the next three subsectors brings the total to 85.4 percent of North Carolina's high SET industry employment—Telecommunications (5.6%), Merchant Wholesalers, Durable Goods (4.8%), and Publishing Industries (4.3%). North Carolina's share of activity for two subsectors—Telecommunications and Publishing Industries, 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. Employment in telecommunications has decreased over time, while Merchant Wholesalers and Publishing have increased. 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. The single high SET industry within Publishing is Software publishing, in which North Carolina has a relatively high degree of concentration. The 14 remaining subsectors together account for 14.6 percent of North Carolina's high SET industry employment.

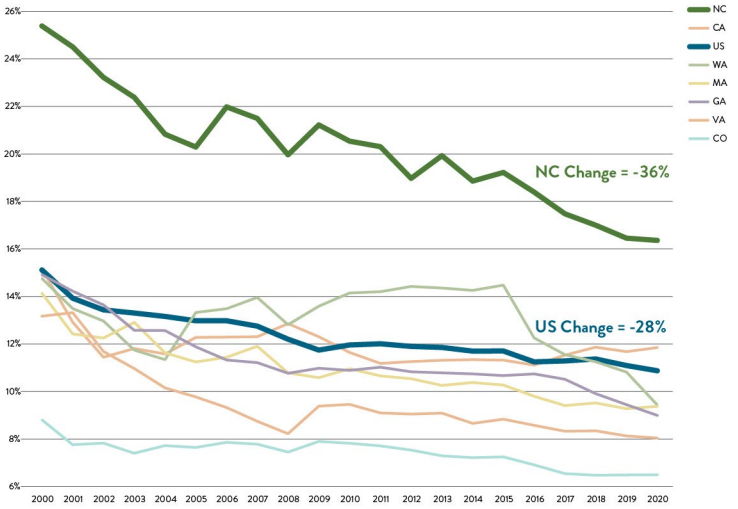
In terms of manufacturing GDP as a percentage of state GDP, North Carolina ranks 7th in the nation, with a level that is 150 percent of the U.S. average value and 65 percent of the value of the state with the highest value, Indiana **[6.4E]**. North Carolina ranks well ahead of all the comparison states and California is the only other state that has a value above the U.S. average. From 2000 to 2020, the percentage of North Carolina's GDP accounted for by manufacturing decreased significantly, by 36 percent, which is greater than the decrease for the U.S. overall, 28 percent. Only Virginia and Georgia experienced a greater decrease in manufacturing as a percentage of GDP than North Carolina **[6.4F]**.

6.4E *Manufacturing GDP as Percentage of State GDP, All U.S. States, 2020*



Source: U.S. Bureau of Economic Analysis.

6.4F *Manufacturing Percentage of State GDP, Comparison States, 2000-2020*



Source: U.S. Bureau of Economic Analysis.

[11] 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.

WHAT DOES THIS MEAN FOR NORTH CAROLINA?

North Carolina's industry mix positions the state, overall, to be an innovation leader in only a small number of industries. 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 less than half are increasing in employment.[12]

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.[13] 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).[14]

Within North Carolina, only 23 percent of the manufacturing jobs are currently in high SET employment industries.[15] Given the importance and impact of high SET manufacturing and given that manufacturing establishments perform 65 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:

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

[12] 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.

[13] 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).

[14] 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).

