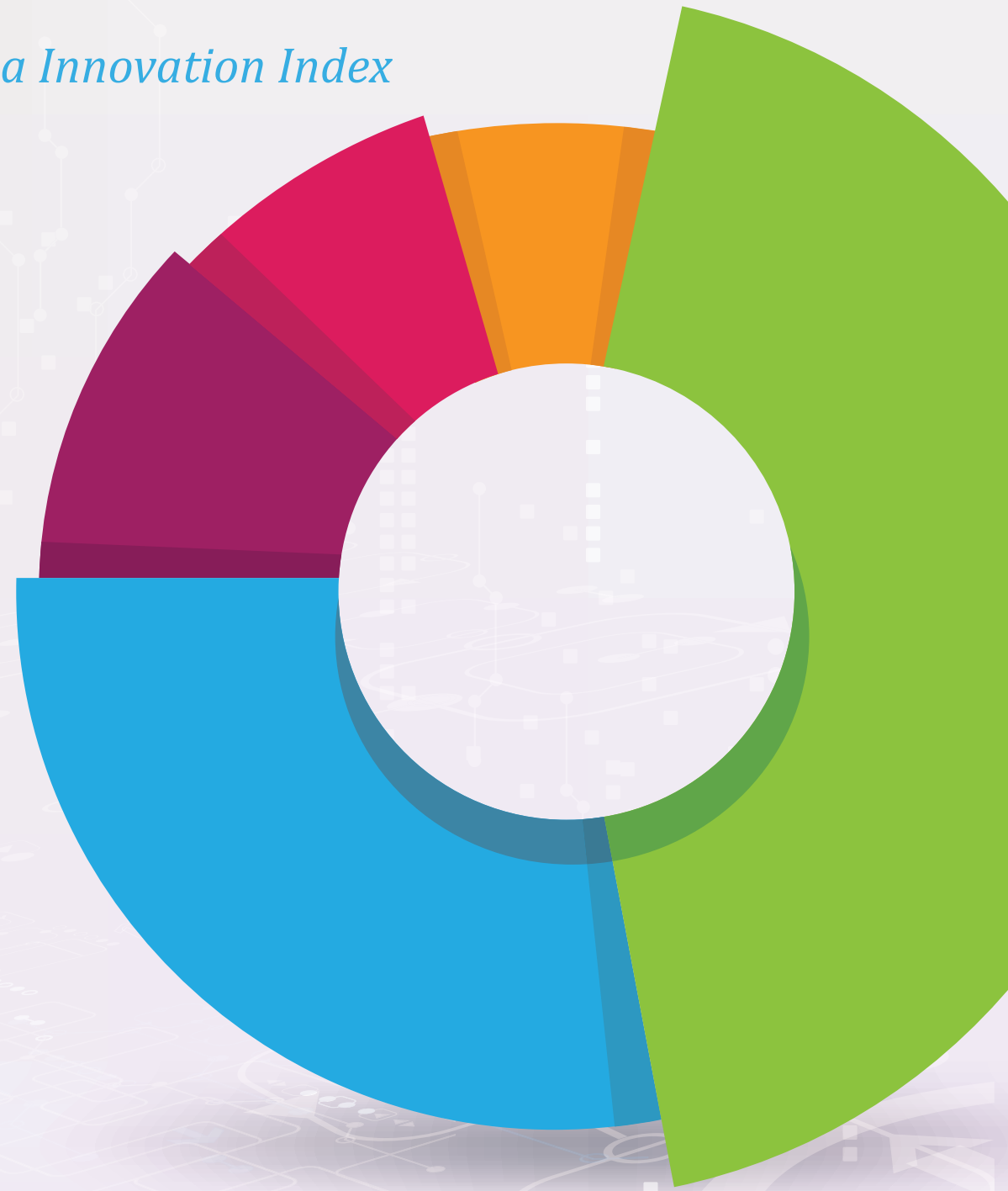
TRACKING INNOVATION

North Carolina Innovation Index

December 2017



North Carolina Department of Commerce
OFFICE OF SCIENCE, TECHNOLOGY & INNOVATION

TRACKING INNOVATION

North Carolina Innovation Index 2017

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ROY COOPER
Governor

ANTHONY M. COPELAND
Secretary

DR. JOHN HARDIN
Executive Director

December 20, 2017

To the Citizens of North Carolina,

It is our pleasure to share with you the 2017 *Tracking Innovation* report. The sixth in a series of periodic reports produced by the Board of Science, Technology & Innovation, it tracks North Carolina's performance across 40 measures of the state's innovation-related assets, activities, and trends.

Simply put, innovation is something new that adds value. Innovation is a force multiplier—an accelerator that helps create new industries, make existing ones globally competitive, and drive future economic growth and well-being. North Carolina's ability to thrive in this increasingly dynamic, global economy depends, fundamentally, on how much it infuses innovation throughout our economic system.

A detailed analysis of the data in the 2015 *Tracking Innovation* report found that the levels of the following three key innovation-related factors are most important for predicting the levels of a state's per capita gross domestic product, average annual pay, and per capita personal income:

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

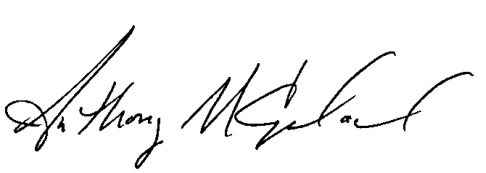
North Carolina should boost these three factors to drive its future economic gains and prosperity.

As shown in this 2017 report, North Carolina has the raw materials to do just that. One of our strongest sources of innovation is our universities, which excel at research & development, generate significant intellectual property, 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 its science, engineering and technology establishments are 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 innovative, high-growth, high-income establishments. This transition will happen only if a larger share of the state's population has the education, training, resources, and infrastructure needed to start, grow, attract, and sustain companies and other organizations that are innovative, entrepreneurial, and able to compete with the best in the world.

A key goal of Governor Cooper's economic development approach is to promote innovation-based economic opportunity throughout the state. This report highlights key trends and themes that should be considered when undertaking these efforts, with the goal of generating informed decision making among North Carolina's policymakers, industries, academic institutions, and citizens.

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



Anthony M. Copeland

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Member, N.C. Board of Science, Technology & Innovation

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Overview

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

This 2017 report, the largest since the series' inception, measures the health of North Carolina's innovation economy. It tracks North Carolina's performance across 40 innovation measures weighed against that of the United States overall, six key comparison states (California, Massachusetts, Georgia, Virginia, Colorado, Washington), and leading countries. These measures provide insights into the links between innovation, resources, and economic results in the North Carolina economy.

Summary Findings

During the most recent time period for which data are available across the report's 40 measures, North Carolina's average rank among the 50 U.S. states is 23rd.[2] Its highest single measure rank is third; its lowest single measure rank is 44th. Additionally, on 28 of the 40 measures, North Carolina's "Percent of U.S. Average Value" is below average, meaning the state underperforms the nation as a whole on those measures (*Dashboard Overview*, next page).

Since the early 2000s, North Carolina's performance relative to itself varied considerably—on 25 measures it improved, on 12 it declined, and on three it stayed the same or could not be measured over time. During that same period, the nation's performance relative to itself also varied considerably—on 29 measures it improved, on 7 it declined, and on four it stayed the same or could not be measured over time.[3] Overall, North Carolina's innovation ecosystem is moderately healthy and has improved slightly since the early 2000s, but is lagging slightly behind the improvements of the nation overall.

Findings by Category

- **Economic Well-Being:** North Carolina has one of the fastest-growing populations in the nation, but the productive capacity of its economy is below average, with a higher-than-average share of its residents unemployed, with low wages and incomes, and/or living in poverty.
- **Research & Development:** North Carolina excels at academic research & development, but the total level of the state's research & development, particularly that performed by business, is below the national average and insufficient to fuel and sustain strong economic growth.
- **Commercialization:** North Carolina organizations, particularly its academic institutions, generate significant intellectual property, but the overall levels of the state's innovation commercialization activities are below the national average and must be stronger to realize the full economic and social benefits of that intellectual property.
- **Innovative Organizations:** North Carolina's high-technology sectors are increasing in employment and have wages that are above the national average for all business establishments, but a higher-than-average share of the state's business establishments and employment is not high-technology in nature and has average levels of entrepreneurial activity.
- **Education & Workforce:** North Carolina has a well-educated and well-trained science & engineering workforce at the more-advanced educational levels, but the overall educational attainment level of its residents is below the national average; additionally, while the average years of education of its recent in-migrants and the in-migration of college educated adults as a percentage of the total state population are above the national average, they are not sufficient to raise the state's overall educational attainment level significantly.

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

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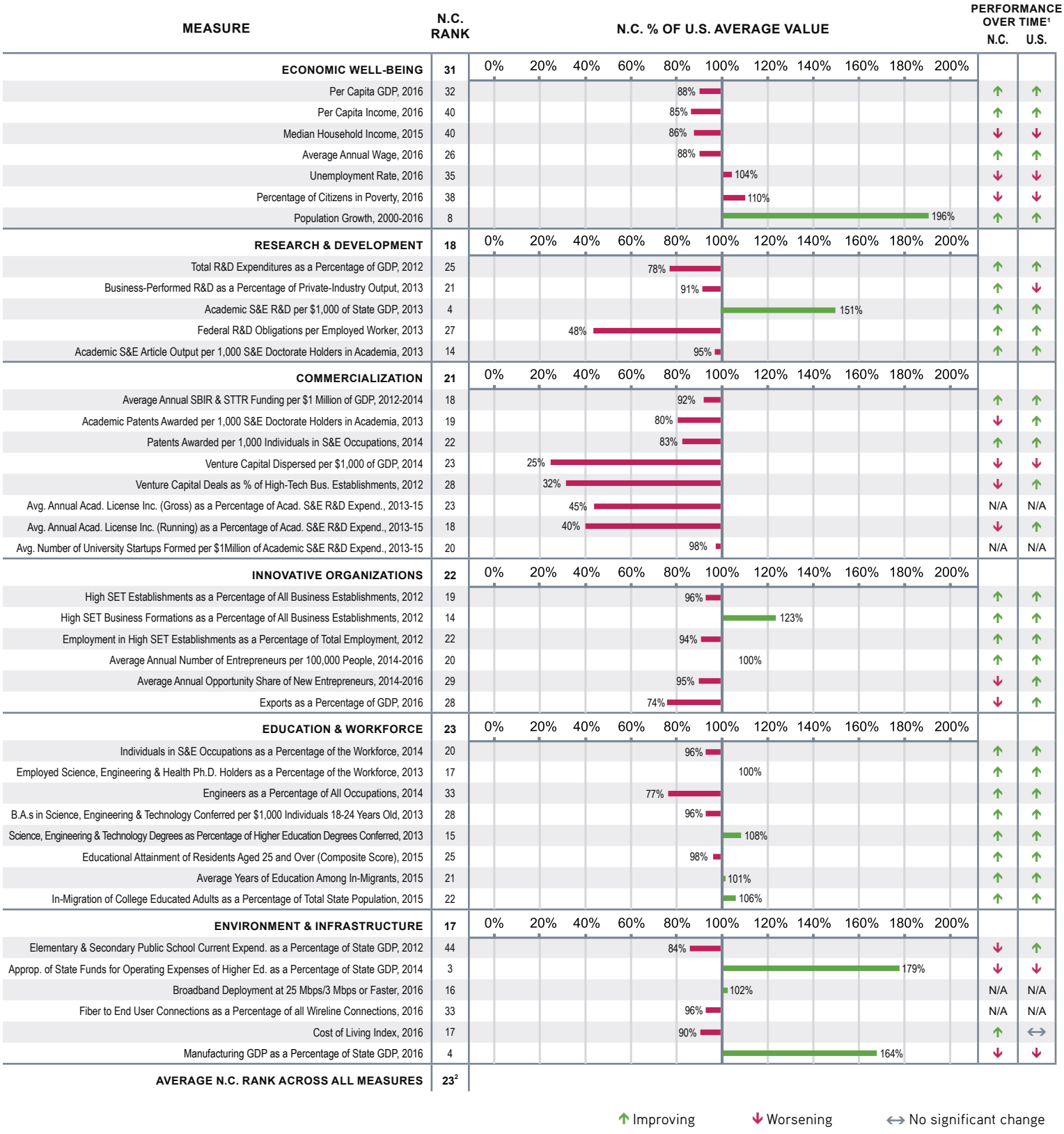
[1] The NC Board of Science, Technology & Innovation has produced five innovation indexes during the last 15 years, in 2000, 2003, 2008, 2013, and 2015.

[2] In the 2015 version of this report, North Carolina's average rank was also 23rd. While these rankings are lower than expected, two aspects help put them in context: (1) the rankings are for the state overall, not just the small number of much-acclaimed, very well-performing regions such as the Research Triangle; (2) all indicators are expressed as ratios or percentages, which "normalizes" the data by controlling for "size" factors such as state population and Gross Domestic Product (GDP), causing larger states like North Carolina (which has higher-than-average population and GDP) to rank lower than expected based only on their size.

[3] Historical data are unavailable for three of the 40 measures.

Dashboard Overview of Measures



[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 measure, the starting year is typically a few years after 2000.

[2]Assumes all measures are weighted equally.

Implications & Priorities

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

- **Research & Development - Increase Volume and Intensity:** To grow its economy significantly in both the short term and long term, North Carolina must increase the volume and intensity of its research & development efforts—particularly those performed by business—relative to other U.S. states and to leading countries. In the near term it should, at a minimum, strive to be at parity with the U.S. average value. One opportune way North Carolina businesses could achieve this is by closer and more frequent research & development partnerships with the state's universities, which have well-above-average research & development performance, and facilities, equipment, and expertise often beyond the scope of most 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, and technology commercialization. Additionally, the state must continue to support its programs focused on capturing and leveraging the benefits of the federal grant programs, such as Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR), which provide working capital to emerging companies. 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 prosper. In addition, to remain competitive in the global economy, the state must continue to explore new markets for the goods and services it produces, particularly by understanding how North Carolina industries fit within global commodity value chains, and deepening and expanding relationships with overseas trading partners.
- **Education & Workforce - Emphasize STEM and Strengthen Fundamentals:** To intensify the innovation-relevant education and training levels of its workforce, North Carolina must grow the share of its community college and university-level students earning degrees in science, technology, engineering, and math (STEM) disciplines. One way to achieve this could entail industries, educators, and government regularly collaborating to develop a North Carolina innovation-focused technology workforce agenda and strategy. The strategy could organize education and workforce programs around broad clusters and skills, particularly ones the state has determined to be in its strategic interests. Additionally, North Carolina must raise the educational attainment of its citizens at all levels of the educational spectrum, to a level at least equal to the national average. Doing so would enhance efforts in the three priorities above and multiply their impacts.
- **Environment & Infrastructure - Reinforce, Enhance, and Broaden:** To ensure that the greatest number and range of its citizens enjoy the economic and social benefits of science, technology, and innovation, North Carolina must continue to invest, throughout its regions, in basic infrastructure elements of its innovation economy, such as elementary, secondary, and higher education organizations; broadband deployment and adoption; and industries that use science and technology and a highly skilled workforce to develop, manufacture, distribute, and export products. Combined with North Carolina's low cost of living and high quality of life, these elements provide the richest and most fundamental foundation for starting, growing, and attracting businesses that improve our economic well-being and quality of life.

Efforts such as those above must be sufficiently long-term and well-funded to make a difference, and they must have the flexibility to respond to continually changing circumstances and to support different needs across regions. 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.

Research & Development

Indicator 2.1: Total Research & Development

Indicator 2.2: Industry Research & Development

Indicator 2.3: Academic Science & Engineering Research & Development

Indicator 2.4: Federal Research & Development

Indicator 2.5: Academic Articles

Commercialization

Indicator 3.1: Small Business Innovation Research & Small Business Technology Transfer Awards

Indicator 3.2: Academic Patents

Indicator 3.3: Patents

Indicator 3.4: Venture Capital

Indicator 3.5: Technology License Income

Indicator 3.6: University Startups

Innovative Organizations

Indicator 4.1: High Science, Engineering & Technology Employment Establishments & Formations

Indicator 4.2: High Science, Engineering & Technology Employment

Indicator 4.3: Entrepreneurial Activity

Indicator 4.4: Exports

Education & Workforce

Indicator 5.1: Science & Engineering Workforce

Indicator 5.2: Employed Science, Engineering & Health Doctorate Holders

Indicator 5.3: Engineers as a Percentage of the Workforce

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

Indicator 5.5: Science, Engineering & Technology Degrees

Indicator 5.6: Educational Attainment

Indicator 5.7: Educational Attainment of In-Migrants

Environment & Infrastructure

Indicator 6.1: Public Investment in Education

Indicator 6.2: Broadband

Indicator 6.3: Cost of Living Index

Indicator 6.4: Industry Mix

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* 2017?

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.

[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 Nager 2014.*

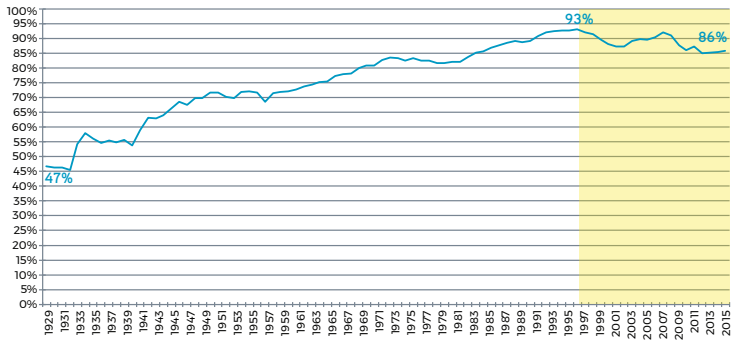
For nearly a century, North Carolina has been transitioning from an agricultural and traditional manufacturing economy to a knowledge- and innovation-based economy fueled by science and technology. In the process, the state's policymakers, businesses, educational institutions, and citizens have made strategic investments in infrastructure, institutions, and human capital. Because of these investments (and as illustrated later in this report), North Carolina has achieved a leading role in the "basic" and early-stage "applied" research that forms the foundation for breakthrough innovations. These innovations have helped North Carolina's per capita income as a share of U.S. per capita income more than double during the last century, increasing steadily from a low of 47 percent in 1929 to a high of 93 percent in 1997 ***[Figure 1]***. But while significant and impactful, these investments have not been sufficient to propel North Carolina's per capita income to a level above the average per capita income for the nation as a whole. And since 1997, North Carolina's per capita income as a share of U.S. per capita income has decreased significantly, currently at 86% in 2016, 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* 2017?

The goal of *Tracking Innovation* 2017 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,

FIGURE 1 *N.C. Per Capita Income as share of U.S. Per Capita Income, 1929-2016*



Source: U.S. Bureau of Economic Analysis.

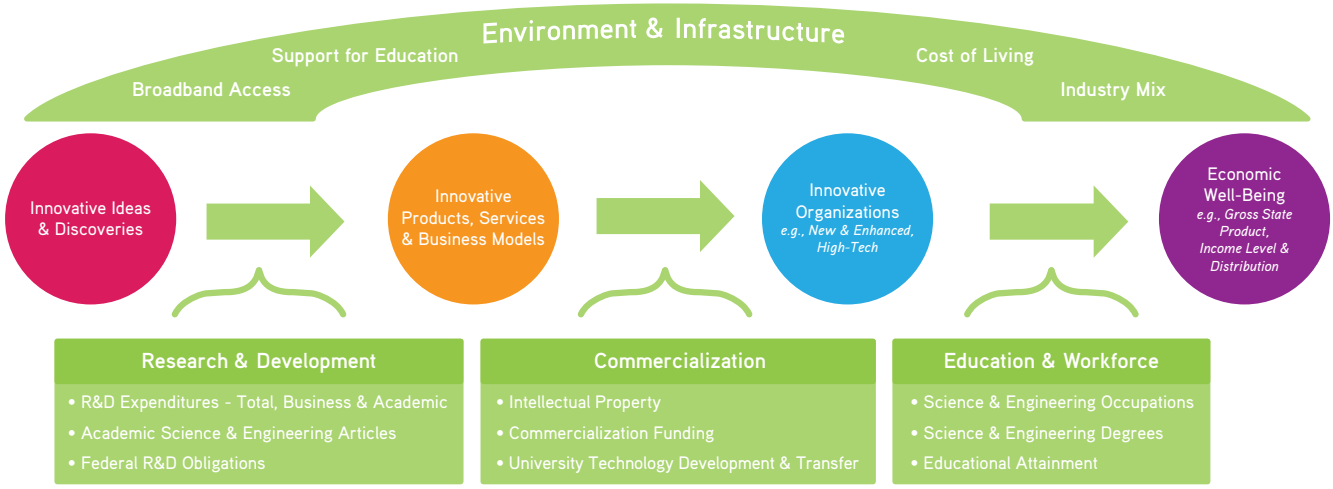
six comparison states, and the U.S. Its 40 measures are summarized under 32 broad indicators of innovation, technology, and economic well-being. Each of the 40 indicators, in turn, falls into one of six general categories:

- **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 five innovation indexes during past 15 years, in 2000, 2003, 2008, 2013, and 2015. See: http://www.nccommerce.com/sti/resources/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* 2017?

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 2014, 2015, and 2016. For virtually all the indicators, there is a one- to three-year lag time between the current year (2017) 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] *For a small number of indicators, the most current data are from as far back as 2012.*

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

An enhancement in this report, not available in *Tracking Innovation* reports before 2015, is the addition, when available, of international data (in the form of a selected set of 20 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).[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]

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[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 3.2 across the three factors (1*.33)+(7*.33)+(1.5*.33)=3.2; similarly, China, for example, ranks 15th, 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, Innovation Ecosystem, previous page]***.
- ***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 26 of the 40 indicators), they are presented, typically in map form, to provide a more nuanced and explicit understanding of the location of innovation-related assets and the performance of those locations, which can vary considerably across the state.

We hope you find the data informative and useful.

[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.*

Indicator 1.1: Gross Domestic Product

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 12th overall but is increasing at a much slower rate.
- Within North Carolina, three Metropolitan Statistical Areas (MSAs) had higher per capita GDPs than the national average for MSAs in 2016; since 2000, the per capita GDP of most of North Carolina's MSAs has increased at a rate slower than the U.S. average.

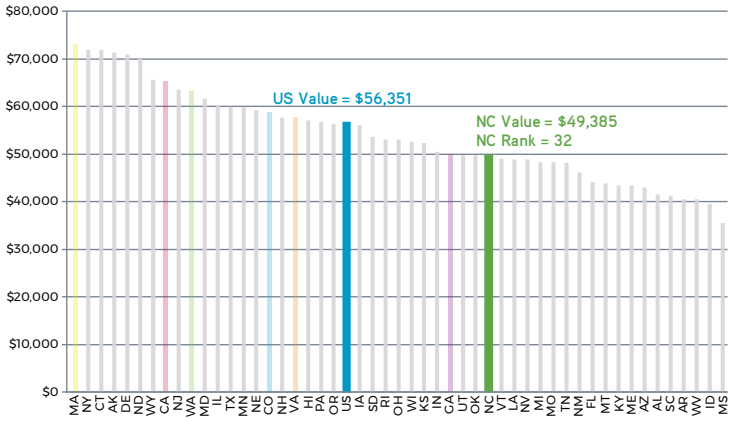
Indicator Overview

Gross domestic product (GDP) per capita captures the overall economic performance of a locale (e.g., state, country, or region). GDP is a measure of the total value of goods and services produced by an economy; on a per capita basis, GDP provides a measure of the productive capacity of a locale's workforce.[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?

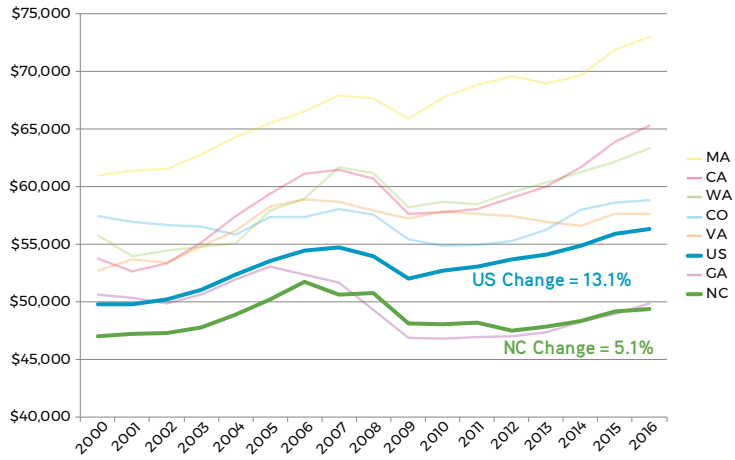
In 2016, North Carolina's per capita GDP of $49,385 was below the national average ($56,351) and below the midpoint of the individual state distribution, ranking 32nd overall ***[1.1A]***. All comparison states except Georgia had an average per capita GDP above the national average. Since 2000, inflation-adjusted per capita GDP has increased in North Carolina by 5.1 percent. This percentage increase is slower than the 13.1 percent growth for the nation ***[1.1B]***. Indeed, North Carolina has fallen from the 21st-ranked state in per capita GDP in 2000 to 32nd in 2016. Among comparison states, Colorado (2.5 percent), Georgia (-1.6 percent), and Virginia (9.3 percent) also experienced lower growth in per capita GDP since 2000.

1.1A *Per Capita Gross Domestic Product, All U.S. States, 2016*



Source: U.S. Bureau of Economic Analysis.

1.1B *Per Capita Gross Domestic Product, Comparison States, 2000-2016*



Source: U.S. Bureau of Economic Analysis.

Note: Adjusted for inflation (2016 dollars).

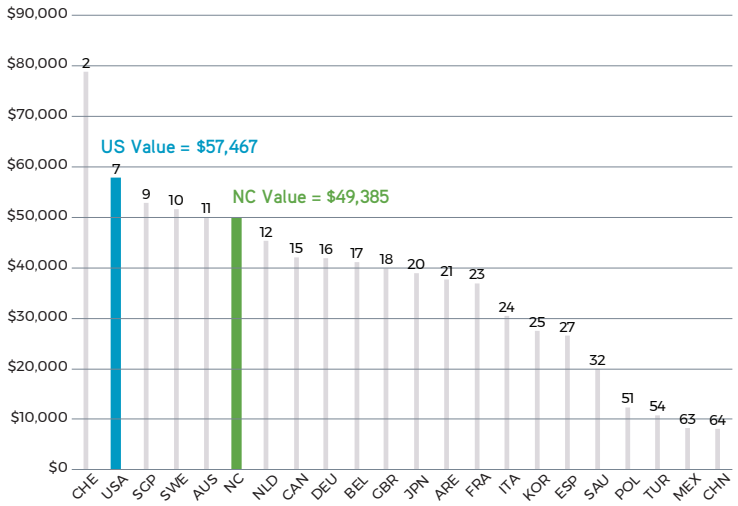
[1] *For the purposes of this report, the term "gross domestic product (GDP)" is used as a general counterpart to the more specific terms "gross state product (GSP)" at the state level, "gross regional product (GRP)" at the regional level, and "gross metro product (GMP)" at the metropolitan statistical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

Indicator 1.1: Gross Domestic Product

Internationally, U.S. per capita GDP was the 7th highest in the world in 2016 ***[1.1C]***. Many of the countries ahead of the U.S. have unique economies (often heavily dependent on native natural resources) and small populations, however, which explains their higher per capita GDP levels. In comparison with top foreign countries, North Carolina's per capita GDP ranks approximately 12th overall, between that of Australia and the Netherlands. While highly populated countries such as China and Mexico have large absolute GDPs, their per capita GDPs remain relatively small, ranking 64th and 63rd, respectively.

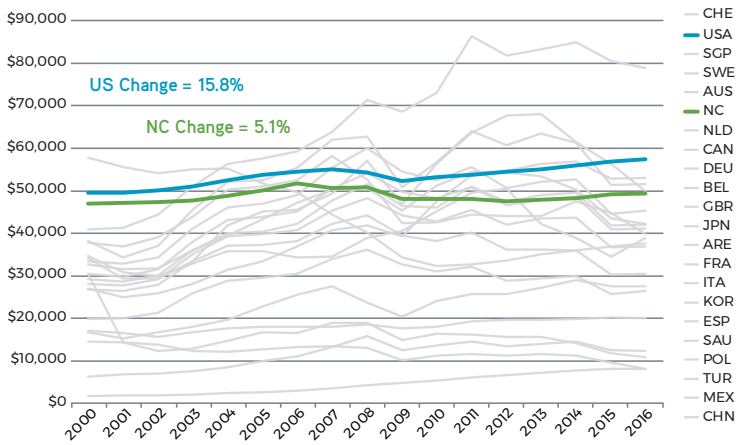
Since 2000, the per capita GDP of each of the 20 comparison countries except Egypt, Great Britain, Mexico, and Turkey has risen at a much faster rate (an average of 67 percent across the countries) than that of the U.S. (15.8 percent) and North Carolina (5.1 percent) ***[1.1D]***. Additionally, while the per capita GDPs of most of the 20 comparison countries were relatively lower than that of the U.S. and North Carolina in 2000, by 2016 the per capita GDP of one country (Switzerland) had risen to be higher than the U.S. and North Carolina's values, and the per-capita GDP in another three countries (Singapore, Sweden and Australia) had risen to be nearly equal to the U.S.'s and North Carolina's. While the per-capita GDP in the remaining comparison countries remained relatively low between 2000 and 2016, their average growth rate was 41.1 percent, with China's GDP growing especially rapidly at 384.8 percent.

1.1C *Per Capita Gross Domestic Product, Comparison Countries, 2016*



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

1.1D *Per Capita Gross Domestic Product, Comparison Countries, 2000-2016*



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

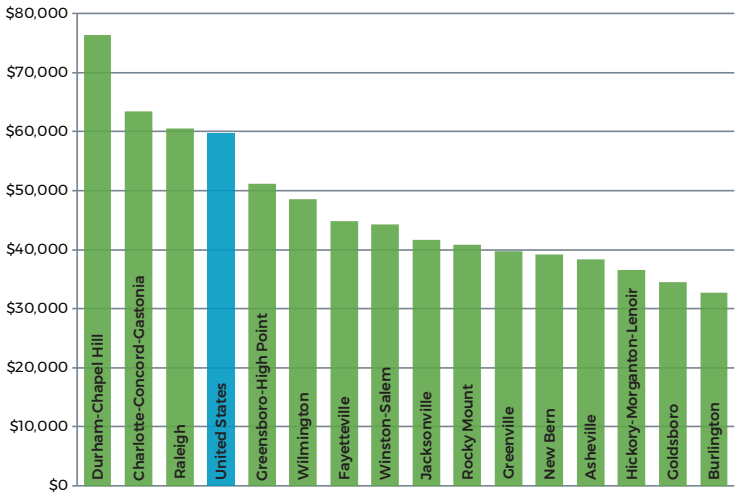
Indicator 1.1: Gross Domestic Product

Within North Carolina, three Metropolitan Statistical Areas (MSAs)—Durham-Chapel Hill, Charlotte-Concord-Gastonia, and Raleigh—had higher per capita GDPs than the U.S. average in 2016 ***[1.1E, 1.1G]***. The remaining 12 metro areas rank below the U.S. average. The Durham-Chapel Hill MSA accelerated between 2000 and 2016, increasing per capita GDP by 19.4 percent ***[1.1F]***. Over the same time period, the U.S. average increased by 11.8 percent, and other large North Carolina MSAs such as Charlotte-Concord-Gastonia and Raleigh increased by 7.9 percent and 3.2 percent, respectively. All other North Carolina MSAs grew at a slower rate than the U.S. average or declined overall.

What Does This Mean for North Carolina?

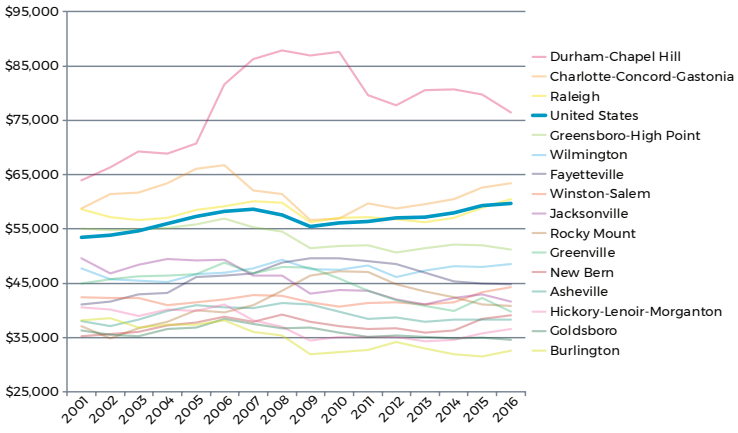
Trends in per capita GDP in North Carolina are a cause for concern. As of 2016, the state performed well below average in comparison with all U.S. states. Additionally, North Carolina's per capita GDP value has grown more slowly since 2000 than has the national value and those of several comparison countries. 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 steps to grow the economy. Fostering innovation is one such step; the value added by innovation can improve productivity and is often compensated with jobs, income, and profit.

1.1E *Per Capita Gross Domestic Product, N.C. MSAs, 2016*



Source: U.S. Bureau of Economic Analysis.

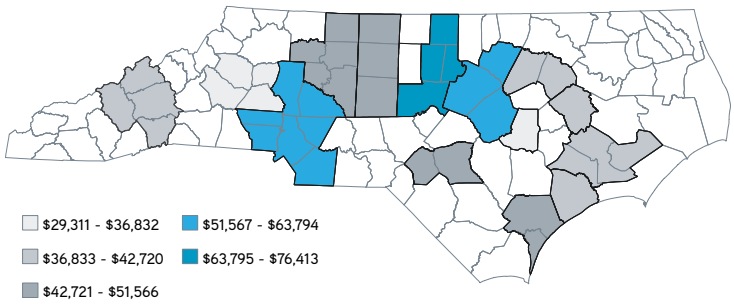
1.1F *Per Capita Gross Metro Product, N.C. MSAs, 2001-2016*



Source: U.S. Bureau of Economic Analysis.

Note: Adjusted for inflation (2016 dollars).

1.1G *Per Capita Gross Metro Product, N.C. MSAs, 2016*



Source: U.S. Bureau of Economic Analysis.

Note: Adjusted for inflation (2016 dollars). Metropolitan Statistical Areas appearing in blue are above the U.S. average.

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 2000, and, adjusted for inflation, has decreased at a rate faster than the U.S. median household income has decreased.
- 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.

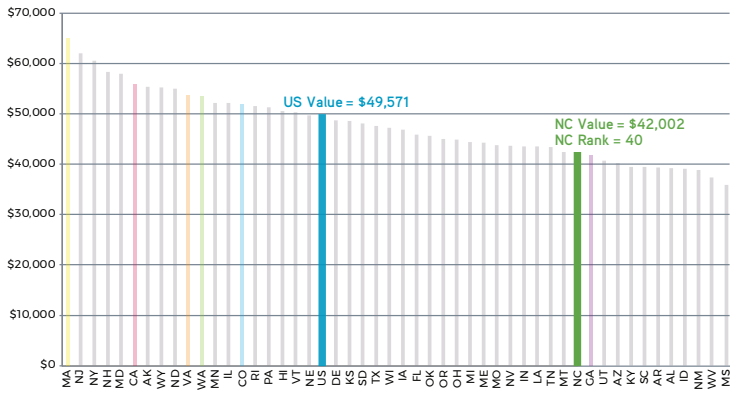
Indicator Overview

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?

