20

Years of the Annual Index of the Massachusetts Innovation Economy | 2016 Edition

MASSACHUSETTS
TECHNOLOGY
COLLABORATIVE

The Index of the Massachusetts Innovation Economy, has been published by the Innovation Institute at the MassTech Collaborative annually since 1997. The Index is the premier fact-based benchmark for measuring the performance of the Massachusetts knowledge economy. To view the Index online and for more information on the Massachusetts Innovation Economy, visit us at: masstech.org/index.

75 North Drive – Westborough, MA 01581 – 508.870.0312
2 Center Plaza, Suite 200 – Boston, MA 02108 – 617.371.3999
masstech.org – masstech.org/index – @mass_tech

MASSACHUSETTS TECHNOLOGY COLLABORATIVE

Welcome

It is my pleasure to introduce the 20th anniversary edition of the *ANNUAL INDEX of the MASSACHUSETTS INNOVATION ECONOMY*. Coming from a long career in financial services, it's extremely clear to me why the *Index* has been a benefit, providing readers with information on emerging trends, areas where we need to improve, industry verticals which need our support, data that's important to businesses, economic development organizations, academia, and government.

My thanks to the many MassTech staffers, Advisory Board members, and local leaders who have made 20 years of the *Index* possible, including our Innovation Institute director Pat Larkin, year-in and year-out a driving force behind this publication.

As I embark as the head of the MassTech team, we will continue to identify ways to strengthen our innovation economy and grow job opportunities across Massachusetts. We'll also take on the charge of using resources like the *Index* and other data-driven reports, bolstered by the stories of the innovation happening across the state, to showcase Massachusetts to the world as the number one innovation hub in the U.S., and as a great place to start and grow a tech-driven company. We look forward to working with each and every one of our stakeholders across the Commonwealth to help us with this effort, and, in future editions of the *Index*, to celebrate the results of our collaborative efforts.

Timothy J. Connelly
Executive Director/CEO, Massachusetts Technology Collaborative

ABOUT MASSTECH

The Massachusetts Technology Collaborative, or MassTech, is an innovative public economic development agency which works to support a vibrant, growing economy across Massachusetts. Through our three major divisions - the Innovation Institute, the Massachusetts eHealth Institute (MeHI), and the Massachusetts Broadband Institute (MBI) - MassTech is fostering innovation and helping shape a vibrant economy.

We develop meaningful collaborations across industry, academia and government which serve as powerful catalysts, helping turn good ideas into economic opportunity.

We accomplish this in three key ways, by: FOSTERING the growth of dynamic, innovative businesses and industry clusters in the Commonwealth, by accelerating the creation and expansion of firms in technology-growth sectors; ACCELERATING the use and adoption of technology, by ensuring connectivity statewide and by promoting competitiveness; and HARNESSING the value of effective insight by supporting and funding impactful research initiatives.

ABOUT THE INNOVATION INSTITUTE AT MASSTECH

The Innovation Institute at MassTech was created in 2003 to improve conditions for growth in the innovation economy by: Enhancing industry competitiveness; Promoting conditions which enable growth; and Providing data and analysis to stakeholders in the Massachusetts innovation economy which promotes understanding and informs policy development.

Our Innovation Institute's mission is to strengthen the innovation economy in Massachusetts, in order to generate more high-paying jobs, higher productivity, greater economic growth, and improved social welfare. The Institute convenes with and invests in academic, research, business, government, and civic organizations which share the vision of enhancing the Commonwealth's innovation economy.

Through the use of an innovative, stakeholder-led process, we implement a "cluster development" approach to economic development. Projects, initiatives, and strategic investments in key industry clusters throughout all regions of the Commonwealth are creating conditions for continued economic growth.

20 Years in Data

1997

1998

1999

2000

2001

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20 Years of the Annual *Index* reports available online:
masstech.org/index

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EXECUTIVE SUMMARY

The 2016 *Index* of the Massachusetts Innovation Economy shows that the Commonwealth is still a top performer nationally, bolstered by our well-trained and talented workers, as well as investments in R&D.

Despite the continued improvement of competitive states and a handful of challenges faced by the Commonwealth, based on the Massachusetts Technology Collaborative's analysis of 22 indicators that cover the categories of **Economic Impact, Research, Technology & Business Development, Capital, Talent, and Infrastructure** (pages 24-60), we found several areas where Massachusetts is a leader nationally:

- **Superior Workforce and Talent Pipeline:** 46.6% of working age adults in Massachusetts had at least a bachelor's degree as of 2014 while also producing **2,698 STEM degrees per million residents**, measures in which Massachusetts continues to lead the Leading Technology States (LTS);
- **Powered by R&D**: Massachusetts had the **second highest overall level of R&D funding in the country in 2014 ($27.98 billion)**, slightly ahead of third-place Texas ($22.49 billion). Given it's much smaller size relative to its nearest competitors California (#1) and Texas (#3), the gross R&D numbers show how Massachusetts 'punches above its weight' when it comes to these investments, the vast majority of which come from private industry (76%).The Massachusetts Innovation Economy experienced steady 2.3% job growth from Q1 2015-Q1 2016, the same rate of job growth as the economy as a whole.
- **Attractive Investment Destination**: Venture capital investment in Massachusetts **grew by 25% in 2015**, faster than in California, and reached a **total of $5.8 billion**.

The *Index* also shows several areas where Massachusetts needs to improve relative to other Leading Technology States (discussed on page 16), including:

- **Declining International Exports**: Exports from Massachusetts **declined by $2 billion in 2015** and Massachusetts has the third lowest level of exports as a share of GDP in the LTS (5.3%);
- **Mass. Held Share of Federal R&D Investment, but Totals on the Decline**: While Massachusetts has maintained its overall share of Federal funding for R&D to universities, colleges, and non-profits, the gross amount awarded **declined by 20.7%** from 2010-2014.

On the following page, MassTech has compiled the leading statistics from each of the six Indicator categories, providing an easy to read summary of each.

This year marks the 20th anniversary edition of the *Index* and to celebrate this milestone, this version contains several new sections, including a Special Analysis section focused on "20 Years of Adaptation & Innovation," (page 9), which takes a reflective look at the trends and forces that have shaped the Massachusetts Innovation Economy over the past two decades. In addition, we've also included a "Special Analysis: Commentary" section which compiles a selection of essays from both national and international thought leaders (pages 11-14), providing an independent outsiders view on the importance of measuring and tracking economic data.

For this Anniversary edition, the 2016 *Index* has also expanded the field of Leading Technology States, or LTS, compared in the *Index*. The growth, from 10 to 15 states is a first for this publication. We've also expanded the LTS profiles, including actions each state has taken to remain competitive in the innovation space (pages 15-21).

MASSACHUSETTS

2015 POP: 6,794,422
2015 GDP: $427.5 billion
# of IE Jobs: 1,286,578
% of IE Jobs: 37.60%

KEY SECTORS

- Biopharma & Medical Devices
- Computer & Communications Hardware
- Defense Manufacturing & Instrumentation
- Financial Services
- Healthcare Delivery
- Postsecondary Education
- Scientific, Technical, & Management Services
- Software & Communications Services

2016 Leading Technology States
State
Massachusetts
California
Pennsylvania
New York
Connecticut
Illinois
Ohio
Minnesota
New Hampshire
Rhode Island
New Jersey
North Carolina
Texas
Wisconsin
Missouri

2016 INDICATOR HIGHLIGHTS

Economic Impact

- Massachusetts' **Innovation economy jobs grew at 2.3%**, the same rate as the rest of the economy over the previous year.
- Massachusetts households **earn $10,000 more than their counterparts** in the average Leading Technology States (LTS).
- Massachusetts exports as a share of GDP are down 7.6% since 2014.
- Output **grew by 36% from 2009-2015 in two sectors**:
  - Computer & Communications Hardware
  - Software & Communications Services

Capital

- Industry funding of Academic and Health R&D in Massachusetts **set a 10-year record in 2014 ($237 million)**.
- Venture Capital invested in Massachusetts firms **increased by nearly $3 billion from 2013-2015**. Early Stage and Expansionary firms were the most popular destinations for funding;
  - **The Biotechnology (38.8%) and Software (28.6%) sectors** accounted for the majority of total Venture Capital funding in 2015.

Research

- Massachusetts leads the LTS in:
  - **Federal R&D Funding for Universities & Non-profits as share of GDP ($6.64 per $1,000 GDP)**;
  - R&D spending as a percent of GDP (5.86%); and
  - NIH R&D Funding per capita ($4,248 per $1 million GDP).

Talent

- Massachusetts continues to rely on an educated workforce as **67.5% of working age adults have at least some college education**.
- Employment rate of adults with a Bachelor's degree has remained flat (75.70%) as compared to 2014.
- **Massachusetts leads the LTS in degrees granted per million residents in STEM fields with 2,698 degrees**.
- Massachusetts maintains an advantage over the LTS in life science graduates (774 per million residents) from 2014-2015.

Technology & Business Development

- Massachusetts is **2nd in the LTS for Small Business Innovation and Research/Technology Transfer (SBIR/STTR) award dollars** as a percentage of GDP ($583 million per $1 million GDP).
- Massachusetts **patents continued to increase to a new high of 6,777 in 2015**, but at a slower rate than previous years.
- Massachusetts leads the LTS in the following Technology Patent Sectors:
  - Drugs & Medical Patents (227 per million residents); and
  - Analytical Instruments & Research Methods Patents (100 per million residents).

WINDOW ON MASSACHUSETTS INNOVATION

NASA's Humanoid Robot, Valkyrie, being tested at the New England Robotics Validation and Experimentation (NERVE) Center at UMass-Lowell. *Photo courtesy of UMass-Lowell NERVE Center.*

TWENTY YEARS OF TRACKING INNOVATION

It is our pleasure to introduce the 2016 *Index of the Massachusetts Innovation Economy*, the Commonwealth's tool for benchmarking the status and progress of our innovation economy. This edition marks the 20th year of publication for the *Index*. It offers a reflection on how the Massachusetts economy has changed over the last two decades, as well as what trends and forces will shape Massachusetts moving forward.

Twenty years of *Index* indicator tracking demonstrates that the Commonwealth's enduring economic strength stems from our talented workforce and capacity for development of new and diverse innovations. Despite the many challenges our economy has faced over the past 20 years, the Commonwealth remains a global hub for new research and development in a wide range of industries. That was driven home in early 2016 when General Electric made the decision to relocate its headquarters to Massachusetts, citing our robust innovation ecosystem and R&D prowess as key reasons for their decision.

The *Index* highlights our competitive advantages when it comes to innovation-focused talent and R&D, including:

- 47% of the working age population in Massachusetts has at least a bachelor's degree, placing the Commonwealth first among the 'Leading Technology States' tracked by the *Index*;
- Our universities and colleges produce more STEM graduates per capita than any Leading Technology State;
- $28 billion was invested in R&D in Massachusetts in 2014, placing us second in the nation, and we had the fastest year-over-year growth among the Leading Technology States from 2011 to 2014 (14%).

We believe our commitment to transparently and thoroughly tracking our annual economic performance helps us stay ahead of the pack and identify areas of focus and improvement. Being data-driven helps our technology ecosystem and informs our economic development strategies.

To stay successful, the Commonwealth must continue supporting the development and commercialization of new innovations, and stay relentless in supporting our talent pipeline, from research universities to vocational-technical schools and beyond. Statewide, roughly 38% of our state's workforce participate in our innovation economy. To truly provide opportunities for all, we must ensure all our residents are trained, prepared, and ready to harness the full benefits of new and changing industries.

As pointed out by economist Mark Zandi of Moody's in the Special Analysis, the Commonwealth has faced many challenges over the years, yet has continued to thrive and become a role model for states and nations looking to build a diverse and resilient innovation economy. This important research would not be possible without the hard work and support of the many MassTech staff, Index Advisory Committee members, elected officials, and innovation community stakeholders that have contributed to the *Index* over the past 20 years. Our thanks to each and every one of you!

Sincerely,

Pat Larkin
Director
Innovation Institute at MassTech

Patricia M. Flynn, PhD
Chairperson, Index Advisory Committee
Trustee Professor of Economics & Management,
Bentley University

SPECIAL ANALYSIS: 20 YEARS OF ADAPTATION

20 YEARS OF ADAPTATION AND INNOVATION
by MassTech Staff

For two decades, the *Index of the Massachusetts Innovation Economy* has tracked the performance of the Massachusetts economy on a diverse set of indicators covering economic impact, research, technology development, business growth, capital, and talent. Since the late 1990's when the *Index* was first published, the Commonwealth of Massachusetts has consistently performed well on these metrics as compared to a group of "Leading Technology States" (LTS), a kind of advanced economic peer group. During the last twenty years, this comparative methodology has been reinforced by examining the proliferation of other 'tech state' rankings and economic comparison studies that have emerged, many of which also score Massachusetts very highly.

Nonetheless, the last 20 years have not been free of challenges, many of which appeared quite severe as they came into view. 'Massachusetts' Flagship Technology Company Acquired by Upstart from Texas' sounds like a recent headline given the merger of Dell and EMC in 2015; yet, this same headline would have been appropriate almost 20 years ago as well. Shortly after the publication of the inaugural *Index of the Massachusetts Innovation Economy* in 1997, Texas-based Compaq acquired Digital Equipment Corporation (DEC). DEC was a rapidly growing computer company and a national leader in the 1970s and 1980s, one of the key forces driving the "Massachusetts Miracle." At that time, this transaction was the largest merger in the history of the technology industry. Worryingly for any remaining prognosticators, neither company exists anymore as, just a few years later, Compaq itself would be acquired and DEC wound down to nothing. At about this same time, two of Massachusetts' former technology titans -- Wang Laboratories and Data General — were also acquired and soon after dismantled. While high profile mergers and acquisitions of Massachusetts companies are understandably viewed as signaling a loss of competitiveness, they are more often indicative of a shift in the growth trajectory of certain industries, and should be viewed as an opportunity to shift focus onto the development of new and emerging trends.

As indicated above, the *Index* was created during a tumultuous economy, one that would eventually suffer severe negative shocks twice during the 2000s. Looking up from the depths of the Dot-com recession of the early 2000s and the Commonwealth's anemic recovery, it would be easy to forgive people that wrote off Massachusetts as yet another post-industrial northeastern state destined to become a permanent member of the Rust Belt.

Yet in 2016 Massachusetts is one of the fastest growing leading technology states (**31% GDP per capita growth since 1997**, 2nd among LTS), has among the highest wages in the United States ($70k median household income), and has a thriving and diverse Innovation Economy that is the envy of the entire world, with the exception of perhaps Silicon Valley. The indicators tracked by the *Index* have consistently shown Massachusetts at or near the front of the LTS, a selection of states that can be viewed as our primary competitors. Today, the Innovation Economy is not powered by computer manufacturers (although they are still strong here), but by the biotech hub in Kendall Square, Cambridge; by upstart software companies that are creating entirely new industries in digital health, cybersecurity, and big data; and by small- to mid-sized manufacturers across the Commonwealth that have adapted to global competition by doubling down on innovation. While existing industries are still an important foundation to build on, Massachusetts has always reinvented itself in order to stay at the forefront of innovation in any era. Whether it was the textile mills in the 19th century, the mini-computer boom around Route 128 in the 1970s and 1980s, or the biotech boom of today, Massachusetts has succeeded due to its strong foundation of research institutions and well-educated workforce to pioneer new, cutting-edge industries to replace those in which its competitive advantage has been eroded. While Massachusetts is clearly not immune to national and global economic trends, it is well positioned to adapt to them and has a successful history of doing so.

Greater Boston is and likely always will be the beating heart of the innovation economy in Massachusetts, but it is far from the only place pushing the boundaries of technology in the Commonwealth. Massachusetts has a long track record of developing new, innovative industries to support economic growth and making long-lead public and private investments in innovation which are now driving increased growth in the state.

In the 1990's, major investments in the University of Massachusetts Medical School and its affiliated medical center in Worcester have turned it into the city's largest employer (4,700

Third Party Publications Rankings for Massachusetts:

- **"Most Innovative State"** - Bloomberg's "Most Innovative States in America" for 2016
- **First in every edition since 2002** - Milken Institute's State Technology and Science Index
- **#1 in the "State New Economy Index"** - Information Technology & Innovation Foundation

GDP Per Capita
Massachusetts, LTS, & U.S., 1997 & 2015

	1997	2015	Absolute Increase	% Increase
California	$41,658	$56,374	$ 14,716	35.3%
Massachusetts	$48,079	$62,925	$ 14,846	30.9%
Texas	$42,126	$53,716	$ 11,590	27.5%
New York	$50,415	$63,939	$ 13,524	26.8%
Minnesota	$43,318	$54,437	$ 11,120	25.7%
Pennsylvania	$39,515	$48,951	$ 9,435	23.9%
New Hampshire	$39,757	$49,230	$ 9,474	23.8%
Rhode Island	$39,208	$48,335	$ 9,127	23.3%
Wisconsin	$39,262	$47,419	$ 8,157	20.8%
U.S.	$41,559	$49,851	$ 8,292	20.0%
Ohio	$39,724	$46,873	$ 7,150	18.0%
Illinois	$46,274	$53,648	$ 7,373	15.9%
Connecticut	$56,138	$64,124	$ 7,986	14.2%
New Jersey	$50,689	$56,729	$ 6,040	11.9%
North Carolina	$40,635	$44,060	$ 3,425	8.4%
Missouri	$40,294	$42,989	$ 2,696	6.7%

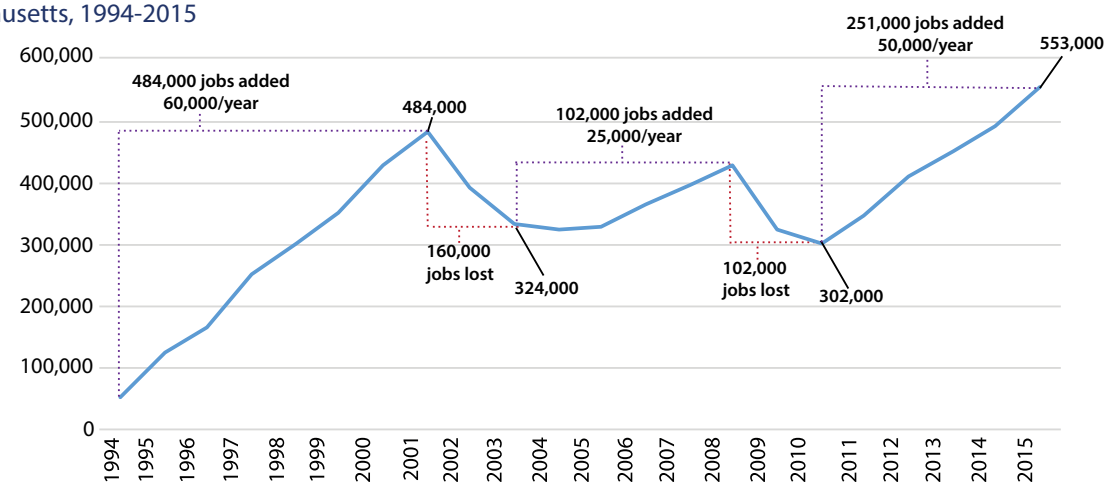
Source: Census Bureau, Bureau of Economic Analysis

Massachusetts had the highest absolute increase and second greatest % increase in per capita GDP in the LTS from 1997-2015.

