January 2011

State Technology and Science Index 2010

Enduring Lessons for the Intangible Economy

Ross C. DeVol, Kevin Klowden, and Benjamin Yeo

Milken Institute

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For more information

An interactive website with data for each state can be found at **www.milkeninstitute.org**.

About the Milken Institute

The Milken Institute is an independent economic think tank whose mission is to improve the lives and economic conditions of diverse populations in the United States and around the world by helping business and public policy leaders identify and implement innovative ideas for creating broad-based prosperity. We put research to work with the goal of revitalizing regions and finding new ways to generate capital for people with original ideas.

We focus on:

> **human capital:** the talent, knowledge, and experience of people, and their value to organizations, economies, and society; **financial capital:** innovations that allocate financial resources efficiently, especially to those who ordinarily would not have access to them, but who can best use them to build companies, create jobs, accelerate life-saving medical research, and solve long-standing social and economic problems; and
> **social capital:** the bonds of society that underlie economic advancement, including schools, health care, cultural institutions, and government services.

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Executive Summary

Eight years after releasing the Milken Institute's first State Technology and Science Index, it is even more apparent that successful state and regional economic development in the United States is increasingly tied to harnessing and nurturing the innovation assets present within their borders. The recent financial and economic crisis highlights the critical role that technological entrepreneurship plays in providing a diverse and flexible economic structure. With many countries making progress in competing against the U.S.—and in some cases exceeding it—in many measures of future preparedness, states must fashion their own strategic direction.

- Massachusetts continued its reign with an overall score of 82.61, but has slipped from 84.9 in our inaugural 2002 index. Massachusetts is a breeding ground of research with world-renowned universities and cutting-edge firms fueling its economy.
- Maryland, second overall with a score of 77.05, trailed Massachusetts in research and development inputs but took first in human capital capacity. The state ranked first in academic R&D per capita, thanks largely to Johns Hopkins University being the top recipient of NIH funding in the country.
- Colorado maintained the same position as in 2008, third overall, and was second in technology concentration and dynamism.
- California, holding steady at fourth, remained a national leader in technology-derived economic development, but measures of human capital continued to fall.
- Utah climbed three places to fifth this year. Utah retained its throne as the top-ranked state in technology concentration and dynamism. Risk capital availability has improved in the state.
- Rounding out the top 10 are Washington (sixth), New Hampshire (seventh), Virginia (eighth), Connecticut (ninth) and newcomer Delaware (10th).
- Alaska and Ohio had the greatest improvement in ranking (both seven), followed by Indiana, North Carolina (both five), and Delaware (four).

The State Technology and Science Index provides a nationwide benchmark for states to assess their science and technology capabilities, along with their ecosystems for converting them into companies and high-paying jobs. There are 79 individual indicators. Each indicator is computed and measured relative to population, gross state product (GSP), number of establishments, number of businesses, and other factors. 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.

Table 1. State Technology and Science Index

Overall rankings, 2010

State	Rank 2010	Rank 2008	Rank change 2008 to 2010	Average score	State	Rank 2010	Rank 2008	Rank change 2008 to 2010	Average score
Massachusetts	1	1	0	82.61	Michigan	26	26	0	50.74
Maryland	2	2	0	77.05	Idaho	27	27	0	49.84
Colorado	3	3	0	75.73	Indiana	28	33	5	49.70
California	4	4	0	73.85	Ohio	29	36	7	49.47
Utah	5	8	3	71.26	Missouri	30	30	0	48.44
Washington	6	5	-1	70.23	Alabama	31	29	-2	47.29
New Hampshire	7	9	2	68.69	Iowa	32	35	3	46.59
Virginia	8	6	-2	68.05	North Dakota	33	31	-2	46.39
Connecticut	9	7	-2	66.56	Nebraska	34	34	0	45.53
Delaware	10	14	4	63.26	Montana	35	32	-3	44.37
New Jersey	11	12	1	62.97	Hawaii	36	28	-8	43.87
Minnesota	12	11	-1	62.65	Alaska	37	44	7	42.79
North Carolina	13	18	5	61.42	South Dakota	38	41	3	41.48
Pennsylvania	14	13	-1	60.78	Oklahoma	39	38	-1	40.32
Arizona	15	17	2	60.21	Florida	40	37	-3	39.96
New York	16	15	-1	59.47	Tennessee	41	40	-1	38.85
Vermont	17	19	2	59.30	Maine	42	39	-3	37.56
New Mexico	18	16	-2	59.05	South Carolina	43	42	-1	36.84
Texas	19	20	1	58.33	Wyoming	44	43	-1	35.76
Illinois	20	21	1	57.13	Louisiana	45	46	1	35.27
Oregon	21	23	2	56.53	Nevada	46	45	-1	34.03
Rhode Island	22	10	-12	55.54	Kentucky	47	47	0	32.70
Kansas	23	24	1	55.48	Mississippi	48	50	2	32.43
Wisconsin	24	22	-2	55.02	West Virginia	49	49	0	30.33
Georgia	25	25	0	51.71	Arkansas	50	48	-2	25.63
								State average	**52.38**

These indicators are subdivided into five equally-weighted major composites:

Research and development inputs: The R&D capabilities that can be commercialized for future state and regional technology growth. 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: The entrepreneurial capacity and risk capital infrastructure of states are the ingredients that determine the success rate of converting research into commercially viable technology services and products. We include several measures of venture capital that capture the amount placed relative to the size of a state's economy and recent growth. It includes patenting activity, business formations, and initial public offerings.

Human capital capacity: Human capital is the most important intangible asset of a regional or state economy. This component includes measures of stocks and flows in various areas of educational attainment. Examples include the number of bachelor's, master's, and Ph.D.s relative to a state's population and measures of specific science, engineering, and technology degrees.

Technology and science workforce: The intensity of the technology and science workforce indicates whether states have sufficient depth of high-end technical talent on the ground. Intensity is derived by finding the percent share of employment for a particular field relative to total state employment; it indicates whether potential human capital is being combined with R&D and financial capital and is actually being transformed into a thriving economy. There are three main categories of computer and information science, life and physical science, and engineers. All together there are 18 different occupation categories.

Technology concentration and dynamism: This is a measure of technology outcomes. By measuring technology growth, we are able to assess the effectiveness of policymakers and other stakeholders in 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 further includes a variety of measures on growth in a number of technology categories. Combined, it provides a number of stock and flow measures of tangible success in technology-based economic development.

The Top Ten

Massachusetts continued its reign as the leader in technology and science, but has seen its score slip from 84.9 in our inaugural 2002 index. Nevertheless, the state maintained its solid edge over second-place Maryland. Massachusetts topped the charts in three components: R&D inputs, risk capital and entrepreneurial infrastructure, and technology and science workforce. Massachusetts is a breeding ground of research with world-renowned universities and cutting-edge firms fueling its economy. In human capital capacity, the state recorded a stellar second-place performance. Its weakest performance was in technology concentration and dynamism, where it ranked seventh.

The state has maintained its elevated score in R&D inputs over the years (consistently above 92). Its score has slipped slightly in risk capital and entrepreneurial infrastructure, but it still ranks first. Massachusetts' biggest challenge is its steady decline in technology concentration and dynamism, to seventh from second in 2002. In part, the decline reflects an improvement in other states' ability to channel innovation assets into technology firms and job creation, but it also highlights the challenges of sustaining the full economic benefits of innovation in a high-cost, regulation-heavy state.

Massachusetts recognizes these challenges and is taking actions to maintain its top overall position in technology-based economic growth. Governor Deval Patrick was able to convince the Legislature to keep funding the state's 10-year, $1.0 billion Life Sciences Initiative. The fiscal year 2011 budget includes $10 million for the Massachusetts Life Sciences Center charged with overseeing the effort, the same as FY 2010.[1] Other initiatives include the Advanced Manufacturing Initiative, which provides low-cost loans to help companies adopt new innovations and purchase technologically advanced equipment[2]; the MassChallenge Venture Funds Competition, which seeks to raise $25 million to support 25 to 30 start-ups per year[3]; and a statewide consortium undertaking development of a $100 million green computing center in the western part of the state.[4]

1 FY 2011 Budget Summary, State of Massachusetts, August 6, 2010. *http://www.mass.gov/bb/gaa/fy2011* (accessed September 23, 2010).

2 Press release, Governor of Massachusetts, "With economic recovery growing, Governor Patrick announces initiative to bolster Massachusetts advanced manufacturing sector," May 21, 2010. *http://www.mass.gov/?pageID=gov3pressrelease&L=1&L0=Home&sid=Agov3&b=pressrelease&f=052110_superconductor&csid=Agov3* (accessed September 26, 2010).

3 "*Massachusetts launches MassChallenge Venture Funds Competition*," TotalCIO blog, IT Knowledge Exchange, June 10, 2009. *http://itknowledgeexchange.techtarget.com/total-cio/massachusetts-launches-masschallenge-venture-funds-competition* (accessed September 26, 2010).

4 Mike Plaisance, "Former site of Mastex Industries chosen as home for Holyoke's high performance computing center," The (Springfield, Mass.) Republican, August 9, 2010. *http://www.masslive.com/news/index.ssf/2010/08/former_site_of_mastex_industri.html* (accessed September 26, 2010).

Maryland, in second place overall with a score of 77.05 (down from 80.04 in 2008), trailed Massachusetts in R&D inputs but took first in human capital capacity. Its weakest performance came in risk capital and entrepreneurial infrastructure, with a rank of 14th. Maryland's overall position has improved over the years; it ranked fourth in 2002.

Maryland's second place in R&D is largely attributable to its exceptional ability to garner federal funding. In federal R&D per capita, first-place Maryland's funding is almost 40 percent greater than that of second-place New Mexico's. Home to leading research facilities such as the National Institutes of Health, no other state has the concentration of federal innovation assets that Maryland has. Another key strength is its top position in academic R&D per capita, led by Johns Hopkins University, the top recipient of NIH funding in the country. But with a weaker entrepreneurial environment than many other leading states, Maryland hasn't been quite as successful at converting these federal and academic research assets into business births and the expansion of gazelle firms (companies that have grown at least 20 percent a year for four years, from a base of at least $100,000 in revenues).

Maryland Governor Martin O'Malley and other state leaders recognize that they must enhance the innovation milieu to capture the full economic benefits of these strong assets. In June, the governor proposed the InvestMaryland program, which would provide tax credits to insurance companies so they could invest either directly in start-up firms or through a venture capital firm.[5] Additionally, the FY11 budget includes $8 million in tax credits for biotech firms and $10.4 million for stem cell research.[6] Lastly, the governor signed legislation that codifies the R&D tax credit through 2020.[7]

Like the top two states, **Colorado** held its ground at third overall, but its score decreased from 78.32 to 75.73 this year, just edging out California. In contrast to Massachusetts, Colorado's strongest performance was in the technology concentration and dynamism component, where it ranked second. Colorado maintained most of its excellent performances across the technology concentration and dynamism indicators, and even climbed six places to sixth in the number of Inc. 500 companies per 10,000 business establishments. These fast-growing, job-creating firms have led to its ascension in technology concentration and dynamism.

Colorado's weakest area was sixth in risk capital and entrepreneurial infrastructure. Colorado's strengths were second in technology concentration and dynamism, and third in human capital capacity. Colorado was second only to Massachusetts in the percentage of its adult population with a bachelor's degree or better. High concentrations of telecommunication services and software explain much of its strength in educational attainment, along with the extensive number of universities and colleges.

5 Press release, Office of Governor Martin O'Malley, "Governor Martin O'Malley Announces InvestMaryland Proposal to Spur Jobs, Investments in Maryland's 'Innovation Economy,'" June 1, 2010. *http://www.governor.maryland.gov/pressreleases/100601.asp* (accessed September 27, 2010).

6 "Maryland Budget Supports BIO 2020 Initiative," SSTI Weekly Digest, April 28, 2010. *http://www.ssti.org/Digest/2010/042810.htm* (accessed September 27, 2010).

7 *http://mlis.state.md.us/2010rs/bills/sb/sb0064t.pdf* (accessed September 26, 2010).

Composite Indexes

The top states in the five subindexes that make up the bigger State Technology and Science Index:

Research and Development Inputs Composite Index

State	Rank 2010	Rank 2008
Massachusetts	1	1
Maryland	2	2
New Hampshire	3	5

Risk Capital and Entrepreneurial Infrastructure Composite Index

State	Rank 2010	Rank 2008
Massachusetts	1	2
California	2	1
Connecticut	3	11

Human Capital Investment Composite Index

State	Rank 2010	Rank 2008
Maryland	1	1
Massachusetts	2	2
Colorado	3	3

Technology and Science Workforce Composite Index

State	Rank 2010	Rank 2008
Massachusetts	1	1
Maryland	2	3
Delaware	3	7

Technology Concentration and Dynamism Composite Index

State	Rank 2010	Rank 2008
Utah	1	1
Colorado	2	5
Washington	3	8

Colorado is prioritizing developing a clean energy economy. Governor Bill Ritter signed legislation that he believes will make the state "a national leader in the New Energy Economy."[8] Colorado's Jobs Cabinet, convened by the governor, has released a series of recommendations in its "Economic Competitiveness through Collaboration, Talent Development and Innovation" report. [9] Colorado is moving forward with developing a long-term plan for higher education, with Ritter stating that "the best economic-development strategy and the best anti-poverty strategy is an education strategy."[10]

California held steady in fourth position with a score of 73.85, a slight decline from 74.62 in the 2008 index but a significant drop from 80.37 in the first index in 2002, when California ranked third. This year it performed well in risk capital and entrepreneurial infrastructure (second), R&D inputs (fourth), and technology concentration and dynamism (fifth). But in human capital capacity, it ranked far below the top three states at 13th. California even fell in the Technology and Science Workforce Composite Index, to seventh from sixth in 2008, due largely to the continued outsourcing of computer, semiconductor, and communications equipment manufacturing abroad and to other states. Most troubling for California is the falloff in recent graduates in the sciences, engineering, and biomedical fields.

Despite these foreboding trends, California remains a national leader in technology-derived economic development. Based on our research, California has five of the top 10 technology clusters in the nation, and Silicon Valley (the San Jose metro area) remains the preeminent high-tech cluster in the world.[11] California has considerable strength in the newly emerging fields of nanotechnology, clean technology, and green technology, and is a leading innovator in public policy to support these areas. Governor Arnold Schwarzenegger signed legislation in March 2010 that provides a sales tax exemption for equipment used by manufacturers in the clean-tech sector.[12] California has been without a formal state economic development office since 2003, when it was a casualty of the last budget crisis. The governor corrected this by signing an executive order in April authorizing the Governor's Office of Economic Development.[13]

Utah shot up three spots to fifth, edging out 2008's fifth-ranked Washington by 1.0 point with a score of 71.26. Utah retained its throne as the top-ranked state in technology concentration and dynamism, and finished in the top eight in all components except R&D inputs, where it was a still respectable 13th. Driving its ascent were a four-place improvement in R&D inputs, an 11-place leap in risk capital and entrepreneurial infrastructure, and a three-place gain in technology and science workforce. Risk capital availability has improved in the state with its venture capital placements relative to GSP now fifth in the nation.

