2018 STATE TECHNOLOGY AND SCIENCE INDEX

Sustaining America's Innovation Economy

By Kevin Klowden, Joe Lee, and Minoli Ratnatunga

MILKEN INSTITUTE

2018 STATE TECHNOLOGY AND SCIENCE INDEX

Sustaining America's Innovation Economy

By Kevin Klowden, Joe Lee, and Minoli Ratnatunga

MILKEN INSTITUTE

ON THE WEB

Data for each state and indicator can be found on our interactive website at www.statetechandscience.org

ABOUT THE MILKEN INSTITUTE

The Milken Institute is a nonprofit, nonpartisan think tank. We catalyze actionable solutions to persistent global challenges by connecting human, financial, and community resources to those who need them. Guided by a conviction that the best ideas, under-resourced, go nowhere, we conduct applied research, convene luminaries from competing viewpoints, and construct programs and initiatives designed to achieve our overarching mission of building meaningful lives.

ABOUT THE CENTER FOR REGIONAL ECONOMICS

The Center for Regional Economics promotes prosperity and sustainable growth by advancing regional competitiveness and job creation. Through research and policy analysis, stakeholder engagement, and programming, we develop and support actionable economic and policy solutions for local, state, and regional leaders.

ACKNOWLEDGMENTS

The authors would like to thank Ross DeVol for providing the methodological foundation on which this report is built. We are also indebted to Milken Institute colleague Jessica Jackson and intern Caitlin Thompson for their input.

CONTENTS

EXECUTIVE SUMMARY

The State Technology and Science Index (STSI) endeavors to benchmark states on their science and technology capabilities and broader commercialization ecosystems that contribute to firm expansion, high-skills job creation, and broad economic growth. It aims to capture a state's innovation pipeline. The index looks ahead, assessing the foundation on which future growth will build and focusing attention on the elements of a knowledge economy that will help states adapt to economic change.

The STSI's 107 individual indicators are sorted into five composites: research and development (R&D) inputs, risk capital and entrepreneurial infrastructure, human capital investment, technology and science workforce, and technology concentration and dynamism. The STSI overall scores are displayed in the table on page 2.

RESEARCH AND DEVELOPMENT INPUTS

RISK CAPITAL AND ENTREPRENEURIAL INFRASTRUCTURE

HUMAN CAPITAL INVESTMENT

TECHNOLOGY AND SCIENCE WORKFORCE

TECHNOLOGY CONCENTRATION AND DYNAMISM

2018 STATE TECHNOLOGY AND SCIENCE INDEX RANKINGS

STATE	2018	2016	RANK CHANGE 2016-2018	SCORE
Massachusetts	1	1	0	86.25
Colorado	2	2	0	80.08
Maryland	3	3	0	79.24
California	4	4	0	78.08
Utah	5	8	3	75.27
Washington	6	5	-1	74.60
Delaware	7	10	3	66.13
Minnesota	8	7	-1	63.11
New Hampshire	9	11	2	62.34
Oregon	10	13	3	61.76
North Carolina	11	12	1	61.24
Virginia	12	9	-3	60.28
Pennsylvania	13	14	1	59.58
Connecticut	14	6	-8	59.50
Illinois	15	16	1	58.35
New York	16	20	4	57.52
Arizona	17	23	6	56.73
Michigan	18	18	0	56.37
Rhode Island	19	15	-4	56.34
Texas	20	19	-1	55.60
New Jersey	21	17	-4	55.12
Georgia	22	24	2	53.25
Vermont	23	26	3	53.24
New Mexico	24	21	-3	52.06
Wisconsin	25	22	-3	51.96
Idaho	26	32	6	50.99
Ohio	27	27	0	50.88
Montana	28	34	6	49.22
Indiana	29	30	1	46.10
Missouri	30	28	-2	46.03
Kansas	31	31	0	45.29
Alabama	32	37	5	43.40
Florida	33	41	8	42.39
Nebraska	34	25	-9	40.84
Hawaii	35	39	4	39.21
Iowa	36	35	-1	38.82
South Carolina	37	43	6	38.00
North Dakota	38	29	-9	36.37
Tennessee	39	40	1	36.23
Maine	40	42	2	35.77
Alaska	41	33	-8	35.70
Wyoming	42	36	-6	35.13
South Dakota	43	38	-5	31.86
Nevada	44	45	1	30.45
Louisiana	45	46	1	25.53
Kentucky	46	47	1	25.48
Oklahoma	47	44	-3	25.01
Arkansas	48	49	1	23.32
West Virginia	49	50	1	19.96
Mississippi	50	48	-2	19.78

Source: Milken Institute.

Findings

Massachusetts ranks No. 1 in the 2018 edition of the STSI, maintaining its hold on the top spot since 2002. The state places first on three of the five sub-indexes—retaining the R&D inputs composite crown and increasing by one rank on both the risk capital and entrepreneurial infrastructure composite and the human capital investment composite. This edition of the STSI marks the second time Massachusetts' rank has declined on the technology and science workforce sub-index, attributable this year to decreases in the concentration of life scientists.

Colorado ranks No. 2 in this year's STSI, maintaining its rank from the 2016 edition. Colorado's score remains remarkably stable from 2016, scoring 80.08 for 2018, only a 0.32-point decrease. The Centennial State ranks third on the R&D inputs, as it has for the last eight years. Maintaining its entrepreneurial success, Colorado ranks in the Top 5 for five of the 12 indicators that make up the risk capital and entrepreneurial infrastructure composite.

Maryland retains its third-place ranking on the 2018 STSI. The state scores 79.24 overall, a decrease of 1.07 points from 2016. The ten-rank decrease in the technology concentration and dynamism composite is largely attributable to a slowing high-tech sector, which resulted in a 38-place drop in the "number of high-tech industries growing faster than U.S. average" indicator. Between 2012 and 2016, Maryland averaged high-tech employment growth of 0.36 percent.

California ranks fourth again in this year's edition of the STSI with a score of 78.08 points. The state maintains its second-place ranking on the technology concentration and dynamism composite for 2018 and continues to enjoy a vibrant high-tech economy. In California, the high-tech sector provides 9.4 percent (No. 3) of private sector employment and 17.2 percent (No. 2) of private sector wages, and 7.3 percent (No. 4) of California establishments are in high-tech industries. California's knowledge economy is diverse, with 18 of the 19 high-tech sectors more concentrated than the national average (No. 1).

Utah jumps from No. 8 to No. 5 in this year's STSI, the only change in the Top 5. The state score is 75.27 points, a 6.13-point increase from the 2016 edition of the STSI. Utah jumps from 13th to 1st on the technology concentration and dynamism composite. Utah has seen the fastest employment growth in the high-tech sector in the nation, at 4.3 percent. Exemplifying the state's focus on building its knowledge economy is the University of Utah, which was the top school in the country for commercializing university R&D.

The state that experienced the largest improvement on the 2018 STSI was Florida, which gained eight places to rise from No. 41 to No. 33. Florida's jump was largely due to an 18-rank increase in the risk capital and entrepreneurial infrastructure sub-index.

Policy Recommendations

A number of common challenges appeared in both the state-by-state comparisons and our case studies. They include the need for a smoother pathway for students as they transition from the university to the workforce, more effective recruitment of students into science and technology majors, and ensuring that enough trained tech workers remain in the state to sustain economic growth. The following policy recommendations are intended to guide policymakers who wish to build and sustain a strong knowledge-based workforce.

- » State legislators should examine and determine mechanisms for their own state for implementing a statewide college promise program directly intended to remove financial barriers and increase opportunities for in-state students pursuing degrees in STEM fields. The intent of this program should be to strengthen the local employment base of skilled workers to not only be educated in but also stay in the state for STEM careers.
- » In order to further facilitate the pathway for STEM and other knowledge-based workers, state legislators and community college administrators should develop stronger curriculum alignment between associate and four-year college degrees.
- » To facilitate more effective in-state job placement, higher education institutions and the private sector should partner more frequently on co-operative and paid internship programs. This would facilitate greater levels of workforce-readiness for students and provide greater access to in-state employment opportunities.
- » In order to facilitate increased access to skilled workers for innovative companies, state legislators should examine the appropriate level of enforcement for non-compete clauses within the state—looking at the examples of California and Massachusetts as two possible pathways. Legislators should work to set reasonable policy on the clauses in terms of their duration, scope, and associated compensation. They should examine and weigh the effect of these contracts on both low-income and high-skill workers in fields where skills devalue more quickly.

INTRODUCTION

Since its inception in 2002, the Milken Institute State Technology and Science Index has served as a model for states to examine their efforts and those of their peers in creating sustainable knowledge-based economic development. The 2018 edition of this index provides direct insight into various initiatives and practices at the state level to develop ecosystems that support technology advancement, knowledge-based development, and entrepreneurship. The aim of the index is to provide a pathway for states to audit not only their own pursuits of future-focused economic development and job creation, but also to consider the effectiveness of peer states in evolving their high-skilled workforce and entrepreneurship.

University and private sector research and development are vital components of knowledge-based economic development. They generate new ideas, products, and processes that help firms stay competitive, seed new industries, and adapt to changing economic and policy environments. Institutions and companies that invest in R&D also develop human capital and foster industrial cluster development, contributing to the robustness of a knowledge-based regional economy. This link between sometimes abstract research activity and new jobs and firms is not always well understood by policymakers and the public, but is a vital component of the United States' competitive advantage.

The index is intended to provide a clear understanding of development efforts over time. Unlike its sister publication, the annual Best-Performing Cities index, STSI is issued every other year in order to provide more time to observe the longer-term changes in key areas, including the strength of states' workforce skill levels, as well as the efforts to continue to produce degree recipients needed to maintain that workforce.

The success stories of states that are profiled in this year's index are backed by the resiliency to not only build, but also maintain their ecosystem. Massachusetts has maintained its lead position in each edition of STSI, not only because of its tremendous concentration of universities, but also its ability to develop and evolve its entrepreneurial ecosystem. States such as Maryland and Virginia have leveraged connections to the federal government due to proximity, but have also benefited from concerted efforts in life sciences in Maryland's case and becoming an early player in the internet and telecoms boom in Virginia.

The State Technology and Science Index captures the core conditions needed to create and sustain a flourishing ecosystem. Five key sub-indices—R&D inputs, risk capital and entrepreneurial infrastructure, human capital investment, technology and science workforce, and technology concentration and dynamism—distill down precisely how each state performs in its ability to fuel and drive innovation.

This index serves as a key foundation of the work of the Milken Institute Center for Regional Economics, which focuses, amongst other ambitions, on knowledge-based economic development. This issue area not only serves as a pillar of the center's research efforts, but also as part of our broader engagement to encourage states and regions to develop effective, actionable plans for sustained development and growth. Regions succeed or fail based on the resilience and flexibility with which their industries, workforce, and institutions anticipate and respond to change. This reality has led us to dedicate our efforts to better understanding, showcasing, fostering, and advocating for practices that strengthen R&D activity and the effective commercialization of new ideas.

This index, and others by the Institute, are only half of the equation toward building an effective knowledge-based economic and workforce development strategy. Although identifying performers that excel and serve as models for others and benchmarking that performance over time is important, change occurs through conversation with policymakers on how to pursue knowledge-based economic development more effectively. Therefore, our overarching aim is to combine the findings of our indices with a suite of policy tools. Beyond provision, further engagement leverages our network, relationships, expertise, and position as a nonpartisan voice to inform and advocate for global, federal, regional, and state policies and to then partner with local leaders to advise on the application and implementation of these policies.

This index is complemented by the center's other research, including our annual Best-Performing Cities U.S. index that provides a metropolitan-level perspective on the communities that people call home but whose rankings are directly influenced by state-level policies on innovation and job creation. Our additional work in the ecosystem examines key aspects of university tech transfer and commercialization, the role of research and development tax credits, and how significant educational attainment is in providing opportunities for higher-paying jobs at the metro and regional levels.

The Center for Regional Economics also focuses on best practices to promote regional competitiveness, both in terms of building and maintaining an infrastructure and environment that people can live and prosper in, but also in interacting with an increasingly competitive global economy. Knowledge-based economic development is multifaceted, involving a variety of interrelated components—sustaining an effective state business climate, supporting a thriving and diverse workforce that generates opportunities for people who live and work in those states, and investing in policies that facilitate jobs that can be maintained in the future, not just those from the past. Our efforts in building better cities not only includes economic development strategies, but also efforts to develop and finance effective infrastructure and housing needed to keep the cities affordable, viable, and able to adapt and grow. We also focus on key efforts to attract investment and capital for small and mid-sized businesses.

At the regional level, the center addresses trade and investment for cities, states, and regions, as all need to be able to export in order to reach the vast majority of the world's middle class that exists beyond U.S. borders. To make regions, cities, and states—and their people and businesses—more competitive on a global level, it's imperative to make possible their growth and success over the next several decades. The center's aim is to present reliable information that is useful to local policymakers and civic leaders who want to build adaptable economies that create prosperity for their communities in the long term.

OVERALL FINDINGS

Outline of Index

The State Technology and Science Index provides a benchmark for states to assess their science and technology capabilities as well as the broader ecosystem that contributes to job and wealth creation. The index computes and measures 107 individual indicators relative to population, gross state product (GSP), number of establishments, percent change, and other factors.[1] Data sources include government agencies, foundations, and private sources. The states are ranked in descending order with the top state being assigned a score of 100, the runner-up a score of 98, and the 50th state a score of 2. The indicators are then combined to create these five composite rankings:

RESEARCH AND DEVELOPMENT INPUTS (RDI): We examine a state's R&D capacity to see if it has facilities that can attract funding and create innovations that can be commercialized. The category includes measures such as industrial, academic, and federal R&D, Small Business Innovation Research awards, and the Small Business Technology Transfer program, among others.

RISK CAPITAL AND ENTREPRENEURIAL INFRASTRUCTURE (RCI): The entrepreneurial capacity and risk capital infrastructure of states are the ingredients that determine their success in converting research into commercially viable technology services and products. We include several measures of venture capital activity as well as entrepreneurial pursuits, including patenting activity, business formations, and initial public offerings.

HUMAN CAPITAL INVESTMENT (HCI): Human capital is the most important intangible asset of a regional or state economy. We look at indicators that suggest 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.

TECHNOLOGY AND SCIENCE WORKFORCE (TSW): The intensity of the technology and science workforce indicates whether states have sufficient depth of high-caliber technical talent. Intensity is derived from the share of employment in a particular field relative to total state employment. We look at 46 occupation categories in three main areas of employment: computer and information sciences, life and physical sciences, and engineering.

TECHNOLOGY CONCENTRATION AND DYNAMISM (TCD): By measuring technology growth, we are able to assess how effective policymakers and other stakeholders have been at transforming regional assets into regional prosperity. This includes 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.

State Technology and Science Index 2018: Top 10

Massachusetts ranks No. 1 in the 2018 edition of the State Technology and Science Index, maintaining its top spot since 2002. Massachusetts scores 86.25 points, an increase of 2.59 from the 2016 STSI, demonstrating its continuing improvement relative to other states. The state places first on three of the five sub-indexes—the R&D inputs composite, the risk capital and entrepreneurial infrastructure composite increasing by one rank, and the human capital investment composite also increasing one rank for this year's STSI. Massachusetts ranks No. 3 for both the technology and science workforce composite, a decline of one rank, and the technology concentration and dynamism composite, an increase of two ranks. This edition of the STSI marks the second time Massachusetts' rank has declined on the TSW sub-index, attributable this year to decreases in the concentration of life scientists. Massachusetts' HCI score rebounds this year by 7.33 points due to high numbers of science and engineering graduates.

The one-rank decline in the TSW can be attributed to a shift in the concentration of engineers and science occupations in the state. A 14-rank increase in the concentration of engineers was offset by an eight-rank reduction in the concentration of scientists. In 2018, the ten-year-old $1 billion life science bill was replaced with a new bill of roughly a half-billion dollars to support the sector.[2] The money appropriated from the state economic development bill should help improve the concentration of the life science workforce as well as maintain its No. 1 rank on the RDI. The bill allocates $150 million to the University of Massachusetts medical school system, a third of which is dedicated to neuroscience research.[3] Massachusetts' continued high rate of R&D investment should provide long-term benefits to help move university research beyond its early stages.

Massachusetts is trying to protect startups from a nonproductive externality—patent trolls. The annual economic development bill proposed by the state senate would create avenues for recourse against entities acting in bad faith claiming patent infringement.[4] Massachusetts outperforms all other states for venture capital as a share of GSP and venture capital funding of biotech, supporting its top RCI rank. However, the state's rate of patents ranks in the bottom half of the nation. This legislation could help innovative operations in Massachusetts' high-tech sector.

Massachusetts ranks 11th in the nation for the concentration of information security analysts. Given the importance of the high-tech sector to the state, the economic development bill provides $2.5 million to the Massachusetts Cybersecurity Innovation Fund.[5] The importance of cybersecurity will only grow as ways to obtain data become more sophisticated and important to business operations. The funds are intended to support infrastructure development and meet workforce needs for the cybersecurity industry. The state has recognized the importance of supporting an industry that is integral to the long-term competitiveness of its high-tech sector.

There is interest in Massachusetts to capitalize on clean technology. MassVentures and Massachusetts Clean Energy Center START program will award $3.4 million to 20 Massachusetts startups in 2018.[6] Efforts have been made through legislation to further support the high-tech sector. Two policies of note did not make the final bill, signed in July 2018: a proposed revenue-neutral carbon tax and a 100 percent renewable energy goal.[7] Despite this setback, Massachusetts ranks high in funding of clean tech (No. 2), but decreases in the levels of funding going to support a clean energy industry may be on the horizon in the coming years.

Colorado ranks No. 2 in this year's STSI, maintaining its rank from the 2016 edition. Colorado's score remains remarkably stable from 2016, scoring 80.08 for 2018, only a 0.32-point decrease. Colorado ranks third on the RDI, as it has for the last eight years. The state rises by one rank on the RCI, reaching second. On the HCI, Colorado drops two spots to third. The state's TSW rank drops by one from the 2016 edition of the STSI, landing at fourth. Rounding out the sub-indexes, Colorado ranks fifth on the TCD, a two-spot decline.

Colorado ranks in the Top 5 for five of the 12 indicators that make up the RCI. The highest ranking of these variables is the rate of new business starts. The strong placements for the rate of Small Business Investment Company (SBIC) funds and the stock measures of venture funding combine to show a robust entrepreneurial culture, which is also reflected by Colorado's ranking fourth for IPO proceeds as a share of GSP. There are 12 programs in Colorado that provide incentives specifically targeting startups or small businesses.[8] Of the state's incentive programs, two are focused on R&D targeting early-stage proof-of-concept efforts of advanced industries.[9] A third program offers grants for companies that partner with Israeli companies for R&D activities. Colorado operates two public venture capital funds for startups as well.

Colorado has a high concentration of engineers, which can be attributed in part to the presence of the aerospace and defense industries. Colorado ranks fifth in the nation for the concentration of aerospace engineers, with 91.17 per 100,000 workers. A related sector that has found a home in Colorado is private space companies. Colorado targets the industry by providing tax incentives for both investment and employment in the aerospace sector.[10] Colorado's aerospace industry includes prominent firms that participate in the space race located throughout the state: United Launch Systems, Ball Aerospace, and Sierra Nevada.[11]

Maryland retains its third-place ranking on the 2018 STSI. The state scores 79.24 overall; this is a decrease of 1.07 points from 2016. Maryland falls on the TCD this year, dropping from No. 1 to No. 11 due to a 38-rank decline in high-tech employment growth. Maryland ranks No. 2 on the RDI where it has placed consistently since 2008. The state has gained two ranks on the RCI, coming in sixth. Maryland also gained two ranks on the HCI, moving from No. 4 to No. 2. The state has retained the No. 1 spot for the TSW, enjoying the highest concentration of high-tech labor in the U.S.

The ten-rank decrease in the TCD is largely attributable to a slowing high-tech sector, resulting in a 38-place drop in the number of high-tech industries growing faster than the U.S. average. From 2012 to 2016, Maryland averaged high-tech employment growth of 0.36 percent. However, given the high concentrations of computer science, engineering, and life science employment in the state, the decline is not overly concerning. Maryland's reliance on the federal government, due to proximity to Washington, D.C., will provide stability for the concentration of high-tech employment. This can be seen in the rate of federal research and development funding the state receives (No. 1). The influence of federal agencies on Maryland's high-tech landscape can be seen in the high concentration of computer and information science experts (No. 1), concentration of engineers (No. 2), and concentration of life and physical scientists (No. 2). These three sub-indexes of the TSW show the benefit of housing over 30 federal agencies including from U.S. Cyber Command to the National Institutes of Health, the Army Research Laboratory, the National Institute of Standards and Technology, and the National Security Agency.

Maryland has several state-run programs to support high-tech businesses, including the Cyber Security Investment Incentive Tax Credit and the Maryland Innovation Initiative (MII). The MII is a state-run partnership to commercialize technology formed by five of the state's universities and the private sector. The universities involved include Johns Hopkins University and the University System of Maryland, which were ranked No. 33 and No. 56 respectively for technology transfer and commercialization in the U.S.[12] One company formed from research started at Johns Hopkins is Neuraly, which recently raised $36 million to continue R&D activities for treatments for Alzheimer's and Parkinson's diseases.[13]

California ranks fourth in this year's edition of the STSI. With a score of 78.08 points, the state increased 2.13 points from the 2016 STSI. California moves up from fifth to fourth on the RDI. The state falls three ranks from first to fourth on this year's RCI sub-index because of lower venture capital growth and a decline in small business investment company lending. California moves up one rank from No. 11 to No. 10 on the HCI. California's TSW rank moves up one from No. 7 to No. 6. The state maintains its second-place ranking on the TCD for 2018.

