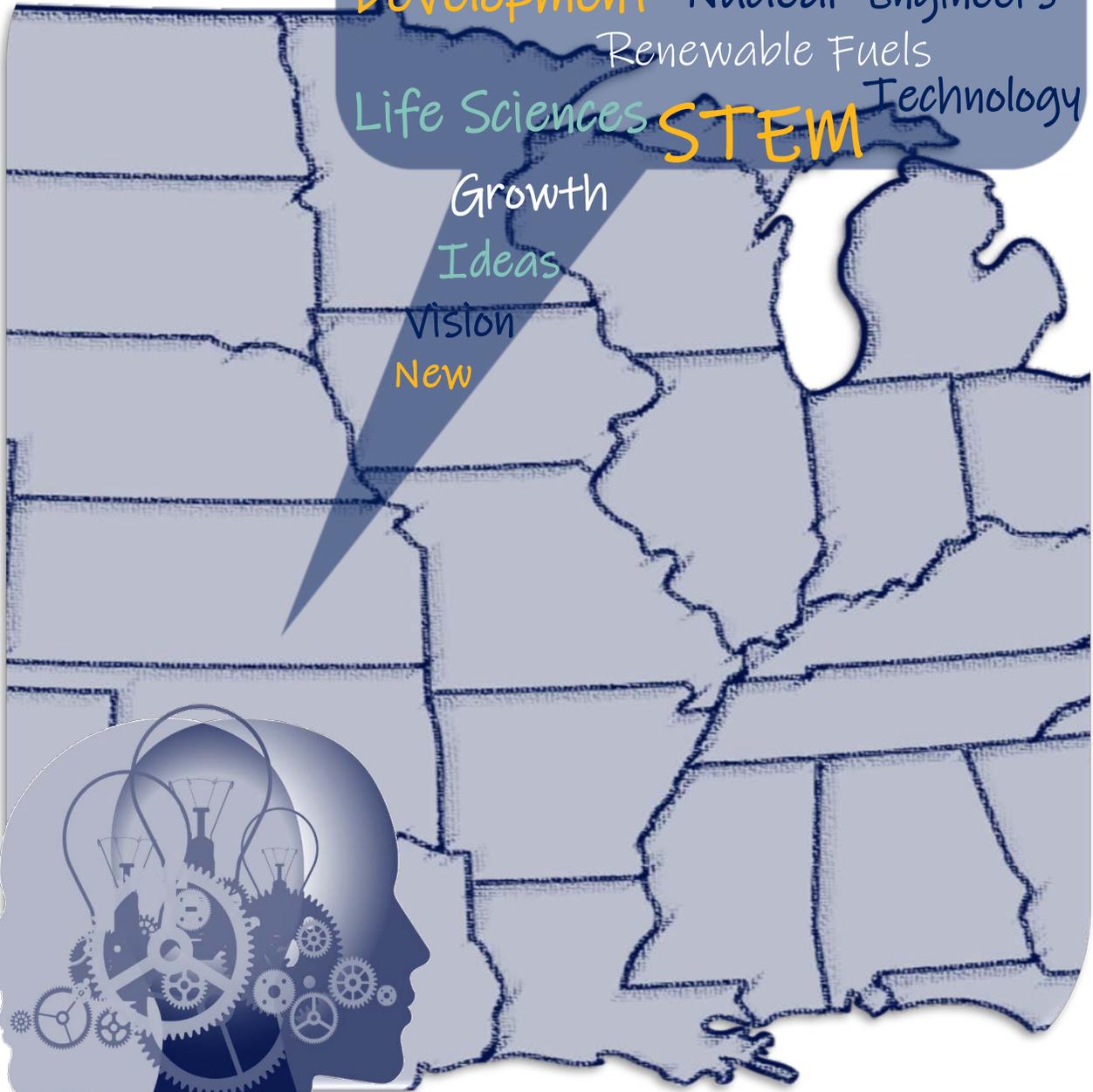


The American Heartland's Position In the Innovation Economy

Entrepreneurial Infrastructure
Research Bio Tech Strategy
Startups University Collaboration
IPO's **Innovation** Nasdaq
Development Nuclear Engineers
Renewable Fuels
Life Sciences **STEM** Technology

Growth
Ideas
Vision
New



ABOUT THE AUTHORS



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The Walton Family Foundation is, at its core, a family-led foundation. The children and grandchildren of our founders, Sam and Helen Walton, lead the foundation and create access to opportunity for people and communities. We work in three areas: improving K-12 education, protecting rivers and oceans and the communities they support, and investing in our home region of Northwest Arkansas and the Arkansas-Mississippi. In 2017, the foundation awarded more than \$535 million in grants in support of these initiatives.

In Northwest Arkansas, having access to amenities that improve the quality of life is key to the economic growth of the region. The Walton Family Foundation supports these efforts through its Home Region Program by developing programs that retain the region’s workforce but also help recruit new talent to sustain the pace of growth of the local economy.

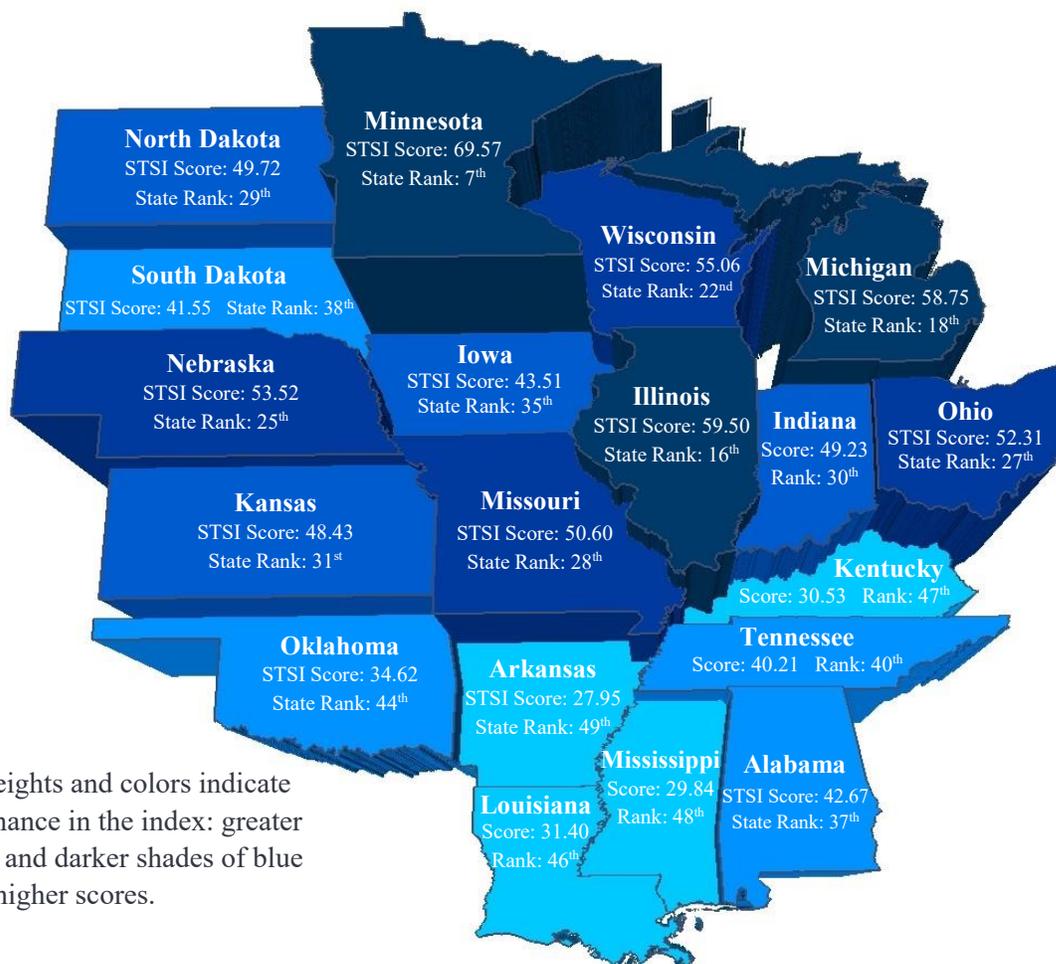
In the Delta, where economic activity has slowed down considerably, foundation programs support quality of life improvements that will prepare the region for strategic growth opportunities. To learn more, visit waltonfamilyfoundation.org and follow us on Facebook and Twitter.

Executive Summary

The innovation capacities of places are a key driver of long-term economic performance in the United States, other advanced nations, and emerging nations. The states and regions who invest in and nurture innovative activities and build human capital will establish ecosystems that create high-paying jobs for their citizens and attract migrants from other states and nations, boosting economic growth further. This paper evaluates the American Heartland's position in the innovation economy relative to the rest of the country. We identify key strengths, but also identify gaps that should be narrowed through the development and implementation of thoughtful, well-articulated public policy.

This analysis demonstrates that there are unrevealed or unrecognized innovation strengths in the American Heartland. However, many opportunities currently exist to improve its economic position. In order to close the divergence in performance between the Coasts and the American Heartland; it must participate more fully in the innovation-driven economy of the 21st Century.

Figure ES1: 19 American Heartland States on the State Technology and Science Index



State heights and colors indicate performance in the index: greater heights and darker shades of blue reflect higher scores.

Source: Milken Institute

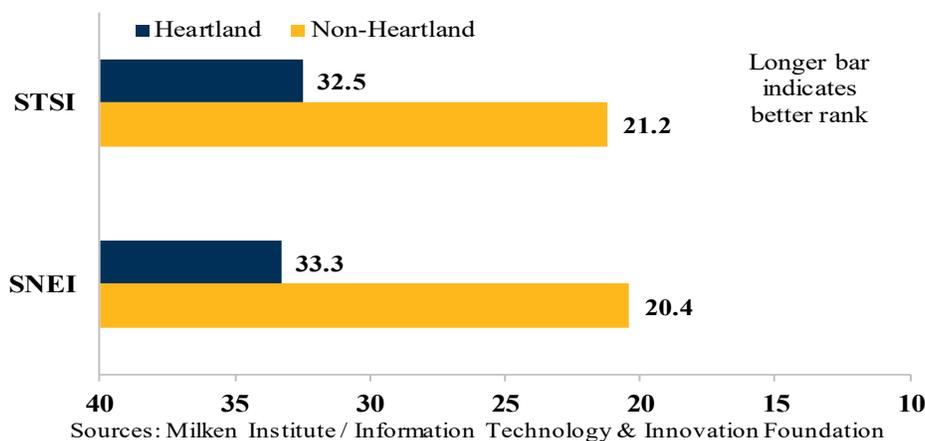
In developing an evaluation of the 19 states included in the American Heartland (see Figure ES1), we utilized the Milken Institute’s State Technology and Science Index (STSI),ⁱ supported by the State New Economy Index published by the Information Technology & Innovation Foundation.ⁱⁱ The two indices are the most widely used measures showing how states are positioned for participation in an environment of innovation-driven economic growth. The lead author of this report, with support from his former colleagues at the Milken Institute, developed the STSI in 2002. The efficacy of the STSI is demonstrated in its ability to explain 75 percent of the difference in real technology-related GDP per capita and two-thirds of income per capita of the working-age population between the 50 states.