SPECIAL ANALYSIS: 20 YEARS OF ADAPTATION

Cumulative Net Job Growth

Massachusetts, 1994-2015



Source: BLS Business Employment Dynamics

In 1997, the best year for net job creation on record, Massachusetts was in the midst of a broad-based national economic upswing. However, the dot-com bubble burst in 2001 and Massachusetts suffered a severe recession, losing 160,000 jobs between 2001-2004, worse than the 124,000 jobs lost during the Great Recession of 2008. Between recessions, Massachusetts never fully recovered the jobs lost during 2001-2004. Yet since 2010, Massachusetts has created 251,000 net jobs, erasing the losses suffered during the 2000s. Since 1994, Massachusetts has created 553,000 net jobs while the labor force has grown by only 342,000, resulting in the unemployment rate dropping from 5.9% in 1994 to 3.9% now.

school & 6,900 hospital employees), **while helping to attract $224 million in research funding in 2015, up from just $2 million in 1977** (roughly $8 million in 2015 dollars). A nascent biotech cluster has catalyzed around the school with a major presence from AbbVie (440,000 sq ft, 700 employees) as well as several start-ups and contract manufacturers, some of which are located in nearby Gateway Park, a private development led by Worcester Polytechnic Institute.

Additionally, in 2013, as part of a $1 billion statewide initiative, the Massachusetts Life Sciences Center approved $100 million in grant funding to support biotech in the western part of the state in an effort to duplicate the success of Gateway Park. This effort included a $95 million grant toward a $150 million capital project at the University of Massachusetts - Amherst to construct the Institute for Applied Life Sciences, a facility which includes the Models to Medicine Center, Center for Bioactive Delivery, and Center for Personalized Health Monitoring. The Pioneer Valley Life Sciences Institute (PVLSI), a joint venture between UMass and Baystate Medical Center, also received $5 million to support bioinformatics work in Springfield, highlighting additional statewide growth in this dominant sector.

Massachusetts has also promoted entrepreneurship through private and public sector investments that support homegrown start-up accelerator and mentoring programs, including the now global non-profit MassChallenge, based in Boston; Entrepreneurship for All (EforAll) in the Merrimack Valley and South Coast regions; and Valley Venture Mentors in Springfield. As of 2015, MassChallenge had accelerated 835 companies, 82% of which were still active, which directly generated 6,500 jobs. **EforAll's startups have generated $5.2 million in revenue, 271 jobs, and raised $7 million in capital**, bringing much needed growth to Massachusetts' Gateway Cities, small and mid-sized municipalities that have faced long-term economic challenges.

Today, Massachusetts continues to invest in new innovation assets to help seed and promote growth around the state for generations to come. The Commonwealth's Collaborative R&D Matching Grant program has provided capital funds for a series of research centers located outside Greater Boston, which include the Printed Electronics Research Collaborative at UMass Lowell, the Center for Marine Robotics at Woods Hole Oceanographic Institution, and the UMass Data Science and Cybersecurity Collaborative at UMass-Amherst. Each of these research centers has attracted significant private sector contributions and present opportunities for the surrounding regions to be future drivers of economic growth.

Massachusetts is also investing in four Manufacturing Innovation Institutes, part of the Manufacturing USA initiative administered by the federal government. Three institutes (Flexible-Hybrid Electronics, Advanced Photonics, and Biopharmaceutical Manufacturing) have Massachusetts-based nodes, while the Advanced Functional Fabrics of America (AFFOA) program will be based at MIT. These initiatives will work with partners across the Commonwealth to support new start-ups and mid-sized firms, as well as train the workforce required for these new sectors to innovate and grow. **Financial, material, and organizational support for innovative R&D projects exemplifies the Commonwealth's efforts to leverage its well-educated workforce and robust network of research institutions;** enduring strengths that have and will continue to help keep the Massachusetts economy resilient.

Massachusetts has undoubtedly been affected by the same trends that have shaped the U.S. economy over the last 20 years, but the Commonwealth has come through the Dot-com recession and the Great Recession of 2008 with a resilient economy that is growing steadily and rich in high wage jobs. The next 20 years look to be shaped by trends that Massachusetts is well-positioned to capitalize on. As long as they are properly fostered, the Commonwealth's talented workforce and network of higher education and research institutions are natural assets that will continue to make Massachusetts an attractive place to start and grow an innovation-driven business well into the future.

SPECIAL ANALYSIS: COMMENTARY

This year's Special Analysis is a reflective look at the Massachusetts economy and actions taken to remain competitive since the inception of the Index. For this edition, we have also included commentaries from both national and international thought leaders on how the economy is shifting and the importance of tracking innovation. - MassTech Staff

Commentary by Mark Zandi, Chief Economist, Moody's Analytics

Moody's Analytics is proud to contribute economic data used to construct the *Index of the Massachusetts Innovation Economy*. The *Index* provides a vital source of information regarding this rapidly growing and integral part of the broader economy.

Accurate and timely information and data like that provided by the *Index* is necessary for designing and effectively implementing policies to support economic growth and innovation. There is no better testimonial to this than the current debate over the causes behind the decline in new business formation in recent years. New businesses have historically been the fountain of innovation and technological change, and they distinguish the Massachusetts and U.S. economies from the rest of the world.

Business starts peaked during the internet-technology boom of the late 1990s, took a dive during the tech bust, and have more-or-less declined ever since. There was a brief pause in the decline during the housing boom of the mid-2000s, but the Great Recession that followed was devastating to entrepreneurship. And while new business formation appears to have picked up very recently, it remains well below that of two decades earlier.

Many theories have been proffered for the low number of new businesses and what it means for productivity growth and, ultimately, for growth in our living standards. The severity of the downturn clearly matters, given the psychological pall that it cast on risk-taking. Perhaps the age composition of the population is behind the innovation slump. Most people who start companies do so in their mid and late 30s, and the large millennia cohort isn't quite there yet. It may also take the millennials longer than past generations to start new companies given the student debt they have had to take on.

There is also the possibility that potential new businesses can't get going because they can't get the necessary capital. Indeed, venture capital investments have become increasingly focused on a handful of tech centers across the country, Massachusetts being one of them. Another, of course, is Silicon Valley. VC money is also flowing freely in the software and biotechnology areas, but much less so in other key areas of likely innovation.

More worrisome, it could be that the pace of technological change has slowed. Yes, there is explosive changes occurring in nanotechnology, the discovery of new cancer drugs, cloud computing, drones, 3D printing, and perhaps even in the apparent coming of driverless cars. But some argue that these innovations, while impressive, fall well short of the innovations of time past. Think of electricity or the transistor.

Gaining an understanding of what is driving the decline in new business formations is key to designing policies to address it. The policy response is one thing if the problem is a lack of equity capital, and it is altogether another if it is onerous student loan debt or a lack of path-breaking new technologies.

These questions can't find answers, at least not quickly enough, without the data and type of analysis that underlies the *Index of the Massachusetts Innovation Economy*. Thank you for allowing Moody's Analytics the opportunity to participate in your important endeavor.

"Venture capital investments have become increasingly concentrated in a handful of tech centers across the country, Massachusetts being one of them."

- Mark Zandi, Chief Economist
Moody Analytics

SPECIAL ANALYSIS: COMMENTARY

Commentary by Erica Groshen, Commissioner, Bureau of Labor Statistics

The Index relies heavily on the products of several federal statistical agencies and one of the most important is the Bureau of Labor Statistics (BLS). The Innovation Institute at MassTech relies on BLS data to complete our Leading Technology States selection process, as well as in the compilation of the Employment & Wages, Occupations & Wages, and Output Indicators. The reliability of BLS data and the continued improvement in both the range and accessibility of its data products are essential in ensuring that the Index continues to be a useful tool for measuring the Innovation Economy. - MassTech Staff

Innovations and the Bureau of Labor Statistics

To my mind, the Big Data era and the Bureau of Labor Statistics (BLS) really began together—as innovations in Massachusetts a long time ago. Why? It was Massachusetts that established the first state-level bureau of labor statistics in 1869. Just a decade and a half later, in 1884, Congress established the first national statistical agency, the Bureau of Labor—which became today's BLS. And, Carroll D. Wright, the Massachusetts bureau's second Chief, became our first Commissioner. During Wright's tenure, the Bureau published numerous ground-breaking studies, including 19 annual and 12 special reports on a wide variety of labor, industrial, and related issues.

Today, BLS carries on that innovative tradition as we produce 7 Principal Federal Economic Indicators (PFEI), such as unemployment and inflation rates, as well as a wide variety of other data, including many that are required or referenced by law. This is an ever present challenge. From the beginning we have had to balance two imperatives: maintaining comparability and reliability of measures over time and evolving to improve our measures and ensure relevance in a rapidly changing economy.

Even for our data series that began 50 or more years ago, how we collect, process, and disseminate surveys has changed over the years. Once, we collected data only via mail, phone calls, and in-person interviews. Now, the BLS makes heavy use of Internet and other electronic platforms. Our Internet data collection center accepted 3.6 million transactions in 2015 and continues to grow.

We also continually investigate new data sources for possible use. Many decades ago, we pioneered the statistical use of administrative Unemployment Insurance records kept by state agencies. We still depend on this partnership. In today's increasingly digitized economy, we are leveraging new alternative, non-survey sources such as government administrative data, private sector aggregators, and corporate data. The goals are to expand coverage, reduce collection costs, and lessen respondent burden. Our challenge is that each opportunity needs to be fully evaluated for quality, consistency, sustainability, and costs. Nevertheless, the potential for tangible long-term benefits of these Big Data sources is real.

To make the best use of our resources, we must always be modernizing how we process data also. For example, in the Consumer Price Index program, we now scrape websites for the product characteristics used to adjust for quality changes in goods. We also now use Computer-Assisted Coding for illnesses and injuries data. Our system "reads" text in survey responses and determines appropriate codes. This improves accuracy and frees staff time to concentrate on unusual entries.

To serve the public well, we continually improve dissemination of data to reach a growing, diverse universe of data users. When BLS began www.bls.gov in 1995 we were among the first federal agencies to have a website. That year, we averaged 72,000 page-views by visitors per month. Today, our website offers 107 million data series, including 540 million estimates. With over 300,000 pages, our website now averages 18 million page-views per month.

Here's a small taste of cool things you can find on bls.gov. When we began online publication of our Occupational Outlook Handbook (the 1996-97 edition), it was a novel concept. A reader favorite ever since, the latest edition now attracts 5.8 million page views per month. More recently, we created The Economics Daily, an online-only visualization of intriguing economic data. You can join the over 40,000 followers of our Twitter account (@BLS_gov). You can automate your access to BLS data with our Application Programming Interface. You can personalize the interactive charts that now accompany most of our PFEI news releases. We are on track to complete the full set by December 2016, and to add charts to other releases after that.

These days, the Big Data world extends far beyond statistical agencies, giving BLS more opportunities to innovate in producing gold-standard data that affect lives and commerce. As in the past, in the future we plan to expand the above efforts, seek further opportunities to collaborate with others and develop more common platforms within BLS—all to create new products, lower costs, and improve data quality.

"These days, the Big Data world extends far beyond statistical agencies, giving BLS more opportunities to innovate in producing gold-standard data that affects lives and commerce."

- Erica Groshen, Commissioner
Bureau of Labor Statistics

SPECIAL ANALYSIS: COMMENTARY

Commentary by Dr. John Hardin, Executive Director, NC Board of Science, Technology & Innovation

One of the most useful functions of the Index is as a tool for comparing the Commonwealth's performance against a selection of competitor states. While most states do not release a similar publication, some of our top competitors do. North Carolina has been periodically included in the Leading Technology States that we compare Massachusetts to in the Index and once again made the list in 2016. North Carolina and Massachusetts have important similarities that tie them together, the most apparent of which is a cluster of leading research universities. There are also many business connections between both states with Massachusetts-based companies such as GE, Biogen, and Fidelity Investments having major operations in North Carolina while several North Carolina-based firms such as Red Hat and LabCorp have a large presence in Massachusetts. Both North Carolina and Massachusetts are popular research bases for large companies with Google, IBM, Cisco, and Novartis as some of the companies with a major presence in both states. - MassTech Staff

Since 2000, the North Carolina Board of Science, Technology & Innovation has produced a periodic *Tracking Innovation* report that assesses the state's performance vis-à-vis other states, the U.S. overall, and other countries across dozens of innovation measures. The report has sparked several initiatives and programs in the last 10 years. Examples include:

- The 2015 *Tracking Innovation* reports showed that the state could broaden and expand innovation-based prosperity from the state's largest urban counties outward to its more rural counties. As a result, in 2015 the Board partnered with a diverse set of statewide partners to help implement the InnovateNC initiative, an intensive two-year cross-city learning collaborative supporting five North Carolina communities. Still underway, the initiative is providing mentoring and technical assistance to help the communities discover, refine, and enhance their distinct advantages in the innovation economy.
- The 2013 *Tracking Innovation* report showed that the state could enhance and speed the translation of its innovative R&D into commercial products and companies. As a result, in 2014 the Board staffed the Governor's Innovation-to-Jobs Working Group, which crafted a targeted set of actionable recommendations to enhance the state's innovation ecosystem by bolstering funding, talent, and processes. A majority of the recommendations resulted in legislation, and the others are currently being implemented.
- The 2003 *Tracking Innovation* report showed that the state could increase and augment its awards from the federal Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs. As a result, in 2005 the Board worked with policy makers to establish one of the nation's first and longest running state-funded matching grant programs for businesses receiving SBIR and STTR grants. In the program's 11-year history, the businesses receiving the matching grants have greatly increased their rate of technology commercialization and the amount of follow-on funding from numerous sources.

Commentary by Charlotte Rønhof, Vice President, Confederation of Danish Industry

Looking globally, there are several examples of small countries that have had to rely on innovation and the skills of their workforce to develop and maintain a high standard of living. Denmark is a prime example of such a country and one that has shown increasing interest in the Index and tracking its own innovation economy. Both Denmark and Massachusetts are major players in biopharmaceuticals and the ties between the two regions are growing. Major Danish company LEO Pharmaceuticals is planning to establish a "Science and Technology Hub" in Massachusetts and Novo Nordisk, one of the world's largest pharmaceutical companies is a member of MassBIO. In addition, Denmark's strengths in marine technology have impacted Massachusetts through investments in the state's emerging marine robotics cluster, such as Danish underwater technology firm MacArtney, which operates a manufacturing facility in Massachusetts. - MassTech Staff

A Danish "Detroit moment"?

In the 1960s Detroit was the world's largest center of manufacturing with the highest per-capita income in the USA. Nevertheless, somewhere in the past 40-50 years Detroit went – imperceptibly – from an upward economic trajectory to a downward trajectory.

Today Denmark is among the most research and development intensive countries globally and an innovative leader in Europe. However, Denmark may be facing – what Silicon Valley based entrepreneur Shomit Ghose has dubbed - a "Detroit moment".

The fact that Denmark has become an innovative leader in Europe is the result of a long-term commitment to the development of the Danish research and innovation system that began in 2006, when the Danish government committed to an ambitious plan to increase public investment in research, innovation and education in Denmark. The ambition was to ensure that Denmark would be ready to face the challenges of globalization and maintain a competitive society with a high standard of living.

The Confederation of Danish Industry (DI) – a private organization funded, owned and managed entirely by approx. 10,000 Danish companies within manufacturing, trade and service industry – has actively supported the national commitment to this development.

We have done so because we recognize that investment in research and development is vital for the individual companies and for the Danish society.

Historically, many large and successful Danish companies have been established through research and close collaboration with universities and public research institutions, and presently the 100 companies in Denmark that invest most in R&D are responsible for 24 percent of all Danish exports.

In recent years we have seen cut backs in public spending on R&D due to pressure on the public finances. At the same time, private investment in R&D has stagnated. That is worrying, as multiple studies have shown that companies investing in R&D have higher productivity levels and are more innovative

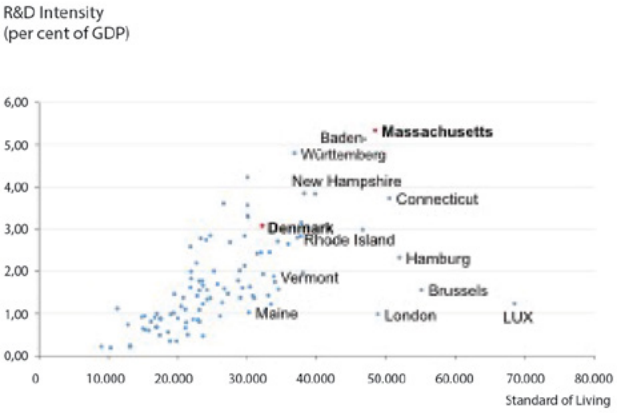
SPECIAL ANALYSIS: COMMENTARY

and ready for global competition. At the same time, we see a connection between the R&D intensity and the standard of living. Consequently, we strongly recommend that public R&D investment is further increased and that this increase aim at supporting the competitiveness of Danish businesses and private investment in research and development. Our focus must be on securing both quality and relevance of public financed R&D investment.

Indeed the tendency is that global competition is becoming increasingly fierce, and regions in China, Korea, the United States and Germany have seen massive increase in R&D as a means to secure competitive, high value jobs. On a whole China has increased its R&D budget by a factor five in the past ten years, and in the Bei-jing region alone, R&D investment exceeds 5.5 percent of GDP.

The result is that the global race to attract companies, researchers and talents is fiercer than ever. Thus, R&D investment has become increasingly important. Hesitation is not an option if we want to maintain our high standard of living and avoid a Danish "Detroit moment".

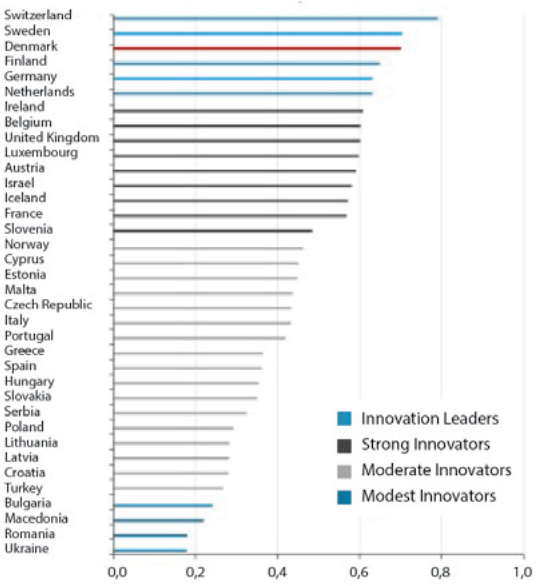
R&D Intensity and Standard of Living for European and New England Regions



Source: Eurostat, OECD, 2016.