California still boasts the high-tech capital of the world, the Bay Area. In the south of the state, Los Angeles has a growing high-tech cluster, and San Diego is still a major high-tech hub. In California, the high-tech sector provides 9.4 percent (No. 3) of private sector employment and 17.2 percent (No. 2) of private sector wages. High-tech industries make up 7.31 percent (No. 4) of the state's establishments. The state has averaged year-over-year high-tech employment growth of 3.5 percent from 2012 to 2016 (No. 6), with ten of the high-tech industries growing faster than the national average (No. 10). California's knowledge economy is diverse, with 18 of the 19 high-tech sectors more concentrated in the state than in the national economy (No. 1).

California has been leading the world in high-tech development, and it continues to expand. Tech companies like Activision Blizzard, Electronic Arts Inc., and Qualcomm have been joined by Netflix, Hulu, and SpaceX as new forces in the high-tech sector.[14] Snap Inc., Oculus, and Dollar Shave Club represent an increasing number of high-tech companies that have blossomed in Southern California. The growing number of venture funds reflects the opportunity in SoCal startups, with 34 funds in the Los Angeles metro alone.[15] A large number of universities, R&D tax credits for basic research, and a concentration of industries that are increasingly tech-dependent create a foundation for continued long-term economic development. California is well-positioned to maintain its Top 5 STSI rank for years to come.

Utah jumps from No. 8 to No. 5 in this year's STSI. The state score is 75.27 points, which is a 6.13-point increase from the 2016 STSI ranking. Utah ranks No. 11 on the RDI this year, representing an increase of three ranks. The state jumped from sixth to third on the RCI, due to a 46-rank increase in business starts. The state places fifth, up from 11th, on the HCI for the 2018 STSI release. Utah declined three ranks from sixth to ninth from the previous ranking of the TSW. With a buoyant economy, Utah jumps from 13th to first on the TCD. In the Best-Performing Cities U.S. ranking for 2017, Utah was home to the No. 1-ranked metro, Provo-Orem, and No. 10, Salt Lake City.[16] Exemplifying the state's focus on building its knowledge economy is the University of Utah, which was the top school in the country for commercializing university R&D.[17]

Utah has seen the fastest employment growth in the high-tech sector in the nation, at 4.3 percent. Along with employment growth, Utah ranks third in the net formation of high-tech establishments.

If this pace of growth continues, the state's rank on the concentration of computer and information science experts sub-index should rebound after dropping five ranks to 13th. The state has set up a program supporting a collaborative effort between the private and public sectors called Utah Pathways to address industry workforce needs. The four industries included in this program are aerospace, energy, life sciences, and software.[18] Utah had 15.43 new graduates in the science and engineering fields per 1,000 workers for the 2016-2017 academic year (No. 1), which will help to support these key industries as the state continues to build its high-tech workforce.

Washington drops one rank to sixth in the 2018 STSI. Washington scores 74.6 points, an increase of 2.76 points from last year, and improves its placement on four of the five sub-indexes. The exception is the RDI, where the state drops to tenth, a three-rank drop from the last STSI release. Washington increases its RCI rank by ten places going from No. 15 to No. 5. The state's improved performance on the RCI comes from a higher rate of business starts and more success attracting venture capital deals to fund the nanotech and clean tech sectors. Washington climbs from eighth to fourth on the TCD, and also improves its performance on the TSW, rising from fifth to second for this edition of the STSI. Washington saw a modest improvement in its rank on the HCI, up to No. 14 from No. 16.

Washington State has a competitive life science sector, reflected by its $15.87 in VC investment in biotech per $100,000 of GSP (No. 6). In 2017, Frazier Healthcare Partners, which has headquarters in the state, raised $419 million in life-science-focused investments.[19] The increase in high-tech funds for Washington is further reflected by venture capitalists like Madrona Venture Group launching in 2018 with a new fund of $300 million.[20] However, the growth of ecommerce and cloud computing—major contributors to the size of the state's high-tech sector—is largely driven by established firms like Microsoft and Amazon. The state ranks No. 1 for both the share of private sector wages and employment in the high-tech sector. Washington has nearly 20 percent of total state wages in the high-tech industry.

Delaware makes gains in this edition of the STSI, moving from tenth to seventh. Delaware scores 66.13, representing an increase of 0.75 points from 2016. Delaware drops three spots on the RDI to ninth. The state experienced a major improvement in its placement on the RCI, rising by 14 to land at No. 15. The state's rise is due to its relative success in attracting venture capital funding and deals. Delaware gained 22 and 34 places for SBIC investments and number of incubators. On the HCI, Delaware decreases by three spots from No. 9 to No. 12. There was a sizable increase of seven places on the TSW from 12th to fifth for the state. Delaware drops to No. 21 from 12th on the TCD, experiencing a slowdown in high-tech employment growth and lower concentrations of high-tech employment.

The knowledge-based economy in Delaware has seen recent support by the state government. Delaware has created the Angel Investor Job Creation and Innovation Act. The new law provides a 25 percent tax credit for companies employing fewer than 25 people who are engaged in R&D activities in select high-tech fields. One of Delaware's major high-tech employers, DowDuPont, has invested $200 million in renovating existing laboratories in Wilmington, DE.[21] The University of Delaware is currently building a 200,000-square-foot, $156 million building for biopharmaceutical research that will support innovative activity in the state.[22] The state ranks fifth in the number of business starts per 100,000 people with 53.43—the 22-place jump indicating the state has become more fertile ground for entrepreneurs.

Minnesota drops one spot to end up eighth on the 2018 STSI. After a strong performance in 2016, Minnesota's score decreased by 6.47 points to 63.11. The state dropped two places on the RDI to land at 21st. Minnesota also ranks 21st on the RCI in this edition of the STSI, a five-rank drop from 2016. Minnesota increased one rank on the HCI to fourth, while the state dropped to seventh from fourth on the TSW sub-index due to decreases in the concentration of computer, engineering, and science-related occupations. Minnesota dropped three ranks to 18th on the TCD.

The state has been focusing on creating a workforce to support the growing high-tech sector. The statewide College Occupational Scholarship Pilot Program for STEM-related degrees is one such program, and in conjunction, Minnesota has built eight IT Center of Excellence facilities to focus resources on education and internship programs. These eight centers provide a pathway for entering the high-tech workforce, with an emphasis on cybersecurity, expanding the high-tech workforce through diversity recruitment, and providing K-12 grades with a tech-related curriculum.[23]

Minnesota is also making efforts to expand access to broadband internet. Currently, Minnesota has 69 percent of households with broadband internet, ranking 19th in the nation. One estimate puts a $1.4 billion price on the infrastructure needed to connect the remaining 31 percent of households in the state.[24] If Minnesota can provide statewide high-speed internet access, this could generate long-term economic benefits by connecting its population to opportunity through modern infrastructure development. By providing the necessary education, workforce, and infrastructure as the knowledge economy develops, Minnesota should be competitive in the long run.

New Hampshire gains two ranks climbing from eleventh to ninth on the STSI this year, scoring 62.34. New Hampshire drops one rank on the RDI to fifth from fourth for this edition of the STSI. The state slid nine ranks on the RCI to 23rd. On the HCI, New Hampshire dropped from tenth to No. 15 this year. New Hampshire jumped 15 ranks going from 26th to 11th on this year's TSW due to an increased concentration of engineers. On the TCD, New Hampshire dropped nine ranks to 19th from tenth in the previous STSI release.

New Hampshire ranked fifth in venture capital funding for its biotech sector and should see continued expansion. A $294 million investment to create the Advanced Regenerative Manufacturing Institute will strengthen the overall high-tech sector. The project has received $80 million in funding from the Department of Defense. The research institute will focus on R&D relating to regenerative tissue.[25] Over the next six years, the University of New Hampshire plans to spend $35 million to expand life science facilities to support the new research institute.[26]

The state has economic anchors that involve the defense industry as well. BAE Systems is a major employer in New Hampshire. The biotech and engineering industries have been adding manufacturing jobs to the state economy. Lonza Biologics is expanding its facilities and has plans to add one million square feet of space.[27] Allegro MicroSystems is also expanding its semiconductor business with a 15,000-square-foot expansion plan.[28]

Oregon breaks into the Top 10 for the first time, rising three spots from No. 13 to tenth. Oregon scores 61.76 on the STSI for 2018. The state ranks No. 13 on the RDI this year, dropping one rank. Oregon declines six ranks to No. 16 on the RCI. The state fell three ranks to No. 20 on the HCI. Jumping nine ranks, Oregon sits at tenth on the TSW for 2018 thanks to an increase in the concentration of engineers. Oregon increases four ranks from No. 17 to No. 13 on the TCD.

Bend-Redmond, OR ranked No. 1 on the Best-Performing Small Cities index for 2017 and 2016, due, in part, to the development of the local high-tech sector. Exemplifying this growth, Azevtec raised $8 million for autonomous vehicles in Bend, OR.[29] The western part of the state has seen recent investment as well. The tech firm Exterro, which provides legal service software, garnered $100 million in new funding in the earlier part of 2018.[30]

Oregon has seen declines in the number of postsecondary science and engineering graduates, but a donation of $500 million from Nike founder Phil Knight will help build a billion-dollar, science-focused addition to the University of Oregon.[31] Boeing has leased a $3.5 million advanced manufacturing unit, which will operate out of the Oregon Manufacturing Innovation Center. This type of investment into the state helps to diversify the high-tech workforce.

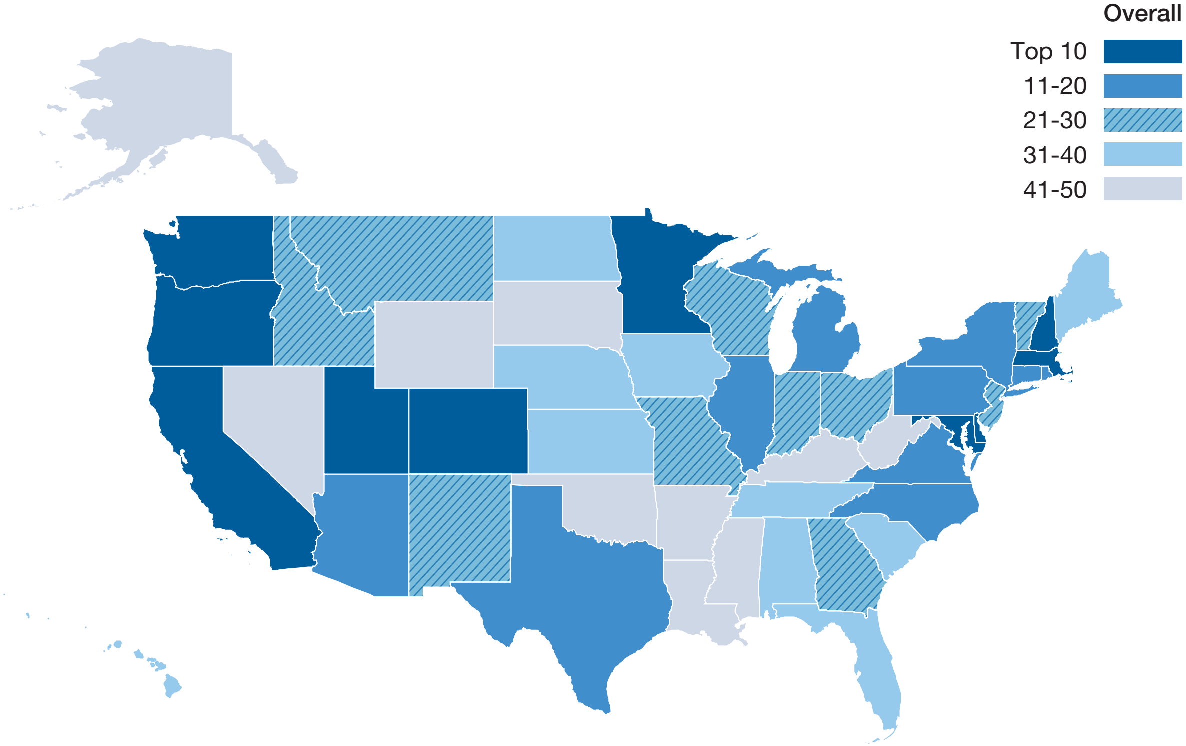
Biggest Gainers

Florida gained eight ranks going from No. 41 in 2016 to No. 33 in the 2018 STSI edition. Florida's increase was largely due to an 18-rank increase in the RCI sub-index. Florida has made a number of capital investments through state-level incentive programs focused on the development of infrastructure to enable high-tech operations. 500 Startups has opened operations to invest in tech startups in the region, and Telemundo has opened a $250 million facility in the Miami area.[32] **Arizona** (No. 17), **Idaho** (No. 26), **Montana** (No. 28), and **South Carolina** (No. 37) all increased their ranks by six places. Arizona increased 14 ranks on the HCI, 13 ranks on the TSW, and 11 ranks on the TCD. Idaho increased 13 ranks on the TSW from No. 25 to No. 12 and jumped 22 ranks on the TCD. Montana increased 13 ranks on the RCI and 21 ranks on the TCD. South Carolina increased 16 ranks on the RCI.

Struggling States

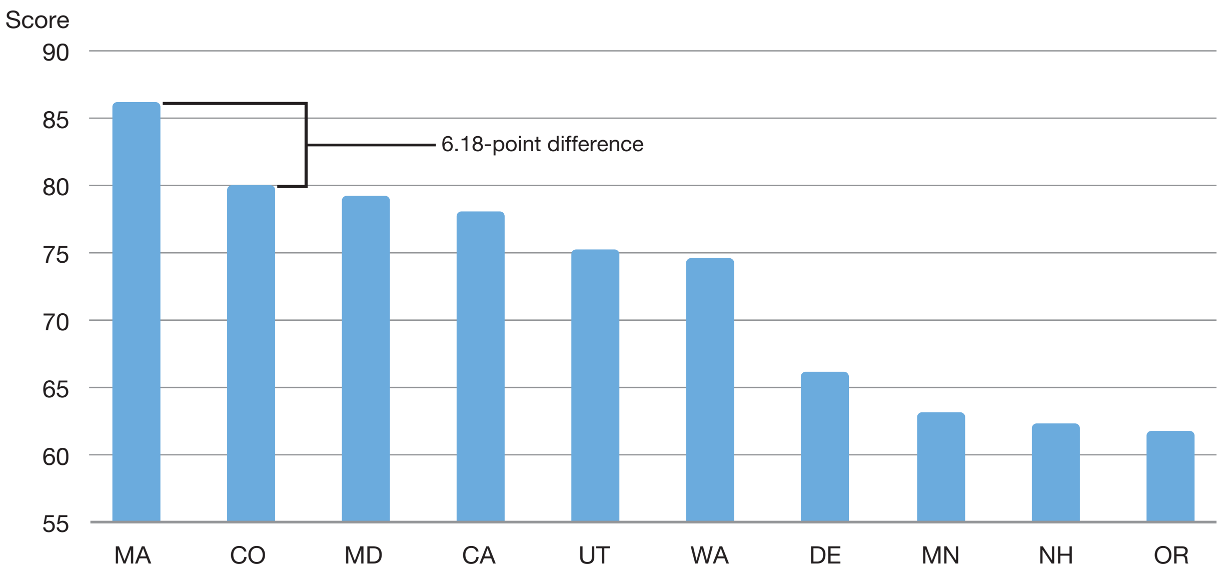
Nebraska and **North Dakota** dropped nine ranks to end up at No. 34 and No. 38, respectively. Nebraska fell 14 ranks on the RCI and 18 ranks on the TSW, which contributed to its overall decline. North Dakota fell 22 ranks on the TSW and 11 ranks on the HCI. **Alaska** and **Connecticut** both dropped eight spots to land at No. 41 and No. 14, respectively. Alaska saw declines in four of the five sub-indexes, but never by more than five ranks. Connecticut declined by 14 ranks on the RCI and 15 ranks on the TCD.

FIGURE 1 2018 State Technology and Science Index Map



Source: Milken Institute.

FIGURE 2 2018 State Technology and Science Index Top 10 States



Source: Milken Institute.

TABLE 1 2018 State Technology and Science Index Rankings

STATE	2018	2016	RANK CHANGE 2016-2018	SCORE
Massachusetts	1	1	0	86.25
Colorado	2	2	0	80.08
Maryland	3	3	0	79.24
California	4	4	0	78.08
Utah	5	8	3	75.27
Washington	6	5	-1	74.60
Delaware	7	10	3	66.13
Minnesota	8	7	-1	63.11
New Hampshire	9	11	2	62.34
Oregon	10	13	3	61.76
North Carolina	11	12	1	61.24
Virginia	12	9	-3	60.28
Pennsylvania	13	14	1	59.58
Connecticut	14	6	-8	59.50
Illinois	15	16	1	58.35
New York	16	20	4	57.52
Arizona	17	23	6	56.73
Michigan	18	18	0	56.37
Rhode Island	19	15	-4	56.34
Texas	20	19	-1	55.60
New Jersey	21	17	-4	55.12
Georgia	22	24	2	53.25
Vermont	23	26	3	53.24
New Mexico	24	21	-3	52.06
Wisconsin	25	22	-3	51.96
Idaho	26	32	6	50.99
Ohio	27	27	0	50.88
Montana	28	34	6	49.22
Indiana	29	30	1	46.10
Missouri	30	28	-2	46.03
Kansas	31	31	0	45.29
Alabama	32	37	5	43.40
Florida	33	41	8	42.39
Nebraska	34	25	-9	40.84
Hawaii	35	39	4	39.21
Iowa	36	35	-1	38.82
South Carolina	37	43	6	38.00
North Dakota	38	29	-9	36.37
Tennessee	39	40	1	36.23
Maine	40	42	2	35.77
Alaska	41	33	-8	35.70
Wyoming	42	36	-6	35.13
South Dakota	43	38	-5	31.86
Nevada	44	45	1	30.45
Louisiana	45	46	1	25.53
Kentucky	46	47	1	25.48
Oklahoma	47	44	-3	25.01
Arkansas	48	49	1	23.32
West Virginia	49	50	1	19.96
Mississippi	50	48	-2	19.78

Source: Milken Institute.

RESEARCH AND DEVELOPMENT INPUTS

Background

The research and development inputs composite index measures a state's research capacity or ability to create new knowledge, placing added emphasis on ideas that have potential commercial value. A strong research infrastructure creates opportunities for innovative discoveries, and effective development systems support a pipeline of new and improved products and processes. While much of this research may not have an immediate economic impact, it has the potential to yield returns in the long term.

Innovation is a cornerstone of knowledge-based economic development and can provide a key competitive advantage to regions pursuing economic growth. Universities perform vital basic research, which typically does not have an obvious commercial application, and private firms are undertaking an increasing share of this type of exploratory work. Development of these ideas for application is led by the private sector. The results of these investments of time and effort yield new or improved products and processes and support the creation of high-tech industry jobs. While different regions may be more or less effective at transforming research findings into innovation with market value, the infrastructure and capability to attract research funding and a culture that values innovative activities are vital components of a robust knowledge economy.

Sub-Index Components

The majority of R&D funds come from three sources: the federal government, private industry, and academia. We rank each state on 18 R&D indicators that fall under the following categories:

Federal R&D expenditures: This captures investments in all basic and applied research in such areas as national defense, health, space research and technology, energy, and general science.

Industry R&D expenditures: This is the total that corporations spent on basic and applied research, including funds spent at federally funded R&D centers. Industry R&D receives greater weight in the composite index because of its large share of overall R&D.

Academic R&D expenditures: This is the total spent on R&D by a state's colleges and universities. All research, basic and applied, performed by colleges and universities is funded by a combination of federal, industry, and academic sources, but more than 60 percent of R&D funding at universities originates from the federal government.

National Science Foundation (NSF) funding: The National Science Foundation, an independent federal agency, funds research and education in science and engineering through grants, contracts, and cooperative agreements. Its R&D expenditures on engineering are a key source of funding at doctorate-granting institutions, but we also include indicators that track NSF support of the physical sciences, environmental sciences, math, computer sciences, and life sciences. Finally, the funding rates of competitive NSF project proposals for basic research are also used to judge the success and research capabilities of a region.

Small Business Technology Transfer (STTR) awards: These federally funded research grants go to innovative small businesses and nonprofit research institutes to support technology commercialization efforts.

Small Business Innovation Research program (SBIR): This program funds the often costly startup and development stages and encourages commercialization of research findings. To be eligible, firms must be for-profit, American-owned, independently operated, and employ a principal researcher and fewer than 500 workers.

TOP STATE

Massachusetts maintains its No. 1 position once again for the 2018 release of the STSI. Massachusetts ranks first in the nation on eight of the 18 variables that make up this sub-index. The state has an additional eight indicators ranked in the Top 5. With 16 of the 18 variables leading the nation, Massachusetts easily secures its place atop the RDI. For field-specific academic R&D funding rates, Massachusetts ranks in the Top 5 for all fields except agricultural R&D. Biomedical and physical science rank No. 1 in the nation for funding per $100,000 of GSP.