8 Bill Summary, House Bill 10-1333, Sixty-seventh General Assembly, State of Colorado. *http://www.leg.state.co.us/CLICS/CLICS2010A/csl.nsf/fsbillcont3/EF619483FD7DC170872576A80027B7F3?Open&file=1333_01.pdf* (accessed September 26, 2010).

9 "Report to the Governor: Economic Competitiveness Through Collaboration, Talent Development and Innovation," Colorado Jobs Cabinet. *http://www.colorado.gov/cs/Satellite?blobcol=urldata&blobheader=application%2Fpdf&blobkey=id&blobtable=MungoBlobs&blobwhere=1239166115839&ssbinary=true* (accessed October 1, 2010).

10 State of the State Address, Office of the Governor, State of Colorado, January 14, 2010. *http://www.colorado.gov/cs/Satellite/GovRitter/GOVR/1251569957669* (accessed September 27, 2010).

11 Ross DeVol, Kevin Klowden, Armen Bedroussian, and Benjamin Yeo, "North America's High-Tech Economy: The Geography of Knowledge-Based Industries" Milken Institute, June 2009, pp. 2-3.

12 "California Gov. Signs Bill Incentivizing Clean Tech Entrepreneurs," SSTI Weekly Digest, March 31, 2010. *http://www.ssti.org/Digest/2010/headlines10.htm* (accessed September, 16, 2010).

13 Press release, "Governor Schwarzenegger Establishes Office of Economic Development," Office of the Governor, State of California. *http://gov.ca.gov/press-release/14844* (accessed October 5, 2010).

Medical devices are an important technology sector for the state with Brigham Young University playing a major role in promoting Utah's life sciences sector. Utah has had success in transforming its R&D assets, as commercialization rates and start-ups in the life sciences show. Not to be left out of the energy race, Utah Governor Gary Herbert announced the Utah Energy Initiative in his 2010 State of the State address, stating, "I am assembling the best minds in the state and charging them with creating a 10-year strategic energy plan whose purpose is threefold: to ensure Utah's continued access to our own clean and low-cost energy resources; to be on the cutting edge of new energy technologies; and to foster economic opportunities and create more jobs."[14]

Washington slipped to sixth overall this year with its score sliding from 72.09 in 2008 to 70.23. The state recorded an impressive third place in technology concentration and dynamism, fourth in technology science workforce, and sixth in R&D inputs. Its overall score suffered most from a six-spot decline to 21st in human capital capacity. Washington was at its weakest in various measures of state appropriations for higher education, and in graduate students in science, engineering, and health sciences. Its strength in technology concentration and dynamism is attributable to Microsoft and its spin-offs, along with other start-up firms, positioning the Seattle area as one of the global centers of software. Seattle is no longer the corporate headquarters of Boeing, but retains a substantial amount of the firm's employment and operations, and related suppliers.

New Hampshire gained ground in the overall rankings, jumping to seventh from ninth in 2008. The state ranked 13th in 2002 and has inched higher with every edition of our index. New Hampshire gained an impressive four points in R&D inputs to 81.01, displacing California in third. New Hampshire had strong positions in funding received from the National Science Foundation (NSF) and in State Technology Transfer Research (STTR) and Small Business Innovation Research (SBIR) awards. With these solid statistics, it was no surprise to see the state leap from fifth in 2008 to its current third in R&D inputs. Given these strengths, New Hampshire is beginning to look more like its neighbor to the south, Massachusetts. Governor John Lynch has made attracting and retaining young workers in New Hampshire a top priority, and his task force on the subject has released a detailed set of recommendations.[15]

Virginia remained in the top 10, but fell from sixth to eighth. Virginia registered its best performances in technology concentration and dynamism (fourth), and technology and science workforce (sixth). Much of this strength stems from the Eastern Virginia suburbs of Washington, D.C., which have benefitted from their proximity to the federal government, a cluster of data-processing firms, and defense and aerospace contractors. Virginia's overall slippage was attributable partly to a decline in human capital investment from eighth in the 2008 index to 15th this year. Virginia's indigenous innovation ecosystem that spawns new firms is less extensive than those of Massachusetts and California. But Governor Bob McDonnell has signed bills in support of his "jobs and opportunity agenda" that attempt to address this gap. The legislation will exempt capital gains taxes on investments in start-up tech or biotech firms.[16]

Connecticut slipped two positions to ninth, with a remarkable eight-place leap in risk capital and entrepreneurial infrastructure. Connecticut recorded great gains in measures of access to venture capital. The state jumped from 13th to first in the growth of venture capital based on figures for 2009.

14 State of the State Address, Office of the Governor, State of Utah, January 26, 2010. Available at *http://www.jayseegmiller*.com/?p=62 (accessed December 5, 2010).

15 "Final Report," The Governor's Task Force for the Recruitment and Retention of a Young Workforce for the State of New Hampshire, *http://www.usnh.edu/initiatives/documents/TaskForceFinal061809.pdf* (accessed October 1, 2010).

16 "Virginia Jobs Plan Advances; $50M Econ. Dev. Increase Requested," SSTI Weekly Digest, February 24, 2010. *http://www.ssti.org/Digest/2010/headlines10.htm* (accessed September 24, 2010).

Connecticut ranked fifth in human capital capacity, where it was third in the number of adults with an advanced degree. The presence of aerospace and financial services explains much of the high ranking. Governor Jodi Rell signed a jobs bill that provides a number of credits to investors in start-up businesses in designated sectors.[17]

Delaware cracked the top 10, up from 14th in 2008. Delaware saw its biggest advance in risk capital and entrepreneurial infrastructure, rising seven places to 29th. It also leaped from seventh to third in technology and science workforce. In terms of the concentrations of biochemists and biophysicists, and microbiologists, Delaware ranks first and second, respectively, stemming largely from the presence of AstraZeneca and smaller biotechnology firms. It is also strong in concentrations of computer systems analysts, and database and network administrators, ranking no lower than third.

Delaware is taking steps that could improve its ranking of 29th in risk capital and entrepreneurial infrastructure, and as a result, its position overall. The state plans to convert a former Chrysler plant into a center for high-tech laboratories, health sciences, alternative energy R&D, and other emerging industries. Delaware Governor Jack Markell outlined his vision for economic development in his State of the State Address in January 2010: "Businesses want to locate where the best and the brightest of our youth come to learn. Whether it be the alternative energy inventions of tomorrow that will spring from the University of Delaware, the optics research being advanced at Delaware State University, or the thousands of future workers who will garner their skills at Delaware Tech, we must entice businesses and jobs today with the promise of a better tomorrow."[18]

Biggest Gainers

Ohio improved its overall position from 36th in 2008 to 29th, tying **Alaska** for the biggest gain in the latest index. Ohio's economy contracted more than the nation's during the Great Recession due to its heavy dependence on traditional manufacturing industries such as autos and steel, but witnessed some clear returns on the investments that were made in its innovation economy under the auspices of the Third-Frontier Project. This is evident in Ohio's 20-place jump in risk capital and entrepreneurial infrastructure and eight-position improvement in R&D inputs from 2008. Leading the overall gains were a notable leap in the number of business starts, a better position in venture capital growth, and a jump from 30th to 21st in academic R&D.

Alaska's biggest gain was in technology and science workforce, followed closely by technology concentration and dynamism. Alaska ranks third in the category of other engineers on a per capita basis. The state has implemented a new program to promote building human capital: High school students who complete four years of math and science will be eligible for college grants if they have a high G.P.A.[19]

Indiana's gains are across several categories, but the risk capital and entrepreneurial infrastructure component is responsible for the bulk of its overall advance from 33rd to 28th this year. Indiana vaulted from 37th in 2008 to 19th in that category, and ranked fourth in venture capital growth this year, gaining ground in both venture capital relative to GSP (from 26th to 17th) and business start-up rates (also 26th to 17th). Indiana University has grown more aggressive in supporting new firm birth, launching a venture capital fund to invest in technology start-ups and dedicating a new Innovation

17 "CT Gov Signs Jobs Bill, FY11 Budget Agreement," STSI Weekly Digest, May 12, 2010. *http://www.ssti.org/Digest/2010/051210.htm* (accessed December 5, 2010).

18 "Restoring Delaware's Promise and Prosperity," State of the State Address, Governor of Delaware, January 21, 2010. *http://governor.delaware.gov/speeches/2010stateofstate.shtml* (accessed October 1, 2010).

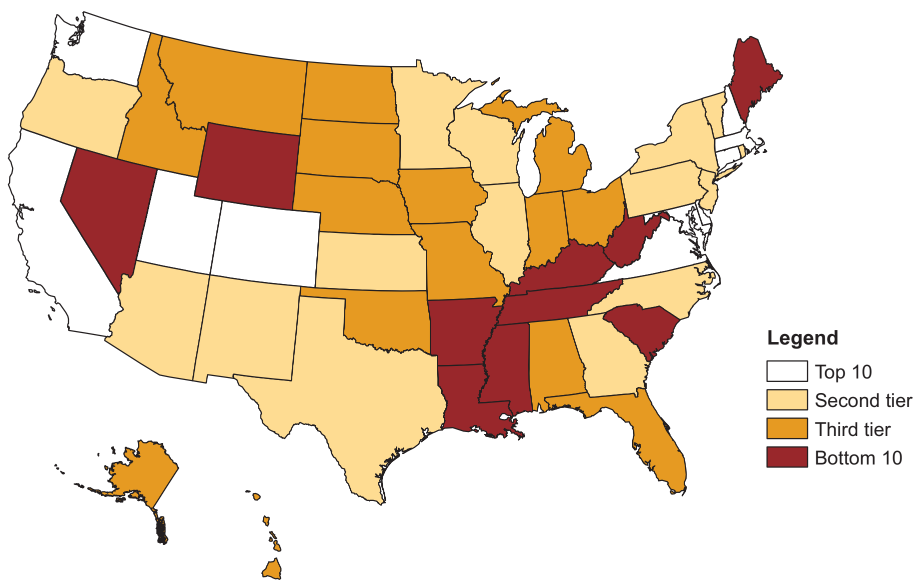
19 State of the State Address, Office of Governor Sean Parnell, January 20, 2010. *http://gov.alaska.gov/parnell/press-room/full-press-release.html?pr=5246* (accessed October 5, 2010).

Center in late 2009. "Indiana University understands the need for commercially-focused research and technology development and the important role the university plays in serving as a catalyst for economic growth for Indiana," IU President Michael McRobbie said.[20]

North Carolina was 1.8 point away from cracking the top 10. Moving from 18th to 13th overall this year, North Carolina recorded its biggest gains in technology and science workforce (from 21st to 15th), and technology concentration and dynamism (from 22nd to 11th). Contributing factors were gains in start-up rates, individual firm growth rates, and number of high-tech sectors growing faster than the U.S. average, where North Carolina ranked first. Growth in life sciences and software occupations were strong contributors to technology and science workforce gains.

Governor Bev Purdue and state leaders are moving to consolidate and expand recent gains in technology-based economic development. As part of the state's broader JobsNOW initiative, the governor signed legislation in November 2009 establishing the North Carolina Innovation Council. Its charge is to provide guidance on how to best promote technology-led firm and job growth in the state. The council will make recommendations on policies to encourage innovation and better coordination of public and private investments in the space. "Innovation is North Carolina's launch pad to success in the global economy, and it's a primary way for us to maintain and sharpen our competitive edge," the governor said.[21]

Figure 1. State Technology and Science Index Map
2010



20 Press release, "IU unveils $10 million Innovate Indiana Fund for investment in faculty research," Indiana University, December 4, 2009. *http://newsinfo.iu.edu/news/page/normal/12745.html* (accessed December 5, 2010).

21 Press release, "Gov. Perdue Establishes the North Carolina Innovation Council," Office of Governor Bev Perdue, November 16, 2009. *http://www.ssti.org/Digest/Indices/indexstate.htm* (accessed December 5, 2010).

Conclusions

As with many other developed countries, the United States faces a drain of intellectual capital from its shores. As a result, states must effectively build and leverage their assets to retain human capital that might escape and attract more from abroad, a fundamental resource in the innovation-oriented economy. As the best and brightest in China and many other developing economies of Asia are offered alternatives to deploy their skills and passion in technology entrepreneurship at home, fewer might find their way to the United States. It is paramount that states support science, technology, engineering, and math (STEM) programs, and funnel more students into these fields.

The Great Recession had harmful effects on U.S. and world innovation activity as measured by patenting activity. Based on data from the World Intellectual Property Organization, while international patent filings declined by 4.5 percent in 2009, many industrialized countries experienced the most dramatic cutbacks. The U.S experienced one of the most severe falloffs. U.S. patent filings dropped by 11.4 percent in 2009, but with 45,790, the U.S. still had almost one third of all applications. However, a number of East Asian countries recorded gains including China (29.7 percent), Singapore (5.5 percent), Japan (3.6 percent), and South Korea (2.1 percent).

Patenting activity is the result of previous investment in R&D. Over the past decade, R&D intensity—research and development spending relative to a country's gross domestic product—remained steady in the U.S., averaging growth around 5 percent annually, but exploded in Asia. In several Asian countries, the R&D growth rate is double, triple, or quadruple the U.S. rate.[22]

Another challenge for states is the diminishing federal and private funds and R&D incentives to support innovation as a result of the recent financial and economic crisis. The federal government will be looking to curtail many important innovation programs in an attempt to reduce future deficits. States need to mount effective advocacy efforts to communicate the benefits of critical programs. For example, funding of the Small Business Innovation Research program was nearly cut by Congress in 2010.

We shouldn't forget that despite some slippage in many innovation measures, the U.S. retains a key advantage in its entrepreneurial and risk financing system. Based on the Global Entrepreneurship and Development Index commissioned by the SBA's Office of Advocacy, the U.S. was third in overall entrepreneurship, but was first in entrepreneurial aspirations.[23] If states are to be successful in competing in the innovation-fueled global economy, they must place heightened emphasis on building entrepreneurial capacity and the technology workforce to provide high-paying jobs for their residents.

22 National Science Board. 2010. *Science and Engineering Indicators 2010*. Arlington, VA: National Science Foundation (NSB 10-01), pp. Chapter 4:8-15. Available at *http://www.nsf.gov/statistics/seind10/* (accessed October 1, 2010).

23 Zoltan J. Acs, Laszlo Szerb Ruxuton, "Global Entrepreneurship and the United States" *http://www.ssti.org/Digest/latest.htm* (accessed October 1, 2010).

Introduction: Innovation and the Economy

It has been eight years since the Milken Institute's first State Technology and Science Index, which has focused nationwide attention on the growing relevance of technology and science assets to regional economic growth. This update provides the latest in-depth look at how each state performs in science and technology.

As with most developed countries, the United States faces a drain of intellectual capital from its shores. As a result, regions must effectively build and leverage their assets to retain human capital, a fundamental resource in the innovation-oriented economy. With diminishing federal and private funds and R&D incentives to support innovation, it becomes more difficult for regions to surmount these challenges.

In the economic downturn, regions around the world have faced unprecedented challenges to expanding and sustaining growth, but the key is still innovation. Regions with strong innovation-based industries possess assets that can help them address the challenges. As Paul Romer proposed in his New Growth Theory,[24] regions with the capacity to innovate are better poised to nurture entrepreneurship, attract venture capital, and develop various growth opportunities.