Note: Standard of living is measured as Purchasing Power Parity GDP, euro per inhabitant. For most regions, numbers are from 2013. US numbers are from 2011. EU regions are NUTS 1 regions by the EU NUTS classification. Finland is considered one region.

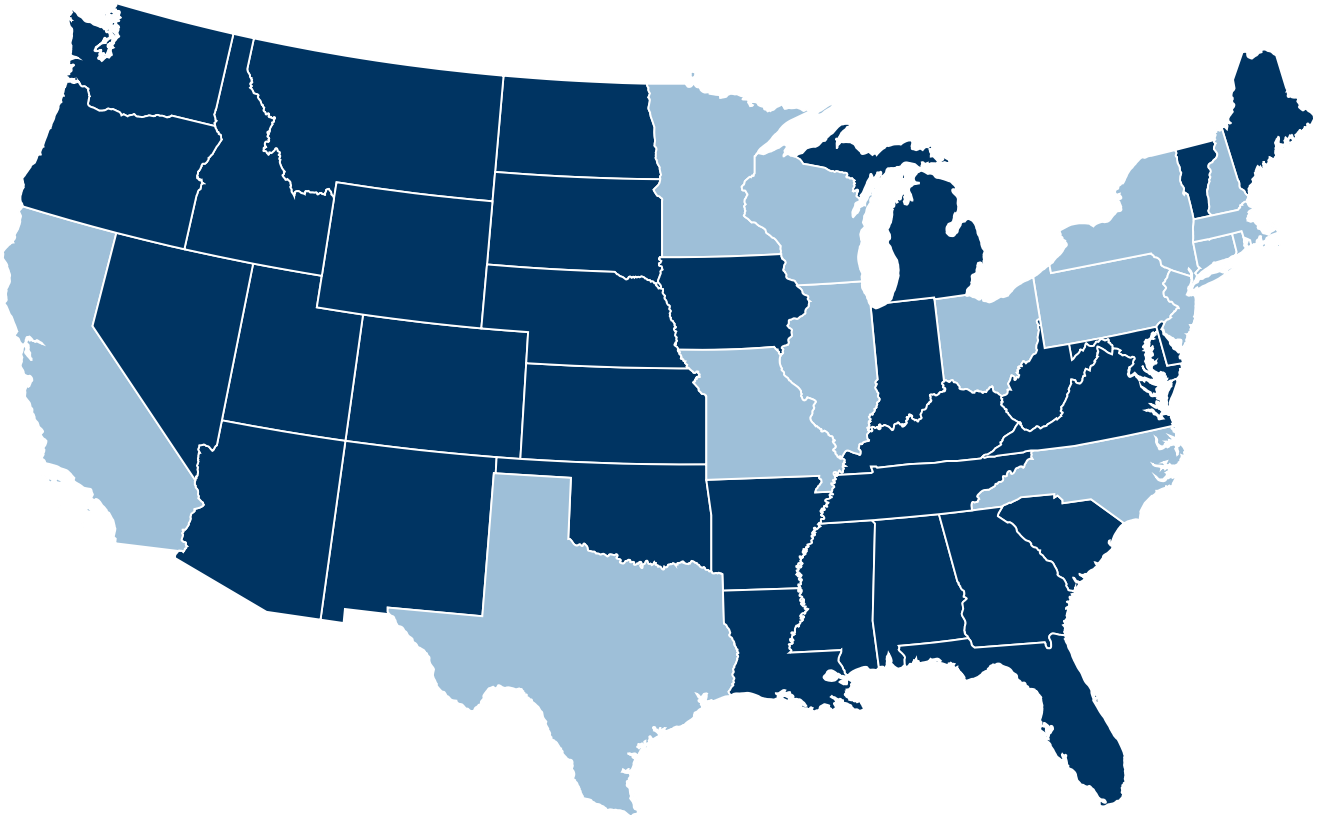
Innovation in European Countries
Innovation Index Scores for European Countries



Source: European Innovation Scoreboard 2016

SELECTION OF THE LEADING TECHNOLOGY STATES (LTS)

Every year, the *Index* compares Massachusetts' performance on a number of metrics to a group of **"Leading Technology States" (LTS)**. The LTS have economies with a significant level of economic concentration and size in the 11 key sectors that compose the **Innovation Economy (IE)** in Massachusetts. The *Index* accounts for three metrics deemed representative of not only the intensity of the innovation economy but also the size and breadth of a state's innovation economy and evaluates them simultaneously.



THE METRICS USED TO SELECT THE 2016 LTS:

Number of key sectors with significantly above average employment concentration

This is defined as the number of innovation economy sectors in each state where employment concentration is more than 10% above the national average and is a measure of the breadth of a state's innovation economy.

Overall innovation economy employment concentration relative to the nation

This is defined as the percent of a state's workers who are employed in the innovation economy relative to the national percentage and is a measure of the overall intensity of a state's innovation economy.

Total innovation economy employment

This measures the number of employees who work within one of the innovation economy sectors in each state and is a measure of the absolute size of a state's innovation economy. A score is then applied to all of the states in order to determine the top 15.

To learn more about the selection methodology for the LTS, see page 63.

2016 Leading Technology States	
State	**Innovation Economy Score**
Massachusetts	2.27
California	2.18
Pennsylvania	2.00
New York	1.71
Connecticut	1.69
Illinois	1.68
Ohio	1.63
Minnesota	1.52
New Hampshire	1.51
Rhode Island	1.49
New Jersey	1.43
North Carolina	1.43
Texas	1.39
Wisconsin	1.33
Missouri	1.32

PROFILES OF LEADING TECHNOLOGY STATES

MASSACHUSETTS

2015 POP: 6,794,422
2015 GDP: $427.5 billion
# of IE Jobs: 1,286,578
% of IE Jobs: 37.60%

KEY SECTORS

- Biopharma & Medical Devices
- Computer & Communications Hardware
- Defense Manufacturing & Instrumentation
- Financial Services
- Healthcare Delivery
- Postsecondary Education
- Scientific, Technical, & Management Services
- Software & Communications Services

UNIVERSITIES & RESEARCH INSTITUTIONS

- MIT
- Harvard University
- UMass-Amherst
- Boston University
- Northeastern University
- Tufts University
- Worcester Polytechnic Institute

COMPANIES

- Raytheon
- Dell-EMC
- Athenahealth
- Fidelity Investments
- State Street Bank
- Biogen
- Genzyme
- GE

INITIATIVES

Collaborative R&D Matching Grant Program: A program to make seed investments in non-profit research centers matched by funds from non-state sources with the end goal of strengthening existing clusters and increasing research activity in Massachusetts, leading to more economic growth in the future. Investments have been made so far in cloud computing, printed electronics, marine robotics, data science & cybersecurity, and health technologies.[1]

Life Sciences Initiative: A $1-billion, state-funded investment initiative being implemented by the Massachusetts Life Sciences Center which states "These investments create jobs and support advances that improve health and well-being. The MLSC offers the nation's most comprehensive set of incentives and collaborative programs targeted to the life sciences ecosystem. These programs propel the growth that has made Massachusetts the global leader in life sciences."[2]

MassChallenge: Non-profit business accelerator that runs a highly competitive program that attracts applicants from all over the world. MassChallenge participants do not give up equity in their companies as winners receive a grant at the end of the program, made possible by public and private sector donors. Since founding in 2010, MassChallenge has grown to become the world's largest accelerator program and has expanded to Israel and the UK. In 2016, PULSE@MassChallenge, a digital health focused program, was set up in Boston's Longwood Medical Area, with state and private sector support.[3]

CALIFORNIA

2015 POP: 39,144,818
2015 GDP: $2,206.8 billion
# of IE Jobs: 4,618,040
% of IE Jobs: 28.30%

KEY SECTORS

- Biopharma & Medical Devices
- Computer & Communications Hardware
- Defense Manufacturing & Instrumentation
- Scientific, Technical, & Management Services
- Software & Communications Services

UNIVERSITIES & RESEARCH INSTITUTIONS

- Stanford
- UC Berkeley
- UCLA
- Cal Tech
- Scripps Oceanographic Institute
- Lawrence Livermore National Lab

COMPANIES

- Amgen
- Intel
- Lockheed Martin
- Google
- Facebook
- Apple
- Cisco
- Oracle
- Wells Fargo
- Qualcomm

INITIATIVES

Biotech Connection Los Angeles: Biotech Connection Los Angeles (BCLA) describes themselves as "an organization run by students, postdocs and young professionals from all over Los Angeles. Our mission is to facilitate the connection between academics across disciplines with each other and the biotech industry to move innovation forward. We engage our community through educational events such as seminars, workshops, panel discussions, and networking opportunities that provide unique industry perspective. We help fostering on-campus conversations between biotech professionals and young academics that strive to be future industry leaders."[4]

SFMade: SFMade describes themselves as a Non-profit organization whose "mission is to build and support a vibrant manufacturing sector in San Francisco, that sustains companies producing locally-made products, encourages entrepreneurship and innovation, and creates employment opportunities for a diverse local workforce."[5]

CONNECT: Non-profit organization spun out of UC San Diego tasked with fostering the growth of San Diego's innovation ecosystem by acting as an incubator of sorts for cluster organizations, eventually spinning them off when they are able to stand on their own.[6]

PROFILES OF LEADING TECHNOLOGY STATES

PENNSYLVANIA

2015 POP: 12,802,503
2015 GDP: $626.7 billion
# of IE Jobs: 1,828,142
% of IE Jobs: 32.10%

KEY SECTORS
- Advanced Materials
- Biopharma & Medical Devices
- Business Services
- Diversified Industrial Manufacturing
- Financial Services
- Healthcare Delivery
- Postsecondary Education

UNIVERSITIES & RESEARCH INSTITUTIONS
- Penn State
- University of Pennsylvania
- University of Pittsburgh
- Carnegie Mellon
- Temple University

COMPANIES
- PNC Financial
- GE Transportation
- Comcast
- Wyeth Pharmaceuticals
- Allegheny Technology
- Uber

INITIATIVES

Catalyst Connection: Non-profit organization headquartered in Pittsburgh that provides consulting and training services to small manufacturers in southwestern Pennsylvania, with the goal of accelerating revenue growth and improving productivity. In 2015, 178 recent Catalyst Connection partners had reported $131M in increased revenue and 982 jobs created or retained.[7]

Ben Franklin Technology Partners(BFTP): BFTP has been an important seed stage capital provider for the Southeastern PA's technology sectors, investing over $175 million in more than 1,750 regional technology companies over the last 30 years, many of which have gone on to become industry leaders. BFTP has also launched university/industry partnerships that accelerate scientific discoveries to commercialization, and has seeded regional initiatives that strengthen the entrepreneurial community in Southeastern PA.[8]

The Science Center: Five educational and medical institutions in Philadelphia joined together in 1963 to create the Science Center, an organization that promotes place and innovation-based economic development in the Philadelphia region by convening entrepreneurs, investors, and academia as well as through the creation of a large, urban science park.[9]

NEW YORK

2015 POP: 19,795,791
2015 GDP: $1,265.7 billion
# of IE Jobs: 2,863,084
% of IE Jobs: 31.80%

KEY SECTORS
- Business Services
- Financial Services
- Postsecondary Education

UNIVERSITIES & RESEARCH INSTITUTIONS
- Cornell University
- Columbia University
- State University of New York System
- New York University
- University of Rochester

COMPANIES
- IBM
- Global Foundries
- Most major banks
- Google
- Bristol Myers Squibb
- Xerox

INITIATIVES

Buffalo Billion: Wide-ranging $1B initiative to regenerate Buffalo through investments and tax credits supporting clean energy, life sciences, and advanced manufacturing. Also incorporates efforts to train the workforce for in-demand high skill positions.[10]

Albany Nanotech: SUNY Poly describes the College of Nanoscale Science and Engineering (CNSE) as "a fully-integrated research, development, prototyping, and educational facility that provides strategic support through outreach, technology acceleration, business incubation, pilot prototyping, and test-based integration support for on-site corporate partners including IBM, TEL, Applied Materials, ASML and International SEMATECH, as well as other "next generation" nanotechnology research activities. CNSE has over 300 global corporate partners to date, and more than 2,600 R&D jobs on site."[11]

NYSTAR Centers for Advanced Technology: NYSTAR funds fifteen Centers for Advanced Technology (CATs) with the intention to "encourage greater collaboration between private industry and the universities of the state in the development and application of new technologies. The CAT program facilitates a continuing program of basic and applied research, development, and technology transfer in multiple technological areas, in collaboration with and through the support of private industry. It plays a critical role in spurring technology-based applied research and economic development in the state; promoting national and international research collaboration and innovation; and leveraging New York's research expertise and funding with investments from the federal government, foundations, businesses, venture capital firms, and other entities."[12]

PROFILES OF LEADING TECHNOLOGY STATES

CONNECTICUT

2015 POP: 3,590,886
2015 GDP: $230.3 billion
# of IE Jobs: 565,793
% of IE Jobs: 34.00%

KEY SECTORS
- Biopharma & Medical Devices
- Computer & Communications Hardware
- Defense Manufacturing & Instrumentation
- Diversified Industrial Manufacturing
- Financial Services
- Postsecondary Education

UNIVERSITIES & RESEARCH INSTITUTIONS
- Yale
- UConn
- Hartford Hospital

COMPANIES
- United Technologies
- GE
- Sikorsky
- General Dynamics
- The Hartford
- Travelers
- Cigna
- Aetna
- Kayak
- Priceline
- Accenture
- Apex

INITIATIVES

UConn Tech Park: Phase one of a new university technology park is due for completion in early 2017. The goal is to facilitate partnerships between industry and the university by providing flexible lab space and access to UConn's research resources and "Industry Centers."[13]

CT Next: Statewide network that connects start-ups to mentors, collaborative workspaces, universities, suppliers, and other entrepreneurs.[14]

Connecticut Skills Challenge: Coding and engineering contests for college students to test their skills and get noticed by employers. Challenge participants are entered into an online directory where employers can search for talent and are invited to participate in Connecticut Technology Council job fairs.[15]

ILLINOIS

2015 POP: 12,859,995
2015 GDP: $689.9 billion
# of IE Jobs: 1,797,220
% of IE Jobs: 30.70%

KEY SECTORS
- Advanced Materials
- Diversified Industrial Manufacturing
- Financial Services
- Postsecondary Education
- Scientific, Technical, & Management Services

UNIVERSITIES & RESEARCH INSTITUTIONS
- Northwestern University
- University of Chicago
- University of Illinois
- University of Illinois-Chicago

COMPANIES
- John Deere
- Caterpillar
- Chicago Mercantile Exchange
- Motorola
- Boeing
- Chase Bank
- AbbVie

INITIATIVES

University of Illinois Research Park: On-campus research park home to more than 100 companies, 1,700 employees, and 600 interns that also includes a 43,000 sq ft incubator for early stage tech companies.[16]

Illinois Innovation Network: Common platform through which startups, innovation-driven enterprises, service providers, research and academic institutions, and community leaders connect, share ideas, and offer tools and resources to accelerate the growth of businesses and industries in the state and beyond.[17]

Illinois Technology Development Account: In 2003, the State Treasurer was authorized to invest up to 1% of the state's investment portfolio into venture capital and private equity in Illinois. Illinois has invested nearly $45 million since 2003, which was matched by $742 million in private investment, creating 3,500 jobs in 60 local companies.[18]

OHIO

2015 POP: 11,613,423
2015 GDP: $533.3 billion
# of IE Jobs: 1,610,890
% of IE Jobs: 30.60%

KEY SECTORS
- Advanced Materials
- Business Services
- Defense Manufacturing & Instrumentation
- Diversified Industrial Manufacturing
- Healthcare Delivery

UNIVERSITIES & RESEARCH INSTITUTIONS
- Ohio State
- Case Western Reserve
- Kent State University
- Cleveland Clinic
- University of Cincinnati
- Wright-Patterson Air Force Base

COMPANIES
- GE Aviation
- General Dynamics
- Timken Steel
- Nationwide Insurance
- Jones Day

INITIATIVES

Bioenterprise: A public private partnership started by the state government, several foundations, research universities, and hospitals to grow the biotech industry in the Cleveland Metropolitan Area.[19]

Edison Welding Institute: Non-profit organization that links manufacturers to cutting edge research in advanced materials joining and manufacturing technology.[20]

Partners for a Competitive Workforce: A public private partnership in the Greater Cincinnati Area that seeks to meet current and future demands for skilled workers through job matching programs, designing new training programs, and working with educational institutions to develop career pathways.[21]

PROFILES OF LEADING TECHNOLOGY STATES

MINNESOTA

2015 POP: 5,489,594
2015 GDP: $298.8 billion
# of IE Jobs: 876,583
% of IE Jobs: 31.60%

KEY SECTORS
- Biopharma & Medical Devices
- Business Services
- Computer & Communications Hardware
- Diversified Industrial Manufacturing
- Financial Services

UNIVERSITIES & RESEARCH INSTITUTIONS
- University of Minnesota
- Mayo Clinic

COMPANIES
- Medtronic
- 3M
- U.S. Bancorp
- United Health
- St. Jude Medical
- IBM

INITIATIVES

MnDRIVE: Minnesota's Discovery, Research, and Innovation Economy (MnDRIVE) is an $18 million annually recurring investment in four research areas at the University of Minnesota (Robotics, Global Food, Environment, Brain Conditions). To date this has leveraged $167 million in external funding and launched 13 start-up companies.[22]

Enterprise Minnesota: Non-profit manufacturing consulting organization that works with small and medium sized companies to increase efficiency and profitability. Also administers the Growth Acceleration Program through which the Minnesota state government provides matching funds to small business looking to invest in improving their operations.[23]

University Ave Innovation District: Effort led by the University of Minnesota to develop an Innovation district between their campus and downtown St. Paul, made possible by large infrastructure investments by the state and local governments including bringing light rail to the area.[24]

NEW HAMPSHIRE

2015 POP: 1,330,608
2015 GDP: $65.5 billion
# of IE Jobs: 203,438
% of IE Jobs: 32.00%

KEY SECTORS
- Computer & Communications Hardware
- Defense Manufacturing & Instrumentation
- Diversified Industrial Manufacturing
- Financial Services
- Postsecondary Education

KEY SECTORS (cont)
- Software & Communications Services

UNIVERSITIES & RESEARCH INSTITUTIONS
- University of New Hampshire
- Dartmouth College
- Dartmouth Hitchcock Medical Center

COMPANIES
- BAE Systems
- Dyn
- Fidelity Investments
- Hypertherm
- Lonza Biologics
- Portsmouth Naval Shipyard

INITIATIVES

New Hampshire Innovation Research Center: Established by the NH legislature to "support innovations through industry and university collaborations, thereby increasing the number of quality jobs in the state. Since its inception, the NHIRC has awarded more than 6 million in state funds to support research projects and has been responsible for the creation or retention of 650 jobs. Awardees have received more than $32 million in federal SBIR grants and over $900 million in investment/acquisition capital."[25]