Massachusetts has been ranked No. 1 on the RDI since the inception of the STSI and most likely will continue to do so. The state's success has been achieved in part through the presence of top universities and related investment from the private sector. PionEar is a medical device startup formed by researchers from Harvard and received a $75,000 innovation prize from the school.[33] Boeing has announced plans to lease space at the Massachusetts Institute of Technology (MIT) to research autonomous aircraft.[34] MIT has secured a Defense Advanced Research Projects Agency contract worth $11 million, intended for use in generating hard to acquire molecules by using the base processes of biological systems. The total value of the contract will increase to $32.2 million with this additional phase of funding.[35] Massachusetts ranks No. 1 in industry R&D spending per capita, exemplified by IBM's investment of $240 million into a joint partnership with MIT to enhance its artificial intelligence platform over the next ten years.[36] As part of Massachusetts' diverse high-tech sector, various life science companies have secured millions in funding. One example is Akouos, which attracted $25 million in new funds in 2018 with another $25 million of funds committed.

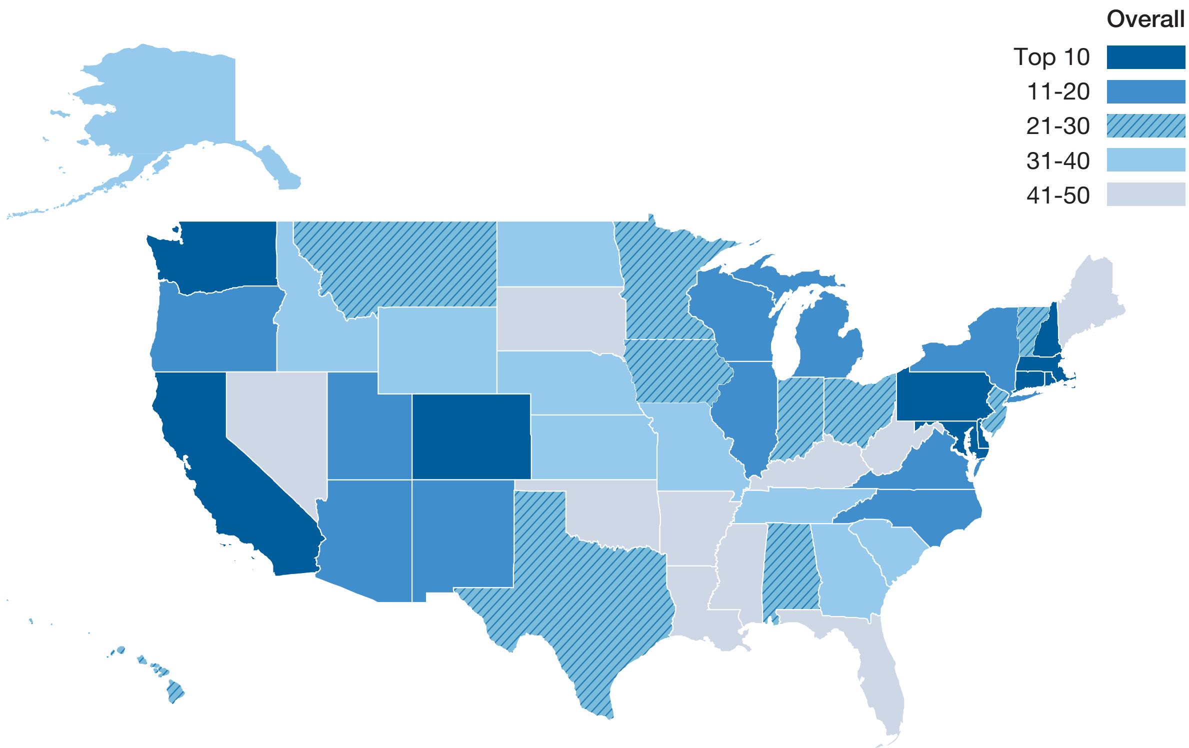
BIGGEST GAINERS

Wyoming increases 16 ranks to No. 34 on the RDI index for 2018. The increase is due to six variables improving by double digits: academic R&D per capita (+22), engineering R&D per capita (+44), math and computer science R&D per capita (+31), agricultural R&D per capita (+47), average number of STTR awards per establishment (+11), and average number of STTR dollars (+19). Wyoming should continue to see improvement in SBIR and STTR funds because of the Wyoming Small Business Development Center, which has its main office at the University of Wyoming. This office provides information and guidance for entrepreneurs looking for seed funding, which will be supported by a recent federal and state technology grant from the SBA. Wyoming's very low population increases the volatility of these variables and makes large swings in relative ranking more likely. **North Carolina** increases eight ranks to land at No. 14. North Carolina increased its average number of STTR awards per establishment by 23 and the average number of SBIR awards per 100,000 people by 12.

STRUGGLING STATES

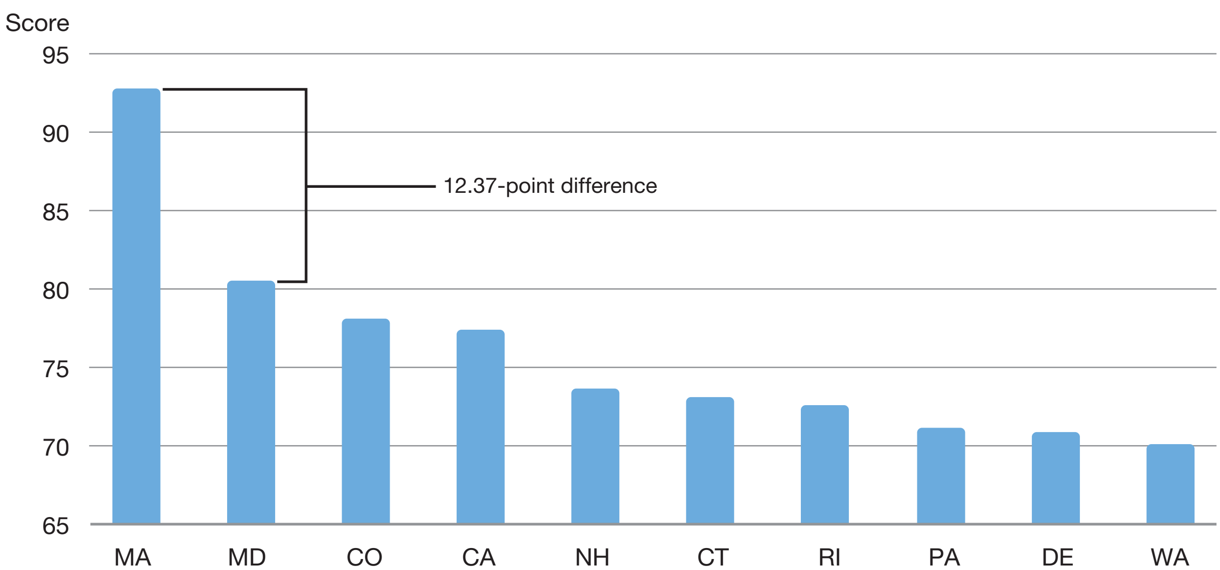
New Jersey dropped eight ranks to No. 26 for 2018's RDI. New Jersey declined in rank on 14 indicators, with agriculture R&D declining 21 ranks, biomedical R&D dropping 33, and the rate of SBIR phase 1 awards dropping ten ranks. **Nevada** also dropped eight ranks to land at No. 49. The state had double-digit declines in seven of the variables: federal R&D dollars per capita (-15), industry R&D dollars per capita (-10), agriculture R&D (-12), biomedical R&D (-25), average STTR awards (-13), SBIR awards (-19), and phase 2 awards (-14).

FIGURE 3 2018 Research and Development Inputs Composite Index Map



Source: Milken Institute.

FIGURE 4 2018 Research and Development Inputs Top 10 States



Source: Milken Institute.

TABLE 2 2018 Research and Development Inputs Composite Index: State Rankings

STATE	2018	2016	RANK CHANGE 2016-2018	SCORE
Massachusetts	1	1	0	92.93
Maryland	2	2	0	80.56
Colorado	3	3	0	78.12
California	4	5	1	77.47
New Hampshire	5	4	-1	73.60
Connecticut	6	8	2	73.08
Rhode Island	7	10	3	72.59
Pennsylvania	8	9	1	71.12
Delaware	9	6	-3	70.85
Washington	10	7	-3	70.12
Utah	11	14	3	69.59
Michigan	12	13	1	68.77
Oregon	13	12	-1	64.19
North Carolina	14	22	8	62.45
Illinois	15	15	0	62.38
Virginia	16	20	4	62.18
Arizona	17	11	-6	61.72
New York	18	21	3	61.41
Wisconsin	19	18	-1	60.93
New Mexico	20	16	-4	59.10
Minnesota	21	19	-2	58.96
Indiana	22	23	1	58.23
Montana	23	27	4	54.66
Alabama	24	28	4	53.82
New Jersey	25	17	-8	53.54

STATE	2018	2016	RANK CHANGE 2016-2018	SCORE
Ohio	26	26	0	52.71
Iowa	27	31	4	51.12
Texas	28	32	4	49.79
Hawaii	29	25	-4	49.17
Vermont	30	24	-6	48.23
Idaho	31	29	-2	45.87
Georgia	32	30	-2	44.92
Nebraska	33	35	2	43.23
Wyoming	34	50	16	41.51
Alaska	35	39	4	40.98
Missouri	36	37	1	40.91
North Dakota	37	33	-4	37.82
Kansas	38	34	-4	37.32
Tennessee	39	36	-3	36.08
South Carolina	40	40	0	29.50
South Dakota	41	42	1	28.34
Florida	42	43	1	27.90
Maine	43	38	-5	27.58
Kentucky	44	46	2	25.23
Oklahoma	45	45	0	22.98
Mississippi	46	44	-2	21.92
Louisiana	47	48	1	18.54
Arkansas	48	49	1	18.24
Nevada	49	41	-8	16.30
West Virginia	50	47	-3	14.24

Source: Milken Institute.

RISK CAPITAL AND ENTREPRENEURIAL INFRASTRUCTURE

Background

The risk capital and entrepreneurial infrastructure sub-index measures the environment for entrepreneurial success, including access to risk capital. Entrepreneurship helps transform ideas into new companies and products. Venture and early stage funding, along with organizations that foster the success of new ventures, form an important connection between company formation and growth. They are crucial to a state's ability to maintain economic growth at a pace that creates opportunity for its residents.

An entrepreneur's ability to recognize the economic value in a patented idea and pursue the realization of that potential using their expertise and experience makes them an asset to their economy. A culture of entrepreneurship, open to creating new companies and incorporating innovation into existing firms, helps regional economies grow in the long term. Firms that secure early stage capital, especially when it is accompanied by management, product development, and business services support from a venture capital firm, are better placed to move beyond the startup phase. Business incubators and accelerators can provide this support in regions that have not yet attracted major private sector investment, aiming to create momentum and increased visibility through successful ventures.

Sub-Index Components

To measure each state's entrepreneurial culture, the risk capital and entrepreneurial infrastructure composite index looks at 12 indicators in categories involving venture capital investment, initial public offerings, business creation, and patent activity:

Flow and strength of venture capital investment: To assess a region's potential for tech-based enterprises, we look at indicators such as growth in total venture capital funding, number of companies (deals) receiving VC investment per 10,000 firms, and VC investment as a percentage of gross state product.

Small Business Investment Company (SBIC) funds: The SBIC program, administered by the Small Business Administration, is geared toward incubator-type establishments that support small businesses, with services ranging from financial capital to management consulting. Like venture capitalists, the SBIC identifies profit potential in unleveraged small businesses and funds them in hopes of high returns on investment.

Business incubators and accelerators: These aim to provide up-and-coming small businesses with guidance and resources such as physical facilities, office equipment, business assistance services, and management consulting.

Patents: The greater the number of patents per 100,000 people in a state, the more inventive and scientifically curious the agencies and institutions in that state are. The numbers also indicate the likelihood of commercialization because the cost and time required to register and protect an idea are significant.

Business formation: Business starts and initial public stock offerings are indicators of entrepreneurship and optimism. Companies that go public typically have a proven track record in terms of revenues or sales history.

Clean tech/green tech, nanotechnology, and biotechnology investments: Nanotechnology, clean tech, and biotech are regarded as the forefront of technological innovation. Investments in these areas represent a cutting-edge mentality and serve as a measure of a state's willingness to take risks.

TOP STATE

Massachusetts reclaims the No. 1 spot from California on this year's RCI sub-index. The state has a diverse high-tech sector, which has led to a large concentration of funding sources. Massachusetts places in the Top 5 for eight of the 12 variables that make up the RCI sub-index, including two at No. 1. Massachusetts barely beats out California for VC funds as a share of GSP at 0.006 percent to rank first. The state far outpaces every other state at the rate of biotech VC funds, with $195.97 per $100,000 of GSP. Massachusetts operates two venture funds, a standard VC fund and a clean energy fund.[37] As part of Massachusetts' diverse high-tech sector, various life science companies have secured millions in funding. SQZ recently attracted $72 million in additional investment to further develop treatments for tumors and autoimmune disorder.

Massachusetts continues to be a major high-tech hub in the U.S. General Catalyst's ninth round of funding, which raised $1.38 billion.[38] Automaker Renault-Nissan-Mitsubishi launched a billion-dollar investment fund, and its first investment was in battery company Ionic Materials, based in Woburn, MA. Earlier in 2018, Glasswing Ventures announced a $112 million fund for artificial intelligence startups.[39] The concentration of financial investment Massachusetts has developed over the decades will support the state's high-tech economy as local expertise continues to drive one of the major high-tech hubs in the U.S.

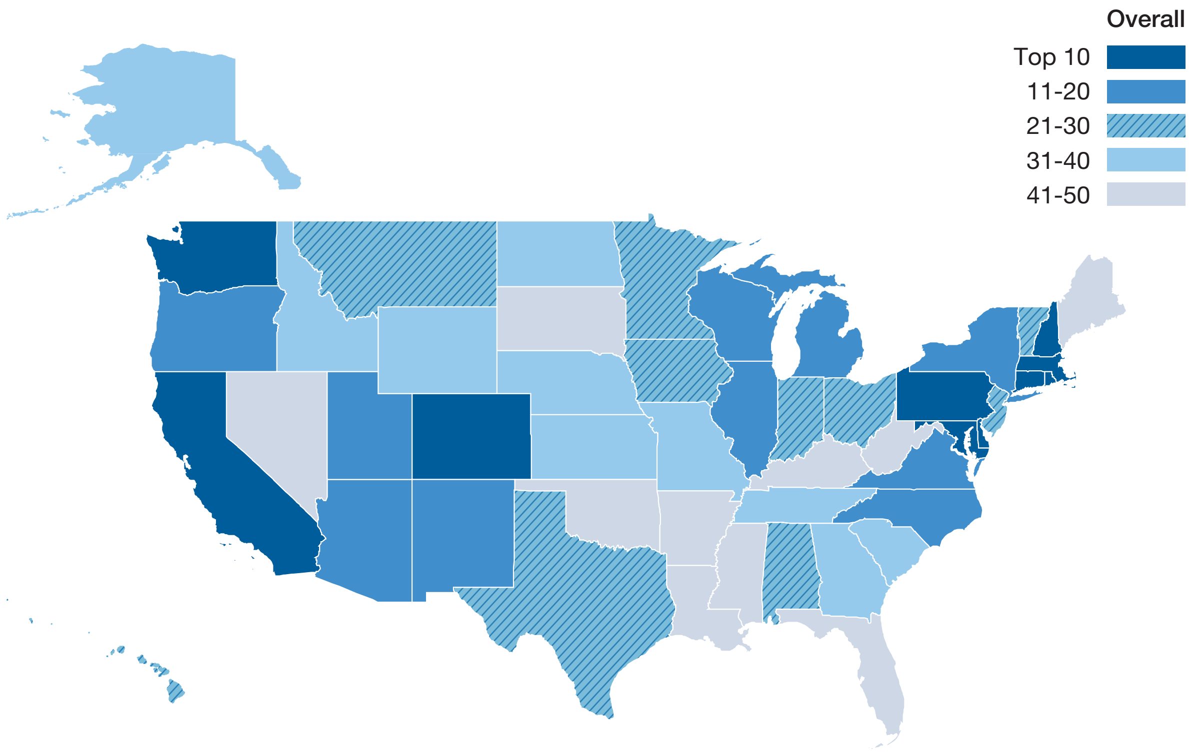
BIGGEST GAINERS

Indiana gained 22 ranks to rank No. 21 on the RCI for the 2018 release of the STSI. This year, Indiana gained 27 ranks for the number of incubators per 10,000 businesses. **Florida** lands at No. 8, which is an 18-rank increase on the RCI from the 2016 release. This jump is driven by three variables increasing ranks by double digits: VC deal growth (+21), VC funds as a percent of GSP (+16), and the number of business starts (+44). Florida startup Magic Leap has been able to secure $2 billion in venture funding for its augmented reality headset.[40] The overall landscape of Florida venture capital continues to deepen and expand with the University of Central Florida, University of South Florida, Florida Institute for the Commercialization of Public Research, and the Florida High Tech Corridor supporting the Florida Angel Nexus network that facilitates early stage investment.[41]

STRUGGLING STATES

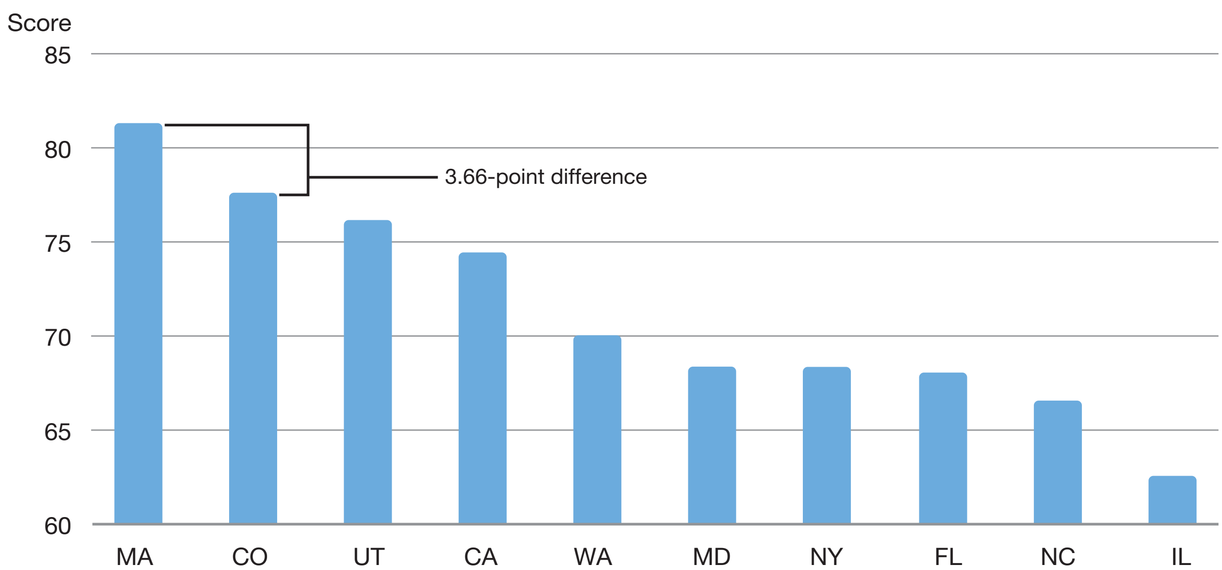
Missouri declined by 20 ranks to No. 27. Missouri had two major declines, falling in the ranks of VC deals per 10,000 business establishments (-18) and deal growth of VC investment (-13). **Vermont** dropped 18 ranks on the RCI to No. 31. Vermont saw declines in the double digits in eight of the 12 indicators that make up the RCI: VC investment growth (-19), rate of venture capital per 10,000 establishments (-13), VC as a percent of GSP (-13), SBIC funds (-17), business starts (-38), IPO proceeds as a percent of GSP (-16), clean tech VC (-18), and biotech VC (-25).

FIGURE 5 2018 Risk Capital and Entrepreneurship Infrastructure Composite Index



Source: Milken Institute.

FIGURE 6 2018 Risk Capital and Entrepreneurship Infrastructure Composite Index Top 10 States



Source: Milken Institute.