New Jersey, for instance, experienced substantial growth in the number of biotechnology companies—from 238 in 2008 to more than 300 in 2010. Its "well-established life science industry and supporting infrastructure"[25] helped offset the economic downturn, the ongoing lack of venture capital and the downsizing that biotech and pharmaceutical companies saw both in New Jersey and nationally.

The state is just one example of how economies that have advanced technological infrastructures and strong innovation mechanisms for production consistently perform well. To compete, states must develop the infrastructure for innovation.

Outline of the Index

The State Technology and Science Index provides a nationwide benchmark for states to assess their science and technology assets, the sustainability of these assets, and whether the assets are competitive in the innovation-based economy. The benchmark analysis in this study allows policymakers and economic development organizations to develop strategies that nurture and sustain homegrown innovation so their states can compete around the globe.

The index is composed of five equally weighted composites that establish common ground for comparison and analysis:

- **Research and development inputs:** We examine what R&D capabilities exist and can be commercialized for future state and regional technology growth.
- **Risk capital and entrepreneurial infrastructure:** This determines the success rate of converting research into commercially viable technology services and products.
- **Human capital investment:** How much is invested in developing the workforce, the most important intangible asset of a regional or state economy.

24 Paul Romer, "Increasing Returns and Long-Run Growth" and "Endogenous Technological Change."

25 "Despite Economic Downturn, NJ Biotechnology Industry Continues to Grow," The Medical News, *http://www.news-medical.net/news/20100614/Despite-economic-downturn-NJ-biotechnology-industry-continues-to-grow.aspx*.

- **Technology and science workforce:** The intensity of the technology and science workforce indicates whether states possess sufficient high-end technical talent. Measured by a particular field's share of total state employment, this indicator reflects whether potential human capital plus R&D and financial capital are actually being transformed into a thriving economy.
- **Technology concentration and dynamism:** This measures technology outcomes as a way of assessing how effective policymakers and other stakeholders have been at parlaying regional assets into regional prosperity.

Seventy-nine individual indicators (see appendix) make up these five components. Each indicator is computed and measured against the relevant factor—population, gross state product (GSP), number of establishments, number of businesses, etc.— and then ranked for all 50 states. Sources include governmental agencies, foundations, and private sources.

Research and Development Inputs

Background and Relevance

The Research and Development Inputs Composite Index measures each state's performance in this area, including its ability to attract various types of federal, industry, and academic funding.

Funding for research and development is a key measure of a region's competitiveness in science and technology. R&D funding supports the research labs, universities and innovative companies that educate the workforce, and invent and develop new technologies. It also helps commercialize the research results, taking inventive new products from minds to markets. These regional research centers attract more entrepreneurs[26] looking to take advantage of the innovative atmosphere, the R&D, the educated workforce, and the businesses that are suppliers, and soon a "cluster" is born. Not only do these clusters produce new products, but they also create high-paying jobs. All this activity results in economic ripple effects for restaurants, retailers, Realtors, and other businesses in the regional economy.

Regions that can create a virtuous cycle of continuous innovation have the capacity to be at the forefront of economic competitiveness in the knowledge-based economy.[27] The presence of R&D activities enables regions to develop unique competitive advantages[28] and generate innovation.[29]

The U.S. is known for its advocacy of cutting-edge R&D. World-renowned high-tech leaders such as Microsoft, Apple, Google, Genentech, and Amgen were launched from the springboard of the country's R&D landscape. Thanks to such global success stories, the country has a high rate of commercializing innovations. In the U.S., approximately 6 percent of adults are involved in start-ups, and university licenses have generated more than 3,800 companies in the U.S. since 1980.[30] The government has helped facilitate this cooperation between universities and industries through its tech transfer offices. In addition, the Bayh-Dole Act in 1980, granting universities the right to own, license, and market the fruits of their faculty research, also has contributed to a strong national foundation for technology transfer and commercialization.[31]

26 Dirk Engel and Andreas Fier, "Does R&D-Infrastructure Attract High-Tech Start-Ups?," ZEW Discussion Paper 00-30 (2000).
27 Benjamin Yeo, *Developing a Sustainable Knowledge Economy. An Investigation of Contextual Factors* (Germany: VDM Publishing, 2009).
28 Malcolm Gladwell, *The Tipping Point: How Little Things Can Make a Big Difference* (Boston: Back Bay Books, 2000).
29 Daniel Bell, ed., *The Coming of the Post-Industrial Society. A Venture in Social Forecasting* (New York: Basic Books, 1973).
30 Magnus Karlsson, "Commercialization of Research Results in the United States: An Overview of Federal and Academic Technology Transfer," (Swedish Institute for Growth Policy Studies (ITPS), 2004).
31 Ross DeVol et al., "Mind to Market: A Global Analysis of University Biotechnology Transfer and Commercialization," (2006).

The use of information technologies to procure goods, services, and information reduces the importance of geography, but industry clusters remain important.[32] California's Silicon Valley and Boston's Route 128 are examples of leading high-tech clusters in the U.S. Although companies now occupying these clusters could collaborate remotely, intrinsic economic value can be more effectively derived in a closely knit cluster. For example, a strong cluster can influence government initiatives that are geared toward economic development, the economic impact of universities, and the configuration of companies.[33]

Composite Index Components

In general, R&D funds come from three general sources: the federal government, private industry, and academia. The index's federal R&D expenditure measure captures the sum of all basic and applied research in federally supported projects, including work pertaining to national defense, health, space research and technology, energy, and general science. The industry R&D measure totals all the money corporations spent on basic and applied research, including amounts spent at federally funded R&D centers. Industry R&D receives great weight in the composite index because of its large share of overall R&D. 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.

The National Science Foundation (NSF) is an independent federal agency that 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 for various basic and applied engineering programs. It also supports physical sciences, environmental sciences, math, computer sciences, and life sciences.

The State Technology Transfer Research (STTR) awards are federally funded research grants to small businesses and nonprofit research institutes to support the technology commercialization efforts of innovative small businesses. The Small Business Innovative Research program (SBIR) funds the often costly start-up and development stages, and encourages commercialization of the research findings. To be eligible, firms must be for-profit, American-owned and independently operated, and must employ a principal researcher and fewer than 500 workers. The funding rates of competitive NSF project proposals for basic research are crucial for generating momentum in the formative stages of R&D at universities. Awards won from all three of these government sources are reflected in each state's composite score.

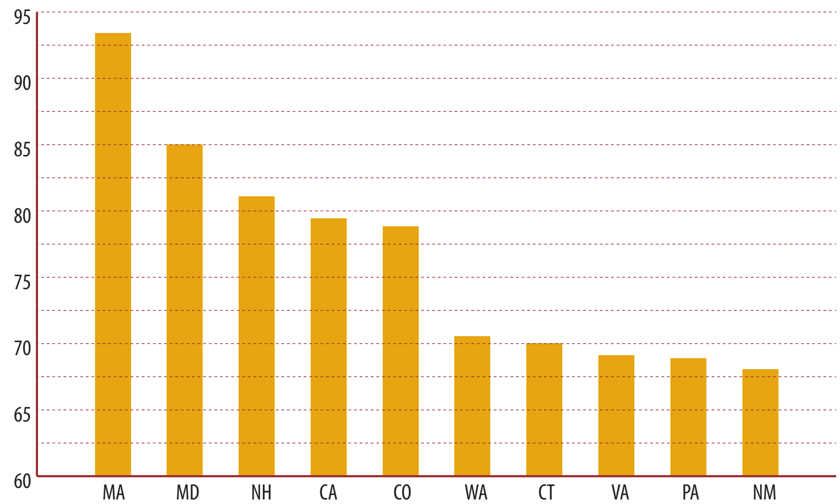
State Rankings

Massachusetts still reigns in R&D, with a composite score of 93.15; it has ranked first in this category since the first State Technology and Science Index in 2002. Massachusetts topped the U.S. in several categories: industry R&D, R&D expenditures in physical sciences, average annual number of STTR awards, STTR awards in dollars to GSP, and all measure of SBIR awards. At the other extreme, Massachusetts scored dead last in per capita R&D expenditures on agricultural sciences, perhaps because of its relatively small agricultural base and the fact that Massachusetts' R&D is specialized, catering to its high-tech and life sciences clusters.

32 Michael E. Porter, "Clusters and the New Economics of Competition," in *World View: Global Strategies for the New Economy*, ed. Jeffrey E. Garten (Boston, MA: Harvard Business School Publishing, 2000).

33 Ibid.

Figure 2. Research and Development Inputs Composite Index
Top 10 states, 2010

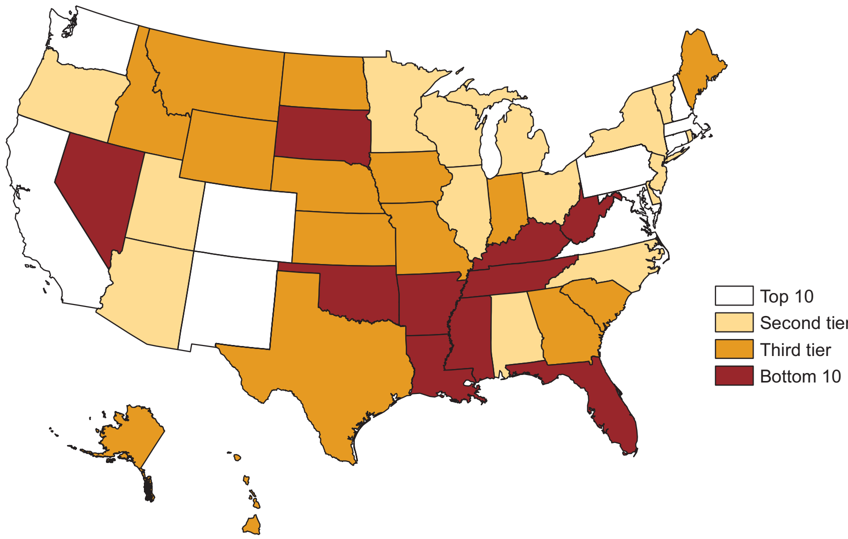


Second-place **Maryland** held its ground since the 2008 index, though its score dropped two points, from 87.08 in 2008 to 84.91 in 2010. **New Hampshire** gained nearly four points—for a score of 81.01—leaping two spots to elbow **California** out of third. The Golden State fell to fourth with a score of 79.06. At 20th, California fell short of expectations in funding received from the National Science Foundation (NSF). Its performance in per capita R&D expenditures on engineering was also less than stellar compared to previous rankings. New Hampshire, on the other hand, performed well in these measures.

Colorado slipped from fourth to fifth place with a score of 78.69. It ranked first and second in two measures of NSF research funding. (Interestingly, Alaska was second and first in the two NSF measures, but it suffered from a relative lack of STTR and SBIR awards, taking its overall ranking in R&D inputs from 33rd in 2008 to 32nd.) **Washington** leaped from eighth to sixth place with a score of 70.56. **Connecticut** retained its seventh-place ranking in R&D inputs. It performed best in per capita R&D expenditures on biomedical sciences and per capita industry R&D dollars, at second for both.

Figure 3. Research and Development Inputs Composite Index map

2010



This year, **Kentucky, Arkansas,** and **Oklahoma** ranked 48th, 49th, and 50th, respectively, in the R&D Inputs Composite Index. Kentucky improved its ranking by one. The biggest change was a four-place gain in STTR awards. Arkansas, which was 50th in R&D inputs in 2008, improved its score by 2.5 points, largely because of increased SBIR and STTR awards.

Oklahoma slipped four places from the 2008 index. Its biggest strength was in per capita R&D expenditures on environmental sciences, coming in at 19th. However, it ranked in the bottom 10 in most other indicators, leading to its low overall ranking in R&D inputs.

Table 2. Research and Development Inputs Composite Index

State rankings, 2010

State	Rank 2010	Rank 2008	Rank change 2008 to 2010	Score 2010	State	Rank 2010	Rank 2008	Rank change 2008 to 2010	Score 2010
Massachusetts	1	1	0	93.15	Hawaii	26	23	-3	53.95
Maryland	2	2	0	84.91	Montana	27	25	-2	53.54
New Hampshire	3	5	2	81.01	Texas	28	29	1	50.05
California	4	3	-1	79.06	Indiana	29	30	1	49.54
Colorado	5	4	-1	78.69	Iowa	30	32	2	45.99
Washington	6	8	2	70.56	North Dakota	31	19	-12	45.13
Connecticut	7	7	0	69.99	Alaska	32	33	1	43.42
Virginia	8	9	1	69.14	Wyoming	33	36	3	40.60
Pennsylvania	9	11	2	68.93	Georgia	34	34	0	40.14
New Mexico	10	10	0	68.07	Nebraska	35	37	2	38.41
Delaware	11	12	1	68.00	Missouri	36	31	-5	37.78
Rhode Island	12	6	-6	66.82	Maine	37	41	4	37.00
Utah	13	17	4	64.76	Idaho	38	38	0	36.66
Oregon	14	13	-1	61.84	South Carolina	39	43	4	36.55
Arizona	15	16	1	60.43	Kansas	40	35	-5	35.79
North Carolina	16	18	2	59.42	Tennessee	41	39	-2	35.42
New York	17	21	4	59.22	Mississippi	42	40	-2	31.70
Michigan	18	14	-4	59.13	Nevada	43	42	-1	27.90
Wisconsin	19	22	3	57.16	South Dakota	44	48	4	26.69
Ohio	20	28	8	56.90	Florida	45	44	-1	25.99
Minnesota	21	24	3	56.18	West Virginia	46	45	-1	24.28
Vermont	22	15	-7	55.71	Louisiana	47	47	0	22.07
Illinois	23	26	3	55.67	Kentucky	48	49	1	21.49
New Jersey	24	20	-4	55.58	Arkansas	49	50	1	20.93
Alabama	25	27	2	54.61	Oklahoma	50	46	-4	18.72
								State average	**51.09**

Risk Capital and Entrepreneurial Infrastructure

Background and Relevance

Entrepreneurs contribute to economic growth through direct and indirect channels.[34] Creating new businesses directly impacts economic growth, but entrepreneurs stimulate regions in other ways: They increase productivity through technological change.[35] They manipulate existing technologies and services, which speeds up the learning curve. And their new products increase competition, persuading established players to innovate as well or risk losing market share. This competition drives down prices and brings about better products.[36]

The role of entrepreneurs has been key to the growth and development of high-tech industries in the U.S. Apple CEO Steve Jobs witnessed Xerox's early prototype of the graphic user interface (GUI), a standard interface in today's computer applications. When Xerox did not thoroughly understand how the technology could be applied, Jobs founded Apple Computer and used the GUI for its Macintosh personal computer. Similarly, Sun Microsystems as a start-up firm created the computer workstation market even though tech giant IBM held the patents to the technology. Eventually, paired with the R&D prowess of the Bay Area's universities, these scientific and technological innovations gave birth to Silicon Valley's vibrant high-tech cluster.