[15] 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

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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.[1] 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 Real GDP in Chained Dollars dataset, U.S. Bureau of Economic Analysis (BEA), U.S. Department of Commerce, accessed October 26, 2021, https://www.bea.gov/iTable/index_regional.cfm. State-level GDP data are normalized using population data from the U.S. Census Bureau (see 1.6: Population Growth). National-level GDP data are from the World Bank, GDP Per Capita dataset, accessed October 27, 2021, https://databank.worldbank.org/source/world-development-indicators. MSA-level GDP data are from the Real GDP by Metro Area dataset, U.S. Bureau of Economic Analysis (BEA), U.S. Department of Commerce, accessed December 28, 2021, https://www.bea.gov/iTable/index_regional.cfm. MSA population data for 2000 to 2010 are midyear population estimates obtained via the MSA-level Personal Income dataset, U.S. BEA, U.S. Department of Commerce, accessed November 1, 2021. MSA population data for 2010 to 2019 are from Vintage 2020 Population Estimates, Metropolitan and Micropolitan Statistical Areas Totals, U.S. Census Bureau, accessed October 28, 2021, https://www.census.gov/programs-surveys/popest/technical-documentation/research/evaluation-estimates.html. MSA population data for 2020 are from the 2020 Census Redistricting Data (Public Law 94-171), U.S. Census Bureau, www.data.census.gov, accessed December 28, 2021. County-level GDP data are from Real GDP by county dataset, U.S. BEA, U.S. Department of Commerce, https://www.bea.gov/iTable/index_regional.cfm, accessed December 28, 2021. County-level GDP was normalized using population data from the U.S. Census Bureau (see 1.6: Population Growth). Subnational over-time data are adjusted for inflation using the BEA's GDP deflator. National over-time data are adjusted for inflation using The World Bank GDP deflator.

[1] Website addresses provided here link to the sites of the relevant organizations or the relevant sections within those sites, including specific reports or data tables, where possible. Such links are often very long, the product of a search query, or subject to change over time (i.e., they may change or expire after publication of this report). In general, the applicable reports and/or data tables can be found on a site by browsing the available information or by using the site's search tool. Readers who are unable to find specific data may contact the authors of this report.

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 October 29, 2021, http://www.bea.gov/iTable/index_regional.cfm. State-level median household income data are from the U.S. Census Bureau, American Community Survey, S1093-Median Income in the Last 12 Months dataset, 1-Year Estimates, accessed October 29, 2021, https://data.census.gov/cedsci/all?q=s1903. County-level median household income data are from the U.S. Census Bureau, American Community Survey, S1903-Median Income in the Last 12 Months dataset, 5-Year Estimates, accessed October 29, 2021, https://data.census.gov/cedsci/all?q=s1903. Over-time data are adjusted for inflation using the Bureau of Labor Statistics (BLS), U.S. Department of Labor, All Urban Consumers Consumer Price Index (CPI), accessed October 29, 2021, https://www.bls.gov/cpi/data.htm.

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 November 10, 2021, https://data.bls.gov/PDQWeb/en. Over-time data are adjusted for inflation using the Bureau of Labor Statistics (BLS), U.S. Department of Labor, Consumer Price Index (CPI), accessed October 29, 2021, https://www.bls.gov/cpi/data.htm.

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 (LAU) Statistics, LAU Tables, accessed November 1, 2021, https://www.bls.gov/lau/#tables.Total U.S. unemployment is from the Current Population Survey, U.S. BLS, U.S. Department of Labor, Employment status of the civilian noninstitutional population, 1950 to date, https://www.bls.gov/cps/tables.htm#empstat, accessed November 1, 2021. 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 November 1, 2021 https://databank.worldbank.org/source/world-development-indicators.

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. 2005 to 2009 data were accessed August 12, 2019, http://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml and 2010 to 2019 data were accessed November 8, 2021, https://data.census.gov/cedsci/table?q=s1701. 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 November 8, 2021, https://data.census.gov/cedsci/table?q=s1701.

1.6: Population Growth

State-level 2020 population data are from the 2020 Census Redistricting Data (Public Law 94-171), https://data.census.gov/cedsci/table?q=p1, accessed September 27, 2021. State-level 2010 to 2019 population data are from the U.S. Census Bureau, Population Division, Annual Estimates of the Resident Population for the United States, Regions, States, the District of Columbia, and Puerto Rico: April 1, 2010 to July 1, 2019; April 1, 2020; and July 1, 2020, accessed September 27, 2021, https://www.census.gov/programs-surveys/popest/technical-documentation/research/evaluation-estimates/2020-evaluation-estimates/2010s-totals-national.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 September 14, 2021, https://www.census.gov/data/tables/time-series/demo/popest/intercensal-2000-2010-state.html. County-level 2020 population data are from the 2020 Census Redistricting Data (Public Law 94-171), accessed November 15, 2021, https://data.census.gov/cedsci/table?q=p1. County-level 2000 population data are from the U.S. Census Bureau, accessed November 15, 2021, https://www2.census.gov/programs-surveys/popest/datasets/2000-2009/counties/totals/. Historical total population data are from the U.S. Census Bureau, via the North Carolina State Demographer, Historic Census dataset, accessed November 16, 2021, https://demography.osbm.nc.gov/explore/?sort=modified. Total population projections are from the North Carolina Office of State Budget and Management, Demographic and Economic Analysis Section, Population Overview, 2010-2050, accessed November 16, 2021, https://files.nc.gov/ncosbm/demog/countytotals_populationoverview.html.