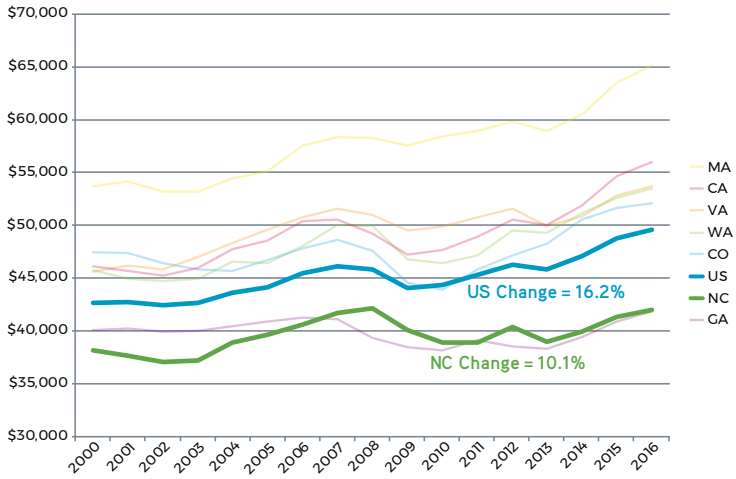
Per capita personal income in North Carolina was $42,002 in 2016 ***[1.2A]***. This income is 85 percent of the national per capita personal income ($49,571) and places North Carolina as the 40th-highest performing state in the country. Since 2000, the inflation-adjusted per capita personal income in North Carolina increased by 10.1 percent while per capita income increased by 16.2 percent for the country as a whole ***[1.2B]***. North Carolina's per capita personal income ranks below that of all comparison states except Georgia. Over the same period, per capita income in some comparison states

1.2A *Per Capita Income, All U.S. States, 2016*



Source: U.S. Bureau of Economic Analysis.

1.2B *Per Capita Income, Comparison States, 2000-2016*



Source: U.S. Bureau of Economic Analysis.

Note: Adjusted for inflation (2016 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.*

has increased faster than the national average; for example, per capita income increased in Massachusetts by 21.2 percent and in Virginia by 17.8 percent.

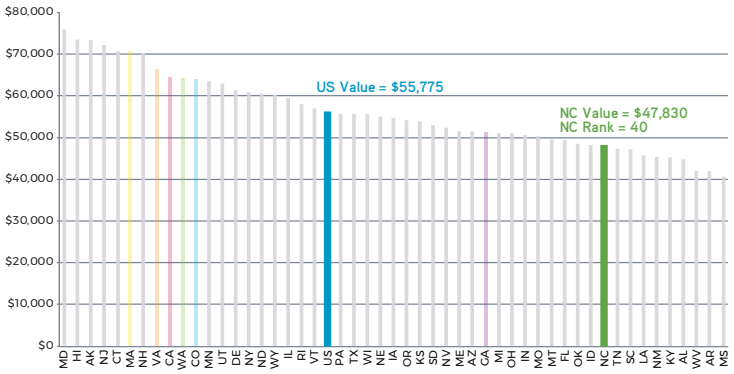
North Carolina's performance in median household income mirrors its performance in per capita income ***[1.2C]***. With a median household income of $47,830 in 2015, North Carolina ranks 40th in the nation and possesses a median income that is 86 percent of the national average ($55,775). Furthermore, North Carolina had the lowest median household income among all comparison states. Along with Georgia and California, North Carolina median household income decreased at a faster rate from 2005 to 2015 (-3.2 percent) than did the national median household income (-0.6 percent) ***[1.2D]***.

Within North Carolina, 16 counties have a per capita personal income higher than the state average, and four have a per capita personal income higher than the U.S. as a whole. The low number of counties above the state average indicates that high-income counties like Mecklenburg and Orange, with per capita personal incomes of more than $52,000, skew the distribution. Twenty-one counties had a median household income higher than the state average, and nine counties had a median income higher than the U.S. median income in 2015 ***[1.2E]***. Median household income ranged from $67,309 in Wake County to $30,027 in Bertie County.

What Does This Mean for North Carolina?

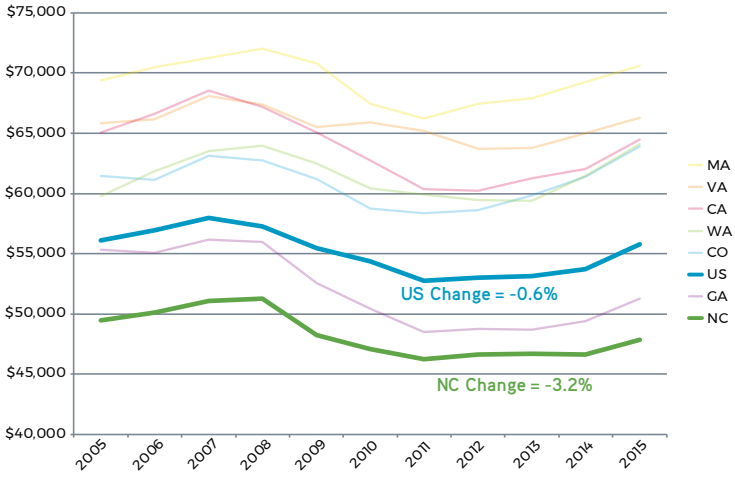
Per capita personal income and median household income in North Carolina compared unfavorably with the U.S. and comparison states in 2016 and 2015, respectively, the most recent years for which data were available for each indicator. Furthermore, historical data show that North Carolina's performance 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-technology, innovative companies in the state's economy.

1.2C Median Household Income, All U.S. States, 2015



Source: U.S. Census Bureau.

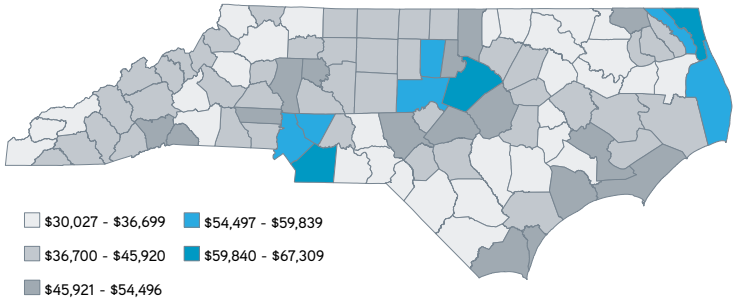
1.2D Median Household Income, Comparison States, 2005-2015



Source: U.S. Bureau of Economic Analysis.

Note: Adjusted for inflation (2016 dollars).

1.2E Median Household Income, N.C. Counties, 2011-2015 Average



Source: U.S. Census Bureau.

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

Indicator 1.3: Average Annual Wage

KEY FINDINGS

- North Carolina's average annual wage in 2016 ranked considerably below the U.S. average and the average wages of all comparison states.
- Between 2000 and 2016, North Carolina's inflation-adjusted average wage increased at a rate slightly faster than the rate of increase in the U.S. average wage. Average annual wages for workers in high science, engineering, and technology (SET) employment industries, in both North Carolina and the U.S. overall, are consistently much higher than the average annual wages for all industries.
- Within North Carolina, only three counties had average annual wages higher than the U.S. average annual wage in 2016; only six counties had average annual wages higher than the N.C. average.

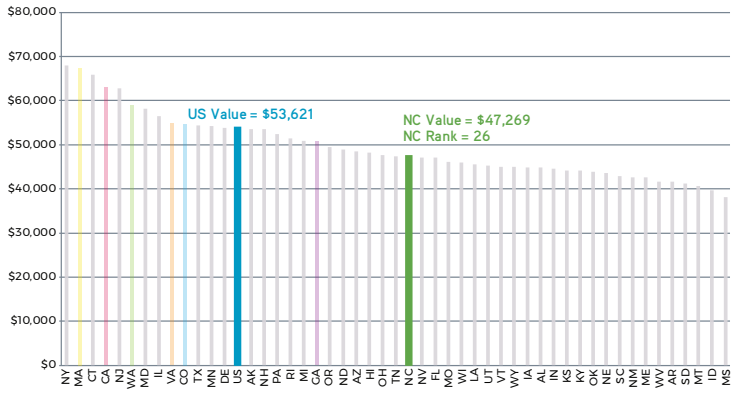
Indicator Overview

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

How Does North Carolina Perform?

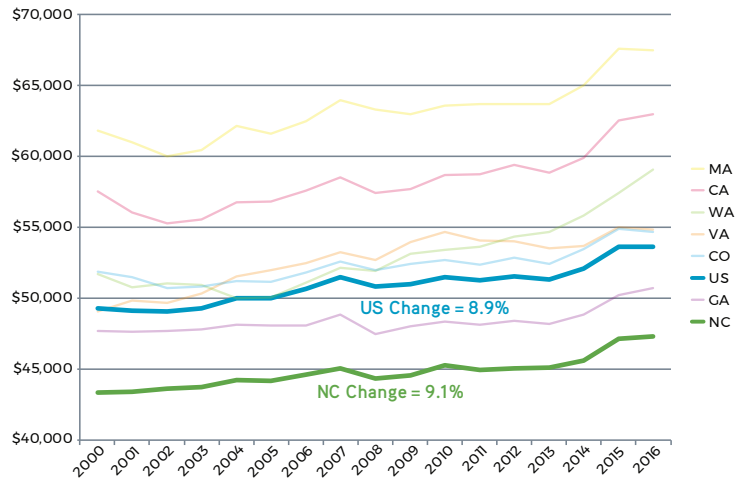
In 2016, the average annual wage in North Carolina was $47,269, ranking the state 26th highest in the country and well below the national average of $53,621 ***[1.3A]***. All six comparison states had higher average wages than North Carolina; Georgia is the only other comparison state with an average wage lower than the national average. North Carolina's modest performance results primarily from the industry mix of its economy, which continues to depend—more than most other states do—on low-technology industries that are sensitive to labor costs (see indicator 4.1). From 2001 to 2016, the inflation–adjusted average annual wage in North Carolina grew by 9.1 percent, which is higher than the national growth rate (8.9 percent) and in the middle of the pack among the comparison states—behind Virginia, Washington, and California, equal to Massachusetts, and ahead of Colorado and Georgia ***[1.3B]***.

1.3A *Average Annual Wage, All U.S. States, 2016*



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

1.3B *Average Annual Wage, Comparison States, 2000-2016*



Source: U.S. Bureau of Economic Analysis.

Note: Adjusted for inflation (2016 dollars).

Indicator 1.3: Average Annual Wage

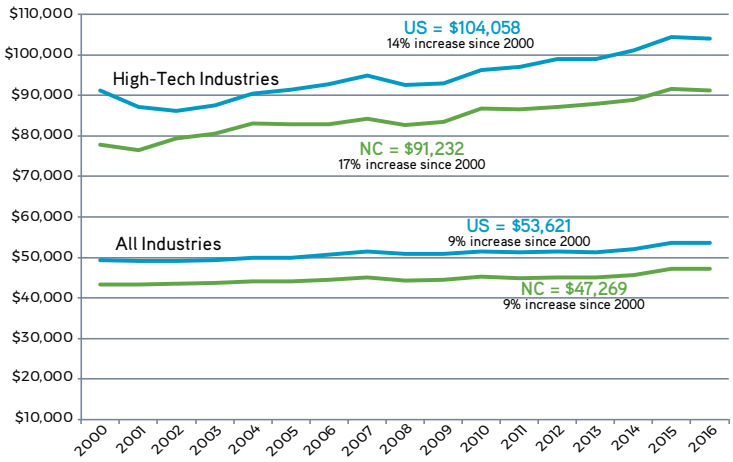
In 2016, the average annual wage for workers in high SET employment industries in North Carolina was $91,232, nearly $44,000 (or nearly 100 percent) greater than average wages for all industries in the state ***[1.3C]***. This pattern reflects national patterns, in which the high SET employment average wage of $104,058 is nearly twice the average wage for all industries.

Within North Carolina, the vast majority of counties have an average annual wage lower than the state average. Only six counties—Durham, Mecklenburg, Wake, Orange, Forsyth, and Iredell—had a 2016 average wage higher than the state average; only three counties—Durham, Mecklenburg, and Wake—had a 2016 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 2016 was below the average annual wage for the nation as a whole and for all comparison states. However, average wages in North Carolina have increased over time, and this increase has been slightly higher than the growth experienced by the country as a whole. Overall, the wage picture in North Carolina is improving somewhat but is still lower than it should be. A key way to increase wages is to increase the number of workers employed in high SET industries and other knowledge-based industries. Growth in these occupations will lead to higher standards of living for North Carolinians, increased consumer spending, and economic growth across the state.

1.3C *Average Annual Wage, High SET Employment Industries & All Industries, U.S. & N.C., 2000-2016[1]*

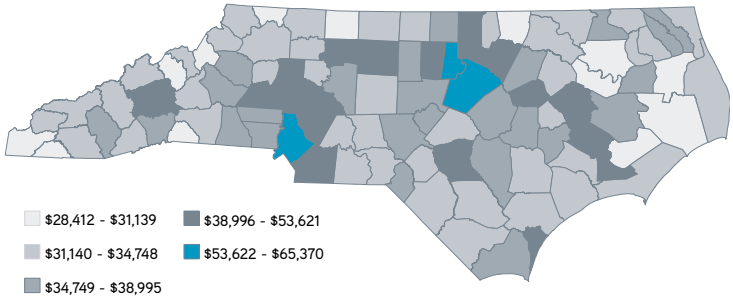


Source: Bureau of Labor Statistics, U.S. Department of Labor.

Note: Adjusted for inflation (2016 dollars).

[1] 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, 2016*



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

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

Indicator 1.4: Unemployment

KEY FINDINGS

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

Indicator Overview

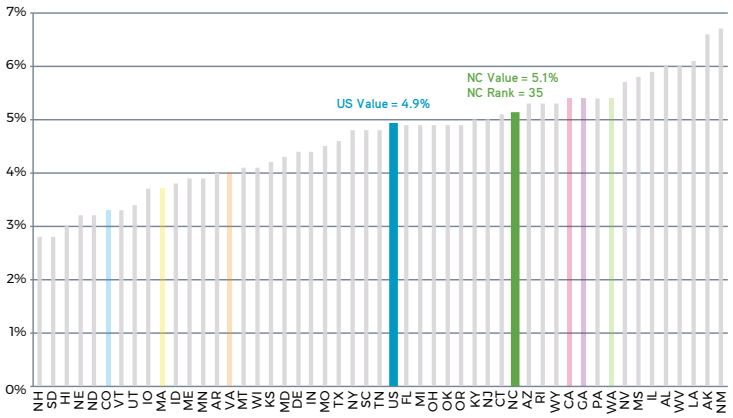
The unemployment rate is the percentage of labor force participants who are unemployed but actively seeking and available for work. Unemployment is generally viewed as a lagging indicator that reflects the performance of an economy. Unemployment rates indicate the degree to which an economy provides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

How Does North Carolina Perform?

The average unemployment rate for North Carolina in 2016 was 5.1 percent ***[1.4A]***. This unemployment rate is slightly higher than the national unemployment rate of 4.9 percent and is the 35th lowest rate of all states in the country. Among comparison states, North Carolina ranks in the middle of the pack, behind Colorado, Virginia, and Massachusetts, but ahead of Washington, Georgia, and California.

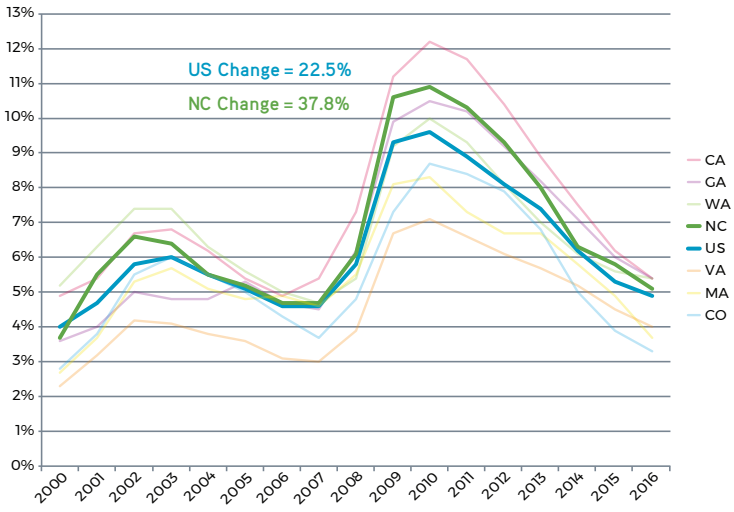
Between 2000 and 2014, North Carolina's unemployment rate rose faster than the national rate; specifically, North Carolina's unemployment rate increased by 37.8 percent, whereas the U.S. unemployment rate increased 22.5 percent ***[1.4B]***. North Carolina's increase was smaller than the increase in three of the comparison states (Georgia, Massachusetts, and Virginia). The increase for all the states and the U.S. overall resulted primarily from the recession beginning in late 2007 and early 2008, which caused unemployment rates to spike in 2010 (particularly in North Carolina) but then to reverse and decrease steadily, though not to pre-recession levels.

1.4A *Unemployment Rate, All U.S. States, 2016*



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

1.4B *Unemployment Rate, Comparison States, 2000-2016*



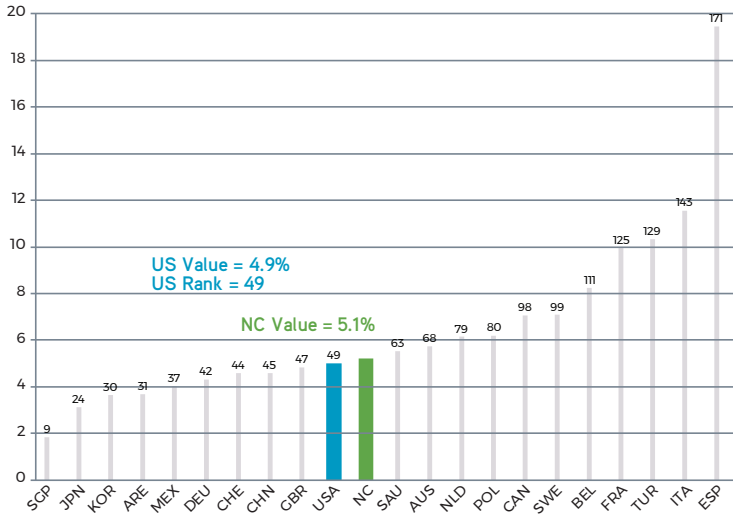
Source: Bureau of Labor Statistics, U.S. Department of Labor.

Indicator 1.4: Unemployment

Internationally, the U.S. had the 49th lowest unemployment rate in the world in 2016 ***[1.4C]***. Among the 20 comparison countries, Saudi Arabia, Australia, the Netherlands, Poland, Canada, Sweden, Belgium, France, Turkey, Italy, and Spain all have higher unemployment rates in 2016. North Carolina's unemployment rate is also lower than that of these countries, but higher than that of the United States overall.

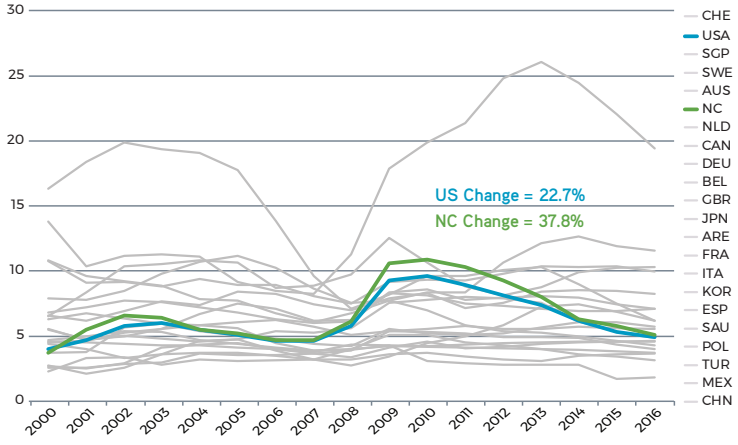
Since 2000, and particularly since the 2007- 2009 recession, the unemployment rates in North Carolina and the U.S. have increased considerably more than the rates in nearly all the comparison countries. Since 2000, the average unemployment rate across the 20 comparison countries rose by 13 percent, compared to 23 percent for the U.S. and 38 percent for North Carolina ***[1.4D]***. Additionally, while the unemployment rate in most of the 20 comparison countries was considerably higher than that of the U.S. and North Carolina in 2000, by 2013 the unemployment rate in the majority of comparison countries was lower than the U.S.'s and North Carolina's. In large part, this change in relative rankings—with the U.S. and North Carolina experiencing higher unemployment rates in recent years—results from the 2007-2009 recession. This downturn hit North Carolina especially hard, due primarily to its disproportionate unemployment impact on sectors such as financial services and low-skill, low-tech manufacturing, in which North Carolina has had a higher-than-average presence.

1.4C *Unemployment Rate, Comparison Countries, 2016*



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

1.4D *Unemployment Rate, Comparison Countries, 2000-2016*



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

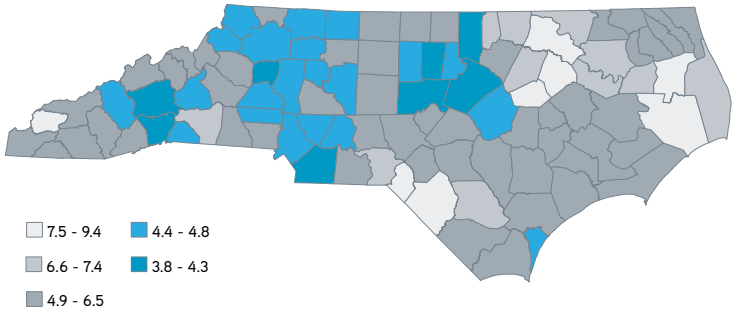
Indicator 1.4: Unemployment

There is significant variability in unemployment rates across North Carolina ***[1.4E]***. In 2016, unemployment rates were lower than or equal to the state average in only 37 counties and lower than or equal to the U.S. average in only 34 counties. At 3.8 percent, Buncombe County had the lowest unemployment rate of all counties. Sixty-two counties had an unemployment rate higher than the state average, and 66 had rates higher than the U.S. average. Hyde County, with unemployment at 9.4 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 lows-kill, 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, 2016*



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

Indicator 1.5: Poverty

KEY FINDINGS

- The percentage of North Carolinians in poverty is above the U.S. average, has been since at least 2005, and is increasing at a rate slower than the U.S. average.
- Within North Carolina, the percentage of the population living in poverty varies greatly; the majority of counties had average poverty levels higher than the state average and the U.S. average.

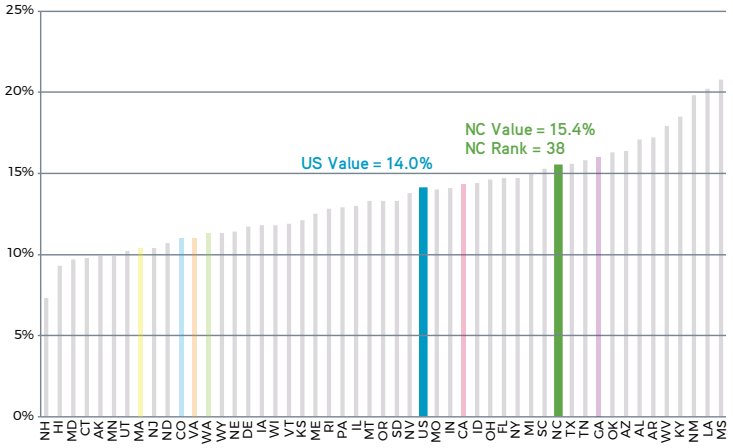
Indicator Overview

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

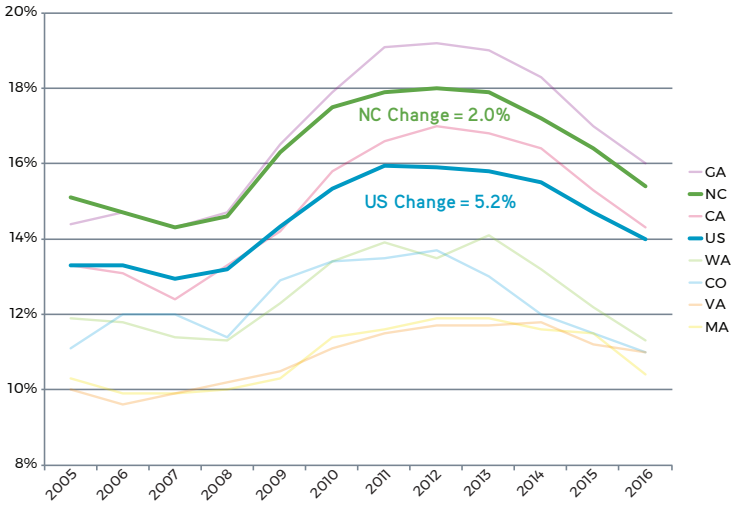
In 2016, 15.4 percent of North Carolinians lived in poverty ***[1.5A]***. This is above the national poverty rate of 14 percent and ranks North Carolina 38th lowest in the country in terms of the share of its population in poverty. North Carolina's rank places it below all comparison states except Georgia. The majority of comparison states possessed a poverty rate lower than the national average. Over time, North Carolina's poverty rate has increased by 2.0 percent from 2005 to 2016 ***[1.5B]***. This percentage increase is less than the national increase (5.2 percent) and all comparison states except Washington, Colorado, and Massachusetts. Washington and Colorado both had decreases in their poverty rates (of 5 percent and 0.9 percent, respectively), while Massachusetts had an increase of only one percent.

1.5A *Percentage of Citizens in Poverty, All U.S. States, 2016*



Source: U.S. Census Bureau.

1.5B *Percentage of Citizens in Poverty, Comparison States, 2005-2016*



Source: U.S. Census Bureau.

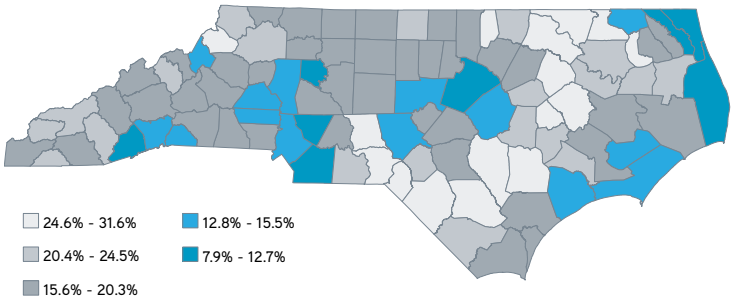
Indicator 1.5: Poverty

Five-year average poverty within North Carolina (2011–2015) ranged from a low of 7.9 percent in Camden County to 31.63 percent in Scotland County, with a state average of 17.9 percent ***[1.5C]***. 33 counties had an average poverty level lower than the state five-year average, and 22 had a poverty level lower than the U.S. average during that five-year period. Sixty-six counties had an average poverty level higher than the state five-year average, and 77 had a poverty level higher than the U.S. average.

What Does This Mean for North Carolina?

Current levels and over-time trends related to poverty in North Carolina are negative. 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 are 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, 2011-2015 Average*



Source: U.S. Census Bureau.

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

Indicator 1.6: Population Growth

KEY FINDINGS

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

Indicator Overview

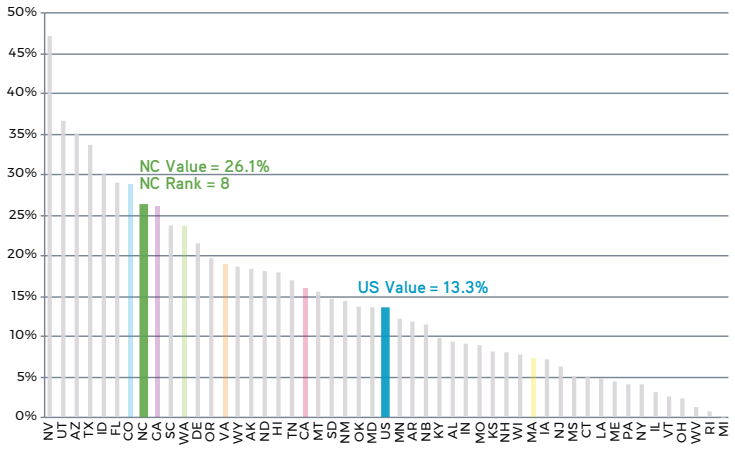
This indicator measures the extent to which North Carolina's total population is growing over time. For a given state, three components make up population growth: (1) natural growth—the excess of births over deaths; (2) in-migration—the movement of people from another state; and (3) immigration—the movement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

How Does North Carolina Perform?

In 2016, North Carolina ranked as the 9th most populous state in the country, with a total resident population of 10,146,788. In terms of percentage change in population between 2000 and 2016, North Carolina ranks eighth in the nation, with a value that is 196 percent of the U.S. value and 55 percent of the value of the top-ranking state, Nevada ***[1.6A]***. Among the comparison states, North Carolina ranks second, slightly behind Colorado, slightly ahead of Georgia and Washington, and well ahead of Virginia, and California, all of which are growing faster than the U.S. average. Massachusetts is the only comparison state whose rate of population growth is below the U.S. average.

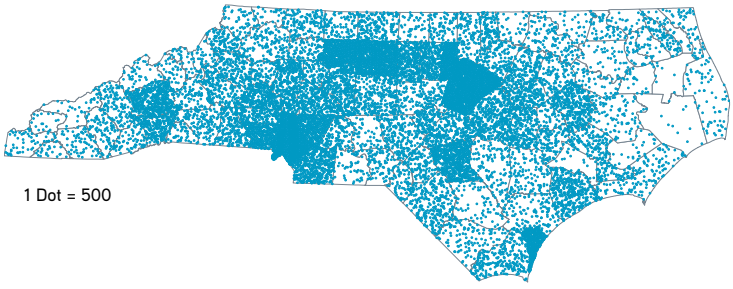
Within North Carolina, the location and growth of the population are highly concentrated in a small number of counties ***[1.6B]***. In terms of location, the state's three most populous counties account for more than 25 percent of the state's population—Mecklenburg (10.4 percent), Wake (10.3 percent), and Guilford (5.1 percent). Together, the 10 next most populous counties—Forsyth (3.7 percent), Cumberland (3.2 percent), Durham (3.0 percent), Buncombe (2.5 percent), Union (2.3 percent), New Hanover (2.2 percent), Gaston (2.1 percent), Cabarrus (2.0 percent), Johnston (1.9 percent), and Onslow (1.8 percent)—account for nearly 25 percent of the state's population. In total, this means that 13 of the state's 100 counties account for slightly more than half the state's population.

1.6A *Percentage Change in Population, All U.S. States, 2000-2016*



Source: U.S. Census Bureau.

1.6B *Estimated Location of Population in N.C., 2016*



Source: U.S. Census Bureau.

Indicator 1.6: Population Growth

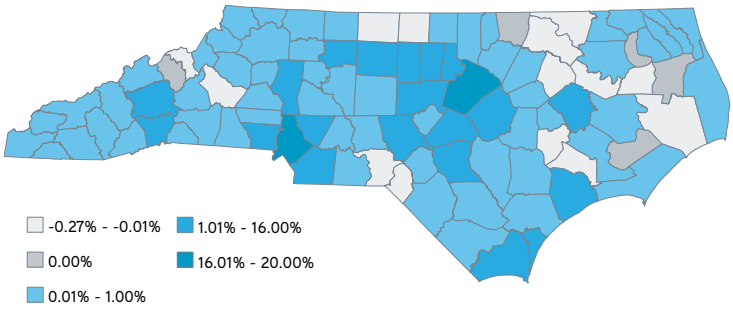
Each of the 14 next most populous counties—Pitt, Iredell, Davidson, Alamance, Catawba, Randolph, Orange, Rowan, Robeson, Harnett, Brunswick, Wayne, Henderson, and Craven—has between 1.8 and 1.0 percent of the state's population, a percentage slightly greater than or equal to each county's respective share (1 percent) of the total number of counties (100). These 14 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 73 counties has less than one percent of the state's total population, and together they account for 30.0 percent of the state's total population.

In terms of growth, the level of concentration is even greater than the distribution of population ***[1.6C, 1.6D]***. Two counties account for 37.1 percent of the population growth between 2000 and 2016—Wake (20.0 percent) and Mecklenburg (17.1 percent). Together, the next three counties—Union (4.9 percent), Guilford (4.8 percent), and Durham (4.0 percent)—account for another 13.7 percent of the state's population growth. In total, this means that five of the state's 100 counties account for over half the state's population growth since 2000. To reach over 75 percent of the state's population growth, only 10 more counties (for a total of 15) are needed—Cabarrus (3.4 percent), Johnston (3.3 percent), Forsyth (3.1 percent), New Hanover (3.0 percent), Brunswick (2.6 percent), Buncombe (2.4 percent), Iredell (2.4 percent), Pitt (2.1 percent), Harnett (1.9 percent), and Onslow (1.8 percent). Each of the remaining 85 counties has approximately one percent or less of the state's total population growth, and together they account for 23.4 percent of the state's total population growth.

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.

1.6C *Population Change, Percent of Total Change, N.C. Counties, 2000-2016*



Source: U.S. Census Bureau.

1.6D *Population Change, N.C. Counties, 2000-2016*

County	Population 2000	Population 2016	Absolute Change 2000-2016	Percent of Total Change	Cumulative Percent of Total Change
Wake	627,846	1,046,791	418,945	20.0%	20.0%
Mecklenburg	695,454	1,054,835	359,381	17.1%	37.1%
Union	123,677	226,606	102,929	4.9%	42.0%
Guilford	421,048	521,330	100,282	4.8%	46.8%
Durham	223,314	306,212	82,898	4.0%	50.7%
Cabarrus	131,063	201,590	70,527	3.4%	54.1%
Johnston	121,965	191,450	69,485	3.3%	57.4%
Forsyth	306,067	371,511	65,444	3.1%	60.5%
New Hanover	160,307	223,483	63,176	3.0%	63.6%
Brunswick	73,143	126,953	53,810	2.6%	66.1%
Buncombe	206,330	256,088	49,758	2.4%	68.5%
Iredell	122,660	172,916	50,256	2.4%	70.9%
Pitt	133,798	177,220	43,422	2.1%	73.0%
Onslow	150,355	187,136	36,781	1.8%	74.7%
Harnett	91,025	130,881	39,856	1.9%	76.6%
85 Other	4,461,261	4,951,786	490,525	23.4%	100.0%
Total	**8,049,313**	**10,146,788**	**2,097,475**	**100.0%**	**100.0%**

Source: U.S. Census Bureau.

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 10th overall and is increasing at a slower-than-average rate.
- Businesses perform more than two-thirds of the R&D in North Carolina and are most concentrated in metropolitan regions; more than 85 percent of the state's university R&D is concentrated in the Research Triangle region.

Indicator Overview

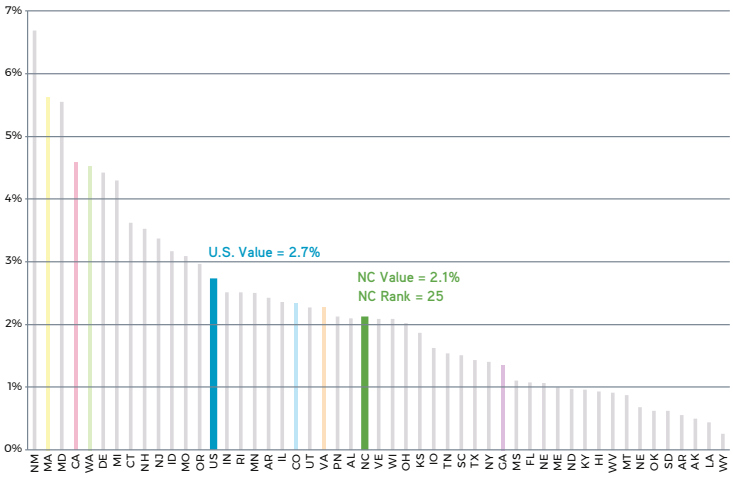
R&D expenditures refer to R&D activities funded by businesses, universities, nonprofit organizations, and federal and state agencies. R&D is the driving force behind innovation and sustained economic growth. Organizations performing R&D create new product or process innovations, thus expanding markets 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 gross state product, North Carolina's value ranks 25th in the nation, with a level that is 78 percent of the U.S. value ***[2.1A]***. In other words, the total amount of R&D in North Carolina is only 78 percent of what we would expect based on national levels of R&D. Moreover, the value of its total R&D is just under one-third the value of the top-ranking state, New Mexico.