Inventions advance knowledge but do not affect the local economy until they are implemented. The process of taking ideas from mind to market has been facilitated greatly by the explosion in the availability of capital to individual entrepreneurs over the past few decades. Intel, Microsoft, Apple, Cisco, Genentech, and Amazon were all venture-backed firms. Venture capital funding represents a small share of the overall capital markets, but its true value cannot be measured in dollars. Venture capitalists assist in business plan development, become board members, lend management skills, suggest strategic partnerships and alliances, assist in expansion plans, and bring in key talent where needed. Studying venture capital activity is an excellent way to assess whether financiers have confidence in the new ideas and entrepreneurial infrastructure of a region.

Composite Index Components

The Risk Capital and Entrepreneurial Infrastructure (RCEI) Composite Index comprises 11 indicators. It aims to measure each state's entrepreneurial culture through the analysis of risk capital vehicles such as venture capital investment and initial public offering activity. It further seeks to gauge the effects of such vehicles in terms of business creation and patent activity.

Several venture capital indicators are included to capture VC's relative size in each state and which states are witnessing rapid gains. A high growth rate in venture capital placements indicates that a state is witnessing early success in building technology-based firms for future economic development and job creation—and likely closing the gap with more advanced states. Growth in total venture capital funding and the number of companies receiving VC investment captures this element.

We include the number of companies receiving venture capital investment per 10,000 firms and VC investment as a percentage of GSP to measure the flow and strength of each state's venture capital activity relative to its total economy. Venture capital's share of a state's economy is important because of the strong relationship between higher venture capital investment activity and entrepreneurial success,

34 Adriaan Johannes van Stel, "Entrepreneurship and Economic Growth Some Empirical Studies" (EIM Business and Policy Research in Zoetermeer, 2005).

35 Zoltan Acs, "How Is Entrepreneurship Good for Economic Growth?," *Innovations: Technology, Governance, Globalization* 1, no. 1 (2006).

36 Jean Tirole, *The Theory of Industrial Organization* (The MIT Press, 1988).

job creation, wealth creation, and higher standards of living. The level numbers represent how the states rank in terms of size for each indicator. The growth indicators demonstrate the continued vitality of the indicators within each state. Combined, they give a more complete picture of how the states are performing.

Another component of the composite index is funding from the Small Business Investment Company (SBIC) program, which is geared toward incubator-type establishments that support small businesses with services ranging from financial capital to management consulting. SBICs are able to provide these services because they are leveraged by the Small Business Association. SBICs behave similarly to venture capitalists; their goal is to identify profit potential in unleveraged small businesses and fund it in hopes of high returns on investment.

Business incubators, another component, aim to provide up-and-coming small businesses with guidance and various resources such as physical facilities, office equipment, business assistance services, and management consulting to enable economic growth and development during the critical formative stages.

Patents granted by the Patent and Trademark Office, a division of the U.S. Department of Commerce, are also part of the index. On a state-by-state basis, generally speaking, the greater the number of patents per 100,000 people, the more inventive and scientifically curious its agencies and institutions 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 is important to a state's local economy because it is an indicator of entrepreneurship, innovative spirit, and optimistic expectations. Included in the indicators are business starts and initial public stock offerings, which occur when a company decides to sell shares to the public. Companies that go public typically have established a proven track record by means of revenues or sales history.

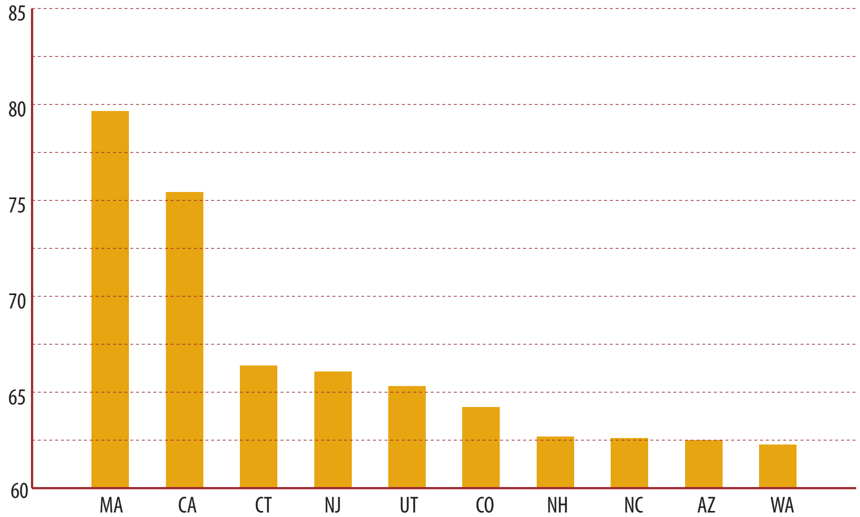
The RCEI Composite Index also includes investments in clean technology and nanotechnology. Clean tech is specifically designed to minimize negative ecological impacts and improve the productivity and responsible use of natural resources. It includes investments in renewable energy like wind turbines, solar panels, and waste-to-energy enclosures as well as processes for improving traditional methods with new techniques (such as coal gasification). Nanotechnology is cutting-edge research, an area where funding typically goes into states with the ability to draw from both traditional and non-traditional business capital. This year, we included an additional component on the sum of equity invested in green tech. This measure further highlights the importance of clean-tech investments in a region's high-tech economy.

State Rankings

Despite losing almost a point, **Massachusetts** leads the RCEI Composite Index, nudging California out of first place. Massachusetts ranked in the top five in many indicators but fell short in others. In terms of total growth in venture capital investment and growth in companies receiving venture capital, the state ranks 14th and 19th, respectively—a marked improvement from 22nd and 26th in the 2008 index. In number of business starts per 100,000 people, the state's position skyrocketed from 46th in 2008 to 14th this year. Most surprising, however, was its plunge from 15th to 38th in the number of business incubators per 10,000 business establishments. This may reflect a maturing of the state's tech business sector as smaller states attempting to catch up to Massachusetts invest more heavily in new incubators.

Figure 4. Risk Capital and Entrepreneurial Infrastructure Composite Index

Top 10 states, 2010

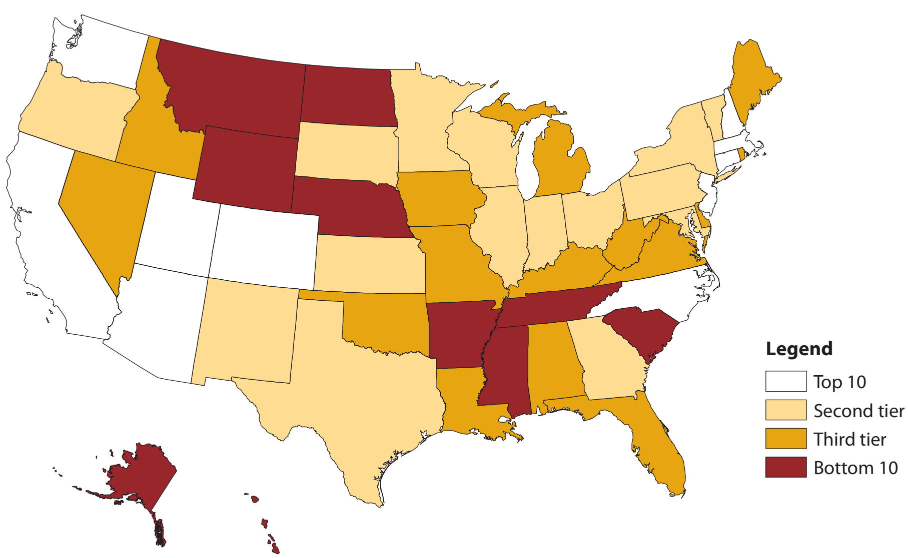


California lost six points but held on to second in 2010, with Connecticut, New Jersey, and Utah following by nearly a 10-point gap. Like Massachusetts, California's high performance on several indicators was offset by the number of business incubators per 10,000 business establishments, also reflecting a more mature tech sector. In that area, California fell from 33rd in the 2008 index to 45th this year, along with a 50 percent drop in score.

In the overall risk capital index, **Connecticut** leapfrogged several places from 11th in 2008 to third in 2010, thanks to nearly 300 percent growth in venture capital investments from 2008 to 2009. For comparison, Connecticut saw VC investment grow by just 44 percent from 2005 to 2006.

Figure 5. Risk Capital and Entrepreneurial Infrastructure Composite Index Map

2010



New Jersey and **Utah** clinched fourth and fifth, respectively, a remarkable feat considering New Jersey was 21st and Utah was 16th in 2008. This year New Jersey benefited from a substantial boost in the number of business starts per 100,000 people. With a score of 28 points and a ranking of 37th in 2008, the state roared back with a score of 84 points that sent it to ninth place in this indicator. Utah's overall performance was bolstered by growth in the number of companies receiving venture capital. Utah's score skyrocketed from 36 points to 86 points, elevating its ranking from 33rd to eighth in that component.

At the bottom of the Risk Capital and Entrepreneurial Infrastructure Composite Index are **South Carolina** at 48th, **Alaska** at 49th, and **Arkansas** at 50th. South Carolina dropped from 32nd in 2008, largely because of its dramatic plunge in the rankings—from fourth to 44th—for growth in the number of companies receiving venture capital investments. The state also shed eight positions to rank 43rd in venture capital investment as a percentage of GSP.

It was no surprise to see Alaska in the bottom three again this year, though it moved up one spot in the rankings. Plummeting 19 spots from 31st, Arkansas replaced Alaska at 50th, partially because of a drop in business starts in Arkansas. In 2008, Arkansas ranked fifth with 118.29 business starts per 100,000 people. This year, the state ranked 31st with just 1.94 business starts per 100,000 people.

The state making the biggest gain in rankings was **Ohio**, which climbed 20 spots to 20th place, largely because its ranking in the number of business starts skyrocketed from 49th to 15th since 2008. **Indiana** skipped 18 places to land at 19th in the Risk Capital and Entrepreneurial Infrastructure Index. The gain can be attributed to Indiana flexing its venture capital muscle; it jumped 31 spots to fourth in total venture capital investment growth.

South Dakota inched just two spots higher to 24th, but the state deserves notice for remarkable growth in companies receiving venture investments. With a 200 percent increase from 2008 to 2009, South Dakota topped the list in this indicator. While it can be argued that this indicator compares growth and not the actual numbers, the increase in the number of companies suggests strength in risk capital and entrepreneurial infrastructure, at least for this year.

The biggest decliner in the Risk Capital and Entrepreneurial Infrastructure Composite Index was **Maine**, which plunged 23 places to 37th in part because of fewer business incubators. In 2008's index, Maine ranked third with 3.15 business incubators per 10,000 business establishments. This time, the state ranked 43rd with only 0.71 incubators per 10,000 business establishments.

Pennsylvania dived 14 spots to 21st in risk capital and entrepreneurial infrastructure after losing ground in growth in companies receiving venture capital investments. In 2008, that indicator grew 34.33 percent, putting Pennsylvania in 10th position. However, in this year's index, the state suffered a 35 percent decline in that indicator to rank 30th.

Table 3. Risk Capital and Entrepreneurial Infrastructure Composite Index
State rankings, 2010

State	Rank 2010	Rank 2008	Rank change 2008 to 2010	Score 2010	State	Rank 2010	Rank 2008	Rank change 2008 to 2010	Score 2010
Massachusetts	1	2	1	79.67	Virginia	26	23	-3	51.17
California	2	1	-1	75.45	Oklahoma	27	24	-3	50.50
Connecticut	3	11	8	66.39	Rhode Island	28	15	-13	48.67
New Jersey	4	21	17	66.08	Delaware	29	36	7	48.33
Utah	5	16	11	65.33	Michigan	30	29	-1	48.20
Colorado	6	3	-3	64.24	Missouri	31	28	-3	47.51
New Hampshire	7	18	11	62.69	Idaho	32	25	-7	46.80
North Carolina	8	8	0	62.61	Louisiana	33	30	-3	46.33
Arizona	9	10	1	62.52	Iowa	34	47	13	45.82
Washington	10	4	-6	62.28	Florida	35	33	-2	45.53
Wisconsin	11	16	5	60.67	Nevada	36	39	3	42.85
Texas	12	12	0	59.92	Maine	37	14	-23	39.06
Minnesota	13	13	0	59.17	Alabama	38	43	5	38.57
Maryland	14	6	-8	58.11	Kentucky	39	42	3	38.00
Georgia	15	9	-6	57.52	West Virginia	40	48	8	37.64
New York	16	5	-11	57.34	North Dakota	41	46	5	37.50
Illinois	17	22	5	57.17	Hawaii	42	27	-15	36.36
Vermont	18	34	16	56.24	Wyoming	42	40	-2	36.36
Indiana	19	37	18	56.01	Nebraska	44	44	0	34.20
Ohio	20	40	20	55.95	Tennessee	45	38	-7	33.33
Pennsylvania	21	7	-14	53.97	Mississippi	46	49	3	30.89
Kansas	22	35	13	53.38	Montana	47	45	-2	30.73
New Mexico	23	20	-3	52.62	South Carolina	48	32	-16	30.36
South Dakota	24	26	2	52.60	Alaska	49	50	1	24.89
Oregon	25	19	-6	51.73	Arkansas	50	31	-19	23.56
								State average	**50.06**

Human Capital Capacity

Background and Relevance

Jane Jacobs draws on social and natural science theories to explain the importance of human capital: "Beginning with the very start of a settlement and continuing for as long as the place maintains an economy, human effort is combined with imports. … And the most important ingredient qualitatively—although not always quantitatively—is human capital. That means skills, information, and experience—cultivated human potentialities—resulting from investments made by the public, by parents, by employers, and by individuals themselves."[37] Human capital represents the source of technological innovation in the knowledge-based economy. While the industrial era saw the importance of capital and land as key productive forces, talent is the driving force in this new era.

At the firm level, successful businesses are able to leverage the knowledge base from human capital to innovate, building new knowledge in the process. This knowledge base is often tied to technological knowledge, as the ubiquity of and reliance on information technology continually increase on the global industrial landscape. Extrapolating this to the regional level, an area with innovative output led by higher value human capital is likely to be more competitive. Alan Greenspan, former chairman of the Federal Reserve, has said one notion that was "virtually unimaginable a half-century ago was the extent to which concepts and ideas would substitute for physical resources and human brawn in the production of goods and services."[38]

37 Jane Jacobs, *The Nature of Economies* (New York: First Vintage Books Edition, 2001).
38 Alan Greenspan, paper presented at the The Conference Board's 80th anniversary dinner, 1996.

Companies sometimes locate their operations where highly skilled human capital is readily available.[39] For example, Google has operations in Pittsburgh, Pennsylvania, to tap the talents at Carnegie Mellon University and the University of Pittsburgh,[40] and Google recently announced plans to expand its base in Pittsburgh.[41] This behavior explains the formation of clusters in a region: Firms are attracted to the same pools of talent.[42] By the same token, knowledge workers are attracted to the same locations because of the knowledge work. As businesses migrate toward these pools of talent, so do knowledge workers to take advantage of the opportunities.