Live Free and Start: LFS "provides startups with the resources and connections they need to build their businesses in the Granite State. It is focused on expanding access to capital, modernizing business regulation, and sharing stories about how NH's inspiring innovators are building a vibrant tech ecosystem."[26]

Tech Women|Tech Girls: This initiative from the NH High Tech Council is described as "a forum focused on building a strong community of women enthusiastic about technology and supporting efforts where girls are exploring STEM as a career or area of study. TechWomen|TechGirls holds programs for professional women to connect, educate, and explore ideas around career development, technology initiatives, and innovation. The community will also deploy volunteers and mentors to support academic STEM initiatives and events for girls happening all over New Hampshire."[27]

RHODE ISLAND

2015 POP: 1,056,298
2015 GDP: $51.1 billion
#of IE Jobs: 149,104
% of IE Jobs: 31.70%

KEY SECTORS
- Biopharma & Medical Devices
- Business Services
- Diversified Industrial Manufacturing
- Financial Services
- Healthcare Delivery
- Postsecondary Education

UNIVERSITIES & RESEARCH INSTITUTIONS
- University of Rhode Island
- Brown University
- U.S. Naval War College
- Rhode Island School of Design

COMPANIES
- Citizens Financial
- Amica Insurance
- Fidelity Investments
- Metlife
- General Dynamics
- Textron
- CVS Caremark

INITIATIVES

Undersea Technology Innovation Center: According to UTIC, the organization "promotes advanced learning in the undersea sector and the rapid development, testing and commercialization of innovative undersea technology for commercial, academic, and defense organizations."[28]

Innovation Vouchers: This RI Commerce Corporation program lets businesses utilize R&D capacity in Rhode Island. Rhode Island businesses with fewer than 500 employees can receive grants of up to $50,000 to fund R&D assistance from a Rhode Island university, research center or medical center.[29]

Innovate RI Fund: The Fund supports a variety of programs through which eligible Rhode Island small businesses may apply for grants to reduce the cost of applying for SBIR/STTR awards, match SBIR/STTR Phase I and Phase II awards and hire interns.[30]

PROFILES OF LEADING TECHNOLOGY STATES

NEW JERSEY

2015 POP: 8,958,013
2015 GDP: $508.2 billion
# of IE Jobs: 1,200,368
% of IE Jobs: 30.80%

KEY SECTORS
- Biopharma & Medical Devices
- Financial Services
- Scientific, Technical, & Management Services
- Software & Communications Services

UNIVERSITIES & RESEARCH INSTITUTIONS
- Princeton University
- Rutgers University
- New Jersey Institute of Technology
- Stevens Institute of Technology

COMPANIES
- Prudential
- Brystol Myers Squibb
- Pfizer
- Merck
- Johnson & Johnson

INITIATIVES

New Jersey Innovation Institute: New Jersey Innovation Institute is a non-profit intended to match local firms with university researchers in order to accelerate research and development in health care, bio-pharmaceutical production, civil infrastructure, defense and homeland security and financial services. This program proved successful for New Jersey in 2014, with 20 start-ups initiated from universities, hospitals, research institutions, and technology investment firms, more than doubling the total amount from 2013.[31]

Technology Center of New Jersey: Technology park developed by the New Jersey Economic Development Authority to leverage its prime location between Princeton and Rutgers University. The park has 325,000 square ft of lab space and ready-to-build sites for over 500,000 sq ft more.[32]

Newark Innovation Acceleration Challenge: Entrepreneurs submit ideas to be evaluated by a panel of judges for the opportunity to win $3,000 to fund a summer fellowship to work on their idea. Open to Newark college students and residents.[33]

NORTH CAROLINA

2015 POP: 10,042,802
2015 GDP: $442.5 billion
# of IE Jobs: 1,267,765
% of IE Jobs: 29.00%

KEY SECTORS
- Advanced Materials
- Biopharma & Medical Devices
- Computer & Communications Hardware
- Postsecondary Education

UNIVERSITIES & RESEARCH INSTITUTIONS
- UNC Chapel Hill
- Duke University
- North Carolina State

COMPANIES
- Bank of America
- SAS Institute
- Cisco Systems
- GlaxoSmithKline
- IBM
- Red Hat

INITIATIVES

Research Triangle Park: Industry, University, and Government partnership leveraging proximity to Duke, UNC Chapel Hill, and NC State to create the world's largest research park run by a non-profit that re-invests profits in improving the community. RTP is home to 200 companies, 50,000 skilled workers, and invests $296M annually in R&D at local universities.[34]

NCBioImpact: NCBioImpact describes itself as an industry-driven program which "combines the resources of North Carolina's university and community college systems to meet the growing demands of the biotechnology and pharmaceutical industries. The training programs partner closely with the North Carolina Biotechnology Center, NCBIO, the NC Department of Commerce and industry to form a unique academic, industry and government collaborative."[35]

NC IDEA: NC IDEA serves as a "catalyst for young, high-growth, technology companies in North Carolina". Its main focus is providing grant financing for companies in IT, Medical Diagnostics and Devices, Material Sciences, and Green Technology. Grantees may also utilize the extensive expertise of NC IDEA management in growing early stage companies.[36]

TEXAS

2015 POP: 27,469,114
2015 GDP: $1,475.5 billion
# of IE Jobs: 3,303,956
% of IE Jobs: 28.30%

KEY SECTORS
- Computer & Communications Hardware

UNIVERSITIES & RESEARCH INSTITUTIONS
- University of Texas
- University of Houston
- Rice
- Texas Medical Center
- NASA Johnson Space Center

COMPANIES
- Dell
- Texas Instruments
- Apple
- Freescale Semiconductor
- Rackspace
- Celanese

INITIATIVES

Governor's University Research Initiative: GURI is a matching grant program to assist eligible institutions of higher education in recruiting distinguished researchers, with the goal of bringing Nobel Laureates, winners of other prestigious awards, and members of national honorific societies to Texas universities.[37]

Texas Enterprise Fund: The Texas Economic Development Corporation describes the fund as "a cash grant used as a financial incentive tool for projects that offer significant projected job creation and capital investment and where a single Texas site is competing with another viable out-of-state option. Since its inception in 2004, the TEF has awarded over 100 grants totaling more than $500 million across a wide variety of industries and projects. Variations in award amounts are influenced by the number of jobs to be created, the expected time frame for hiring, and the average wages to be paid. In the past, awards have ranged from $194,000 to $50 million."[38]

BioHouston: Non-profit organization leading a broad-based effort to establish the Houston region as a top-tier global competitor in life science and biotechnology commercialization. Its mission is to create an environment that will stimulate technology transfer and research commercialization, thereby generating economic growth for the Houston region and making it a global competitor in the life sciences industry.[39]

PROFILES OF LEADING TECHNOLOGY STATES

WISCONSIN

2015 POP: 5,771,337
2015 GDP: $273.7 billion
# of IE Jobs: 849,930
% of IE Jobs: 30.40%

KEY SECTORS
- Advanced Materials
- Business Services
- Defense Manufacturing & Instrumentation
- Diversified Industrial Manufacturing
- Financial Services

UNIVERSITIES & RESEARCH INSTITUTIONS
- Marquette
- University of Wisconsin System
- Milwaukee School of Engineering

COMPANIES
- Kohler
- Rockwell Automation
- Johnson Controls
- John Deere
- Caterpillar
- Oshkosh
- Harley Davidson
- Epic Systems
- Fiserv

INITIATIVES

Qualified New Business Venture Program: QNBV is a program intended to incentivize investment in early stage businesses developing innovative products, processes or services by angel investors, angel investment networks and qualified venture capital funds through providing a tax credit equal to 25 percent of the amount of the equity investment.[40]

The Water Council: The Water Council describes themselves as a "non-profit organization established by Milwaukee-area businesses, education and government leaders with a mission of aligning the regional freshwater research community with water-related industries. The Water Council links together global water technology companies, innovative water entrepreneurs, government agencies, non-governmental organizations, acclaimed academic research programs and some of the nation's brightest and most energetic water professionals."[41]

UW Milwaukee Innovation Campus: A "third generation" research park that offers technology transfer and business incubation services, as well as incorporates the academic and research enterprise of the university directly into the development of a private sector park that will leverage the research and intellectual property generated by the university.[42]

MISSOURI

2015 POP: 6,083,672
2015 GDP: $261.5 billion
# of IE Jobs: 822,197
% of IE Jobs: 30.30%

KEY SECTORS
- Business Services
- Defense Manufacturing & Instrumentation
- Financial Services
- Healthcare Delivery

UNIVERSITIES & RESEARCH INSTITUTIONS
- University of Missouri
- Washington University
- St. Louis University
- University of Missouri-Kansas City

COMPANIES
- General Motors
- Ford
- Emerson Electric
- Monsanto
- Cerner
- Express Scripts

INITIATIVES

Cortex: Public-private partnership to create a biotech-focused innovation district in St. Louis anchored by Washington University and two major hospitals.[43]

Missouri Innovation Center: Non-profit operator of incubator and accelerator programs for the University of Missouri. Current initiatives include a 33,000 sq ft life sciences incubator and the Mid-MO Tech Accelerator. Also provides assistance obtaining financing.[44]

Missouri Innovation Corporation: According to the MIC, their mission is "to foster business and community development and facilitate the process of innovation to enhance the regional economy of Southeast Missouri and support the technology transfer and commercialization of innovations derived from research within Southeast Missouri State University, to create new, high-value jobs and positive economic or social benefits for the University and regional economy."[45]

WINDOW ON MASSACHUSETTS INNOVATION

In September 2016, the new digital health lab, PULSE@MassChallenge, unveiled their program application process during an event in Boston. Supported by the Massachusetts Digital Health Initiative, the PULSE@ effort connects digital health entrepreneurs with established partners from across the health care, technology, and non-profit sectors. Shown here is a blackboard highlighting the established partner organizations participating in the PULSE@ program. *Photo courtesy of MassChallenge.*

INDICATORS

Prior to the selection of the LTS, *Index* staff and Advisory Committee members select a series of key Indicators which the eventual grouping of LTS will be compared against. Once the LTS are scored and selected, they are compared against each other in the key Indicators and sub-Indicators, helping avoid bias.

- In **this year's *Index,* 22 individual Indicators were selected** and compiled **using the most recent data sources available**;
- These 22 Indicators and their sub-Indicators are categorized into six focus areas, outlined below:
  - Indicators 1-5 **Economic Impact**
  - Indicators 6-9 **Research**
  - Indicators 10 & 11 **Technology Development**
  - Indicators 12 & 13 **Business Development**
  - Indicators 14-16 **Capital**
  - Indicators 17-22 **Talent**

- Within each of these Indicators and Sub-Indicators, the Commonwealth of Massachusetts and the 14 other Leading Technology States are compared.

INDICATORS 1-5: ECONOMIC IMPACT

A key goal of the *Index* is to convey how innovation impacts the Commonwealth's economy. One way innovation contributes to economic prosperity in Massachusetts is through employment and wages in key industry clusters. Jobs created in the innovation economy typically pay high wages, which directly and indirectly sustain a high standard of living throughout the Commonwealth. Economic growth in key industry clusters hinges on the ability of individual firms to utilize innovative technologies and processes which improve productivity and support the creation and commercialization of innovative products and services. In addition, manufacturing exports are becoming an increasingly important driver of business, competitiveness, and overall economic growth. Success in the national and global marketplaces brings in revenue that enables businesses to survive, prosper, create, and sustain high-paying jobs.

INDUSTRY CLUSTER EMPLOYMENT AND WAGES

Annual Average Wage in Key Sectors

Massachusetts, 2009-2015
2015 $

Sector	2009 Average Wage	2015 Average Wage	2019-2015 % Change
Financial Services	$ 123,715	$ 147,121	18.9%
Biopharma & Medical Devices	$ 111,509	$ 143,793	29.0%
Scientific, Technical & Management Services	$ 102,631	$ 129,521	26.2%
Software & Communications Services	$ 110,850	$ 124,904	12.7%
Business Services	$ 98,345	$ 114,584	16.5%
Computer & Communications Hardware	$ 102,086	$ 111,660	9.4%
Defense Manufacturing & Instrumentation	$ 100,973	$ 109,601	8.5%
Diversified Industrial Manufacturing	$ 66,319	$ 75,869	14.4%
Advanced Materials	$ 64,457	$ 68,379	6.1%
Healthcare Delivery	$ 67,602	$ 68,113	0.8%
Postsecondary Education	$ 61,352	$ 64,671	5.4%

Why Is It Significant?

Technology and knowledge-intensive industry clusters provide some of the highest paying jobs in Massachusetts. Increased employment concentration in these clusters also indicates a competitive advantage for Massachusetts and potential for future economic growth as strength in these areas usually indicates innovation and business growth.

How Does Massachusetts Perform?

In most of the LTS the innovation economy experienced slower employment growth than the economy as a whole between Q1 2015 and Q1 2016. This is not entirely unexpected because the rebound from the recent recession significantly benefits the construction industry, a major non-innovation economy employer. Strong job growth in this sector is outweighing gains in the innovation economy in many places.

Among the LTS, Minnesota, Pennsylvania, Rhode Island, New Hampshire, and Texas were the only states where innovation economy growth exceeded that in the economy as a whole. Texas is unusual this year as it has seen several innovation economy sectors (Defense, Diversified Industrial Manufacturing, and Advanced Materials) in Q1 2016 contract substantially from Q1 2015 to Q1 2016, likely due to their connection to the oil and gas industry which has struggled lately. Since the oil & gas industry doesn't directly affect all innovation economy sectors, the innovation economy grew faster in Texas than the economy as a whole from Q1 2015 to Q1 2016. **In Massachusetts, innovation economy employment grew at a similar rate as the state employment figures as a whole (2.3%).** Biopharma & Medical Devices and Scientific, Technical & Management Services were the leading innovation sectors in terms of employment growth, expanding at 4.5% and 5.1% respectively.

Wage growth has been particularly strong in several Massachusetts innovation economy sectors since 2009, the end of the recession. These include BioPharmaceuticals & Medical Devices, Scientific Technical & Management Services, Financial Services, and Business Services. Counterintuitively, two of the four sectors with the largest wage growth since 2009 have seen stagnant or even declining employment figures over the same period (Diversified Industrial Mfg and Financial Services). The Commonwealth's fastest growing sector in terms of wage growth, BioPharmaceuticals & Medical Devices (29.0%) experienced mild employment growth relative to 2009 (7.0%). The Scientific, Technical & Management Services Sector saw an average wage increase of 26.2% since 2009, and maintained the fastest employment growth out of all innovation sectors since 2009 (22.0%). This sector is reflective of the strengths Massachusetts has in R&D outside of the biotech industry, as well as technical and managerial consulting. Healthcare Delivery and Postsecondary Education are sectors within the innovation economy that have each experienced employment growth of at least 10% since 2009 but both sectors have seen average wage growth lag behind relative to employment growth in the same period of time.

Data Source for Indicator 1: Bureau of Labor Statistics (BLS) Quarterly Census of Employment and Wages (QCEW)

INDUSTRY CLUSTER EMPLOYMENT AND WAGES

Employment Growth in Key Sectors

Massachusetts & LTS, Q1 2015-Q1 2016

	Advanced Materials	Biopharma & Medical Devices	Business Services	Computer & Communications Hardware	Defense Manufacturing & Instrumentation	Diversified Industrial Manufacturing	Finance	Healthcare Delivery	Postsecondary Education	Scientific, Technical & Management Services	Software & Communications Services	Innovation Economy	Total Jobs
CA	-0.5%	4.6%	0.1%	5.4%	-1.5%	-0.2%	2.2%	3.9%	-0.1%	0.8%	5.5%	2.3%	3.2%
CT	-0.7%	-12.3%	1.1%	-4.8%	-1.1%	-2.4%	0.4%	0.2%	-2.7%	6.8%	0.0%	-0.4%	0.5%
IL	0.3%	1.4%	1.1%	-1.8%	-3.7%	-2.9%	-0.3%	2.0%	-1.2%	7.1%	-0.3%	0.8%	1.4%
MA	-1.3%	4.5%	0.7%	3.5%	-0.5%	-0.9%	1.1%	3.3%	0.7%	5.1%	3.4%	2.3%	2.3%
MN	0.1%	3.9%	-0.5%	-2.2%	0.7%	2.5%	-0.8%	3.4%	3.2%	*27.3%	0.5%	2.6%	1.6%
MO	0.3%	2.2%	0.6%	1.9%	-3.3%	-1.1%	1.6%	1.4%	-1.2%	9.9%	1.4%	1.2%	1.7%
NH	4.5%	-0.9%	2.2%	0.8%	1.2%	-1.8%	3.3%	2.1%	4.0%	3.0%	2.0%	2.2%	2.0%
NJ	-0.5%	3.0%	1.5%	-1.7%	0.1%	-1.7%	0.7%	1.7%	2.0%	2.7%	0.3%	0.2%	1.8%
NY	-0.5%	0.6%	-0.3%	2.1%	-3.0%	-1.6%	0.7%	3.4%	1.1%	4.3%	2.2%	1.7%	1.9%
NC	0.7%	-0.5%	2.0%	-0.9%	0.9%	3.0%	3.0%	1.9%	5.2%	5.5%	4.4%	2.6%	2.7%
OH	-0.2%	-4.7%	-0.4%	-1.1%	-2.1%	-3.8%	-1.3%	2.5%	0.6%	5.8%	2.1%	0.6%	1.7%
PA	0.2%	3.8%	1.9%	-1.4%	-5.0%	-3.1%	-0.1%	1.6%	0.6%	8.6%	1.0%	1.3%	0.8%
RI	-2.2%	-4.5%	6.4%	-1.0%	18.7%	7.2%	8.7%	0.2%	0.5%	1.3%	0.1%	2.7%	1.6%
TX	-1.1%	3.2%	-1.1%	-0.9%	-8.3%	-6.3%	2.0%	3.2%	3.5%	8.1%	2.2%	1.7%	0.9%
WI	1.2%	3.3%	6.2%	2.8%	-1.5%	-1.3%	1.3%	-1.7%	-1.6%	5.0%	4.6%	0.9%	1.5%

*Due in part to a reclassification of one or more businesses within the NAICS System

Employment by Industry Sector

Massachusetts, 2009-2015

Sector	2015 Employment Total	% Change in Employment 2009-2015
Healthcare Delivery	375,208	13%
Financial Services	157,890	-3%
Software & Communications Services	155,024	19%
Business Services	150,099	1%
Postsecondary Education	155,867	13%
Scientific, Technical & Management Services	83,373	22%
Biopharma & Medical Devices	69,728	7%
Diversified Industrial Manufacturing	38,266	-7%
Defense Manufacturing & Instrumentation	36,926	-3%
Computer & Communications Hardware	35,478	-11%
Advanced Materials	28,899	-8%

Data Source for Indicator 1: Bureau of Labor Statistics (BLS) Quarterly Census of Employment and Wages (QCEW)

OCCUPATIONS AND WAGES

Why Is It Significant?