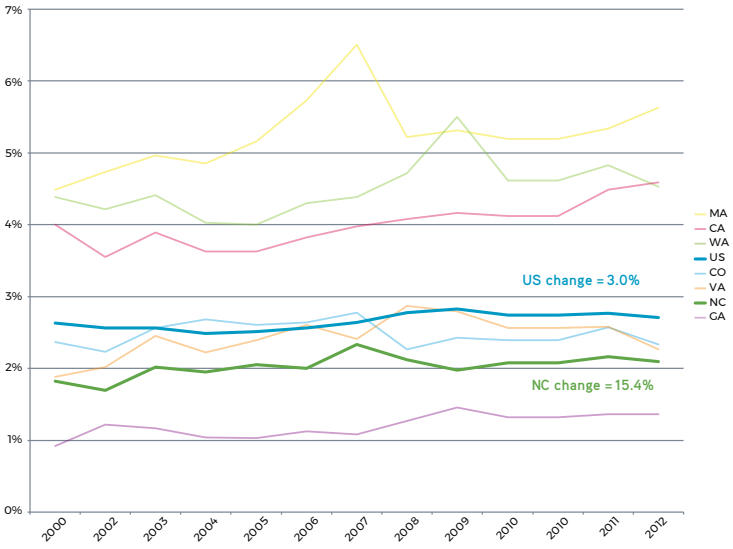
This modest ranking reflects the relative distribution of academic R&D to industry R&D within North Carolina and nationally. Specifically, North Carolina's academic R&D level per state GDP (see indicator 2.3) is 150 percent of the U.S. level, while its industry R&D level per industry output (see indicator 2.2) is only 91 percent of the U.S. level and slightly more than one third of the leading state's (California). Nationwide and in North Carolina, industry R&D accounts for more than 71 percent of total R&D,[1] meaning that North Carolina's low rate of industry R&D puts it at a competitive disadvantage in total R&D. Since 2000, however, North Carolina's total R&D rate has been growing more than five 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, 2012*



Source: National Science Board.

2.1B *Total R&D Expenditures a Percentage of GDP, Comparison States, 2000-2012*



Source: National Science Board.

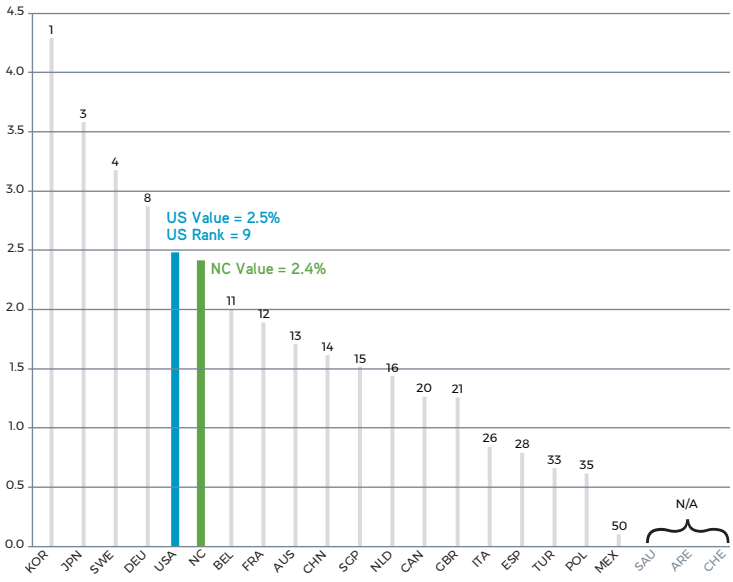
[1] *National Science Board, Science and Engineering Indicators 2016, Chapter 4, "Research and Development: National Trends and International Comparisons."*

Indicator 2.1: Total Research & Development

Internationally, the U.S. was the 9th most R&D-intensive country in 2014, at 56 percent of the intensity of the leading country, Korea ***[2.1C]***. In comparison with top foreign countries, North Carolina's R&D intensity ranks approximately 10th overall, between that of Germany and Belgium. Since 2000, however, the R&D intensity of many of the most R&D-intensive countries has risen steadily, and often at a much higher rate than in the U.S. and North Carolina ***[2.1D]***. These other countries increasingly are making larger investments in R&D to fuel their economies.

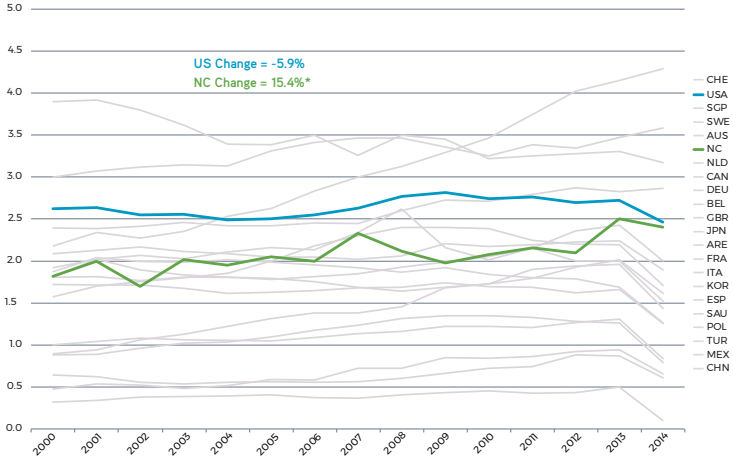
Within North Carolina, R&D is highly concentrated in a pattern that reflects the location of the state's population and research universities. Data indicating the location and level of all R&D within North Carolina are not available[2], but mapping the location of all manufacturing businesses (which conduct approximately 68 percent of all industry R&D)[3] and universities in North Carolina provides a rough approximation ***[2.1E]***. While it is reasonable to assume more balanced rates of R&D across industries, the rate of R&D across universities is not equal, with more than 85 percent occurring in the Research Triangle Region.[4] In general, this pattern suggests that R&D is most concentrated in metropolitan regions, particularly those with major research universities.

2.1C *Total R&D Expenditures as a Percentage of GDP, Comparison Countries, 2014*



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

2.1D *Total R&D Expenditures as a Percentage of GDP, Comparison Countries, 2014*



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

[2] *Business-performed R&D information is proprietary to the businesses and not currently available in a systematic, accurate form. However, in 2008 the National Science Foundation (NSF) launched a new Business R&D and Innovation Survey (BRDIS) to better understand and measure how R&D is conducted in today's innovation- and global-based economy. Data from the pilot survey and subsequent surveys are beginning to be incorporated into NSF's reports and statistics. Based on those data, future releases of the Tracking Innovation report will provide more precise measures of industry R&D in North Carolina.*

[3] *National Science Board, Science and Engineering Indicators 2016, Chapter 4, "Research and Development: National Trends and International Comparisons."*

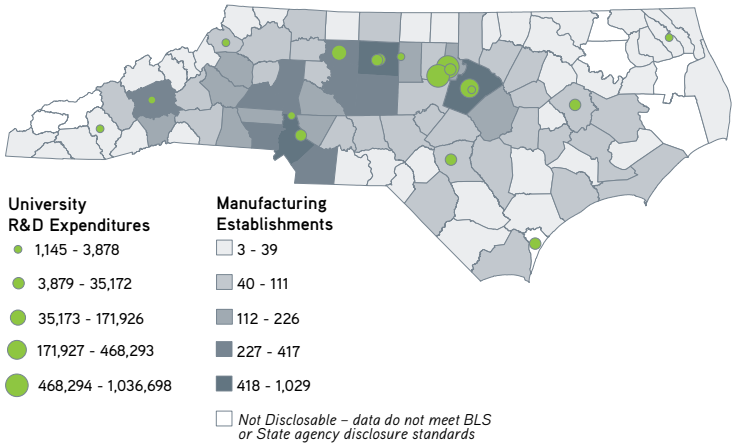
[4] *The extent to which this approximation is accurate depends on the size of the businesses and the industry mix across the states. In general, large companies conduct more research than small companies do. Moreover, National Science Foundation data indicate that trends in U.S. business R&D performance are driven by five industries that together accounted for $239.0 billion, or 81 percent, of domestic business R&D performance in 2011: computer and electronic product manufacturing, chemicals manufacturing (including pharmaceuticals), transportation equipment (including aerospace), information (including software publishers), and professional, scientific, and technical (PST) services.*

Indicator 2.1: Total Research & Development

What Does This Mean for North Carolina?

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

2.1E *Location of R&D Expenditures in N.C., 2016*



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

Note: Business establishments perform 71% of R&D in NC; of that, Mfg. establishments perform 68%; universities perform 25% of R&D.

Indicator 2.2: Industry Research & Development

KEY FINDINGS

- North Carolina's business-performed R&D as a percentage of private-industry output ranks below the U.S. average and has remained relatively stable or increased slightly since 2000.
- Within North Carolina, business-performed R&D is highly concentrated in a pattern that reflects the location of the state's population.

Indicator Overview

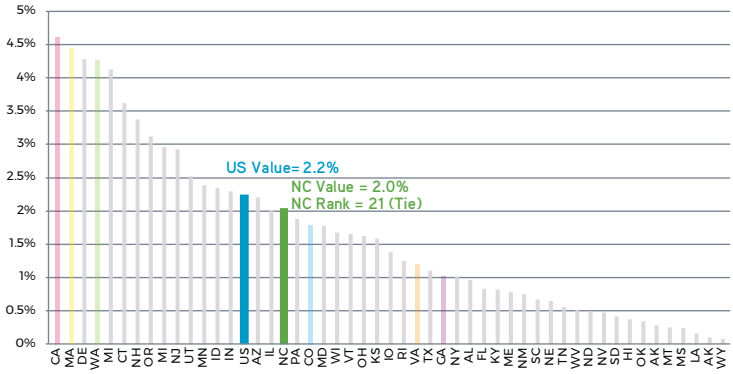
The business sector is the largest performer of U.S. R&D. Nationwide, business-performed R&D accounts for more than half of all U.S. applied research funding and more than 80 percent of all development funding.[1] For a given state, a high value for this indicator shows that businesses within the state 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 21st in the nation, with a level that is 91 percent of the U.S. value ***[2.2A]***. Moreover, the value of North Carolina's business-performed R&D as a percentage of private-industry output is 43 percent of the value of the top-ranking state, California.

This modest ranking reflects North Carolina's economic history, which is heavily based in agricultural, industrial, and branch-plant operations. Because of this, comparatively few companies within the state have significant research operations, which typically locate at or near company headquarters, often located outside of North Carolina. Although it peaked in 2013, North Carolina's business-performed R&D rate has remained relatively stable or increased slightly since 2000. The rate for the U.S. overall has remained relatively stable or decreased slightly since 2000 ***[2.2B]***.

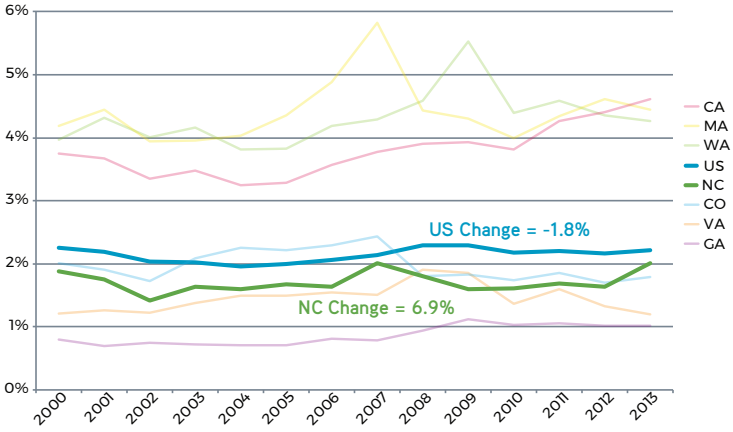
2.2A *Business-Performed R&D as a Percentage of Private-Industry Output, All U.S. States, 2013*



Source: National Science Board.

Note: MO data not available.

2.2B *Business-Performed R&D as a Percentage of Private Industry Output, Comparison States, 2000-2013*



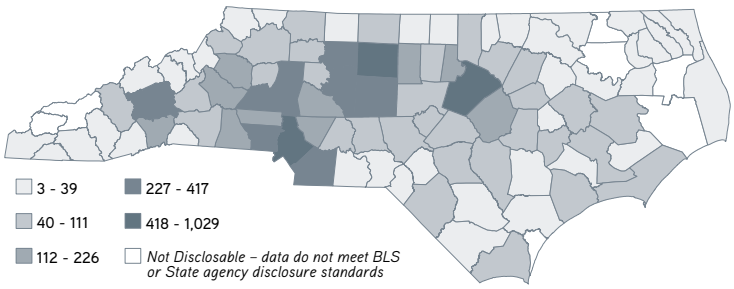
Source: National Science Board.

[1] *National Science Board, Science and Engineering Indicators 2016, Chapter 4, "Research and Development: National Trends and International Comparisons."*

Indicator 2.2: Industry Research & Development

Within North Carolina, business-performed R&D is highly concentrated in a pattern that reflects the location of the state's population ***[2.2C]***. Data indicating the location and level of business-performed R&D within North Carolina are not available,[2] but mapping the location of all manufacturing businesses (which conduct approximately 68 percent of all business-performed R&D)[3] in North Carolina provides a fair approximation. Assuming roughly equal rates of R&D across the businesses, the distribution of manufacturing businesses across the state gives an approximation of the distribution of industry R&D across the state.[4] In general, the pattern suggests that business-performed R&D is most concentrated in metropolitan regions, which are home to the majority of the state's manufacturing businesses.

2.2C *Location of Business-Performed R&D Expenditures in N.C., 2016*



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

Note: Business establishments perform 71% of R&D in NC; of that, Mfg. establishments perform 68%; universities perform 25% of R&D.

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, but which currently exhibits a lower share of high-tech establishments nationally and relative to comparison states (see, e.g., indicators 4.1–4.3 and 6.4). For North Carolina to increase its business-performed R&D, it will need to increase the share of high science, engineering and technology (SET), innovation-focused businesses in its economy.

[2] *Business-performed R&D information is proprietary to the businesses and not currently available in a systematic, accurate form. However, in 2008 the National Science Foundation (NSF) launched a new Business R&D and Innovation Survey (BRDIS) to better understand and measure how R&D is conducted in today's innovation- and global-based economy. Data from the pilot survey and subsequent surveys are beginning to be incorporated into NSF's reports and statistics. Based on those data, future releases of the Tracking Innovation in North Carolina report will provide more precise measures of industry R&D in North Carolina.*

[3] *National Science Board, Science and Engineering Indicators 2016, Chapter 4, "Research and Development: National Trends and International Comparisons."*

[4] *The extent to which this approximation is accurate depends on the size of the businesses and the industry mix across the states. In general, large companies conduct more research than small companies do. Moreover, National Science Foundation data indicate that trends in U.S. business R&D performance are driven by five industries that together accounted for $239.0 billion, or 81 percent, of domestic business R&D performance in 2011: computer and electronic product manufacturing, chemicals manufacturing (including pharmaceuticals), transportation equipment (including aerospace), information (including software publishers), and professional, scientific, and technical (PST) services.*

Indicator 2.3: Academic Science & Engineering R&D

KEY FINDINGS

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

Indicator Overview

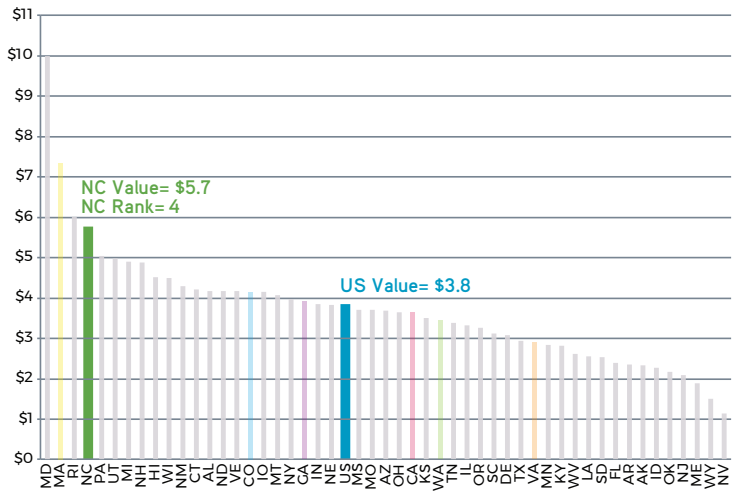
R&D is the driving force behind innovation and sustained economic growth. The ratio of R&D expenditures at a state's colleges and universities relative to the size of the state's economy measures the intensity of the state's academic R&D. Across the U.S., academic R&D performers account for slightly more than half of the U.S. basic research, about a third of total research (basic plus applied), and roughly 14 percent of all R&D conducted in the U.S. While industry performs more than 70 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 fourth in the nation, behind only Maryland, Massachusetts, and Rhode Island ***[2.3A]***.[2] North Carolina's academic R&D intensity is 150 percent of the U.S. value, meaning that the amount of academic R&D in North Carolina is 50 percent higher than what we would expect based on the levels of academic R&D in all other states.

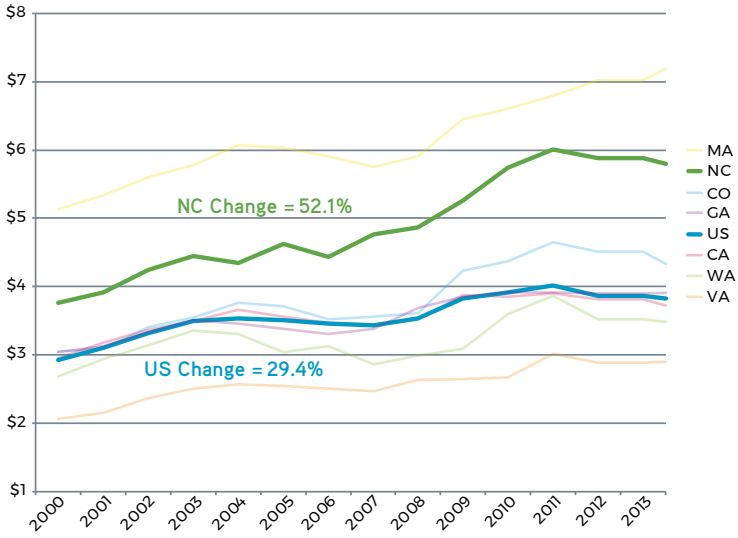
This strong ranking reflects a long-standing pattern in North Carolina: The core strength of North Carolina's R&D activities is in its colleges and universities. North Carolina has a comparatively large number of colleges and universities for its population, and several are national leaders in the sciences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

2.3A *Academic Science & Engineering R&D per $1,000 of State GDP, All U.S. States, 2013*



Source: National Science Board.

2.3B *Academic Science & Engineering R&D per $1,000 of State GDP, Comparison States, 2000-2013*



Source: National Science Board.

[1] *National Science Board, Science and Engineering Indicators 2016, Chapter 4, "Research and Development: National Trends and International Comparisons."*

[2] *Academic R&D is reported for institutions with R&D more than $150,000.*

Indicator 2.3: Academic Science & Engineering R&D

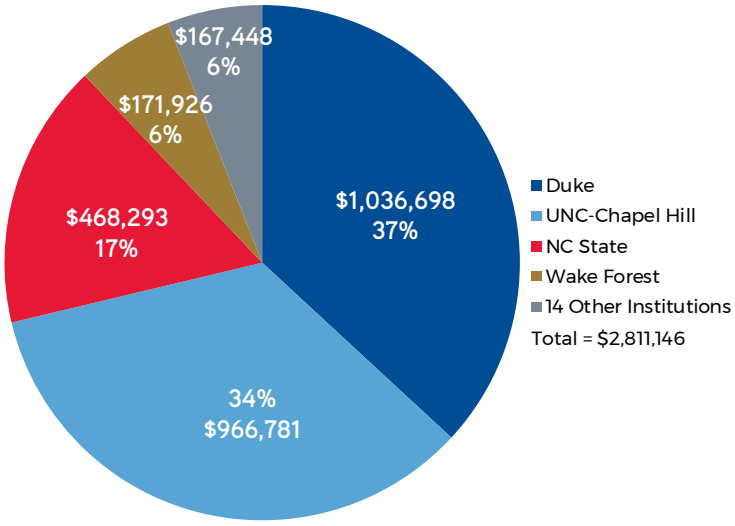
Since 2000, North Carolina's academic R&D intensity has been growing at a rate more than 50 percent faster than the U.S. rate, further increasing the gap between the two ***[2.3B]***. This rate of increase is also faster than the rate of increase in any of the comparison states.

Within North Carolina, academic R&D is highly concentrated in the Research Triangle region. The three largest universities located in that region—Duke University, UNC-Chapel Hill, and North Carolina State University—account for 88 percent of all academic R&D expenditures within the state ***[2.3C, 2.3D]***. Wake Forest University in Winston-Salem also has significant academic R&D, while 14 other public and private universities conduct the state's remaining academic R&D across the state.

The source of funds for academic R&D reflects, to some extent, the nature of the R&D, and varies considerably across the U.S. and North Carolina's academic institutions ***[2.3E]***. Nationwide and across North Carolina, the federal government is the largest supporter of academic R&D, in most cases funding a significant majority of that R&D. Within North Carolina, North Carolina State University is the only academic institution that receives less than 50 percent of its academic R&D funding from the federal government, although it 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 (21 percent) of its funding from state and local government.

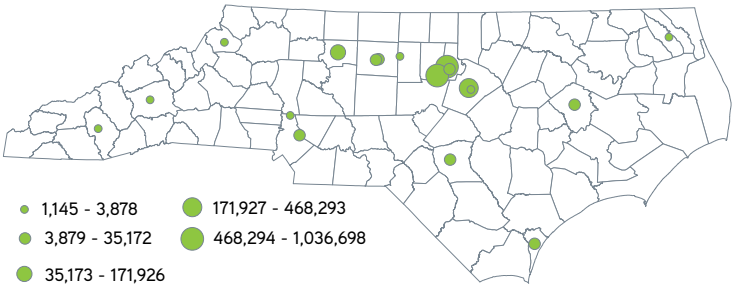
While business also funds a substantial share of academic R&D, for most institutions that share is 11 percent or less, with the exception in North Carolina being Duke University, which receives 23 percent of its funding from business. This larger-than-average share results from the activities of the Duke Clinical Research Institute (DCRI), which conducts medically focused clinical trials for industry.

2.3C *N.C. University R&D Expenditures (dollars in thousands), 2016*



Source: National Science Board.

2.3D *N.C. University R&D Expenditures (dollars in thousands), 2016*



Source: National Science Board.

Indicator 2.3: Academic Science & Engineering R&D

What Does This Mean for North Carolina?

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

2.3E *University R&D Expenditures by Source of Funds, U.S. Average & N.C. Institutions, 2016*

Higher Education Institution	Source of Funds				
	Federal Government	State & Local Government	Business/ Industry	Institution Funds	Nonprofits
US Average	61%	6%	5%	21%	6%
Duke	54%	0%	23%	14%	7%
UNC-Chapel Hill	61%	3%	3%	26%	7%
NC State University	43%	21%	11%	25%	0%
Wake Forest	86%	4%	5%	1%	4%
14 Other NC Institutions	64%	7%	3%	21%	4%

Source: National Science Board.

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.
- While North Carolina's ratio of federal R&D obligations to employed worker has increased significantly since 2000, this rate increase is lower than the pace of the U.S. ratio overall and is in the middle among comparison states.

Indicator Overview

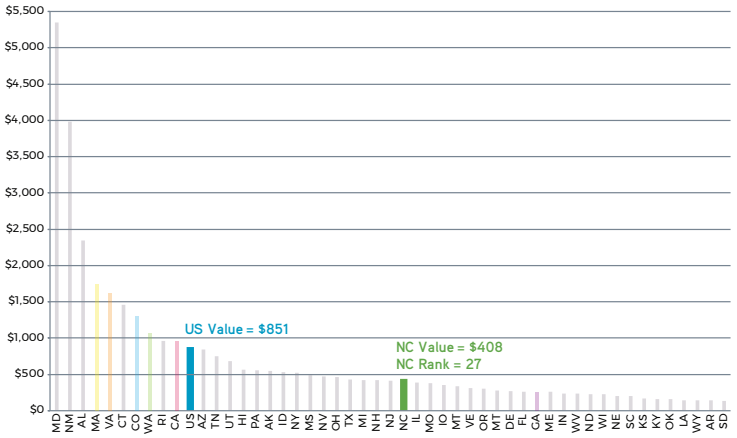
This indicator represents how federal R&D obligations are disbursed geographically relative to the size of a state's employed civilian workforce. Federal R&D obligations are a binding financial commitment in a congressional budget appropriation and include contracts, staff employment, and purchases of 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.[1] While this funding comes from 11 federal agencies, the Department of Defense (DoD) disburses the most funding, approximately 50 percent of the total.[2] States with a high value on this indicator typically have a number of large prime contractors or major federally funded R&D facilities in state.

How Does North Carolina Perform?

The value of North Carolina's federal R&D obligations per employed worker ranks 27th in the nation, with a level that is 48 percent of the U.S. value and 8 percent of the value of the top-ranking state, Maryland ***[2.4A]***. North Carolina's low ranking reflects the fact that it has a relatively small number of federal prime contractors and federally funded R&D centers.

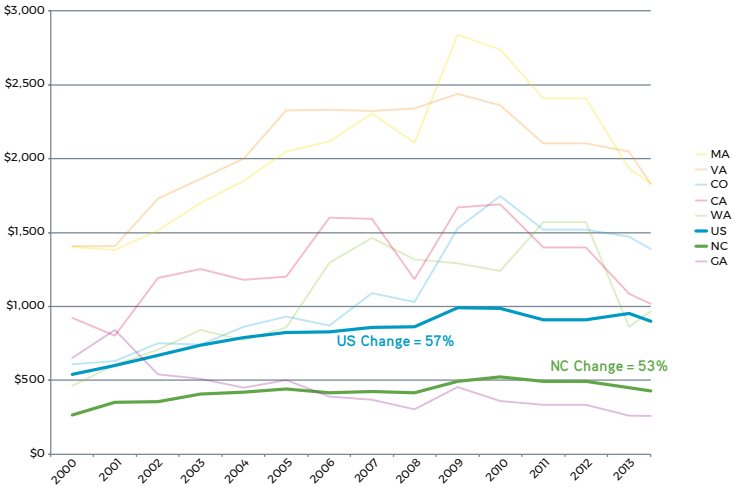
Since 2000, North Carolina's federal R&D obligations per employed worker have risen significantly, at a rate of 53 percent ***[2.4B]***, slightly slower than the rate of increase for the U.S. overall (57 percent). Among the comparison states, North Carolina's increase in federal R&D obligations per employed worker ranks considerably below Washington and Colorado, but above Massachusetts, Virginia, California, and Georgia.

2.4A *Federal R&D Obligations per Employed Worker, All U.S. States, 2013*



Source: National Science Board.

2.4B *Federal R&D Obligations per Employed Worker, Comparison States, 2000-2013*



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, Science and Engineering Indicators 2016, Chapter 4, "Research and Development: National Trends and International Comparisons."*

Indicator 2.4: Federal Research & Development

What Does This Mean for North Carolina?

Federal R&D obligations to all U.S. states amounted to $123 billion in 2013. Although this amount represents less than half the amount of industry R&D in 2013 ($323 billion), it is substantial and drives a considerable amount of innovation.[3] In 2013, only 10 states exceeded the national average of $851 in federal R&D obligations per worker, meaning that these states received the majority of federal R&D obligations. North Carolina should strive to remain competitive on this front by working to increase its number of prime federal contractors. It should also work to increase its number of subcontractors to prime federal contractors.[4]

[3] *National Science Board, Science and Engineering Indicators 2016, Chapter 4, "Research and Development: National Trends and International Comparisons."*

[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 ranks below the U.S. average, but since 2000 has increased at rate slightly faster than the U.S average rate.
- North Carolina's academic S&E articles are highly concentrated in a small number of universities located primarily in the Research Triangle region, though universities outside that region also produce a significant number of articles.

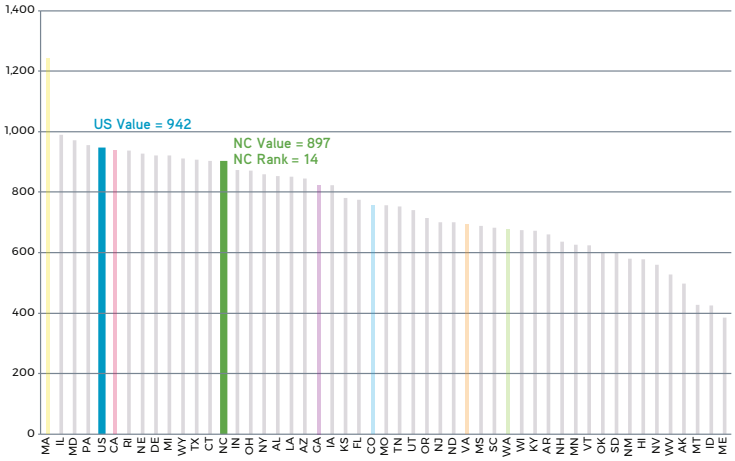
Indicator Overview

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.

How Does North Carolina Perform?

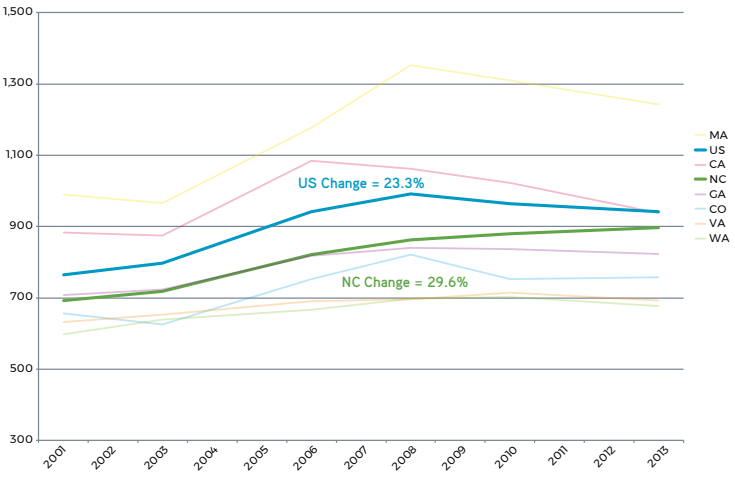
The value of North Carolina's academic S&E article output per 1,000 SEH doctorate holders in academia ranks 14th in the nation, a level that is 95 percent of the U.S. value and 72 percent of the value of the top-ranking state, Massachusetts ***[2.5A]***. Among the comparison states, Massachusetts and California are the only states that top North Carolina on this indicator in 2013, and North Carolina ranks well above the remaining four comparison states. As with S&E R&D (see indicator 2.3), this strong ranking reflects a longstanding pattern in North Carolina: the core strength of North Carolina's innovation ecosystem is its colleges and universities.

2.5A *Academic Science & Engineering Article Output per 1,000 Science, Engineering & Health Doctorate Holders in Academia, All U.S. States, 2013*



Source: National Science Board.

2.5B *Academic Science & Engineering Article Output per 1,000 Science, Engineering & Health Doctorate Holders in Academia, Comparison States, 2001-2013*



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 as of May 2015. The journal set consists of science and engineering publications (including publications on the natural sciences, the applied sciences, the medical sciences, and the 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 ensures 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 are attributed to state A, and one-third is attributed to state B.*

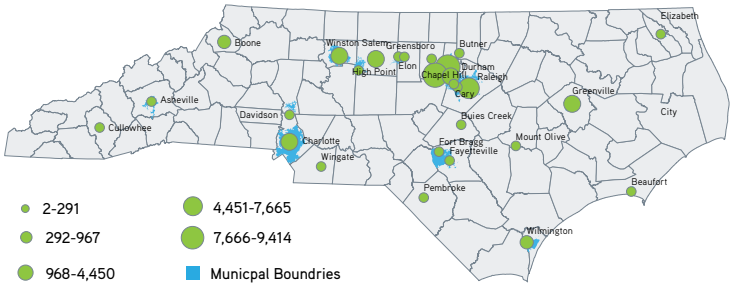
Indicator 2.5: Academic Articles

Since 2000, North Carolina's S&E article output per 1,000 SEH doctorate holders in academia has increased by 29.6 percent, a rate that is slightly higher than the U.S. rate of increase ***[2.5B]***. Among the comparison states, North Carolina's rate ranks higher than all comparison states. Within North Carolina, the production of S&E articles is highly concentrated in the Research Triangle region. Together, the three largest universities located in that region account for 69 percent of all academic S&E articles produced within the state—Duke University (29.5 percent), UNC-Chapel Hill (24.7 percent), and North Carolina State University (14.6 percent) ***[2.5C]***. Wake Forest University in Winston-Salem also produces a significant share of the state's S&E articles (7.3 percent), as does UNC Charlotte (5.8 percent), NC A&T State University and UNC Greensboro in Greensboro (3.6 percent), ECU (3.4 percent), and UNC Wilmington (1.3 percent).[2] The remaining 6 percent of the state's S&E articles is spread across universities in 19 other cities, none of which produces more than one percent of the state's S&E articles.[3]

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 *Average Annual Number of Science & Engineering Articles, N.C. Organizations, 2014 - 2016*



Source: Scopus, Elevier.

[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.*

[3] *Unlike the state-level data above, for the institution-level data, articles with authors from different institutions were not counted fractionally. For instance, for a publication with authors at multiple institutions, each contributing institution would be credited once for the article.*

Indicator 3.1: SBIR & STTR Awards

KEY FINDINGS

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

Indicator Overview

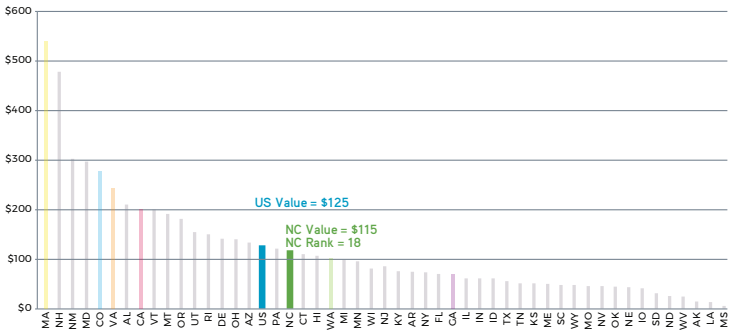
Funds awarded through the highly competitive federal Small Business Innovation Research (SBIR) grant program support technological innovation in companies with 500 or fewer employees. The awards enable the small businesses to evaluate the feasibility and scientific merit of new technology (Phase I ~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

SBIR and STTR grants are the single largest source of early-stage technology development and commercialization funding for small businesses (more than $2.2 billion in 2015). 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.[2] The amount of SBIR/STTR funding in a state strongly correlates with successful technology-based economic development.