Richard Florida studied the geography of human capital and found that creative classes of workers influence the level of economic growth in a region.[43] Thus, education, learning, training procedures, and outcomes, as determinants of human capital, also influence economic growth.[44]

Collaboration is vital to knowledge growth. Knowledge thrives in clusters that have heavy concentrations of connected educational and research institutions and large research-based businesses. The contrasting economic performances of California's Silicon Valley and Boston's Route 128 highlight the importance of this collaborative characteristic to economic growth. Silicon Valley was characterized by establishments that were inter-connected and collaborative. In contrast, Route 128 housed longstanding businesses that operated independently.[45]

With the transition toward knowledge-based production, traditional models of economic growth have become less applicable. As a result, New Growth Theory emerged to include intangible factors of production such as ideas and creativity as determinants of economic growth.[46] Paul Romer argued that "What is important for growth is integration not into an economy with a large number of people, but rather one with a large amount of human capital."[47] Knowledge workers possess more complex skill sets and have bigger roles in the innovation process. Therefore, in the knowledge-based economy, these workers are paid more because they are the human capital necessary to trigger economic growth.

Creating a concentrated presence of human capital facilitates a region's economic growth.[48] The percentage of adults with bachelor's degrees in a region is closely associated with variations in per capita income,[49] suggesting that, collectively, they are more productive.[50] Regions and states must create pools of human capital to generate and leverage knowledge to gain competitive advantages in today's knowledge-driven economy. As a result, universities and research institutions that create innovation are critical to economic growth.

39 Edward E. Leamer and Michael Storper, "The Economic Geography of the Internet Age," NBER Working Paper, no. 8450 (2001).
40 Perry Wong, Benjamin Yeo, and Ross DeVol, "Pittsburgh Technology Strategy: Swot Analysis," (Santa Monica, USA: Milken Institute, 2006).
41 "Google in Pittsburgh signals tech burst," American Public Media, September 7, 2010. *http://marketplace.publicradio.org/display/web/2010/09/07/am-tech-companies-set-up-shop-in-pittsburgh/?refid=0*
42 Edward Glaeser, "Are Cities Dying?," *Journal of Economic Perspectives* (1998).
43 Richard Florida, *The Rise of the Creative Class and How It's Transforming Work, Leisure, Community and Everyday Life* (New York: Basic Books, 2002).
44 Ross DeVol, "State Technology and Science Index: Comparing and Contrasting California," (Santa Monica, USA: Milken Institute, 2002).
45 Annalee Saxenian, ed., *Regional Advantage: Culture and Competition in Silicon Valley and Route 128* (Cambridge, MA: Harvard University Press, 1996).
46 Paul M. Romer, "Endogenous Technological Change," *Journal of Political Economy* 98, no. 5 (1990); and Romer, "Increasing Returns and Long-Run Growth," *Journal of Political Economy* 94, no. 5 (1986).
47 Paul Romer, "Increasing Returns and Long Run Growth," *Journal of Political Economy* 94 (1986).
48 Paul D. Gottlieb and Michael Fogarty, "Educational Attainment and Metropolitan Growth," Milken Institute Research Report (1999).
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50 Paul Plummer and Mike Tayler, "Theories of Local Economic Growth (Part 2): Model Specification and Empirical Validation," *Environment and Planning A* 33, no. 3 (2001).

Composite Index Components

Verbal Scholastic Aptitude Test (SAT) scores are important to state education analysts because they allow them to measure the verbal competence of high school students on a time series and cross-sectional basis. Average math SAT scores are important to a state's secondary education because they are evidence of the strength and effectiveness of its mathematics and critical-thinking curriculum. American College Testing Assessment (ACT) scores, like SAT scores, provide colleges and universities with a means of measuring students' aptitude as well as an instrument to predict academic performance during the first year of college.

Another component of the index, the prevalence of bachelor's degrees, signals both the level of educational attainment and the type of skills that are demanded by the firms in a given state. Breaking it down further, the share of bachelor degrees granted in science or engineering fields demonstrates where college students' professional interests lie. Measuring the number of recent bachelor's, master's and doctoral degrees granted in science or engineering allows stakeholders and policymakers to assess momentum and popularity, and guides future efforts to attract students. Because firms typically rely on research labor from nearby universities, a large pool of available support is a considerable asset and a valuable amenity that firms take into consideration when choosing a location.

The total number and the percentage of the population with advanced degrees or greater indicate a state labor pool's sophistication and level of skill development. Another measure is the concentration of those with doctoral degrees. States with high concentrations of Ph.D.s are assumed to be equipped with quality R&D centers and a robust system of higher education. States that retain Ph.D. holders after graduation are also assumed to have attracted a solid base of technical jobs in those relevant fields.

Large concentrations of doctoral scientists and engineers are an indication of the work being performed in various R&D projects. Regions with clusters in biotechnology, communications technologies, and medical research are expected to have concentrations of doctoral scientists to fuel innovation. An engineer's main professional purpose is to innovate and enable performance; states that recognize and meet the need for state-sponsored programs in their university systems will position themselves to attract and develop engineering talent.

The presence and constant flow of graduate students in science and engineering is important to a state because it serves as a means to enhance the future of the science and engineering community. Social scientists frequently use the number of graduate students as a proxy for a research university's quality of education. Graduate students are supported by the department's ability to win grants and other research funding. Therefore, the program size is indicative of the quality of the school's department.

Post-doctoral work is crucial to Ph.D.s and institutions alike because it allows degree-holders to further their own knowledge while advancing scholarship in their chosen fields. Post-doctoral students typically choose an institution based solely on its reputation and research. Their salaries are minimal. A larger post-doctoral population is an indicator of an institution's prestige.

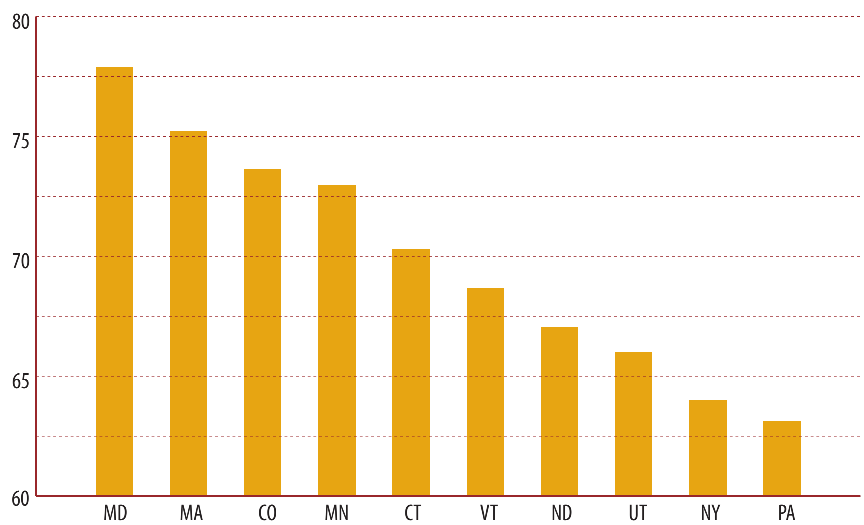
States can use their budgets to compete for graduate-level talent by funding universities and offering favorable financial aid packages to attract students to their institutions. State appropriations for higher education show how much money is being allocated by the state to run its community college and university systems. Increases in state appropriations for higher education give analysts insight into shifts in state spending patterns and into whether states are making wise investments in their future labor forces.

The indicator on home computer penetration illustrates the extent to which the population is technically proficient. Penetration coupled with Internet access allows access to resources, both commercial and educational, for which residents might otherwise have to travel long distances.

State Rankings

For the second consecutive year, **Maryland** took the crown for human capital capacity, thanks to its highly educated workforce and high number of advanced degrees. The state's rankings in the indicators remained fairly consistent with the 2008 index. Home to several renowned research universities, Maryland ranks in the top five in nine components, including percentage of people with bachelor's degrees or greater, advanced degrees or greater, and Ph.D.s; number of graduate students in science, engineering, and health (ages 25-34); and percentage of bachelor's degrees granted in science and engineering. Also of note, the state improved its ranking in ACT scores from 25th in the 2008 index to 16th in 2010. However, the state does not spend as much on student aid as other states do and still has relatively low average SAT scores compared with other leading states in this category. Instead, its excellence in human capital stems more from its longstanding technology assets that build and attract talent than from state stimuli to encourage education.

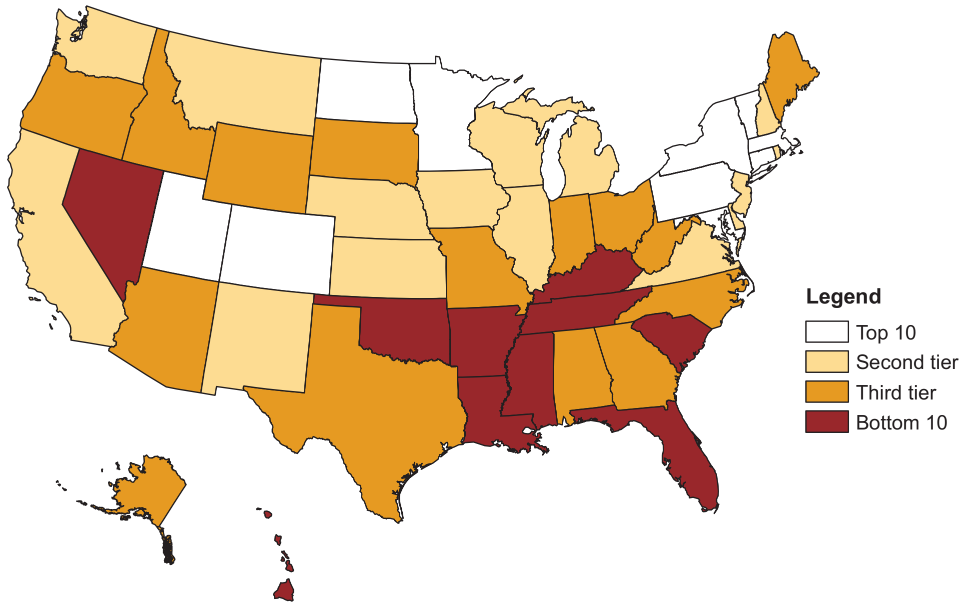
Figure 6. Human Capital Investment Composite Index
Top 10 states, 2010



Trailing Maryland by more than two points is **Massachusetts**, which held its No. 2 position from the 2008 index. Like Maryland, Massachusetts benefits from a longstanding technology base and academic excellence in science and engineering. With high numbers of advanced degrees in science and engineering, as well as world-class universities, the state will likely sustain its human capital capacity in the years to come.

Colorado kept its third-place ranking from the previous year, while **Minnesota** advanced to fourth from fifth. Colorado's greatest strength continues to be its percentage of degree holders age 25 and older (it ranks second in bachelor's degrees as a percent of population and seventh in advanced degrees), but it ranks 47th in state appropriations for higher education per capita. Meanwhile, Minnesota's biggest improvement occurred in the number of doctoral engineers per 100,000 people, propelling it from 24th to 15th in the rankings for this indicator.

Figure 7. Human Capital Investment Composite Index Map
2010



The emergence of **North Dakota** and **Pennsylvania** in the top 10 was the most notable change in this year's rankings. North Dakota was the biggest gainer, jumping 15 spots to seventh. The state gained significant ground in appropriations for higher education and now tops the list for growth in this indicator. The North Dakota Talent Initiative was initiated earlier this decade to create and retain high-quality jobs in the state, which may be partly responsible for the state's rise in the human capital rankings.[51] North Dakota also leaped from 23rd to fourth place in number of master's degrees in science and engineering, augmenting its relatively high proportion of degree holders.

In contrast, Pennsylvania's appearance in the top 10 came from its consistent performance across all the indicators. Pennsylvania is known for world-class research universities and a strong state university system. The state's second-place ranking in recent Ph.D.s in science and engineering is further evidence that these institutions have helped Pennsylvania become one of the strongest players in human capital.

At the bottom of the index, **Arkansas** and **Nevada** remained 49th and 50th, the same as in 2008, and they were joined by **Florida**, which slid from 46th to 48th. Dramatic change in their positions is unlikely anytime soon, given that human capital development generally requires a relatively long period of incubation.

Among the biggest gainers, **Texas** hurdled six spots to 38th this year, and **Maine** advanced eight places, landing at 34th. As mentioned, North Dakota was the biggest gainer, advancing 15 positions.

Taking advantage of a strong state balance sheet, Texas upped state appropriations for higher education this time around. Furthermore, the number of science, engineering and health doctorates awarded per 100,000 people ages 25-34 also increased since the last index.

51 The North Dakota Talent Initiative: Workforce Development for Economic Development. *http://www.workforce.nd.gov/uploads%5Cresources%5C360%5Cthe-north-dakota-talent-initiative-april-2008.pdf* (accessed October 1, 2010).

Maine also increased in per capita appropriations for higher education, moving up two positions to 36th in that indicator. But at 50th in both verbal and math SAT scores, Maine faces a significant challenge to future growth.

Michigan made marked improvements in several indicators, particularly in the number of master's and doctoral degrees in science and engineering as a percentage of its civilian workforce. However, in contrast to Texas and Maine, Michigan lowered state appropriations for higher education this year.

The largest decline in rankings went to **Hawaii**, which plunged 16 positions to 43rd, largely because of a 6.1 percent decline in state appropriations for higher education. Its ranking in that area sank 16 places to 31st since the last index.

Table 4. Human Capital Investment Composite Index

State rankings, 2010

State	Rank 2010	Rank 2008	Rank change 2008 to 2010	Score 2010	State	Rank 2010	Rank 2008	Rank change 2008 to 2010	Score 2010
Maryland	1	1	0	77.90	North Carolina	26	26	0	52.57
Massachusetts	2	2	0	75.24	Oregon	27	25	-2	51.81
Colorado	3	3	0	73.62	Missouri	28	27	-1	50.76
Minnesota	4	5	1	72.95	South Dakota	29	30	1	50.60
Connecticut	5	4	-1	70.29	Indiana	30	35	5	50.19
Vermont	6	9	3	68.67	Alaska	31	32	1	47.62
North Dakota	7	22	15	67.05	Arizona	32	33	1	47.24
Utah	8	7	-1	66.00	Wyoming	33	31	-2	43.81
New York	9	6	-3	64.00	Maine	34	42	8	41.90
Pennsylvania	10	14	4	63.14	Ohio	35	36	1	40.95
Delaware	11	10	-1	62.76	Idaho	36	41	5	40.76
Nebraska	12	11	-1	60.86	Georgia	37	38	1	39.81
California	13	13	0	60.67	Texas	38	44	6	39.33
Illinois	13	18	5	60.67	West Virginia	39	43	4	38.76
Virginia	15	8	-7	60.48	Alabama	40	37	-3	38.67
Rhode Island	16	15	-1	59.81	Louisiana	41	34	-7	38.19
New Hampshire	17	12	-5	58.48	Tennessee	42	40	-2	37.90
Kansas	18	19	1	58.29	Hawaii	43	27	-16	36.00
Wisconsin	18	23	5	58.29	Oklahoma	44	39	-5	35.24
Michigan	20	24	4	56.95	Kentucky	45	45	0	32.67
Washington	21	16	-5	55.90	South Carolina	46	48	2	31.14
Iowa	22	17	-5	55.81	Mississippi	47	47	0	29.14
New Jersey	23	21	-2	55.24	Florida	48	46	-2	28.10
Montana	24	29	5	54.00	Arkansas	49	49	0	25.43
New Mexico	25	20	-5	52.95	Nevada	50	50	0	19.33
								State average	**51.16**

Technology and Science Workforce

Background and Relevance

Transforming innovation into commercial products and services requires a skilled technical and scientific workforce. This process is most successful in a dynamic and collaborative setting that brings research, design, and production together.[52] If concentrated in a specific region, this skilled workforce represents a labor pool with relevant industry skill sets.[53] Companies near these labor pools benefit from agglomeration effects. With the increasing cross-industry linkages in today's knowledge-based industries, these companies can leverage the multitude of skills and lower production costs.