TABLE 3 2018 Risk Capital and Entrepreneurship Infrastructure Composite Index Rankings

STATE	2018	2016	RANK CHANGE 2016-2018	SCORE
Massachusetts	1	2	1	81.17
Colorado	2	3	1	77.50
Utah	3	6	3	76.17
California	4	1	-3	74.33
Washington	5	15	10	70.00
Maryland	=6	8	2	68.33
New York	=6	4	-2	68.33
Florida	8	26	18	68.00
North Carolina	9	5	-4	66.50
Illinois	10	17	7	62.50
Texas	11	12	1	59.67
Michigan	12	23	11	58.50
Rhode Island	13	28	15	58.33
Pennsylvania	14	24	10	58.17
Delaware	15	29	14	57.67
Oregon	=16	10	-6	54.33
Wisconsin	=16	20	4	54.33
New Mexico	18	32	14	54.00
Georgia	19	9	-10	53.50
New Jersey	20	21	1	53.00
Indiana	=21	43	22	52.50
Minnesota	=21	16	-5	52.50
New Hampshire	23	14	-9	52.00
Ohio	24	33	9	50.33
Connecticut	25	11	-14	49.17
South Carolina	26	42	16	48.17
Missouri	27	7	-20	47.67
Idaho	28	27	-1	45.17
Maine	29	31	2	42.33
Arizona	30	18	-12	42.17
Vermont	31	13	-18	41.50
Montana	32	45	13	40.50
Nebraska	33	19	-14	38.17
Nevada	=34	37	3	36.67
Virginia	=34	25	-9	36.67
Arkansas	36	41	5	36.17
Kansas	37	30	-7	35.50
Tennessee	38	22	-16	35.17
Alabama	39	38	-1	35.00
Louisiana	40	36	-4	33.83
Iowa	41	46	5	33.00
Kentucky	42	39	-3	26.50
Oklahoma	43	35	-8	25.17
North Dakota	44	40	-4	23.60
South Dakota	45	34	-11	19.20
Wyoming	46	47	1	17.40
Hawaii	47	50	3	16.33
Alaska	48	44	-4	13.80
Mississippi	49	49	0	11.33
West Virginia	50	48	-2	10.33

Source: Milken Institute.

HUMAN CAPITAL INVESTMENT

Background

Investment in human capital is essential to the competitiveness of regional economies. Local universities, community colleges, and accredited technical and vocational training facilities develop students' skills and make a vital contribution to the rising quality of the workforce.[42] Higher education, especially in science, technology, engineering, and mathematics fields, creates a workforce more adaptable to change and enhances the ability to innovate. It also increases a region's appeal to potential employers, promising a steady flow of skilled local graduates. In a knowledge-based economy, prosperity depends more on workforce talent than on traditional material inputs and land.

As fewer Americans choose to relocate, investment in higher education offers states the ability to raise the skills level within their workforce.[43] Geographic areas with concentrated human capital and the associated higher wage employment opportunities see benefits across the entire economy, thanks to jobs created in related industries and as a result of higher consumer spending. This manifests itself in higher GDP per capita and higher real wages per worker as average educational attainment for current workers with at least a high school diploma increases.[44]

Sub-Index Components

The human capital investment composite index contains 21 indicators in the following categories, measuring educational attainment and state funding for schools as a way of determining a region's commitment to an educated workforce:

The prevalence of various degrees: We look at almost a dozen indicators involving bachelor's, master's, and doctoral degrees, focusing particularly on the fields of science and engineering. These indicators suggest the labor pool's interests, its level of sophistication and skill development, and the availability of quality R&D centers and institutions of higher education. They also give clues as to the local job base and the area's ability to attract grants and other research funding.

State spending: We look at state spending on student aid and appropriations for higher education and the change in appropriations, which indicate a region's commitment to producing an educated workforce and the future quality of the labor force.

Home computer penetration and internet access: These illustrate the extent to which the population is technically proficient. Computer ownership coupled with internet access allows access to resources, both commercial and educational, for which residents might otherwise have to travel long distances.

Test scores: This includes the Scholastic Aptitude Test (SAT) and American College Testing Assessment (ACT) scores of high school students on a time-series and cross-sectional basis. Average math scores, in particular, measure the strength and effectiveness of secondary schools' math and critical-thinking curricula.

TOP STATE

Massachusetts ranks No. 1 in eight of the 22 indicators on the human capital investment sub-index with six more variables placing in the Top 5. The number of universities in Massachusetts helps to provide a high rate of science and engineering graduates that help fuel the state's stellar performance in this edition of the STSI. MIT, Harvard, and the University of Massachusetts system rank respectively No. 8, No. 27, and No. 65 on the Milken Institute University Technology Transfer and Commercialization Index. The universities in the state provide a highly educated workforce as well as a massive capacity to commercialize cutting-edge research. Massachusetts ranks fifth, second, and first for the recent rate per 1,000 workers of bachelor's, advanced degrees, and Ph.Ds. in science and engineering, respectively. These ranks are consistently high, and this reflects the state's ability to maintain a workforce that supports its high-tech economy.

For Massachusetts to maintain its No. 1 rank, the state will need to find ways to expand access to education for the overall population. The average 2016 graduate in Massachusetts has $31,563 of debt, and 60 percent of students will have at least some debt.[45] Maintaining a competitive high-tech workforce will require higher education not only to teach viable work-related skills, but also to avoid excluding the bottom of the income bracket. Massachusetts will need to think about its long-term position in education to maintain a high-tech workforce. The state has 14.77 percent of bachelor's degrees granted that are in science and engineering fields (No. 24), but this is a 17-rank drop from 2016 and is its lowest rank since 2010.

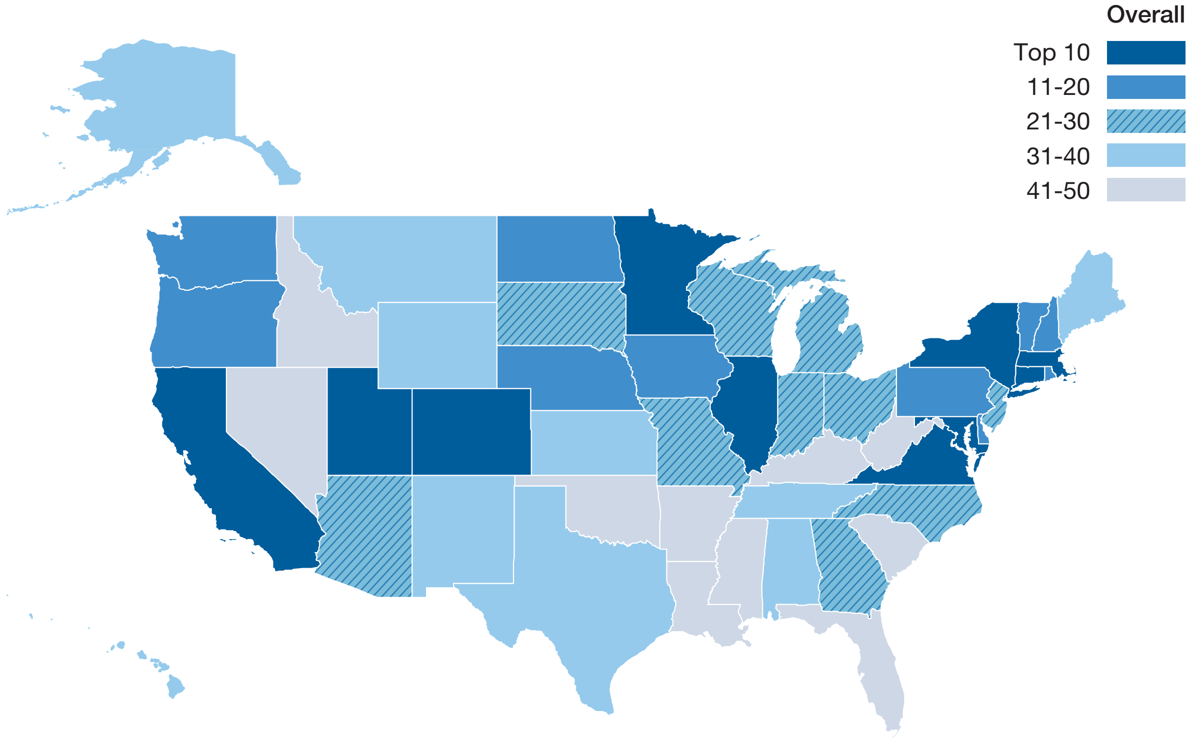
BIGGEST GAINERS

Illinois, **Pennsylvania**, and **Arizona** all increased their rank by 14 to land at No. 6, No. 13, and No. 27, respectively. The main contributions to Illinois' improved performance are the percent change in state appropriations for higher education (+48), all recent science and engineering degrees (+34), science, engineering, and health Ph.Ds. awarded (+28), and percent of bachelor's degrees in science and engineering fields (+28). Pennsylvania saw large increases in percent change in state appropriations for higher education (+25), science, engineering, and health Ph.Ds. awarded (+35), and all recent science and engineering degrees (+22). Arizona's rank increased due to percent change in state appropriations for higher education (+30), percent of bachelor's degrees in science and engineering (+22), all recent science and engineering degrees (+24), and recent bachelor's degrees in science and engineering fields (+39). Arizona has transferable core lower-division courses and a common labeling system for community college courses, facilitating transferability. Illinois and Pennsylvania both have transferable core lower-division courses and statewide guaranteed admission for associate's degrees. These states each have two of four programs commonly targeting community colleges to reduce the financial burden of higher education.[46] Implementing all four programs—transferable core lower-division credits, statewide common course numbering, guaranteed admission with an associate's degree, and statewide reverse transfer—could help strengthen a high-tech workforce by making higher education more accessible.

STRUGGLING STATES

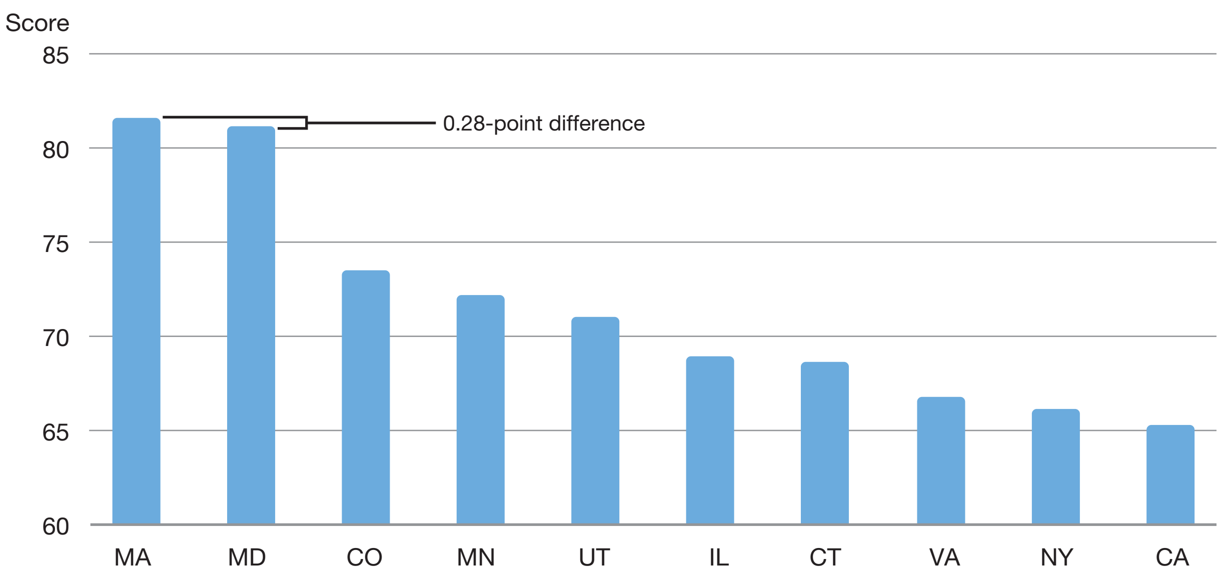
New Mexico (-17), **Wyoming** (-12), and **Oklahoma** (-12) had the largest declines on the HCI index for this edition of the STSI. New Mexico (No. 31) declined in student aid per capita (-26), percent change in state appropriations for higher education (-22), and all recent science and engineering degrees awarded (-32). Oklahoma (No. 50) saw a 24-rank decline in verbal SAT scores and a 21-rank decrease in all recent science and engineering degrees awarded. Wyoming (No. 34) experienced a 48-rank decline in percent change in state appropriations for higher education; science, engineering, and health Ph.Ds. awarded slid 24 places; and all recent science and engineering degrees awarded experienced a decline of 23 spots.

FIGURE 7 2018 Human Capital Investment Composite Index Map



Source: Milken Institute.

FIGURE 8 2018 Human Capital Investment Composite Index Top 10 States



Source: Milken Institute.

TABLE 4 2018 Human Capital Investment Composite Index Rankings

STATE	2018	2016	RANK CHANGE 2016-2018	SCORE
Massachusetts	1	2	1	81.62
Maryland	2	4	2	81.33
Colorado	3	1	-2	73.43
Minnesota	4	5	1	72.10
Utah	5	11	6	71.05
Illinois	6	20	14	68.86
Connecticut	7	3	-4	68.57
Virginia	8	7	-1	66.76
New York	9	15	6	66.10
California	10	11	1	65.24
Rhode Island	11	8	-3	64.76
Delaware	12	9	-3	64.38
Pennsylvania	13	27	14	63.71
Washington	14	16	2	59.33
New Hampshire	15	10	-5	58.76
Vermont	16	13	-3	58.48
North Dakota	17	6	-11	58.19
Iowa	18	18	0	57.52
Nebraska	19	19	0	56.57
Oregon	20	17	-3	55.62
New Jersey	21	21	0	54.38
North Carolina	22	24	2	52.57
Michigan	23	23	0	51.71
Indiana	24	28	4	51.52
Wisconsin	25	26	1	51.43
Ohio	26	32	6	51.14
Arizona	27	41	14	50.86
South Dakota	28	25	-3	49.30
Missouri	29	33	4	49.14
Georgia	30	36	6	48.48
New Mexico	31	14	-17	48.10
Hawaii	32	31	-1	47.43
Kansas	33	29	-4	46.76
Wyoming	34	22	-12	46.30
Montana	35	30	-5	44.29
Texas	36	35	-1	41.43
Maine	37	34	-3	40.95
Alabama	38	42	4	40.19
Alaska	39	37	-2	38.38
Tennessee	40	40	0	37.24
Idaho	41	39	-2	33.71
West Virginia	42	45	3	33.43
Florida	43	46	3	29.62
Louisiana	44	43	-1	29.52
Kentucky	=45	44	-1	29.43
Mississippi	=45	47	2	29.43
South Carolina	47	48	1	28.76
Arkansas	48	49	1	28.19
Nevada	49	50	1	23.71
Oklahoma	50	38	-12	22.48

Source: Milken Institute.

TECHNOLOGY AND SCIENCE WORKFORCE

Background

Technology and science employees help convert innovative ideas into successful commercial ventures, making a skilled workforce a key component of a knowledge-based economy. These workers install, maintain, and operate advanced tools and processes, with rising complexity leading firms to seek out regions with a large pool of potential employees with the needed STEM expertise. While some occupations, including engineers, biochemists, and software developers, typically require a university education, the technology and science workforce also encompasses skilled technicians with less than a bachelor's degree. Together, they apply and implement new technologies and add value as experienced developers of novel approaches that may eventually lead to new patentable ideas and entrepreneurial opportunities.

In addition to attracting and staffing innovative firms, a large science and technology workforce creates positive externalities through knowledge spillovers and agglomeration effects. Information spreads through informal networks of professionals and researchers, aiding the adoption of new discoveries. The concentration of related opportunities also enables more frequent switches from one firm to another, which speeds the dissemination of knowledge between firms in a cluster.[47]

Sub-Index Components

The technology and science workforce composite index reveals the research and innovative capacity in specific fields of high-tech employment. The occupations chosen as indicators—in the broad fields of computer and information science, life and physical science, and engineering—are considered the foundations of a high-tech economy. The 47 occupations collectively convey the entrepreneurial activity present in each region. We look at their intensity, or prevalence, relative to total state employment:

Intensity of computer and information science experts: This group contains the intensity scores of computer and information research scientists, computer systems analysts, information security analysts, computer programmers, software developers - applications, software developers - systems software, web developers, database administrators, network and computer systems administrators, computer network architects, computer user support specialists, computer network support specialists, computer occupations - all other, operations research analysts, and statisticians. These categories represent high value-added occupations and are a necessity in most technology or science firms.

Intensity of engineers: This looks at the intensity of agricultural and food scientists, aerospace engineers, biomedical engineers, chemical engineers, civil engineers, computer hardware engineers, environmental engineers, industrial engineers, materials engineers, mechanical engineers, mining and geological engineers, including mining safety engineers, nuclear engineers, petroleum engineers, and engineers - all other. These occupations are important to the scientific community because they support and promote entrepreneurial activities.

Intensity of life and physical scientists: This calculates the prevalence of soil and plant scientists, biochemists and biophysicists, microbiologists, zoologists and wildlife biologists, biological scientists - all other, medical scientists (except epidemiologists), life scientists - all other, physicists, atmospheric and space scientists, chemists, materials scientists, environmental scientists and specialists (including health and geoscientists, except hydrologists and geographers), physical scientists - all other, agricultural and food science technicians, biological technicians, chemical technicians, and nuclear technicians. These professionals drive vitality because they design and construct everything from the largest of bridges to the tiniest, most intricate medical devices.

TOP STATE

Maryland maintains its No. 1 spot on the TSW for a consecutive edition of the STSI. The state ranks No. 1 for concentration of computer and information science experts, No.2 for the concentration of engineers, and No. 2 for the concentration of life and physical scientists. Maryland has an above-average concentration in eight high-tech sectors and has employment growth above the national average in five high-tech industries. This state directly benefits from proximity to the nation's capital and is home to many federal agencies that employ a large high-tech workforce. The workforce has a substantial amount of private sector high-tech employment, concentrating the high-tech sector further. The high ranks in all three sub-indexes of the TSW index show Maryland has a highly diverse high-tech workforce that can support almost any aspect of the sector. Of the 14 occupations that form the pool of computer and information science experts, 11 are more concentrated in Maryland than the national average, resulting in a Top 5 rank on the relevant sub-index.

Maryland can attribute some success to its workforce development program Employment Advancement Right Now. The program is a public-private partnership meant to engage businesses while providing certifications and credentials to get people back into the workforce. The University of Maryland system recently received a $219 million donation to help target fields like neuroscience, cybersecurity, and engineering. A percentage of the funds will be set aside for a need-based scholarship not focused on any particular field. Starting in 2019, Maryland will award Promise Scholarships of up to $5,000 that will cover two years of community college. The scholarship will help to reduce the overall cost of higher education in the state, which will also benefit the high-tech workforce.

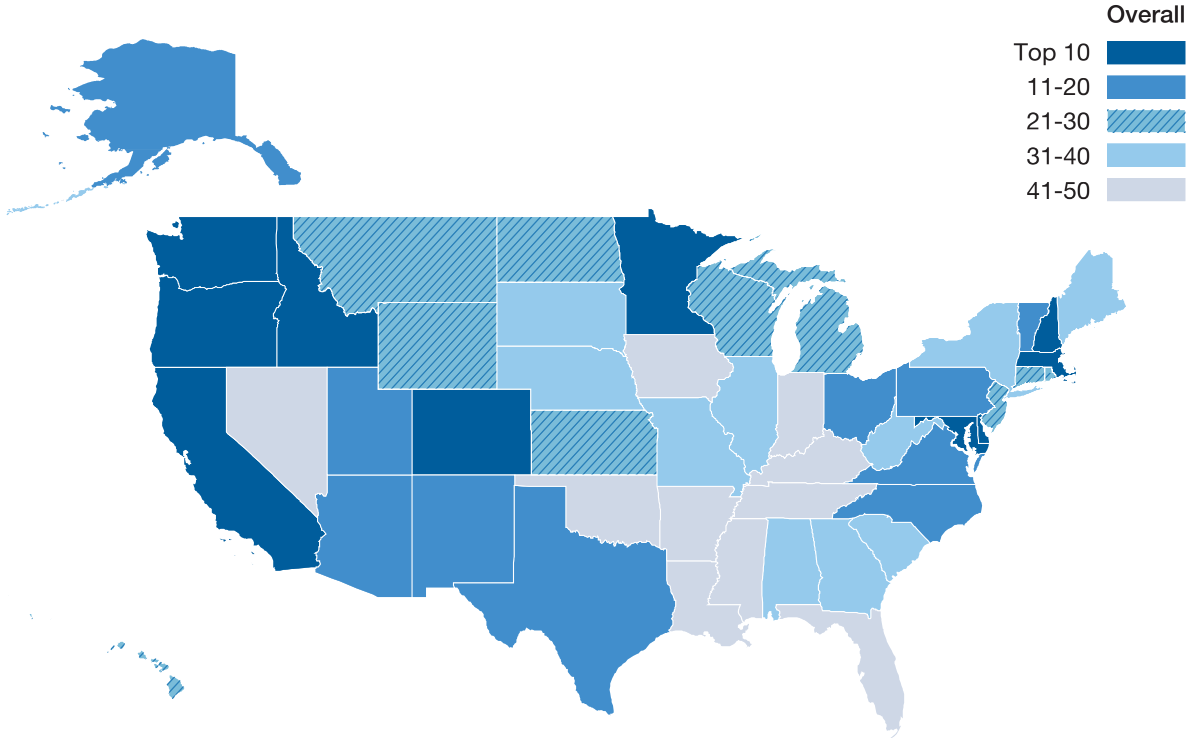
BIGGEST MOVERS

Vermont increased 22 spots, moving from No. 38 to No. 16. **New Hampshire** and **Idaho** rose 17 ranks to land at eighth and ninth, respectively. Vermont increased 29 ranks to No. 21 for the concentration of engineers and 40 ranks for the concentration of life and physical scientists to land at No. 9. New Hampshire increased 22 ranks on the concentration of engineers sub-index and 20 places on the concentration of life and physical scientists sub-index. Idaho saw increases in the concentration of computer and information experts (+12) and concentration of engineers (+17).