The STSI includes 107 individual metrics that segment into five subcategories to benchmark where states are positioned on innovative activities. All metrics are normalized relative to some benchmark such as population, gross state product (GSP) or other measures to adjust for the size of each state’s economy. The five composites include **1) Research and Development Inputs, 2) Risk Capital and Entrepreneurial Infrastructure, 3) Human Capital Investment, 4) Technology and Science Workforce and 5) Technology Concentration and Dynamism** (please see the **Introduction** section for a more thorough description).

American Heartland Overview

The average rank of the 19 American Heartland states on the STSI was 32.5. The number indicates the Heartland is about seven positions below the mean for the nation. Another way to view this relationship is that the 31 non-Heartland states have an average rank of 21.2. On the State New Economy Index (SNEI), the Heartland states have an average rank of 33.3 which is indicative of consistent evaluation with the STSI overall (see Figure ES2). However, the general positioning of the Heartland masks some exemplary performances among several states. For example, at seventh overall in the STSI, Minnesota is the best-scoring Heartland state in measures of preparedness and participation in the innovation economy. Minnesota’s latest STSI score resulted in a five-position improvement from where it was in 2014. Illinois (16th), Michigan (18th), Wisconsin (22nd) and Nebraska (25th) all were in the top half of states.

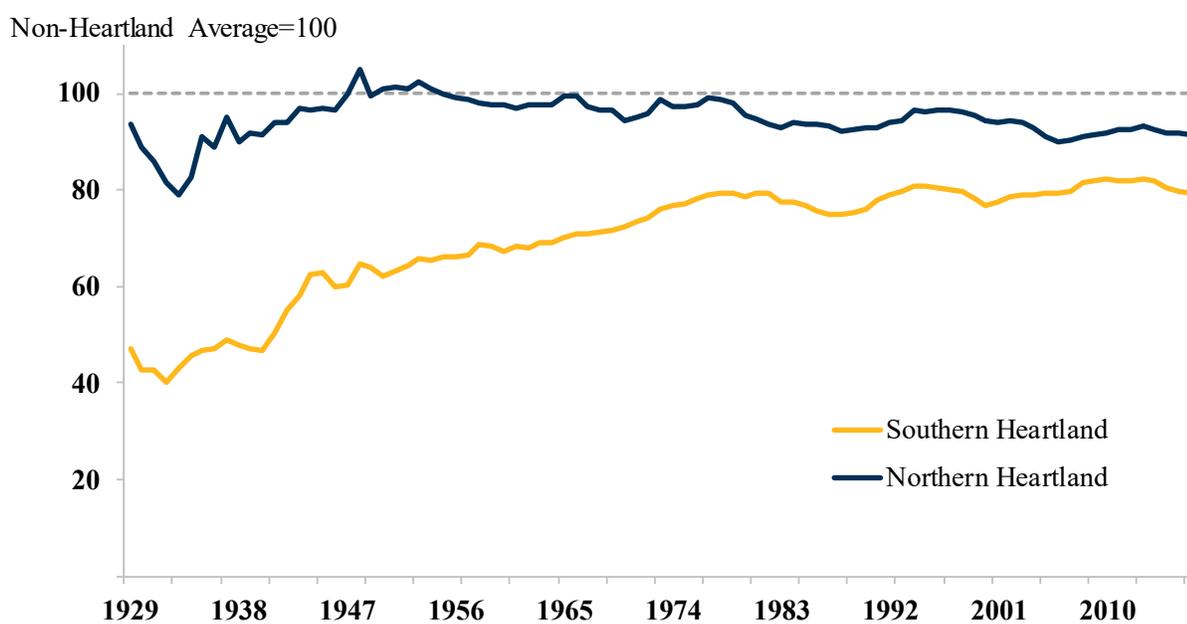
Figure ES2: Average American Heartland vs. non-Heartland Rank



There is a clear separation between the northern and southern sections of the Heartland in preparedness to compete in the innovation economy. The average rank of the 12 states in the northern section was 25.5 versus 44.4 in the seven southern states. Five states (Oklahoma, 44th; Louisiana, 46th; Kentucky, 47th; Mississippi, 48th; and Arkansas, 49th) are in the bottom ten. This divergence has been in place since the North began to industrialize. The southern American Heartland states did not maintain critical investment during the financial crisis and the aftermath of the Great Recession, which devastated state revenues.

While the southern section of the Heartland has been narrowing the gap in per capita income with the rest of the nation for many decades, progress has stalled primarily due to the lack of fuller participation in innovation-driven economic activity (see Figure ES3). Additionally, there are rural pockets that do not have much involvement in high-value-added economic activity due to lingering intergenerational legacies stemming from interrelated low educational attainment, poverty, unhealthy behaviors and high rates of chronic disease. The mechanization of agriculture and low-value-added manufacturing have harmed labor market participation too. The non-metropolitan populations of the southern Heartland represent a larger proportion of the region's total population, providing them with fewer opportunities to have critical innovation assets such as research universities or federal laboratories that can be leveraged to promote economic growth. Scale does bestow economic advantages in concentrating on innovative endeavors but does not obviate the responsibility to invest in regions with less density and fewer initial endowments.ⁱⁱⁱ

Figure ES3: Per-Capita Personal Income Relative to non-Heartland, Percent



Source: Bureau of Economic Analysis

Within the five composites that comprise the STSI, there were several kernels of strength and recent improvements in the American Heartland (see Table ES1).

Table ES1: State Technology and Science Index with Five Composites

	Overall		Research & Development Inputs		Risk Capital & Entrepreneurial Infrastructure		Human Capital Investment		Technology & Science Workforce		Technology Concentration & Dynamism	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank
Minnesota	69.57	7	65.13	19	62.72	16	70.47	5	88.00	4	61.55	15
Illinois	59.50	16	67.68	15	61.63	17	56.66	20	52.00	24	59.55	18
Michigan	58.75	18	68.82	13	56.36	23	53.90	23	53.33	23	61.33	16
Wisconsin	55.06	22	66.68	18	58.00	20	52.19	26	61.33	17	37.11	38
Nebraska	53.52	25	44.48	35	58.60	19	57.90	19	68.00	11	38.66	36
Ohio	52.31	27	56.70	26	48.00	33	46.00	32	59.33	18	51.55	25
Missouri	50.60	28	43.85	37	70.40	7	45.42	33	42.66	33	50.66	26
North Dakota	49.72	29	46.68	33	43.33	40	65.50	6	64.66	13	28.44	48
Indiana	49.23	30	61.20	23	42.00	43	50.95	28	46.66	28	45.33	29
Kansas	48.43	31	46.40	34	51.81	30	50.85	29	43.33	32	49.77	27
Iowa	43.51	35	49.33	31	39.40	46	58.19	18	34.66	37	36.00	40
Alabama	42.67	37	53.05	28	43.45	38	35.52	42	42.00	34	39.33	35
South Dakota	41.55	38	33.38	42	47.33	34	52.60	25	46.00	29	28.44	48
Tennessee	40.21	40	44.19	36	57.27	22	36.95	40	27.33	42	35.33	41
Oklahoma	34.62	44	25.58	45	46.72	35	39.90	38	30.66	40	30.22	45
Louisiana	31.40	46	22.08	48	44.54	36	35.04	43	16.66	45	38.66	36
Kentucky	30.53	47	23.68	46	43.40	39	33.80	44	16.66	45	35.11	42
Mississippi	29.84	48	29.07	44	32.85	49	31.04	47	16.00	48	40.22	32
Arkansas	27.95	49	21.88	49	43.00	41	30.00	49	14.66	49	30.22	45

Source: Milken Institute

(1) Research and Development Inputs

In research and development (R&D), Michigan is the top-ranked Heartland state at 13th, and has seen steady advances on its score; rising from 54.39 in 2002 to 68.82. Michigan has enacted some of the most well-articulated policies in the country to enhance its future position in the innovation economy. Michigan-based firms have a long history of working with universities and a prime example is the University of Michigan ranking 16th in the nation on measures of commercialization.^{iv} Michigan is seventh in the nation in industrial R&D. Illinois rose five places in the overall STSI score since 2014—mainly attributable to a 6.8-point advance in R&D. A critical asset for Illinois in innovation is its strong bi-directional and cross-collaboration between universities, industry, and the state’s two national labs, Argonne and Fermilab.

Wisconsin recorded one of the most substantial improvements in R&D in the nation since 2002 when the first STSI rankings were released: its score rose to 66.68 from 46.58—a noteworthy gain in rank of nine. Advances in academic R&D, coupled with a first-place national ranking in R&D in biomedical sciences, bolstered Wisconsin’s standing. Indiana’s score in R&D increased partly due to Purdue’s rising stature in commercialization and the state’s robust national ranking of 11th in industrial R&D. Even states not widely known for strong R&D performance exhibit encouraging trends. For example, Arkansas experienced gains in attracting more Small Business Technology Transfer programs (STTR) and Small Business Innovation Research (SBIR) phase I awards where it came in 17th and 27th, respectively. These are prestigious programs and demonstrate the state is developing intellectual property that has commercial potential. Tennessee is 13th in federal R&D, aided by its national laboratories, punching in above weight in this category.

(2) Risk Capital and Entrepreneurial Infrastructure

Missouri is the strongest performer in risk capital and entrepreneurial infrastructure at seventh, a 24-place leap from where it stood in 2014. There are more flow measures in this indicator as opposed to stock measures. One notable improvement within the category was the number of companies receiving venture capital investment relative to total businesses; eighth overall. Clearly, a direct connection with the state's strategic plan. One of Nebraska's most significant gains occurred in risk capital and entrepreneurial infrastructure where the state now ranks 19th. The latest score was a remarkable 31-point improvement from 2012. Nebraska ranks 17th in venture capital investment as a percent of GSP.

Wisconsin experienced a sizeable improvement since 2014, rising by 16 positions. The state's most impressive gains were in access to venture capital. Kansas came in second for the increase in the number of companies receiving venture capital and ninth in green tech investments. Surprising to some, but not to officials in Alabama, the state jumped to third from 44th in 2014 in total venture capital investment growth. Kentucky was first in total venture capital investment growth, displaying an encouraging sign for future advances in fast-growing companies.

(3) Human Capital Investment

Minnesota placed fifth in human capital investment—tops in the Heartland. The state ranked tenth in the percent of the adult population with a Bachelor's Degree or higher. On future workforce preparedness, Minnesota stood second in the proportion of graduate students that are in science, engineering or health. However, North Dakota saw the most notable improvement in human capital investment where the state climbed to sixth from 12th in 2014. North Dakota was first in recent Bachelor's Degrees in science and engineering per 1,000 civilian workers and fifth for PhDs awarded in science, engineering and health. Many of the recent year gains are attributable to the growing demand for petroleum engineers related to technological advances in horizontal drilling techniques and the boom in shale oil exploration.

South Dakota improved to 25th in human capital investment from 30th in 2014. Notable performances were recorded in science, engineering, and health PhDs awarded among people aged 25-34 (third) and recent Bachelor's Degrees in science and engineering (sixth). Oklahoma rose four positions in human capital investment from 2014. Encouraging signs are seen in Oklahoma being 26th in recent Master's Degrees in science and engineering, and 30th in recent Bachelor's Degrees in the same category. Louisiana improved its rank by three since 2014. Strength was exhibited in recent Degrees in science and engineering where it was 17th.