Extrapolating this to the societal level, regions with a strong technology and science workforce are more competitive and better positioned for economic growth. The high-tech industry benefits from

52 Ross DeVol et al., "Manufacturing Matters: California's Performance and Prospects," in Milken Institute Research Report (2002).
53 Paul Krugman, "What's New About the New Economic Geography?," *Oxford Review of Economic Policy* 14, no. 2 (1998).

this flexibility.[54] With a concentrated pool of skilled tech and science workers, companies reduce search costs. In the process, firm formation is facilitated, and mature high-tech firms are sustained.[55]

California's Silicon Valley is an example of a flexible, knowledge-sharing, high-tech cluster. Workers move from company to company and maintain informal contact with their ex-colleagues. This leads to informal labor-market networks [56] that can be a source of knowledge accumulation and transfer, boosting the overall knowledge capacity of the region.

Retaining this pool of skilled technical and scientific workers is critical to a region's economic well-being. However, these workers are the hardest to retain because they are flexible and mobile, gravitating to the center of innovation and opportunities. Silicon Valley, with one of the greatest concentrations of innovation in the world, has a highly fluid workforce. Companies there understand that, without challenging work, their employees will change employers.[57] This understanding has helped companies retain workers, which has bolstered Silicon Valley's high-tech leadership.

The definition of a worker in science and technology fields can go beyond the technician. By examining the role of a skilled and valuable workforce, this component focuses on work roles that require higher order cognitive processing. This goes beyond simply applying technical know-how to get things done. It involves leveraging existing knowledge and creating new concepts and processes. By generating new knowledge, these workers contribute to the innovation process and transfer these new products and services to the market.

Given the complex work, these employees often operate in a collaborative, inter-dependent environment. Knowledge is cumulative, so knowledge work flourishes in collaborative systems, highlighting the importance of industry clusters. Over time, these workers create professional communities that maintain a unique body of knowledge that is not easily transmitted via information technologies.

These skilled workers are scientists, engineers, and skilled technicians who are highly trained in disciplines related to science and engineering and/or work in these fields. Although these workers constitute just 5 percent of the workforce on average, their outsized influence on their regional economies belies their small numbers.[58]

According to the National Association of Colleges and Employers, entry-level engineers continue to be in demand among manufacturing firms despite layoffs during the recession.[59] In view of this growing demand, computer and mathematical scientists experienced a 20.4 percent increase in their salaries in the past decade—substantially more than the average 15 percent increase in all fields.[60]

A technology and science workforce contributes directly to technology-based economic development by engaging in tech-based production as a part of their work.[61] The quality of this workforce is vital to the attraction and retention of high-tech firms and, in turn, the industry's growth in a region.[62]

54 Christopher Benner, *Work in the New Economy: Flexible Labor Markets in Silicon Valley* (Blackwell Publishers, 2002).
55 David P. Angel, "High-Technology Agglomeration and the Labor Market," in *Understanding Silicon Valley: The Anatomy of an Entrepreneurial Region*, ed. Martin Kenney (Stanford: Stanford University Press, 2000).
56 Kenneth J. Arrow, "Economic Welfare and the Allocation of Resources for Invention," in *The Rate and Direction of Inventive Activity: Economic and Social Factors* (Princeton: Princeton University Press, 1962).
57 Gary Hamel, *Leading the Revolution* (Boston: Harvard Business Press, 2002).
58 Jarle Moen, "Is Mobility of Technical Personnel a Source of R&D Spillover?," NBER Working Paper, no. 7834 (2000).
59 "10 Highest Paying Degrees 2010 – Best Majors in Demand Now." *http://www.darwinsfinance.com/top-10-college-degrees-2010-best-majors* (accessed October 12, 2010).
60 "Science and Engineering Indicators–2008," ed. National Science Board (National Science Foundation, 2008). See also: *http://www.nsf.gov/statistics/seind08/c3/c3s1.htm*.
61 Michael H. Best, *The New Competitive Advantage: The Renewal of American Industry* (New York: Oxford University Press, 2001).
62 Joel Kotkin, *The New Geography: How the Digital Revolution Is Reshaping the American Landscape* (New York: Random House, 2002).

Composite Index Components

The Technology and Science Workforce Composite Index is intended to measure qualities of the current workforce, revealing the research and innovative capacity in specific fields of high-tech employment. The occupations chosen as indicators for the index are considered the foundations of a high-tech economy, so they convey the entrepreneurial activity present in each region.

We have divided the technology and science workforce into three distinct general fields: computer and information science, life and physical science, and engineering. This division allows us to investigate the overall strength of these fields.

The first component, intensity of computer and information science (IS) experts, is calculated by averaging the intensity scores of six different types of computer and information science-related occupations: computer and information scientists, computer programmers, software engineers, computer support specialists, systems analysts, and database and network administrators. "Intensity" is derived by finding the percent share of employment (in computer and information science, in this case) relative to the total state employment.

The indicator for intensity of life and physical scientists is calculated by averaging the intensity scores of six different types of life and physical science-related occupations: agricultural and food scientists, biochemists and biophysicists, microbiologists, medical scientists, physicists, and miscellaneous life and physical sciences. These occupations are important to a region's scientific community because they provide support and promote entrepreneurial activities.

The intensity of engineers indicator is calculated by averaging the intensity scores of six different types of engineering-related occupations: electronics engineers, electrical engineers, computer hardware engineers, biomedical engineers, architectural engineers, and other engineers. Engineers drive a region's vitality because they design and construct everything from the largest of bridges to the tiniest, most intricate medical devices.

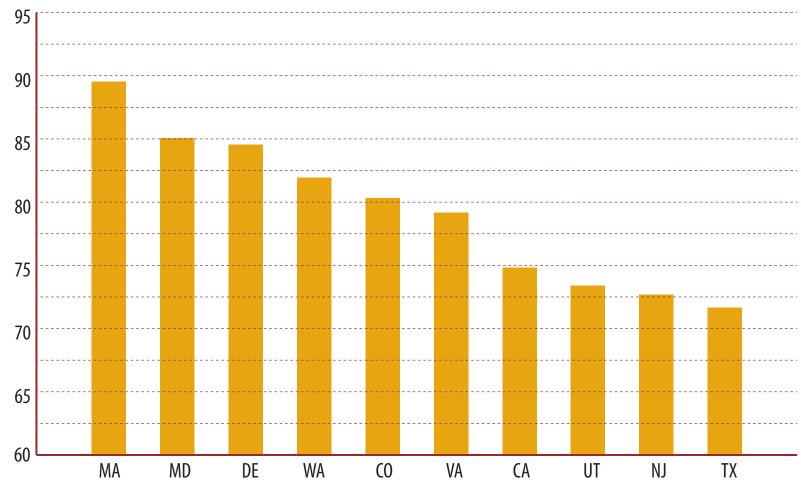
In the last release of the State Technology and Science Index, we noted the continuing trend of U.S. firms outsourcing "back-office" support operations to overseas locales like India and the Philippines, where labor costs are cheaper. While there is concern about the loss of these jobs, states like California are looking ahead, rebuilding the computer platform and retooling applications for the next generation of more niche-driven computer systems, leaving service-driven occupations to places with lower labor costs. Therefore, rankings for computer and IS experts will continue to represent a significant portion of the state's workforce and economic well-being.

State Rankings

Massachusetts secured the top position once again, while **Maryland** inched up a spot to second. New to the top 10 this year is **Utah**, which climbed from 11th to eighth. **Connecticut** dropped out of the leaders, sliding from ninth to 14th.

Massachusetts retained its top position in the tech and science workforce component, although its score fell slightly to 89.41 points from 91.06 points in 2008. The state continued to outperform all other states in its concentration of medical scientists and biomedical engineers, but it slid eight places to 17th in concentration of computer programmers.

Figure 8. Technology and Science Workforce Composite Index
Top ten states, 2010



Maryland leads the states in concentration of microbiologists, thanks to its healthy life sciences industry. Its weakest performance was a ranking of 32nd in concentration of other engineers. Delaware soared four positions from seventh in 2008 to third. The state's performance was boosted by an improvement from 14th to second in concentration of microbiologists. It also retained its top position in concentration of biochemists and biophysicists, and its ranking of third in concentration of computer programmers.

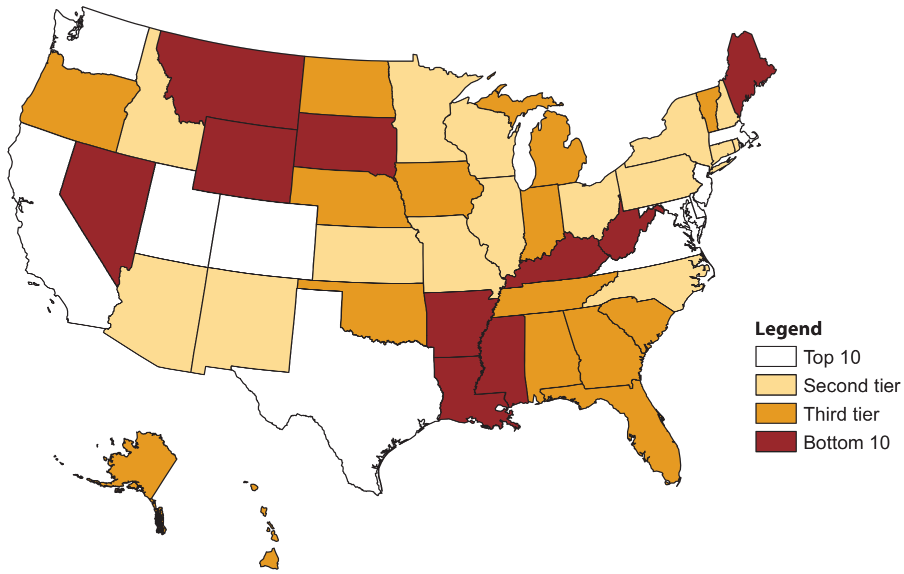
Washington, home to software giant Microsoft, performed well in concentrations of computer and information scientists, medical scientists, and software engineers, ranking fourth in those indicators. Its weakest ranking occurred in concentration of life and physical scientists, with a ranking of 21st.

Colorado excels in electronics due to its ties to the defense industry. The state topped the charts in concentrations of electronics engineers and computer hardware engineers. Colorado's worst performance was 32nd in concentration of agricultural and food scientists.

In the bottom three, **Wyoming** inched up from 50th to 48th, while **West Virginia** held steady at 49th, and **Nevada** slid from 48th to 50th.

Wyoming performed about the same across the indicators as in the previous index, except for a striking leap from 50th to 36th in concentration of electrical engineers, thanks to a 42-point gain in score. Similarly, West Virginia's performance was relatively unchanged except for a slight improvement—from 46th to 41st—in the concentration of computer programmers. Nevada's performance also yielded few surprises except for a remarkable drop in concentration of computer hardware engineers, from 19th to 31st place.

Figure 9. Technology and Science Workforce Composite Index Map
2010



The biggest gainer in this year's ranking was **New Mexico**, which climbed 12 places to 25th. Contributing factors were higher rankings in the concentration of biomedical engineers, and database and network administrators. New Mexico also gained ground in the concentration of computer support specialists, jumping from 42nd to 33rd.

On the other end of this spectrum, the biggest decliners were **Hawaii**, **Indiana**, **Rhode Island**, and **Wisconsin**, all of which slipped eight positions.

Table 5. Technology and Science Workforce Composite Index

State rankings, 2010

State	Rank 2010	Rank 2008	Rank change 2008 to 2010	Score 2010	State	Rank 2010	Rank 2008	Rank change 2008 to 2010	Score 2010
Massachusetts	1	1	0	89.41	Vermont	26	19	-7	58.89
Maryland	2	3	1	84.94	Michigan	27	20	-7	56.82
Delaware	3	7	4	84.40	Alabama	28	26	-2	55.20
Washington	4	4	0	81.78	Georgia	29	30	1	55.11
Colorado	5	2	-3	80.12	Oklahoma	30	27	-3	50.33
Virginia	6	5	-1	79.06	Iowa	31	34	3	50.13
California	7	6	-1	74.67	Oregon	32	41	9	49.88
Utah	8	11	3	73.41	Alaska	33	43	10	49.40
New Jersey	9	10	1	72.56	Nebraska	34	28	-6	49.18
Texas	10	8	-2	71.56	South Carolina	35	38	3	45.75
Minnesota	11	12	1	67.56	North Dakota	36	33	-3	45.45
Pennsylvania	12	15	3	66.67	Tennessee	37	36	-1	45.18
New Hampshire	13	18	5	66.46	Florida	38	35	-3	44.78
Connecticut	14	9	-5	64.94	Indiana	39	31	-8	44.13
North Carolina	15	21	6	64.47	Hawaii	40	32	-8	43.86
Kansas	16	23	7	63.14	South Dakota	41	40	-1	43.69
Illinois	17	16	-1	62.38	Montana	42	39	-3	41.57
Idaho	18	29	11	62.00	Kentucky	43	42	-1	39.14
New York	18	17	-1	62.00	Arkansas	44	45	1	36.83
Arizona	20	22	2	61.47	Maine	45	44	-1	33.85
Rhode Island	21	13	-8	60.00	Mississippi	46	47	1	33.41
Wisconsin	22	14	-8	59.76	Louisiana	47	46	-1	29.18
Ohio	23	24	1	59.56	Wyoming	48	50	2	28.22
Missouri	24	25	1	59.53	West Virginia	49	49	0	22.17
New Mexico	25	37	12	59.43	Nevada	50	48	-2	21.67
								State average	**56.10**

Technology Concentration and Dynamism

Background and Relevance

In the 21st century, high-tech industries play a key role in a region's economy. Their expansion is critical to the region's economic development strategy. It is not surprising to note that states with strong high-tech clusters perform better than those without. The component on technology concentration and dynamism applies several metrics to ascertain the intensity and presence of high-tech businesses by state.

High-tech clusters are the loci of technological activities where new technologies emerge and companies are formed. Because of the geographic proximity of these clusters, knowledge can be efficiently shared[63] and new knowledge formed. Clusters are also characterized by informal social networks, which promote the sustainability of technological clusters.

In the knowledge-based economy, states with vibrant technology clusters are well-positioned for economic growth. Today, regional economic viability depends at least partially on the ability to create these high-tech industry clusters. These industry clusters must be able to leverage local competencies such as customer and supplier relationships, entrepreneurial infrastructure, management practices, motivation, and quality-of-place attributes that allow firms to thrive.[64]

63 Ross DeVol, "Blueprint for a High-Tech Cluster: The Case of the Microsystems Industry in the Southwest."

64 Rosabeth Moss Kanter, *Thriving Locally in the Global Economy*, World View: Global Strategies for the New Economy (Boston: Harvard Business School Publishing, 2000).