STRUGGLING STATES

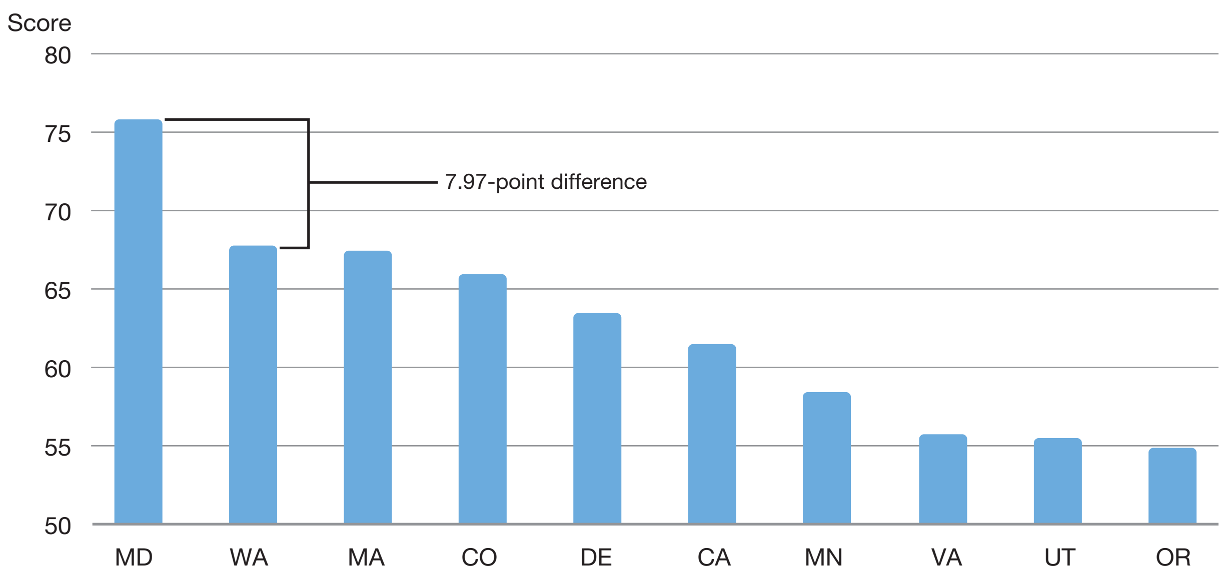
North Dakota decreased 22 ranks to No. 35 from No. 13 and **Nebraska** dropped 18 ranks to No. 29. Nebraska had declines in the concentration of engineers (-21) and the concentration of life and physical scientists (-12). North Dakota dipped four ranks on the concentration of computer and information science experts and saw declines in ranks in 19 of the 47 individual occupations making up the TSW.

FIGURE 9 2018 Technology and Science Workforce Composite Index Map



Source: Milken Institute.

FIGURE 10 2018 Technology and Science Workforce Composite Index Top 10 States



Source: Milken Institute.

TABLE 5 2018 Technology and Science Workforce Composite Index Rankings

STATE	2018	2016	RANK CHANGE 2016-2018	SCORE
Maryland	1	1	0	75.76
Washington	2	5	3	67.79
Massachusetts	3	2	-1	67.48
Colorado	4	3	-1	65.94
Delaware	5	12	7	63.47
California	6	7	1	61.47
Minnesota	7	4	-3	58.43
Virginia	8	8	0	55.70
Utah	9	6	-3	55.47
Oregon	10	19	9	54.89
New Hampshire	11	26	15	54.45
Idaho	12	25	13	53.76
Alaska	13	9	-4	52.70
Arizona	14	27	13	52.22
Pennsylvania	15	14	-1	51.16
Vermont	16	38	22	50.15
Texas	17	15	-2	49.81
Connecticut	18	10	-8	49.50
North Carolina	19	21	2	49.40
New Jersey	20	19	-1	49.18
Rhode Island	21	21	0	49.01
New Mexico	22	31	9	48.41
Ohio	23	18	-5	48.15
Montana	24	29	5	46.72
Wyoming	25	15	-10	46.62
Illinois	26	24	-2	46.41
Missouri	27	33	6	46.32
Georgia	28	35	7	44.25
Nebraska	29	11	-18	43.83
Wisconsin	30	17	-13	43.76
Michigan	31	23	-8	43.51
Kansas	32	32	0	43.17
Alabama	33	34	1	42.36
Hawaii	34	40	6	42.31
North Dakota	35	13	-22	41.20
South Carolina	36	39	3	40.31
South Dakota	37	29	-8	40.23
New York	38	36	-2	39.83
Maine	39	43	4	38.45
Oklahoma	40	40	0	36.43
Indiana	41	28	-13	36.11
Tennessee	42	42	0	35.37
West Virginia	43	45	2	35.27
Iowa	44	37	-7	34.18
Florida	45	44	-1	33.11
Arkansas	46	49	3	31.23
Kentucky	47	45	-2	28.66
Mississippi	48	48	0	27.09
Louisiana	49	45	-4	26.42
Nevada	50	50	0	25.86

Source: Milken Institute.

TECHNOLOGY CONCENTRATION AND DYNAMISM

Background

In the technology concentration and dynamism sub-index, we apply several metrics that attempt to measure the intensity and expansion of high-tech businesses by state. This captures the effect of business climate factors that lie outside the core analysis, but that are vital to the success of a knowledge-based economic strategy. Infrastructure, tax and regulatory policies, quality of life, proximity to market, and many other components of regional competitiveness contribute to a state's ability to transform small entrepreneurial firms into large anchor companies.

A large, dynamic, and diverse high-tech sector points to a fertile environment for similar firms. Alongside the advantages of industry clusters, strengths in a variety of high-tech sectors suggest a more robust economy less vulnerable to obsolescence and external economic shocks. Growth in these industries generates effects throughout the economy, stimulating additional economic activity through employee spending and supply chain impact.

Sub-Index Components

After states pull in financing from public and private sources, invest in human capital, and amass a skilled workforce, what results do they produce? In essence, this composite reveals each state's entrepreneurial, governmental, and policymaking success (or failure) based on high-tech employment, payroll activity, net business formations, and growth:

High-tech employment: High-tech businesses are vital to a region's economic growth, especially given that jobs in this sector typically command above-average salaries. Drawing comparisons between employment and establishments in the high-tech sector with salaries being paid to high-tech workers allows analysts to determine the quality of jobs being created in the sector and in the economy as a whole. The STSI looks at the percent of high-tech businesses, employment, and payroll in each state.

High-tech business births: New companies are a sign of economic stability and optimism—and business births in the technology sector are particularly important because regional prosperity during the past three decades has been linked to high-tech expansion. This indicator looks at the net formation of high-tech business establishments and percent of business births in the tech sector.

High-performing tech companies: The number of companies named in Deloitte's Technology Fast 500—an index that identifies the fastest-growing private tech companies—reflects the growth and expansion of the high-tech sector. We also look at the Inc. 500 rankings for a general snapshot of all companies. Taken together, they measure how well tech firms are performing against a wider field.

Growth in tech-sector industries: To see which industries in the high-tech sector are more successful in various regions, the STSI looks at the average yearly growth in high-tech industries to capture where technology has grown fastest in the past five years, the number of industries that are growing faster than the U.S. average, and high-tech industries with a location quotient (LQ) higher than 1.0, which indicates how prevalent those industries are in a region.

TOP STATE

Utah regains its No. 1 position for the TCD sub-index, largely due to its robust economic growth in the Provo and Salt Lake City regions. Utah increases 12 ranks from the last release. The state has six of the nine variables ranked in the Top 5, of which two rank No. 1 in the nation. The net formation of high-tech businesses and rate of Fast 500 companies rank third, while the average yearly growth of high-tech employment and the rate of Inc. 500 companies rank No. 1. These indicators show the state has been growing a high-tech sector with a strong entrepreneurial foundation. Utah boasts roughly 8.1 percent of employment related to the high-tech sector and around 11.5 percent of wages in the state paid by the high-tech sector. Utah has a diverse high-tech economy, with a location quotient higher than 1 in 12 of the 19 industries that make up the high-tech sector.

The state has generated tech unicorns and has earned a reputation as a good place for startups. Utah's tech cluster can be seen in small towns like St. George, which ranked No. 2 on the best-performing U.S. small city index. St. George's Dixie State University received a grant of $1.75 million to promote mid-skill jobs associated with innovations.[48] The metro's investment into expanding higher education options may have long-run benefits on a nascent regional cluster with PrinterLogic, a St. George company, ranked 317 on the Inc. 500 co-locating near the new Dixie Applied Technology College.[49] AvidXchange has announced a $35 million expansion of facilities in Sandy, UT.[50] The development of Utah's high-tech sector is not just confined to startups; established software firm Adobe is investing $90 million into its Lehi operations.

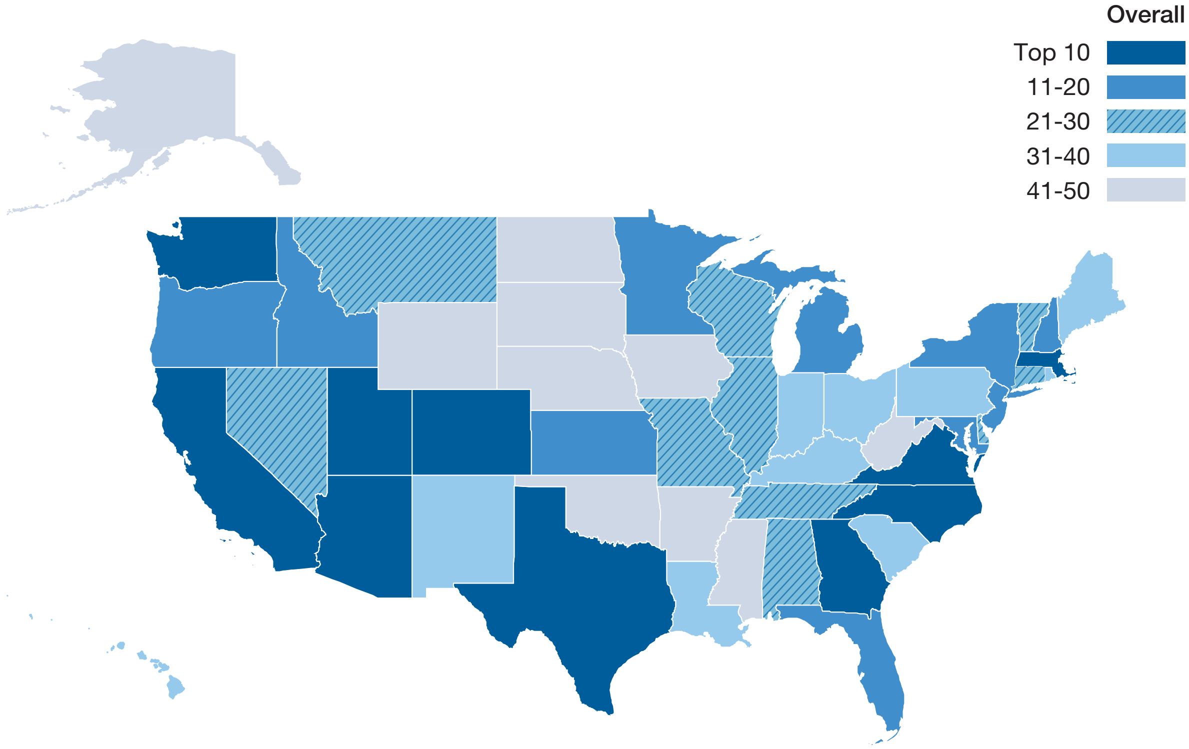
BIGGEST GAINERS

Idaho jumped 22 ranks to land at No. 10, while **Montana** rose 21 ranks, winding up at No. 26. Idaho increases 16 ranks for the percent of high-tech employment and 14 ranks for the percent of high-tech wages going to the high-tech sector. Montana increased 16 ranks for the number of high-tech industries growing faster than U.S. average.

STRUGGLING STATES

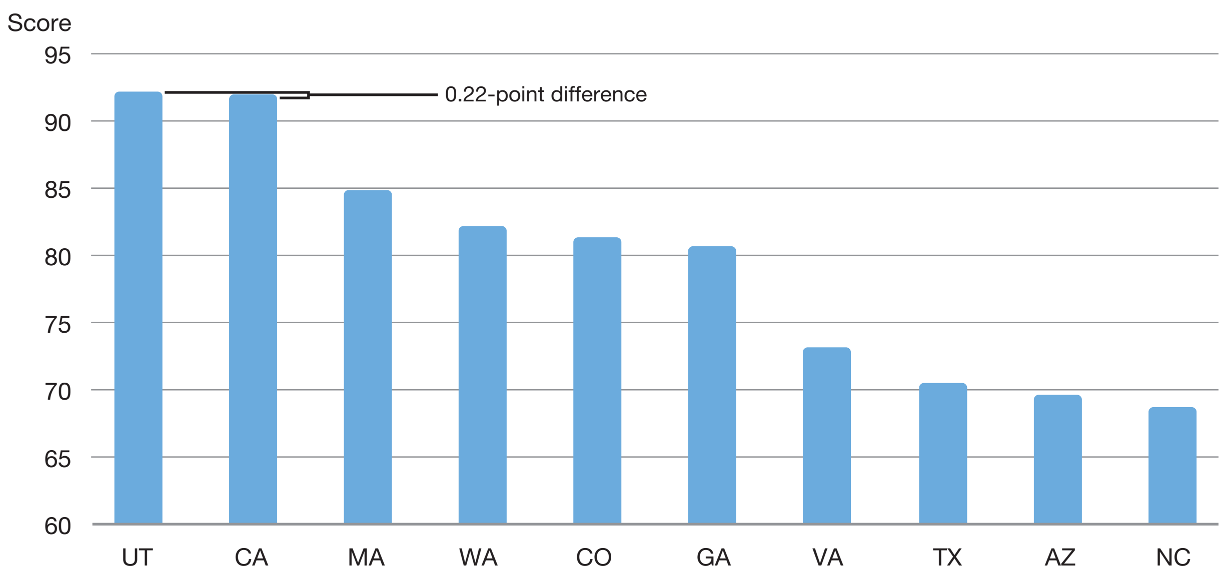
Pennsylvania dropped 17 ranks (No. 31), and **Rhode Island** decreased by 16 ranks (No. 38). Pennsylvania dropped 24 ranks for the number of high-tech industries with employment growing faster than the national average. The state also lost 29 ranks for the average annual growth of high-tech employment. Rhode Island dropped 15 places for the average yearly growth of high-tech industries and 25 ranks in the number of high-tech industries with employment growing faster than the national average.

FIGURE 11 **2018 Technology Concentration and Dynamism Composite Index Map**



Source: Milken Institute.

FIGURE 12 **2018 Technology Concentration and Dynamism Composite Index Top 10 States**



Source: Milken Institute.

TABLE 6 2018 Technology Concentration and Dynamism Composite Index Rankings

STATE	2018	2016	RANK CHANGE 2016-2018	SCORE
Utah	1	13	12	92.22
California	2	2	0	92.00
Massachusetts	3	5	2	84.89
Washington	4	8	4	82.22
Colorado	5	3	-2	81.33
Georgia	6	9	3	80.67
Virginia	7	7	0	73.11
Texas	8	4	-4	70.44
Arizona	9	20	11	69.56
North Carolina	10	5	-5	68.67
Maryland	11	1	-10	67.33
Florida	12	20	8	66.44
Oregon	13	17	4	64.67
New Jersey	14	19	5	61.33
Kansas	15	27	12	60.89
New York	16	24	8	59.11
Idaho	17	39	22	58.22
Minnesota	18	15	-3	57.33
New Hampshire	19	10	-9	56.67
Michigan	20	16	-4	56.22
Delaware	21	12	-9	55.11
Nevada	22	28	6	54.89
Vermont	23	30	7	54.67
Illinois	24	18	-6	54.00
Connecticut	25	10	-15	52.67

STATE	2018	2016	RANK CHANGE 2016-2018	SCORE
Montana	26	47	21	52.00
Missouri	27	26	-1	49.78
Wisconsin	28	38	10	48.44
Alabama	=29	35	6	44.67
Tennessee	=29	41	12	44.67
Pennsylvania	31	14	-17	44.22
South Carolina	32	32	0	43.56
Ohio	33	25	-8	42.89
Indiana	34	29	-5	38.22
New Mexico	35	23	-12	37.78
Hawaii	36	32	-4	36.44
Kentucky	37	42	5	33.56
Rhode Island	38	22	-16	32.67
Maine	39	43	4	30.00
Louisiana	40	36	-4	27.11
Oklahoma	=41	45	4	25.78
Iowa	=41	40	-1	25.78
Nebraska	43	36	-7	22.89
South Dakota	44	48	4	21.78
Alaska	45	43	-2	20.00
Wyoming	46	31	-15	17.78
North Dakota	=47	48	1	17.56
Mississippi	=47	32	-15	17.56
Arkansas	49	45	-4	14.00
West Virginia	50	50	0	9.78

Source: Milken Institute.

CASE STUDY: NON-COMPETE CONTRACTS AND EMPLOYEE MOBILITY

The generation and flow of knowledge through an innovation cluster is a key component of the cluster's success. However, the incentives that prompt more private sector investment in R&D often act in opposition to the incentives that facilitate the dissemination of the R&D results through a cluster. This applies to codified intellectual property (which can be patented) and to employees' tacit knowledge of effective procedures and processes that form part of their human capital. The tools available to prevent the use of skills and understanding developed at one firm at a rival company vary by state and can affect R&D investment and training decisions for firms and employees. They also have implications for the knowledge economy, as they can affect entrepreneurship, employee mobility, and the speed at which knowledge spreads through a cluster.

The relationship between the factors that make up our research and development inputs (RDI) index and those that constitute the risk capital and entrepreneurial infrastructure (RCI) captures the efficiency with which innovative discoveries can be brought to market. Factors included in the RCI, such as incubators, help smooth this transition. We have examined the relationship between universities and the private sector in recent work.[51] Our research underscored the importance of university research and technology transfer for regional economic growth. However, the private sector has been increasing its share of basic R&D activity (accounting for approximately 26 percent of spending in 2016[52]), and exploring how ideas are disseminated within the private sector is vital to understanding the value and mechanisms of industry clusters.

Employee Mobility and Knowledge Transfer

The creation of industry clusters depends in part on the movement of ideas between private firms through informal channels. While networking and social ties cultivated through geographic proximity can create these opportunities, so can the flow of workers between employers.

Knowledge of innovative discoveries can spread through employee mobility when workers change jobs and take their understanding of processes and products into a new workplace. While the sharing of trade secrets and proprietary information are prohibited by law, informal knowledge (not protected by patents and confidentiality) forms part of the human capital employees build and retain. Skills and expertise accumulated during employment at a firm through training and experience add to a worker's value. Social capital and relationships developed with clients and suppliers are similarly a result of employment and do not naturally dissipate as soon as an employee resigns.

These inalienable components of an employee's human capital can affect the investments employers are willing to make in training their workforce. When workers can move on without restriction, there is evidence that employer investment in their employees' human capital is reduced.[53] This increases the importance of lifelong learning tools, like certifications and technical education, to allow workers to invest in their own human capital.

An alternative approach would be to allow employers to protect their investment in human capital by forbidding their workers from joining rival firms. This would avoid the workers' training from benefiting future employers (who may be competitors) and avoid costly hiring processes to replace the employee. However, at-will employment gives workers the right to quit, so separate non-compete agreements must be signed with workers in order to place limits on their mobility.

Non-Compete Agreements

Post-employment covenants (non-competes) in employment contracts are commonly used to place limits on employee mobility. These agreements, typically entered into by employees as a condition of employment, penalize or prevent an individual from working for a different company in the same field for some specified period of time after leaving the current employer. They typically apply for a specified period of time and may also be limited by geographic area (e.g., in state) or industry. In some cases, workers are paid by their former employer for the period covered by the non-compete (sometimes called "garden leave").

By preventing a departing worker from joining a rival firm, non-competes aim to preclude a range of actions, including client poaching, employee raiding, and the use of knowledge of products in development or corporate strategy to inform competitors. The time limit serves several purposes: creating a buffer between employers to reduce the relevance of timely information, making an employee less attractive to competitors (who may fear becoming embroiled in lengthy litigation), and creating a disincentive for the worker to seek a new job. Violation of the terms of a non-compete can result in an injunction preventing a worker from joining a firm or fines.

Some of the proscribed actions would also be in violation of non-disclosure agreements. However, someone who has signed a non-compete agreement would violate it just by being hired at a competitor, something that is easily observable. This allows a firm to seek an injunction against the former employee without needing to prove that any patents or proprietary information have been used improperly.

The period and geography over which state courts will allow non-compete contracts to apply vary by state, but a "reasonableness test" is typically part of how the assessment is made.[54] Pennsylvania courts have enforced three-year agreements, while Florida considers six months reasonable, and California courts typically refuse to recognize out-of-state restrictions of any length.[55] The injunctions companies seek against former employees offered jobs at competitors also vary in scope. In some cases, injunctions prevent the solicitation of work only from clients they interacted with directly at the first employer; in others, they prohibit contact with any client of the former employer, irrespective of whether the departing worker had any previous dealings with them.

In some states, courts are willing to enforce non-competes that extend several years into someone's career. Given how fast high-tech industries develop, this can be a major limit on earnings and prospects and act as a significant disincentive to change jobs.[56] Courts sometimes take the industry into account when determining the appropriate length of time for which a non-competition agreement should apply.