(4) Technology and Science Workforce

In technology and science workforce, Heartland's highest score of 88.00 came from Minnesota, which placed fourth. This was a 17-point improvement from its seventh-place finish in 2014, eclipsing California and only behind Maryland, Massachusetts and Colorado. Given the state's industry composition, it should not come as a surprise that Minnesota's strength in technology and science workforce is highest in occupations in life sciences and areas of engineering. Minnesota was second in the intensity of biomedical engineers; third in biochemists and biophysicists; third in materials scientists; fourth in life scientists; tenth in medical scientists; second in industrial engineers and tenth in mechanical engineers. Nebraska was 11th in technology and science workforce, landing it just out of a top-ten ranking. Nebraska's success is due to a strong performance in a number of occupational categories comprised of computer and information sciences. North Dakota witnessed a leap of 34 positions from 2014 to 13th in the latest reading. North Dakota was fifth in the intensity of mining and geological engineers and seventh in petroleum engineers.

Ohio climbed 12 places from 2014 to 18th overall in technology and science workforce. Ohio was fourth in material scientists; fifth in computer network support specialists; sixth in industrial engineers; seventh in aerospace engineers, chemical engineers and mechanical engineers and ninth in chemists, displaying its prowess in key engineering occupations. Indiana rose four places in the latest reading, holding first in the intensity of material engineers and fourth for the intensity of mechanical engineers. Illinois was sixth in nuclear engineers and seventh in physicists courtesy of its two national labs. Despite a weak score overall, Arkansas was fourth in agricultural and food science technicians. With strengths in rice and protein production, Arkansas remains among the national leaders in food and agricultural science. However, technology and science workforce is where the southern section of the American Heartland has its lowest participation.

(5) Technology Concentration and Dynamism

Minnesota was 15th in technology concentration and dynamism, a gain of five positions since 2014. Minnesota's advance was attributable to an improvement to ninth in the number of Inc. 500 firms. Within this category, Michigan had the most significant gains, rising by 14 places and 12.2 points from 2014. Even more extraordinary, Michigan jumped from 46th in 2010, the largest jump of any state. An excellent example of the tremendous gains was in the net formation of high-tech establishments relative to total business establishments where it rose from 48th in 2010 to ninth in 2016. Over the past ten years, the New Economy Initiative (NEI) focused on the Detroit metropolitan area supporting inclusive entrepreneurial programs and diversification of the economy.

Mississippi recorded its highest score in technology concentration and dynamism placing 32nd, a gain of 18 places from 2004, attained by adding fast-growth technology firms. Ohio improved to 25th in this category. As recently as 2008, Ohio was 48th on this outcome measure. Ohio was first in the nation in average yearly growth in high-tech industries over a five-year period. Further, Ohio was sixth in the net formation of high-tech establishments per 10,000 business establishments. Cleveland Clinic Innovations, the commercialization arm of the Cleveland Clinic, has spun off nearly 80 companies since 2000, including Cleveland HeartLab. Iowa moved up two positions and Tennessee four from 2014, rising to 17th in net formation of high-tech establishments.

Leading Public Policy Initiatives

Nebraska Governor Pete Ricketts advocates policy ideas to improve tech connections to rural areas of the state. The Library Innovation Studios project was initiated to improve the availability of makerspaces and access to technology tools to encourage creativity and promote entrepreneurship. This is an increasing trend among policy-makers around the nation attempting to broaden access to the innovation economy. The University of Tennessee System added initiatives to its strategic plan in 2015 that focus on funding the development of university research into marketable products, and developing research partnerships with private companies.

Governor Mark Dayton and the Legislature are improving access to early-stage financing through Minnesota's Angel Tax Credit program. The program provides tax credits to investors or funds that invest in startups in high technology. Since the program started in 2010, over 400 businesses and startups have collected over \$370 million in investment. Wisconsin utilized tax incentives to recruit Taiwan's Foxconn Technology Group Inc., a major supplier of Apple, to create a \$10 billion megaplant. The hope is that 13,000 technology-manufacturing jobs will be created for Wisconsin workers and to help attract skilled labor from outside the state.

Arkansas Governor Hutchinson has implemented a new program to build the science and technology workforce: ArFuture grants, enable the state to pay for all tuition and mandatory fees for individuals to attend a two-year college program or technical school in the pursuit of a high-need job skill or degree. This will be a crucial test for how southern Heartland states can improve their position through a bootstrapping approach. Missouri's 2011 strategic plan for economic development serves as strong policy evidence. The plan focused on growing several STEM fields and training workers. More than 57,000 individuals received training in the first five years. Michigan Governor Snyder unveiled a new program to address challenges in STEM education called the "Marshall Plan for Talent." This extensive plan targets investments through a three-pronged approach: K-12 education, higher education and the state's existing workforce. It includes funding for apprenticeship programs and tech-directed tuition assistance.

The Illinois Innovation Network and the Discovery Partners Institute, located at the University of Illinois, are state programs launched to better partner university research with entrepreneurship. The diverse relationship leads to higher business formation rates. A recent announcement made by Ohio State University's Fisher College of Business stated they support future startup efforts. The University has received a pledge of \$17 million to develop a new entrepreneurship center. The state of North Dakota invested \$17 million of public money in the Grand Sky infrastructure to add high-paying jobs for residents processing data collected by drones, maintaining drones and piloting them, a necessary investment to build a new cluster. In 2017, Louisiana laid out an explicit strategic plan to cultivate "small business, innovation, and entrepreneurship." The central effort is to work with both universities and economic developers to create a path for innovation in Louisiana. There are numerous creative policy initiatives underway in the American Heartland and the main body of this report discusses many of them.

Conclusion

The American Heartland is presented with unique opportunities to enhance its participation in the innovation economy in 2018 and beyond. Many technology firms and workers are searching for more business-friendly locations with lower costs of doing business, fewer restrictive regulations and more affordable housing options.

The American Heartland must implement policies to build and capitalize on its research capacity. It must invest in programs to facilitate entrepreneurial awareness and build the capacity to execute technology-based economic development. Funding and redirecting training resources toward career technical education with a focus on Associate Degrees, certificates of completion and advanced degree programs at universities in science, technology, engineering and mathematics (STEM) are critical. It may be a fortuitous opportunity for relocation tax credits (in the form of fixed amounts) targeted at tech talent who originated from the Heartland and now reside on the coasts. Enacting some sort of a relocation tax credit may be enough to lure them back. The low cost of a relocation tax credit is an investment states should consider to build the depth of technology talent. Further, greater investments in building human capital, especially in the STEM areas, are vital for larger participation in the innovation economy.

The American Heartland states must emphasize collaborative investments between federal and state governments, universities and the private sector in research and curriculum development.^v Programs that are designed to support scaling up university-based and other startups in technology and science fields are necessary on a sustained basis. It is imperative to identify and understand the relative strengths and gaps that should be filled through solicitous policy interventions by creating sustained long-term commitments.

Introduction

While assessing the American Heartland's position in the innovation economy, we drew upon metrics utilized in the Milken Institute's (MI) State Technology and Science Index (STSI)^{vi} and augmented them by using the Information Technology & Innovation Foundation's (ITIF) State New Economy Index.^{vii} The report's lead author (Ross DeVol) and his former Milken Institute colleagues developed the State Technology and Science Index in 2002 and released many reports based upon its metrics to benchmark where states are positioned in innovative endeavors. Many policy recommendations were developed to improve performance. More broadly, the STSI metrics and ITIF's State New Economy Index facilitate an assessment of where the Heartland is positioned relative to other major regions of the country. Where available, other sources of metrics are reviewed on individual states to provide deeper context and perspective.

The STSI provides a benchmark for states to assess their science and technology capabilities as well as the broader innovation ecosystem that contributes to job and wealth creation. The STSI should be interpreted as a measure of a state's innovation pipeline as it measures the capacity to innovate along a broad continuum, but also evaluates the ability of individual states to convert those assets into measures that improve economic performance in high-valued activities. The STSI was not developed as a measure of near-term economic impact, but to provide an assessment of returns on science and technology endowments that will likely accrue over the longer term. While extensive human capital is a prerequisite, individuals who possess the ability to recognize entrepreneurial opportunity, and hold the knowledge and skills to exploit it, are among the strongest resources a state or region can command in today's fast-paced, innovation-based economy. Equally, if not more important, is to have technology management skills and the capital to scale up many of the nascent startups.

The STSI incorporates 107 individual metrics by computing and measuring each of them relative to population, gross state product (GSP), number of establishments, and other benchmark variables in the denominator. This normalizes comparisons across states on stock measures that change slowly over time. Flow measures such as percentage change or other growth measures are in the mix to capture recent advances. Data sources include government agencies such as the National Science Foundation, the Small Business Administration, the U.S. Department of Education and private sources including Thomson Financial, Deloitte & Touche and Moody's Analytics. A score is created for each of the 107 indicators with the top state receiving 100; followed by the second state with a score of 98; all the way to the state in 50th, which records a score of two. The indicators are then segmented into the following **five composites**.

Research and Development Inputs: Measures a state's research and development (R&D) capabilities based upon attracting research funding forming the intellectual property that can be converted to a private sector business opportunity and commercialized in an existing or start-up enterprise. The primary sources of R&D funding are the federal government, universities and private industry. Federal funding is principally directed at basic scientific and medical research. However, it forms the basis of subsequent applied research and development that has commercial applicability. Corporations are providing more funding for universities that has led to more applied research, but the majority of university funding is basic research based upon federal sources.

Industry invests more in research and development than any other source—typically between 60 to 65 percent of the total. Large U.S. corporations are among the most innovative in the world and invest a large proportion of their sales back into R&D. The U.S. also benefits from a wide array of more R&D intensive small firms that transform discoveries into products and services in the marketplace. This includes federal programs such as the Small Business Innovation Research awards (SBIR); the Small Business Technology Transfer program (STTR) and National Science Association Foundation (NSF) Funding. There are 18 R&D gauges in this composite.

Risk Capital and Entrepreneurial Infrastructure: Evaluating the entrepreneurial capacity and risk capital infrastructure of states is critical to the process of transforming research prowess into commercially viable technology-based products or services in the marketplace. Entrepreneurial competencies are critical to building and maintaining an ecosystem of innovation in a geographic area.^{viii} While today's innovative stalwarts are at the technology production frontier, many firms will stagnate or disappear as technological change disrupts their business model. Entrepreneurs are vital in a world with rapid technological change because they see the potential in the newly developed intellectual property. Because they are not burdened by past personal and corporate institutional biases, entrepreneurs can recognize and exploit new opportunities. Early-stage financing such as crowd-funding, angel investing or venture capital is vital to the process of new firm formation. Many startups that are based upon research from a federal lab or university require large external financial commitments over a period of years to develop their intellectual property (IP) into a feasible product or service.

Included are measures in business incubators and accelerators, Small Business Investment Company (SBIC) funds, the level and growth in venture capital placements, patenting activity, business formations, and initial public offerings. There are 12 indicators in this category.