Businesses in close proximity can benefit from the interactions of workers. For example, engineers are likely to have informal relationships with scientists in the region based on university relationships or past collaborations. Their interactions facilitate the possibility of further collaboration[65] that could result in innovation. From a firm's perspective, these constitute contacts that have the potential to develop into formal working relationships.[66]

In a global economy based on technology, regions must develop strong high-tech clusters and support infrastructure to be competitive. With productive use of inputs, these clusters can create innovative competencies that trigger a value chain of sustainable growth. By creating value links to other regions, these clusters gain access to best practices and industry trends.[67] As a result, local firms and talents can grow, while attracting investments and innovation to the region.

This geography of economic activities is essential to understanding how an economy functions.[68] This notion of space is captured in innovative industry clusters. Spatial analyses of economic activities show that businesses and workers tend to be in geographical proximity to each other so as to leverage mutual advantages. These agglomeration effects are the result of primarily labor-force pooling, supplier networks, and technology spillovers. These are all part of cluster activities and suggest the importance of high-tech activity concentrations in today's economy.

Industry clusters comprise multiple industries that are linked to each other through production value chains and supplier networks, creating a geographic concentration of industry activities.[69] It must be noted that an industry cluster is different from the traditional definition of an industry group. It is made up of research-oriented companies and institutions that contribute to its complex production chain. Clusters also encompass universities, and governmental and other nongovernmental entities such as public/private partnerships, trade associations, and think tanks that provide high-value skills training, education, and research.[70] Entities in these clusters enjoy advantages in efficiency, effectiveness, and flexibility.[71] Together, they facilitate wealth creation through the development of goods and services and their exportation.

High-tech concentrations of firms, universities, and research institutions require more than a few dominant anchor players to be effective in facilitating economic growth. They must be sufficiently dynamic to include newly formed entrepreneurial firms that tap the flow of technologies and play a role in the value-added networks. The presence of these smaller firms may help quicken the pace of innovation and provide avenues for new entrants to the networks. This results in a flexible and sustainable conglomeration that continues to produce innovation and create new market opportunities.

To be sustainable, technology clusters require a diverse base of industries. Clusters composed of a few technology industries run the risk of becoming a liability during an economic downturn.[72] In addition, this diversity serves as an engine of innovation in the cluster, creating a competitive advantage for the

65 Rupert Waters and Helen Lawton Smith, "Social Networks in High-Technology Local Economies: The Cases of Oxfordshire and Cambridgeshire," *European Urban and Regional Studies* 15, no. 1.

66 Albert-Laszlo Barabasi, *Linked: How Everything Is Connected to Everything Else and What It Means* (Plume, 2003).

67 Diane Coyle, *Paradoxes of Prosperity: Why the New Capitalism Benefits All* (New York: TEXERE, 2001).

68 Mashisa Fujita, Paul Krugman, and Anthony J. Venables, *The Spatial Economy: Cities, Regions, and International Trade* (Cambridge: The MIT Press).

69 Joel Kotkin and Ross DeVol, "Knowledge-Values Cities in the Digital Age," Milken Institute Research Report (2001).

70 Porter, *On Competition*.

71 Porter, *Clusters and the New Economics of Competition*.

72 Ross DeVol, "America's High-Tech Economy, Development, and Risks for Metropolitan Areas," Milken Institute Research Report (Santa Monica: Milken Institute, 1999).

region. Diversity also facilitates the fast adoption of technologies in a collective cumulative fashion.[73] According to R.N. Kostoff, "an advanced pool of knowledge must be developed in many fields before synthesis leading to innovation can occur."[74] Furthermore, this diversity supports cross-industry collaborations that have been the hallmark of new and top-performing inter-disciplinary industries such as biotechnology.

Composite Index Components

Unlike the four indices presented earlier, this composite measures technology outcomes. After states pull in financing from public and private sources, invest in human capital, and amass a skilled workforce, what results do they produce? This measurement illustrates how efficiently each state is performing given its many investments. In essence, the composite reveals each state's entrepreneurial, governmental, and policy-formulating success, or lack thereof. Measuring high-tech employment, payroll activity, net business formations, and growth relays the successes or failures of regional efforts.

Although the U.S. trade balance in high-tech manufacturing has declined, due mainly to the loss in export shares by U.S. industries producing communications equipment and office machinery and computers, high-tech services and manufacturing remain a large component of global manufacturing-sector growth.[75] In the latest Science and Engineering Indicator (2008) the United States still ranks first in three of the five high-technology industries (scientific instruments, aerospace, and pharmaceuticals) and second in the other two (communications equipment and office machinery and computers).

High-tech businesses are vital to a region's economic growth, especially given that jobs in this sector typically command above-average salaries. The aggregate nature of the high-tech industries also induces similar firms to establish themselves in close proximity to take advantage of the economies of scale in knowledge and manufacturing. Drawing comparisons between employment and establishments in the high-tech sector to 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 intangible economy is constantly changing. Narrowly examining which high-tech industries are most affected by changes in the economy and in global demand allows economists to trace the impact on the state's economic performance and predict whether there will be consequences for household employment and public policy agendas that are intrinsically tied to corporate revenues and personal income.

Business births 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. The indicator on net formation of high-tech business establishments allows analysts and policymakers to gauge the supplier network and the state of a regional economy.

The component focusing on the number of Technology Fast 500 companies in a state reflects the success of its high-technology sector in terms of growth and expansion. The presence of Fast 500 companies shows where the fastest-growing privately held companies are located. While the Tech Fast 500 list focuses solely on high-tech firms, the Inc. 500 rankings give a general snapshot of all companies. When taken together, they measure how well tech firms are performing against a wider field.

73 Jane Jacobs, *The Economies of Cities* (New York: Vintage Books, 1968).
74 R.N. Kostoff, "Successful Innovation: Lessons from the Literature," *Research-Technology Management* 60, no. 1 (1994).
75 *http://www.nsf.gov/statistics/seind08/c6/c6h.htm#c6h1* (accessed March 21, 2008).

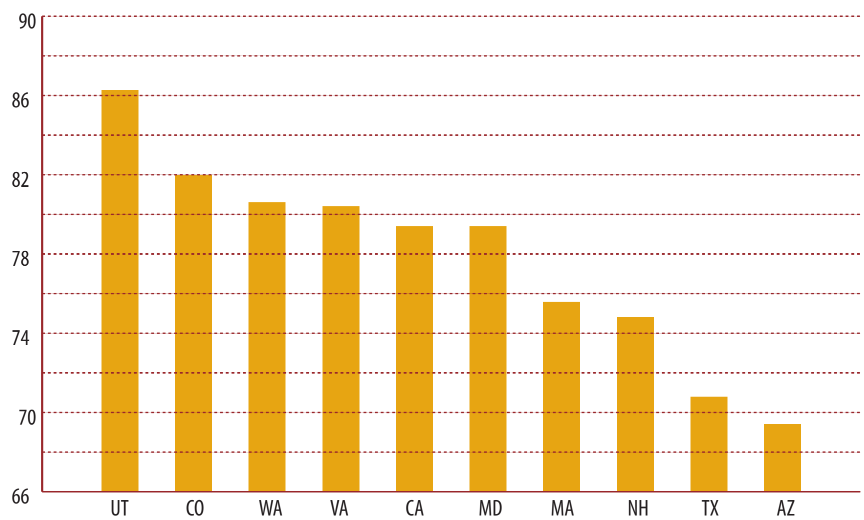
Examining where technology is prevalent is not the same as examining where technology is growing. The indicator for average yearly growth in high-tech aims to capture where technology has grown fastest in the past five years regardless of industry base. Determining the number of industries that are growing faster than the U.S. average is critical to performing cross-state analyses because it allows analysts to see exactly which industries within the high-tech sector are more successful in different parts of the country than in others. High-tech industries stimulate the economy differently based on the size of the region and the corresponding multiplier effect.[76]

State Rankings

Utah retains the top position in the technology concentration and dynamism component with an overall score of 86.80 points. For a second consecutive index, the state led the rankings in net formation of high-tech establishments per 10,000 business establishments, with 56 new businesses compared with 24 in the 2008 index. It ranked first in Inc. 500 companies per 10,000 business establishments, with 2.0 companies versus 1.4 two years ago.

Figure 10. Technology Concentration and Dynamism Composite Index

Top 10 states, 2010



With a score of 82.00 points, **Colorado** moved up three places to second. The state performed well across most indicators (first in percent of high-tech establishments, second in percent of high-tech employment, and third in percent of high-tech establishment births) and even advanced six positions since 2008 in number of Inc. 500 companies per 10,000 business establishments.

Washington, with a score of 80.60 points, skipped five positions to third. Washington's solid performances across the indicators generally held (third in percent of high-tech employment and first in percent of payroll in high-tech industries), but it fell eight places to 22nd in percent of establishment births in the high-tech industry.

Fourth place goes to **Virginia**, inching down from third with an overall score of 80.40 points. Virginia topped the list in percent of establishment births in high-tech industries, and it ranked second in net formation of high-tech establishments per 10,000 business establishments and in number of Inc. 500

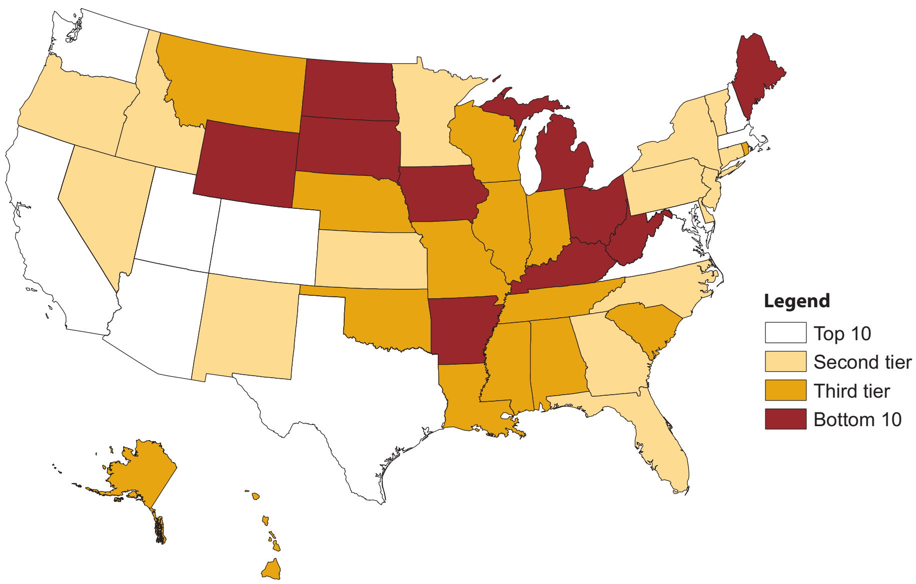
76 Yujeung Ho, "Contribution of High-Technology Industry to Regional Economic Growth at Different Positions in the Distribution of a Region's Size," *International Review of Public Administration,* vol. 12, no 1 (2007).

companies per 10,000 business establishments. The state, however, fell from the fifth to the seventh position in terms of percentage of high-tech employment.

Maryland slid from second to fifth with a score of 79.40 points versus 80.40 in the 2008 index. It dropped 22 points in net formation of high-tech establishments, plummeting from ninth to 20th.

Figure 11. Technology Concentration and Dynamism Composite Index Map

2010



The bottom three states in the technology concentration and dynamism component are **Wyoming**, **West Virginia**, and **Arkansas**. Wyoming sunk 11 places to 48th, West Virginia fell four places to 49th, and Arkansas plunged 12 spots to 50th. Particularly noteworthy is West Virginia's freefall from 13th to 49th in net formation of high-tech establishments per 10,000 business establishments.

Wyoming's bleak performance is largely due to slow growth in high-tech industries. The state plunged 41 spots to 47th in annual growth in high-tech industries, and it shed 38 spots to rank 42nd in the number of high-tech industries growing faster than the U.S. average. On the upside, Wyoming skyrocketed from 48th to 16th in percentage of high-tech establishment births since the last index.

Similarly, Arkansas plummeted from fourth to 47th in the number of high-tech industries growing faster than the U.S. average, and slid from 43rd to 44th in percentage of high-tech establishments.

The largest gainers in this indicator are **Oklahoma**, which jumped 15 places to 31st, and **Louisiana**, which advanced 13 places to 37th. Oklahoma's success was largely due to an improvement from 50th to 24th in average annual growth in high-tech industries, with a growth rate of 1.68 percent. Louisiana performed well in the same indicator, climbing from 46th to 14th with an average annual growth rate of 2.79 percent.

The biggest decliner by far was **Rhode Island**, which nose-dived 21 spots to 34th. The state's performance deteriorated in many indicators, including dropping from fifth to 39th in average annual growth in high-tech industries. While Rhode Island's high-tech industries registered average annual growth of 3.3 percent in the previous index, growth shrunk 0.79 percent in the latest computation.

Table 6. Technology Concentration and Dynamism Composite Index

State rankings, 2010

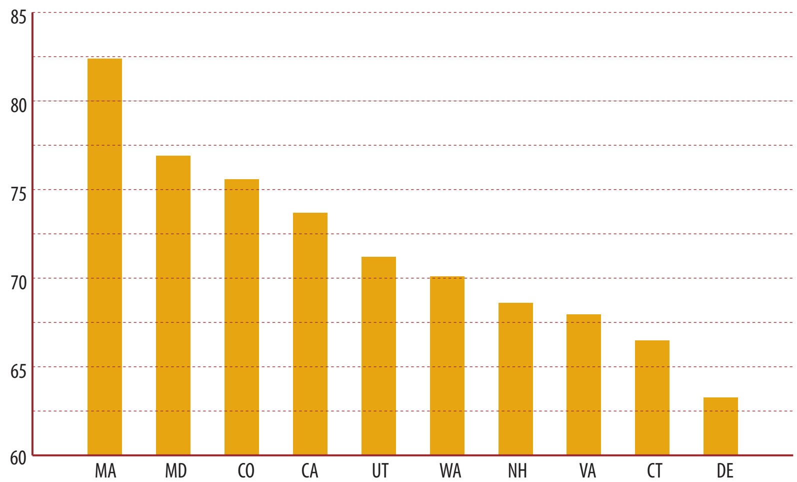
State	Rank 2010	Rank 2008	Rank change 2008 to 2010	Score 2010	State	Rank 2010	Rank 2008	Rank change 2008 to 2010	Score 2010
Utah	1	1	0	86.80	Illinois	26	31	5	49.80
Colorado	2	5	3	82.00	Alabama	27	25	-3	49.40
Washington	3	8	5	80.60	Hawaii	28	30	-2	49.20
Virginia	4	3	-1	80.40	Alaska	29	36	7	48.60
California	5	7	2	79.40	Indiana	29	27	-2	48.60
Maryland	5	2	-3	79.40	Oklahoma	31	46	15	46.80
Massachusetts	7	11	4	75.60	Missouri	32	33	1	46.60
New Hampshire	8	10	2	74.80	Nebraska	33	42	9	45.00
Texas	9	15	6	70.80	Tennessee	34	44	10	42.40
Arizona	10	6	-4	69.40	Rhode Island	34	13	-21	42.40
North Carolina	11	22	11	68.00	Montana	36	26	-10	42.00
Oregon	12	16	4	67.40	Louisiana	37	50	13	40.60
Kansas	13	18	5	66.80	South Carolina	38	32	-6	40.40
Georgia	14	17	3	66.00	Wisconsin	39	33	-6	39.20
New Jersey	15	9	-6	65.40	Mississippi	40	49	9	37.00
Idaho	16	12	-4	63.00	North Dakota	41	35	-6	36.80
New Mexico	17	4	-13	62.20	Maine	42	41	-1	36.00
Connecticut	18	14	-4	61.20	Iowa	43	39	-4	35.20
Nevada	19	23	4	58.40	Ohio	44	48	4	34.00
Minnesota	20	19	-1	57.40	South Dakota	45	47	2	33.80
Vermont	21	24	3	57.00	Michigan	46	43	-3	32.60
Florida	22	19	-3	55.40	Kentucky	47	40	-7	32.20
New York	23	29	6	54.80	Wyoming	48	37	-11	29.80
Delaware	24	21	-3	52.80	West Virginia	49	45	-3	28.80
Pennsylvania	25	28	3	51.20	Arkansas	50	38	-12	21.40
								State average	**53.50**

Overall Findings

Taken together, the *State Technology and Science Index* measures the technology and science assets at the state level. These assets can be leveraged to foster economic growth. Five components were used to compute the index: research and development inputs, risk capital and entrepreneurial infrastructure, human capital capacity, technology and science workforce, and technology concentration and dynamism. Each component is composed of several indicators that provide depth, breadth, and relevance.