How Does North Carolina Perform?[3]

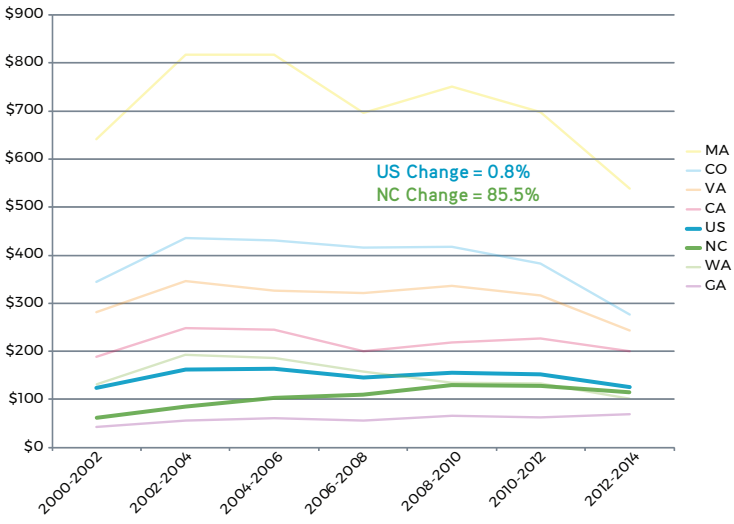
In terms of the level of SBIR/STTR funding relative to the size of its economy, North Carolina ranks 18th in the nation and below the U.S. average ***[3.1A]***.[4] Specifically, the ratio of North Carolina's SBIR/STTR funding relative to the size of its total GDP is 92 percent of the U.S. value, meaning that the amount of SBIR/STTR funding in North Carolina is about one tenth lower than what we would expect based on the levels of such funding in other states. Moreover, its per-GDP level of SBIR/STTR funding is only 21 percent of the leading state's (Massachusetts) level. This comparatively low level of early stage funding suggests that North Carolina is potentially missing out on opportunities to fund and commercialize its innovative discoveries.

3.1A *Average Annual SBIR & STTR Funding per $1 Million of Gross Domestic Product, All U.S. States, 2012-2014*



Source: National Science Board.

3.1B *Average Annual SBIR & STTR Funding per $1 Million of Gross Domestic Product, Comparision States, 2000-2014*



Source: National Science Board.

[1] *Eleven federal agencies participate in the SBIR program and five in the STTR program.*

[2] *See, e.g., National Research Council. 2008. An Assessment of the SBIR Program. Washington, DC: The National Academies Press.*

[3] *The total award dollars reported here include both Phase I and Phase II SBIR/STTR awards.*

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

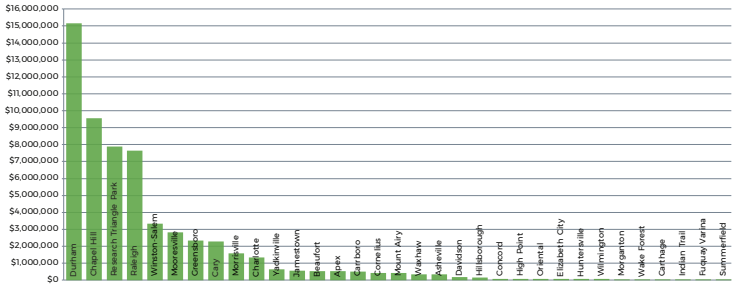
Indicator 3.1: SBIR & STTR Awards

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

Since 2000, the ratio of North Carolina's SBIR and STTR funding relative to its GDP has increased by nearly 86 percent, compared to a less than 1 percent increase for the U.S. overall ***[3.1B]***. Additionally, the ratio of SBIR and STTR funding to GDP has seen a minor increase of less than 1 percent in all of the comparison states combined. These minor increases in the U.S. overall and comparison states are reflective of the of minor increases to the Federal SBIR program over time, from $1.96 billion in 2002–04 to $2.1 billion in 2012–14. Notably, during that time period North Carolina experienced the largest increase compared to the U.S. and any of the comparison states. This is due, in part, to two steps taken to improve North Carolina's SBIR/STTR award rate: (1) the creation in 2001 of an SBIR program specialist position at the North Carolina Small Business and Technology Development Center (STBDC) and (2) the creation in 2006 of the state's SBIR/STTR matching fund program, the One North Carolina Small Business Program. The former provides assistance to small businesses to help them identify and apply for SBIR/ STTR proposal opportunities; the latter awards matching grants to small businesses in North Carolina that have received SBIR/ STTR grants. These state matching grants supplement and leverage the federal grants and make North Carolina small businesses better investment opportunities in the eyes of federal funding agencies.

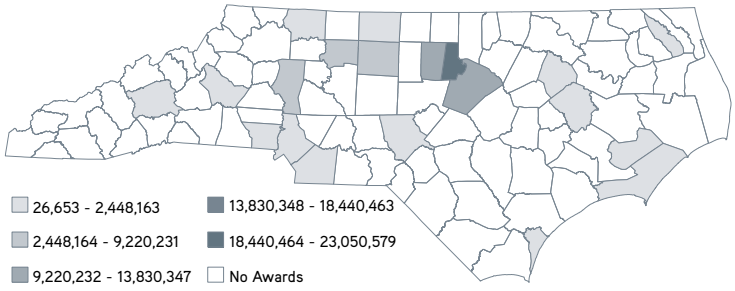
Within North Carolina, SBIR/STTR funding is highly concentrated in the Triangle region of the state, which contains the cities of Durham, Chapel Hill, the Research Triangle Park region, and Raleigh ***[3.1C, 3.1D]***. Combined, these four locales receive 76 percent of the state's SBIR/ STTR funding. The next 20 percent goes primarily to cities in the Piedmont Triad (e.g., Greensboro and Winston-Salem),

3.1C Average Annual SBIR & STTR Awards, N.C. Cities, 2014-2016



Source: SBIR.gov.

3.1D Average Annual Amount of SBIR & STTR Awards, N.C. Counties, 2014–2016



Source: SBIR.gov.

Charlotte region (e.g., Charlotte and Mooresville), and the cities of Cary and Morrisville (within the Triangle region). The remaining 4 percent is dispersed across 22 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.

What Does This Mean for North Carolina?

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

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

[5] This program was started after the 2003 Tracking Innovation in NC report (available at: http://www.nccommerce.com/scitech/resources/innovationreports) indicated that NC ranked 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.

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 slightly below the U.S. average and has decreased from a ratio higher than the U.S. average in 2001.
- North Carolina's academic patenting activity is highly concentrated in a small number of universities located primarily in the Research Triangle region.

Indicator Overview

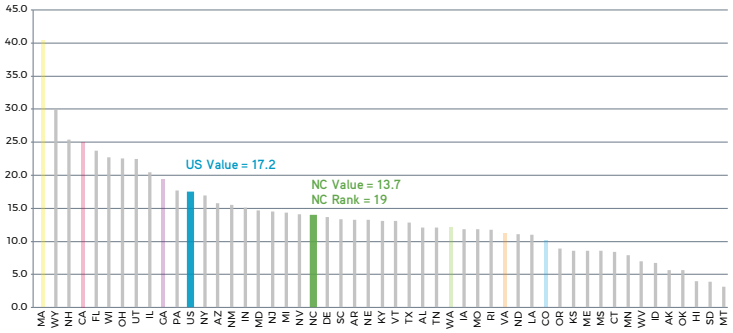
This indicator relates the number of academic-owned utility patents to the size of the doctoral science & engineering (S&E) workforce in academia. Academia includes two-year colleges, four-year colleges and universities, medical schools, and university-affiliated research centers. S&E doctorates include 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 80 percent of the U.S. value and 34 percent of the value of the top-ranking state, Massachusetts ***[3.2A]***. North Carolina's upper-mid range ranking reflects the fact that it has stronger than average academic institutions, many of which have offices dedicated to patenting.[4]

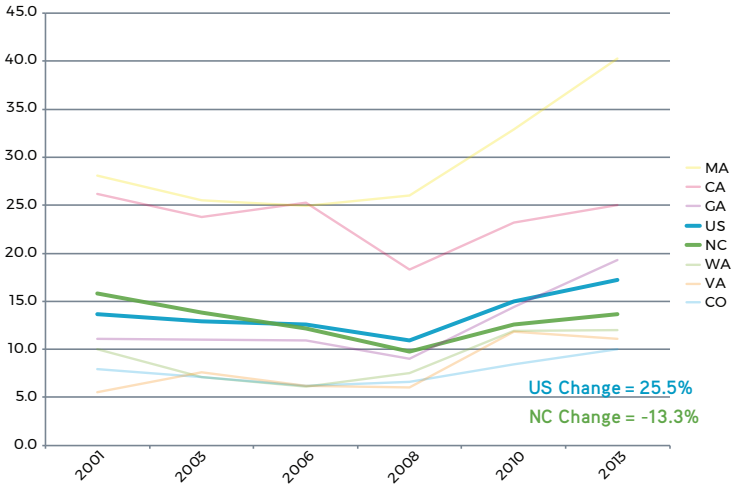
Since 2000, the ratio of North Carolina's academic patents relative to S&E doctorate holders in academia has decreased significantly, at a rate of 13 percent, whereas the ratio for the U.S. overall has increased by 26 percent ***[3.2B]***. Among the comparison states, North Carolina's and California's (-5 percent) ratios decreased over time, while the other comparison states' ratios increased between 20 percent (Washington) and 102 percent (Virginia).

3.2A *Academic Patents Awarded per 1,000 Science & Engineering Doctorate Holders in Academia, All U.S. States, 2013*



Source: National Science Board.

3.2B *Academic Patents Awarded per 1,000 Science & Engineering Doctorate Holders in Academia, Comparison States, 2001-2013*



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

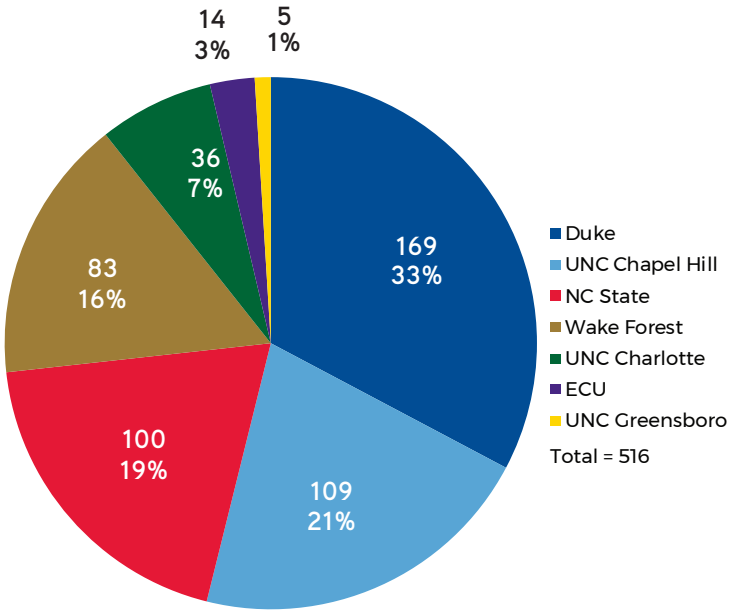
Within North Carolina, academic patenting activity is highly concentrated in the Research Triangle region and reflects both the nature and size of that region's universities' R&D activities, as well as the resources devoted to their patenting offices ***[3.2C, 3.2D]***. The three largest universities in that region—Duke University, the University of North Carolina (UNC) at Chapel Hill, and North Carolina State University—account for 73 percent of all academic patenting activity within the state, a pattern very similar to the pattern for academic R&D expenditures (see indicator 2.3). Wake Forest University in Winston-Salem also has significant academic patenting activity (16 percent of the state total), while UNC Charlotte, ECU, and UNC Greensboro account for 7 percent, 3 percent and 1 percent of the state total, respectively.

What Does This Mean for North Carolina?

While one of North Carolina's innovation-related strengths is its academic R&D (see indicator 2.3, on which NC ranks in the top 10 percent and has a value significantly greater than the U.S. value), it fares less well on academic patenting, one of the key measures of the economic value of its academic discoveries. Its 19th place ranking on academic patenting puts it ahead of sixty percent 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. Moreover, rather than improving over time, North Carolina's academic patenting activity relative to that of the comparison states and the U.S. average is decreasing overall.

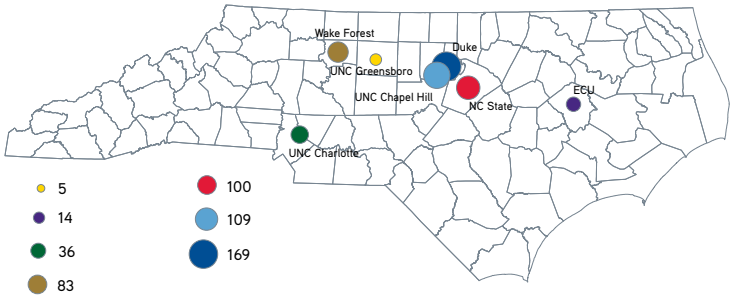
To reverse this trend and bring the level of its academic patenting activity in line with the level of its academic R&D, North Carolina's universities should focus more attention on their offices and activities that generate patents. This would not necessarily entail a large increase in resources. For example, the University of North Carolina System'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 *Academic Patents Awarded to N.C. Universities, 2013-2015*



Source: Association of University Technology Managers.

3.2D *Academic Patents Awarded to N.C. Universities, 2013–2015*



Source: Association of University Technology Managers.

[5] *Our Time, Our Future: The UNC Compact with North Carolina, Strategic Directions 2013-2018, available at www.northcarolina.edu.*

[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, but since 2000 has been increasing at a rate slightly faster 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

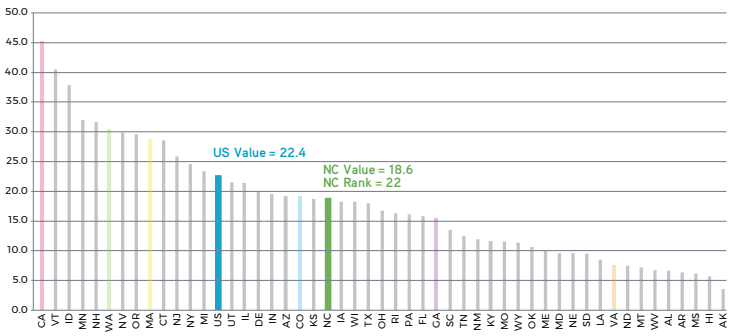
This indicator represents state patent activity normalized to the size of a locale's science and engineering (S&E) workforce and its economy. For the state-by-state charts (3.3A and 3.3B), utility patents—commonly known as patents for inventions—are presented.[1] The S&E workforce includes engineers 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] GDP is a measure of the total value of goods and services produced by an economy.

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

How Does North Carolina Perform?

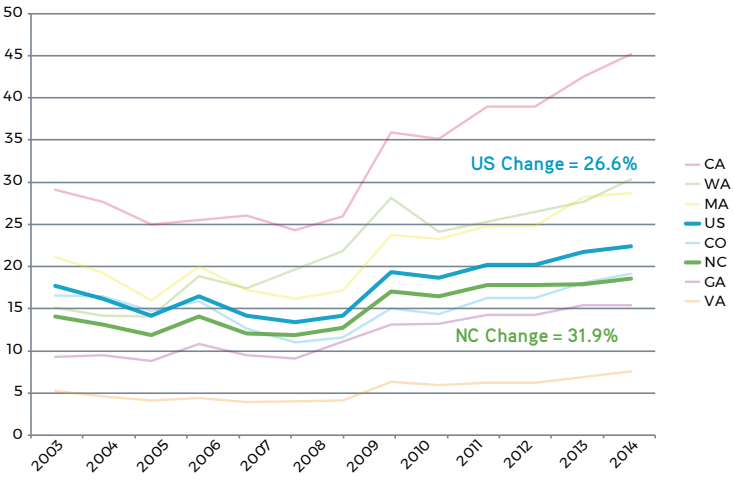
The value of North Carolina's patents per 1,000 individuals in science & engineering occupations ranks 22nd in the nation, with a level that is 83 percent of the U.S. value and 41 percent of the value of the highest-ranking state, California ***[3.3A]***. Among the comparison states, North Carolina's rate of patenting ranks in the middle of the pack, ahead of Georgia and Virginia, but behind California, Washington, Massachusetts, and Colorado. Overall, North Carolina's rate of patents compares less favorably than its rate of academic patents, reflecting, in part, its lower level of industry R&D (see indicator 2.2) as well as its relatively low number of high-tech business establishments (see indicator 4.1). As a broad indicator

3.3A *Patents Awarded per 1,000 Individuals in Science & Engineering Occupations, All U.S. States, 2014*



Source: National Science Board.

3.3B *Patents Awarded per 1,000 Individuals in Science & Engineering Occupations, Comparison States, 2003-2014*



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.*

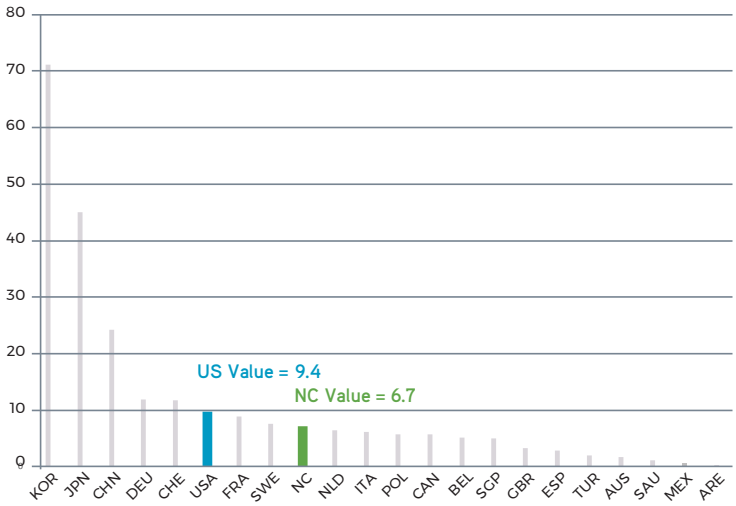
Indicator 3.3: Patents

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. Since 2003, however, the ratio of North Carolina's patents to individuals in science & engineering occupations increased at a rate of 31.9 percent, which is slightly higher than the 26.6 percent rate of increase for the U.S. overall ***[3.3B]***. Among the comparison states, North Carolina's rate of increase is ahead of Colorado's rate, but behind Washington, Georgia, California, Virginia, and Massachusetts. Combined, the comparison states' patenting activity increased 53 percent, which is significantly higher than North Carolina's increase.

While ranking the U.S. patent activity internationally among all countries isn't possible due to data limitations, among the comparison countries, the U.S. ranks 8th but well behind the leading countries, South Korea and Japan ***[3.3C]***. It ranks behind but much closer to countries such as Germany, Switzerland, France, and Sweden, and well ahead of most of the other comparison countries. Since 2000, the patent activity of China has risen considerably (364 percent) and much faster than the rate for all other comparison countries, whose combined average is 35 percent and much closer to the rates for the U.S. and North Carolina ***[3.3D]***. Half of the comparison countries decreased their rate of patenting activity over time.[4]

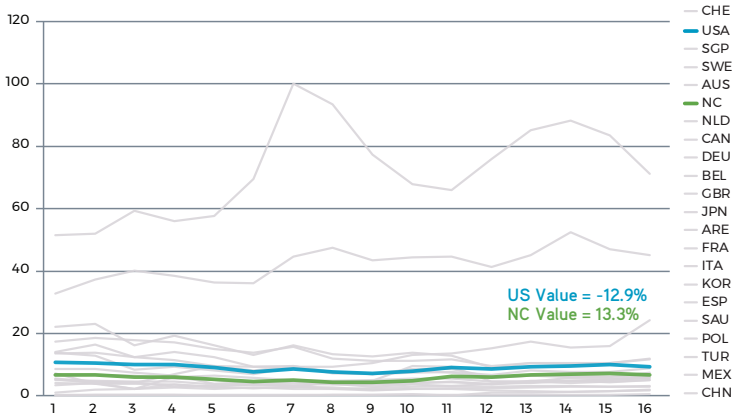
Within North Carolina, patenting activity is highly concentrated in a small number of counties, with nearly 80 percent of all patents being awarded in six counties ***[3.3E, 3.3F]***. Wake County, with 44 percent of all the state's patents, has the largest share, followed by Mecklenburg (9 percent), Durham (9 percent), Orange (8 percent), Guilford (4 percent) and Forsyth (4 percent). The next 13 counties, each with 1 percent of all the state's patents, account for 13 percent of the state's patents overall, while the remaining 81 counties account for the final 8 percent of the state's patents. This high concentration of patents reflects a combination of the state's population (see indicator 1.6), the location and mix of its companies (see indicators 4.1, 4.2, and 6.4), the location and mix of its academic and business R&D (see indicator 2.2 and 3.1), the location of its academic patents (see indicator 3.2), and the educational attainment levels of its citizens (see indicator 5.6).

3.3C Grants for Direct Patent Applications Per Billion Dollars in GDP, Comparison Countries, 2015



Source: World Bank, World Development Indicators; World Intellectual Property Organization; U.S. Bureau of Economic Analysis.

3.3D Grants for Direct Patent Applications Per Billion Dollars in GDP, Comparison Countries, 2000-2015



Source: World Bank, World Development Indicators; World Intellectual Property Organization; U.S. Bureau of Economic Analysis.

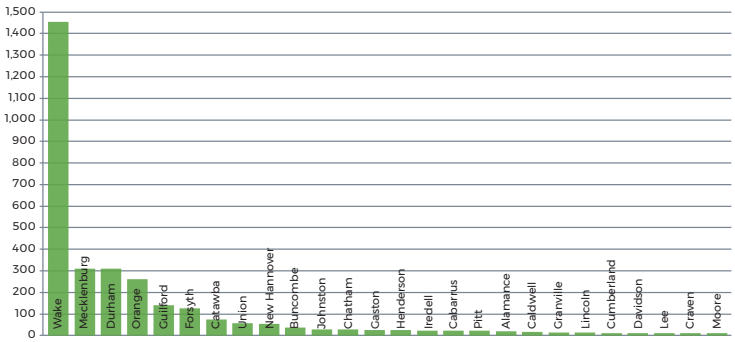
[4] *While difficult to see in chart 3.3D, the raw data indicate that all but five of the comparison countries decreased over time.*

Indicator 3.3: Patents

What Does This Mean for North Carolina?

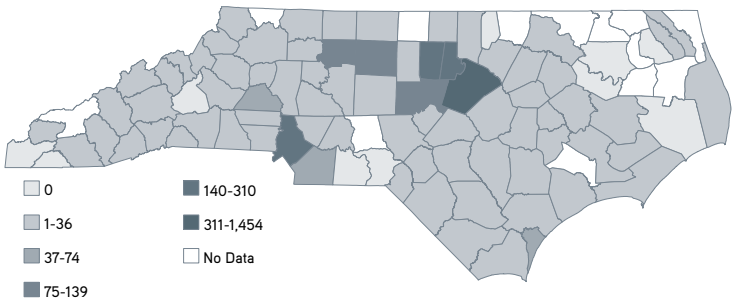
Academic institutions own less than 10 percent of North Carolina's patents,[5] meaning businesses and individuals hold the vast majority of legally protected intellectual property in the state. Although North Carolina's patenting rate ranks slightly below the U.S. average, its rate is above that of most 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, N.C. Counties, 2013-2015*



Source: United States Patent and Trademark Office.

3.3F *Average Annual Number of Patents, N.C. Counties, 2013-2015*



Source: United States Patent and Trademark Office.

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

Indicator Overview

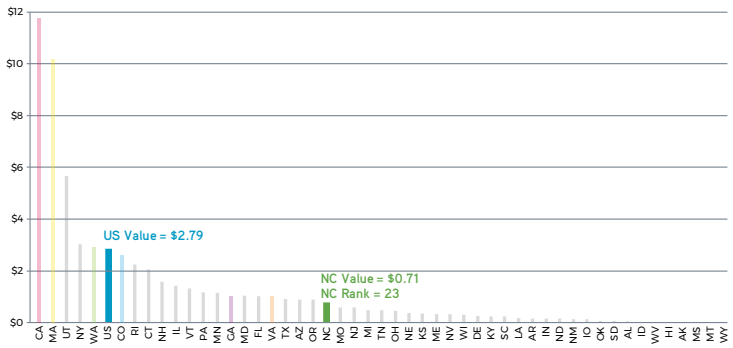
Venture capital dollars disbursed per $1,000 in state gross domestic product (GDP) is a measure of the magnitude of venture capital investment, adjusting for the size of a state economy. Venture capital is financial capital provided to early-stage, high-potential, high-risk, growth startup companies.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

How Does North Carolina Perform?

In terms of venture capital investment adjusted for state economy size, North Carolina ranks 23rd in the nation, with a value that is 25 percent of the U.S. value ***[3.4A]***. This paradoxical mid-level ranking but well-below-average value is the result of very high concentrations of venture capital investment in Massachusetts and California, which skew the national average upward. More than 66 percent of all venture capital disbursements are made in Massachusetts and California alone, and only three other states (Utah, New York, and Washington) possess averages higher than the national average.

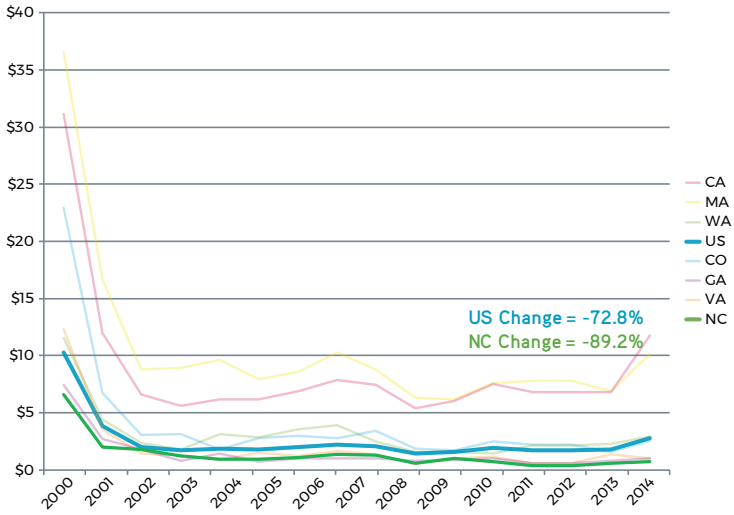
Between 2000 and 2014, venture capital investment in North Carolina firms decreased by 89.2 percent, from $6.58/$1,000 GDP to $.71/$1,000 GDP ***[3.4B]***. Although this decline is significant, it parallels declines across the nation. Over the same period, the U.S. average decreased by 72.8 percent, and all comparison states experienced similar declines. This across-the-board decline is explained by high venture capital investment in 2000—all states

3.4A *Venture Capital Dispersed per $1,000 GDP, All U.S. States, 2014*



Source: National Science Board.

3.4B *Venture Capital Dispersed per $1,000 GDP, Comparison States, 2000-2014*



Source: National Science Board.

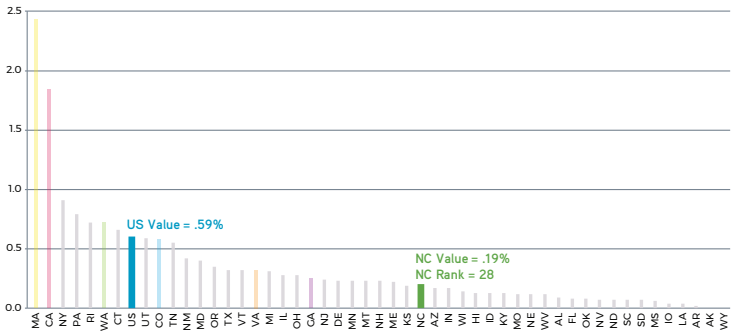
Indicator 3.4: Venture Capital

had their highest venture capital values in that year, the peak of the dot-com bubble and the first year in this analysis. Since 2001, North Carolina venture capital per $1,000 GDP has fluctuated between $2.01 and $0.41.

North Carolina performs just under half of all states in terms of the number of venture capital deals as a percentage of high-technology business establishments ***[3.4C]***. On this measure, North Carolina ranks 28th in the nation and has a value that is 32 percent of the U.S. value. Between 2003 and 2012, North Carolina's performance on this measure decreased by 32 percent. During that same period, the U.S. increased by 8 percent on this measure, and three of the comparison states (California, Massachusetts, and Washington) increased on this measure, whereas three other states (Colorado, Georgia, and Virginia) decreased on this measure ***[3.4D]***. This pattern, combined with the pattern for charts 3.4A and 3.4B, indicates that both the number and the size of venture capital deals in North Carolina is decreasing over time, particularly relative to the level of the state's GDP.

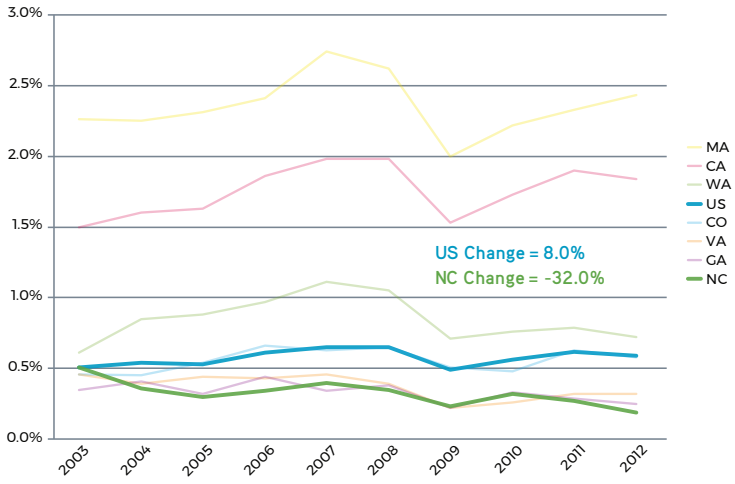
From 2014-2016, a total of $659 million worth of venture capital investments were made in North Carolina. However, nearly 90 percent of all of the State's venture capital investment was made in three urban counties (Durham, Wake and Mecklenburg) ***[3.4E]*** Overall, 48 percent of all venture capital investments took place in Durham County, followed by Wake (23 percent) and Mecklenburg (21 percent) over this timeframe. Venture capital investments took place in ten other counties, which had a combined total of 8 percent of North Carolinas' remaining investment activity.

3.4C Venture Capital Deals as a Percentage of High-Technology Business Establishments, All U.S. States, 2012



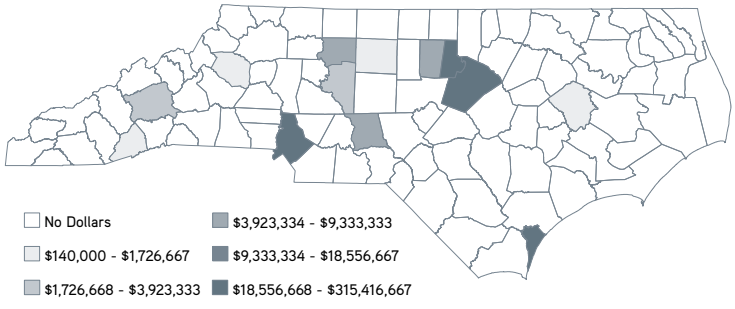
Source: National Science Board.

3.4D Venture Capital Deals as a Percentage of High-Technology Business Establishments, Comparison States, 2003-2012



Source: National Science Board.

3.4E Location of Venture Capital Investments in N.C., Average Annual Investments, 2014-2016



Source: PitchBook Data Inc.

Indicator 3.4: Venture Capital

What Does This Mean for North Carolina?

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

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 increased more slowly than the U.S. average 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.

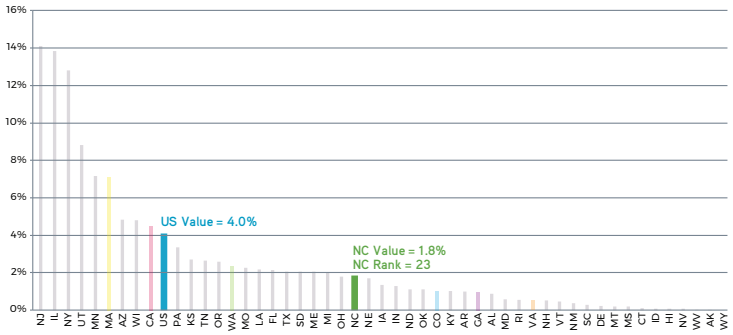
This indicator measures technology license income two ways: 1) gross income received and 2) running royalties received, with each measured as a percentage of academic science & engineering R&D expenditures. Gross income is the more inclusive measure, and it includes license issue fees, payments under 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 23rd in the nation, with a value that is 45 percent of the U.S. value and 13 percent of the value of the top-ranking state, New Jersey ***[3.5A]***. Among the comparison states, North Carolina ranks behind Massachusetts, California, and Washington, but ahead of Colorado, Georgia, and Virginia.

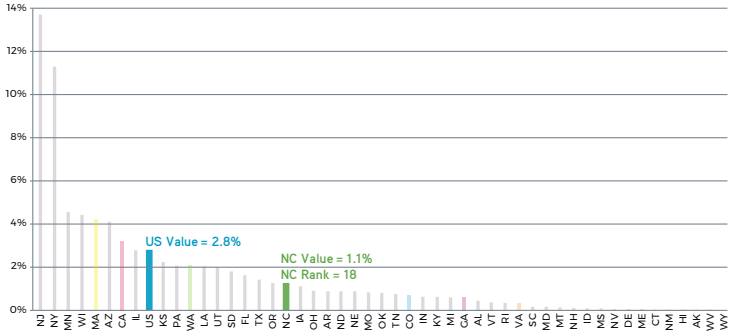
North Carolina fares similarly for running royalties as a percentage of academic science & engineering R&D expenditures, ranking 18th in the nation, with a value that

3.5A *Academic License Income (Gross Received) as a Percentage of Academic Science & Engineeering R&D Expenditures, All U.S. States, 2013-2015 Average*



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

3.5B *Academic License Income (Running Royalties) as a Percentage of Academic Science & Engineeering R&D Expenditures, All U.S. States, 2013-2015 Average*



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

Indicator 3.5: Technology License Income

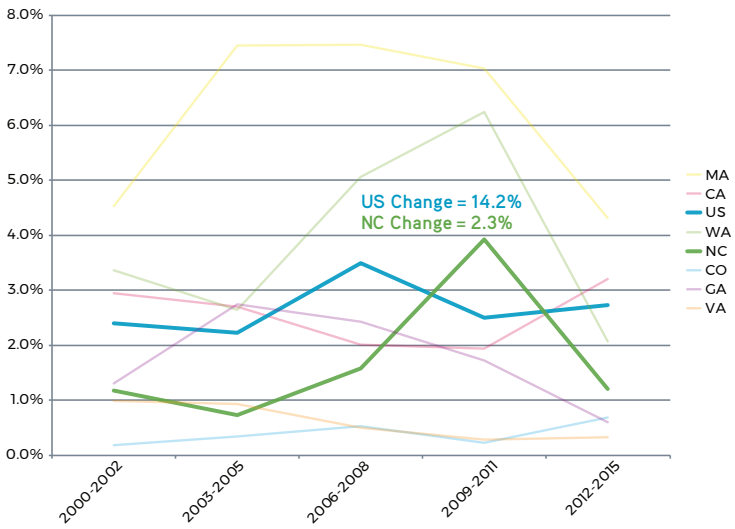
is 44 percent of the U.S. value and 9 percent of the value of the top-ranking state, New Jersey ***[3.5B]***. Among the comparison states, and similar to the gross income measure, North Carolina ranks behind Massachusetts, California, and Washington, but ahead of Colorado, Georgia, and Virginia. Since 2000, North Carolina's running royalties as a percentage of academic science & engineering R&D expenditures have increased by 2 percent, which is slower than the rate of increase for the U.S. (14 percent) and two of the comparison states, specifically Colorado and California ***[3.5C]***.

Within North Carolina, seven universities report significant technology license income—Duke University, ECU, North Carolina State University, UNC Charlotte, UNC Greensboro, UNC Chapel Hill, and Wake Forest University ***[3.5D, 3.5E]***.[1] Between 2013 and 2015, together the universities received, on average, nearly $48 million in licensing income.[2]

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.[3] 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

3.5C Academic License Income (Running Royalties) as a Percentage of Academic Science & Engineeering R&D Expenditures, Comparison States, Three-Year Averages, 2000-2015



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

3.5D Academic License Income, U.S. Average & N.C. Institutions, 2011-2013 Annual Average

Higher Education Institution	Gross Received	Running Royalties
US Average	$14,235,204	$10,147,145
Duke	$33,944,544	$25,057,038
ECU	$121,202	$69,469
NC State	$7,305,809	$5,732,585
UNC Charlotte	$99,100	$17,267
UNC Greensboro	$43,970	$12,720
UNC Chapel Hill	$4,794,872	$316,180
Wake Forest	$1,587,388	$1,159,566

Sources: Association of University Technology Managers.