Human Capital Investment: Human capital is the most important intellectual property of a regional or state economy. Clustering human capital in a geography assists in boosting higher value-added regional economic growth and wages of workers.^{ix} The rate of return to investing in incremental postsecondary education is exceptionally high for regional economies. Real GDP per capita rises by 17.4 percent and real wages per capita by 17.8 percent by adding one-year of schooling to the average educational attainment of the workforce.^x The accumulation of skills over decades builds the stock of human capital and is typically measured by degree attainment. As economic growth is increasingly based upon talent, we are shifting to a knowledge-based economy that diminishes the role of physical capital and land in determining success. Investments in human capital provide higher returns to firms, not just individuals. Businesses that attract and invest more in human capital exhibit superior performance in such areas as sales growth, market share, capital investment, productivity, profitability and market capitalization.

These indicators explore the skill levels of the current and future workforce. Examples include the number of Bachelor's, Master's, and Doctorate degrees relative to a state's population, and measures specific to science, engineering, and technology degrees. It measures flows by looking at recent degrees achieved. In total, the human capital investment composite incorporates 21 indicators.

Technology and Science Workforce: The intensity of the technology and science workforce indicates whether states have adequate reservoirs of technical talent. Research and development can only be conducted by scientific and technical talent and converted into a commercially viable venture with their involvement. Clusters with a dense concentration of science, technology, engineering and mathematics (STEM) workers provide another series of competitive advantages: pooling workers and creating a labor force with essential industry-specific skills.^{xi} Companies embedding themselves within technology clusters benefit from positive externalities such as knowledge spillovers and agglomeration effects. Additionally, labor productivity tends to be higher in locations densely populated with technology and science workers. One important study concluded that doubling employment concentration boosted productivity by nearly 6 percent.^{xii} It is not just tech and science workers with advanced degrees that aid economic growth: skilled technicians with less than a Bachelor's degree are essential to developing prototypes and maintaining critical research equipment.

This composite includes 43 occupation categories in three main areas: computer and information sciences (such as computer and information research scientists, software developers – applications and computer network support specialists), life and physical sciences (such as microbiologists, materials scientists and chemical technicians), and engineering (including biomedical, materials and petroleum).

This composite includes 43 occupation categories in three main areas: computer and information sciences (such as computer and information research scientists, software developers – applications and computer network support specialists), life and physical sciences (such as microbiologists, materials scientists and chemical technicians), and engineering (including biomedical, materials and petroleum).

Technology Concentration and Dynamism: The previous four composite indices measure the innovation assets which states possess that can be capitalized on to foster future technology-based economic growth. This technology concentration and dynamism composite attempts to measure the intensity and expansion of high-tech business activity by state. States that give birth to entrepreneurial-driven firms and provide a pathway to develop them into large, multinational firms are critical to high-quality, high-paying job creation. Ultimately, the metrics assess the degree of success policymakers and other stakeholders have achieved in transforming innovation assets into regional economic prosperity. After states garner research funding, provide financing from public and private sources, develop entrepreneurial capabilities, invest in human capital and accumulate a tech workforce, what results or economic outcomes do they produce?

This outcome composite index includes nine indicators of stocks and flows. It incorporates measures such as the percent of establishments, employment, and payrolls that are in high-tech categories. It also measures growth in a number of technology categories such as high-tech business births and high-performing tech companies.

The ITIF describes its State New Economy Index in the following way: “The purpose of the State New Economy Index is to measure states’ economic structure. Unlike other reports that assess state economic performance or state economic policies, this study focuses more narrowly on a simple question: To what degree does the structure of the 50 state economies match the ideal structure of the innovation-driven New Economy?”^{xiii} It includes 25 indicators segmented into five categories: Knowledge jobs; Globalization; Economic dynamism; The digital economy; and Innovation capacity.

This paper discusses the American Heartland’s position in the innovation economy to better identify and understand the relative strengths and gaps that should be filled through thoughtful policy interventions.

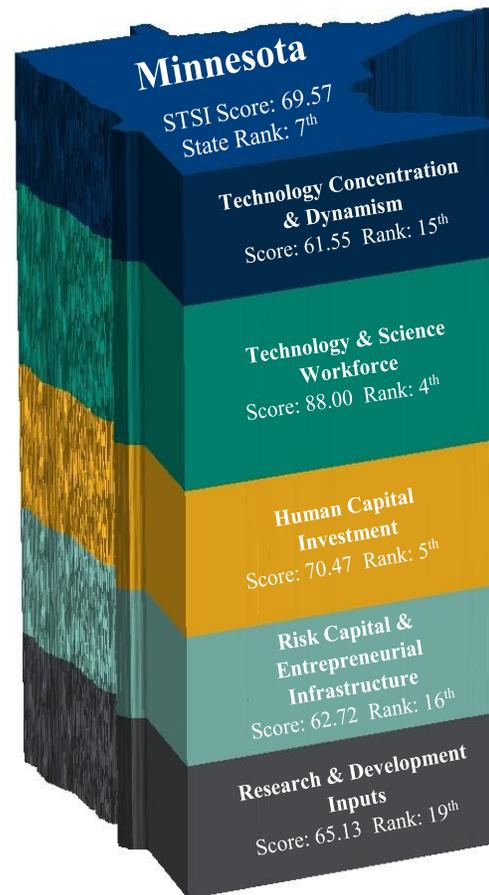
Individual American Heartland States in the Innovation Economy

The following 19 state maps depict three-dimensional stacked bar charts and are proportionally represented to illustrate the scope of the STSI individual category score and rank. The height of the state's map depicts its relative position to all of the other 18 states.

Minnesota is the top performer among Heartland states in measures of participation and preparedness in the innovation economy. Minnesota scored a solid 69.57 on the STSI placing it seventh in the nation, the state's highest position across all STSI iterations.

Minnesota's lofty ranking is supported by other measures such as the State New Economy Index where it placed 12th. In the latest reading, Minnesota advanced five positions in the STSI from where it was in 2014. Further demonstrating forward momentum, Minnesota witnessed an improvement from its last position in the State New Economy Index. Minnesota has significant assets in medical research, technology with anchors like the Mayo Clinic and Medtronic, who deepen the pool of the technology and science workforce. Minnesota has a long record of accomplishment in promoting research and education policies.

Minnesota's overall rise in the STSI was driven by its 17-point ascension to 88.00 in the Technology and Science Workforce, moving the state from seventh in 2014 to fourth in the latest reading. Gains in Research and Development in the Technology Concentration and Dynamism contributed to Minnesota moving to seventh overall. The latest reading on the Technology and Science Workforce places Minnesota solidly in the top five for the first time, eclipsing California and only behind Maryland, Massachusetts and Colorado. Given the state's industry composition, it should not come as a surprise that Minnesota's strength in technology and science workforce is highest in occupations in life sciences and areas of engineering.



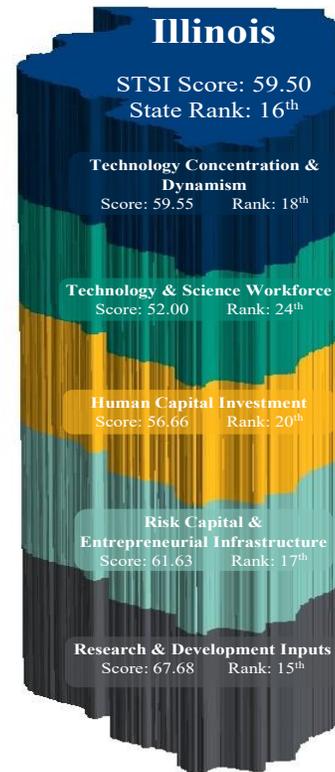
Minnesota was second in the intensity of biomedical engineers; third in biochemists and biophysicists; third in materials scientists; fourth in life scientists; tenth in medical scientists; second in industrial engineers; and tenth in mechanical engineers. These are rankings that might be expected in states such as Massachusetts and California. Minnesota's prowess also extends into computer and information science. It was fourth in the intensity of computer network architects and sixth in both software developers and web developers.

Minnesota as fifth in Human Capital Investment. Its strong position was due to consistent performance across a number of indicators. For example, it ranks tenth in the percent of the adult population with a Bachelor's Degree or higher. On future workforce preparedness, the state is second in the proportion of graduate students that are in science, engineering or health. The state has been at the forefront in providing tax credits for college internships in science, technology, engineering and math (STEM) at Minnesota firms.^{xiv}

Within Research and Development Inputs, Minnesota's most impressive accomplishment was ninth in industrial R&D per capita. Industry is the largest funder of R&D. The presence of 3M, medical devices and IBM bolster its position. The state had a strong showing in competitive NSF proposal funding rates at fourth. However, an area that was surprisingly low and in definite need of improvement was academic R&D per capita where Minnesota was 33rd. Minnesota's gains in Technology Concentration and Dynamism were propelled by the state's ninth position in the number of Inc. 500 firms. Additionally, Minnesota was 12th in the number of high-tech industries that are more concentrated in the state than for the nation overall. The state witnessed a strong growth rate in high-tech industries as well. Information that is more recent shows that Minnesota added 3,500 technology jobs in 2017 and high-tech industries contributed \$27.9 billion to the state's economy.^{xv}

Minnesota fell five places in the Risk Capital and Entrepreneurial Infrastructure category, but still placed 16th. Matching its position on venture capital investment relative to Gross State Product with the best reading in patents at fourth. In 2016, Minnesota received the largest amount of venture capital investment in healthcare of any state in the Midwest.^{xvi} On most other indicators in this area, the state falls into the middle range. Governor Mark Dayton and the Legislature are improving access to early-stage financing through Minnesota's Angel Tax Credit program. The program provides tax credits to investors or funds that invest in high technology startups.^{xvii} Since the program started in 2010, over 400 businesses and startups have collected over \$370 million

in investment. A 2013 change in policy at the Mayo Clinic allowed researchers to hold leadership positions in firms based upon their intellectual property. The policy has spurred many more medical technology startups.^{xviii}



Illinois records a solid position in innovation-economy preparedness at 16th in the nation and second among Heartland states. At 59.5, Illinois scored better than New Jersey, Texas and New York on the STSI. Confirming Illinois' strong status in innovation was its 16th position in the State New Economy Index. Illinois rose by a substantial five places relative to being 21st on the STSI in 2014. The biggest contribution to Illinois' improvement came from a 6.8-point increase in the Research and Development component, even though its rank within the category only improved by one position. Technology Concentration and Dynamism provided the second-largest contribution to Illinois' improvement since 2014. However, the state witnessed a slippage in both Human Capital and the Technology and Science Workforce.

Illinois' per capita academic R&D funding places it at an unimpressive 28th despite having some of the top universities in the nation. The state is seventh in R&D expenditures in math and computer science.