Massachusetts continued its reign with an overall score of 82.61, unchanged from its previous score. Massachusetts topped the charts in three components: R&D inputs, risk capital and entrepreneurial infrastructure, and technology and science workforce. In human capital capacity, the state scored a respectable second place. Its weakest performance was seventh in technology concentration and dynamism.

Figure 12. State Technology and Science Index
Top 10 states, 2010



Maryland, in second place overall with a score of 77.05, trailed Massachusetts in R&D inputs but took first in human capital capacity. Its weakest performance came in the risk capital and entrepreneurial infrastructure component, in which the state was ranked 14th.

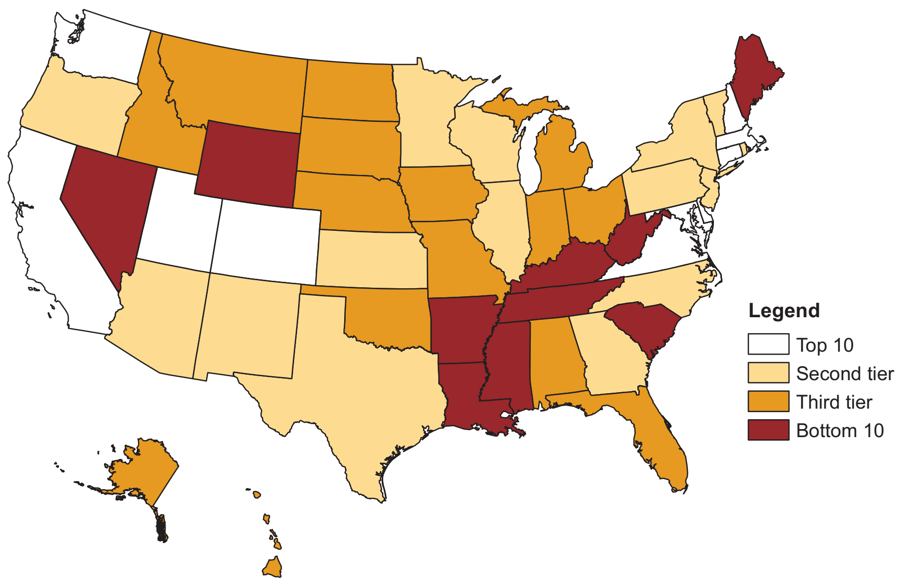
Colorado maintained third place with a score of 75.73, declining 2.6 points from its previous score of 78.32. Its strongest performance was second in the technology concentration and dynamism component. Its lowest ranking was sixth in risk capital and entrepreneurial infrastructure.

California held on to fourth with a score of 73.85, performing well in risk capital and entrepreneurial infrastructure, and R&D inputs, in which the state ranked second and fourth, respectively. However, at 13th in human capital capacity, it ranked far below the top three states.

Utah moved up the ranks to occupy the fifth position from its previous eighth. It attained a score of 71.26 points, less than three points behind California. Utah performed best in the risk capital and entrepreneurial infrastructure, and technology concentration and dynamism components, in which it ranked fifth and first, respectively. Its weakest performance came in the R&D inputs component, where it occupied the 13th position.

Delaware was new to the top 10 this year, transitioning from 14th to 10th. In terms of risk capital and entrepreneurial infrastructure, the state moved up the ranks from 36th to 29th. Another key factor in its rise is the move into third place overall in the tech and science workforce component, climbing from seventh in the 2008 index.

Figure 13. State Technology and Science Index Map
2010



At the other end of the spectrum were **Mississippi**, moving from 50th to 48th; **West Virginia**, unchanged at 49th; and **Arkansas**, sliding from 48th to 50th.

Mississippi's best performance was 40th in tech concentration and dynamism, and its weakest performance was 47th in human capital investment. Mississippi's overall score improved to 32.43 in the 2010 index from 29.81 in 2008.

West Virginia's overall score fell from 30.49 to 30.33 points. Its best performance was 39th in the human capital capacity component. West Virginia was at its weakest in the technology and science workforce and technology concentration and dynamism components, at 49th in both.

Arkansas' score declined from 32.96 to 25.63 points. The state performed its best in the technology and science workforce component, ranking 44th. It was 49th or 50th in all other components.

Although the states' performances saw little substantial change this year, science and technology industries are fast-moving. States that performed well must continue to innovate to sustain their growth. Those that fell short have the opportunity to catch up by leveraging their strengths and opportunities. A global economy anchored in science and technology is challenging and competitive indeed.

Table 7. State Technology and Science Index

Overall rankings, 2010

State	Rank 2010	Rank 2008	Rank change 2008 to 2010	Average score	State	Rank 2010	Rank 2008	Rank change 2008 to 2010	Average score
Massachusetts	1	1	0	82.61	Michigan	26	26	0	50.74
Maryland	2	2	0	77.05	Idaho	27	27	0	49.84
Colorado	3	3	0	75.73	Indiana	28	33	5	49.70
California	4	4	0	73.85	Ohio	29	36	7	49.47
Utah	5	8	3	71.26	Missouri	30	30	0	48.44
Washington	6	5	-1	70.23	Alabama	31	29	-2	47.29
New Hampshire	7	9	2	68.69	Iowa	32	35	3	46.59
Virginia	8	6	-2	68.05	North Dakota	33	31	-2	46.39
Connecticut	9	7	-2	66.56	Nebraska	34	34	0	45.53
Delaware	10	14	4	63.26	Montana	35	32	-3	44.37
New Jersey	11	12	1	62.97	Hawaii	36	28	-8	43.87
Minnesota	12	11	-1	62.65	Alaska	37	44	7	42.79
North Carolina	13	18	5	61.42	South Dakota	38	41	3	41.48
Pennsylvania	14	13	-1	60.78	Oklahoma	39	38	-1	40.32
Arizona	15	17	2	60.21	Florida	40	37	-3	39.96
New York	16	15	-1	59.47	Tennessee	41	40	-1	38.85
Vermont	17	19	2	59.30	Maine	42	39	-3	37.56
New Mexico	18	16	-2	59.05	South Carolina	43	42	-1	36.84
Texas	19	20	1	58.33	Wyoming	44	43	-1	35.76
Illinois	20	21	1	57.13	Louisiana	45	46	1	35.27
Oregon	21	23	2	56.53	Nevada	46	45	-1	34.03
Rhode Island	22	10	-12	55.54	Kentucky	47	47	0	32.70
Kansas	23	24	1	55.48	Mississippi	48	50	2	32.43
Wisconsin	24	22	-2	55.02	West Virginia	49	49	0	30.33
Georgia	25	25	0	51.71	Arkansas	50	48	-2	25.63
								State average	**52.38**

Appendix

Research and Development Inputs	
Federal R&D Dollars per Capita	National Science Foundation (NSF)
Industry R&D Dollars per Capita	NSF
Academic R&D Dollars per Capita	NSF, Academic R&D Expenditure
National Science Foundation Funding	NSF, Experimental Program to Stimulate Competitive Research
National Science Foundation Research Funding	NSF, Experimental Program to Stimulate Competitive Research
R&D Expenditures on Engineering	NSF, Academic R&D Expenditure
R&D Expenditures on Physical Sciences	NSF, Academic R&D Expenditure
R&D Expenditures on Environmental Sciences	NSF, Academic R&D Expenditure
R&D Expenditures on Math and Computer Science	NSF, Academic R&D Expenditure
R&D Expenditures on Life Sciences	NSF, Academic R&D Expenditure
R&D Expenditures on Agricultural Sciences	NSF, WebCASPAR
R&D Expenditures on Biomedical Sciences	NSF, WebCASPAR
STTR Awards per 10,000 Businesses	Small Business Administration, U.S. Census Bureau
STTR Award Dollars	Small Business Administration
SBIR Awards per 100,000 People	Small Business Administration
SBIR Awards per 10,000 Businesses (Phase I)	NSF, Experimental Program to Stimulate Competitive Research (EPSCoR)
SBIR Awards per 10,000 Businesses (Phase II)	NSF, EPSCoR
Competitive NSF Proposal Fuding Rate	NSF, EPSCoR
Risk Capital and Entrepreneurial Infrastructure	
Total Venture Capital Investment Growth	PricewaterhouseCoopers/National Venture Capital Association MoneyTree Report, Thomson Financial
Number of Companies Receiving VC per 10,000 Firms	PricewaterhouseCoopers/National Venture Capital Association MoneyTree Report, Thomson Financial
Growth in Number of Companies Receiving VC	PricewaterhouseCoopers/National Venture Capital Association MoneyTree Report, Thomson Financial
Venture Capital Investment as Percent of GSP	PricewaterhouseCoopers/National Venture Capital Association MoneyTree Report, Thomson Financial
SBIC Funds Disbursed per $1,000 of GSP	Small Business Administration
Business Incubators per 10,000 Establishments	National Business Incubation Association, U.S. Census Bureau
Patents Issued per 100,000 People	U.S. Patent and Trademark Office
Business Starts per 100,000 People	U.S. Census Bureau
IPO Proceeds as Percent of GSP	Securities Data Corporation, Thomson Financial
VC Investment in Nanotechnology as Percent of GSP	Thomson Financial
VC Investment in Clean Technology as Percent of GSP	Thomson Financial
Sum of Equity Invested in Green Tech per $100,000 GSP	Thomson Financial
Human Capital Investment	
Percentage of Population with Bachelor's Degrees or Higher	U.S. Department of Education
Percentage of Population with Advanced Degrees	U.S. Department of Education
Percentage of Population with PhDs	U.S. Department of Education
Graduate Students in Science and Engineering	NSF, EPSCoR
Per Capita State Spending on Student Aid	NSF, EPSCoR
Average Verbal SAT Scores	NSF, EPSCoR
Average Math SAT Scores	NSF, EPSCoR
Average ACT Scores	NSF, EPSCoR
State Appropriations for Higher Education (per capita)	NSF, EPSCoR

** All population statistics are from the U.S. Census Bureau. All Gross State Product figures are from the U.S. Department of Commerce.*

Human Capital Investment *con't.*	
Percent Change in State Appropriations for Higher Education	NSF, EPSCoR
Doctoral Scientists per 100,000 People	NSF, Division of Science Resources Studies
Doctoral Engineers per 100,000 People	NSF, Division of Science Resources Studies
Science, Engineering, and Health PhDs Awarded	NSF, Division of Science Resources Studies
Science, Engineering, and Health Postdoctorates Awarded	NSF, Division of Science Resources Studies
Percentage of Bachelor's Degrees in Science and Engineering	National Center for Education Statistics, U.S. Department of Education
Recent Bachelor's Degree in Science and Engineering	NSF, Division of Science Resources Studies
Recent Master's Degree in Science and Engineering	NSF, Division of Science Resources Studies
Recent PhD Degree in Science and Engineering	NSF, Division of Science Resources Studies
Recent Degrees in Science and Engineering	NSF, Division of Science Resources Studies
Percentage of Households With Computers	U.S. Department of Commerce
Percentage of Households With Internet Access	U.S. Department of Commerce
Technology and Science Workforce	
Intensity of Computer and Information Scientists	Bureau of Labor Statistics, Milken Institute
Intensity of Computer Programmers	Bureau of Labor Statistics, Milken Institute
Intensity of Software Engineers	Bureau of Labor Statistics, Milken Institute
Intensity of Computer Support Specialists	Bureau of Labor Statistics, Milken Institute
Intensity of Computer Systems Analysts	Bureau of Labor Statistics, Milken Institute
Intensity of Database and Network Administrators	Bureau of Labor Statistics, Milken Institute
Intensity of Agricultural and Food Scientists	Bureau of Labor Statistics, Milken Institute
Intensity of Biochemists and Biophysicists	Bureau of Labor Statistics, Milken Institute
Intensity of Microbiologists	Bureau of Labor Statistics, Milken Institute
Intensity of Medical Scientists	Bureau of Labor Statistics, Milken Institute
Intensity of Physicists	Bureau of Labor Statistics, Milken Institute
Intensity of Other Life and Physical Science Occupations	Bureau of Labor Statistics, Milken Institute
Intensity of Electronics Engineers	Bureau of Labor Statistics, Milken Institute
Intensity of Electrical Engineers	Bureau of Labor Statistics, Milken Institute
Intensity of Computer Hardware Engineers	Bureau of Labor Statistics, Milken Institute
Intensity of Biomedical Engineers	Bureau of Labor Statistics, Milken Institute
Intensity of Agricultural Engineers	Bureau of Labor Statistics, Milken Institute
Intensity of Other Engineers	Bureau of Labor Statistics, Milken Institute
Technology Concentration and Dynamism	
Percent of Businesses in High-Tech NAICS Codes	Bureau of Labor Statistics, Milken Institute, U.S. Census Bureau
Percent of Employment in High-Tech NAICS Codes	Bureau of Labor Statistics, Milken Institute, U.S. Census Bureau
Percent of Payroll in High-Tech NAICS Codes	Milken Institute, U.S. Census Bureau
Percent of Business Births in the High-Tech Sector	U.S. Census Bureau
Net Formation of High-Tech Establishments	U.S. Census Bureau
Number of Technology Fast 500 Companies	Deloitte & Touche; U.S. Census Bureau
Average Yearly Growth of High-Tech Industries	Moody's Economy.com; Milken Institute
High-Tech Industries Growing Faster Than U.S. Average	Moody's Economy.com; Milken Institute
High-Tech Industries With LQs Higher Than 1.0	Moody's Economy.com; Milken Institute
Number of Inc. 500 Companies	Inc. Magazine, U.S. Census Bureau

** All population statistics are from the U.S. Census Bureau. All Gross State Product figures are from the U.S. Department of Commerce.*

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