[1] *These seven universities are the same ones that have offices focusing on technology patenting and commercialization and that appear in indicator 3.2: Academic Patents. 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.*

[2] *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.*

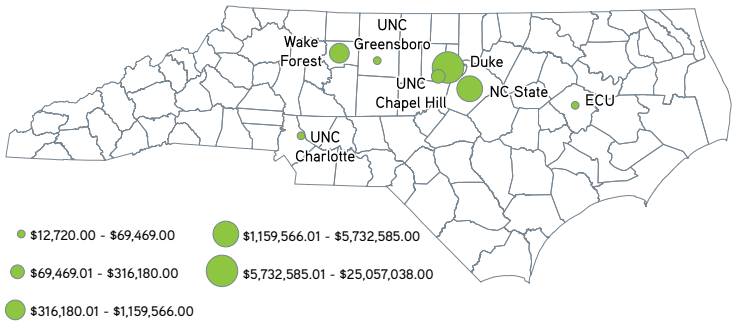
[3] *Our Time, Our Future: The UNC Compact with North Carolina, Strategic Directions 2013-2018, available at http://www.northcarolina.edu.*

Indicator 3.5: Technology License Income

the importance of commercializing university innovations.[4] 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.

3.5E

Location of Academic License Income (Running Royalties) in N.C., Average Annual Income, 2013–2015



Sources: Association of University Technology Managers.

[4] *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 3.6: 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 slightly 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 slightly above the U.S. average.
- North Carolina has experienced a downward trend in the number of university startups (as well as those that remained in the state) formed per $1 million of academic science and engineering R&D expenditures since 2000.
- Within North Carolina, seven universities produced startups from 2013-2015, three of them at a rate higher than the national average.

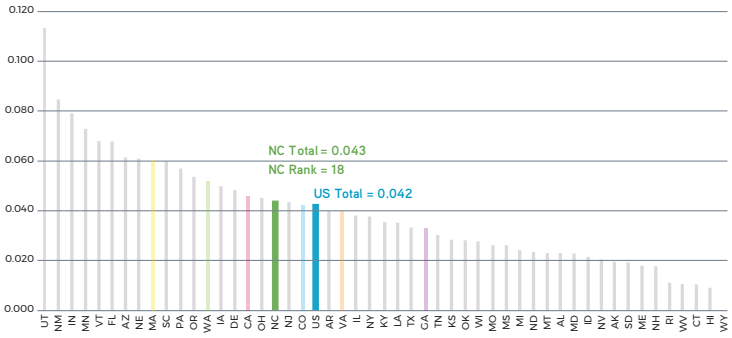
Indicator Overview

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?

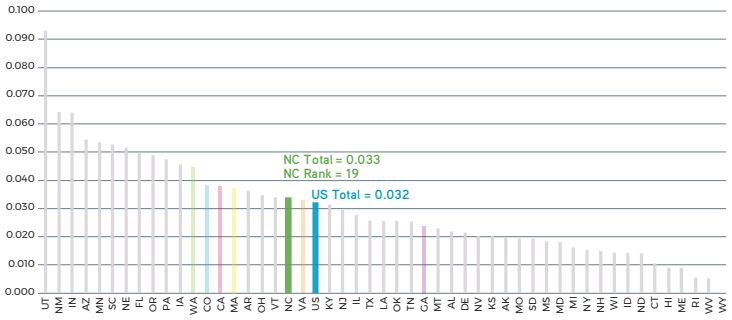
In terms of the number of university startups formed per $1 million of academic science and engineering R&D expenditures, North Carolina ranks 18th in the nation, with a rate just above that of the overall national average ***[3.6A]***. North Carolina also ranks in the middle when viewed against the comparison states, behind Massachusetts, Washington, and California, but ahead of Colorado, Virginia, Georgia. North Carolina's value is just over one-third of the rate of the highest-ranking state, Utah. Similarly, when measured against university startups that remained within their home state, North Carolina ranks 19th in the nation and is slightly ahead of the national average ***[3.6B]***. Versus the comparison states, North Carolina ranks ahead of Virginia and Georgia on this measure. North Carolina's value on this measure is also one-third of the value of Utah, the highest-raking state.

3.6A *Average Number of University Startups Formed per $1 Million of Academic Science & Engineering R&D Expenditures, 2013-2015*



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

3.6B *Average Number of University Startups Formed & Remaining in Home State per $1 Million of Academic Science & Engineering R&D Expenditures, 2013-2015*



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

Indicator 3.6: University Startups

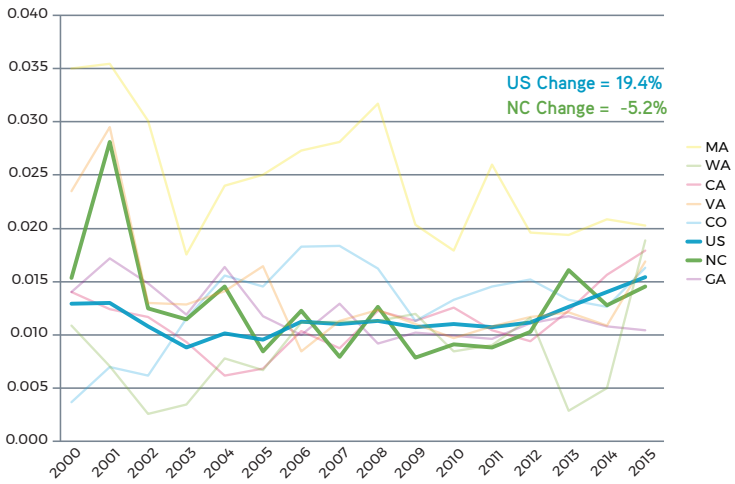
Since 2000, North Carolina has experienced a declining trend in the number of university startups formed per $1 million of academic science and engineering R&D expenditures. While quite variable over this time fame, North Carolina experienced a decline of -5.2 percent from 2000 to 2015 ***[3.6C]***. Meanwhile, the U.S. experienced a positive trend of 19.4 percent. Relative to comparison states, North Carolina experienced the smallest decline, putting it ahead of Georgia, Virginia, and Massachusetts.

From 2013-2015, seven North Carolina universities reported having formed university startups—Duke University, ECU, North Carolina State University, the University of North Carolina at Charlotte, the University of North Carolina at Greensboro, the University of North Carolina at Chapel Hill, and Wake Forest University. Among all universities within the state, the University of North Carolina at Chapel Hill had the highest average number of startups formed from 2013-2015, and North Carolina State University had the highest average number of startups formed that remained in the state ***[3.6D]***. Duke University, the University of North Carolina at Chapel Hill, and North Carolina State University 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, although Wake Forest University's average number of university startups formed is above the U.S. average.

What Does This Mean for North Carolina?

Because North Carolina's innovation- and research-related strengths are derived primarily from academic institutions (see indicators 2.3 and 2.5), it is not surprising that several of the state's universities produce startup companies. Additionally, based on raw numbers alone, North Carolina ranks 7th and 6th overall in the number of university startups (as well as those that remained in the state), respectively.[1] When these numbers are normalized to account for science and engineering R&D expenditures, North Carolina ranks considerably lower nationally, primarily because the state ranks particularly high on academic R&D expenditures — 4th nationally and well above the U.S. average (see indicator 2.3). To maximize the value of the state's strong academic R&D, a larger number of North Carolina's universities should focus increased attention on their offices and activities that

3.6C *Number of University Startups Formed per $1 Million of Academic Science & Engineering R&D Expenditures, Comparison States, 2000-2015*



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

3.6D *Average Number of University Startups Formed & Stayed in Home State, U.S. Average & N.C. Institutions, 2013-2015*

Higher Education Institution	Average Number of University Startups Formed	Average Number of University Startups Formed & Stayed in Home State
US Total	5	4
Duke	7	5
ECU	1	1
NC State	10	9
UNC Charlotte	4	3
UNC Greensboro	1	1
UNC-Chapel Hill	11	8
Wake Forest	6	3

Sources: Association of University Technology Managers.

[1] *These estimates are not presented in the charts.*

Indicator 3.6: University Startups

generate patents and other forms of IP that form the basis of a startup company. This would not necessarily entail a large increase in resources. For example, the University of North Carolina's 2013–2018 strategic directions include establishing and supporting a "scout team" and core support staff that any campus could utilize for market assessment, legal assistance, new venture services, and other operational support, such as patenting and copyrighting, for commercialization.[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 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 http://www.northcarolina.edu.*

[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 Science, Engineering, and Technology (SET) employment ranks below the U.S. average, but since 2003 has been increasing at a rate faster than the U.S. average rate.
- The number of net business formations in high SET employment industries as a percentage of the total number of business establishments is higher than the U.S. average, but since 2004 has been declining at a rate faster than the U.S. average rate.
- North Carolina's high SET employment establishments are highly concentrated in a small number of urban counties.

Indicator Overview

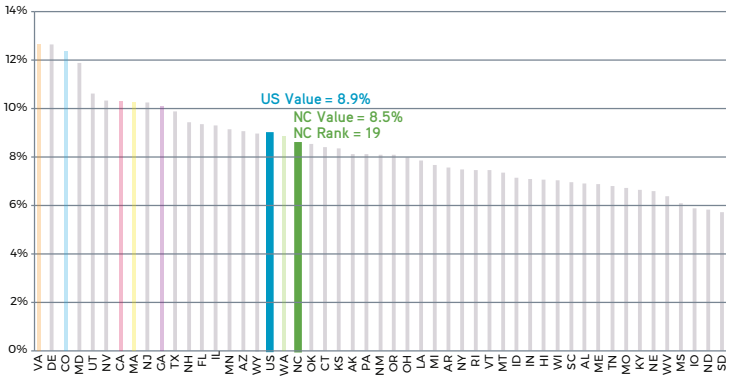
This indicator measures high science, engineering, and technology (SET) employment establishments two ways: 1) the percentage of a state's business establishments that are classified as being part of high SET employment industries, and 2) the number of net business formations that occur in high SET employment industries as a percentage of the total number of business establishments in a state. 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 technical occupations that employ workers who generally possess in-depth knowledge of the theories and principles of science, engineering, and mathematics at a postsecondary level.[1]

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?

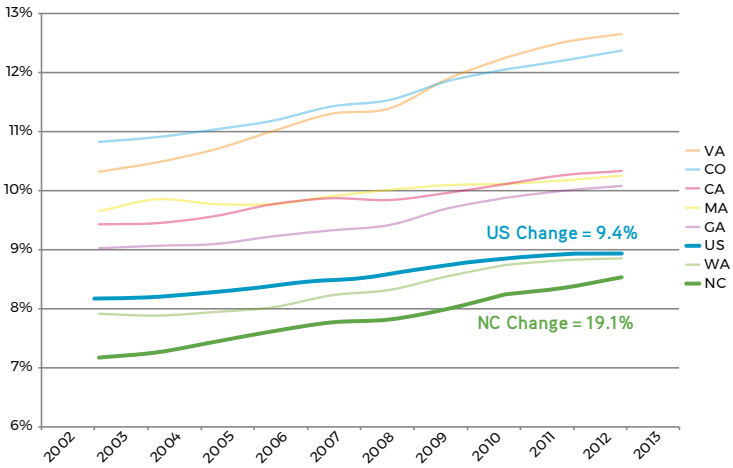
North Carolina's high SET employment establishments represent 8.5 percent of all business establishments in the state, with a value that ranks 19th in the nation and is 96 percent of the U.S. value and 67.5 percent of the value of the top-ranking state, Virginia ***[4.1A]***. Among the comparison states, North Carolina's percentage of high SET employment establishments ranks last. The percentage of high SET employment business establishments in North Carolina has increased by 19.1 percent since 2003, however, a rate more

4.1A *High SET Employment Establishments as a Percentage of All Business Establishments, All U.S. States, 2012*



Source: National Science Board.

4.1B *High SET Employment Establishments as a Percentage of All Business Establishments, Comparison States, 2003-2012*



Source: National Science Board.

[1] *The data pertaining to establishments for the years 2003 to 2008 are based on their classification according to the 2002 edition of the North American Industry Classification System (NAICS). The data for the years 2009–12 are based on their classification according to the 2007 edition of the NAICS. See the Appendix for a list of the 48 industries (by 4-digit NAICS code) that are defined as having high SET employment.*

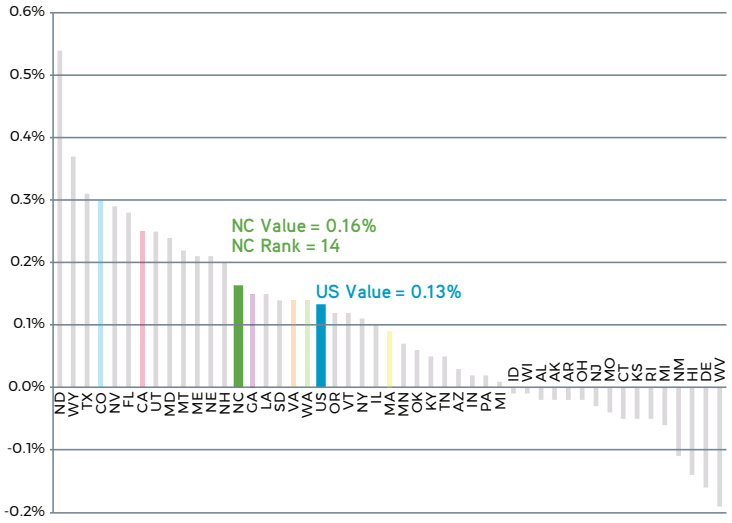
Indicator 4.1: High SET Employment Establishments & Formations

than twice the rate for the U.S., 9.4 percent, and faster than the rates of all but one of the comparison states, which average 13 percent ***[4.1B]***.

In terms of high SET employment business formations as a percentage of all business establishments, North Carolina's value of .16 percent is larger than the U.S. value of .13 percent, but only one quarter of the value of the highest state, North Dakota ***[4.1C]***. Among comparison states, North Carolina is ahead of all states except Colorado (.30 percent) and California (.25 percent). The percentage of high SET employment business formations in North Carolina has decreased by 33.3 percent since 2004. This rate of decrease is nearly double the rate of decrease for the U.S., -18.8 percent, and the average rate for the comparison states, -11 percent ***[4.1D]***. Notably, most of this decrease results from the 2008-2009 recession, which caused a sharp downturn in the rate of high SET employment business formations. Since 2009, the rate has increased significantly for the U.S. overall and for all the comparison states.

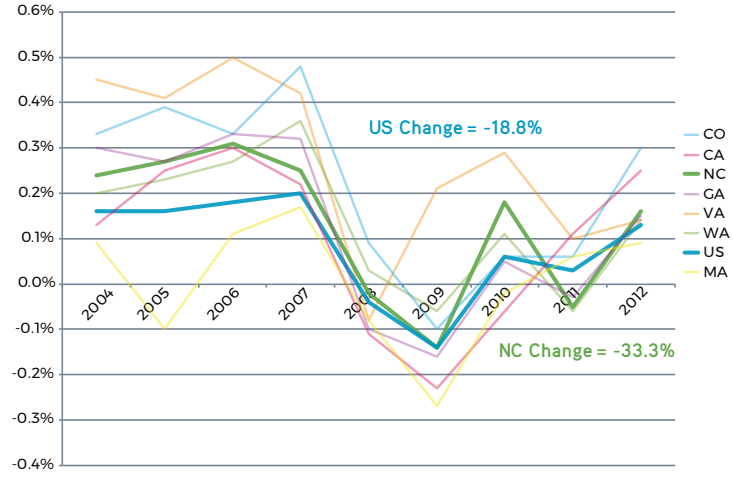
Although high SET employment establishments are located in each of North Carolina's 100 counties, nearly half (49 percent) of those establishments are located in just three counties—Wake (23.0 percent), Mecklenburg (20.6 percent), and Durham (5.4 percent) ***[4.1E]***. The next six counties combined—Guilford (5.1 percent), Buncombe (3.7 percent), Forsyth (3.3 percent), New Hanover (3.2 percent), Orange (2.5 percent), and Union (2.4 percent)—account for another 20 percent of the state's high SET employment establishments. This means that nine of the state's 100 counties contain more than two-thirds of the state's high SET employment establishments. These nine counties plus seven others—Iredell, Cabarrus, Brunswick, Moore, Chatham, Lincoln, and Franklin—are the only ones in the state whose high SET employment establishments as a percentage of total establishments is higher than the U.S. average. Of the remaining 84, four account for between one and two percent of the state's high SET employment establishments each, whereas each of the remaining 80 counties has less than one percent of the state's high SET employment establishments.

4.1C Net High SET Employment Business Formations as a Percentage of all Business Establishments, All U.S. States, 2012



Source: National Science Board.

4.1D Net High SET Employment Business Formations as a Percentage of All Business Establishments, Comparison States, 2004-2012



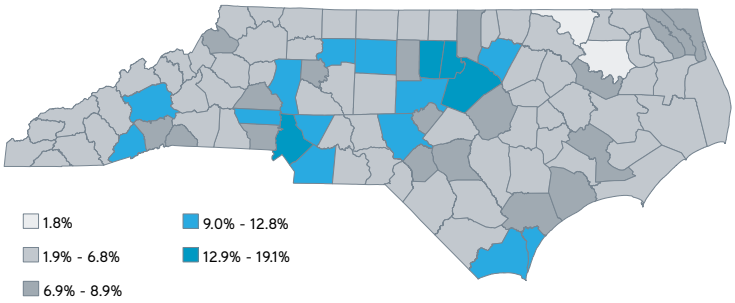
Source: National Science Board.

Indicator 4.1: High SET Employment Establishments & Formations

What Does This Mean for North Carolina?

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

4.1E *High SET Employment Establishments as a Percentage of Total Establishments, N.C. Counties, 2016*



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

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

Indicator 4.2: High SET Employment

KEY FINDINGS

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

Indicator Overview

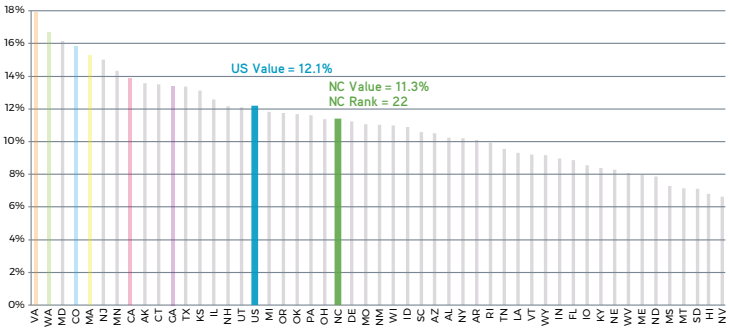
This indicator represents the extent to which a state's workforce is employed in industries with high employment in science, engineering, and technology (SET) occupations.[1] High SET employment industries are defined as those in which the proportion of employees in technology-oriented occupations is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

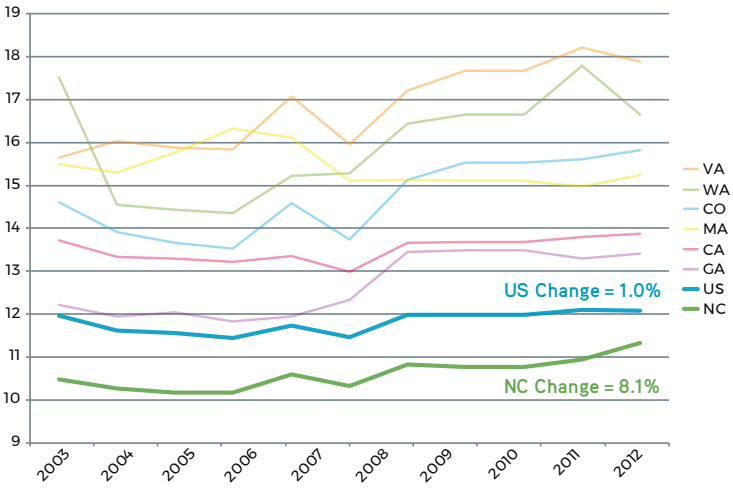
North Carolina's employment in high SET employment establishments is 11.3 percent of the state's total employment, a value that ranks 22nd in the nation and is 94 percent of the U.S. average value and 63 percent of the value of the top-ranking state, Virginia ***[4.2A]***. Among the comparison states, North Carolina's employment in high SET employment establishments as a percentage of total employment ranks last, two percentage points lower than the next highest state, Georgia. The percentage of North Carolina's employment in high SET employment establishments has increased by 8.1 percent since 2003 ***[4.2B]***. This rate of increase is higher than the 1.0 percent rate of increase for the U.S., lower than the rates of increase

4.2A *Employment in High SET Employment Establishments as a Percentage of Total Employment, All U.S. States, 2012*



Source: National Science Board.

4.2B *Employment in High SET Employment Establishments as a Percentage of Total Employment, Comparison States, 2003-2012*



Source: National Science Board.

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

[2] *The data pertaining to establishments in 2003 through 2008 are based on their classification according to the 2002 edition of the North American Industry Classification System (NAICS). The data for the years 2009–12 are based on their classification according to the 2007 edition of the NAICS. See the Appendix for a list of the 48 industries (by 4-digit NAICS code) that are defined as having high SET employment. Data on total employment and NAICS industry establishment employment are provided by the Census Bureau and differ from workforce data provided by the Bureau of Labor Statistics.*

Indicator 4.2: High SET Employment

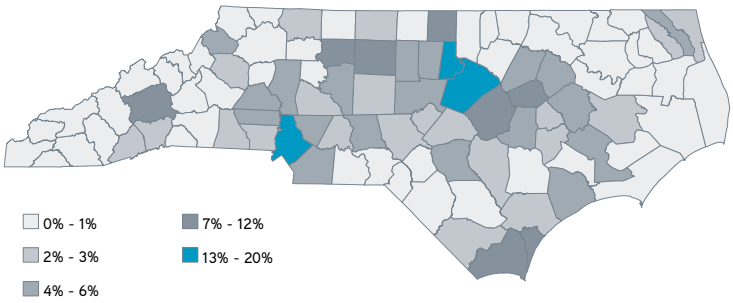
for Virginia, and Georgia, and Colorado, but above the rates for California, Massachusetts, and Washington, whose values ranged between -5.0 and 1 percent.

Although high SET employment establishments employ workers in nearly all of North Carolina's 100 counties, two-thirds (67.0 percent) of those employees work in just three urban counties—Mecklenburg (29.9 percent), Wake (25.9 percent), and Durham (11.6 percent) ***[4.2C]***. Moreover, those three counties are the only ones in the state whose employment in high SET employment establishments as a percentage of total county employment is greater than or equal to than the U.S. average (12.0 percent). Establishments located in each of the next nine counties—Guilford (6.6 percent), Forsyth (3.4 percent), New Hanover (2.8 percent), Buncombe (2.4 percent), Iredell (2.0 percent), Catawba (1.4 percent), Cumberland (1.2 percent), Johnston (1.0 percent), and Orange (1.0 percent)—account for nearly twenty percent of the state's high SET workers. This means that establishments located in only 12 percent of the state's counties employ nearly 90 percent of the state's high SET workers. Each of the remaining 88 counties has less than one percent of the state's high SET employment.

What Does This Mean for North Carolina?

As with high SET employment establishments (see indicator 4.1), North Carolina's below-average level of employment in high SET employment establishments reflects the dual facts that a large proportion of North Carolina remains rural in nature and has a higher-than-average share of companies in lower-technology manufacturing industries and agriculture. Moreover, looking across the state, the distribution of high SET workers is more concentrated than the distribution of high SET employment establishments. This pattern of geographically concentrated high SET employment establishments and high SET workers is considerably more concentrated than the state's population (see indicator 1.6).

4.2C *Employment in High SET Employment Establishments as a Percentage of Total Employment, N.C. Counties, 2016*



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.

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.

Indicator 4.3: Entrepreneurial Activity

KEY FINDINGS

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

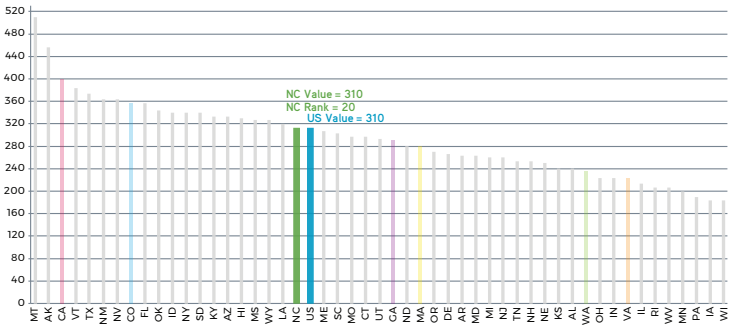
Indicator Overview

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. It will 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 20th in the nation, with a level that is equal to the U.S. value and 61 percent of the value of the top-ranking state, Montana[2] ***[4.3A]***. Specifically, North Carolina's monthly rate of business creation is 0.3 percent; in other words, entrepreneurs in North Carolina started 300 businesses each month for every 100,000 adults living in the state. Among comparison states, North Carolina's monthly rate is in the middle of the pack—lower than California and Colorado, but higher than Georgia, Massachusetts, Washington, and Virginia.

4.3A *Average Annual Number of Entrepreneurs Per 100,000 People, All U.S. States, 2014-2016*



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 http://www.kauffman.org/kauffman-index/about/kiea-microdata.*

[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.*

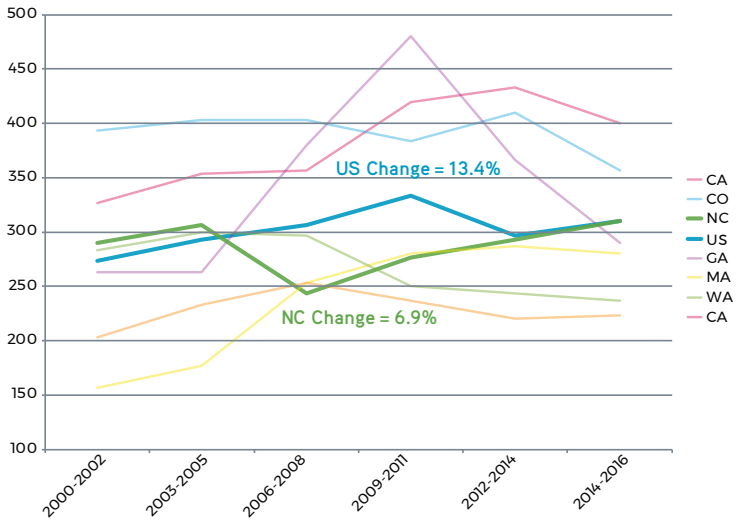
Indicator 4.3: Entrepreneurial Activity

Since 2000, North Carolina's three-year entrepreneurship index average has remained fairly constant in growth, dipping only during the 2006–2008 period ***[4.3B]***. Overall, North Carolina's index increased by 6.9 percent and the U.S. index increased by 13.4 percent from 2000–2016. Four of the comparison states—Massachusetts, California, Georgia, and Virginia—experienced significant increases over time and grew faster than the North Carolina average. Two states—Colorado and Washington—experienced declines in entrepreneurship from 2000-2016.

In terms of the average opportunity share of new entrepreneurs, North Carolina's ranks 29th in the nation, with a level that is 95 percent of the U.S. value and 86.8 percent of the value of the top-ranking state, North Dakota ***[4.3C]***. Specifically, North Carolina's average opportunity share of new entrepreneurs is 79 percent, meaning slightly more than three-fourths of North Carolina's new entrepreneurs were not unemployed before starting their businesses. Among comparison states, North Carolina's opportunity share of new entrepreneurs is below Colorado and Virginia, but ahead of Washington, California, Massachusetts, and Georgia.

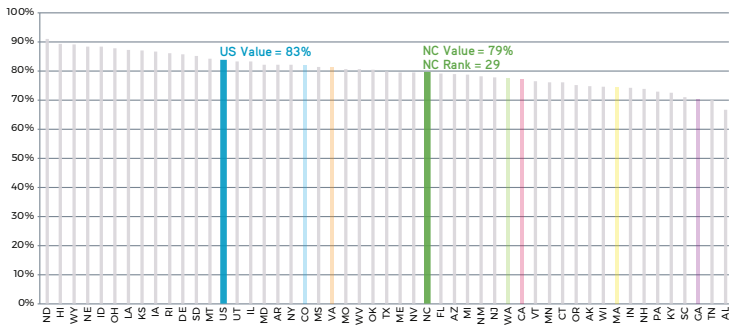
Since 2000, North Carolina's average opportunity share of new entrepreneurs has decreased by 8.6 percent ***[4.3D]***. During that same period of time, the opportunity share of new entrepreneurs in the U.S. overall increased by 1.4 percent. In all the comparison states, the opportunity share of new entrepreneurs also decreased, with four of the comparison states—Colorado, Virginia, California, and Massachusetts—having rates of decrease slower than North Carolina's, and two—Georgia and Washington—having faster rates of decrease than North Carolina's.

4.3B *Average Annual Number of Entrepreneurs Per 100,000 People, Comparison States, 2000-2016*



Source: Kauffman Foundation.

4.3C *Average Opportunity Share of New Entrepreneurs, All U.S. States, 2014-2016*



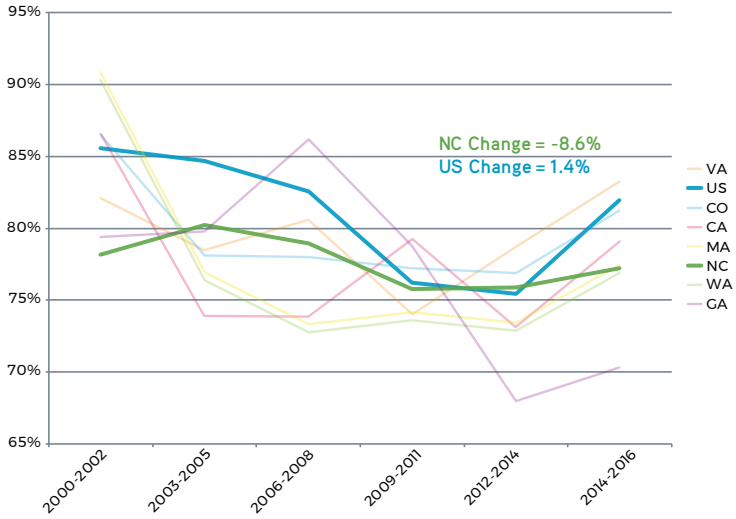
Source: Kauffman Foundation.

Indicator 4.3: Entrepreneurial Activity

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 below average; more can be done to improve state conditions for, and levels of, entrepreneurial activities.

4.3D *Average Opportunity Share of New Entrepreneurs, Comparison States, 2000-2016*



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, has since at least the early 2000s, and has remained relatively constant over that period.
- 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.

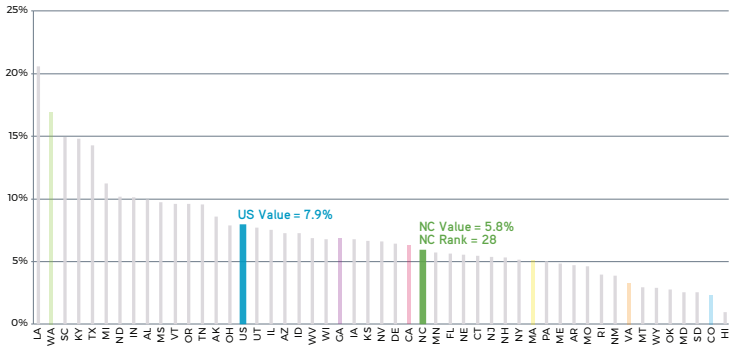
Indicator Overview

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., 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] On average, exports contribute an additional 18 percent to workers' earnings in U.S. manufacturing.[4] 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?

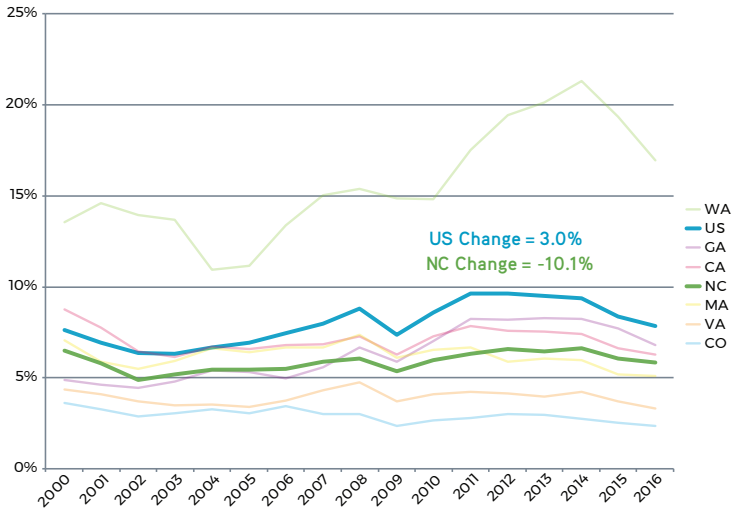
In terms of exports as a percentage of state GDP, North Carolina ranks 28th in the nation, with a value that is 73 percent of the U.S. value and 28 percent of the value of the top-ranking state, Louisiana ***[4.4A]***. Among the comparison states, North Carolina's exports as a percentage of state GDP ranks behind Washington, Georgia, and California, but ahead of Massachusetts, Virginia and Colorado. Between 2000 and 2016, North Carolina's exports as a percentage of state GDP decreased by 10.1 percent, a rate below that for the U.S., 3.0 percent ***[4.4B]***. While North Carolina's rate of decrease ranks it lower than Georgia and Washington, whose exports as a percentage of state GDP increased significantly,

4.4A *Exports as a Percentage of GDP, All U.S. States, 2016*



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

4.4B *Exports as a Percentage of GDP, Comparison States, 2000-2016*



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] *Riker, David. 2010. "Do Jobs in Export Industries Still Pay More? And Why?" Washington, DC: International Trade Administration.*

Indicator 4.4: Exports

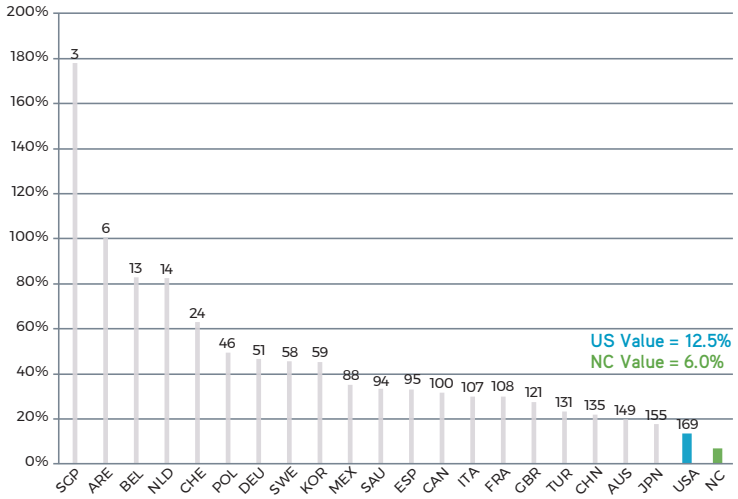
its rate of decrease is slightly less than the rates for Virginia, Massachusetts, California, and Colorado.[5]

Internationally, the U.S. ranks as the 169th most export-intensive country, making its export intensity 7.1 percent of the rate of the most export-intensive country, Singapore ***[4.4C]***.[6] North Carolina's export intensity ranks behind that of all the comparison countries. Since 2000, the export intensity of most of the comparison countries has risen at roughly the same rate as the U.S. rate or, in some cases, at a considerably higher rate (e.g., United Arab Emirates at 104.3 percent, Poland at 81.2 percent, and Japan at 66.0 percent) ***[4.4D]***. A small number of countries saw their export intensities decrease (e.g., Malaysia at -31.8 percent, Saudi Arabia at -28.6 percent, and Singapore at -5.6 percent).