As a general rule, the innovation economy supports jobs with above average wages, thereby contributing to a higher standard of living in the Commonwealth. Changes in occupational employment and wages suggest shifts in job content and skill utilization. Generally, professional and technical employment has tripled as a percentage of the workforce in the last century, so anything but continued employment growth would indicate a shift away from the norm. An important difference between this indicator and the previous one is that Employment and Wages tracks total employment in an industry for all job types found within in it, while Occupations and Wages tracks employment by job type across all industries.

How Does Massachusetts Perform?

Massachusetts has higher wages than the U.S. and LTS averages in 10 of 11 occupational categories tracked by the *Index*. The gap between Massachusetts and the LTS and U.S. is even bigger in terms of overall wages than within any occupational category, at 19.0% higher than the LTS and 22.0% higher than the U.S., indicating that Massachusetts has a larger percentage of its employment in high paying occupational categories. However, in real terms, wage recovery among occupational groups in Massachusetts has been disappointing since the recession, as Construction & Maintenance and Healthcare were the only occupation groups that experienced an increase in real wages (1% and 2% respectively). Below we highlight certain key occupational categories.

- Business, Financial & Legal Services, Arts & Media, and Construction & Maintenance were the only occupational categories in Massachusetts during 2015 to have recovered to 2009 levels in terms of real average wage.
- The Computers & Math and Business, Financial & Legal occupational categories had significantly higher wages than the LTS and the U.S. for these occupations. Computers & Math occupations in Massachusetts paid 12% more in average wages to workers in those occupations compared to competing LTS states.
- Healthcare occupations continued their positive wage growth and remain higher than the LTS and U.S., but employment was stagnant (down 590 out of 340,000), possibly due to growing pressures to control healthcare costs, which are now affecting even the state's most prestigious institutions.
- Science & Engineering experienced positive employment growth in Massachusetts in 2015, but employment and wages for Science & Engineering occupations have still not returned to 2009 levels. A decline in Science & Engineering occupations, as well as their pay, could be reflective of many long term trends. People with STEM degrees may now have career opportunities that appeal to them more in non-Science & Engineering occupations. In addition, layoffs and restructurings at major employers of S&E talent over the last few years would subtract from the numbers, while new jobs created in the innovation economy might not fall under the traditional S&E classification, some having shifted under the Computers & Math classification which has experienced employment gains (+12,000).
- Social Services continued to pay below average wages in 2015 relative to the LTS and U.S. ($45,610 v $46,985 -LTS v $46,160 -U.S.).

Data Source for Indicator 2: BLS Occupational Employment Statistics, Consumer Price Index (CPI)

OCCUPATIONS AND WAGES

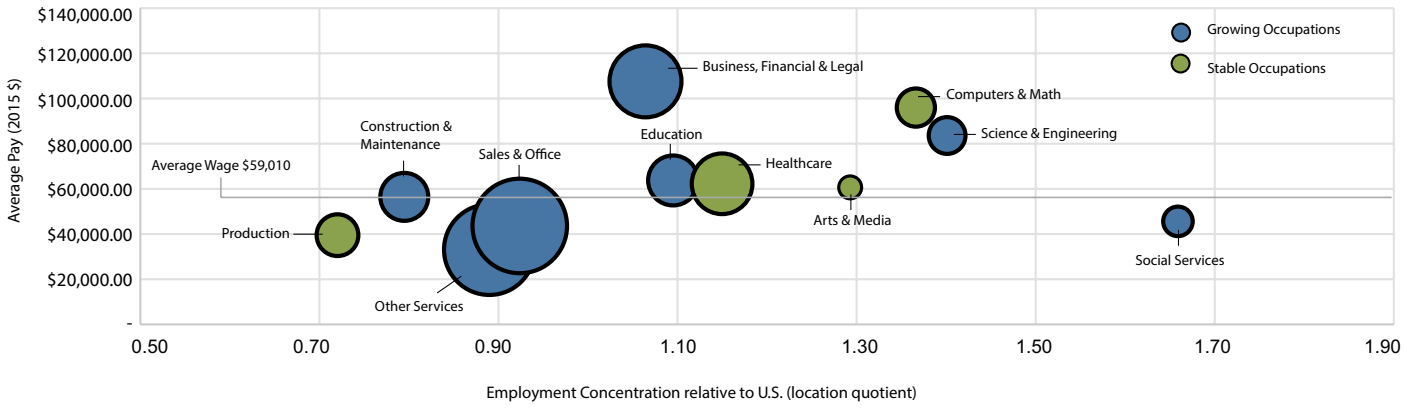
Average Wages by Occupation

Massachusetts, LTS, & U.S., 2015

Occupation	Average Wage		
	Massachusetts	LTS	U.S.
Arts & Media	$ 60,650	$ 54,442	$ 56,980
Business, Financial, Legal	$ 107,584	$ 96,483	$ 94,919
Computers & Math	$ 95,980	$ 84,195	$ 86,170
Construction & Maintenance	$ 56,455	$ 49,073	$ 46,793
Education	$ 63,720	$ 54,664	$ 53,000
Healthcare	$ 72,798	$ 62,630	$ 61,763
Other Services	$ 33,095	$ 29,632	$ 29,278
Production	$ 39,500	$ 36,904	$ 36,220
Sales & Office	$ 43,583	$ 38,769	$ 37,521
Science & Engineering	$ 83,615	$ 77,635	$ 79,258
Social Services	$ 45,610	$ 46,985	$ 46,160
All Occupations Categories	$ 59,010	$ 49,451	$ 48,320

Occupations by Employment Concentration and Annual Pay

Massachusetts, 2015



Data Source for Indicator 2: BLS Occupational Employment Statistics, Consumer Price Index (CPI)

HOUSEHOLD INCOME

Household Income

% Change from Previous Year, 2011-2015
Massachusetts, LTS, & U.S.

Year	MA	LTS Average	U.S.
2011	-1.83%	-1.44%	-1.25%
2012	1.84%	0.12%	0.00%
2013	0.71%	0.41%	0.83%
2014	1.93%	0.64%	0.75%
2015	2.00%	3.71%	2.86%

Percentage of Households by Income Level

Massachusetts, LTS, & U.S., 2015

Household Income	MA	LTS Average	U.S.
Under $35,000	26.5%	30.1%	31.9%
$35,000-$99,999	38.0%	43.0%	43.2.%
Above $100,000	35.5%	26.9%	24.9%

Why Is It Significant?

Median household income tracks changes in the general economic condition of middle-income households and is a good indicator of prosperity. Rising household incomes enable increased purchasing power and higher living standards. The distribution of income also provides an indication of which Massachusetts economic groups are benefiting.

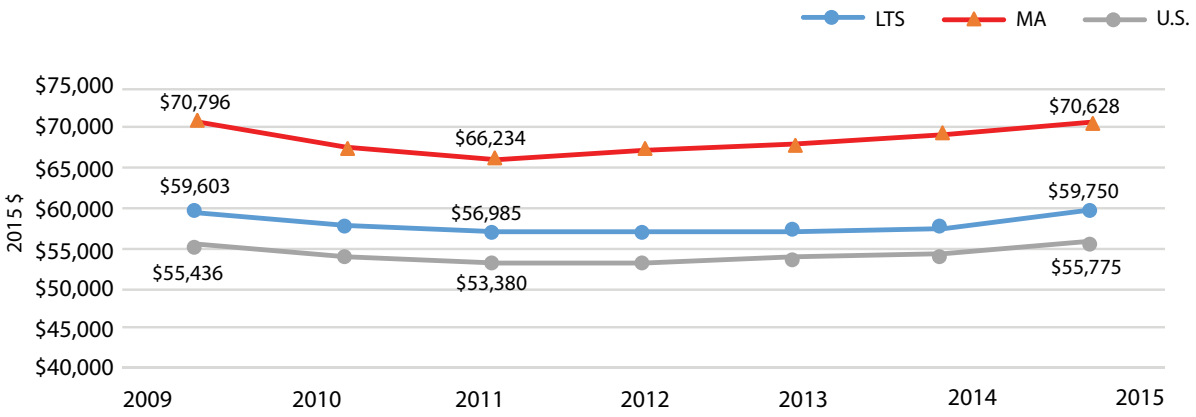
How Does Massachusetts Perform?

Massachusetts had a higher household income than both the average LTS and the U.S. as a whole in 2015. After experiencing a sharp decline in 2011, Massachusetts has seen a faster recovery in household income than the LTS or U.S., recording 6.6% household income growth since 2011, while the LTS grew by only 4.8%, and the U.S. by 4.4%. However, after adjusting for inflation, median household income is still lower in Massachusetts than it was in 2009 prior to the Great Recession in which Massachusetts suffered larger declines in absolute and percent terms than either the U.S. or LTS. During the same time frame the U.S. and LTS have rebounded into slightly positive growth, but the gap between Massachusetts, the LTS, and U.S. has stayed largely the same.

Massachusetts has proportionally many more households with incomes above $100,000 than both the LTS and U.S. This could partly explain why incomes have recovered at a faster rate in Massachusetts than elsewhere, since over the last several decades higher income households have seen larger gains in household income than the population as a whole. This is largely due to increasing returns on college education, and Massachusetts, having a high relative proportion of degree holders. As such, the state should see larger income gains than would be experienced elsewhere. Over the past year, the LTS and U.S. have both seen much greater household income growth relative to recent years, which could be the result of them finally experiencing the catch-up growth that Massachusetts has had over the last several years.

Median Household Income

MA, LTS, & U.S., 2009-2015



Data Source for Indicator 3: U.S. Census Bureau, Bureau of Economic Analysis (BEA)

OUTPUT

Output in Key Sectors

Massachusetts, 2009 & 2015

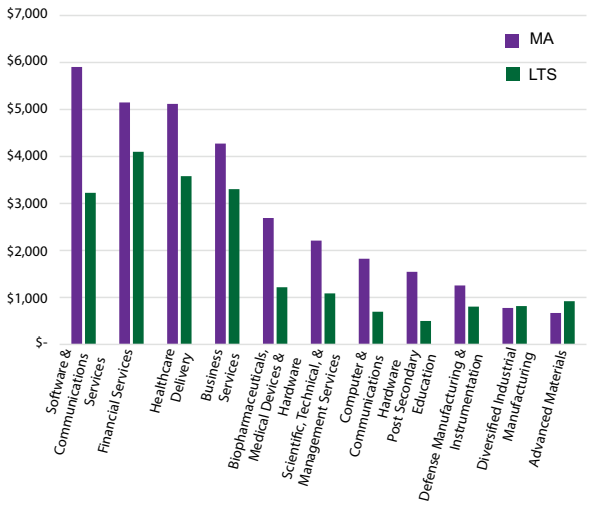
Output Growth in Key Sectors

Massachusetts, 2009-2015

Sector (In Order of Absolute Growth)	% Growth	Absolute Growth Millions $
Software & Communication Services	36.0%	$ 10,619
Healthcare Delivery	13.7%	$ 4,179
Computer & Communications Hardware	36.3%	$ 3,297
Business Services	12.6%	$ 3,258
Scientific, Technical & Management Services	27.3%	$ 3,218
Biopharmaceuticals, Medical Devices & Hardware	15.0%	$ 2,379
Defense Manufacturing & Instrumentation	23.5%	$ 1,621
Financial Services	1.5%	$ 511
Postsecondary Education	3.6%	$ 363
Diversified Industrial Manufacturing	-2.8%	$ (150)
Advanced Materials	-12.4%	$ (646)

Output per Capita in Key Industry Sectors

Massachusetts & LTS, 2015



Data Source for Indicator 4: U.S. Census Bureau, Moody's, QCEW

Why Is It Significant?

Industry Output is an important measure of the value of the goods and services produced by each sector of the innovation economy. Output per employed worker is a measure of labor productivity, which is a key driver of wage growth within an economy. It can also be viewed as an indicator of business cycles and used as a tool for GDP and economic performance forecasts.

How Does Massachusetts Perform?

Between 2009 and 2015 output increased in all of the Commonwealth's key sectors with the exception of Advanced Materials and Diversified Industrial Manufacturing. Computer & Communications Hardware and Software & Communications Services were the fastest growing sectors between 2009-2015, both growing output by 36.0%. In absolute terms, Software & Communications Services is a clear driver of growth in the economy as its output increased by $10.6 billion, becoming the largest of the key sectors in Massachusetts.

In per capita output, Massachusetts outperforms the LTS average in all key sectors except for Advanced Materials and Diversified Industrial Manufacturing. These are the Commonwealth's smallest sectors in terms of output and together make up only 5.0% of innovation economy employment. With the introduction of five new LTS, LTS output per capita within the innovation economy increased in the Advanced Materials industry as well as the Biopharmaceuticals, Medical Devices & Hardware industry. The increase in output per capita in Advanced Materials is attributed to the introduction of Texas ($1,598), Wisconsin ($1,306) and North Carolina ($1,242). In the Biopharmaceuticals, Medical Devices & Hardware industry, New Jersey ($2,228) and North Carolina ($2,092) have the highest output per capita in the LTS. Massachusetts has a per capita output double the LTS in Computer & Communications Hardware and in Biopharmaceuticals & Medical Devices. Massachusetts has a per capita output triple that of the LTS in Postsecondary Education.

Massachusetts' position as a leader in Biopharmaceuticals & Medical Devices has been further strengthened by the relocation of the headquarters or major R&D facilities of several pharmaceutical companies to the Boston area. There are now almost 1,900 establishments in the Biopharmaceuticals and Medical Devices industry in Massachusetts.

Despite lackluster output growth since the recession as well as stagnant wage growth, Postsecondary Education remains one of the Commonwealth's strongest sectors relative to the LTS, with output almost twice that of the LTS average. A slowdown in enrollment growth after the 2009 recession due to increasing tuition prices and smaller levels of funding available nationwide have led states to make increasing efforts to lower cost of attendance, which could result in stagnating output growth as students choose lower-cost programs and schools find ways to economize. Massachusetts has attempted to increase its state funding for higher education, but has not returned to 2008 levels of spending. For more information on public investment in higher education, see Indicator 18 on page 56.

EXPORTS

Why Is It Significant?

Nearly all of Massachusetts' top 25 exported products are produced within the Innovation Economy. Manufacturing exports are an indicator of global competitiveness. Selling into global markets can bolster growth in sales and employment. In addition, diversity in export markets and products can offset domestic economic downturns. Manufacturing represents approximately ten percent of all private sector jobs in the state and approximately 20 percent of manufacturing jobs in Massachusetts are tied to exports. 111,000 jobs are supported by manufacturing exports in Massachusetts; 6.2 million jobs are tied to manufacturing exports nationwide.

How Does Massachusetts Perform?

Massachusetts has seen some variability in the destination of its exports between 2011-2015, with destinations that have historically been important trade partners such as the United Kingdom and Canada purchasing fewer goods from Massachusetts businesses. The UK in 2014 was the second ranked export destination for Massachusetts but in 2015 fell to seventh, a 49.8% drop in value. Exports to Canada, Massachusetts' number one trading partner over the period, were down in 2015, falling by 16.7%. Exports to Mexico (#2) and Switzerland (#8) have grown tremendously during the period 2011-2015, following large export growth in 2015. China (#3), the Netherlands (#6) and South Korea (#9) have experienced fairly consistent growth. **Massachusetts, Connecticut, and New Jersey were the only states among the LTS where exports as a percentage of GDP are still below 2009 levels.** Massachusetts has declined from 4th among the LTS in exports as a percentage of GDP in 2009 to 13th in 2015.

U.S. exports fell in 2015 for the first time since 2009, declining 7.5% or $123 billion in total goods trade balance from 2014-2015. National trends in declining export values have affected Massachusetts as well. After two years of export growth following the Great Recession, Massachusetts' exports fell by nearly $3 billion in 2012, to $26.3 billion. From 2012-2014, Massachusetts exports experienced growth equivalent to $1.02 billion, but in 2015 export value decreased 7.6% or $2.08 billion to $25.28 billion. Overall Massachusetts export value in 2015 was lower than it was in 2009 in real terms.

Massachusetts' top five export commodities in 2015 consisted of surgical or medical instruments, and machinery or mechanical appliances, which made up 18.6% of the state's total exports. These export commodities did not experience a drop off in exports from 2014-2015, the bulk of the export value lost came from electro-diagnostic apparatuses, medical substances used for therapy, and digital processing units. These export commodities together generated a decline of $288 million. Medical substances experienced the steepest decline relative to 2012 value, $359 million. Meanwhile, the state's economy as a whole grew by 16.0% in real terms.

The slowdown in global economic growth as well as increased purchasing power of the dollar continue to hinder state exports as it becomes more expensive for goods to be purchased by international trading partners. The major currencies of the Commonwealth's have lost purchasing power against the dollar (Euro, Canadian dollar, Chinese yuan, Japanese yen, and Mexican peso). The strengthening of the dollar may be a factor in Massachusetts' decreased export value.

Massachusetts Exports:
Top Ten Destinations and Value
($ Millions), 2011-2015

2015 Rank	Country	2011 $	2015 $	%Change 2011-2015
1	Canada	$ 3,796	$ 3,162	-16.7%
2	Mexico	$ 1,437	$ 2,623	82.5%
3	China	$ 2,088	$ 2,053	-1.7%
4	Germany	$ 2,046	$ 1,911	-6.6%
5	Japan	$ 2,044	$ 1,476	-27.8%
6	Netherlands	$ 1,107	$ 1,399	26.4%
7	United Kingdom	$ 3,285	$ 1,179	-64.1%
8	Switzerland	$ 563	$ 1,025	82.1%
9	South Korea	$ 1,030	$ 1,005	-2.4%
10	Hong Kong	$ 751	$ 928	23.6%

Data Source for Indicator 5: U.S. Census Bureau Foreign Trade Division, Staying Power II Report, xe.com

EXPORTS

Exports as Percentage (%) of GDP
Massachusetts & LTS, 2009 & 2015

State	2009	2015
Texas	14.1%	15.1%
Ohio	7.2%	8.5%
Illinois	6.6%	8.2%
Wisconsin	6.8%	7.5%
California	6.3%	6.8%
Minnesota	5.9%	6.0%
North Carolina	5.4%	5.9%
Connecticut	6.2%	5.8%
Pennsylvania	5.1%	5.8%
New York	5.3%	5.7%
New Hampshire	5.1%	5.6%
New Jersey	5.7%	5.5%
Massachusetts	6.4%	5.3%
Missouri	4.0%	4.7%
Rhode Island	3.2%	3.8%

Total Value of Exports
Massachusetts, 2009-2015

Unadjusted							
Year	2009	2010	2011	2012	2013	2014	2015
Exports (Billions $)	$23.57	$26.25	$27.71	$25.54	$26.79	$27.36	$25.28

Change in Exchange Rate
USD$/Currency of Trading Partners
2011-2015

	% Change 2014-2015	% Change 2011-2015
$/£(GDP)	7.73%	4.97%
$/€(EURO)	19.63%	25.45%
$/$ (CAD)	15.64%	29.19%
$/¥(CNY)	1.37%	-3.62%
$/₳ (JPY)	14.25%	51.67%
$/$ (MXN)	19.23%	27.57%

Data Source for Indicator 5: U.S. Census Bureau Foreign Trade Division, Staying Power II Report, xe.com

WINDOW ON MASSACHUSETTS INNOVATION

The Massachusetts Green High Performance Computing Center (MGHPCC), Holyoke, Mass. *Photo courtesy of MGHPCC.*

INDICATORS 6-9: RESEARCH

The *Index* defines innovation as the capacity to continuously translate ideas into novel products, processes and services that create, improve, or expand business opportunities. The massive and diversified research enterprise concentrated in Massachusetts' universities, teaching hospitals, and government and industry laboratories is a major source of new ideas that fuel the innovation process. Research activity occurs on a spectrum that ranges from curiosity-driven fundamental science, whose application often becomes evident once the research has started, to application-inspired research, which starts with better defined problems or commercial goals in mind. Academic publications and patenting activity reflect both the intensity of new knowledge creation and the capacity of the Massachusetts economy to make these ideas available for dissemination and commercialization.