2.1: Total Research & Development (R&D)

State-level total R&D data are from the National Science Board, *Science and Engineering Indicators 2020,* State Indicator S-41: R&D as a Percentage of Gross Domestic Product (Percent) dataset, accessed December 29, 2021, 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 October 28, 2021, https://databank.worldbank.org/source/world-development-indicators. MSA-level business R&D data are from the National Center for Science and Engineering Statistics and U.S. Census Bureau, Business Research and Development Survey, Table 14, 2018, accessed November 18, 2021, https://ncses.nsf.gov/pubs/nsf21312. University-level R&D data are from the National Science Foundation, National Center for Science and Engineering Statistics, Higher Education Research and Development Survey, FY 2019, Table 5, accessed November 16, 2021, https://ncses.nsf.gov/pubs/nsf21314.

2.2: Business-Performed R&D

State-level business-performed R&D data are from the National Science Board, *Science and Engineering Indicators 2020,* State Indicator S-45: Business-Performed R&D as a Percentage of Private-Industry Output (Percent) dataset, accessed December 29, 2021, https://www.nsf.gov/statistics/state-indicators/indicator/business-performed-rd-to-private-industry-output. MSA-level business R&D data are from the National Center for Science and Engineering Statistics and U.S. Census Bureau, Business Research and Development Survey, Table 14, 2018, accessed November 18, 2021, https://ncses.nsf.gov/pubs/nsf21312. Industry-specific business R&D data is also from the 2018 Business Research & Development Survey, Table 28-B. National Science Board, Science and Engineering Indicators 2020, Chapter 4, "U.S. R&D Performance and Funding," Available at https://ncses.nsf.gov/pubs/nsb20201/.

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,* State Indicator S-46: Academic Science and Engineering R&D per $1,000 of Gross Domestic Product (Dollars) dataset, accessed December, 29, 2021, 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 Research and Development Survey, FY 2019, Table 5, accessed November 16, 2021, https://ncses.nsf.gov/pubs/nsf21314. National Science Board, *Science and Engineering Indicators 2020,* Chapter 4, "U.S. R&D Performance and Funding," Available at https://ncses.nsf.gov/pubs/nsb20201/.

2.4: Federal R&D

State-level federal R&D obligations data are from the National Science Board, *Science and Engineering Indicators,* State Indicator S-42: Federal R&D Obligations per Employed Worker (Dollars) dataset, accessed December, 30, 2021, https://www.nsf.gov/statistics/state-indicators/indicator/federal-rd-obligations-per-employed-worker. This indicator draws from the National Center for Science and Engineering Statistics, Federal Funds for Research and Development: Fiscal Years 2019–20 report, Available at https://ncses.nsf.gov/pubs/nsf21329/.

National Science Board, *Science and Engineering Indicators 2020,* Chapter 4, "U.S. R&D Performance and Funding," Available at https://ncses.nsf.gov/pubs/nsb20201/.

2.5: Academic Articles

State-level academic articles data are from the National Science Board, *Science and Engineering Indicators,* State Indicator S-48: Academic Science and Engineering Article Output per 1,000 Science, Engineering, and Health Doctorate Holders in Academia (Articles) dataset, accessed December 29, 2021, 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*, 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 May 13, 2021, 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 December 15, 2021, https://www.sbir.gov/sbirsearch/award/all.