What Does This Mean for North Carolina?

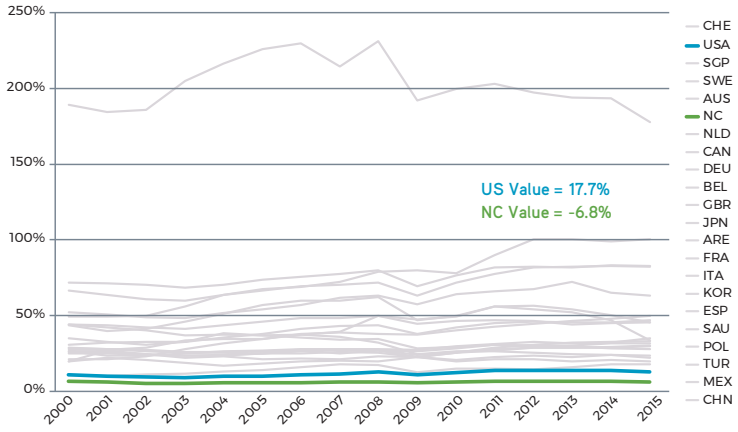
Exports continue to be one of the key drivers for North Carolina's economic development. In 2013, for example, North Carolina exported more than $29.3 billion in products and services to international markets. Exporting helps companies in North Carolina diversify their business portfolios and become more profitable and resilient in the global market. Exports are also critical in employment growth; nearly one out of every 10 jobs in the state is supported by 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, 2015



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

4.4D Exports as a Percentage of GDP, Comparison Countries, 2015



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

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

[6] 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., Malaysia), or have abundant supplies of natural resources, such as natural gas, that comprise a large share of their exports (e.g., Netherlands).

[7] Based on the 2010 IMPLAN analysis performed by the N.C. Department of Commerce to estimate export contribution to the state's economy.

[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 has staff in the state and in seven 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 slightly 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.

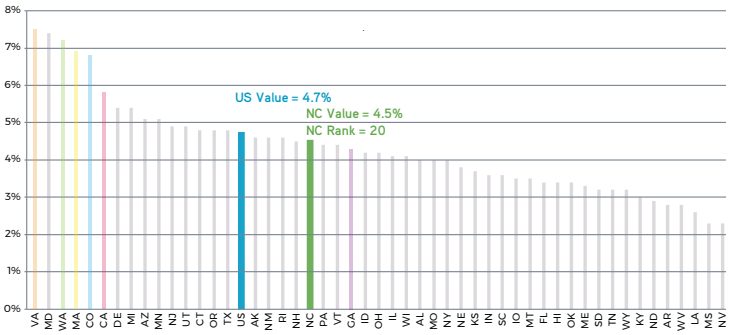
Indicator Overview

This indicator represents the extent to which a state's workforce is employed in Science and Engineering (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. 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?

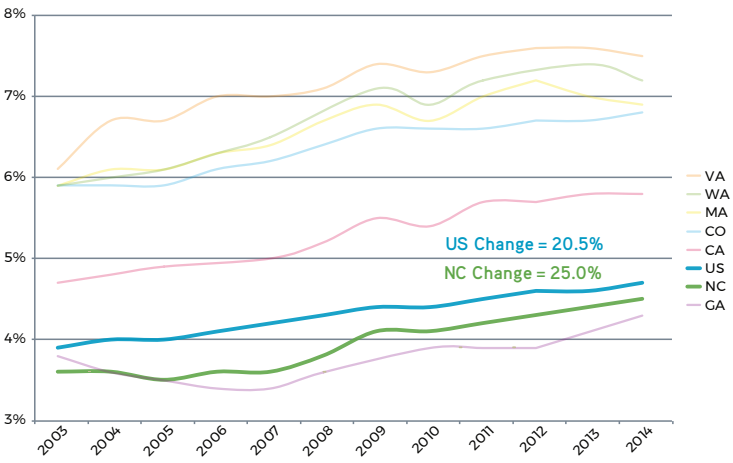
In terms of individuals in S&E occupations as a percentage of the workforce, North Carolina ranks 20th in the nation, with a level that is 96 percent of the U.S. average value and 59 percent of the value of the top-ranking state, Virginia ***[5.1A]***. With the exception of Georgia, all of the comparison states rank well ahead of North Carolina and are within the top 10 among all states. From 2003 to 2014, the percentage of North Carolina's workforce in S&E occupations increased significantly, by 25 percent. This rate is faster than the rate of increase for the U.S. overall, and ahead of the rate for all of the comparison states ***[5.1B]***.

5.1A *Individuals in Scince & Engineering Occupations as a Percentage of the Workforce, All U.S. States, 2014*



Source: National Science Board.

5.1B *Individuals in Science & Engineering Occupations as a Percentage of the Workforce, Comparison States, 2003-2014*



Source: National Science Board.

Note: Data were not available for Washington in 2008 and 2012, and were not available for California in 2006 and Georgia in 2009. Lines for those years were extroplated from 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 840 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 keeping pace and gaining relative to the U.S. overall. The share of the state's workers in S&E occupations reflects the share of its establishments composed of high science, engineering and technology (SET) employment establishments (see indicator 4.1) and the share of its employment that works in high SET employment establishments (see indicator 4.2). On both these measures, North Carolina ranks slightly below average and close to the median among all states. 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 increase the technology levels of its existing companies and to start and grow new high SET companies. The concentrated geographic distribution and employment of the state's high SET establishments suggest that broadening the distribution of such establishments across North Carolina, as well as deepening the existing concentrations of such establishments, would help increase the share of the state's employment in S&E occupations.

Indicator 5.2: Employed Science, Engineering & Health (SEH) Doctorate Holders

KEY FINDINGS

- The percentage of North Carolina's workforce holding science, engineering, and health (SEH) doctorates ranks the same as the U.S average and has since at least the early 2000s, and is increasing at a rate roughly equal to the U.S. average.

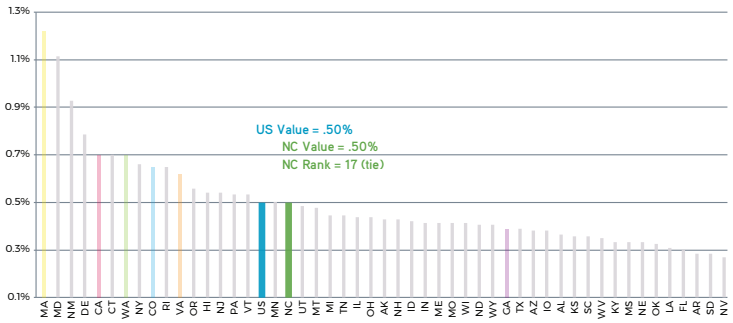
Indicator Overview

This indicator represents a state's ability to attract, retain and grow highly trained scientists, engineers, and healthcare (SEH) professionals. These individuals often conduct research and development (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?

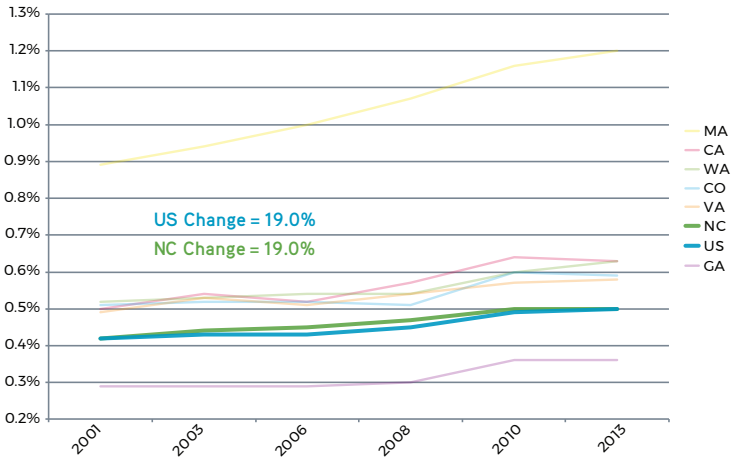
In terms of employed SEH doctorate holders as a percentage of the workforce, North Carolina ranks 17th in the nation, with a level that is 100 percent of the U.S. average value and 42 percent of the value of the top-ranking state, Massachusetts ***[5.2A]***. With the exception of Georgia, all the comparison states rank well ahead of North Carolina, and all are within the top 10 among all states. From 2001 to 2013, employed SEH doctorate holders as a percentage of the workforce in North Carolina increased significantly, by 19 percent. This rate is slightly slower than the rate of increase for Massachusetts, California, Washington, and Georgia, roughly equal to the rate for the U.S. overall, but slightly faster than the rate of increase for Colorado and Virginia ***[5.2B]***.

5.2A *Employed Science, Engineering & Health Doctorate Holders as a Percentage of the Workforce, All U.S. States, 2013*



Source: National Science Board.

5.2B *Employed Science, Engineering & Health Doctorate Holders as a Percentage of the Workforce, Comparison States, 2001-2013*



Source: National Science Board.

[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.*

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 most 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, S&E) employment establishments (see indicator 4.1) and the share of its employment that works in high SET employment establishments (see indicator 4.2). On both these measures, North Carolina ranks slightly below average and close to the median among all states. For North Carolina to outpace the comparison states and rise above the U.S. average on employed SEH doctorate holders, it would likely also need to increase the technology levels of its existing companies, start and grow new high SET companies, or increase its number of other research-intensive organizations. The concentrated geographic distribution and employment of the state's high SET establishments suggest that broadening the distribution of such establishments across North Carolina, as well as deepening the existing concentrations of such establishments, would help increase the share of the state's employees holding SEH doctorates.

Indicator 5.3: Engineers as a Percentage of the Workforce

KEY FINDINGS

- The percentage of trained engineers in North Carolina's workforce ranks well below the U.S average, has since at least the early 2000s, and is increasing at a rate slightly faster than the U.S. average.

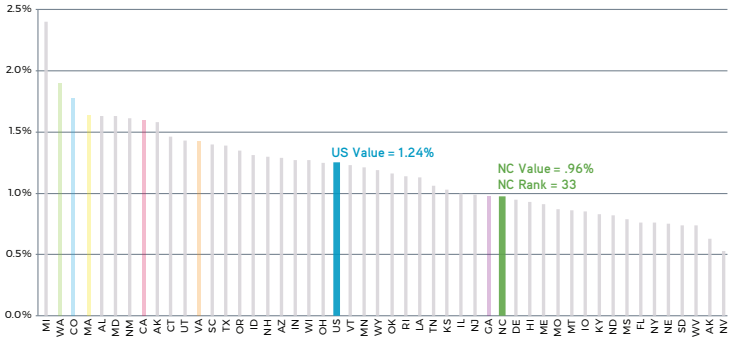
Indicator Overview

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] Faculty teaching in science & engineering (S&E) fields are not included as workers in S&E occupations.

How Does North Carolina Perform?

In terms of the percentage of trained engineers in a state's workforce, North Carolina ranks 33rd in the nation, with a level that is 77 percent of the U.S. average value and 40 percent of the value of the top-ranking state, Michigan ***[5.3A]***. All of the comparison states rank ahead of North Carolina and, with the exceptions of Georgia and Virginia, are within the top 10 among all states. From 2003 to 2014, the percentage of trained engineers in North Carolina's workforce increased by 14.3 percent, slightly higher than the rate of increase for the U.S. overall (7.8 percent). This rate is slower than the rate of increase for Georgia, but faster than the rate of increase for the other comparison states ***[5.3B]***.

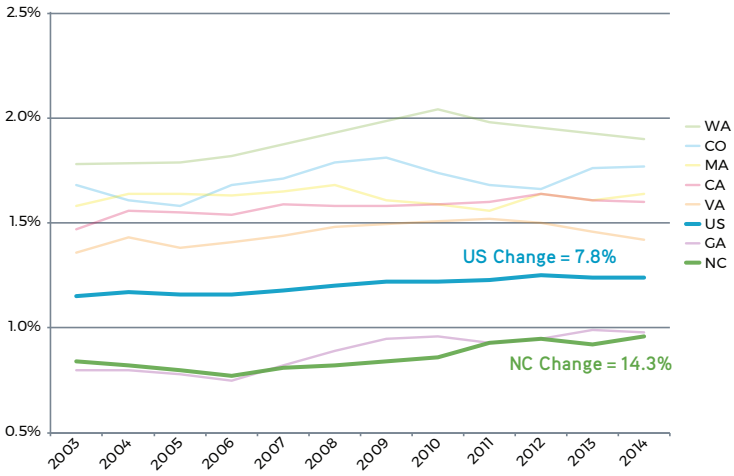
5.3A *Engineers as a Percentage of All Occupations, All U.S. States, 2014*



Source: National Science Board.

Note: 2014 data not available for Pennsylvania.

5.3B *Engineers as a Percentage of All Occupations, Comparison States, 2003-2014*



Source: National Science Board.

Note: Data not available for Washington for 2004, 2007, 2009, 2012, and 2013; Virginia for 2009. Lines for missing years were extrapolated 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 840 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.*

Indicator 5.3: Engineers as a Percentage of the Workforce

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 a share of total employment, such as Massachusetts, California, and Colorado (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 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 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 45 engineers per 1,000 employees is twice as high as any other big metro area, which is a key reason it is one of the nation's most affluent metro areas.*

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

KEY FINDINGS

- The ratio of Science, Engineering & Technology (SET) bachelor's degrees to the population ages 18–24 years in North Carolina ranks slightly below the U.S average and has since at least the early 2000s, and is increasing at a rate slightly below the U.S. average.

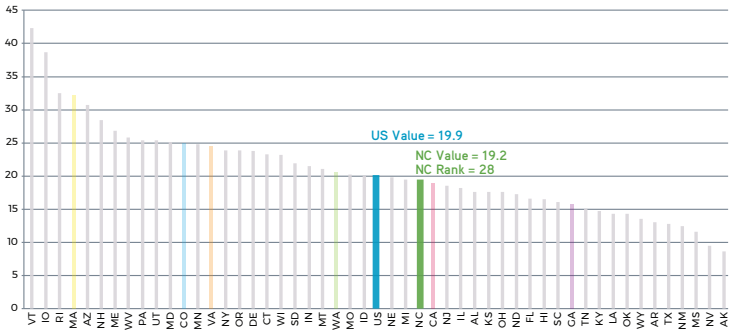
Indicator Overview

This indicator is the ratio of new SET 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. SET fields include the physical, life, earth, ocean, atmospheric, computer and social sciences; mathematics; engineering; psychology; science technologies; and engineering technologies.[1]

How Does North Carolina Perform?

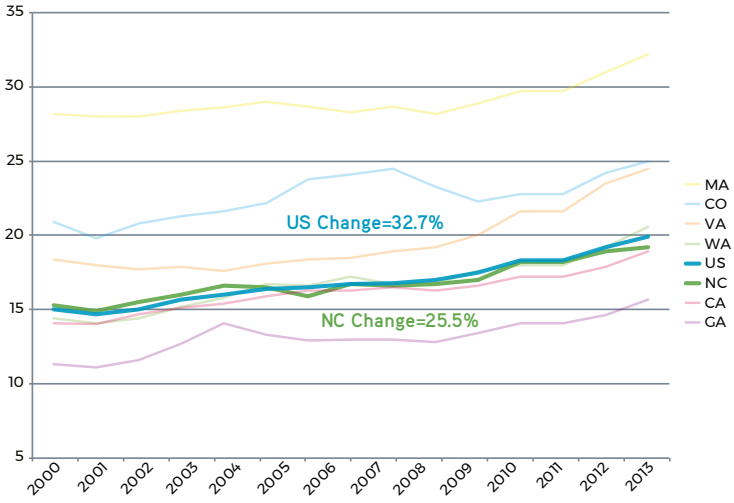
In terms of the ratio of new SET bachelor's degrees to the population ages 18–24 years, North Carolina ranks 28th in the nation, with a level that is 96 percent of the U.S. average value and 45 percent of the value of the top-ranking state, Vermont ***[5.4A]***. Relative to the comparison states, North Carolina ranks below Massachusetts, Colorado, Virginia, and Washington, but ahead of California and Georgia. From 2000 to 2013, the ratio of new SET bachelor's degrees to the population ages 18–24 years increased by 25.5 percent, a rate slightly lower than the rate of increase for the U.S. overall (32.7 percent). North Carolina's rate of increase is slower than the rates of increase for California, Washington, Virginia and Georgia, and slightly higher than the rates for Massachusetts and Colorado ***[5.4B]***.

5.4A *Bachelor's Degrees in Science, Engineering & Technology Conferred per 1,000 Individuals 18–24 Years Old, All U.S. States, 2013*



Source: National Science Board.

5.4B *Bachelor's Degrees in Science, Engineering & Technology Conferred per 1,000 Individuals 18–24 Years Old, Comparison States, 2000-2013*



Source: National Science Board.

[1] *The number of bachelor's degrees awarded in SET 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 SET fields. Because students often relocate after graduation, this measure does not directly indicate the qualifications of a state's future workforce. A state's value for this indicator may also be high when its higher education system draws a large percentage of out-of-state students, a situation that sometimes occurs in states with small resident populations and the District of Columbia.*

What Does This Mean for North Carolina?

Educational attainment in an SET 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 SET field also prepares an individual for advanced technical education. A high value for this indicator indicates the successful provision of undergraduate training in SET fields. North Carolina's slightly below average performance on this indicator suggests room for improvement. While the ratio of new SET bachelor's degrees to the population ages 18–24 years in North Carolina is increasing over time, this rate of increase is just keeping pace with, or is slightly 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 SET 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 SET workers.

Indicator 5.5: B.S., M.S. & Ph.D. Degrees in Science, Engineering & Technology

KEY FINDINGS

- The percentage of higher education degrees conferred in science, engineering & technology (SET) fields in North Carolina ranks above the U.S average and has since at least the early 2000s, and is increasing slightly faster than the U.S. average.

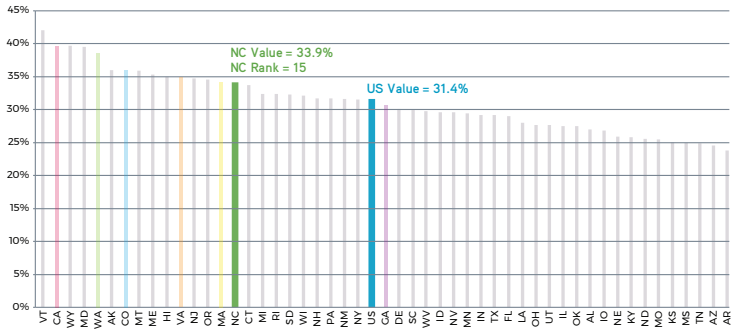
Indicator Overview

This indicator represents the extent to which a state's higher education programs are concentrated in science, engineering & technology (SET) fields. SET fields include the physical, life, earth, ocean, atmospheric, computer, and social sciences; mathematics; engineering; psychology; science technologies; and engineering technologies. Counts of both SET 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?

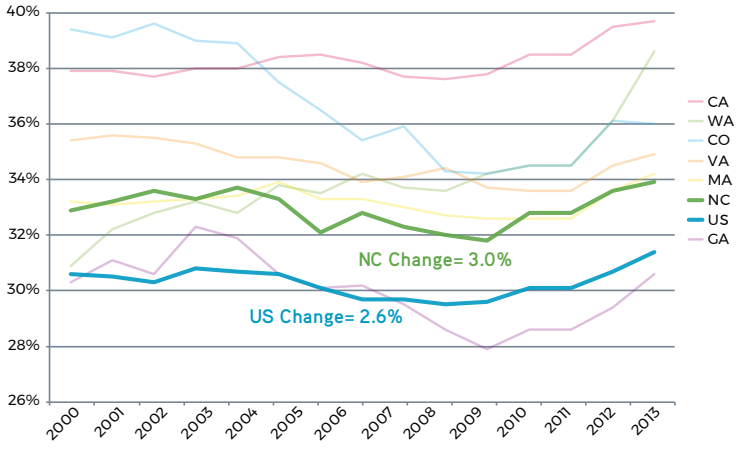
In terms of SET degrees as a percentage of higher education degrees conferred, North Carolina ranks 14th in the nation, with a level that is 108 percent of the U.S. average value and 80 percent of the value of the top-ranking state, Vermont ***[5.5A]***. Relative to the comparison states, North Carolina ranks below all the comparison states except Georgia. From 2000 to 2013, SET degrees as a percentage of higher education degrees conferred in North Carolina increased by 3.0 percent ***[5.5B]***, a rate slightly faster than the rate of increase for the U.S. overall (2.6 percent). North Carolina's rate of increase is less than the rates of increase for Washington and California, but higher than the rates of increase for Massachusetts and Georgia. Colorado's and Virginia's rates decreased.[1]

5.5A *Science, Engineering & Technology Degrees as Percentage of Higher Education Degrees Conferred, All U.S. States, 2013*



Source: National Science Board.

5.5B *Science, Engineering & Technology Degrees as Percentage of Higher Education Degrees Conferred, Comparison States, 2000-2013*



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 2013 represent degrees conferred during the 2012–13 academic year. All degree data are actual counts.*

What Does This Mean for North Carolina?

Irrespective of degree level, educational attainment in SET 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 SET 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 SET fields (see indicator 5.4) suggests that North Carolina's provision of SET 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 SET fields in North Carolina is increasing over time, and this rate of increase is slightly more than the rate of increase for the U.S. overall. That is a positive trend. 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 SET fields.

Indicator 5.6: Educational Attainment

KEY FINDINGS

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

Indicator Overview

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

How Does North Carolina Perform?

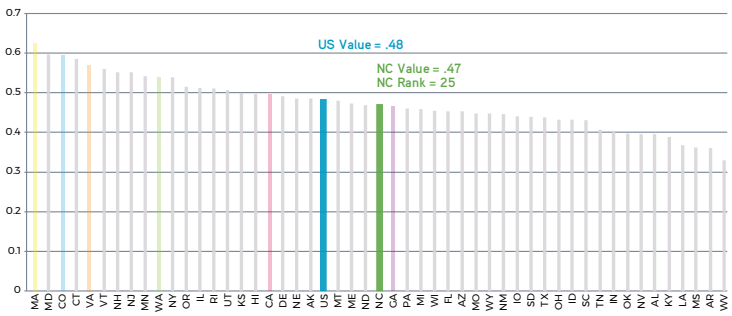
In terms of its educational attainment composite score, North Carolina's value ranks 25th in in the nation, with a level that is 98 percent of the U.S. value and 76 percent of the value of the top-ranking state, Massachusetts ***[5.6A]***. This composite score derives from the following statistics: 13 percent of North Carolina citizens over 25 years of age have not completed high school, 26 percent completed their education with a high school degree, 22 percent completed with a high school degree and have some college experience, 9 percent completed with an associate degree, 19 percent completed with a bachelor's degree, and 11 percent completed with a graduate or professional degree.[1]

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

5.6A

Educational Attainment, All U.S. States, 2015

Weighted measure (composite score) of the education attainment of residents aged 25 years & over

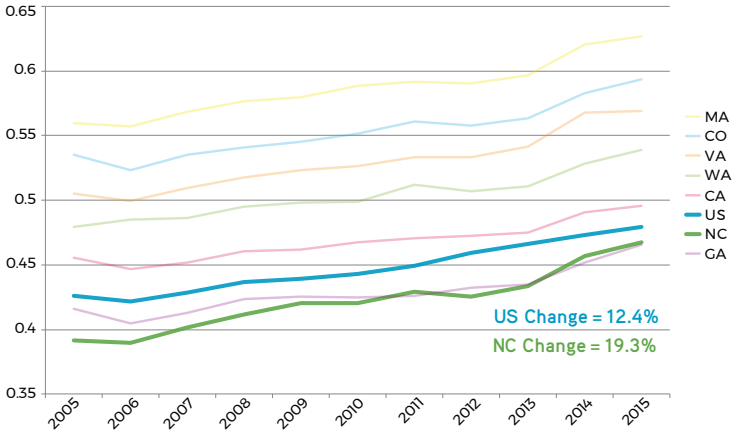


Source: U.S. Census Bureau.

5.6B

Educational Attainment, Comparison States, 2005–2015

Weighted measure (composite score) of the education attainment of residents aged 25 years & over



Source: U.S. Census Bureau.

[1] *Using these statistics and the weighted measure methodology described on the last page of this indicator, North Carolina's composite score for 2015 is calculated as follows .13(-.05) + 26(0) + .22(.25) +. 09(.5) + .19(1) + .11(1.75) = .47 (as shown in charts 5.6a and 5.6b).*

Indicator 5.6: Educational Attainment

states had a higher educational attainment composite score than North Carolina's score.

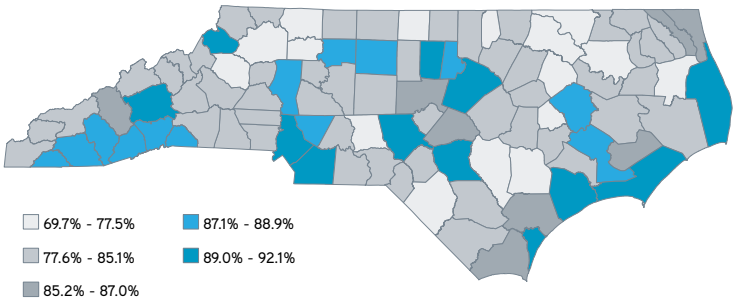
From 2005 to 2013, North Carolina's composite score increased by 19.3 percent, which was slightly greater than the increase for the U.S. average composite score (12.4 percent) and the average of the composite scores for the comparison states (11.4 percent) ***[5.6B]***. It was also greater than the increase for any of the comparison states individually.

Within North Carolina, educational attainment is considerably higher in urban counties (e.g., Mecklenburg, Wake, Guilford) and counties with high numbers of retirees (e.g., Buncombe, Dare, New Hanover), military personnel (e.g., Craven, Cumberland, Onslow), or universities (e.g., Orange, Pitt, Watauga) ***[5.6C, 5.6D]***. Of the state's 100 counties, only 24 have, for residents 25 years and older, a high-school completion rate higher than the U.S. average, 87.1 percent. In terms of the percentage of residents 25 years and over who have completed a bachelor's degree or more education, only 13 counties have a rate higher than the U.S. average, 30.6 percent. For the educational attainment composite score, the pattern is similar but considerably more concentrated ***[5.6E]***. This is because the composite score includes higher levels of educational attainment and places greater weight on those higher attainment levels.

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

5.6C

Percentage of Residents 25 Years & Over Who Have Completed High School or More Education, N.C. Counties, 2011–2015 Estimate

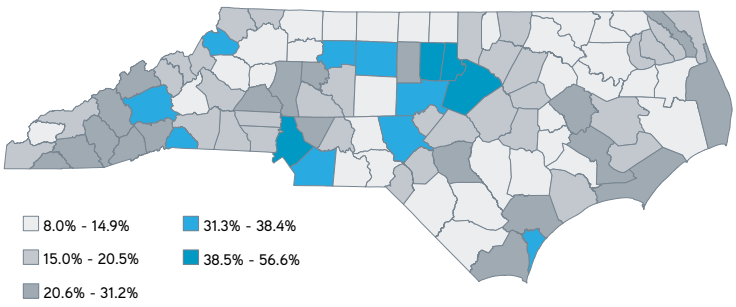


Source: U.S. Census Bureau.

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

5.6D

Percentage of Residents 25 Years & Over Who Have Completed a Bachelor's Degree or More Education, N.C. Counties, 2011–2015 Estimate



Source: U.S. Census Bureau.

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

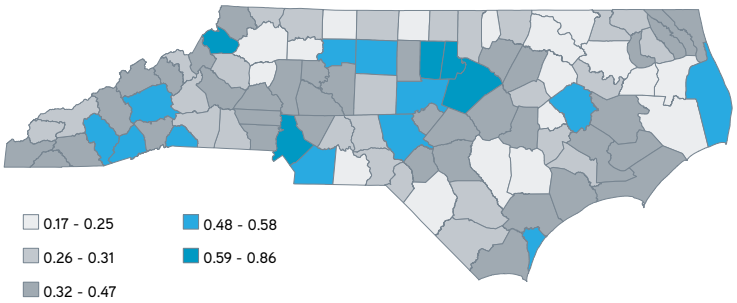
Indicator 5.6: Educational Attainment

What Does This Mean for North Carolina?

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

5.6E

Weighted Measure (composite score) of the Education Attainment of Residents Aged 25 Years & Over, N.C. Counties, 2011–2015 Estimate



Source: U.S. Census Bureau.

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

Methodological Note

The weighted measure (composite score) used in charts 5.6A and 5.6B and map 5.6E 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, master's 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 slightly faster than the U.S. average.
- North Carolina's in-migration of college-educated adults as a percentage of total state population ranks slightly above the U.S. average, has been both above and below the U.S. average in different years since the mid 2000s, and is increasing at a rate much faster than the U.S. average, which is also increasing.
- Within North Carolina, the in-migration of individuals with a bachelor's degree or higher is very concentrated in a small number of counties.

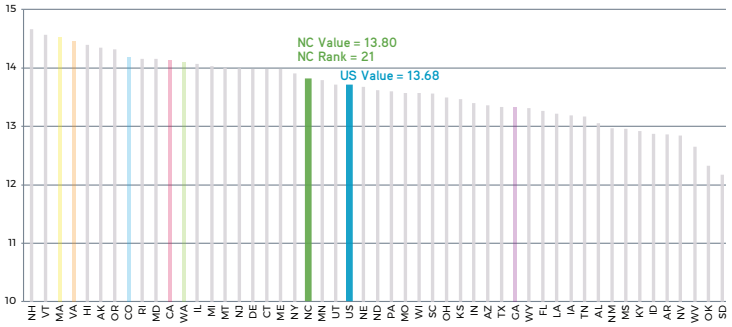
Indicator Overview

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: 1) average years of education among in-migrants, and 2) 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?

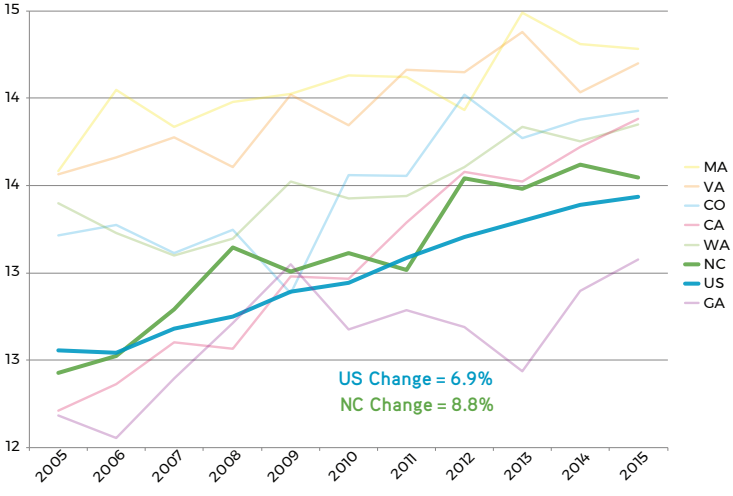
In terms of average years of education among in-migrants, North Carolina ranks 21st in the nation, with a value that is 101 percent of the U.S. average value, and 94 percent of the value of the top-ranking state, New Hampshire ***[5.7A]***. Among the comparison states, only Georgia ranks lower than North Carolina on this measure. From 2005–2015, the average years of education among in-migrants in North Carolina increased by 8.8 percent, which is faster than the 6.9 percent increase for the U.S. overall ***[5.7B]***. North Carolina's rate of increase is slightly less than the rate of increase for California, and slightly faster than the rates for Georgia, Virginia, Massachusetts, Colorado, and Washington.

5.7A *Average Years of Education Among In-Migrants, All U.S. States, 2015*



Source: U.S. Census Bureau.

5.7B *Average Years of Education Among In-Migrants, Comparison States, 2005-2015*



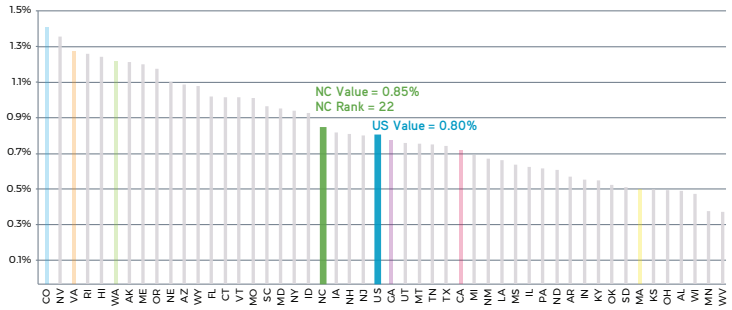
Source: U.S. Census Bureau.

Indicator 5.7: Educational Attainment of In-Migrants

In terms of in-migration of college-educated adults as a percentage of total state population, North Carolina ranks 22nd in the nation, with a value that is 106 percent of the U.S. average value, and 60 percent of the value of the top-ranking state, Delaware ***[5.7C]***. Among the comparison states, California, Massachusetts, and Georgia rank lower than North Carolina on this measure. From 2005–2015, the in-migration of college-educated adults as a percentage of total state population increased by 46.3 percent, whereas the percentage for the U.S. overall increased by 17.6 percent ***[5.7D]***. North Carolina's rate of increase is higher than that of all other comparison states.

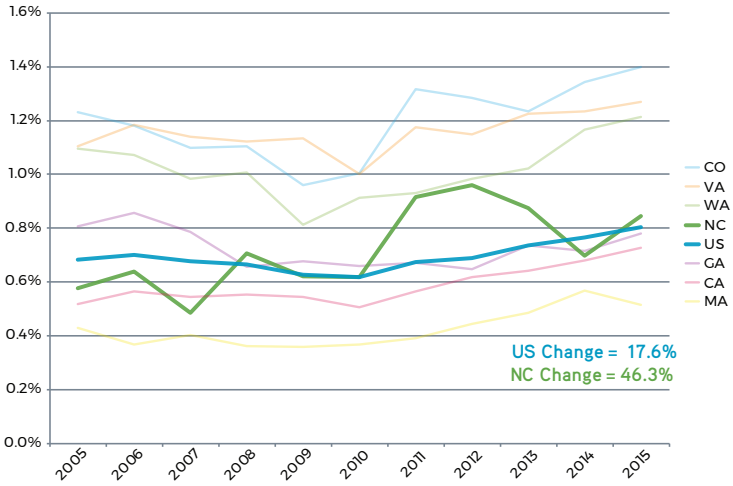
Within North Carolina, the in-migration of individuals with a bachelor's degree or higher is very concentrated in a small number of counties ***[5.7E]***.[1] Two counties combined account for 37.9 percent of the state's in-migrants with a bachelor's degree or higher during 2013—Mecklenburg (20.5%) and Wake (17.4%.). The next eight counties combined—Durham (7.2%), Cumberland (4.6%), Guilford (3.9%), Buncombe (3.9%), Orange (3.9%), Forsyth (3.3%), Onslow (2.4%) and Union (2.1%)—account for another 31.3 percent of the state's in-migrants with a bachelor's degree or higher during 2015. In total, this means that 10 of the state's 100 counties account for slightly more than two-thirds of the state's in-migrants with a bachelor's degree or higher during 2015. The next 9 counties combined—Brunswick (2.1%), New Hanover (2.0%), Henderson (1.7%), Moore (1.6%), Harnett (1.5%), Cabarrus (1.4%), Iredell (1.4%), Pitt (1.3%), and Craven (1.1%)—account for another 14.1 percent of the state's in-migrants with a bachelor's degree or higher during 2015. Each of the remaining 81 counties accounts for less than one percent of the state's in-migrants with a bachelor's degree or higher during 2015, and together they account for 18.2 percent of that in-migration.

5.7C *In-Migration of College Educated Adults as a Percentage of Total State Population, All U.S. States, 2015*



Source: U.S. Census Bureau.