RESEARCH AND DEVELOPMENT

R&D Spending as Percent of GDP

Massachusetts & LTS, 2011, 2012, 2013 & 2014

	2011	2012	2013	2014
Massachusetts	5.67%	5.59%	5.47%	5.86%
California	4.79%	4.59%	4.73%	4.67%
Connecticut	3.88%	3.57%	3.70%	3.95%
New Hampshire	3.90%	3.55%	3.53%	3.34%
Missouri	NA	3.06%	3.02%	2.71%
New Jersey	3.18%	3.33%	2.95%	2.71%
Minnesota	2.64%	2.47%	2.55%	2.47%
Rhode Island	2.82%	2.50%	2.49%	2.27%
North Carolina	2.15%	2.07%	2.42%	2.27%
Pennsylvania	2.35%	2.10%	2.30%	2.16%
Illinois	2.38%	2.38%	2.34%	2.06%
Ohio	2.11%	1.99%	1.98%	1.97%
Wisconsin	2.21%	2.09%	2.01%	1.89%
New York	1.59%	1.42%	1.39%	1.44%
Texas	1.56%	1.41%	1.39%	1.42%

Total R&D Expenditures

Millions of 2015 $

	2011	2012	2013	2014	% Change 2011-2014
California	$ 96,329	$ 100,684	$ 106,500	$ 114,981	7.96%
Massachusetts	$ 23,204	$ 24,909	$ 24,549	$ 27,978	13.97%
Texas	$ 21,730	$ 21,341	$ 22,068	$ 22,493	1.92%
New York	$ 19,563	$ 18,839	$ 18,944	$ 20,844	10.03%
Illinois	$ 16,832	$ 17,277	$ 17,227	$ 15,983	-7.22%
New Jersey	$ 16,548	$ 18,200	$ 16,154	$ 15,388	-4.74%
Pennsylvania	$ 14,384	$ 13,637	$ 15,000	$ 14,916	-0.56%
Ohio	$ 10,915	$ 11,281	$ 11,358	$ 12,019	5.82%
North Carolina	$ 9,858	$ 9,685	$ 11,515	$ 11,356	-1.38%
Connecticut	$ 9,205	$ 8,962	$ 9,283	$ 10,231	10.21%
Minnesota	$ 7,791	$ 7,620	$ 7,982	$ 8,254	3.42%
Missouri	NA	$ 8,501	$ 8,511	$ 7,966	-6.40%
Wisconsin	$ 5,906	$ 5,882	$ 5,817	$ 5,796	-0.36%
New Hampshire	$ 2,604	$ 2,421	$ 2,468	$ 2,427	-1.68%
Rhode Island	$ 1,471	$ 1,333	$ 1,352	$ 1,299	-3.88%

Why Is It Significant?

R&D performed in Massachusetts is an indicator of the size and health of the science and technology enterprise. Although not all new ideas or products emerge from defined R&D efforts, R&D data provides a basis for estimating a region's general capacity for knowledge creation. The distribution of R&D expenditures by type of performer illustrates the relationship states have with the different types of R&D performers and how a differentiated list of performers help produce an innovative and diverse ecosystem.

How Does Massachusetts Perform?

R&D as a percentage of GDP in Massachusetts experienced an increase of .39 percentage points in 2014, the largest in the LTS, as Massachusetts continued to be the top state in the LTS in terms of R&D as a percentage of GDP. This is in opposition to a downward trend that was experienced from 2011- 2013. The increase in R&D expenditures as a share of GDP from 2013-2014 was rare among the LTS in 2014 as only three other states experienced a year-over-year percentage point increase (average of .11). While Massachusetts is the leader in R&D as a percentage of GDP, California still maintains a significant lead in total R&D funding ($114.98 billion in 2014). **Massachusetts had the second highest overall level of R&D funding in the country in 2014 at $27.98 billion**, slightly ahead of Texas ($22.49 billion).

The majority of R&D in 2014 was performed by private industry throughout the LTS. In 2014, 76.0% of R&D expenditure in Massachusetts were performed by private industry; placing Massachusetts eighth in the LTS and outperforming the U.S. average of just over 71.3%.

Massachusetts ranks fourth among the LTS in terms of R&D performed by universities, colleges, and non-profits with $3.5 billion, an 18.70% increase in R&D expenditures from Universities and Non-Profits from 2011-2014. Massachusetts also has the second highest percentage of R&D performed at Federally Funded Research and Development Centers (5%) in the LTS, which is unusual as most states that perform well in this category are home to one or more National Labs, while Massachusetts has none.

Data Source for Indicator 6: National Science Foundation (NSF), BEA, CPI

RESEARCH AND DEVELOPMENT

R&D Expenditures from Non-Profits & Academia

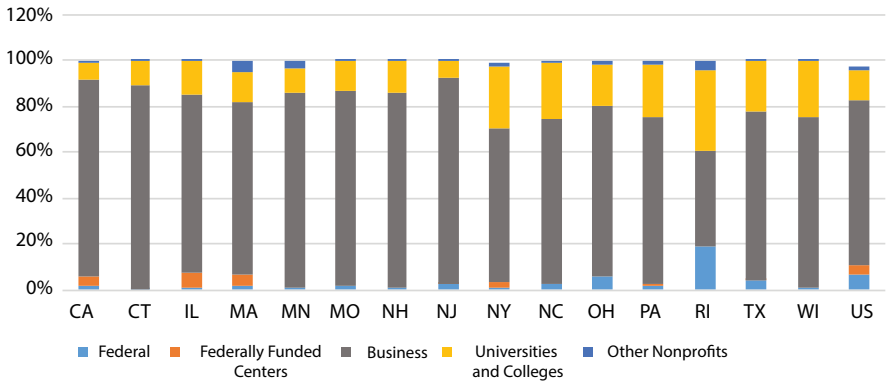
Massachusetts & LTS, 2011, 2012, 2013 & 2014

Millions $

	2011	2012	2013	2014	% change 2011-2014
California	$ 9,703	$ 9,650	$ 9,353	$ 9,279	-4%
New York	$ 5,953	$ 5,899	$ 5,929	$ 5,982	0%
Texas	$ 5,085	$ 5,016	$ 5,066	$ 5,060	0%
Massachusetts	$ 4,727	$ 4,954	$ 5,095	$ 5,004	6%
Pennsylvania	$ 3,792	$ 3,650	$ 3,688	$ 3,663	-3%
North Carolina	$ 2,905	$ 2,878	$ 2,985	$ 2,931	1%
Illinois	$ 2,574	$ 2,529	$ 2,638	$ 2,412	-6%
Ohio	$ 2,532	$ 2,421	$ 2,415	$ 2,357	-7%
Wisconsin	$ 1,541	$ 1,548	$ 1,459	$ 1,431	-7%
New Jersey	$ 1,221	$ 1,170	$ 1,216	$ 1,145	-6%
Connecticut	$ 1,021	$ 1,000	$ 1,103	$ 1,088	7%
Missouri	$ 1,212	$ 1,162	$ 1,115	$ 1,078	-11%
Minnesota	$ 1,178	$ 1,143	$ 1,160	$ 1,194	1%
Rhode Island	$ 558	$ 586	$ 559	$ 507	-9%
New Hampshire	$ 381	$ 434	$ 363	$ 346	-9%

Distribution of R&D by Performer

Massachusetts, LTS, & U.S., 2014



R&D Expenditures

Massachusetts, 2013 & 2014

2015 $

Performing Sector	Source of Funding	Expenditures 2013	Expenditures 2014
Federal	Federal	$ 394,762,106	$ 588,697,942
Federally Funded R&D Centers	Federal	$ 1,357,350,840	$ 1,271,507,460
	Non-Federal	$ 3,052,284	$ 3,003,561
Business	Own Funds	$ 14,243,993,527	$ 17,121,298,480
	Federal	$ 955,364,994	$ 900,067,092
	Non-Federal	$ 2,499,820,864	$ 3,109,686,748
Universities & Colleges	Federal	$ 2,217,993,278	$ 2,160,561,495
	Other Government	$ 25,435,703	$ 33,039,170
	Business	$ 219,764,472	$ 237,281,313
	Universities & Colleges	$ 691,851,114	$ 620,735,925
Non-Profit Institutions	Federal	$ 1,500,706,461	$ 1,499,778,090
	Total	$ 24,548,505,415	$ 27,978,170,050

Data Source for Indicator 6: National Science Foundation (NSF), BEA, CPI

ACADEMIC ARTICLE OUTPUT

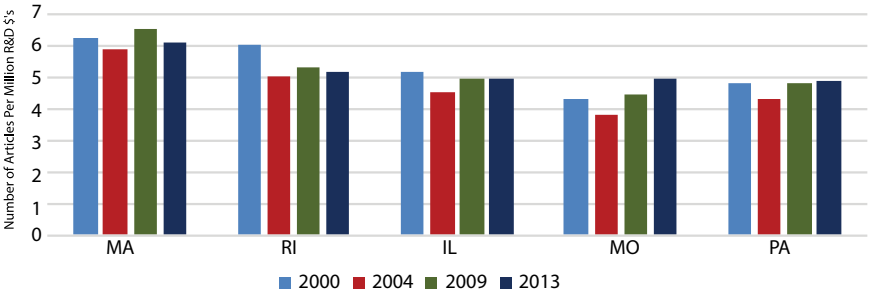
Science and Engineering (S&E) Academic Article Output

per Million Residents
Massachusetts & International, 2013

	S&E Article Output per Million Residents
Massachusetts	2,998
Switzerland	2,603
Denmark	2,223
Australia	2,068
Sweden	2,017
Singapore	1,974
Norway	1,940
Finland	1,867
Netherlands	1,810
Canada	1,644
New Zealand	1,631

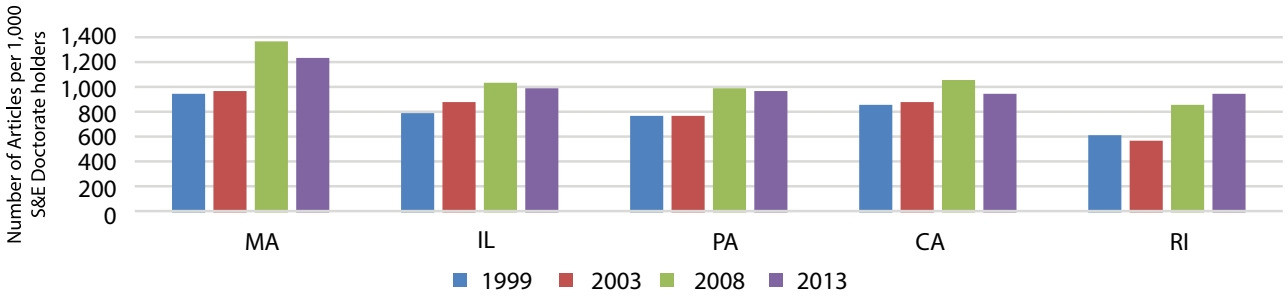
Science and Engineering (S&E) Academic Article Output

per Million Academics R&D $
Massachusetts & LTS, 2000, 2004, 2009, 2013



Science and Engineering (S&E) Academic Article Output

per 1,000 S&E Doctorate Holders
Massachusetts & LTS, 1999, 2003, 2008, 2013



Why Is It Significant?

In contrast to R&D expenditures, which are inputs to research, academic article publication is a measure of research output and can be viewed as a leading indicator of patents and business development. In addition, the ratio of articles produced per dollar spent on research and articles produced per researcher measures the productivity of research activity.

How Does Massachusetts Perform?

Massachusetts maintained a high rate of science and engineering academic article output relative to its population in 2013, the most recent year for which data are available. **In 2013, S&E academic article output climbed to 2,998 academic articles per million residents, three times the U.S. average (975).** Massachusetts also stands out internationally. In 2013, Massachusetts ranked first, outperforming second-place Switzerland by roughly 390 articles per million residents.

Massachusetts also performs well in terms of academic productivity. It continues to lead the LTS in article output per million dollars of academic R&D funding. In 2004, 2009, and 2013, Massachusetts produced more S&E Academic Articles per R&D dollar than all of the other LTS and the nation overall. In 2013, the state reported 6.0 articles per million academic R&D dollars spent. Massachusetts is also the leader in a second measure of research productivity, articles per 1,000 S&E Doctorate Holders. The median measure of the rest of the LTS (884) is 28.8% lower than Massachusetts' 1,452 figure, followed by Illinois which ranked second at 989.

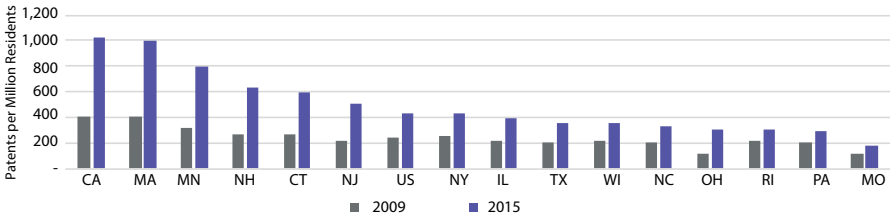
Articles per researcher and articles per research dollar increased from 2012-2013 in both the U.S. and Massachusetts due to fairly stable academic spending on a national level. National academic funding was $63.4 billion in 2013, with Massachusetts receiving 5.0% of that spending. Although Massachusetts' population is only 2.1% of the U.S., Massachusetts' Life Sciences and Engineering sectors dominated the share of total U.S. academic R&D spending, together accounting for 21% of that funding.

Data Source for Indicator 7: NSF, CPI

PATENTS

Patents per Million Residents

Massachusetts, LTS & U.S., 2009 & 2015



Percent Change in Utility Patents

Massachusetts, LTS & U.S., 2009-2015

State	Percent Change
California	94.7%
Massachusetts	83.4%
Illinois	73.5%
United States	71.1%
Texas	67.4%
Minnesota	67.4%
North Carolina	66.7%
New Jersey	62.1%
New York	61.6%
New Hampshire	56.8%
Ohio	53.4%
Missouri	52.8%
Connecticut	52.4%
Pennsylvania	44.0%
Rhode Island	40.3%
Wisconsin	39.0%

Why Is It Significant?

Patents are the leading form of legal codification and ownership of innovative thinking and its application. A patent award is particularly important for R&D-intensive industries when the success of a company depends on its ability to develop, commercialize, and protect products resulting from investments in R&D. High levels of patenting activity indicate an active R&D enterprise combined with the capacity to codify and translate research into ideas with commercial potential. U.S. Patent and Trademark Office (USPTO) patents represent one-fifth of global patents.

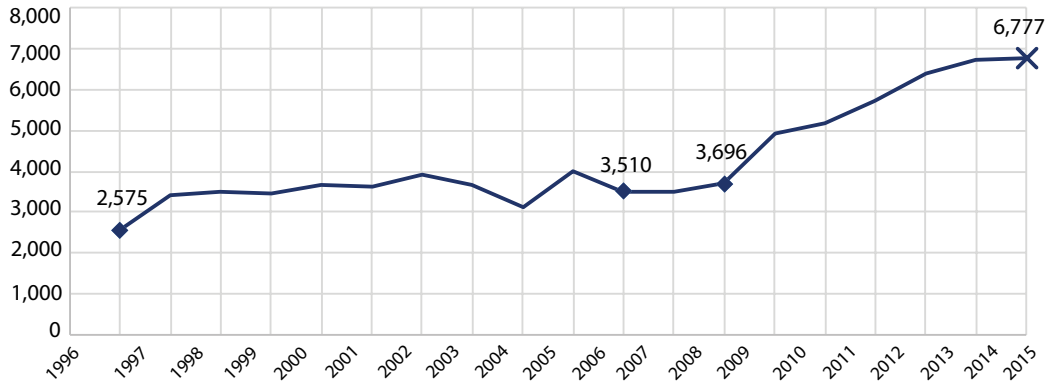
How Does Massachusetts Perform?

In 2015, Massachusetts again saw record numbers of patents granted, reaching a total of 6,777. Its share of U.S. patents was 4.8%, evidence that Massachusetts is a dominant state for translating research into protected products meant for commercialization. Massachusetts' growth rate in patents granted per million residents from 2009-2015 was 83.4%, placing it second among the LTS after California at 94.7%. All of the LTS experienced strong growth in patent activity with each state registering at least a 40% increase in per capita terms relative to 2009. Massachusetts ranks fourth among the LTS in total numbers of patents granted, behind California, Texas and New York; second only to California in patents granted per capita.

The U.S. patent approval rate was 55.9% in 2000, dropped to 37.8% in 2005, and rebounded to 51.7% in 2015. If combined with an increase in applications, this could help explain the surge in patents over the last few years.