However, where Illinois' research universities excel best is in translational research and bringing intellectual property to the market. For example, the University of Illinois is 18th and Northwestern is 23rd among all U.S. research universities in turning research funding into intellectual property measured by patents, licenses, startups and generating licensing income.^{xix}

A critical asset for Illinois in innovation is its strong bi-directional and cross-collaboration between universities, industry, and the state's two national labs, Argonne and Fermilab. Illinois is tenth in industry R&D with high contributions from Abbot Laboratories (the biopharmaceutical firm is the largest private employer in the state), Caterpillar and Motorola Solutions. Illinois was third in competitive NSF proposal funding rate. Overall, Illinois achieved its highest ranking at 15th on the Research and Development composite within the STSI. Given recent challenges in enacting a state budget, providing stable funding for higher education in the state will be critical.^{xx}

In measures of outcomes in the innovation economy, Illinois was 18th in Technology Concentration and Dynamism in the STSI. On this metric, the state rose from 23rd in 2014. Illinois had its strongest positions at 13th in percent of payroll in the high tech industry, number of Technology Fast 500 companies, and growth in high-tech industries. Illinois was 15th in the net formation of high-tech establishments relative to total establishments. The Illinois Innovation Network^{xxi} and the Discovery Partners Institute, located at the University of Illinois, are state programs launched to better partner university research with entrepreneurship and lead to higher business formation rates.^{xxii}

Illinois was 20th in Human Capital Investment and 24th in Technology and Science Workforce. The state has a bimodal distribution in its performance on the metrics included in these categories—it scored either high or low. Illinois was first in the nation in average math and English SAT scores. However, most students taking the SAT in Illinois are those looking to attend top private schools in the state such as the University of Chicago or Ivy League schools. ACT scores placed Illinois at 31th. Illinois was fifth in recent Master's Degrees in science and engineering and 13th in that category for PhDs.

The state was tenth in the percent of the adult population with an Advanced Degree and 12th with a Bachelor's or higher. Illinois' weakest performance was in the growth rate for state appropriations for higher education where it was 49th. This is an area of concern for Illinois. The state must invest in higher education on a sustained basis rather than attempt to fill gaps after a budget impasse. Among occupational categories, Illinois was sixth in nuclear engineers and seventh in physicists courtesy of its two national labs. The state also records solid scores in industrial engineers (11th), mechanical engineers (15th) and biochemists (15th).



Michigan witnessed steady advances in the measures of its position in the innovation economy and is third amid Heartland states and 18th in the nation on the STSI. Its latest 58.75 score on the STSI represented an 8.0-point increase and moved up eight positions from 2010—Michigan's highest rank since 2002. The State New Economy Index placed Michigan even higher at 15th. Further supporting Michigan's rising fortunes in innovation was its 3-position improvement in the State New Economy Index from 2014. Several measures of globalization are evaluated in the State New Economy Index where Michigan had high scores.

Michigan's fortunes have been transformed by a large gain in Technology Concentration and Dynamism and an appreciable increase in Research and Development. The Great Recession devastated Michigan's economy due to its high dependence on the auto industry and caused a temporary retrenchment in investments in innovation. However, Michigan has enacted some of the most well-articulated policies in the country to enhance its future position in the innovation economy. Michigan's economic development officials are attempting to diversify its industry composition by targeting alternative fuel technologies, the life sciences and information technology, among others. It is estimated that nearly one in eight jobs in Michigan are in life, medical and health sciences.^{xxiii}

Michigan's most significant gains were recorded in measures of outcomes within Technology Concentration and Dynamism. Between 2014 and the latest reading on the STSI, Michigan's score in Technology Concentration and Dynamism rose 12.2 points and 14 places. Even more remarkable, the state improved from 46th in 2010 to 16th in this category in 2016, the most of any state. An excellent example of the tremendous gains are seen in the net formation of high-tech establishments relative to total business establishments where it rose from 48th in 2010 to ninth in 2016.

Another illustration of the fundamental alternation of Michigan's fortunes is a rise from 47th in 2010 to sixth in a number of high-tech industries growing faster than the U.S. average. Michigan experienced an improvement in the quality of the firms growing in the state as evidenced by placing 13th in the number of Inc. 500 companies per 10,000 business establishments. The New Economy Initiative (NEI) focused on the Detroit metropolitan area has been supporting inclusive entrepreneurial programs and diversification of the economy over the past ten years. NEI's impact audit demonstrated how they assisted in launching 2,500 companies, employing 24,610 workers and leveraged more than \$1.2 billion in follow-on capital.^{xxiv}

Research and Development is another area where Michigan is making strides: its score rose to 68.82 in 2016, up from 59.13 in 2010 and 54.39 in 2002. Michigan now ranks 13th in research and development in the STSI. This consistent long-term advance displays the commitment to invest in its innovation pipeline to promote high-value-added economic growth in the state. A prime example is a jump in academic R&D rising from \$150 per capita in 2010 to \$226 per capita in 2016, propelling the state from 26th to 17th. Michigan has solid scores on NSF funding and research where it was 12th and 13th, respectively. Michigan has collected federal funding for research and now ranks tenth on both R&D expenditure in engineering and in physical sciences.

The University of Michigan is one of the top research universities in the nation but is even stronger in its ability to commercialize IP where it ranks 16th.^{xxv} One of Michigan's innovation bedrocks is its seventh position in industry R&D. General Motors, Ford and many components manufacturers, along with Johnson Controls, contribute to Michigan's strength in research and development. Michigan's firms have a long history of working with universities such as Michigan State in collaborative research engagements. An effort is underway to test the feasibility of a particle accelerator cluster in East Lansing.^{xxvi}

Michigan has maintained its near-median position of 23rd in both Human Capital Investment and Technology and Science Workforce. Within Human Capital, it is ninth in the concentration of Doctoral engineers and recent Master's Degrees in science and engineering. Reflecting its industry composition, Michigan is first in the intensity of both industrial engineers and mechanical engineers in the nation and held solid rankings in other measures of engineering talent. However, Michigan is not as strong in other STEM occupational categories. Governor Snyder has unveiled a new program to address challenges in STEM education called the "Marshall Plan for Talent."^{xxvii} The extensive plan targets investments through a three-pronged approach: K-12 education, higher education and the state's existing workforce. It includes funding for apprenticeship programs and tech-directed tuition assistance.



To build a 21st-century economy, **Wisconsin** recognizes how it is essential to make the most of its human capital, resources, and opportunities, and to meet the challenges posed by the rise of the knowledge economy.^{xxviii} Specifically, in the technology and science category, Wisconsin’s STSI rank of 22nd holds steady at slightly above the national median, with an average STSI score of 55.06. Wisconsin did improve by three positions over its 2014 rank with a slight 1.16 point increase. The 2017 State New Economy Index gave Wisconsin 26th place, a higher level than many of their Heartland counterparts.

Wisconsin Governor Scott Walker understands the importance of improving their STSI rank, and how human capital is an integral link to the state’s economic future. His recent workforce initiative with the Wisconsin Technical College System, the University of Wisconsin System and private colleges and universities in Wisconsin will strengthen their human capital with the use of \$20 million designated in Act 58 to establish a new Wisconsin Career Creator program on campuses all over the state.^{xxix}

Wisconsin lies centrally between Chicago and the Twin Cities, forming a region rich in technology and science called the I-Q Corridor. Wisconsin ranks 17th on the Technology and Science Workforce Composite Index, with mechanical engineers topping the list at second. Industrial engineers command third and chemists claim the fifth rank.^{xxx} A recent \$778,352 grant from the U.S. Economic Development Administration (EDA) will fund a cluster feasibility study to identify and assess current economic development assets within the Milwaukee area. The study will provide recommendations on how to forge new connections between technological commercialization, entrepreneurial business development, and manufacturing networks. Completion of the project will support the growth of high-technology clusters and create high-wage jobs in non-traditional manufacturing sectors.^{xxxi} This initiative could improve Wisconsin’s risk capital and entrepreneurial infrastructure composite rank where it currently holds the 20th spot.

Wisconsin has recruited a key supplier of Apple Inc., Taiwan’s Foxconn Technology Group, to construct a \$10 billion megaplant. The project is anticipated to seed technology manufacturing jobs for Wisconsin workers and help attract skilled labor from outside the state. Foxconn broke ground in southeastern Wisconsin on June 28th. Formally known as Hon Hai Precision Industry Co., the firm pledged to construct a 20 million-square-foot complex to build liquid-crystal display panels. They promised 13,000 new jobs in the state over several years. Sizeable incentives attracted Foxconn to Wisconsin but, not without controversy. Nonetheless, the expectation is to have a significant spillover effect that will result in spawning a new cluster within the state and assist in diversifying the overall state economy.^{xxxii}



Nebraska's overall STSI score of 53.52 places it at 25th in the nation—essentially at the national median. Nebraska did improve five places from 30th in 2014 and added 5.4 points to its score over the period. Longer term, Nebraska rose from 32nd in the initial benchmarking year of 2002. There is substantial evidence that Nebraska has improved its position in the innovation economy in recent years.

The State New Economy index placed the state at 27th, up eight places from its assessment three years prior. A series of Nebraskan governors supported investments and policies to promote technology-based economic development. Current Governor Pete Ricketts advocates for policies to improve technology connections to rural areas of the state. Governor Ricketts also supports the Library Innovation Studios project that works to strengthen makerspaces and access to technology tools that encourage creativity and promote entrepreneurship.^{xxxiii} Entrepreneurial policies are an increasing trend among politicians around the nation; they attempt to broaden access to the innovation economy. Nebraska's innovation economy is principally based in Omaha and Lincoln. Nebraska's gains in the overall STSI index are attributable to significant improvements in the Technology and Science Workforce index, followed by Risk Capital and Entrepreneurial Infrastructure.

The state was 11th in Technology and Science Workforce, landing it just out of a top ten ranking. Nebraska owes its success to a strong performance in some occupational categories in Computer and Information Sciences (CIS). Nebraska is fourth in the intensity of database administrators; fifth in computer hardware engineers; eighth in network and computer systems administrators; tenth in software developers systems; and 12th in computer network architects. To explain the concentration of CIS occupations, Omaha claims the headquarters of First Data Corporation along with major PayPal operations, CSG International and Mutual of Omaha also employ many of the CIS workers in the area.

Over the longer term, Nebraska's most impressive gains have been in Risk Capital and Entrepreneurial Infrastructure where the state now ranks 19th. As recently as 2012, Nebraska was 47th and the latest score was a remarkable 31-point improvement. Nebraska ranks 17th in venture capital investment as a percent of gross state product. Just in 2010, Nebraska ranked 46th on this measure. Over the most recent two-year period, Nebraska was sixth in the growth of venture capital investment. Impactful gains have been made in measures of entrepreneurial activity where business startups per capita rank Nebraska at 17th. Opportunities to support higher levels of entrepreneurship include the Southeast Community College Entrepreneurship Center.^{xxxiv}

They offer education, business coaching, networking and office space services to entrepreneurs. Nebraska is weak in the area of Research and Development performing at 35th. Nebraska is 35th in federal R&D and 30th in industry R&D. It ranks among the third tier on most competitive federal funding programs such as SBIR awards, STTR awards and NSF funding rates. State policy makers are attempting to address these shortcomings. Nebraska's Business Innovation Act provides technical support R&D grants for startup firms and entrepreneurs.^{xxxv} Lincoln, Nebraska's Innovation Campus (NIC) research facility is designed to enhance and initiate partnerships between the business sector and the University of Lincoln researchers. NIC's aspirational goal is to be the "most sustainable research and technology campus in the U.S."^{xxxvi}



Ohio remains in the middle-tier performers as far as participation and preparedness for the future in the innovation-based economy. The state’s 52.31 score on the STSI places it 27th overall and sixth among Heartland states. Ohio was 25th in the State New Economy Index and rose four positions from the score it recorded in 2013. Ohio ranks just above Missouri and three spots ahead of Indiana in the STSI. The state is still experiencing challenges stemming from the severity of the Great Recession, although its Third-Frontier investments maintained at a high level and Ohio did not slip in innovation.