5.7D *In-Migration of College Educated Adults as a Percentage of Total State Population, Comparison States, 2005-2015*



Source: U.S. Census Bureau.

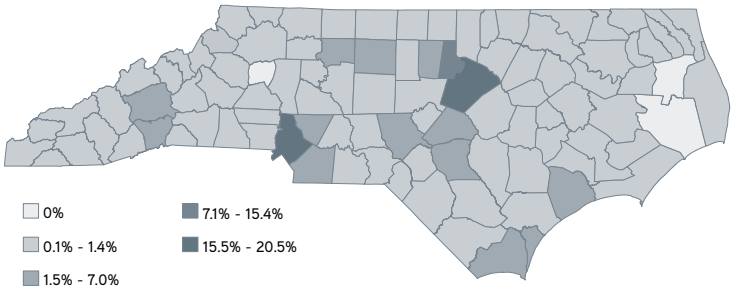
[1] *The percentages presented here are based, for a given county, on the number of in-migrants that have a bachelor's degree or higher and that relocated from another county within the state, a different state, or from a different country in 2015. The trends illustrated in map 5.7E are highly correlated with trends illustrated in map 1.6B and chart 1.6C.*

Indicator 5.7: Educational Attainment of In-Migrants

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 do more to attract highly educated individuals to relocate here. Additionally, a small number of counties accounts for the majority of the state's in-migration of individuals with a bachelor's degree or higher. These findings suggest that the state should work to increase the opportunities for highly educated individuals to relocate from other states and countries. This holds especially true for counties with a low percentage of college-educated in-migrants.

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



Source: U.S. Census Bureau.

Note: The 2016 1-year estimtes do not include all NC counties. 2015 ACS 5-year estimates were used for several counties. Margin of Error estimates are removed from this table.

Indicator 6.1: Public Investment in Education

KEY FINDINGS

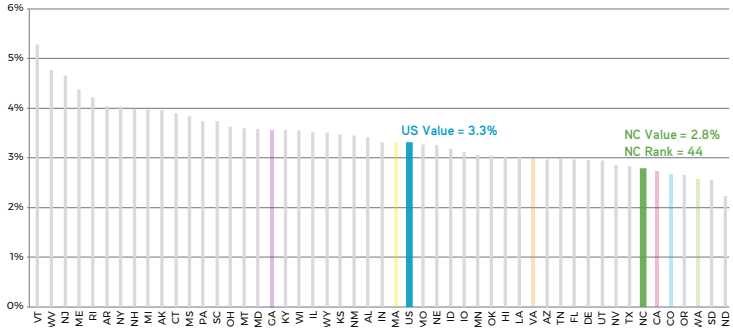
- North Carolina's elementary and secondary public school current expenditures as a percentage of state gross domestic product (GDP) rank well below the U.S. average, have since at least the early 2000s, and are increasing at a rate slower than the U.S. average.
- North Carolina's appropriations of state 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, and are increasing at a rate faster than the U.S. average.
- 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.

6.1A *Elementary & Secondary Public School Current Expenditures as a Percentage of State GDP, All U.S. States, 2012*



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 2012 calendar year in current dollars.*

[2] *Because of decreases in state tax collections in FY 2009-2011, 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. The state monies used to calculate this indicator do not include federal stimulus funds for education stabilization or 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.*

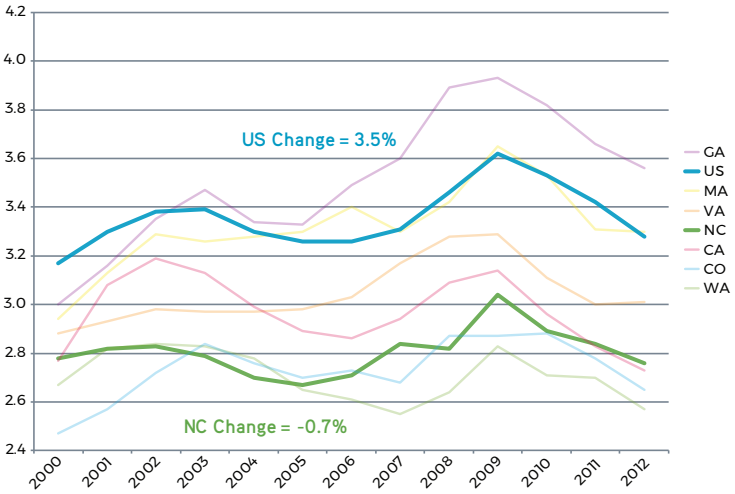
Indicator 6.1: Public Investment in Education

How Does North Carolina Perform?

In terms of the elementary and secondary public school current expenditures as a percentage of state GDP, North Carolina ranks 44th in the nation, with a level that is 85 percent of the U.S. average value and 53 percent of the value of the state with the highest value, Vermont ***[6.1A]***. Of the comparison states, California, Colorado, and Washington spend a lower percentage of their state GDP on elementary and secondary public school current expenses than North Carolina. Among the other comparison states, only Virginia spends a lower percentage of its state GDP on elementary and secondary public school current expenses than the U.S. average. Georgia and Massachusetts spend a relatively higher percentage of their state GDP on elementary and secondary public education, at levels that are higher than the U.S. average. From 2000 to 2012, North Carolina's elementary and secondary public school current expenditures as a percentage of state GDP decreased slightly by -0.7 percent, which is less than the 3.5 percent increase for the U.S. overall ***[6.1B]***. Over this same period, four of the comparison states (Georgia, Massachusetts, Colorado, and Virginia) increased the percentage of their state GDP on elementary and secondary public school current expenses, most by considerably more than North Carolina.

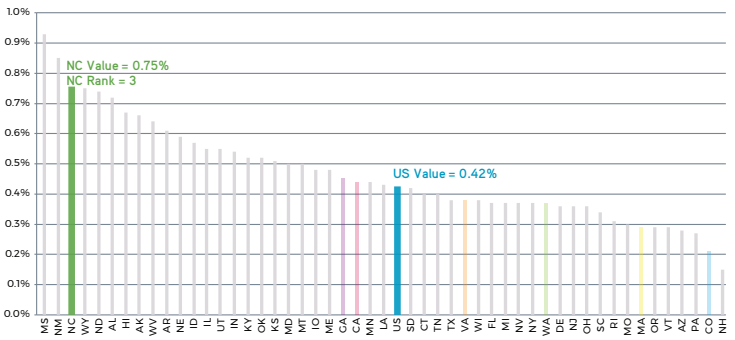
In terms of appropriations of state tax funds for operating expenses of higher education as a percentage of state GDP, North Carolina ranks 3rd in the nation, with a level that is 179 percent of the U.S. average value and 80 percent of the value of the state with the highest value, Mississippi ***[6.1C]***. North Carolina ranks well ahead of all of the comparison states, of which only two—Georgia and California— have percentages above the U.S. average. Each of the four other comparison states—Virginia, Washington, Massachusetts, and Colorado—has a percentage considerably below the U.S. average. From 2000 to 2014, North Carolina's appropriations of state tax funds for operating expenses of higher education as a percentage of state GDP decreased by 8.5 percent, which is smaller than the 16 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 28 percent).

6.1B *Elementary & Secondary Public School Current Expenditures as a Percentage of State GDP, Comparison States, 2000-2012*



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, 2014*



Source: National Science Board.

Indicator 6.1: Public Investment in Education

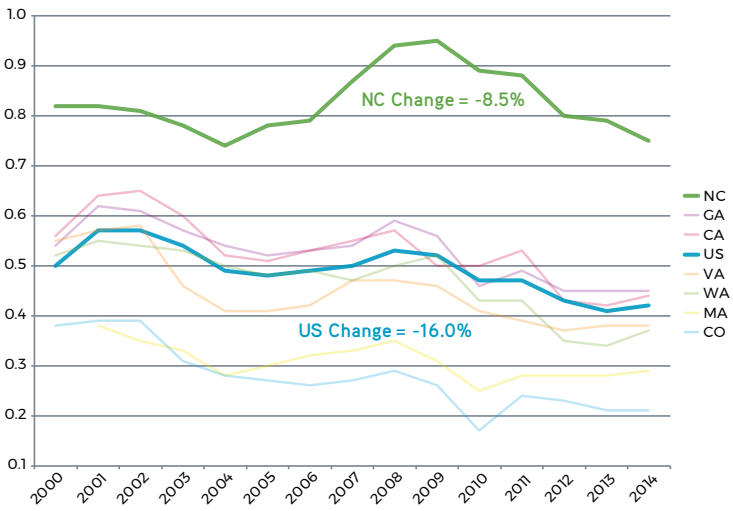
Within North Carolina, the pattern of authorized appropriations for the University of North Carolina (UNC) institutions is highly correlated with the size of the institutions ***[6.1E]***.[4] For example, the three largest institutions together account for nearly 43 percent of total appropriations to UNC institutions—NC State University (19.9 percent), UNC-Chapel Hill (12.7 percent), and UNC-Charlotte (10.5 percent). In contrast, the three smallest institutions together account for 4 percent of total appropriations to UNC institutions—Elizabeth City State University (1.6 percent), NC School of the Arts (1.5 percent), and NC School of Science and Mathematics (1.0 percent).

What Does This Mean for North Carolina?

In general, North Carolina's public investment in education correlates highly with its performance in the other education-related indicators tracked in this report. Specifically, given the state's low ranking on elementary and secondary public school current expenditures as a percentage of state GDP, it isn't surprising that it ranks similarly low in terms of the educational attainment of its residents age 25 and older (see indicator 5.6) and its employment in high-tech establishments as a percentage of total employment (see indicator 4.2), and high in its unemployment rate (see indicator 1.4).[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), employed S&E doctorate holders as a percentage of the workforce (see indicator 5.2), and science, engineering & technology degrees as percentage of total higher education degrees conferred (see indicator 5.5).

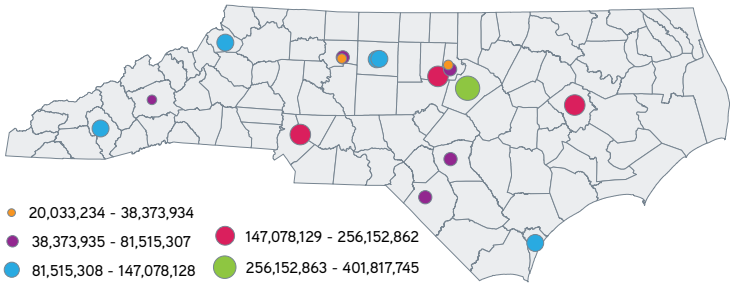
North Carolina's ability to compete in a knowledge- and innovation-driven economy depends critically on the education and training of its workforce at all levels. Given the link between investment in education and related measures of success in education, it is clear that North Carolina should continue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

6.1D *Appropriations of State Tax Funds for Operating Expenses of Higher Education as a Percentage of State GDP, Comparison States, 2000-2014*



Source: National Science Board.

6.1E *Authorized Appropriations, University of North Carolina (UNC) Institutions, FY 2015-2017 Average*



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

Note: These data include only General Fund appropriations, not other funding sources that comprise the UNC system budget. Additionally, the data include only FY 2015-2017 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 ECU.

[4] *Here size is measured by the headcount enrollment in 2015. 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).*

[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. 2016. Science and Engineering Indicators 2016 (Chapter 8, State Indicators).*

Indicator 6.2: Broadband

KEY FINDINGS

- North Carolina's broadband deployment rate ranks slightly above the U.S. average.
- North Carolina's fiber deployment rate ranks significantly below the U.S. average.
- North Carolina's rate of broadband subscription ranks slightly below the U.S. average.
- 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

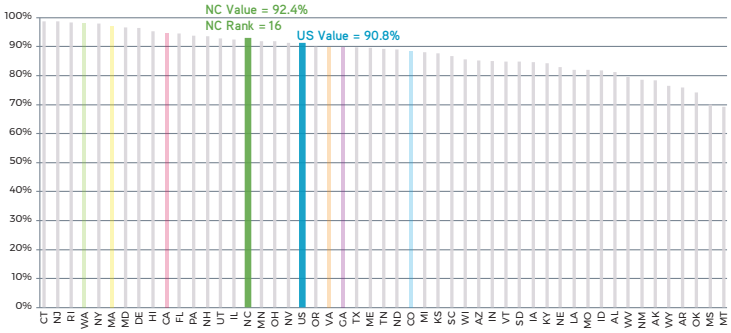
The term "broadband" refers to a range of technologies (e.g., fiber, coax cable, copper, and wireless technologies) that allow for higher capacity and faster data transmission with the Internet. Broadband is a platform for innovation in that using broadband technologies can foster and enable innovation 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 in three ways: (1) deployment rate, (2) the percent of fiber connections to the end user, and (3) subscription rates. The deployment rate measures the basic "supply" level of broadband. It is 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 is presented as a more refined measure of the deployment rate, as fiber technology generally offers the fastest internet connections possible. It is measured here as a percentage of all wireline connections—to the home and businesses. The subscription rate measures the demand for broadband by calculating the number of households purchasing internet subscriptions for their homes.

How Does North Carolina Perform?[1]

At the speed examined, North Carolina's broadband deployment rate (92.4 percent) ranks 16th in the nation[2] and is 102 percent of the U.S. average and 94 percent of the rate of the top-ranking state, Connecticut ***[6.2A]***.[3] Among the comparison states, North Carolina's rate is ahead of those of Virginia, Georgia, and Colorado, but behind those of California, Massachusetts, and Washington.

6.2A *Percent of Population with Broadband Access (Deployment Rate) at 25 Mbps/3 Mbps or Faster, All U.S. States, 2016*



Source: Federal Communications Commission.

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

[2] *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.*

[3] *Source: Data provided to the North Carolina Broadband Infrastructure Office from the Federal Communication's Commission. June 2016.*

Indicator 6.2: Broadband

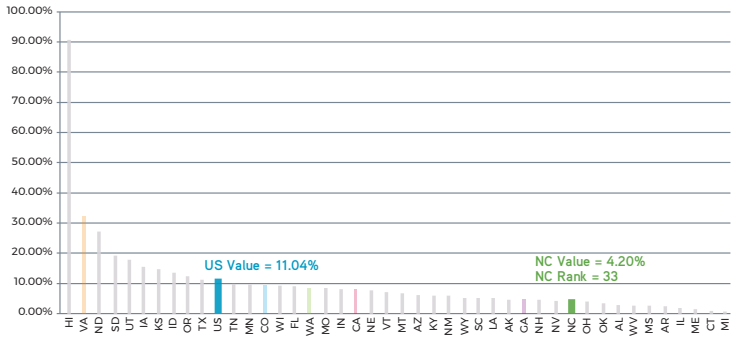
In terms of fiber to the end-user connections as a percentage of all wireline connections, North Carolina ranks considerably lower than the U.S. average and all of the peer states ***[6.2B]***. Its 137,000 fiber-to-the-end-user connections translate to roughly four percent of all wireline connections, ranking it 33rd nationally, with a value that is 38 percent of the U.S. value and 5 percent of the value of the top-ranking state, Hawaii.[4] North Carolina also ranks below all the comparison states for which data are available.[5]

North Carolina's subscription rate, 45 percent at the examined speed threshold, indicates that just under half of North Carolina's households purchase broadband in their homes. The subscription rate is useful in that it gives a clear picture of the number of households with and without service in their homes. North Carolina ranks 23rd nationally, with a value that is 96 percent of the U.S. value and 56 percent of the value of the to-ranking state, New Jersey ***[6.2C]***. North Carolina also ranks lower than all comparison states except for Georgia.[6]

Within North Carolina, 52 of the 100 counties have a household broadband deployment rate at the download speed examined, equal to or above the U.S. average of 90.8 percent ***[6.2D]***[7] Broadband subscription rates by county are not available in NC, but adoption rates (the percent of households subscribing to broadband who have access to it) are. In 2015, when considering all speeds, 23 counties equaled or surpassed the state's average of 74.1 percent adoption.[8]

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

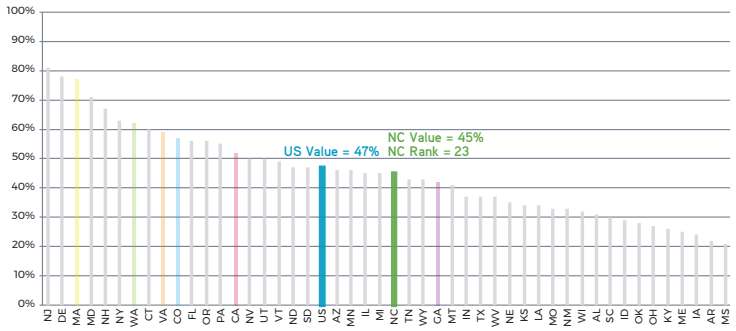
6.2B *Percent of Fiber to the End User Connections of all Wireline Connections, All Reporting U.S. States*, 2016*



Source: Federal Communications Commission.

**43 US States Reported.*

6.2C *Broadband Subscription rate 25Mbps/3Mbps or Faster, All U.S. States*, 2016*



Source: Federal Communications Commission.

**Alaska, Hawaii, and Rhode Island Subscribership Rates Not Reported.*

[4] *Source: FCC. "Internet Access Services: Status as of June 30, 2016". Industry Analysis and Technology Division Wireline Competition Bureau. Accessed September 2017.*

[5] *Data for Massachusetts are not available.*

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

[7] *The county-level deployment rate is measured at download speed only (25 Mbps), instead of the speed combination (download/upload) at which the states and the U.S. are compared.*

[8] *The Adoption data is calculated from American Community Survey data. Most recent calculations are from 2015.*

Indicator 6.2: Broadband

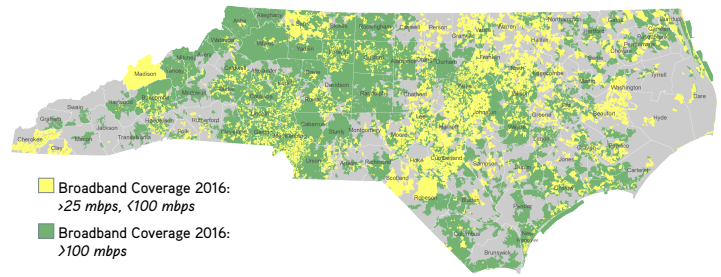
What Does This Mean for North Carolina?

Deployment rates show that much of North Carolina has access to basic broadband. However, roughly 767,000 North Carolinians continue to lack service—92 percent of which live in the state's rural areas.[9] 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, compiled and released "*Connecting North Carolina: State Broadband Plan,*" in 2016.[10] The plan contains over nearly 80 recommendations to promote the expansion of broadband deployment, adoption and reach the State's vision that every North Carolinian should be able to access affordable high-speed internet anywhere, at any time. When fully implemented, the recommendations will lead to an environment where the barriers to the expansion of broadband deployment, adoption and use are reduced and the necessary infrastructure and resources to use it are more widely available.

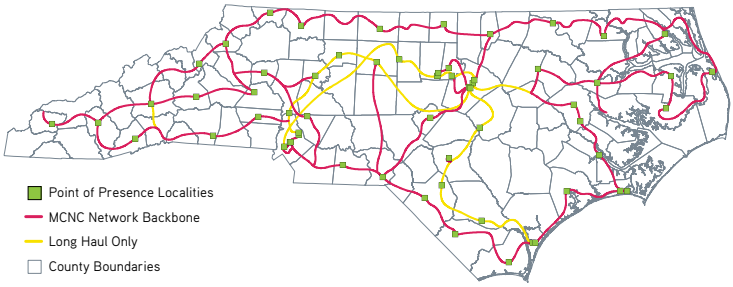
The chief obstacles to effectively harnessing broadband's power as an innovation enabler is the low adoption rate, and the ever-increasing need for higher speeds. Broadband adoption is a complex challenge, with many factors impacting the subscription of wired broadband at home, such as the cost of the service and the device, literacy and digital literacy, availability of other public internet access (such as libraries), and relevancy. 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 *Estimates of Households with Broadband Coverage, N.C. Counties, June 2016*



Source: Fixed Broadband Deployment Data from FCC Form 477, June 2016.

6.2E *MCNC Broadband Fiber Network Statewide, 2017*



Source: MCNC.

[9] *Source: Calculated from data provided to the North Carolina Broadband Infrastructure Office from the Federal Communication's Commission.*

[10] *The Broadband Infrastructure Office, Division of North Carolina Department of Information Technology. Connecting North Carolina: State Broadband Plan. Raleigh, NC. Accessed at: www.ncbroadband.gov/sbp.*

Indicator 6.3: Cost of Living Index

KEY FINDINGS

- North Carolina's Cost of Living Index ranks slightly below the U.S. average, has since at least the early 2000s, and is decreasing at a rate slightly faster than the U.S. average.
- Within North Carolina, the cost of living varies, but only moderately compared to variations nationwide. Approximately one-third of the counties have Cost of Living Index values roughly equal to or moderately higher than the U.S. average. Approximately two-thirds of the counties have Cost of Living Index values equal to or slightly lower than the U.S average.

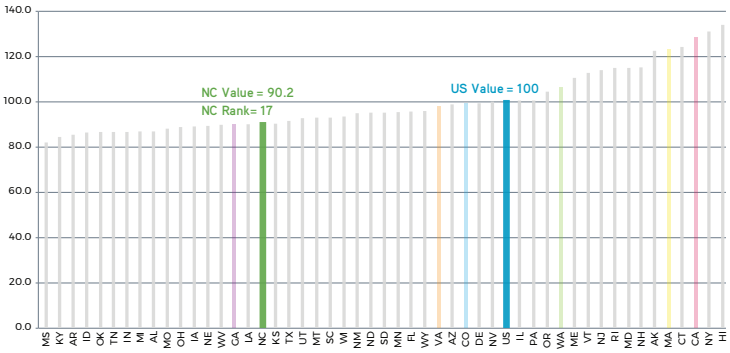
Indicator Overview

This indicator is a price index that compares cost of living differences among urban areas based on the price of consumer goods and services. Specifically, it uses the Cost of Living Index produced quarterly by the Council for Community and Economic Research (C2ER).[2] 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 17th in the nation, with a level that is 90.2 percent of the U.S. average value and 110 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 value lower than North Carolina. Of the comparison states, Colorado, Virginia, and Georgia have cost of living values that are lower than the U.S. average. The Cost of Living Index value for Washington is slightly above the U.S. average, while the values for Massachusetts and California

6.3A *Cost of Living Index, All U.S. States, 2016*



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 6.3c.*

[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 no 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

are considerably above the U.S. average and among the top-10 most expensive states.

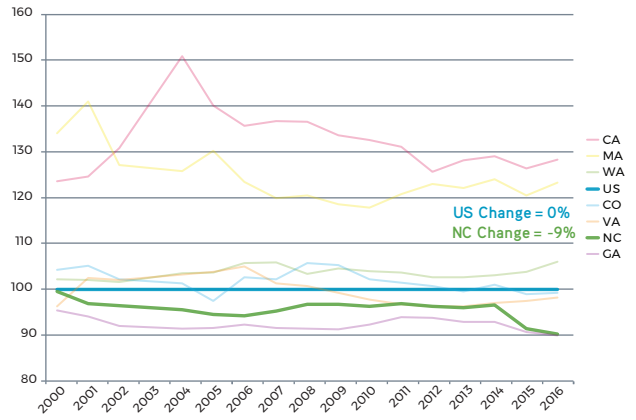
From 2000 to 2016, North Carolina's Cost of Living Index decreased by 9 percent ***[6.3B]***. Over this same period, the index for California, Washington, and Virginia increased and the indexes for Colorado, Georgia, and Massachusetts decreased.

Within North Carolina, the cost of living index varies by county, but only moderately when compared to the variance across all counties nationwide ***[6.3C]***. The NC county indexes range from a high of 108.0 (Mecklenburg county) to a low of 93.4 (Graham County). Historically, county values nationwide range widely, from as high as 188.3 in Kings County, New York to as low as 84.3 in Zapata County, Texas.[4] In total, 23 of North Carolina's 100 counties have a cost of living roughly equal to or higher than the U.S. average. The 77 remaining North Carolina counties have a cost of living lower than the U.S. average.

What Does This Mean for North Carolina?

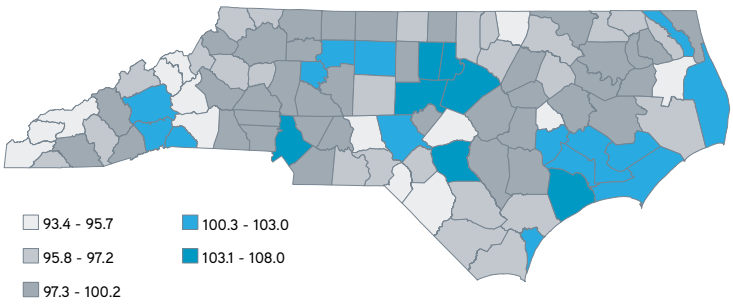
In general, independent of other factors, an affordable, close-to-average cost of living is an advantage for a state or region. A cost of living that is significantly higher than the U.S. average could be unattractive to both employers and employees, as costs for employers could be excessive, and workers may prefer to live in lower-cost areas. Alternatively, a cost of living that is significantly lower than the U.S. average could also be unattractive to both employers and employees, potentially indicating the area has fewer amenities and infrastructure. On average, North Carolina's cost of living is neither excessively high nor overly low. In general, counties with a cost of living slightly above or slightly below the U.S. average are more likely to be the targets for innovative activity, as they are relatively affordable and more likely to possess a good mix of infrastructure, amenities, goods, and services. Those counties with a cost of living that is significantly 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, Comparison States, 2000-2016*



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

6.3C *Cost of Living Index, N.C. Counties, 2016*



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

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

[4] *The standard deviation of the index across all U.S counties is 9.43, meaning at least 68 percent of all U.S. counties would normally be expected to have values within 9.43 points, plus or minus, of 100. At least 95 percent of all U.S. counties would be expected to have values within 18.86 points (two standard deviations) of 100. Values more than two standard deviations away from the average are typically considered statistically significant. None of the NC county indexes are more than one standard deviation away from 100, suggesting that the cost living for any given NC county does not differ dramatically from the U.S. average.*

Indicator 6.4: Industry Mix

KEY FINDINGS

- North Carolina's overall industry mix does not position the state, overall, to be a leader in innovation.
- A large portion of the state's industries and employment is not high technology 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 technology, virtually all have wages well above the U.S. average for all sectors, and slightly more than half are increasing in employment.
- North Carolina's manufacturing GDP as a percentage of state GDP ranks above the U.S. average, has since at least the early 2000s, and is decreasing at a rate slightly faster than the U.S. average.

Indicator Overview

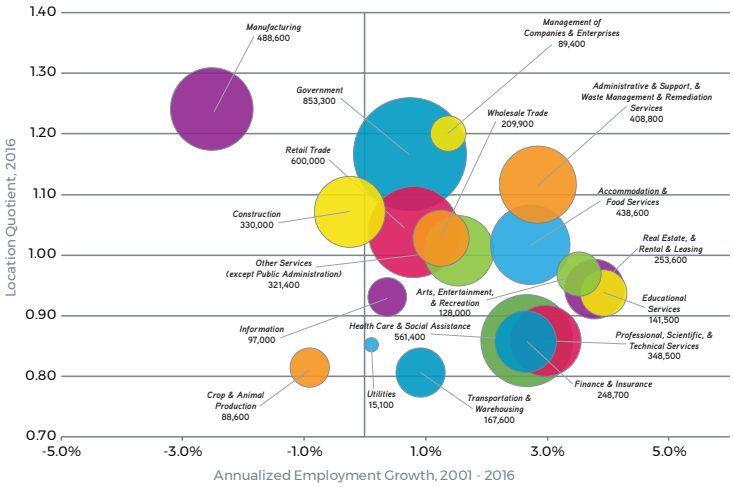
This indicator measures North Carolina's industry mix (i.e., the basic industry composition and trends of North Carolina's economy) in several ways. Industry mix is measured first by detailing—for each major economic sector—four factors:[1] the level of employment, employment change (2001-2016), relative 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., Innovative Organizations in Section 4) and Employment (e.g., Workforce in Section 5).[3]

How Does North Carolina Perform?

In terms of major economic sectors, more than half of North Carolina's employment is in five major economic sectors—Government (14.7%),[4] Retail Trade (10.3%), Health Care and Social Assistance (9.7%), Manufacturing (8.4%),[5] and Accommodation and Food Services (7.6%) ***[6.4A, 6.4B]***.[6] Of these, Government, Health Care and Social Assistance, and Manufacturing have wages above the North Carolina average (see indicator 1.3),[7] and only Manufacturing has a substantial

6.4A

Industry Employment *(bubble size & number),* ***Annualized Employment Growth*** *(horizontal axis),* ***& Concentration*** *(vertical axis),* ***All N.C. Industries***



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

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[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 2007 edition of the North American Industry Classification System (NAICS). See Appendix 2 for a list of the 48 industries (by 4-digit NAICS code) that are defined having high science, engineering & technology (SET) employment.*

[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] *Government excludes federal military.*

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

[6] *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.*

[7] *"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).*

Indicator 6.4: Industry Mix

share of high SET employment industries and employment ***[6.4C, 6.4D]***.[8] The next four sectors—Administrative and Support and Waste Management and Remediation (7.0%), Professional, Scientific, and Technical Services (6.0%), Construction (5.7%), and Other Services (5.5%)—together account for just over 24 percent of all of North Carolina's employment. Of these, only Professional, Scientific, and Technical Services has above-average wages and 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 of the nine sectors comprising approximately three-fourths of North Carolina's employment are lower than the average wages of the 11 sectors comprising approximately one-fourth of North Carolina's employment.

In terms of the sectors' relative concentration, as measured by location quotients, there are four sectors in which North Carolina has a larger share of activity in the industry than we would expect based on national trends—Manufacturing, Management of Companies and Enterprises, Government, and Administrative and Support and Waste

6.4B

Sector Employment, Annualized Employment Growth, Concentration (Location Quotient), & Average Wage, All N.C. Sectors (sorted in descending order by employment)

2-Digit NAICS Code	Industry	Employment					
		Total 2016	Share of Total 2016	Cumulative Share of Total 2016	Annualized Growth Rate (Compound Annual Growth Rate) 2001-2016	Location Quotient 2016	2017 Average Earnings (Rounded)
90	Government	853,300	14.7%	14.7%	0.7%	1.17	$61,600
44	Retail Trade	600,000	10.3%	25.1%	0.8%	1.04	$29,900
62	Health Care and Social Assistance	561,400	9.7%	34.7%	2.6%	0.86	$52,200
31	Manufacturing	488,600	8.4%	43.2%	-2.5%	1.24	$68,500
72	Accommodation and Food Services	438,600	7.6%	50.7%	2.7%	1.02	$19,500
56	Administrative and Support and Waste Management and Remediation Services	408,800	7.0%	57.8%	2.8%	1.11	$32,600
54	Professional, Scientific, and Technical Services	348,500	6.0%	63.8%	3.0%	0.86	$68,300
23	Construction	330,000	5.7%	69.5%	-0.3%	1.07	$46,700
81	Other Services (except Public Administration)	321,400	5.5%	75.0%	1.5%	1.01	$24,900
53	Real Estate and Rental and Leasing	253,600	4.4%	79.4%	3.8%	0.94	$30,500
52	Finance and Insurance	248,700	4.3%	83.7%	2.7%	0.86	$81,800
42	Wholesale Trade	209,900	3.6%	87.3%	1.3%	1.03	$74,600
48	Transportation and Warehousing	167,600	2.9%	90.2%	0.9%	0.81	$48,200
61	Educational Services	141,500	2.4%	92.6%	3.9%	0.94	$37,700
71	Arts, Entertainment, and Recreation	128,000	2.2%	94.8%	3.5%	0.97	$25,100
51	Information	97,000	1.7%	96.5%	0.4%	0.93	$83,900
55	Management of Companies and Enterprises	89,400	1.5%	98.1%	1.4%	1.20	$117,900
11	Crop and Animal Production	88,600	1.5%	99.6%	-0.9%	0.81	$30,100
22	Utilities	15,100	0.3%	99.8%	0.1%	0.85	$122,200
21	Mining, Quarrying, and Oil and Gas Extraction	9,100	0.2%	100.0%	2.2%	0.21	$47,300

Source: QCEW Employees, Non-QCEW Employees, Self-Employed & Extended Proprietors - EMSI 2017.3 Class of Worker.

Note: Excludes NAICS code 99 (Unclassified Industry); Average Wage, and Employment numbers rounded to the nearest hundreds.

[8] *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.*

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

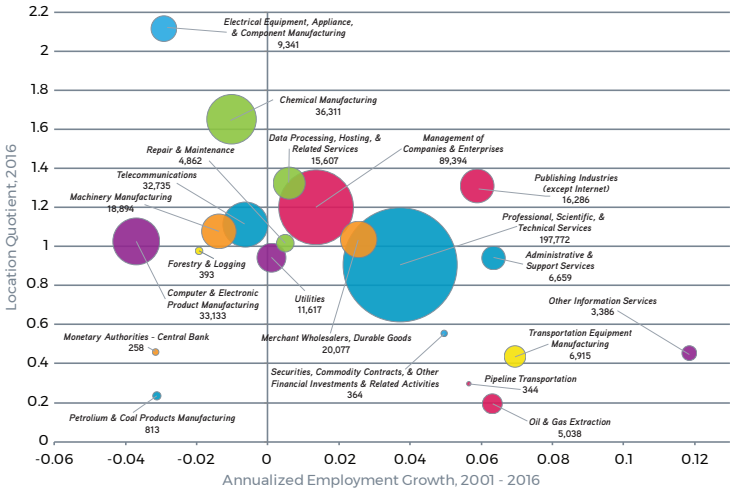
Indicator 6.4: Industry Mix

Management and Remediation Services. Of these, only two sectors—Management of Companies and Enterprises, and Manufacturing—have above-average wages and a substantial share of high SET employment industries. The first of these sectors is growing in employment over time, whereas the other is shrinking in employment over time. Of the sectors in which North Carolina has a smaller share of activity in the industry than we would expect based on national trends, there are three that have above-average wages and a substantial share of high SET employment industries and employment—Professional, Scientific, and Technical Services; Finance and Insurance; and Utilities. All of these are growing in employment over time. In terms of high SET employment industries, more than half (56.3%) of North Carolina's high SET employment is in industries within two subsectors—Professional, Scientific and Technical Services (38.8%) and Management of Companies and Enterprises (17.5%) ***[6.4C, 6.4D]***.[9] In the first subsector—Professional, Scientific and Technical Services—North Carolina has a 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 closest to 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.

The next two subsectors, both focused on manufacturing, together account for 13.6 percent of North Carolina's high SET employment—Chemical Manufacturing (7.1%) and Computer and Electronic Product Manufacturing (6.5%). In each subsector, North Carolina has a larger or slightly larger share of activity than we would expect based on national trends and average wages well above the U.S. average wage for all industries, but employment levels that are decreasing. Within the first subsector—Chemical Manufacturing—North Carolina has a relatively high degree of concentration in all high SET employment industries except Basic Chemical Manufacturing; in the latter subsector—Computer and Electronic Product Manufacturing—North Carolina has a relatively high degree of concentration in all of the high SET employment industries except for Semiconductor and Other Electronic Components Manufacturing. Together,

6.4C

Industry Employment *(bubble size & number),* ***Annualized Employment Growth*** *(horizontal axis),* ***& Concentration*** *(vertical axis),* ***High SET Employment Industries, N.C.***



Source: QCEW Employees, Non-QCEW Employees, Self-Employed & Extended Proprietors - EMSI 2017.3 Class of Worker.