Non-competes achieve the aim of limiting employee mobility in states where they are enforced. In an analysis of the effect of a change in enforceability in Michigan in 1985 on employee mobility, Marx et al., found that the higher enforcement of non-compete contracts was associated with a significant drop in mobility for inventors (workers who had filed patents) outside the automotive industry.[57] There is evidence that non-competition contracts help executive stability but reduce individuals' own investment in their human capital (dominating the effect of companies' increased investments).[58]

By making human capital less mobile, firms may shift toward more skills-intensive processes and reduce their capital investments in states where non-competes are enforceable.

Concerns for Knowledge Economies

What is good for the individual firm may not be good for the industry cluster as a whole. Contractual restrictions like non-competes limit the flow of employees between firms and thus slow the spread of tacit knowledge within an industry cluster and reduce the knowledge-spillovers that facilitate innovation.[59] Since non-competes can also prevent employees from leaving to start their own companies, they can have a chilling effect on entrepreneurship.[60] An analysis of biotech firm formation supported the thesis that high enforceability of non-competes slows startup activity.[61] Venture capital investments have been found to have a smaller impact on the regional economy in high-enforcement states.[62]

In practice, not all non-competes are enforceable as signed, but workers may be unaware of this and become more reluctant to seek other employment as a result. [63] This limits movement of workers, possibly to the detriment of both the worker and the cluster as a whole. As a result of geographic and industry restrictions used in non-competes, workers may choose to switch industries (possibly incurring a career penalty) or move out of state and no longer contribute to the local knowledge economy.

California Competes

While California has a reputation for regulating the market more than other states, it is unusual in not enforcing non-compete clauses. Section 16600 of the California Business and Professions Code is taken to prohibit non-compete agreements outside of sales roles.[64] This facilitates the movement of workers between competing firms and supports California's entrepreneurial culture. Leaving a software firm to start one's own, for example, is less likely to be prevented by California courts because of non-compete agreements. When competing for out-of-state STEM talent, this could add to California's allure. Despite only ranking tenth on the human capital index, California has a science and tech workforce that ranks sixth in the nation, indicating that it is attracting high-skilled workers from other states (and nations).

This high degree of employee mobility has been identified as a cornerstone of the high-tech culture in Silicon Valley, where entrepreneurship and job switching are accepted norms. As a result, firms are more porous, and networks of former colleagues and other professional and social ties support collaboration between competing firms, aiding the overall size of the high-tech sector.[65] California ranks second in the nation on our indicator for private sector R&D, suggesting that this openness has not inhibited activity. California's high-tech sector is the most diverse in the U.S., and the state ranks second on the technology concentration and dynamism sub-index thanks to its healthy high-tech economy.

These cultural differences have also been cited as causes of the differing trajectories of Silicon Valley and Route 128 in Massachusetts.[66] The California high-tech hub has continued to thrive through multiple waves of technological change, whereas Route 128 initially lost momentum in the advent of the personal computer. However, Massachusetts (score of 92.93) far outperforms California on the research and development inputs (score of 77.47) and continues to lead on R&D. However, the gap between the two states is narrowed in the next step in the commercialization process, and in previous years California outperformed Massachusetts on the RCI.

Recent State Policy Changes

While developments in Silicon Valley may have originated in a desire to develop a counterweight to eastern industrial hubs and the associated brain drain out of the West, it has long become the standard against which industry clusters are judged.[67] Although the factors that contributed to its growth cannot all be reproduced, some characteristics influencing the culture of Silicon Valley are within the control of state policymakers. Restrictions on employee mobility through the enforcement of non-compete contracts are determined by state law, and in recent years, several states have made changes to related policies.

In 2015, Hawaii passed targeted legislation to make non-compete clauses in the software and information technology industries unenforceable, aiming to increase the flow of workers through their high-tech firms and keep skilled workers in state. In Utah, legislation passed in 2016 specifies a maximum length of a non-compete period of one year. To improve transparency, in Oregon employers are now required to inform potential workers before they are hired that the firm will be requesting a non-compete agreement.

In August 2018, after many years of discussion, Massachusetts passed a law that changes the terms of non-competes. To be enforceable, non-competes can last a year at most, must include some compensation for the employee, and limit the scope of proscribed activities and geographic area to what is necessary to protect legitimate business interests.[68] Massachusetts' enforcement remains more restrictive than California's, but the changes send a clear signal that the state is less tied to the interests of incumbent firms than in the past.

The effects of these changes are not yet visible in the state technology and science data, but it can be expected to shift the choices of some high-tech firms and workers in the coming years. Further changes to state policy are probable, as the use of non-competes has spread to low-skill occupations, focusing attention on the effect of these contracts on low-income workers' livelihoods. While outright prohibitions on non-competes might not be the right policy for every innovation economy, ensuring that these contracts have a reasonable scope and duration and are applied appropriately is vital.

CASE STUDY: HIGH-TECH WORKFORCE AND HIGHER EDUCATION

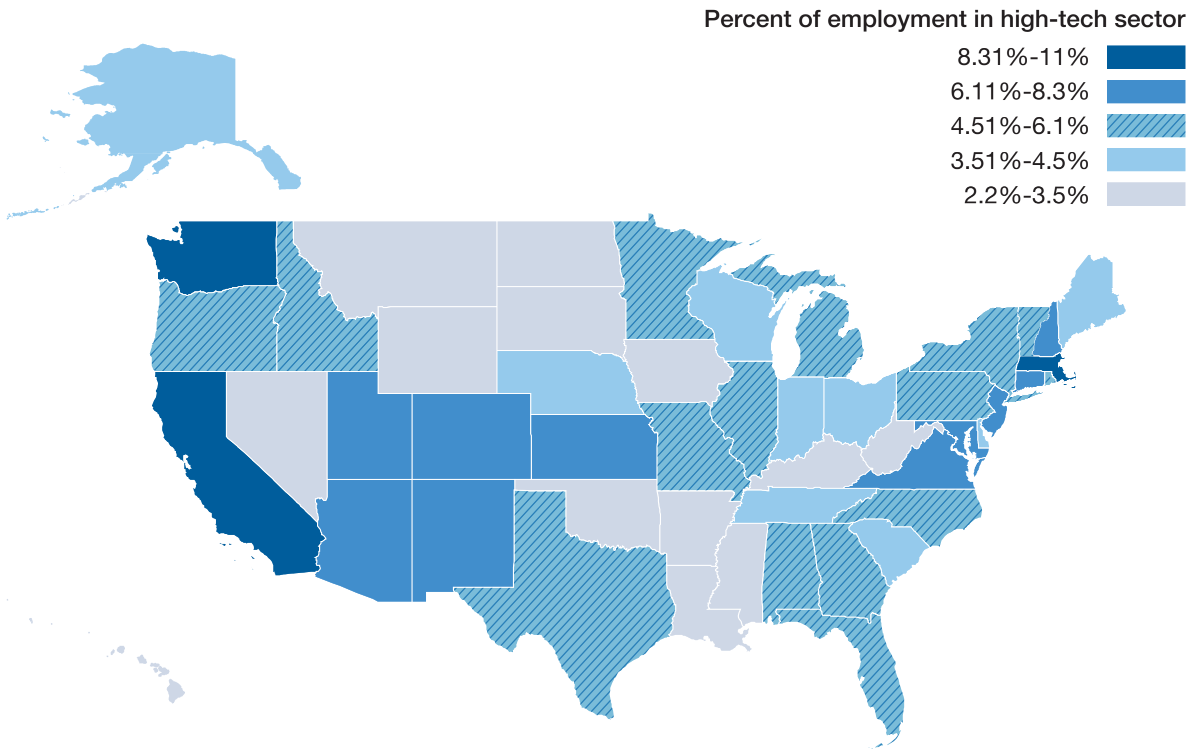
The high-tech sector has an unending demand for a highly educated workforce. States are coming around to the idea that a necessary condition for developing a high-tech sector or attracting companies is a highly skilled workforce. This was shown by Amazon's HQ2 search, which emphasized education as one of the most important aspects of any location it chooses.[69] The HCI and the TSW reflect this relationship, with these two sub-indexes explaining nearly 59 percent of each other.[i] Occupations in the high-tech sector provide wages that on average are around $24,500 higher than the state-level median. The average education level required for entry-level positions in high-tech occupations shows 87.5 percent of those occupations generally require at least a bachelor's degree. However, 77 percent of the TSW entry-level occupations on average are filled by people with at least a B.A. From 2012 to 2016 high-tech employment has increased year-over-year by 2.4 percent. This year-over-year growth represents an 8.6 percent total increase over the same period in total high-tech employment in the U.S. As the sector continues to expand and impact more of the national economy, the need for a competitive workforce will be a major part of long-term success.

Two notable standouts in the STSI Top 10 are Utah, having the largest five-year average high-tech employment growth at 4.3 percent, and Minnesota. Both are the only non-coastal states in the Top 10 for the HCI and TSW. Minnesota ranks No. 4 in the number of recent science, engineering, and health Ph.Ds. awarded. These two states have the highest concentration of their high-tech employment in the computer science and information workforce. The high-tech share of private sector employment in the U.S. ranges from 2.3 percent to 10.5 percent of total employment (see Figure 13). The share of wages of the U.S. represented by the high-tech sector ranges from 3.1 percent to 19.1 percent. In every state, the percentage of wages in high-tech fields is higher than the percentage employed in the high-tech sector, indicating the high-quality jobs created by firms in these industries.

For the class of 2016, student debt per student ranges from $19,975 to $36,367 by state. The state percentage of students with debt ranges from a low of 43 percent to a high of 77 percent. Nationally, student debt grew from 2012 Q1 to 2018 Q2 by 54 percent. As of June 2018, student debt in the U.S. totaled $1.53 trillion. The growth of student debt indicates that more people are pursuing a college education and are taking on debt levels that may take decades to pay off. However, going forward, ways to reduce the cost of higher education will be an ongoing issue. These points illustrate the growing need to reduce higher education costs and facilitate the transition to the workforce.

i. R^2 value of 0.586

FIGURE 13 2016 Percentage of High-Tech Employment of Total Non-Farm Employment



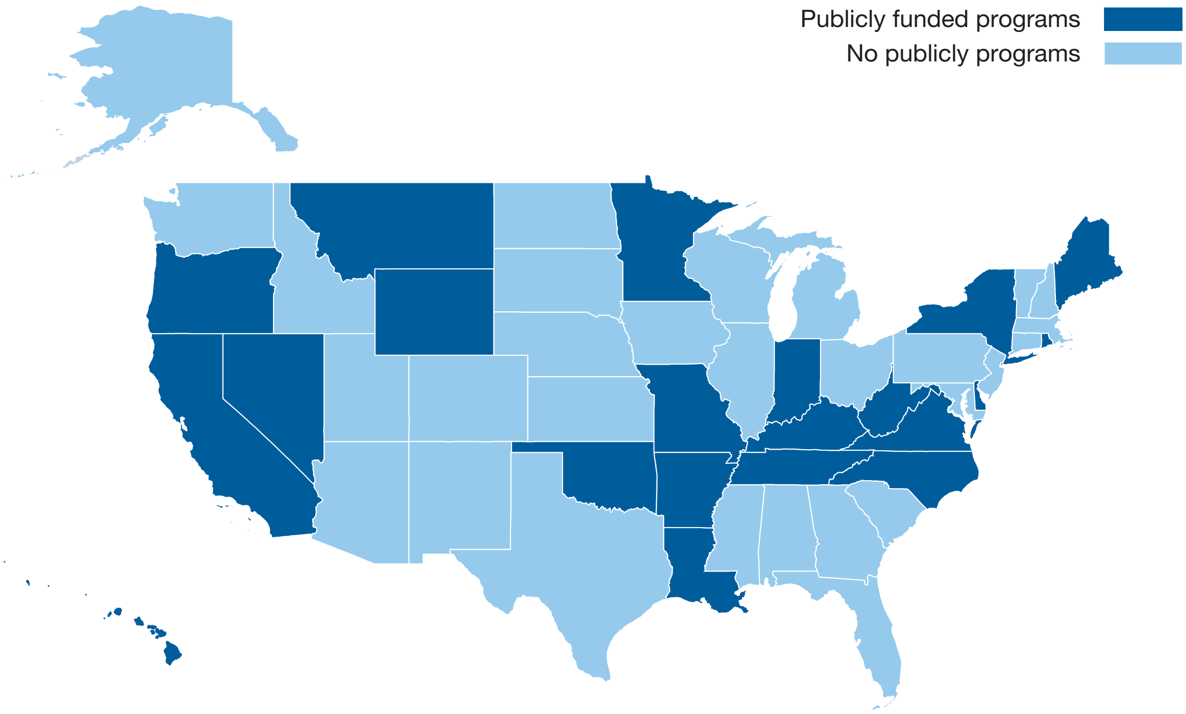
Source: Milken Institute, Moody's Analytics.

Reducing Costs

The high-tech sector's reliance on postsecondary degrees makes reducing higher education costs imperative for creating and maintaining a competitive high-tech workforce. As of 2016, 18.8 percent of the U.S. has a bachelor's degree, 10.1 percent has a master's or professional degree, and 1.3 percent has a Ph.D. In the 2016-2017 academic year, 860,504 people graduated with a bachelor's or greater in science and engineering degrees or certificates. The production of science and engineering graduates is relatively small in comparison to the overall 10.28 million total graduates. In the U.S., 28.6 million people 25 and older have a bachelor's degree in science, engineering, or a related discipline. The talent pool for the high-tech sector represents less than 10 percent of the total adult U.S. population. The creation of in-state talent is important to maintain a high-tech sector because people are unlikely to relocate.[70]

An ongoing issue in the high-tech field is the generation of talent. In 2016, of the U.S. population that held at least a bachelor's degree, 13.27 percent held one in science, engineering, or related fields. Cost reduction can help improve overall graduation rates, and programs can be specifically targeted to those who can benefit the most. Policymakers recognize that cost reduction can increase access by reducing financial barriers to higher education, and there has been a string of recent state-level legislative moves to make community colleges free. The most prominent effort is the College Promise Campaign.

FIGURE 14 Statewide Publicly Funded Higher Education Tuition-Free Programs as of Sept. 7, 2018



Source: Milken Institute, College Promise Campaign.

There is a total of 201 programs aimed at free higher education currently active with the vast majority operating only within cities.[71] States have been implementing similar programs that are modeled on these city-level programs (see Figure 14). Such programs are one way to reduce the amount of money required to graduate from college. The reduction of such a significant barrier opens up opportunities for millions of people on the low end of the wage distribution. As high-tech jobs command higher wages on average, this facilitates socioeconomic mobility. However, attracting people to pursue degrees in STEM fields will remain a challenge.

While cities have led the way in creating pathways to free higher education, there are an increasing number of states that have or are introducing free community college. These states have established programs that are supported with public funds to address broad-based reductions in higher education costs (see Figure 14).[72] Maryland will begin its free community college program in 2019. Free college tuition programs vary greatly in scope and purpose. The Tennessee Promise provides free community college for four semesters and in 2017 expanded to cover all adults rather than just recent high school graduates.[73] Almost all of the Promise Programs are last-dollar scholarships, which means a student needs to have pursued other funding sources like Pell Grants first. Tennessee Promise is a public-private partnership that is made up of four groups to cover all counties. The expansion of the program allows for broader access to higher education opportunities for retraining or continuing higher education. Facilitating lifelong learning helps support a resilient workforce by enabling workers to adapt their skills as the nature of work changes through automation.

Minnesota started its College Occupational Scholarship Pilot Program in 2016. A college graduate from Minnesota's class of 2016 had an average of $31,915 in student debt. The scholarship covers four semesters at any community college for students pursuing STEM degrees. Minnesota ranks No. 4 (HCI) and No. 7 (TSW), and by making active efforts to reduce the cost of education, the state has more potential to improve. The cost reductions will only help those who are pursuing STEM degrees, which means that graduates should enjoy a wage premium if they land related employment.[74] The focus on STEM degrees should add to the percentage of recent science and engineering graduates, who currently make up 16.07 percent of Minnesota's recent B.A. graduates.

The most extensive and ambitious statewide free college tuition program in the U.S. is New York's Excelsior Scholarship (ES). The Excelsior Scholarship covers both recent high school graduates and non-traditional students attending two- and four-year state-run higher educational institutions. By 2019, ES will cover households making up to $125,000, which accounts for 75.7 percent of New York families.[75] This last-dollar scholarship, along with other scholarships, has a set of minimum conditions that apply, such as residence, GPA, on-time completion, and credit requirements, that must be met to maintain funding. The total cost of this program is estimated to be $163 million annually.[76] New York produces a lot of science and engineering graduate-level talent, with 19,397 students earning degrees in the 2016-2017 academic year. This helped to put New York in the Top 10 of the HCI for the 2016-2017 school year. New York has immense educational capacity, graduating a total of 58,109 science and engineering and 486,458 total students for the 2016-2017 academic year. However, this has not translated into a similar concentration of high-tech occupations, placing the state 38th on the TSW. The Excelsior Scholarship can open up a pathway to support the high-tech workforce in New York.

California has 44 Promise Programs covering various cities. Within this set of 44 Promise Programs, the number of semesters covered ranges from one to four, with the majority covering two. The notable exceptions are Stockton and Oakland, which allocate funds for four-year universities. The Oakland Promise Program provides scholarships to any two- or four-year university in the U.S.[77] For low-income Oakland high school graduates, tuition is waived for any California State University (CSU) or University of California (UC) institution, and students are guaranteed admission to CSU East Bay. However, the state program does much less than most city-level programs. The state-level program covers two semesters at any community college. This first-dollar scholarship fills in geographic holes in the tuition-free higher education scholarships for high school students in California. The California Promise Program does have a feature that involves the CSU system that is designed to get students through college in four years. Through specific counseling, early class registration, and guaranteed course availability, the program offers another incentive to continue higher education. This program does not guarantee to reduce the cost of higher education due to students paying per credit, but it does maximize potential lifetime earnings by getting students to graduation within four years.

The variation in the Promise Programs does not guarantee the high-tech sector will experience the benefits of lower costs for higher education. Higher education programs that are incentivizing cost savings of community college transfers to four-year schools allow for more people to pursue higher education. These programs allow students to target courses that more easily transfer credits to a four-year university. One way many states have made the transfer process easier is guaranteed admission. California, Florida, and Virginia all have such programs with varying scopes. California's guarantee covers the CSU system and will soon cover the UC system using an A.A. degree that has a designate for the guarantee.[78] Florida's legislation requires the curriculum of an associate's degree to meet all general education requirements and that students holding an A.A. degree be granted admission to any state-run higher education institution. Virginia has a statewide guarantee program to get transfer students into public universities.[79] Guaranteed admission programs reduce the uncertainty for community college students who want to transfer to a four-year university.

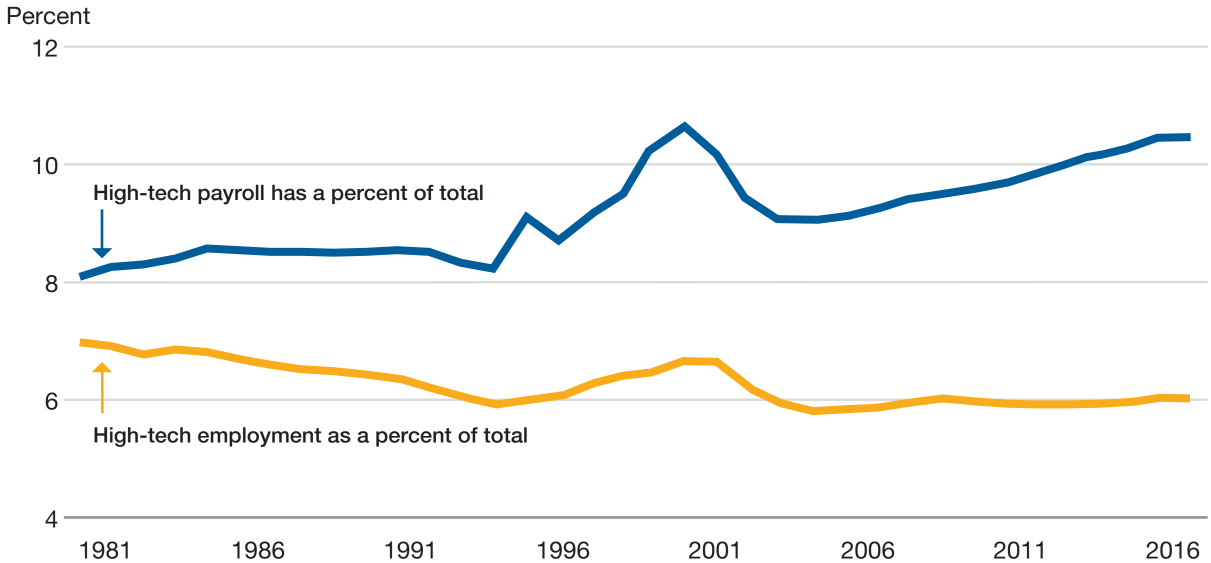
Arizona, Pennsylvania, and Massachusetts have prioritized their students' ability to easily transfer credits through clearly defined designations that higher education institutions accept. In Arizona, these credits are called Arizona Core Education Curriculum. The credits can be transferred to any of the three public universities. Pennsylvania uses a program called PA TRAC and a 30-credit transfer framework. This program covers all state-run universities and five private universities in Pennsylvania. Massachusetts has the MassTransfer program, which emphasizes being a full-time student and transferring from community college to any public state university. Massachusetts' program guarantees the transfer of credits as well as a set of conditions for an average cost reduction up to 40 percent on a bachelor's degree and guaranteed admission. [80] Recent data on transfer students show that 42 percent completed a bachelor's degree. This kind of program, in tandem with statewide higher education cost reduction programs, can support the high-tech sector by reducing barriers and facilitating graduation.