Ohio witnessed a meaningful improvement in measures of its Technology and Science Workforce rising to 18th from 30th in 2014 within the STSI. Some of the gains were attributable to utilizing a more inclusive measure of technology and science in occupational categories where fewer advanced degrees were required than in the previous version from 2014. Nevertheless, Ohio witnessed some fundamental advances. An area of strength for Ohio is its fourth position in the intensity of material scientists.

Ohio has several other strong occupations with high intensity residing in technology and science: it is fifth in computer network support specialists; sixth in industrial engineers; seventh in aerospace engineers, chemical technicians and mechanical engineers; ninth in chemists and 14th in biomedical engineers.

Shortly after taking office, Governor Kasich initiated a new program by creating the Governor’s Office of Workforce Transformation. The head of this initiative reports directly to the Governor.^{xxxvii} In part, the office matches employer’s needs to skilled workers. They also encourage students to enter technology training programs. Technology jobs in the state pay an average of \$82,120 versus the average state wage of \$48,480, a wage premium of 69 percent.^{xxxviii} There was an advance in Ohio’s score in Technology Concentration and Dynamism as the state rose to 25th from 32nd in 2014. As recently as 2008, Ohio was 48th on this outcome measure. While Ohio still ranks close to the median range on measures of high-tech concentration, flow measures of performance demonstrate a discernable upward trend. For example, Ohio was the first in the nation on average yearly growth in high-tech industries over a five-year period. Further, Ohio was sixth in the net formation of high-tech establishments per 10,000 business establishments.

Cleveland Clinic Innovations, the commercialization arm of the research powerhouse Cleveland Clinic, has spun off nearly 80 companies since 2000, including Cleveland HeartLab, a cardiovascular diagnostic testing firm acquired by Quest Diagnostics in late 2017.^{xxxix} Ohio’s score on both the Human Capital Investment and Research and Development Inputs composites in the STSI rose slightly from 2014, but at 32nd and 26th, respectively, there is substantial opportunity for improvement. Some encouragement is found in Ohio’s 15th position in the number of recent Master’s Degrees in science and engineering relative to the size of the civilian workforce. Ohio is 24th and 25th in industry and academic R&D per capita, but at seventh and sixth in SBIR awards in Phase 1 and Phase 2, making for a sturdier position.

Ohio's is diversifying its economy through improved support systems available to startups with a particular emphasis on early-stage technology firms. The Third-Frontier initiative provides entrepreneurs access to mentorship, business expertise, talent and capital. The supportive program helps cultivate entrepreneurial ideas into growing firms with high-paying jobs.^{xi} The Fund for Our Economic Future in the greater Cleveland area provides similar startup services. They have aided in the creation/retention of 33,900 jobs and attracted \$8.4 billion in working capital.^{xii} TechColumbus offers comparable services by injecting capital into technology companies in Central Ohio. Ohio State University's Fisher College of Business made a recent announcement to support future startups with a pledge of \$17 million to develop a new entrepreneurship center.^{xiii} Recent venture capital placements demonstrate how Ohio sees an infusion of information technology, electronic devices and data analytics startups.^{xiii}



Missouri has played a historical role in the westward expansion of the United States, and today, the Heartland state expands its relevance in technology with an overall STSI score of 50.60. Placing them at 28th in the nation, this is the highest score across the seven STSI iterations. From 2014, the state improved six ranks and six points, giving them the second largest score increase of any Heartland state.

Missouri also improved their rank in the State New Economy index from 33rd in 2014 to 28th in 2017. The state's strategic plan for economic development implemented in 2011, sponsored by former Governor Jay Nixon, focused on growing several STEM fields within the state. Training workers for jobs in the STEM fields led to job preparedness for more than 57,000 individuals with the provision of more than \$28 million in venture capital during the first five years.^{xliiv}

Consistent with Missouri's strategic plan and outcomes, the Risk Capital and Entrepreneurial Infrastructure category is where the state improved the most. Jumping from 31st in 2014 to seventh in 2016 with a notable improvement from 30th in the first STSI ranking in 2002. One significant increase within the category was the number of companies receiving venture capital investments relative to total businesses. The growth confirms the connection to the state's strategic plan.^{xlv}

Missouri did improve their Research and Development Inputs index and Technology Concentration and Dynamism index rankings. Yet, their Human Capital Investment index and Technology and Science Workforce index rankings declined six and eight spots, respectively. The decline in Human Capital Investment was primarily due to a relative decrease in the number of recent PhDs and Postdoctorates in science, engineering, and health fields. Similarly, low densities of scientists, engineers, and health-related professionals drove Missouri's workforce ranking. Looking ahead, an explicit focus on bioscience, health sciences, and advanced manufacturing in the strategic plan may induce an upturn in the workforce deficiencies. The Donald Danforth Plant Science Center is a leading research group that collaborates with several public and private organizations to solve global biotech problems.^{xlvi} Their continued growth will accelerate candidates into the workforce, helping to offset the current human capital shortage.



As for **North Dakota**, the state has an overall STSI rank of 29th. This number has stayed the same since 2014. With no growth in the rank number, North Dakota has taken notice. Last year, school Superintendent Kirsten Baesler successfully urged the North Dakota legislature to approve a new law that allows for high school students in the state to substitute a computer science course in place of a math class.^{xlvii} North Dakota claims third for average math SAT scores. The STSI ranks North Dakota first in recent Bachelor’s Degrees in science and engineering per 1,000 civilian workers and the fifth for PhDs awarded in science, engineering and health.

Some may not know that North Dakota is America’s leading state in drone research and testing. Four elements came together in North Dakota to give the state a head start in the unmanned aerial systems industry (UAS) — its emptiness, its weather, its university and its UAS-friendly policies.^{xlviii} Swoyer’s Grand Sky is the first commercial UAS business park in the U.S. Located 20 miles west of Grand Forks, the 217-acre, former Cold War installation currently flies only robot aircraft for the United States military and Customs and Border Protection.^{xlix} The development also allows all commercial drone companies to conduct UAS testing and training.

The state of North Dakota invested \$17 million of public money in the Grand Sky infrastructure to add high-paying jobs for residents processing data collected by drones, maintaining drones and piloting them. North Dakota has spent around \$34 million fostering the state’s unmanned aerial vehicle business.¹

North Dakota, the owner of the land where the Bakken Shale formation was initially discovered in 1951,^{li} experienced a recent peak in production in 2012. Recent numbers confirm the resurgence in volumes extracted from the formation may see record highs in 2018. Roughly, 56 drilling rigs were active in January, up four from the December average, while a year ago, North Dakota had just 38 rigs operating. Expansion in the number of groups searching for oil and gas in the state indicates rebounding drilling activities and production.

Though the rig count is still down substantially from the 2012 peak when North Dakota had 218 rigs drilling, one must take into consideration how refined drilling rigs have permitted producers to extract more oil out of each well. In essence, state-of-the-art oil rigs have facilitated output. North Dakota’s financial equilibrium demonstrates how shale firms are putting more rigs and employees back to work.^{lii} The intensity of mining and geological engineers, including mining safety engineers, are ranked fifth on the STSI.

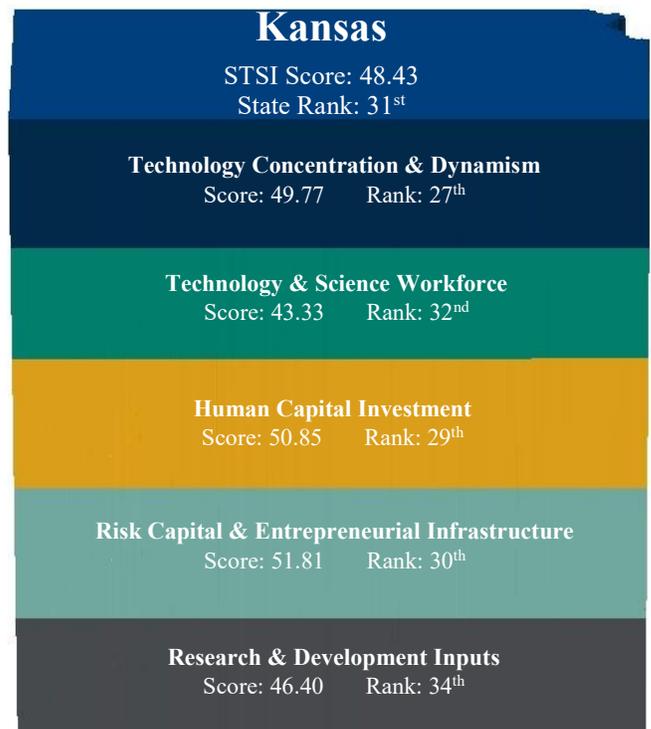


The diversified economy in **Indiana** lands the Hoosier state in 30th, three spots lower than their 2014 status of 27th. Other indications are showing how Indiana has improved its position in the innovation economy in recent years. The State New Economy index placed Indiana at 33rd, up five places from its assessment three years ago. Indiana has had former Gov. Mitch Daniels and current Governor Eric Holcomb supporting investment and policies to promote technology-based economic development, especially in the STEM areas.

“As Indiana emphasizes the importance of STEM-related courses and their impact, we always want to identify, recognize and elevate our best and brightest science, technology, engineering, students to honor them for their hard work,” Gov. Holcomb said.^{liii}

Indiana holds first place for the intensity of material engineers on the Technology and Science Workforce Composite Index and fourth for the intensity of mechanical engineers. In May, Purdue University scientists announced they would receive \$1.8 million in the form of a U.S. Department of Energy’s Bioenergy Technologies Office grant. The University’s goal is to convert solid biomass into a slurry, allowing the material to move freely through systems within the biorefineries.^{liv}

According to Indiana.gov, there has been \$105 million in venture capital funding in 2017.^{lv} Indiana has tied Nebraska for the 15th spot for the number of high-tech industries exhibiting fast growth. Indiana is leading a tech transformation in the Midwest, with an impressive portfolio of tech companies emerging in Central Indiana. Indianapolis is home to several tech clusters. Growing companies have set up shop there, establishing offices and hiring new talent. Salesforce, a cloud platform company, bought the Indy-based firm ExactTarget in 2013. They purchased a 278,000 square-foot-footprint in the city’s Chase Tower on Monument Circle and plan to hire more than 800 plus personnel by 2021.^{lvi} Currently, there are 84,500 tech industry jobs in Indiana.^{lvii}



Kansas is well known for their tornadic weather, but less well known is Kansas’ overall STSI score of 48.43 placing it at 31st in the nation. The state’s position lowered slightly from 2014, with its rank falling three spots and score dipping a point. Overall, Kansas’ ranking and score have declined over the past three STSI iterations, to its lowest-ever ranking and score.