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

Indicator 6.4: Industry Mix

6.4D *Employment & Wages in High SET Employment Industries, N.C.*
(sorted in decending order by number of employees)

NAICS Code	High SET Employment Industry	High SET Employment					
		Total 2016	"Share of Total 2016"	Cumulative Share of Total 2016	Annualized Growth Rate (Compound Annual Growth Rate) 2001-2016	Location Quotient 2016	"Average Wage 2017"
541	Professional, Scientific, and Technical Services	197,800	38.8%	38.8%	3.7%	0.91	$84,322
5416	Management, Scientific, and Technical Consulting Services	70,400	13.8%		5.7%	0.99	$67,716
5415	Computer Systems Design and Related Services	62,200	12.2%		3.9%	0.87	$94,229
5413	Architectural, Engineering, and Related Services	42,400	8.3%		1.0%	0.82	$76,656
5417	Scientific Research and Development Services	22,800	4.5%		4.4%	1.03	$122,822
551	Management of Companies and Enterprises	89,400	17.5%	56.3%	1.4%	1.20	$117,914
5511	Management of Companies and Enterprises	89,400	17.5%		1.4%	1.20	$117,914
325	Chemical Manufacturing	36,300	7.1%	63.4%	-1.0%	1.65	$112,363
3254	Pharmaceutical and Medicine Manufacturing	20,900	4.1%		0.7%	2.38	$126,320
3252	Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments Manufacturing	4,400	0.9%		-5.2%	1.54	$85,333
3251	Basic Chemical Manufacturing	2,900	0.6%		-2.3%	0.64	$101,933
3259	Other Chemical Product and Preparation Manufacturing	3,400	0.7%		-1.2%	1.29	$77,351
3253	Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	2,200	0.4%		-2.6%	1.96	$133,433
3255	Paint, Coating, and Adhesive Manufacturing	2,400	0.5%		0.6%	1.19	$83,755
334	Computer and Electronic Product Manufacturing	33,100	6.5%	69.9%	-3.7%	1.02	$127,891
3345	Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	12,200	2.4%		1.5%	1.00	$132,740
3341	Computer and Peripheral Equipment Manufacturing	10,200	2.0%		-4.0%	2.03	$145,629
3344	Semiconductor and Other Electronic Component Manufacturing	6,500	1.3%		-7.2%	0.58	$98,683
3342	Communications Equipment Manufacturing	2,900	0.6%		-3.0%	1.08	$122,788
3346	Manufacturing and Reproducing Magnetic and Optical Media	600	0.1%		-11.9%	1.21	$123,292
3343	Audio and Video Equipment Manufacturing	700	0.1%		-2.0%	1.05	$79,057
517	Telecommunications	32,700	6.4%	76.3%	-0.6%	1.11	$79,702
5171	Wired Telecommunications Carriers	20,800	4.1%		-0.1%	0.98	$80,533
5172	Wireless Telecommunications Carriers (except Satellite)	6,600	1.3%		0.4%	1.44	$66,901
5179	Other Telecommunications	5,100	1.0%		-3.4%	1.58	$93,174
5174	Satellite Telecommunications	200	0.0%		4.6%	0.58	$73,614
423	Merchant Wholesalers, Durable Goods	20,100	3.9%	80.2%	2.5%	1.03	$104,783
4234	Professional and Commercial Equipment and Supplies Merchant Wholesalers	20,100	3.9%		2.5%	1.03	$104,783
333	Machinery Manufacturing	18,900	3.7%	83.9%	-1.3%	1.08	$80,372
3339	Other General Purpose Machinery Manufacturing	8,000	1.6%		-2.1%	0.99	$85,293
3336	Engine, Turbine, and Power Transmission Equipment Manufacturing	4,600	0.9%		1.0%	1.53	$84,556
3332	Industrial Machinery Manufacturing	4,000	0.8%		-3.1%	1.12	$68,910
3333	Commercial and Service Industry Machinery Manufacturing	2,300	0.5%		1.8%	0.82	$74,786
511	Publishing Industries (except Internet)	16,300	3.2%	87.1%	5.9%	1.31	$129,240
5112	Software Publishers	16,300	3.2%		5.9%	1.31	$129,240
518	Data Processing, Hosting, and Related Services	15,600	3.1%	90.2%	0.6%	1.33	$104,134
5182	Data Processing, Hosting, and Related Services	15,600	3.1%		0.6%	1.33	$104,134

Source: QCEW Employees, Non-QCEW Employees, Self-Employed & Extended Proprietors - EMSI 2017.3 Class of Worker.

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

Indicator 6.4: Industry Mix

6.4D

Employment & Wages in High SET Employment Industries, N.C.
(sorted in decending order by number of employees), continued

NAICS Code	High SET Employment Industry	High SET Employment					
		Total 2016	"Share of Total 2016"	Cumulative Share of Total 2016	Annualized Growth Rate (Compound Annual Growth Rate) 2001-2016	Location Quotient 2016	"Average Wage 2017"
221	Utilities	11,600	2.3%	92.5%	0.1%	0.94	$134,754
2211	Electric Power Generation, Transmission and Distribution	11,600	2.3%		0.1%	0.94	$134,754
335	Electrical Equipment, Appliance, and Component Manufacturing	9,300	1.8%	94.3%	-2.9%	2.11	$85,510
3353	Electrical Equipment Manufacturing	9,300	1.8%		-2.9%	2.11	$85,510
336	Transportation Equipment Manufacturing	6,900	1.4%	95.6%	6.9%	0.43	$110,878
3364	Aerospace Product and Parts Manufacturing	6,200	1.2%		6.8%	0.42	$115,374
3369	Other Transportation Equipment Manufacturing	700	0.1%		8.4%	0.63	$73,194
561	Administrative and Support Services	6,700	1.3%	97.0%	6.4%	0.94	$59,099
5612	Facilities Support Services	4,500	0.9%		6.7%	0.83	$52,913
561312	Executive Search Services	2,100	0.4%		5.8%	1.35	$72,160
211	Oil and Gas Extraction	5,000	1.0%	97.9%	6.3%	0.19	$36,211
2111	Oil and Gas Extraction	5,000	1.0%		6.3%	0.19	$36,211
811	Repair and Maintenance	4,900	1.0%	98.9%	0.5%	1.01	$64,997
8112	Electronic and Precision Equipment Repair and Maintenance	4,900	1.0%		0.5%	1.02	$64,997
519	Other Information Services	3,400	0.7%	99.6%	11.8%	0.45	$63,145
519130	Internet Publishing and Broadcasting and Web Search Portals	3,400	0.7%		11.8%	0.45	$63,145
324	Petroleum and Coal Products Manufacturing	800	0.2%	99.7%	-3.1%	0.23	$103,293
3241	Petroleum and Coal Products Manufacturing	800	0.2%		-3.1%	0.23	$103,293
113	Forestry and Logging	400	0.1%	99.8%	-1.9%	0.98	$62,880
1131	Timber Tract Operations	200	0.0%		-2.2%	0.81	$59,808
1132	Forest Nurseries and Gathering of Forest Products	200	0.0%		-1.6%	1.32	$66,629
523	Securities, Commodity Contracts, and Other Financial Investments and Related Activities	400	0.1%	99.9%	5.0%	0.55	$75,343
5232	Securities and Commodity Exchanges	400	0.1%		5.0%	0.55	$75,343
486	Pipeline Transportation	300	0.1%	99.9%	5.6%	0.30	$96,993
4869	Other Pipeline Transportation	300	0.1%		5.7%	0.94	$99,373
4862	Pipeline Transportation of Natural Gas	100	0.0%		5.5%	0.10	$90,176
4861	Pipeline Transportation of Crude Oil	<10			--	--	--
521	Monetary Authorities-Central Bank	300	0.1%	100.0%	-3.2%	0.46	$118,643
5211	Monetary Authorities-Central Bank	300	0.1%		-3.2%	0.46	$118,643
Total		506,400					

Source: QCEW Employees, Non-QCEW Employees, Self-Employed & Extended Proprietors - EMSI 2017.3 Class of Worker.

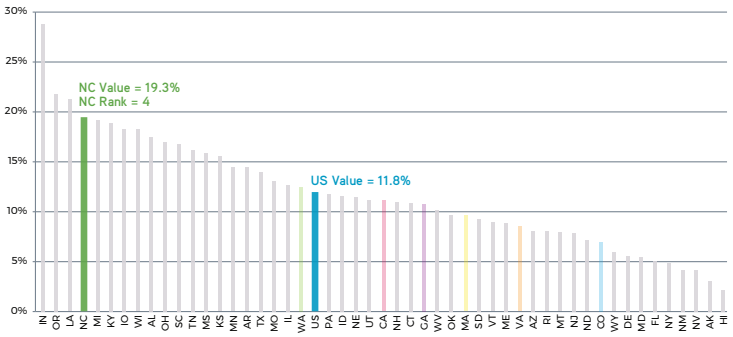
Note: Average wage and employment numbers rounded to the nearest hundreds.

Indicator 6.4: Industry Mix

these first four subsectors account for more than two-thirds (69.9%) of North Carolina's high SET industry employment.[10] Adding the next three subsectors brings the total to 83.9 percent of North Carolina's high SET industry employment—Telecommunications (6.4%), Merchant Wholesalers, Durable Goods (3.9%), and Machinery Manufacturing (3.7%). In each subsector, North Carolina's share of activity is consistent with what we would expect, based on national trends, except for Telecommunications, which is more concentrated. Average wages are well above the U.S. average wage for all industries. Two of the subsectors—Telecommunications and Machinery Manufacturing—have decreasing employment levels, whereas the Merchant Wholesalers, Durable Goods subsector has increasing employment levels. Within the first subsector—Telecommunications—North Carolina has a relatively high degree of concentration in all the high SET employment industries except Satellite Telecommunications. Within the second subsector—Merchant Wholesalers, Durable Goods—North Carolina's activity level is slightly above the U.S. level. Within the third subsector—Machinery Manufacturing—North Carolina has a relatively high degree of concentration in half of the high SET employment industries and a relatively low degree of concentration in the other half. The 14 remaining subsectors together account for 16.1 percent of North Carolina's high SET industry employment.

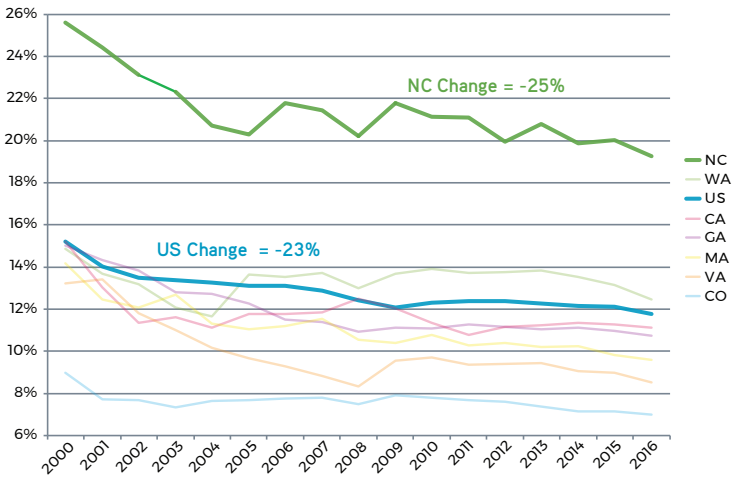
In terms of manufacturing GDP as a percentage of state GDP, North Carolina ranks 4th in the nation, with a level that is 164 percent of the U.S. average value and 67 percent of the value of the state with the highest value, Indiana ***[6.4E]***. North Carolina ranks well ahead of all the comparison states, most of which have values lower than the U.S. average. From 2001 to 2016, the percentage of North Carolina's GDP accounted for by manufacturing decreased significantly, by 25 percent, which is greater than the decrease for the U.S. overall, 22 percent, and for all comparison states except Colorado and Washington ***[6.4F]***.

6.4E *Manufacturing GDP as Percentage of State GDP, All U.S. States, 2016*



Source: U.S. Bureau of Economic Analysis.

6.4F *Manufacturing Percentage of State GDP, Comparison States, 2000-2016*



Source: U.S. Bureau of Economic Analysis.

What Does This Mean for North Carolina?

North Carolina's overall industry mix does not position the state, overall, to be a leader in innovation. Specifically, as summarized in indicators 4.1 (High SET Employment Establishments) and 4.2 (Employment in High SET

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

Indicator 6.4: Industry Mix

Establishments) and illustrated in more detail here, a large portion of the state's industries and employment is not high tech in nature and, therefore, less likely to produce the types of innovations that drive growth, employment, and higher wages in the economy. Among the small number of sectors that are defined as having SET employment, however, virtually all have wages well above the U.S. average for all sectors, and slightly more than half are increasing in employment.[11]

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.[12] 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).[13]

Within North Carolina, only 22 percent of the manufacturing jobs are currently in high SET employment industries.[14] Given the importance and impact of high SET manufacturing, and given that manufacturing establishments perform 68 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:

$$\frac{\text{Employment Industry i, NC}}{\text{(Total Employment, NC)}} \div \frac{\text{Employment Industry i, US}}{\text{(Total Employment, US)}}$$

[11] *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.*

[12] *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).*

[13] *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).*

[14] *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 (105,300) by the total number of manufacturing jobs (488,600) in table 6.4B.*

High Science, Engineering & 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. For data years up through 2008, the 2002 NAICS codes were used to define business establishments. Subsequent data years reflect the use of the 2007 NAICS codes. The list of high SET employment industries used in this report includes the 48 four-digit codes from the NAICS listing below.

NAICS code	2007 NAICS code	Industry
1131	1131	Timber track operations
1132	1132	Forest nurseries and gathering of forest products
2111	2111	Oil and gas extraction
2211	2211	Electric power generation, transmission, and distribution
3241	3241	Petroleum and coal products manufacturing
3251	3251	Basic chemical manufacturing
3252	3252	Resin, synthetic rubber, and artificial synthetic fibers and filaments manufacturing
3253	3253	Pesticide, fertilizer, and other agricultural chemical manufacturing
3254	3254	Pharmaceutical and medicine manufacturing
3255	3255	Paint, coating, and adhesive manufacturing
3259	3259	Other chemical product and preparation manufacturing
3332	3332	Industrial machinery manufacturing
3333	3333	Commercial and service industry machinery manufacturing
3336	3336	Engine, turbine, and power transmission equipment manufacturing
3339	3339	Other general purpose machinery manufacturing
3341	3341	Computer and peripheral equipment manufacturing
3342	3342	Communications equipment manufacturing
3343	3343	Audio and video equipment manufacturing
3344	3344	Semiconductor and other electronic component manufacturing
3345	3345	Navigational, measuring, electromedical, and control instruments manufacturing
3346	3346	Manufacturing and reproducing magnetic and optical media
3353	3353	Electrical equipment manufacturing
3364	3364	Aerospace product and parts manufacturing
3369	3369	Other transportation equipment manufacturing
4234	4234	Professional and commercial equipment and supplies, merchant wholesalers
4861	4861	Pipeline transportation of crude oil
4862	4862	Pipeline transportation of natural gas
4869	4869	Other pipeline transportation
5112	5112	Software publishers
5161	na	Internet publishing and broadcasting
na	519130	Internet publishing and broadcasting and Web search portals
5171	5171	Wired telecommunications carriers
5172	5172	Wireless telecommunications carriers (except satellite)
5173	na	Telecommunications resellers
5174	5174	Satellite telecommunications
5179	5179	Other telecommunications
5181	na	Internet service providers and Web search portals
5182	5182	Data processing, hosting, and related services
5211	5211	Monetary authorities, central bank
5232	5232	Securities and commodity exchanges
5413	5413	Architectural, engineering, and related services
5415	5415	Computer systems design and related services
5416	5416	Management, scientific, and technical consulting services
5417	5417	Scientific research and development services
5511	5511	Management of companies and enterprises
5612	5612	Facilities support services
na	561312	Executive search services
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 Per Capita Real GDP by State dataset, U.S. Bureau of Economic Analysis (BEA), U.S. Department of Commerce, accessed September 1, 2017, https://www.bea.gov/iTable/index_regional.cfm. National-level GDP data are from the World Bank, GDP Per Capita dataset, accessed November 13, 2017, http://databank.worldbank.org/data/home.aspx. MSA-level GDP data are from the Per Capita Real GDP by Metro Area dataset, U.S. Bureau of Economic Analysis (BEA), U.S. Department of Commerce, accessed September 1, 2017, https://www.bea.gov/iTable/index_regional.cfm. Over-time data are adjusted for inflation using the BEA's GDP deflator.

1.2: Income

State-level per-capita income data are from the U.S. Bureau of Economic Analysis (BEA), U.S. Department of Commerce, Per Capita Personal Income dataset, accessed September 8, 2017, http://www.bea.gov/iTable/index_regional.cfm. State-level median household income data are from the U.S. Census Bureau, American Community Survey, Median Income in the Last 12 Months dataset, 1-Year Estimates, accessed September 8, 2017, http://www.census.gov/acs/www/. County-level median household income data are from the U.S. Census Bureau, American Community Survey, Median Income in the Last 12 Months dataset, 5-Year Estimates, accessed September 8, 2017, http://www.census.gov/acs/www/. Over-time data are adjusted for inflation using the Bureau of Labor Statistics (BLS), U.S. Department of Labor, Consumer Price Index (CPI).

[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.*

1.3: 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 October 10, 2017, http://www.bls.gov/cew/datatoc.htm. Over-time data are adjusted for inflation using the BLS Consumer Price Index (CPI).

1.4: Unemployment

State and county-level unemployment data are from the Bureau of Labor Statistics (BLS), U.S. Department of Labor, Local Area Unemployment Statistics, Multi-Screen Data Search, Unemployment Rates, accessed September 14, 2017, http://data.bls.gov/cgi-bin/dsrv?la. National-level unemployment data are from the International Labour Organization, Key Indicators of the Labour Market database, Unemployment, total (% of total labor force) (modeled ILO estimate), as provided by the World Bank, accessed August 29, 2017, http://data.worldbank.org/indicator.

1.5: Poverty

State-level poverty data are from the U.S. Census Bureau, American Community Survey, Poverty Status in the Last 12 Months dataset, 1-Year Estimates, accessed September 19, 2017, http://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml. County-level poverty data are from the U.S. Census Bureau, American Community Survey, Poverty Status the Last 12 Months dataset, 5-Year Estimates, accessed September 19, 2017, http://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml.

1.6: Population Growth

State-level 2016 population data are from the U.S. Census Bureau, Population Division, Current Estimates Data, Annual Estimates of the Resident Population for the United States, Regions, States, and Puerto Rico: April 1, 2010 to July 1, 2016, accessed August 22, 2017, https://www.census.gov/data/datasets/2016/demo/popest/nation-total.html. State-level 2000 population data are from the U.S. Census Bureau, Resident Population of the 50 States, the District of Columbia, and Puerto Rico: Census 2000, accessed August 22, 2017, https://www.census.gov/population/www/cen2000/maps/respop.html. County level population data are from the U.S. Census Bureau, Population Division, Annual Estimates of the Resident Population for Counties: April 1, 2010 to July 1, 2016, accessed August 22, 2017, https://www2.census.gov/programs-surveys/popest/datasets/2010-2016/counties/totals/.

2.1: Total Research & Development (R&D)

State-level total R&D data are from the National Science Board, Science and Engineering Indicators 2016, 8-39: R&D as a Percentage of Gross Domestic Product (Percent) dataset, accessed January 12, 2017, https://www.nsf.gov/statistics/2016/nsb20161/#/singleind/39/M. National-level total R&D data are from the World Bank, Research & Development Expenditure (% of GDP) dataset, accessed August 24, 2017, http://databank.worldbank.org/data/home.aspx. Business-level R&D data are an approximation based on mapping the location of all manufacturing establishments in North Carolina, as provided by the Bureau of Labor Statistics (BLS), U.S. Department of Labor, Quarterly Census of Employment and Wages dataset, as provided by the Demand Driven Data Delivery (D4) System, North American Industry Classification (NAICS) codes 31-33 (Manufacturing), Annual by County, accessed November 15, 2017, http://d4.nccommerce.com/QCEWSelection.aspx. University-level R&D data are from the National Science Foundation, National Center for Science and Engineering Statistics, Table 21: Higher Education R&D Expenditures by Source of Funds dataset, accessed August 24, 2017, https://ncsesdata.nsf.gov/herd/2016/html/HERD2016_DST_21.html.

National Science Board. 2016. Science and Engineering Indicators 2016. Arlington, VA: National Science Foundation (NSB-2016-1). Chapter 4, "Research and Development: National Trends and International Comparisons." Available at: https://www.nsf.gov/statistics/2016/nsb20161/#/downloads/report.

2.2: Business-Performed R&D

State-level business-performed R&D data are from the National Science Board, Science and Engineering Indicators 2016, 8-43: Business-Performed R&D as a Percentage of Private-Industry Output dataset, accessed January 17, 2017, https://www.nsf.gov/statistics/2016/nsb20161/#/singleind/43/T. Business-level R&D data are an approximation based on mapping the location of all manufacturing establishments in North Carolina, as provided by the Bureau of Labor Statistics (BLS), U.S. Department of

Labor, Quarterly Census of Employment and Wages dataset, as provided by the Demand Driven Data Delivery (D4) System, North American Industry Classification (NAICS) codes 31-33 (Manufacturing), Annual by County, accessed November 15, 2017, http://d4.nccommerce.com/QCEWSelection.aspx.

National Science Board, 2016, Science and Engineering Indicators 2016.

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 2016, 8-44: Academic Science and Engineering R&D per $1,000 of Gross Domestic Product dataset, accessed May 7,2017, https://www.nsf.gov/statistics/2016/nsb20161/#/singleind/44/M. University-level R&D data are from the National Science Foundation, National Center for Science and Engineering Statistics, Higher Education R&D Expenditures by Source of Funds dataset, Table 21, accessed August 24, 2017, https://ncsesdata.nsf.gov/herd/2016/html/HERD2016_DST_21.html.

National Science Board, 2016, Science and Engineering Indicators 2016.

2.4: Federal R&D

State-level federal R&D obligations data are from the National Science Board, Science and Engineering Indicators 2016, 8-40: Federal R&D Obligations per Employed Worker dataset, accessed January 25, 2017, https://www.nsf.gov/statistics/2016/nsb20161/#/singleind/40/M.

2.5: Academic Articles

State-level academic articles data are from the National Science Board, Science and Engineering Indicators 2016, 8-46: Academic Science and Engineering Article Output per 1,000 S&E Doctorate Holders in Academia dataset, accessed January 27, 2017, https://www.nsf.gov/statistics/2016/nsb20161/#/singleind/46/M. County-level academic articles data are from Scopus, Elsevier, accessed November 28, 2016, 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 2016, 8-53: Average Annual Federal Small Business Innovation Research and Small Business Technology Transfer Funding per $1 Million of Gross Domestic Product, accessed June 6, 2017, https://www.nsf.gov/statistics/2016/nsb20161/#/singleind/53/M. State-level STTR data are from SBIR.gov, Awards Search, accessed June 6, 2017, https://www.sbir.gov/sbirsearch/award/all. City, county, and ZIP Code-level SBIR and STTR data are from SBIR.gov, Awards Search, accessed June 6, 2017, 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 2016, 8-48: Academic Patents Awarded per 1,000 Science and Engineering Doctorate Holders in Academia dataset, accessed April 12, 2017, https://www.nsf.gov/statistics/2016/nsb20161/#/singleind/48/M. University-level academic patents data are from the Association of University Technology Managers (AUTM), FY 2015 Licensing Survey, accessed August 4, 2017, http://www.autm.net/resources-surveys/research-reports-databases/licensing-surveys/.

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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.

3.3: Patents

State-level patents data are from the National Science Board, Science and Engineering Indicators 2016, 8-49: Patents Awarded per 1,000 individuals in Science and Engineering Occupations dataset, accessed April 21, 2017, https://www.nsf.gov/statistics/2016/nsb20161/#/singleind/49/M. National-level patents data are from the World Intellectual Property Organization (WIPO) IP Statistics Data Center, Grant for Direct Applications, accessed September 3, 2017, http://ipstats.wipo.int/ipstatv2/index.htm?tab=patent. National-level GDP data are from the World Bank, GDP (Current, US$) dataset, accessed August 24, 2017, http://databank.worldbank.org/data/home.aspx. State-level GDP data are from the Per Capita Real GDP by State dataset, U.S. Bureau of Economic Analysis (BEA), U.S. Department of Commerce, accessed August 17, 2015, http://www.bea.gov/regional/. County-level patents data are from the U.S. Patent and Trademark Office (USPTO), U.S. State Patenting, Breakout by Regional Component, Count of 2000-2015 Utility Patent Grants, As Distributed By Calendar Year of Grant, accessed September 26, 2017, https://www.uspto.gov/web/offices/ac/ido/oeip/taf/countyall/nc_county_gd.htm.

3.4: Venture Capital

State-level venture capital data are from the National Science Board, Science and Engineering Indicators 2016, 8-56: Venture Capital Disbursed per $1,000 of Gross Domestic Product dataset, accessed April 28, 2017, https://www.nsf.gov/statistics/2016/nsb20161/#/singleind/56/M and 8-57: Venture Capital Deals as a Percentage of High-Technology Business Establishments dataset, April 28, 2017, https://www.nsf.gov/statistics/2016/nsb20161/#/singleind/57/M. ZIP Code-level venture capital data are from PitchBook Data, Inc., accessed August 22, 2017, http://pitchbook.com/.

3.5: Technology License Income

State and university-level license income data are from the Association of University Technology Managers (AUTM), FY 2015 Licensing Survey, accessed August 4, 2017, http://www.autm.net/resources-surveys/research-reports-databases/licensing-surveys/. Academic science & engineering R&D data are from the National Science Board, Science and Engineering Indicators 2016, 8-44: Academic Science and Engineering R&D per $1,000 of Gross Domestic Product dataset, accessed May 7,2017, https://www.nsf.gov/statistics/2016/nsb20161/#/singleind/44/M.

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3.6: University Startups

University startup data are from the Association of University Technology Managers (AUTM), FY 2015 Licensing Survey, accessed August 4, 2017, http://www.autm.net/resources-surveys/research-reports-databases/licensing-surveys/. State-level academic science & engineering R&D data are from the National Science Board, Science and Engineering Indicators 2016, 8-44: Academic Science and Engineering R&D per $1,000 of Gross Domestic Product dataset, accessed May 7,2017, https://www.nsf.gov/statistics/2016/nsb20161/#/singleind/44/M.

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

State-level high SET employment establishments data are from the National Science Board, Science and Engineering Indicators 2016, 8-50: High SET Employment Establishments as a Percentage of All Business Establishments dataset, accessed May 2, 2017, https://www.nsf.gov/statistics/2016/nsb20161/#/singleind/50/M. State-level high SET Employment Business Formations data are from the National Science Board, Science and Engineering Indicators 2016, 8-51: Net High SET Employment Business Formations as a Percentage of All Business Establishments dataset, accessed May 5, 2017, https://www.nsf.gov/statistics/2016/nsb20161/#/singleind/51/M. 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 24,

2017, http://www.bls.gov/cew/datatoc.htm. The data pertaining to establishments are based on their classification according to the 2007 edition of the North American Industry Classification System (NAICS). See the Appendix for a list of the 48 industries (by 4-digit NAICS code) that are defined as having high SET employment.

4.2: High SET Employment

State-level high SET employment data are from the National Science Board, Science and Engineering Indicators 2016, 8-52: Employment in High SET Employment Establishments as a Percentage of Total Employment dataset, accessed May 9, 2017, https://www.nsf.gov/statistics/2016/nsb20161/#/singleind/52/M. 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 24, 2017, http://www.bls.gov/cew/datatoc.htm, http://www.bls.gov/cew/datatoc.htm. The data pertaining to establishments are based on their classification according to the 2007 edition of the North American Industry Classification System (NAICS). See the Appendix for a list of the 48 industries (by 4-digit NAICS code) that are defined as having high SET employment.

4.3: Entrepreneurial Activity

State-level entrepreneurial activity data are from the Kauffman Foundation, Kauffman Index of Entrepreneurial Activity, accessed June 19, 2017, http://www.kauffman.org/kauffman-index/about/kiea-microdata. State-level opportunity share of new entrepreneurs data are from the Kauffman Foundation, Kauffman Index of Entrepreneurial Activity, accessed June 19, 2017, http://www.kauffman.org/kauffman-index/about/kiea-microdata.

4.4: Exports

State-level export data are from the World Institute for Strategic Economic Research (WISER), WISERTrade, State Exports by NAICS database, purchased on July 14, 2017, http://www.wisertrade.org/home/portal/index.jsp. State-level GDP data are from the Per Capita Real GDP by State dataset, U.S. Bureau of Economic Analysis (BEA), U.S. Department of Commerce, accessed September 1, 2017, https://www.bea.gov/iTable/index_regional.cfm. National-level export data are from the World Bank, Exports of Goods and Services (% of GDP) dataset, accessed August 2, 2017, http://databank.worldbank.org/data. National-level GDP data are from the World Bank, GDP Per Capita dataset, accessed August 2, 2017, http://databank.worldbank.org/data/.

Riker, David. July 2010. "Do Jobs in Export Industries Still Pay More? And Why?" Manufacturing and Services Economics Brief. United States Department of Commerce: International Trade Administration. Available at: https://www.trade.gov/mas/ian/build/groups/public/@tg_ian/documents/webcontent/tg_ian_003208.pdf.

5.1: Science & Engineering Workforce

State-level science and engineering workforce data are from the National Science Board, Science and Engineering Indicators 2016, 8-31: Individuals in Science and Engineering Occupations as a Percentage of All Occupations dataset, accessed May 29, 2017, https://www.nsf.gov/statistics/2016/nsb20161/#/singleind/31/M.

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 2016, 8-32: Employed Science, Engineering and Health Doctorate Holders as a Percentage of the Workforce dataset, accessed May 25, 2017, https://www.nsf.gov/statistics/2016/nsb20161/#/singleind/32/M.

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 2016, 8-37: Engineers as a Percentage of All Occupations dataset, accessed May 26, 2017, https://www.nsf.gov/statistics/2016/nsb20161/#/singleind/37/M.

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 2016, 8-18: Bachelor's Degrees in Science, Engineering and Technology Conferred per 1,000 Individuals 18–24 Years Old dataset, accessed May 17, 2017, https://www.nsf.gov/statistics/2016/nsb20161/#/singleind/18/M.

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 2016, 8-19: Science, Engineering, and Technology Degrees as a Percentage of Higher Education Degrees Conferred dataset, accessed May 19, 2017, https://www.nsf.gov/statistics/2016/nsb20161/#/singleind/19/M.

5.6: Educational Attainment

State-level educational attainment data are from the U.S. Census Bureau, American Community Survey, Educational Attainment for the Population 25 Years and Over, American Community Survey 1-Year Estimates datasets, accessed August 17, 2017, http://www.census.gov/programs-surveys/acs/. County-level educational attainment data are from the U.S. Census Bureau, American Community Survey, S1501 Educational Attainment, North Carolina and all Counties 2011-2015 American Community Survey 5-Year Estimates dataset, accessed September 29, 2017, https://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t#none.

5.7: Educational Attainment of In-Migrants

State-level educational attainment of in-migrants data are from the U.S. Census Bureau, ACS, Geographic Migration by Selected Characteristics, Population 25 Years and Over in the United States, American Community Survey 1-Year Estimates datasets, accessed August 9, 2017, http://www.census.gov/programs-surveys/acs/. County-level educational attainment data are from the U.S. Census Bureau, Geographical Mobility in the Past Year by Educational Attainment for Current Residence in the United States, Population 25 Years and Over in the United States, 2011-2015 American Community Survey 5-Year Estimates dataset, accessed October 2, 2017, https://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t#none.

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 2016, 8-10: Elementary and Secondary Public School Expenditures as Share of Gross Domestic Product dataset, accessed June 2, 2017, https://www.nsf.gov/statistics/2016/nsb20161/#/singleind/10/M. State-level appropriations of state tax funds for operating expenses of higher education data are from the National Science Board, Science and Engineering Indicators 2016, 8-25: Appropriations of State Tax Funds for Operating Expenses of Higher Education as a Percentage of Gross Domestic Product dataset, accessed June 2, 2017, https://www.nsf.gov/statistics/2016/nsb20161/#/singleind/25/M. Authorized appropriations data to University of North Carolina (UNC) institutions is from the NC Office of State Budget and Management, via special request, November 29, 2017.

6.2: Broadband

State-level data for broadband deployment are from the Federal Communications Commission, received October 2017, http://www.broadbandmap.gov/. State-level data for broadband percent fiber deployment and broadband subscription data are from the same source. County-level broadband access data are from the Federal Communications Commission, June 2016, processed by the North Carolina Center for Geographic Information and Analysis for the North Carolina Broadband Infrastructure Office on April 2017.

Broadband Infrastructure Office. 2016. "Connecting North Carolina: State Broadband Plan." Raleigh, NC: Division of North Carolina Department of Information Technology. Available at: https://ncbroadband.gov/wp-content/uploads/2016/06/akljsnenx.pdf.

Industry Analysis and Technology Division. April 2017. "Internet Access Services: Status as of June 30, 2016." Washington, DC: Federal Communications Commission, Wireline Competition Bureau. Available at: https://apps.fcc.gov/edocs_public/attachmatch/DOC-344499A1.pdf.

6.3: Cost of Living Index

State-level Cost of Living Index data are from the Council for Community and Economic Research (C2ER), via the AccessNC online data portal operated by the North Carolina Department of Commerce, accessed July 11, 2017, https://accessnc.opendatasoft.com/explore/?q=cost+of+living&sort=modified. County-level Cost of Living Index data are from C2ER, County Cost of Living Index, accessed on December 28, 2016, http://www.coli.org/.

6.4: Industry Mix

Industry mix data are from the Economic Modeling Specialists, Inc. (EMSI), accessed October 24, 2017, http://www.economicmodeling.com/. 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) and Current Employment Statistics (BLS). 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 mostly based on the ACS, Nonemployer Statistics, and BEA State and Local Personal Income Reports. 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. See www.economicmodeling.com. 2017.Q3 Class of Worker Data were used to produce the requested data. The average earnings, also called "Current Total Earnings," is the total industry earnings for a region divided by number of jobs. It includes wages, salaries, supplements (additional employee benefits), and proprietor income.

Manufacturing industries are defined as those industries whose 2-digit NAICS code ranges from 31-33. The National Science Foundation defines "high science, engineering and technology (SET) employment" industries at the 4-digit NAICS level according to the 2007 NAICS coding scheme. EMSI employment data are reported according to the 2012 NAICS coding scheme. Industries considered "high SET" in this analysis follow the NSF's classification method, except where adjusted to account for differences between the 2007 and 2012 NAICS coding scheme as described below. 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 do not match similar data for the entire industry defined at the 3-digit NAICS level.

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Explanation of 2002-2007 "High SET Employment" NAICS Reconciliation

The National Science Foundation defines "high SET employment" industries at the 4-digit NAICS level according to the 2002 NAICS coding scheme. EMSI's employment data are reported according to the 2007 NAICS coding scheme.

In the shift from the 2002 to the 2007 NAICS coding scheme, many codes remained the same. In other instances, two or more 2002 codes were combined under one new or preexisting 2007 code, a 2002 code may have been divided among many new or preexisting 2007 codes, a 2002 code was eliminated, or a code changed in scope.

Such shifts from 2002 to 2007 NAICS codes affected several of the codes that the NSF identified as being "high SET employment" industries. Where code shifts did not change whether a code was composed entirely of "high SET" or entirely not of "high SET," no adjustment was required. In cases where a code resulted in a mix of "high SET" and not "high SET" employment industries based on 2002 classifications, *Tracking Innovation* report staff determined whether the 2007 code qualified as "high SET" for the purposes of the 2017 report. These special determinations are summarized here:

Using the table in the Appendix, *Tracking Innovation* report staff utilized Census NAICS crosswalks from 2007 to 2012 NAICS codes to compare the vintage codes for the high-technology industries. NAICS descriptions for the 2007 vintage generally matched those for the 2012 vintage, with the exception of the limited differences in titles listed below. Thus, the 2007 vintage list was used for the recent data in this report.

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Thanks also go to the members of the NC Board of Science, Technology & Innovation, who provided valuable oversight and feedback during the development of this report.

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

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