Importance of Work Experience

For many, the promise of college is higher-paying employment. The scale of high-tech employment ranges from Washington State with the largest percentage (10.49), to Wyoming, with the lowest percentage (2.27). In the U.S. as a whole, the high-tech sector represents 10.47 percent of total wages all while only making up 6.01 percent of total employment (see Figure 15). In 2016, the high-tech industry made up only 5.62 percent of total U.S. establishments, but these had outsized economic influence per their proportion of the overall economy, representing 11.62 percent of real GDP. These indicators show a high wage premium, a relatively small percentage of employment opportunities, and a small set of companies with enormous impact on the overall economy. However, the transition from college student to the workforce is not a straightforward process for everyone. Having beyond a bachelor's degree can help smooth the transition, but there is no doubt that relevant work experience can jump-start a career for new graduates. Three of the main channels utilized during a college career that can assist with the transition are career services, internships, and co-op education programs.

Career services are one of the most common departments in higher education institutions. Data from Gallup find the percentage of students that found career services very helpful has declined from 1949 to 2016 by 14 percentage points. While 80 percent of students found some value in going to a career service office, only 43 percent of students said they found career services helpful or very helpful. Science and engineering majors had similar experiences at a career service office for those students who found it to be helpful or very helpful.[81] Transfer students were the only group of students not to have a majority of the group go to a career service office at least once. However, transfer students that did go at least once found at least some value at about the same proportion as all other groups.[82] It is clear that having some form of career services does add value for students, but the effectiveness of such programs is unclear. There are many criticisms of career services, but one of the largest problems is that, due to a lack of funding, the vast majority of universities can't support a robust career service department.

FIGURE 15 Percent of U.S. High-Tech Payroll and Employment Totals, 1981 to 2016



Source: Milken Institute, Moody's Analytics.

There is a sizeable amount of evidence that internships benefit early career outcomes.[83] Data from those with relevant work experience indicate people with internship experience end up in the field of study that maximizes their investment in education while setting an individual on a career path. Internships are a good option for gaining work experience, and 55 percent of college graduates have had an internship by the time they graduate, as of 2016. This change is a 5 percent increase from a 2008 study and a 38 percent increase from a 1992 survey from Northwestern University.[84] As internships have become a source of competitive advantage for graduates, companies are turning to paid internships, seeing a 5.4 percentage point increase over the last seven years.[85] The increase in the number of paid internships may be due to wanting to attract as much talent as possible, and it also makes it possible for those who cannot forgo an income to intern instead of taking paid work unrelated to their chosen career path. For 2017, full-time entry-level hires with internal internships experienced a retention rate of 70.7 percent. People with outside internship experience for entry-level full-time hires was 57.3 percent.[86] The lower retention rate for people with outside internship experience shows that companies prefer to use internships as a hiring tool. However, this does not indicate what other employment options people with outside internship experience had. There is a clear advantage to getting as much relevant work experience as you can before leaving school.

One option that extends the time in school but provides a robust work and educational experience without the need for traditional internships is co-op education. Drexel University has one of the more established co-op programs. The basic idea is that a student takes two to six quarters to be employed by a company and takes classes over the summer adding up to one more year at school. Drexel University has partnerships with companies such as Boeing, Google, and Independence Blue

Cross to provide relevant high-tech workforce experience to students.[87] These programs seem to make the most sense to get students workforce experience, and even more valuable are programs that cater to students' field of study. Co-op education programs are not uncommon in engineering schools. However, there are a few universities that have such programs school-wide. The National Association of Colleges and Employers 2017 survey on internships and co-op retention rates shows that internal hiring of co-op students is 57.4 percent and for external hiring 45.1 percent for one-year retention rates.[88] The interesting difference between the internship and co-op employment is internships have higher rates of employee retention than co-op students, which could be a reflection of the increased work experience through the co-op opening up better job opportunities for graduates.

The 2014 U.S. Workforce Innovation and Opportunity Act prioritizes collaboration between relevant stakeholders at various regional levels. Co-op education is one of the better examples of integrating this type of collaboration systemically. By increasing exposure of students to employers and transferable skills, the transition from new graduate to the workforce can be eased. The high-tech industry is concentrated in a few well-known states, which are exemplified by the Top 10 of the STSI. For these states, the ability to generate talent within industrial clusters will continue to add value. For states looking to expand the footprint of the high-tech sector, a defined pathway can help the development of the industry. Efforts that states make to reduce the cost of higher education and speed up graduation will add value as both the high-tech and overall workforces are strengthened. The ability for a university to engage and provide its students with opportunities outside of the classroom is an underutilized source of value that can be added to the university experience. The high-tech labor force draws talent from around the world, increasing competition in the labor market. For recent graduates to be competitive, they will need to acquire practical experience in the workplace. States that are trying to create a competitive high-tech workforce by prioritizing higher educational attainment in tandem with creating pathways for students to gain workforce experience while in school can create the foundation for long-term economic success.

APPENDIX

RESEARCH AND DEVELOPMENT INPUTS	SOURCE
Federal R&D Dollars per Capita	NSF, National Patterns of R&D Resources, Survey of Federal Funds for Research and Development
Industry R&D Dollars per Capita	NSF, National Patterns of R&D Resources, Business Research and Development and Innovation Survey
Academic R&D Dollars per Capita	NSF, National Patterns of R&D Resources, Higher Education Research and Development Survey
National Science Foundation Funding per 100,000 of GSP	NSF, Budget Internet Information System
National Science Foundation Research Funding per 100,000 of GSP	NSF, Budget Internet Information System
R&D Expenditures on Engineering per Capita	NSF, Survey of Research and Development Expenditures at Universities and Colleges/Higher Education Research and Development Survey
R&D Expenditures on Physical Sciences per Capita	NSF, Survey of Research and Development Expenditures at Universities and Colleges/Higher Education Research and Development Survey
R&D Expenditures on Environmental Sciences per Capita	NSF, Survey of Research and Development Expenditures at Universities and Colleges/Higher Education Research and Development Survey
R&D Expenditures on Math and Computer Science per Capita	NSF, Survey of Research and Development Expenditures at Universities and Colleges/Higher Education Research and Development Survey
R&D Expenditures on Life Sciences per Capita	NSF, Survey of Research and Development Expenditures at Universities and Colleges/Higher Education Research and Development Survey
R&D Expenditures on Agricultural Sciences per Capita	NSF, Survey of Research and Development Expenditures at Universities and Colleges/Higher Education Research and Development Survey
R&D Expenditures on Biomedical Sciences per Capita	NSF, Survey of Research and Development Expenditures at Universities and Colleges/Higher Education Research and Development Survey
Average Annual Number of STTR Awards per 10,000 Business Establishments	SBA, SBIR, STTR
Average STTR Award Dollars per $1 Million of GSP	SBA, SBIR, STTR
Average Annual Number of SBIR Awards per 100,000 People	SBA, SBIR, STTR
Average SBIR Awards per 10,000 Businesses (Phase I)	SBA, SBIR, STTR
Average SBIR Awards per 10,000 Businesses (Phase II)	SBA, SBIR, STTR
Competitive NSF Proposal Funding Rate	NSF, Budget Internet Information System

RISK CAPITAL AND ENTREPRENEURIAL INFRASTRUCTURE	
Total Venture Capital Investment Growth	PwC, Moneytree Report
VC deals per 10,000 Business Establishments	PwC, Moneytree Report
Deal growth of VC Investment	PwC, Moneytree Report
Venture Capital Investment as Percent of GSP	PwC, Moneytree Report
Average SBIC Funds Disbursed per $1,000 of GSP	Congressional Research Service, University of North Texas, SBA Small Business Investment Company Program
Business Incubators per 10,000 Establishments	INBIA
Patents Issued per 100,000 People	USPTO, Performance and Accountability Report
Business Starts per 100,000 People	U.S. Census Bureau, County Business Patterns
Average IPO Proceeds as Percent of GSP	Pitchbook
Average VC Investment in Nanotechnology per $1,000 of GSP	Pitchbook
Average VC Investment in Clean Technology/Green Technology per $1,000 of GSP	Pitchbook
Average Venture Capital in Biotechnology per 100,000 GSP	Pitchbook

HUMAN CAPITAL INVESTMENT	
Percentage of Population with Bachelor's Degrees or Higher	American Community Survey 5-year estimates
Percentage of Population with Advanced Degrees	American Community Survey 5-year estimates
Percentage of Population with PhDs	American Community Survey 5-year estimates
Graduate Students in Science & Engineering & Health per 1,000 people	NSF-NIH, Survey of Graduate Students & Post Doctorates in Science and Engineering
Per Capita State Spending on Student Aid	National Association of State Student Grant & Aid Programs Annual Fiscal Report
Average Evidence-Based Reading and Writing SAT Scores	College Board
Average Math SAT Scores	College Board
Average ACT Scores	ACT
State Appropriations for Higher Education (per capita)	Illinois State University, Grapevine
Percent Change in State Appropriations for Higher Education	Illinois State University, Grapevine
Doctoral Scientists per 100,000 People	NSF, Survey of Doctorate Recipients
Doctoral Engineers per 100,000 People	NSF, Survey of Doctorate Recipients
Science, Engineering, and Health PhDs Awarded per 100,000 people	NSF, Survey of Earned Doctorates
Science, Engineering, and Health Post-doctorates Awarded per 100,000 people	NSF-NIH, Survey of Graduate Students & Post-doctorates in Science and Engineering
Percentage of Bachelor's Degrees in Science and Engineering	IPEDS, Completions Survey
Recent Bachelor's Degree in Science and Engineering per 1,000 workers	IPEDS, Completions Survey
Recent Master's Degree in Science and Engineering per 1,000 workers	IPEDS, Completions Survey
Recent PhD Degree in Science and Engineering per 1,000 workers	NSF, Survey of Earned Doctorates
Recent Degrees in Science and Engineering per 1,000 workers	IPEDS, Completions Survey
Percentage of Households With Computers	American Community Survey 5-year estimates
Percentage of Households With Broadband Access	American Community Survey 5-year estimates

S&T WORKFORCE INDEX	
Intensity of Computer and Information Research Scientists per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Computer Systems Analysts per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Information Security Analysts per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Computer Programmers per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Software Developers, Applications per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Software Developers, Systems Software per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Web Developers per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Database Administrators per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Network and Computer Systems Administrators per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Computer Network Architects per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Computer User Support Specialists per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Computer Network Support Specialists per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Computer Occupations, All Other per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Operations Research Analysts per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Statisticians per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Aerospace Engineers per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Biomedical Engineers per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Chemical Engineers per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Civil Engineers per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Computer Hardware Engineers per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Electrical Engineers per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Environmental Engineers per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Industrial Engineers per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Materials Engineers per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Mechanical Engineers per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Mining and Geological Engineers, Including Mining Safety Engineers per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Nuclear Engineers per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Petroleum Engineers per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Engineers, All Other per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Soil and Plant Scientists per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Biochemists and Biophysicists per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Microbiologists per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Zoologists and Wildlife Biologists per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics

Intensity of Biological Scientists, All Other per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Epidemiologists per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Medical Scientists, Except Epidemiologists per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Life Scientists, All Other per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Physicists per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Atmospheric and Space Scientists per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Chemists per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Materials Scientists per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Environmental Scientists and Specialists, Including Health per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Geoscientists, Except Hydrologists and Geographers per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Physical Scientists, All Other per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Agricultural and Food Science Technicians per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Biological Technicians per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Chemical Technicians per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics
Intensity of Nuclear Technicians per 100,000 workers	Bureau of Labor Statistics, Occupational Employment Statistics

TECHNOLOGY CONCENTRATION AND DYNAMISM	
Percent of Employment in High-Tech NAICS Codes	Quarterly Census of Wages and Employment, Moody's Analytics
Percent of Payroll in High-Tech NAICS Codes	Quarterly Census of Wages and Employment, Moody's Analytics
Percent of Establishments in High-Tech NAICS Codes	County Business Patterns
Net Formation of High-Tech Establishments per 10,000 establishments	County Business Patterns
Number of Technology Fast 500 Companies per 10,000 establishments	Deloitte Fast 500 Technology
Average Yearly Employment Growth of High-Tech Industries	Quarterly Census of Wages and Employment, Moody's Analytics
Number of High-Tech Industries Growing Faster Than U.S. Average	Quarterly Census of Wages and Employment, Moody's Analytics
Number of High-Tech Industries With LQs Higher Than 1.0	Quarterly Census of Wages and Employment, Moody's Analytics
Number of Inc. 500 Companies per 10,000 establishment	Inc. Magazine

ENDNOTES

1. This report is based on methodology and includes material from previous editions of the Milken Institute's State Technology and Science Index.
2. Kaplan, Justin, "Baker Signs Bill Allotting Nearly Half a Billion to Mass. Life Sciences," WBUR, June 15, 2018, http://www.wbur.org/commonhealth/2018/06/15/baker-life-sciences-2.
3. Ibid.
4. Schoenberg, Shira, "Crackdown on 'Patent Trolls' Part of Massachusetts Senate's $601 Million Economic Development Bill," *MassLive*, July 24, 2018, https://www.masslive.com/politics/index.ssf/2018/07/crackdown_on_patent_trolls_par.html; State House New Service, "$600M Economic Development Bill Aims to Correct Imbalances," *Worcester Business Journal*, July 26, 2018, http://www.wbjournal.com/article/20180726/NEWS01/180729961/600m-economic-development-bill-aims-to-correct-imbalances.
5. "Bill H.4714," Commonwealth of Massachusetts, accessed August 3, 2018, https://malegislature.gov/Bills/190/H4714/Amendments/House.
6. Anderson, Kate, "MassVentures & the MA Clean Energy Center Announce New Partnership," MassVentures, March 29, 2017, https://www.mass-ventures.com/massventures-ma-clean-energy-center-announce-new-partnership/.
7. Serreze, Mary C., "Clean Tech Praises Massachusetts Energy Bill as Activist Community Vows Continued Engagement," *MassLive*, August 1 ,2018, https://www.masslive.com/politics/index.ssf/2018/08/massachusetts_energy_bill_wins.html.
8. "Colorado Business Grant & Tax Credit Incentive Programs," Colorado Office of Economic Development & International Trade, Accessed November 29, 2018, https://choosecolorado.com/doing-business/incentives-financing/.
9. "Colorado Small Business Resources & Startup Help," Colorado Office of Economic Development & International Trade, Accessed November 29, 2018, https://choosecolorado.com/doing-business/incentives-financing/startups-small-business/.
10. Ibid.
11. "Company Directory," Colorado Space Coalition, Assessed November 29, 2018, http://www.spacecolorado.org/do-business/company-directory.
12. DeVol, Ross, Joe Lee, and Minoli Ratnatunga, "Concept to Commercialization: The Best Universities for Technology Transfer," Milken Institute, April 2017, https://www.milkeninstitute.org/publications/view/856.
13. Babcock, Stephen, "Johns Hopkins Spinout Neuraly Launches with $36M Funding Round," Technical.ly Baltimore, July 20, 2018, https://technical.ly/baltimore/2018/07/20/johns-hopkins-spinout-neuraly-launches-with-36m-funding-round/.
14. Grover, Ronald, "Billions Pour into LA as It Gears Up to Be the Next Silicon Valley," September 26, 2017, https://www.cnbc.com/2017/09/26/billions-pour-into-la-as-it-gears-up-to-be-the-next-silicon-valley.html.
15. "Los Angeles Venture Capital Directory," Cayenne Consulting, Accessed August 13, 2018, https://www.caycon.com/los-angeles-venture-capital.
16. Jackson, Jessica, Joe Lee, Michael C.Y. Lin, and Minoli Ratnatunga, "2017 Best-Performing Cities: Where America's Jobs Are Created and Sustained," Milken Institute, January 2018, https://www.milkeninstitute.org/publications/view/897.
17. DeVol, Ross, Joe Lee, and Minoli Ratnatunga, "Concept to Commercialization: The Best Universities for Technology Transfer," Milken Institute, April 2017, https://www.milkeninstitute.org/publications/view/856.
18. "Talent Ready Utah: Building Our Workforce," Utah Governor's Office of Economic Development, Accessed September 10, 2018, http://www.talentreadyutah.com/.

19. McGrane, Clare, “Frazier Healthcare Partners Raises $419M for Life Science Venture Fund, Signaling Huge Interest in Health Investment,” *GeekWire*, November 1, 2017, https://www.geekwire.com/2017/frazier-healthcare-partners-raises-419m-life-science-venture-fund-signaling-huge-interest-health-investment/.

20. Soper, Taylor, “Madrona Raises $300M Venture Fund, Reveals Strategy for Investing in Pacific Northwest Startups,” *GeekWire*, May 22, 2018, https://www.geekwire.com/2018/madrona-raises-300m-venture-fund-reveals-strategy-investing-pacific-northwest-startups/.

21. “Delaware Bio Applauds Passage of Angel Investor Tax Credit Legislation,” Business Wire, May 7, 2018, https://www.businesswire.com/news/home/20180507005201/en/Delaware-Bio-Applauds-Passage-Angel-Investor-Tax.

22. “Does DowDuPont’s $200 Million Investment Signal an End to Turmoil?” delaware online, Accessed August 13, 2018, https://www.delawareonline.com/story/money/business/2018/06/11/dowduponts-200-million-laboratoryrenovations-sign-end-turmoil/689963002/.

23. “New Biopharmaceutical Building Part of UD’s Plan to Attract 1,500 New Jobs to Area,” delaware online, Accessed August 13, 2018, https://www.delawareonline.com/story/money/business/2017/10/19/ud-break-ground-156-million-star-campus-building/776269001/.

24. “How High Tech Is Taking Over Higher Education,” Twin Cities Business, Accessed August 13, 2018, http://tcbmag.com/news/articles/2018/august/how-high-tech-is-taking-over-higher-education.

25. Van Berkel, Jessie, “Minnesota Needs $1.4B to Hook Up Everybody to Broadband, Task Force Concludes,” government technology, Accessed August 13, 2018, http://www.govtech.com/network/Minnesota-Needs-14B-to-Hook-Up-Everybody-to-Broadband-Task-Force-Concludes.html.

26. Hayward, Mark, “Kamen to Lead $294M Effort in Manchester Millyard to Grow Human Organs on Industrial Scale” armi, Accessed August 13, 2018, https://www.armiusa.org/news/2017/5/23/kamen-to-lead-294m-effort-in-manchester-millyard-to-grow-human-organs-on-industrial-scale.

27. “University System Proposes $86m Bio-Tech Expansion,” *New Hampshire Union Leader*, Accessed September 10, 2018.

28. “Lonza Biologics Expansion Approved, up to 1,000 New Jobs at Pease International Tradeport,” *New Hampshire Union Leader*, Accessed August 13, 2018.

29. Area Development News Desk, “Allegro MicroSystems Expands Manchester, New Hampshire, Production Complex,” AreaDevelopment, December 22, 2017, http://www.areadevelopment.com/newsItems/12-22-2017/allegro-microsystems-operations-center-manchester-new-hampshire.shtml.

30. Nickelsburg, Monica, “Mysterious Oregon Startup Azevtec Raises $8M for Self-Driving ‘Zero-Emission Vehicle Systems,’” *GeekWire*, July 3, 2018, https://www.geekwire.com/2018/mysterious-oregon-startup-azevtec-raises-8m-self-driving-zero-emission-vehicle-systems/.

31. Rogoway, Mike, “Legal Tech Firm Exterro Lands $100 Million-Plus Investment,” *The Oregonian*, May 23, 2018, https://www.oregonlive.com/silicon-forest/index.ssf/2018/05/legal_tech_firm_exterro_lands.html.

32. Theen, Andrew, “Phil and Penny Knight Will Give $500 Million to University of Oregon for Science Complex,” *The Oregonian*, March 23 2017, https://www.oregonlive.com/business/index.ssf/2016/10/phil_and_penny_knight_will_giv.html.

33. Swan, Darryl, “Highlight of Boeing R&D Lands at OMIC,” Columbia County Spotlight, Accessed August 13, 2018. https://pamplinmedia.com/scs/83-news/392403-284405-highlight-of-boeing-r-and-d-lands-at-omic.

34. “High Impact Business Performance Incentive,” Enterprise Florida, Accessed November 29, 2018, http://www.enterpriseflorida.com/wp-content/uploads/incentive-high-impact-performance-grant.pdf.

35. Rodriguez, Rene, “Telemundo’s New Headquarters Embraces the Future. It May Transform This Area, Too,” *Miami Herald*, April 9, 2018, https://www.miamiherald.com/news/business/real-estate-news/article208183099.html; Wile, Rob, “A $400 Million Silicon Valley Fund Is Bringing a Major Program to Miami,” *Miami Herald*, August 3, 2018, https://www.miamiherald.com/news/business/article216037720.html.

36. Lee, Joe and Minoli Ratnatunga, “Building a Knowledge Economy: How Academic R&D Supports High-Tech Employment,” Milken Institute, August 2018, https://www.milkeninstitute.org/publications/view/930.