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3.2: Academic Patents

State-level academic patents data are from the National Science Board, *Science and Engineering Indicators*, State Indicator S-50: Academic Patents Awarded per 1,000 Science, Engineering, and Health Doctorate Holders in Academia (Patents) dataset, accessed December 30, 2021, 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 2020 Licensing Survey, accessed September 3, 2021, https://autm.net/surveys-and-tools/surveys/licensing-survey/.

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3.3: Patents

State-level patents data are from the National Science Board, *Science and Engineering Indicators*, State Indicator S-51: Patents Awarded per 1,000 Individuals in Science and Engineering Occupations (Patents) dataset, accessed January 3, 2022, 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 22, 2021, https://www3.wipo.int/ipstats/index.htm?tab=patent. National-level GDP data are from the World Bank, GDP (Current, US$) dataset, accessed November 22, 2021, https://databank.worldbank.org/source/world-development-indicators. State-level GDP data are from the Real GDP in Chained Dollars dataset, U.S. Bureau of Economic Analysis (BEA), U.S. Department of Commerce, accessed October 26, 2021, https://www.bea.gov/iTable/index_regional.cfm. 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 November 23, 2021, 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*, State Indicator S-58: Venture Capital Disbursed per $1 Million of Gross Domestic Product (Dollars) dataset, accessed January 14, 2021, https://www.nsf.gov/statistics/state-indicators/indicator/venture-capital-per-1-million-state-gdp and State Indicator S-60: Venture Capital Disbursed per Venture Capital Deal dataset, accessed January 3, 2021, https://ncses.nsf.gov/indicators/states/indicator/venture-capital-per-deal. ZIP Code-level venture capital data are from PitchBook Data, Inc., accessed November 22, 2021, http://pitchbook.com/.

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3.5: Technology License Income

State and university-level license income data are from the Association of University Technology Managers (AUTM), FY 2020 Licensing Survey, accessed September 3, 2021, 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,* State Indicator S-46: Academic Science and Engineering R&D per $1,000 of Gross Domestic Product dataset, accessed December 29, 2021, https://www.nsf.gov/statistics/state-indicators/indicator/academic-rd-per-1000-state-gdp.

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3.6: University Startups

University startup data are from the Association of Association of University Technology Managers (AUTM), FY 2020 Licensing Survey, accessed September 3, 2021, 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*, State Indicator S-46: Academic R&D per $1,000 of Gross Domestic Product (Dollars) dataset, accessed December 29, 2021, https://www.nsf.gov/statistics/state-indicators/indicator/academic-rd-per-1000-state-gdp.

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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.

4.1: High Science, Engineering and Technology (SET) Employment Establishments and Formations

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 October 22, 2021, https://data.bls.gov/cew/apps/data_views/data_views.htm#tab=Tables. 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

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 October 22, 2021, https://data.bls.gov/cew/apps/data_views/data_views.htm#tab=Tables. 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 monthly rate of new entrepreneurs and opportunity share of entrepreneurs data are from the Kauffman Foundation, Kauffman Indicators of Entrepreneurship, accessed August 25, 2021, 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 August 31, 2021, 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 31, 2021, https://apps.bea.gov/regional/downloadzip.cfm. National-level export data are from the World Bank, Exports of Goods and Services (% of GDP) dataset, accessed November 8, 2021, https://databank.worldbank.org/source/world-development-indicators.

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5.1: Science & Engineering Workforce

State-level science & engineering workforce data are from the National Science Board, *Science and Engineering Indicators,* State Indicator S-32: Individuals in Science and Engineering Occupations as a Percentage of All Occupations (Percent) dataset, accessed January 03, 2022, 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,* State Indicator S-33: Employed Science, Engineering, and Health Doctorate Holders as a Percentage of the Workforce (Percent) dataset, accessed December 30, 2021, 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,* State Indicator S-38: Engineers as a Percentage of All Occupations (Percent) dataset, accessed June 28, 2021, https://www.nsf.gov/statistics/state-indicators/indicator/engineers-to-all-occupations.