The State New Economy index tells a slightly different story, with the state improving one spot to 30th from 2014 to 2017. The University of Kansas Center for STEM Learning and the Kansas State University Center for Research and Innovation in STEM Education are taking action to reverse the downward trend in science and technology. The University of Kansas provides K-12 teachers and students with the opportunity to be mentored by STEM field experts, resulting in the positive development of class experiments and student research.^{lviii}

The focus to improve STEM education is vital to stimulate Kansas' STEM economy. The state's most significant categorical declines in the STSI were in the Human Capital Investment index and the Technology and Science Workforce index; they suffered declines of five and 11 spots from 2014 to 2016. The prospect of mentors growing student interest in STEM careers is key, given the state had ranked 47th in Bachelor's Degrees granted in science and engineering in 2016.

Kansas' most substantial STSI improvement from 2014 to 2016 was in the Risk Capital and Entrepreneurial Infrastructure index, where it climbed four spots to 30th in the state rankings. There is continued progress toward strengthening their rank with The Catalyst program at the University of Kansas. The program initiatives help students launch their startups by providing access to fellow-student research assistance, funding opportunities, and legal advice, among other resources.^{lix}

Flint STEM Camps, a company born from The Catalyst program is working to improve STEM education: the company provides educators with an all-inclusive summer camp intended for educators to initiate STEM exploration in young minds. With a startup environment created by foundational programs like The Catalyst, in addition to improving STEM education, Kansas could make a fast comeback in the STSI ranks.



Iowa, known for its agricultural economy, is making the transition to a diversified economy in the early stages of the 21st century. Iowa's overall STSI score was 43.51, placing it at 35th in the nation. Compared to 2014, the state's rank fell four spots, and the score dropped 4.5 points. Iowa's rank remained equal to the first STSI iteration in 2002, and the score improved by a point.

In the State New Economy index, Iowa had demonstrated steady progress from 42nd in 1999 – the index's first iteration – to 37th in 2017. Their relative position in science, technology, and economic structure have changed little over the past two decades. Iowa is not content with the trend of stagnation; their newly developed initiatives and programs give indicators toward a positive uptick.

The Iowa Innovation Corporation helps small innovative companies obtain government funding, mainly from the Federal Small Business Innovation Research program (SBIR).^{lx} From 2016 through 2017, the group helped Iowa companies secure more than \$14 million in SBIR funding.^{lxi}

Funding assistance for innovation-focused firms ought to improve Iowa's position in two STSI categories: Research and Development Inputs and Technology Concentration and Dynamism. In 2016, Iowa ranked 31st and 40th in the two areas. There are three components to the Research and Development Inputs related to the number of SBIR awards received. Iowa performs poorly in all of them in 2016.

Iowa is attempting to recover its position in Research and Development Inputs from the last ranking. If some of the award recipients can grow into thriving high-tech companies, key measures within the Technology Concentration and Dynamism measure should also rise.

Iowa has been consistent in the Human Capital Investment Input index, where it ranked 18th in 2016. However, this success has not translated into a STEM-intensive workforce, as the state ranked 37th in the Technology and Science Workforce index for the same year. That may soon change, as US News ranked Iowa the best state in the country in its 2018 Best States ranking, up from sixth in 2017. The state made the top ten in health care, education, opportunity, infrastructure, and quality of life categories.^{lxii} Iowa's strong performance across multiple categories implies the likelihood of retaining top STEM workers while attracting more talent from outside the state bounda



Alabama has played a key role in the history of U.S. space exploration; it is home to one of the three remaining Saturn V Apollo rockets housed in the Saturn V Hall at the Davidson Center for Space Exploration in Huntsville. Alabama strives to bring this legacy into the modern age with an overall STSI score of 42.67, placing it at 37th in the nation. Like many other southern Heartland states, Alabama's position declined from 2014. The state fell five places from 32nd with its score dropping 3.4 points. Looking across all seven STSI iterations, 37th is Alabama's lowest rank.

Similar to its STSI trend, Alabama's placement in the State New Economy index fell from 41st in 2014 to 44th in 2017. While Alabama's downward trend in the two indexes is disconcerting, there are signs how the state is working to improve economic performance. Governor Kay Ivey's 2017 education initiative – Strong Start, Strong Finish—focuses on exposing students to computer science and STEM fields during middle and high school, and on increasing post-secondary education attainment.^{lxiii}

The governor's initiative directly combats the key reasons for Alabama's fall in the STSI rankings from 2014 to 2016: declines in the Human Capital Investment and Technology and Science Workforce indexes of six and 12 spots, respectively. Alabama ranked 43rd in the percentage of Bachelor's Degrees granted in science and engineering; that is a 21 spot fall from 2012. Of all Technology and Science Workforce subcomponents, Alabama's three lowest rankings were in computer science-related areas, the very areas of emphasis for Governor Ivey's Strong Start, Strong Finish program.

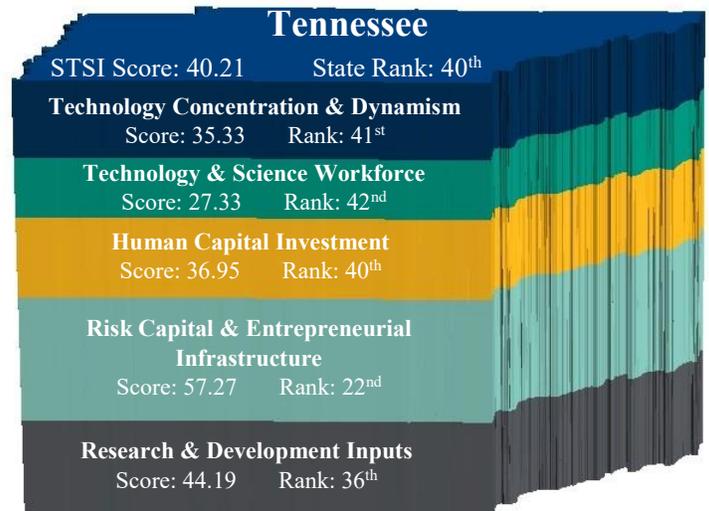
If Alabama succeeds in growing its human capital and STEM workforce, it could see a large rise in the next STSI overall ranking. The state already improved seven and four spots from 2014 to 2016 in the Risk Capital and Entrepreneurial Infrastructure index and Technology Concentration and Dynamism index. The improvement in Risk Capital and Entrepreneurial Infrastructure was driven by a jump from 44th to third in total venture capital investment growth. Gains are likely to continue, with the second iteration of the state-sponsored Accelerate Alabama strategic plan implemented in 2016, centering on STEM-related manufacturing and services growth.^{lxiv}



South Dakota ranks 38th on the STSI report, climbing four positions higher than their 2014 spot. Their average score had an impressive 6.5 point increase over the 2014 score. On the ITIF report, South Dakota ranks 41st, just one place higher than their 2014 rank. The state is aware they are weak in their rankings, so they have stood tall when it comes to taking action to have a positive influence on economic growth. The coordinated framework of the 2020 Vision: The South Dakota Science and Technology (S&T) plan, a collaboration between state government, higher education and the private sector. The S&T plan outlines a set of strategic initiatives to aid in the advancement and growth of economic and workforce development.^{lxv}

A couple of impressive technology and science workforce areas on the STSI include agricultural and food science technicians who rank third, with computer network support specialists coming in at fourth. The Science and Technology plan is having a positive effect on the state's economy. For example, to elevate science literacy and to drive science-based economic development, South Dakota added a \$20 million program supported by the National Science Foundation and supplemented with \$12 million in state funds. The combination commissioned by Governor Dennis Daugaard endorses a 2020 master vision in science and technology.^{lxvi} South Dakota ranks eighth in total venture capital investment growth and 11th in the number of high-tech industries growing faster than US average.

Lastly, South Dakota offers a business climate designed to support entrepreneurs toward success. The South Dakota entrepreneur has a competitive edge over all other business counterparts in the United States: they receive tax incentives that include no corporate income tax, no personal income tax, no personal property tax, no business inventory tax, and no inheritance tax to give them a major advantage where they can earn money and keep it.^{lxvii}



Tennessee has played a critical, creative role in the development of many forms of favorite American music, including country, blues, and rock and roll. Music, a key output in the state's economy, now has competition with newer trending businesses that have technology and innovation in mind. Tennessee's overall STSI score of 40.21 places it at 40th in the nation. Similar to bordering states Alabama and Kentucky, Tennessee fell four spots from 2014 due to a score decline of 3.5 points. While these declines are notable, the state's 2016 rank and score are at or very near its medians across the seven iterations of the STSI.

Meanwhile, the state improved eight spots in the State New Economy index from 2014 to 2017. Looking ahead, there is significant evidence that Tennessee will strengthen its position in technology and science. The University of Tennessee System, for example, added initiatives to its strategic plan in 2015 that focus on funding the development of university research into marketable products and developing research partnerships with private companies.^{lxviii}

Tennessee’s overall STSI score is the result of declines in the Human Capital Investment index and the Technology and Science Workforce index more than negating small to moderate improvements in the Research and Development Inputs, Risk Capital and Entrepreneurial Infrastructure, and Technology Concentration and Dynamism categories. With initiatives such as the University of Tennessee System’s, the latter three categories should continue to trend upward. Tennessee is addressing the human capital and STEM workforce deficiencies with a computer coding initiative in the fast-growing Knoxville-Oak Ridge Innovation Valley. In the fall of 2017, over 6,000 students from across the state began learning to code all at the very same time. Together, the massive student body earned a Guinness world record for their educational feat.^{lxxix}



Oklahoma has fallen steadily one point each consecutive year since 2004. They currently hold 44th on the STSI and a comparable 45th on the ITIF. The low ranks situate Oklahoma to take needed action. Oklahoma Governor Mary Fallin in her eighth and final state of the state speech acknowledged how it had been a “very difficult past year.”^{lxxx} The State is targeting its technology soft spots with the launch of an innovative program designed to improve government, encourage civic engagement and support new businesses in the local economy.

The new Oklahoma initiative – Creating the Silicon Prairie will form strong partnerships between the Office of Management and Enterprise Services (OMES) and the Oklahoma Center for the Advancement of Science and Technology (OCAST), and other state entities to modernize state government.^{lxxxi} The program will encourage innovation with citizens and the business community through engagement and feedback.

The Silicon Prairie will focus on increasing technology occupations like coders and programmers, who currently hold the 36th rank. The initiative will ultimately attract innovators and entrepreneurs through new companies and startups. Oklahoma claims the tenth spot for total VC investment growth. Developing Oklahoma’s tech economy will help keep local talent local, as well as recruit talent from outside the state.^{lxxii} The STSI places Oklahoma second for the number of business incubators per 10,000 business establishments. The high rank validates how the state is taking action to improve its tarnished reputation.



Louisiana's economy is thrusted by their agricultural products like seafood, and tourism, especially in the New Orleans parish. The state holds an overall STSI score of 31.40, placing it 46th in the nation. Both the score and ranking were up slightly from 2014, the score came up 0.1 point and rank up two spots. However, looking across all iterations of the STSI, the 2014 rank and score were Louisiana's lowest. The situation is similar for Louisiana's State New Economy index ranking, which, at 46th, went unchanged from 2014 to 2017. Overall, Louisiana has been near the bottom of both index rankings for several years, but the state government has recently shown its unwillingness to remain there. In 2017, the government laid out a strategic plan with an explicit priority of cultivating small business, innovation, and entrepreneurship. Central to this priority is a plan to work with both universities and economic developers to create a path for innovation in Louisiana.^{lxxiii}

Louisiana's rankings did improve in four categories with the one deline being the Risk Capital and Entrepreneurial Infrastructure category. One positive development was in human capital investment; Louisiana jumped from 48th in 2014 for growth in state appropriations for higher education to 12th in 2016.