Utility Patents Issued

Massachusetts, 1997-2015



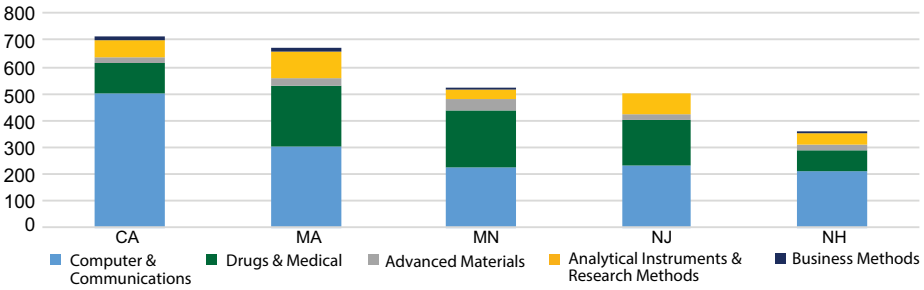
Data Source for Indicator 8: U.S. Patent and Trademark Office (USPTO), Census Bureau, World Intellectual Property Organization, U.S. Department of Commerce, World Bank

TECHNOLOGY PATENTS

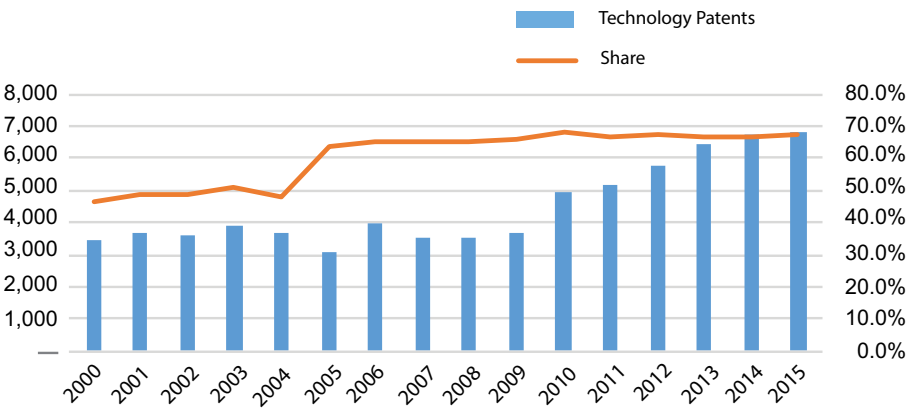
Technology Patents by Category
Massachusetts, 2015

Category	Percent of Patents	# of Patents
Computer & Communications	45.3%	2,056
Drugs & Medical	33.9%	1,540
Analytical Instruments & Research Methods	15.0%	681
Advanced Materials	4.4%	201
Business Methods	1.4%	64

Technology Patents
per Million Residents by Field
Massachusetts & Top 5 LTS, 2015



Technology Patents and Share of Total Patents
Massachusetts, 2000-2015



Data Source for Indicator 9: USPTO, Census Bureau

Why Is It Significant?

The amount of patenting per capita by technology category indicates those fields in which Massachusetts' inventors are most active and suggests comparative strengths in knowledge creation, which is a vital source of innovation and business creation. The patent categories in this comparison are selected and grouped on the basis of their connection to key industries of the Massachusetts innovation economy.

How Does Massachusetts Perform?

Massachusetts is the per-capita leader in two of the five technology patent categories tracked by the Index and places second among the LTS in the other three. The combination of Computer & Communications patents and Drugs & Medical patents accounted for 79.2% of all Massachusetts technology patents in 2015, with 303 and 227 patents per million residents respectively. California maintained its lead in Computer & Communication Patents (500 per million residents) and **Massachusetts overtook Minnesota (212 per million residents) to lead the LTS in Drugs and Medical patents.**

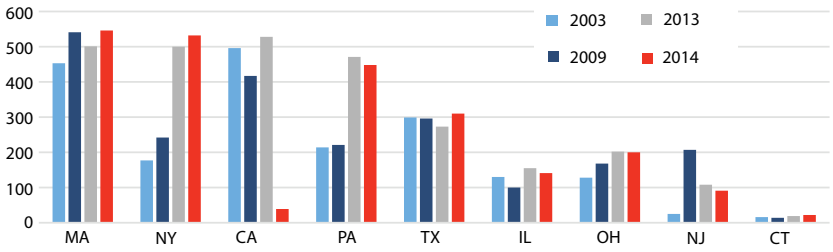
Massachusetts ranked first in Analytical Instrument & Research Method patents for the sixth year in a row with 100 per million residents, approximately 50% more than California, the next highest state. California and Massachusetts are home to some of the world's most prolific research universities, and institutions which helps explain their strong performance on this metric relative to the other LTS. Massachusetts' Business Method patents continued to fall in 2015, yet still ranked second among the LTS, trailing only California, where these patents also fell. Business Methods patents relate to new methods of doing business, for example, new forms of e-commerce such as Amazon's "1 click shopping". Business Methods have been decreasing since a 2014 Supreme Court case (Alice Corp. v. CLS Bank International) which held that patent protection is ineligible for abstract ideas, such as e-commerce methods, via computer software. Massachusetts' Advanced Materials patents increased from 26 to 30 per million residents and the Commonwealth ranked second in this category. Technology patents have continued to increase since 2007, and their share of total Massachusetts patents since 2005 is 62.9%.

INDICATORS 10-11: TECHNOLOGY DEVELOPMENT

In close interaction with research activities, but with a specific application as a goal, product development begins with research outcomes and translates them into models, prototypes, tests, and artifacts that help evaluate and refine the plausibility, feasibility, performance, and market potential of a research outcome. One way in which universities, hospitals, and other research institutions make new ideas available for commercialization by businesses and entrepreneurs is through technology licensing. Small Business Innovation Research (SBIR) and Technology Transfer (STTR) grants enable small companies to test, evaluate, and refine new technologies and products. In the medical device and biopharma industries, both significant contributors to the Massachusetts innovation economy, regulatory approval of new products is an important milestone in the product development process.

TECHNOLOGY LICENSING

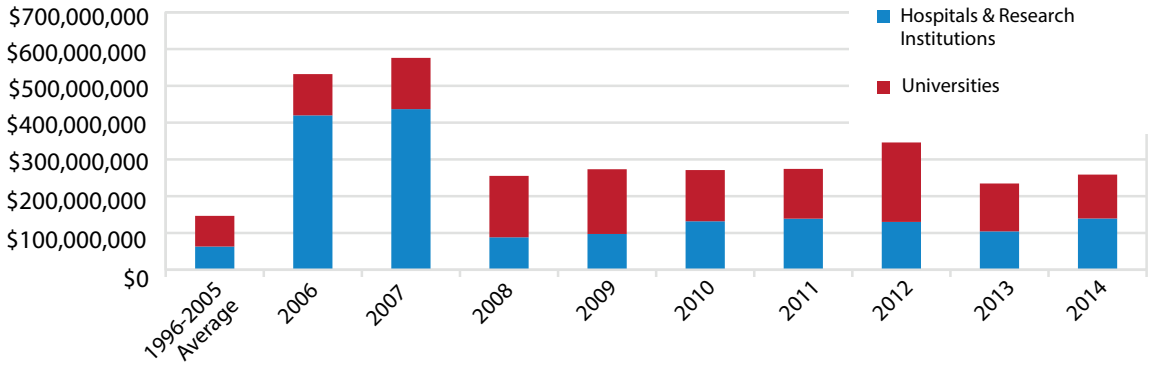
Technology Licenses and Options Executed
Massachusetts & LTS, 2003, 2009, 2013, 2014



Technology Licenses and Options Executed
Research Institutions, Hospitals & Universities
Massachusetts, 2003, 2009, 2013, 2014

	2003	2009	2013	2014
Research Institutions & Hospitals	186	303	264	292
Universities	267	238	237	254

Revenues from Technology Licenses and Options Executed
Universities, Hospitals & Non-profit Research Institutions
Massachusetts, 2006-2014 (2014 $)



Why Is It Significant?

Technology licenses provide a vehicle for the transfer of codified knowledge in the form of intellectual property (IP) from universities, hospitals, and non-profit research organizations to companies and entrepreneurs seeking to commercialize the technology. License royalties are evidence of the value of IP in the marketplace and are typically based on revenue generated from the sales of products and services using the licensed IP or from the achievement of milestones on the path to commercialization. Increases in royalty revenue totals are important, validating the original research and innovation, and generating funds that can be reinvested in new or follow-on R&D.

How Does Massachusetts Perform?

Massachusetts has remained a leader in the number of technology licenses and options executed over the last eleven years, edging out New York for the top spot in the LTS in 2013 and 2014. New York and Pennsylvania were also big movers, more than doubling the number of licenses and options executed from 2009-2014. Massachusetts did experience a drop in the number of technology licenses and options executed from 2012-2013 owing to a decrease from Massachusetts General Hospital (-33), which accounted for 84.62% of the drop. **Since 2003, there has been a shift among the types of institutions in Massachusetts that comprise a majority of licenses and options executed from universities to research institutions and hospitals.** This situation is unique among the LTS and is likely due to the Commonwealth's singular concentration of world-class research institutions and hospitals. Massachusetts research institutions and hospitals accounted for 54.6% of the technology licenses and options executed within the LTS in 2014 by these types of organizations. Revenue from IP licenses in Massachusetts remained fairly steady from 2008-2014 except for a 26% increase between 2011 and 2012 which reversed itself in 2013. The two-year spike in 2006 and 2007 was due to a spike in revenues from Massachusetts General Hospital, which resulted from a one-time legal settlement.

Data Source for Indicator 10: Association of University Technology Managers (AUTM), CPI

SBIR/STTR AWARDS

SBIR/STTR Awards Funding

Massachusetts & LTS, 2015

State	Total Funding Amount	Awards Funding per $1 Million GDP
New Hampshire	$ 47,868,276	$ 668
Massachusetts	$ 279,152,344	$ 583
California	$ 465,164,189	$ 190
Rhode Island	$ 9,212,931	$ 164
Ohio	$ 90,101,514	$ 150
Pennsylvania	$ 102,083,774	$ 149
Connecticut	$ 32,165,878	$ 123
North Carolina	$ 58,787,923	$ 115
Minnesota	$ 29,298,748	$ 88
New York	$ 109,325,928	$ 75
New Jersey	$ 42,055,462	$ 73
Wisconsin	$ 20,205,749	$ 67
Texas	$ 95,748,542	$ 58
Illinois	$ 44,254,808	$ 57
Missouri	$ 14,250,865	$ 49

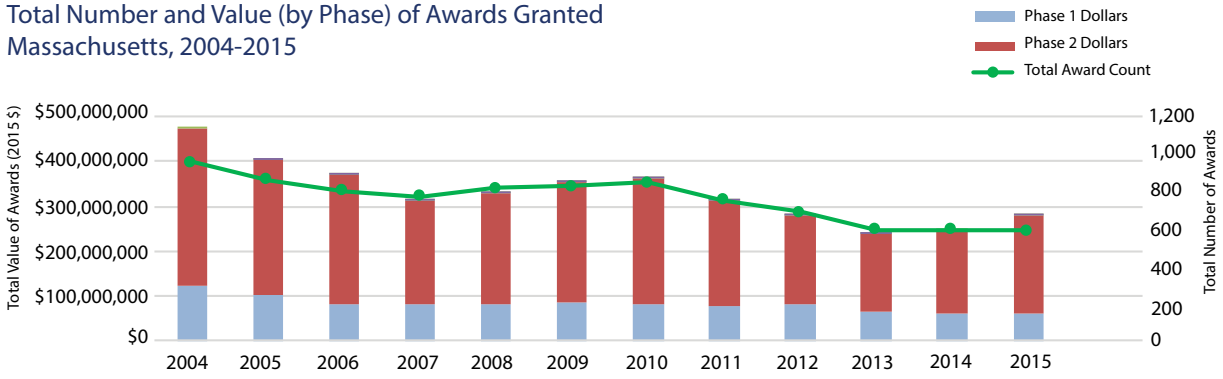
SBIR & STTR Awards by Agency

Massachusetts, 2015

Agency	Funding	# of Awards
Department of Defense	$135,367,034	268
Health & Human Services	$69,159,813	137
Department of Energy	$31,343,027	54
National Science Foundation	$17,688,459	42
National Aeronautics & Space Administration	$16,023,266	50

SBIR & STTR Awards

Total Number and Value (by Phase) of Awards Granted
Massachusetts, 2004-2015



Data Source for Indicator 11: U.S. Small Business Administration, CPI

Why Is It Significant?

The Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) Programs are highly competitive federal grant programs that enable small companies to conduct proof-of-concept (Phase I) research on technical merit and idea feasibility and prototype development (Phase II) building on Phase I findings. Unlike many other federal research grants and contracts, SBIR and STTR grants are reserved for applicant teams led by for-profit companies with fewer than 500 employees. Participants in the SBIR and STTR program are often able to use the credibility and experimental data developed through their research to design commercial products and to attract strategic partners and investment capital.

How Does Massachusetts Perform?

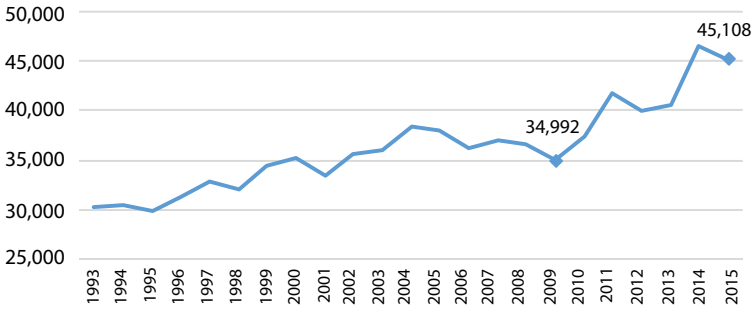
There was a slight decline in the number of SBIR and STTR awards from 2014 to 2015, decreasing to 588 in 2015. **SBIR and STTR award funding increased from 2014 to 2015, to $279 million.** The decline in awards since 2010 was steep and Massachusetts received $84 million less than it did in 2010 ($363 million). Meanwhile, SBIR/STTR award funding nationwide has fallen 14.5% since 2010. New Hampshire, is first in SBIR/STTR Award funding per $1million GDP, reflective of New Hampshire's relatively small GDP. While Massachusetts ranks second, it receives nearly 5 times that of New Hampshire in absolute dollar funding($279 million vs. $47 million). Among the SBIR and STTR awards in Massachusetts in 2015, the Department of Defense accounted for the most funding (48%) and awards (268). Health and Human Services followed with 24% of total funding and 137 awards.

INDICATORS 12-13: BUSINESS DEVELOPMENT

Business development involves commercialization, new business formation and business expansion. For existing businesses, growing to scale and sustainability often involves an initial public offering (IPO), a merger, or an acquisition (M&A). Technical, business and financial expertise all play a role in the process of analyzing and realizing business opportunities, which result after research and development are translated into processes, products, or services.

BUSINESS FORMATION

Business Establishment Openings
Massachusetts, 1993-2015



Net Change in Number of Business Establishments
Key Industry Sectors
Massachusetts & LTS, 2010-2015

	Net Change
California	29,383
Illinois	11,043
North Carolina	10,885
New York	5,237
Pennsylvania	4,849
Massachusetts	4,185
Ohio	4,058
Minnesota	1,611
New Hampshire	1,348
Connecticut	1,291
Rhode Island	695
Missouri	-2,197
Wisconsin	-2,198
Texas	-2,199
New Jersey	-2,200

Why Is It Significant?

New business formation is a key source of job creation and cluster growth, typically accounting for 30 to 45 percent of all new jobs in the U.S. It is also important to the development and commercialization of new technologies. The number of 'spin-out' companies from universities, teaching hospitals, and non-profit research institutes (including out-licensing of patents and technology) is an indicator of the overall volume of activity dedicated to the translation of research outcomes into commercial applications.

How Does Massachusetts Perform?

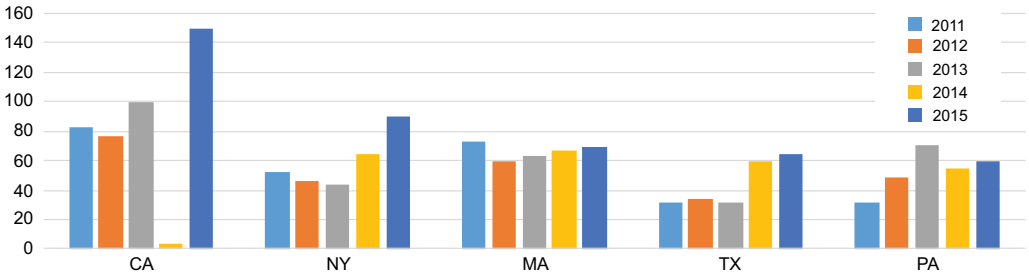
In 2015 Massachusetts experienced strong business establishment growth, reaching 45,108 new openings. Relative to 2014, business establishment openings have decreased by 1,282.

Massachusetts also saw an increase in the number of business establishments in key innovation economy sectors per million employees, with over 4,180 net new establishments opened within those sectors relative to 2010. Although Massachusetts has had a greater number of establishment openings in key innovation sectors, the concentration of business openings has remained relatively the same from 2010-2015. **Business Services, Finance, Healthcare Delivery, Scientific, Technical & Management Services, and Software make up the majority of new businesses within the innovation economy (87.0%).** The increase in business establishment openings in key sectors relative to 2010 places Massachusetts 5th in the LTS behind California, Illinois, Pennsylvania, and New York.

In 2015, start-up formation from universities, hospitals, research institutions and technology investment firms in Massachusetts increased to 69. From 2011-2015, Massachusetts has averaged 66 start-ups initiated per year from universities, hospitals, research institutions and technology investment firms. Of the LTS, only New York and California lead Massachusetts in start-up formation. New York increased at a 41.0% rate from 2014-2015, climbing to second in the LTS. Texas maintained its growth in start-ups initiated from 2014 and in 2015 reached 64.

Start-up Companies Initiated
From Universities, Hospitals, Research Institutions & Technology Investment Firms
Massachusetts and Top 5 LTS, 2011-2015

*Note: California universities did not report any data in 2014 so their total of 4 is likely inaccurate.

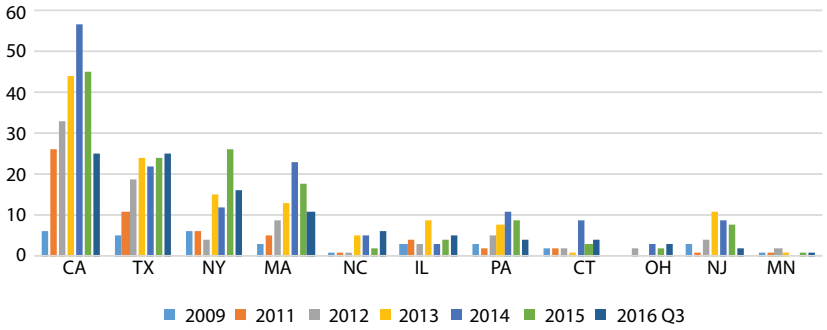


Data Source for Indicator 12: BLS Business Employment Dynamics, QCEW, Census Bureau, AUTM, 2010 Kauffman Index of Entrepreneurial Activity

IPO AND M&A

Number of Initial Public Offerings (IPO)

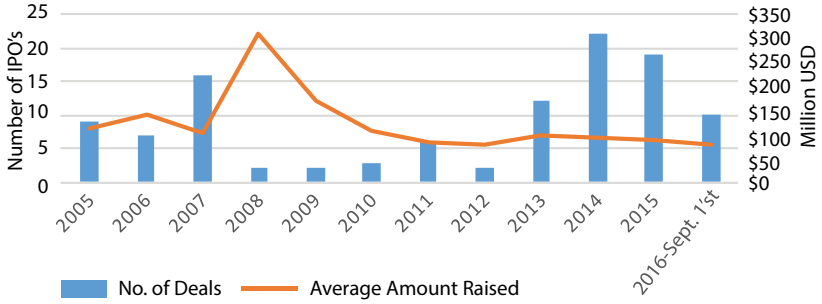
Massachusetts & LTS-2009, 2011-November 2016



Venture Backed IPOs

Number of Deals and Average Value (2015 $)

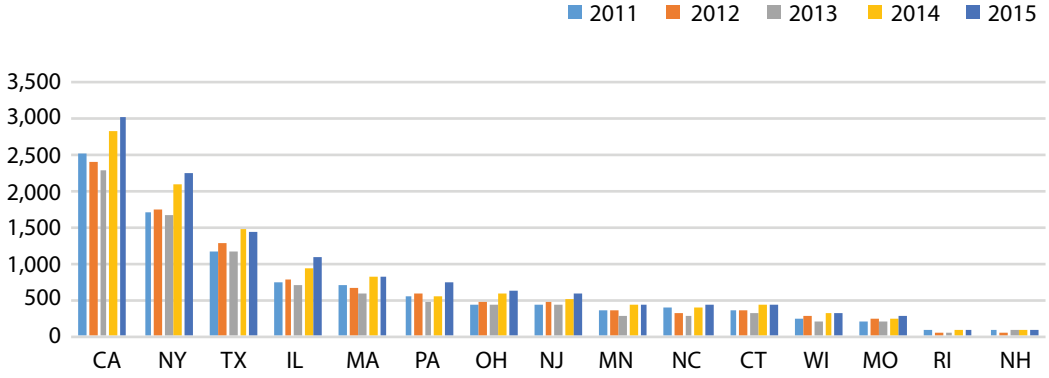
Massachusetts, 2005-2016



Number of Participating Companies

Mergers & Acquisitions

MA & LTS, 2011-2015



Data Source for Indicator 13: Renaissance Capital, IPO Home, National Venture Capital Association (NVCA), Mergerstat

Why Is It Significant?