Metro-level employment data are from the U.S. Bureau of Labor Statistics, U.S. Department of Commerce, May 2020 Occupational Employment and Wage Statistics Survey, https://www.bls.gov/oes/#data, accessed December 16, 2021.

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,* State Indicator S-19: Bachelor's Degrees in Science and Engineering Conferred per 1,000 Individuals 18–24 Years Old (Degrees) dataset, accessed June 29, 2021, 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,* State Indicator S-20: Science and Engineering Degrees as a Percentage of Higher Education Degrees Conferred (Percent) dataset, accessed June 30, 2021, 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 October 14, 2021, https://data.census.gov/cedsci/table?q=S1501. County-level educational attainment data are from the U.S. Census Bureau, American Community Survey, S1501 Educational Attainment; North Carolina and all Counties, 2015-2019 American Community Survey 5-Year Estimates dataset, accessed January 04, 2022, https://data.census.gov/cedsci/table?q=S1501.

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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 October 19, 2021, https://data.census.gov/cedsci/table?q=b07009&tid=ACSDT1Y2019.B07009. State-level total population (all ages) data are from the U.S. Census Bureau, 2019 American Community Survey, Total Population, 1-year estimate, Table B01003, https://data.census.gov/cedsci/table?q=population&g=0100000US%240400000&tid=ACSDT1Y2019.B01003&hidePreview=true&tp=true&moe=false, accessed October 25, 2021. 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, 2015-2019 American Community Survey 5-Year Estimates dataset, Table B07009, accessed October 26, 2021, https://data.census.gov/cedsci/table?q=b07009&g=0400000US37,37%240500000&tid=ACSDT5Y2019.B07009&hidePreview=true&moe=false&tp=true.

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,* State Indicator S-10: Elementary and Secondary Public School Expenditures as a Percentage of Gross Domestic Product (Percent) dataset, accessed December 30, 2021, 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*, State Indicator S-26: Appropriations of State Tax Funds for Higher Education as a Percentage of Gross Domestic Product (Percent) dataset, accessed September 13, 2021, 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, December 8, 2021.

6.2: Broadband

State-level data for broadband deployment, fiber to end user connections, and adoption rate are from the Federal Communications Commission, Fourteenth Broadband Deployment Report, December 2019 and Internet Access Services Report, August 2020, received via special request from the Broadband Infrastructure Office, North Carolina Department of Information Technology on October 20, 2021. County-level broadband subscription rates are from the 2015-2019 American Community Survey, 5-year estimates, Table S2801, accessed October 21, 2021, https://data.census.gov/cedsci/table?q=s2801&tid=ACSST5Y2019.S2801. MCNC Broadband Fiber network map obtained from MCNC's website on October 20, 2021, https://assets.mcnc.org/uploads/2020/02/MCNCMap_8.5x11-8-24-2021.pdf.

6.3: Cost of Living Index

State-level and county-level Cost of Living Index data are from the Council for Community and Economic Research (C2ER), provided by NC Department of Commerce Labor and Economic Analysis Division on October 13, 2021, 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 29, 2021 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 third quarter of 2021 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.

The National Science Foundation (NSF) created a table that showed a list of 2002, 2007, and 2012 NAICS codes that constitute high-technology industries. Like the 2019 Innovation Index data, we utilized Census NAICS crosswalks from 2007 to 2012 NAICS codes to compare the vintage codes for the high-technology industries. The EMSI data utilizes 2017 NAICS codes, which updates codes for the categories below:

Industry (NSF Report)	2012 NAICS Code	2017 NAICS Code
Wired telecommunications carriers	5171	517311
Wireless telecommunications carriers (except satellite)	5172	517312

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.

Gross Domestic Product by manufacturing and all industries data are from the GDP by state dataset, Bureau of Economic Analysis, U.S. Dept. of Commerce, accessed November 3, 2021, https://apps.bea.gov/itable/index.cfm. Manufacturing industries are defined as those industries whose 2-digit NAICS code ranges from 31-33.

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NORTH CAROLINA
BOARD OF SCIENCE, TECHNOLOGY & INNOVATION

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