The current Governor John Edwards advocates the spending increase in higher education and has pushed for it to continue.^{lxxiv} The increase in human capital, when coupled with FIRST Louisiana, a statewide initiative aimed explicitly at harnessing university research to drive innovation across Louisiana, creates a promising outlook for all aspects of the state's STEM economy.



Today **Kentucky's** economy is more diversified than in the past, with an emphasis on auto manufacturing, energy fuel production, and medical facilities. Kentucky's overall STSI score of 30.53 places it at 47th in the nation. Compared to 2014, the state fell three positions and 2.1 points. Longer term, 47th is the state's median rank across the seven STSI iterations, but 30.53 is the lowest score Kentucky has received.

The State New Economy index tells a different story: Kentucky improved five spots to 39th from 2014 to 2017. The divergence between the two indexes indicates that Kentucky scores higher in measures such as globalization and some upward momentum. This explanation seems likely, given the new Governor Matt Bevin is noted for removing barriers to new and expanding businesses.^{lxxv} In 2017, Amazon announced plans for a \$1.5 billion cargo facility in northern Kentucky,^{lxxvi} and Toyota recommitted to the state with an announcement of a \$1.3 billion upgrade to a Kentucky manufacturing facility.^{lxxvii}

One STSI category where Kentucky did not improve or maintain its rank from 2014 to 2016 was Research and Development Inputs. The state fell five positions in the category, but this area is experiencing improvement given the governor’s focus; Toyota also recently opened a Production Engineering and Manufacturing Center where hundreds of engineers will work on product development.^{lxxviii} While the Human Capital Investment index and the Risk Capital and Entrepreneurial Infrastructure index did not decline from 2014 to 2016, the state ranked in the mid-40’s for both. To address the deficiencies and prepare for the influx of investment into the state, the Kentucky Workforce Innovation Board, a group of Kentucky business leaders that advises the Governor, unveiled a new strategic plan in 2018. The plan focuses on aggressively training the current workforce, schooling the students for STEM positions.^{lxxix}



Mississippi's historic low state rankings on many measures have given rise to the saying "Thank God for Mississippi," denoting relief from other states that their state isn't the lowest.^{lxxx} Mississippi’s overall STSI score was 29.84, placing it at 48th in the nation. 48th is the highest rank the state has received across the seven STSI iterations and one position improved from 2014. However, Mississippi’s score fell a point from 2014. Mississippi placed 50th the past four years on the State New Economy index. The state is in a difficult situation, yet, not ignoring its relative struggles; it has begun a multifaceted effort to improve its overall and STEM economy. Mississippi 2020 Vision is a strategic plan developed by the Governor’s State Workforce Investment Board, with a mission to “maximize resources in support of education and occupational skill development.”^{lxxxi}

The program addresses significant needs for Mississippi: human capital and workforce development. In 2016, Mississippi ranked 47th and 48th in the Human Capital Investment index and Technology and Science Workforce index. And 49th in the percentage of 25 or older population with a Bachelor’s Degree. In 2018, the Mississippi Department of Education launched an initiative to address the issue: The Mississippi Innovation Lab Network is centered on student-specific learning plans to better prepare students for college and other career paths.^{lxxxii}

The state has improved its Technology Concentration and Dynamism index ranking from 50th in 2004 to 32nd in 2016 by adding fast-growth technology firms. The multi-university collaboration Mississippi Science and Technology Plan focuses on using university research to drive the state innovation economy. This plan, combined with the others recently unveiled across Mississippi, may lead to a thriving, STEM-focused Mississippi in the near future.



Arkansas, housing several homegrown Fortune 500 companies, has implemented a number of policy initiatives over the years to augment its position in the innovation-based economy. Thus far, they have not had the desired impact as other states continue to invest—making it a challenge to close the gap. On the STSI, Arkansas ranked 49th in the nation and last among Heartland states. Arkansas ranked 49th on the State New Economy Index confirming that further efforts are necessary to improve its competitive position in the innovation economy.

On a positive note, Arkansas' overall score of 27.95 in the latest reading of the STSI was 5.15 points higher than it recorded in 2002. Arkansas fell from 45th in 2014 on the STSI; however, the bulk of this decline was concentrated in Technology and Science Workforce and was largely attributable to a change in the methodology between the two years.

Arkansas' score on the Technology and Science Workforce fell to 14.66 points and 49th in 2016, a decline of 21.03 points from 2014. The State's position deteriorated due to poor scores on newly added occupational categories that had a lower mix of Bachelor's Degrees or above and a higher prevalence of Associate Degrees. Nevertheless, this does not absolve Arkansas for its lagging position in workforce preparedness in technology and science. Its strongest occupational category was in agricultural and food science technicians where the state was fourth in the nation.

With strengths in rice and protein production, the state remains among the national leaders in food and agricultural science. Additionally, Arkansas was 14th in the intensity of microbiologists. Arkansas score in Human Capital Investment rose 4.19 points between 2014 and 2016. However, it ranked 49th. Arkansas scored poorly on most stock measures within human capital, but there was some encouragement in that the state ranks higher in flow measures. For example, Arkansas was 32nd in recent Master's Degrees in science and engineering and 16th in science, engineering and health PhDs awarded.

Governor Asa Hutchinson is attempting to address the gaps in the technology and science workforce. The legislation was passed requiring all public high schools to offer computer science curriculum and backed it by providing funding for training teachers.^{lxxxiii} Governor Hutchinson has implemented a new program, ArFuture grants, where the state pays for all tuition and mandatory fees to attend a two-year college program or technical school to pursue a high-need job skill or degree.^{lxxxiv}

An area of particular concern for Arkansas is its weak readings on Research and Development where it was 49th. Federal R&D funding per capita was 49th in the nation. However, a particularly troubling area for Arkansas was its 46th position in academic R&D. If the state is going to see fundamental improvements in its position in the innovation economy over the long-term, more emphasis and policy must be directed toward attracting additional research funds at its flagship institution - the University of Arkansas-Fayetteville, the University of Arkansas for Medical Sciences and other research institutions in the state.

Commercialization and technology transfer must improve, but more research funding is required to secure a stronger position. Arkansas has witnessed gains in attracting more STTR and SBIR awards where it was 17th and 27th, respectively. One influential group addressing the research challenge in the state is the Arkansas Research Alliance. It draws together the leadership of leading Arkansas-based firms and the chancellors of the state's five research universities in promoting understanding of the importance of research for Arkansas' future economic growth and funds programs recruiting out-of-state scholars.^{lxxxv}

At 41st in Risk Capital and Entrepreneurial Infrastructure, Arkansas had its highest score across the five composites. Significant resources are directed toward improving support systems for entrepreneurs, although there remain challenges in attracting early-stage risk capital. Startup Junkie Consulting offers a variety of services to the entrepreneurial community as an incubator-accelerator.^{lxxxvi} Innovate Arkansas, at Winrock International in Little Rock, develops and manages programs to support tech-based startups. Additionally, it assists clients in capital structure with a focus on management talent development.^{lxxxvii} Another new entrepreneurial infrastructure boosting business is Grit Studios; this accelerator aids high-impact entrepreneurs to scale up their businesses.^{lxxxviii}

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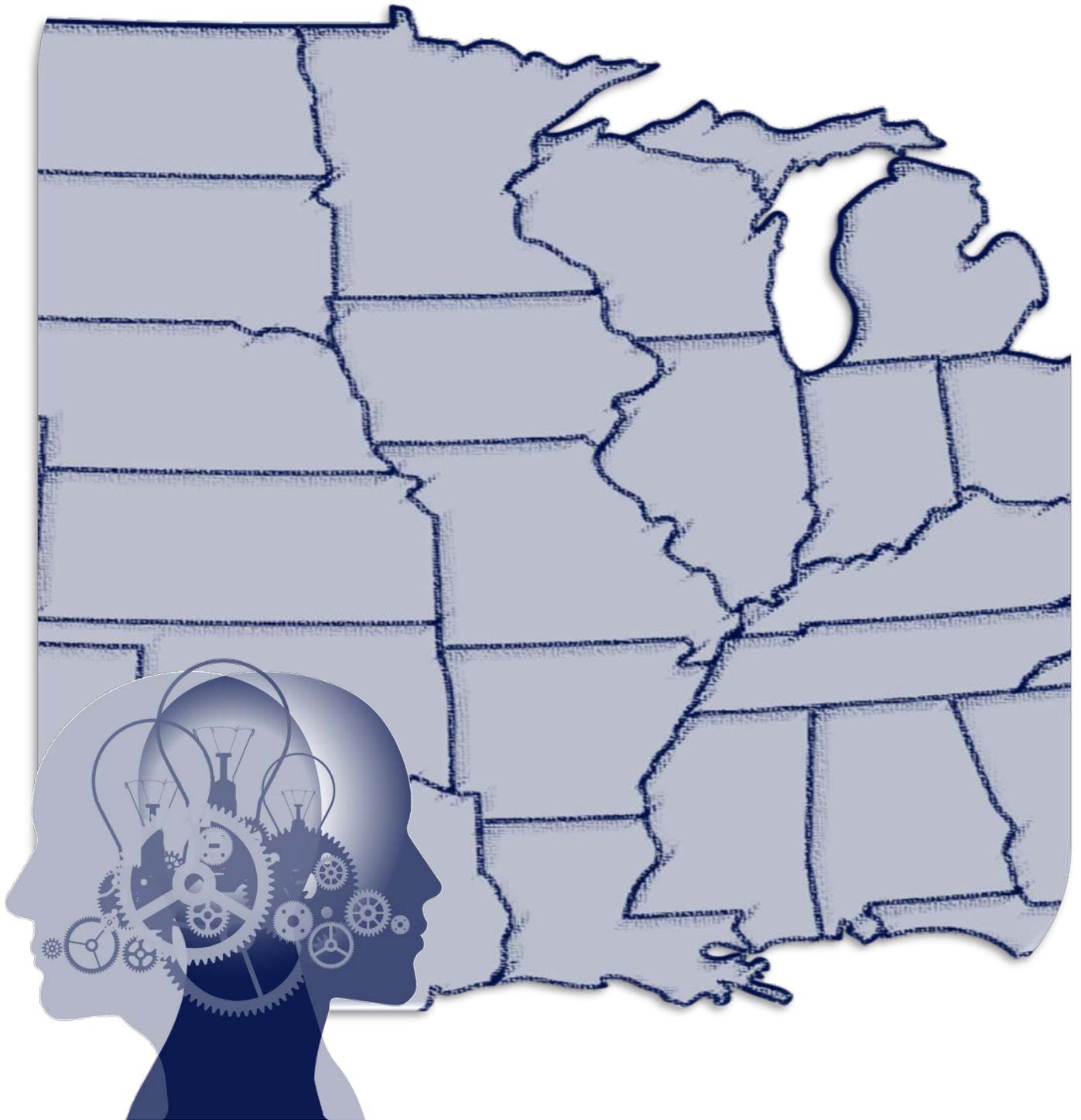
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