37. Smith, Adam, "Harvard-Born Startup Hears Success With New Ear Tube Technology," AmericanInno, May 11, 2018, https://www.americaninno.com/boston/boston-startup/harvard-born-startup-hears-success-with-new-ear-tube-technology/.

38. The Shepard News Team, "Boeing Plans New R&D Centre in Massachusetts," Shepard Media, August 3 ,2018, https://www.shephardmedia.com/news/uv-online/boeing-plans-new-rd-centre-massachusetts/.

39. LaPorta, James, "DARPA Taps MIT for Research on High-Value Molecules," *UPI*, May 3, 2018, https://www.upi.com/DARPA-taps-MIT-for-research-on-high-value-molecules/9431525369340/.

40. Tilley, Aaron, "IBM Invests $240 Million into AI Research Lab with MIT as It Struggles in AI Battle," September 7, 2017, https://www.forbes.com/sites/aarontilley/2017/09/07/ibm-invests-240-million-for-ai-research-lab-with-mit-as-it-struggles-in-ai-battle/#15562654612e.

41. Vinluan, Frank, "Xconomy: Now Hear This: Akouos Secures $50M for Hearing Loss Gene Therapy R&D," Xconomy, August 7, 2018. https://xconomy.com/boston/2018/08/07/now-hear-this-akouos-secures-50m-for-hearing-loss-gene-therapy-rd/.

42. "Wyoming SBDC Network Receives Grant to Commercialize Tech Innovations," University of Wyoming, Accessed September 5, 2018, http://www.uwyo.edu/uw/news/2018/09/wyoming-sbdc-network-receives-grant-to-commercialize-tech-innovations.html.

43. Audretsch, David, *Everything in Its Place: Entrepreneurship and the Strategic Management of Cities, Regions, and States*, (New York: Oxford University Press, 2015), 70-72.

44. Audretsch, David, Max Keilback, and Erik Lehmann, *Entrepreneurship and Economic Growth*, (New York: Oxford University Press, 2006); Audretsch, David and Max Keilback, "The Theory of Knowledge Spillover Entrepreneurship," *Journal of Management Studies*, 2007, Vol. 4, pp. 1242-1254; Braunerhjelm, Pontus, Zoltan Acs, David Audretsch, and Bo Carlsson, "The Missing Link: Knowledge Diffusion and Entrepreneurship in Endogenous Growth," *Small Business Economics: An Entrepreneurship Journal*, 2010, Vol. 34, pp. 105-125.

45. "Venture Capital Funding," Housing and Economic Development, January 15, 2013, http://www.mass.gov/hed/business/funding-financing/venture-funding/index.html; "Bill H.4714," Accessed August 13, 2018, https://www.malegislature.gov/Bills/190/H4714/Amendments/House.

46. Terry, Mark, "SQZ Biotechnologies Closes Oversubscribed $72 Million Series C." BioSpace, August 8, 2018, https://www.biospace.com/article/sqz-biotechnologies-closes-oversubscribed-72-million-series-c/.

47. Rowley, Jason D., "General Catalyst Raises $1.375 Billion in Its Largest Fund to Date," *Crunchbase News*, March 26, 2018, https://news.crunchbase.com/news/general-catalyst-raises-1-375-billion-ninth-fund-largest-date/.

48. Shieber, Jonathan, "Renault-Nissan-Mitsubishi Launches $1 Billion Corporate Venture Capital Fund," TechCrunch, Accessed August 13, 2018, http://social.techcrunch.com/2018/01/09/renault-nissan-mitsubishi-launches-1-billion-corporate-venture-capital-fund/.

49. Wiggers, Kyle, "Glasswing Ventures Raises $112 Million for AI-Focused Fund," VentureBeat, July 12, 2018, https://venturebeat.com/2018/07/12/glasswing-ventures-raises-112-million-for-ai-focused-fund/.

50. Wile, Rob, "Magic Leap, the $2 Billion 3D Software Startup, Is Finally Live. It Doesn't Come Cheap," *Miami Herald*, August 9, 2018, https://phys.org/news/2018-08-magic-billion-3d-software-startup.html.

51. Roush, Morgan, "Florida Funders Forges Joint Venture with Florida Angel NEXUS," PRWeb, August 21, 2018, https://www.prweb.com/releases/florida_funders_forges_joint_venture_with_florida_angel_nexus/prweb15704279.htm.

52. Hanushek, Eric A., and Ludger Woessman, *The Knowledge Capital of Nations: Education and the Economics of Growth*, (Cambridge: MIT Press, 2015).

53. Lee, Joe, "Educating a Workforce: Keeping Local Talent," Milken Institute, June 22, 2018, https://www.milkeninstitute.org/publications/view/918.

54. DeVol, Ross, I-Ling Shen, Armen Bedroussian, and Nan Zhang, "A Matter of Degrees: The Effect of Educational Attainment on Regional Economic Prosperity," Milken Institute, February 2013, https://www.milkeninstitute.org/publications/view/564.

55. "State by State Data," The Institute for College Access and Success, Accessed August 13, 2018, https://ticas.org/posd/map-state-data.

56. "Transfer and Articulation - All State Profiles," Education Commission of the States, Accessed August 29, 2018, http://ecs.force.com/mbdata/mbprofallrta?Rep=TA18STA.

57. Ibid.

58. Acs, Zoltan J., David B. Audretsch, and Erik E. Lehmann, "The Knowledge Spillover Theory of Entrepreneurship," *Small Business Economics 41*, no. 4 (2013): 757-74.

59. Richman, Talia, "University of Maryland Receives $219 Million Gift, Largest in College's History," *Baltimore Sun*, October 4, 2017, http://www.baltimoresun.com/news/maryland/education/bs-md-umd-donation-20171002-story.html.

60. Anderson, Nick, "A Record-Breaking Gift to the University of Maryland: $219 Million," *The Washington Post*, October 4, 2017, https://www.washingtonpost.com/local/education/a-record-breaking-gift-to-the-university-of-maryland-219-million/2017/10/04/80cb1e54-a76f-11e7-850e-2bdd1236be5d_story.html?noredirect=on&utm_&utm_term=.90cb628c05ec.

61. "Community College Promise Scholarship," Maryland Higher Education Commission, Accessed August 13, 2018, https://mhec.maryland.gov/Pages/Community-College-Promise-Scholarship.aspx.

62. Matthias, Lauren, "$1.75 Million Grant for Dixie State Will Help Job Growth in St. George," ABC4, July 10, 2018, https://www.good4utah.com/southern-utah/-175-million-grant-for-dixie-state-will-help-job-growth-in-st-george/1292740929.

63. Raymond, Art, "Ridge Overlooking St. George Poised to Become Mini-Mecca of Tech Companies," *Deseret News*, February 19, 2018, https://www.deseretnews.com/article/900010796/ridge-overlooking-stgeorge-poised-to-become-mini-mecca-of-tech-companies.html.

64. Foreman, Kelsie, "AvidXChange Hosts Ceremony for $35 Million Utah Expansion with Sandy Mayor," Utah Business, June 27, 2018, https://utahbusiness.com/avidxchange-hosts-ceremony-for-35-million-utah-expansion-with-sandy-mayor/.

65. Raymond, Art, "Software Giant Adobe to Build New Facility, Double Utah Workforce," *Deseret News*, July 13, 2017, https://www.deseretnews.com/article/865684738/Software-giant-Adobe-to-build-new-facility-double-Utah-workforce.html.

66. DeVol, Ross, Joe Lee, and Minoli Ratnatunga, "Concept to Commercialization: The Best Universities for Technology Transfer," Milken Institute, April 20, 2017, https://www.milkeninstitute.org/publications/view/856; Lee, Joe and Minoli Ratnatunga, "Building a Knowledge Economy: How Academic R&D Supports High-Tech Employment," Milken Institute, August 2018, https://www.milkeninstitute.org/publications/view/930.

67. "National Patterns of R&D Resources: 2015-16 Data Update," National Science Foundation, Accessed October 5, 2018, https://www.nsf.gov/statistics/2018/nsf18309/#chp2.

68. Garmaise, Mark J., "Ties That Truly Bind: Noncompetition Agreements, Executive Compensation, and Firm Investment," *Journal of Law, Economics, & Organization 27,* no. 2 (2011): 376-425.

69. Schaller, William Lynch, "Jumping Ship: Legal Issues Relating to Employee Mobility in High Technology Industries," *The Labor Lawyer 17*, no. 1 (2001): 25-106.

70. Garmaise, Mark J., "Ties That Truly Bind: Noncompetition Agreements, Executive Compensation, and Firm Investment," *Journal of Law, Economics, & Organization 27*, no. 2 (2011): 376-425.

71. Schaller, William Lynch, "Jumping Ship: Legal Issues Relating to Employee Mobility in High Technology Industries," *The Labor Lawyer 17*, no. 1 (2001): 25-106.

72. Marx, Matt, Deborah Strumsky, and Lee Fleming, "Mobility, Skills, and the Michigan Non-Compete Experiment," *Management Science 55*, no. 6 (2009): 875-89.

73. Garmaise, Mark J., "Ties That Truly Bind: Noncompetition Agreements, Executive Compensation, and Firm Investment," *Journal of Law, Economics, & Organization 27*, no. 2 (2011): 376-425.

74. Acs, Zoltan J., David B. Audretsch, and Erik E. Lehmann, "The Knowledge Spillover Theory of Entrepreneurship," *Small Business Economics 41*, no. 4 (2013): 757-74.

75. Samila, Sampsa, and Olav Sorenson, "Noncompete Covenants: Incentives to Innovate or Impediments to Growth," *Management Science 57*, no. 3 (2011): 425-38.

76. Stuart, Toby E., and Olav Sorenson, “Liquidity Events and the Geographic Distribution of Entrepreneurial Activity,” *Administrative Science Quarterly 48*, no. 2 (2003): 175-201.

77. Samila, Sampsa, and Olav Sorenson, “Noncompete Covenants: Incentives to Innovate or Impediments to Growth,” *Management Science 57*, no. 3 (2011): 425-38.

78. Marx, Matt, “Reforming Non-Competes to Support Workers,” The Hamilton Project, Brookings, February 2018, https://www.brookings.edu/wp-content/uploads/2018/02/es_2272018_reforming_noncompetes_support_workers_marx_policy_proposal.pdf.

79. Schaller, William Lynch, “Jumping Ship: Legal Issues Relating to Employee Mobility in High Technology Industries,” *The Labor Lawyer 17*, no. 1 (2001): 25-106.

80. Adams, Stephen B., “Regionalism in Stanford’s Contribution to the Rise of Silicon Valley,” *Enterprise & Society 4*, no. 3 (2003): 521-43.

81. Saxenian, AnnaLee, *Regional Advantage: Culture and Competition in Silicon Valley and Route 128.* Harvard University Press, 2000.

82. Leslie, Stuart W., and Robert H. Kargon, “Selling Silicon Valley: Frederick Terman’s Model for Regional Advantage,” *The Business History Review 70*, no. 4 (1996): 435-72.

83. Winton, Erik J., and Colin A. Thakkar, “Massachusetts Legislature (Finally) Passes Non-Compete Law,” jackson lewis, August 1, 2018, https://www.jacksonlewis.com/publication/massachusetts-legislature-finally-passes-non-compete-law.

84. Green, Dennis, “Amazon’s HQ2 Race Is Making Cities Embark on Projects They Hadn’t Considered Before,” Inc., July 2, 2018, https://www.inc.com/business-insider/amazon-hq2-effect-cities-improve-education-infrastructure-projects.html.

85. “Student Debt and the Class of 2016: 12th Annual Report,” The Institute for College Access and Success, September 2017, https://ticas.org/sites/default/files/pub_files/classof2016.pdf.

86. “Consumer Credit - G.19,” Board of Governors of the Federal Reserve System, July 9 2018, https://www.federalreserve.gov/releases/g19/current/default.htm.

87. Bidwell, Allie, “Student Loan Expectations: Myth vs. Reality,” U.S. News and World Report, October 7, 2014, https://www.usnews.com/news/blogs/data-mine/2014/10/07/student-loan-expectations-myth-vs-reality; “How Long Does It Take to Pay Off a Student Loan?” Consumer Financial Protection Bureau, August 7, 2017, https://www.consumerfinance.gov/ask-cfpb/how-long-does-it-take-to-pay-off-a-student-loan-en-621/.

88. Lee, Joe, “Educating a Workforce: Keeping Local Talent,” Milken Institute, June 22, 2018, https://www.milkeninstitute.org/publications/view/918.

89. “Program Search-Active,” College Promise Campaign, Accessed July 18, 2017, http://collegepromise.org/advanced-search/.

90. “Program Search: State Wide, Active,” College Promise Campaign, Accessed July 18, 2017, http://collegepromise.org/advanced-search/; “Tuition-Free Degree Program: The Excelsior Scholarship,” New York State, Accessed July 20, 2018, https://www.ny.gov/programs/tuition-free-degree-program-excelsior-scholarship.

91. Associated Press, “It’s Official: Maryland Community Colleges to Offer Free Tuition in 2019,” Washington4, May 8, 2018, https://www.nbcwashington.com/news/local/Gov-Hogan-Signs-Bill-to-Offer-Free-Community-College-Tuition-482105591.html.

92. Lobosco, Katie, “Tennessee Makes Community College Free for All Adults,” CNN Money, May 11, 2017, https://money.cnn.com/2017/05/11/pf/college/tennessee-free-community-college/index.html; “Tennessee Promise,” College Promise Campaign, Accessed July 20, 2018, http://collegepromise.org/programs/tennessee-promise/.

93. “Student Debt and the Class of 2016: 12th Annual Report,” The Institute for College Access and Success, September 2017, https://ticas.org/sites/default/files/pub_files/classof2016.pdf.

94. Fergus, Meredith and Sung Tae Jang, “MnSCU Two-Year Occupational Grant Pilot Program Report: Fall 2016,” Minnesota Office of Higher Education, April 2017, https://www.ohe.state.mn.us/pdf/MnSCUOccGrantReport2016.pdf.

95. "Governor Cuomo Announces First-in-the-Nation Excelsior Scholarship Program Will Provide Tuition-Free College to Middle-Class Families," New York State, April 8, 2017, https://www.governor.ny.gov/news/governor-cuomo-announces-first-nation-excelsior-scholarship-program-will-provide-tuition-free.

96. "New York's Promise to Students: Ever Upward," New York State, Accessed July 20, 2018, https://www.ny.gov/sites/ny.gov/files/atoms/files/ExcelsiorScholarship_Toolkit.pdf.

97. "Oakland Promise," College Promise Campaign, Accessed July 20, 2018, http://collegepromise.org/programs/oakland-promise/.

98. "Enhancing Student Transfer-A Memorandum of Understanding Between the California Community Colleges and the University of California," California Community Colleges and University of California, April 2017, https://www.universityofcalifornia.edu/sites/default/files/UC-CCC-MOU.pdf; "Transfer and Articulation: Statewide Guaranteed Transfer of an Associate Degree," Education Commission of the States, June 2018, http://ecs.force.com/mbdata/MBquest3RTA?Rep=TR1803.

99. "Transfer and Articulation: Statewide Guaranteed Transfer of an Associate Degree," Education Commission of the States, June 2018, http://ecs.force.com/mbdata/MBquest3RTA?Rep=TR1803.

100. "MassTransfer," Massachusetts Department of Higher Education, Accessed July 21, 2018, http://www.mass.edu/masstransfer/home.asp.

101. Shapiro, Doug, et al., "Tracking Transfer: Measures of Effectiveness in Helping Community College Students to Complete Bachelor's Degrees," National Student Clearinghouse Research Center, September 2017, https://nscresearchcenter.org/wp-content/uploads/SignatureReport13.pdf.

102. "Great Jobs. Great Lives. The Value of Career Services, Inclusive Experience and Mentorship for College Graduates," Gallup, December 13, 2016, https://news.gallup.com/reports/199229/6.aspx.

103. Ibid.

104. Ibid.

105. Saltikoff, Nathalie, "The Positive Implications of Internships on Early Career Outcomes," NACE, May 1, 2017, http://www.naceweb.org/job-market/internships/the-positive-implications-of-internships-on-early-career-outcomes/.

106. "Great Jobs. Great Lives. The Value of Career Services, Inclusive Experience and Mentorship for College Graduates," Gallup, December 13, 2016, https://news.gallup.com/reports/199229/6.aspx.

107. Gardner, Phil, "The Debate Over Unpaid College Internships," Intern Bridge Inc., January 2010, http://www.ceri.msu.edu/wp-content/uploads/2010/01/Intern-Bridge-Unpaid-College-Internship-Report-FINAL.pdf.

108. "Trend is Toward Paid Internships," National Association of Colleges and Employers, February 15, 2018, https://www.naceweb.org/about-us/press/2018/trend-is-toward-paid-internships/.

109. "Retention Rates for Former Intern/Co-Ops Decreasing," National Association of Colleges and Employers, July 19, 2017, https://www.naceweb.org/talent-acquisition/internships/retention-rates-for-former-interns-co-ops-decreasing/.

110. "How University Co-Op Work," Drexel University, Accessed July 23, 2018, http://drexel.edu/difference/co-op/how-co-op-works/.

111. "Retention Rates for Former Intern/Co-ops Decreasing," National Association of Colleges and Employers, July 19, 2017, https://www.naceweb.org/talent-acquisition/internships/retention-rates-for-former-interns-co-ops-decreasing/.

ABOUT THE AUTHORS

Kevin Klowden is the executive director of the Milken Institute's Center for Regional Economics. He specializes in the study of key factors that underlie the development of competitive regional economies (clusters of innovation, patterns of trade and investment, and concentration of skilled labor), and how these are influenced by public policy and in turn affect regional economies. On a national level, he is heavily involved in issues of capital access for small business, including serving as chair of the U.S. Department of Commerce's Trade Finance Advisory Council. He also helps to coordinate the Partnership for Lending in Underserved Markets initiative with the U.S. Small Business Administration, which focuses on funding for minority-owned small businesses. His areas of expertise include technology-based development, capital access, infrastructure, the global economy, media, and entertainment.

Klowden was the lead author of "Strategies for Expanding California's Exports," which examined the vital role trade and exports play in the state economy, and its underperformance relative to the country over the past decade. Further work on trade and investment has included "A Golden Opportunity with China: How California Can Become an Even Bigger Destination for Chinese Foreign Investment." He has also written on the role of transportation infrastructure in economic growth and job creation in reports such as "California's Highway Infrastructure: Traffic's Looming Cost" and "Jobs for America: Investments and Policies for Economic Growth and Competitiveness," as well as in publications including *The Wall Street Journal*.

He has addressed the role of technology-based development in publications such as the "2014 State Technology and Science Index," "North America's High-Tech Economy," and location-specific studies on Arkansas and Arizona. In addition, Klowden was the lead author of several studies on the economics of the entertainment industry, including "New Skills at Work: Keeping Los Angeles at the Cutting Edge in an Evolving Industry," "A Hollywood Exit: What California Must Do to Remain Competitive in Entertainment—and Keep Jobs," "Fighting Production Flight: Improving California's Filmed Entertainment Tax Credit Program," "Film Flight: Lost Production and Its Economic Impact in California," and "The Writers' Strike of 2007-2008: The Economic Impact of Digital Distribution"—each of which analyzes the changing dynamics of the entertainment industry.

Klowden is a frequent speaker on state fiscal issues and has served on multiple advisory boards on business growth, economic development, and infrastructure. He holds graduate degrees from the University of Chicago and London School of Economics.

Joe Lee is a research analyst with the Milken Institute on the regional economics team. He specializes in labor economics with a focus on human capital and regional competitiveness.

At the Milken Institute, Lee has focused on how the U.S. has been impacted by changes in technology, geography, and opportunity. Lee's work has contributed to the Center for Regional Economics research on how human capital develops regional economic clusters in the U.S. He has a focus on commercialization of R&D, the development of local labor, and geographic mobility. He recently presented research at the 2018 Western Economic Association International conference where he showcased work on academic research and development of local high-tech labor.

Lee received his master's in economics from California State University, Long Beach, and his undergraduate degree is from The Evergreen State College.

Minoli Ratnatunga is an economist and the director of regional economics research at the Milken Institute Center for Regional Economics. With her team, she investigates the key economic development issues facing regions, including competitiveness, fostering innovation and entrepreneurship, and building human capital.

Ratnatunga's publications include "Concept to Commercialization: The Best Universities for Technology Transfer," "Building a Knowledge Economy—How Academic R&D Supports High-Tech Employment," "Regional Performance Over Time: Thriving and Reviving Amid Economic Challenges," and "California's Innovation-Based Economy: Policies to Maintain and Enhance It." She has also coauthored multiple editions of the State Technology and Science Index and the Best-Performing Cities series.

Before joining the Institute, she worked for eight years at the Allegheny Conference on Community Development, a regional economic development organization focused on the Pittsburgh area's competitiveness and quality of life. There she focused her research on energy policy, transportation and infrastructure funding, and state tax competitiveness, working with civic and business leaders to help key decision-makers make better policy choices. Ratnatunga has a bachelor's degree in philosophy and economics from the London School of Economics and a master's degree in public policy and management from Carnegie Mellon University.

MILKEN INSTITUTE

SANTA MONICA | WASHINGTON | NEW YORK | LONDON | SINGAPORE