Initial Public Offerings (IPOs) and Mergers and Acquisitions (M&As) represent important business outcomes with which emerging companies can access capital, expand operations, and support business growth. IPOs and M&As are opportunities for early-stage investors to liquidate their investments and free up capital for future investment. IPOs of venture-backed companies can reflect investor confidence in the market. Overall figures are relatively low so it is expected that year-over-year figures will fluctuate which is why it is important to review trends over multiple years.

How Does Massachusetts Perform?

IPOs, which are heavily concentrated in a few states, seem to have recovered from lows experienced in 2009, but have decreased in 2016 relative to 2015. California, Texas, New York, and Massachusetts are traditionally major generators of IPOs due to their focus on advanced technology cluster development. Massachusetts-based IPOs experienced growth from 2009-2014, reaching a five year peak of 23 IPOs in 2014. Since 2014, Massachusetts-based IPOs dropped to 18 in 2015 and only 11 as of November 2016.

Massachusetts IPOs were dominated by biotech companies in 2015 and 2016. In 2015, sixteen IPOs were biotech or pharmaceutical companies. **In 2016, there were ten IPOs that were biotech or pharmaceutical companies.** The average dollar amount raised in the IPO of these companies has remained steady from 2010-2016 at $89 million, ranging from a low of $78 million to a high of $98 million and far below the 2008 figure of $308 million. In 2016, the average amount raised from eleven IPOs was $79 million.

All of the LTS increased their number of mergers and acquisitions from 2015 to 2016, except for Texas and Rhode Island. California, New York, Illinois, and Pennsylvania had the largest absolute increases and accounted for 78.2% of the growth in LTS M&As from 2014 to 2015. Massachusetts' average ratio of buyers to sellers from 2010-2015 is 1.14; the highest ratio of buyers to sellers in the LTS belongs to New York (1.46). The rate of increase from 2014-2015 for buyers and sellers ranged from -7.5% in New Hampshire to 34.3% in Pennsylvania.

INDICATORS 14-16: CAPITAL

Massachusetts attracts billions of dollars of funding every year for research, development, new business formation, and business expansion. The ability to attract public and private funds sustains the unparalleled capacity of individuals and organizations in the state to engage in the most forward looking research and development efforts. Universities in Massachusetts benefit from industry's desire to remain at the cutting edge of research and product development through university-industry interactions. For new business formation and expansion, Massachusetts' concentration of venture capitalists and angel investors is critical. Investors in these areas, capable of assessing both the risk and opportunities associated with new technologies and entrepreneurial ventures, are partners in the innovation process and vital to its success.

FEDERAL FUNDING FOR ACADEMIC AND HEALTH R&D

Why Is It Significant?

Universities and other non-profit research institutions are critical to the Massachusetts innovation economy. They advance basic science and create technologies and know-how that can be commercialized by the private sector. This R&D also contributes to educating the highly-skilled individuals that make up one of Massachusetts' greatest economic assets. The National Institutes of Health (NIH) is the federal government's main source of funding for medical research. Awards from the NIH help fund the Commonwealth's biotechnology, medical device, and health services industries which together comprise the Life Sciences cluster.

How Does Massachusetts Perform?

Due to federal budget cuts, funding declined in all the LTS in 2014, with every state falling below the 2006 levels except Rhode Island and Minnesota. Massachusetts remains second in federal R&D funding awarded to universities and non-profit institutions following California. At $3.1 billion, Massachusetts trails California by roughly $1.6 billion; however California's population is nearly six times the size of Massachusetts'.

Each of the LTS received its highest amount of federal R&D funding for universities and non-profit institutions in 2010 (except New Hampshire, which received the most in 2014), as federal spending on research increased that year as part of the national economic stimulus program to combat the recession. Now that the LTS economies are growing faster than the growth in federal funding, the share of GDP decreased for every LTS in 2014.

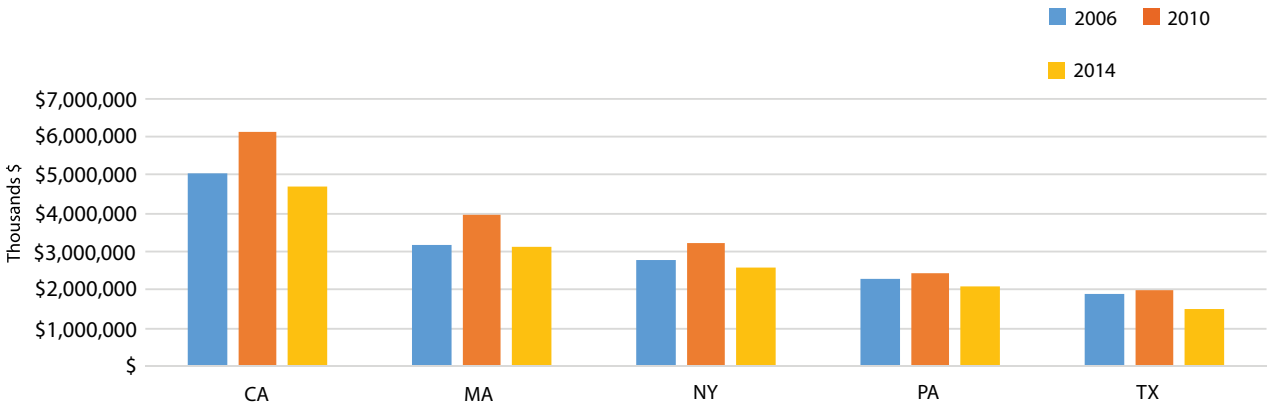
Massachusetts continues to maintain a lead in federal funding for Academic and Health R&D per $1,000 GDP at $6.64, almost twice as much as second ranked Rhode Island, which also benefits from a large concentration of research hospitals and medical schools. Despite leading the LTS, Massachusetts has suffered a 31% decrease in federal funding for Academic and Health R&D per $1,000 GDP since 2010.

Of the 41,867 awards from the National Institute of Health (NIH) in the United States in 2015, Massachusetts accounts for 4,030 or 9.6%. Massachusetts also has a 10.7% share in national funding from NIH in 2015. Nine Massachusetts organizations attracted more than $100 million in NIH funding, combining for 2,718 awards and over $1.4 billion in NIH funding. Boston and Cambridge together combined for a total of 2,855 awards and more than $1.7 billion in NIH funding due to the high density of hospitals, universities, and pharmaceutical companies in these cities.

Massachusetts continues to attract the largest share of NIH funding per $1 million GDP, although that figure declined to $4.10 per $1,000 GDP in 2014. Massachusetts' amount of NIH funding per $1 million GDP is unparalleled in the LTS, reaching more than 3 times the median amount of funding for the next 10 states. Massachusetts received the second highest number of NIH awards (4,030 in 2015) following only California (6,131). In terms of the absolute amount of NIH funding, Massachusetts ranked second ($2.0 billion) to California ($2.9 billion). On a per capita basis, however, Massachusetts ranks first ($301) ahead of second place California ($73).

Federal Funding for R&D

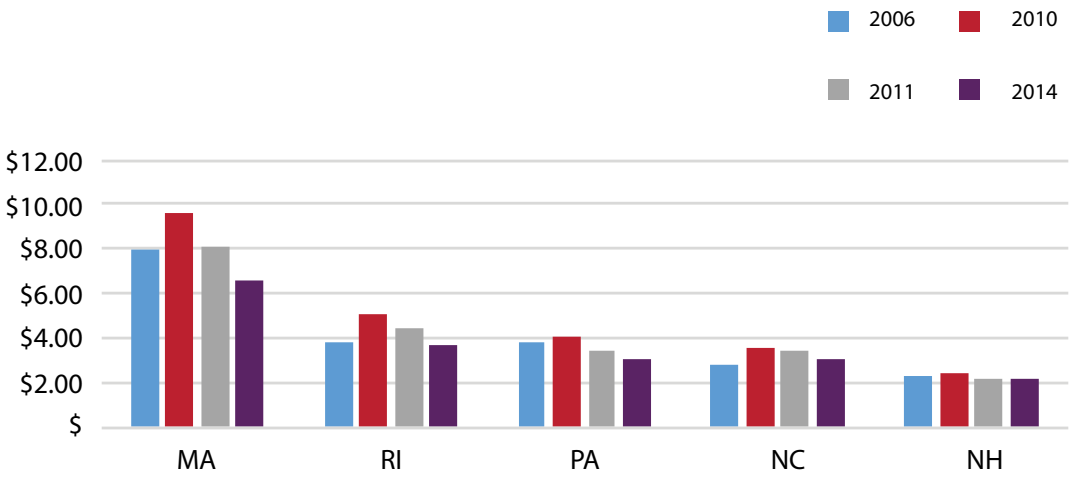
Universities, Colleges and Non-Profit Organizations
Massachusetts & Top 5 LTS, 2006, 2010, 2014



Data Source for Indicator 14: NSF, BEA, National Institutes of Health (NIH), Census Bureau

FEDERAL FUNDING FOR ACADEMIC AND HEALTH R&D

Federal Funding for R&D per $1,000 GDP
Universities, Colleges and Non-Profit Organizations
Massachusetts & Top 5 LTS, 2006, 2010, 2011, 2014



National Institutes of Health (NIH) R&D Funding
per $1 million GDP
Massachusetts & LTS, 2015

	Number of Awards	Absolute Funding (Millions $)	Funding per $1 Million GDP
Massachusetts	4,030	$ 2,034	$ 4,247.63
Rhode Island	362	$ 120	$ 2,136.58
Pennsylvania	2,853	$ 1,298	$ 1,897.14
North Carolina	1,714	$ 860	$ 1,689.16
Connecticut	970	$ 415	$ 1,583.94
Missouri	959	$ 409	$ 1,408.21
Minnesota	836	$ 416	$ 1,242.91
Wisconsin	750	$ 367	$ 1,223.11
New York	3,965	$ 1,761	$ 1,210.43
New Hampshire	178	$ 85	$ 1,187.25
California	6,131	$ 2,864	$ 1,169.91
Ohio	1,334	$ 569	$ 949.92
Illinois	1,601	$ 648	$ 839.88
Texas	2,075	$ 836	$ 510.19
New Jersey	442	$ 175	$ 302.19

Massachusetts Hospitals Receiving $100M+ in NIH Funding
2015

	Awards	Funding (Thousands $)
Brigham and Women's Hospital	470	$ 301,836
Massachusetts General Hospital	654	$ 299,452
Harvard Medical School	288	$ 162,360
University of Mass Medical School Worcester	289	$ 126,560
Children's Hospital Corporation	287	$ 121,064
Harvard School of Public Health	141	$ 107,556
Beth Israel Deaconess Medical Center	213	$ 105,960
Boston University Medical Campus	201	$ 100,390
Dana-Farber Cancer Institute	175	$ 97,835

Data Source for Indicator 14: NSF, BEA, National Institutes of Health (NIH), Census Bureau

INDUSTRY FUNDING OF ACADEMIC RESEARCH

Why Is It Significant?

Industry funding of academic research is one measure of industry-university relationships and the ability to transfer academic research into the commercial market. Industry-university research partnerships may result in advances in technology industries by promoting basic research that may have commercial applications. Moreover, university research occurring in projects funded by industry helps educate individuals in areas directly relevant to industry needs.

How Does Massachusetts Perform?

After a decline in 2010, industry funding for academic research and development in science and engineering (S&E) in Massachusetts recovered, reaching a 10-year peak in 2014 at $237 million, an $18.4 million increase over 2013. Over the last five years, Massachusetts' share of the U.S. total has remained relatively steady, averaging 6.2% each year. Massachusetts' share of the U.S. total in 2014 reached 6.4%.

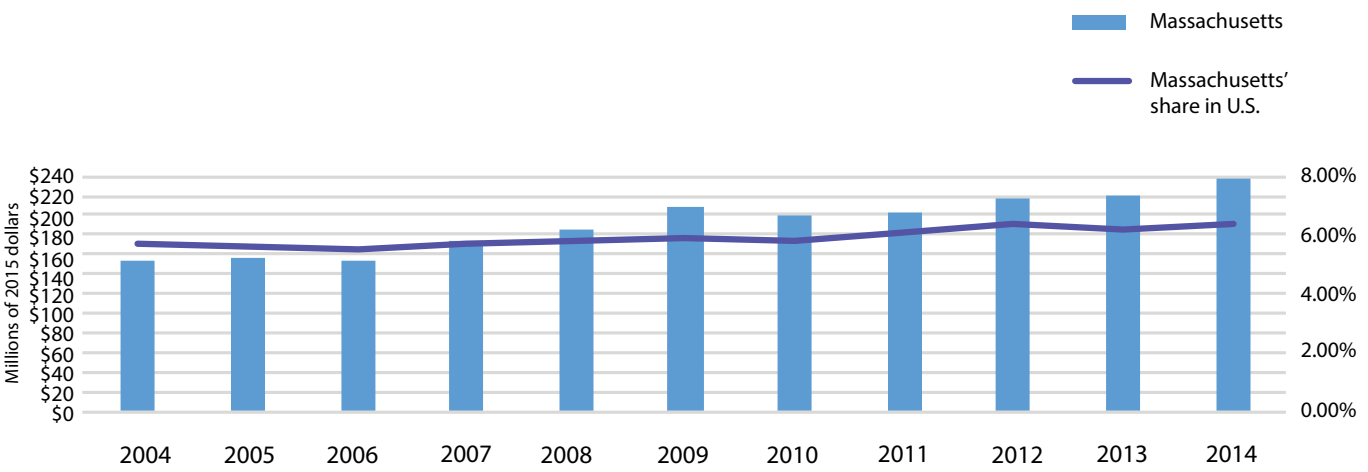
Since 2013, the majority of the LTS have experienced considerable growth in industry funded academic research in S&E as a percentage of GDP, beginning to reverse the decline that began in 2009. In 2014, Massachusetts experienced an increase of $21 million of Industry Funded academic research from the previous year. North Carolina leads the LTS in industry funding for academic research in S&E per $100,000 GDP with $68.49, followed by Massachusetts second with $49.55, and all other LTS substantially behind the two leaders.

In 2014, industry funding as a share of total academic S&E research funding increased to 6.8% in Massachusetts, an increase from 2013 (6.1%). North Carolina was the leader in 2014 at 12.40%, followed by Ohio with 8.16%, and New York at 6.9%.

Since industry funding for academic research in S&E for each of the LTS is relatively small compared with the total research enterprise in each state, funding amounts can change dramatically from year to year. In some states, a single large grant or collaboration from a big company can significantly impact the total. Additionally, states strong in defense and medical research, traditionally funded by the federal government, will usually have lower shares of industry funded R&D compared to total R&D. Connecticut and Minnesota are good examples of this given their strength in the defense and medical sectors respectively.

Industry Funding for Academic Research in S&E

Massachusetts, 2004-2014



Data Source for Indicator 15: NSF, BLS, Census Bureau

INDUSTRY FUNDING OF ACADEMIC RESEARCH

Industry Share of States' Total Academic R&D Funding in S&E
Massachusetts & LTS, 2014

	Share
North Carolina	12.40%
Ohio	8.16%
New York	6.90%
Texas	6.82%
Massachusetts	6.78%
Missouri	6.25%
California	6.05%
Pennsylvania	5.27%
Illinois	4.96%
Connecticut	4.49%
New Hampshire	3.83%
New Jersey	3.33%
Minnesota	3.17%
Wisconsin	2.70%
Rhode Island	1.17%

Rank in 2014 and Growth Rate in Industry Funding for Academic Research in S&E per $100,000 GDP
Massachusetts, LTS & U.S., 2009-2014

	2014	Growth Rate 2009-2014
North Carolina	$ 68.49	4.00%
Massachusetts	$ 49.55	-2.76%
Ohio	$ 29.40	-5.84%
New York	$ 26.75	4.91%
Pennsylvania	$ 25.64	-12.07%
Missouri	$ 25.42	5.62%
Texas	$ 23.49	1.89%
USA	$ 21.47	-0.70%
California	$ 20.77	-6.93%
New Hampshire	$ 18.22	1.55%
Connecticut	$ 18.19	6.03%
Illinois	$ 14.97	3.79%
Wisconsin	$ 14.17	4.26%
Rhode Island	$ 9.25	-5.98%
Minnesota	$ 8.71	-4.85%
New Jersey	$ 6.49	-2.35%

Data Source for Indicator 15: NSF, BLS, Census Bureau

VENTURE CAPITAL

Why Is It Significant?

Venture capital (VC) firms are an important source of funds for the creation and development of innovative new companies. VC firms also typically provide valuable guidance on strategy as well as oversight and governance. Trends in venture investment can indicate emerging growth and recruiting opportunities in the innovation economy. Empirical research suggests that the amount of VC in a region has a positive effect on economic growth.

How Does Massachusetts Perform?

Massachusetts' average share of annual U.S. VC investment from 2005 to 2015 was 10.94%, ranging from around 9% to 12% annually. Massachusetts' VC investment increased to 9.73% of the U.S. total in 2015, signaling faster growth in Massachusetts than the U.S. as a whole, but still below the historical average. California was the number one destination for VC investment after a 16% increase from 2014-2015, rising to $34.26 billion. The largest gain from 2014-2015 was in New Jersey, which experienced a 156% increase in VC investment, from $382 million in 2014 to $980 million in 2015. The Commonwealth continued to trail California in VC funding as a share of GDP despite funding increasing from $9.88 to $12.16 per $1,000 GDP in 2015.

Biotechnology and Software were by far the largest target industries for VC funding in Massachusetts in 2015, representing 38.8% and 28.6% respectively, of total VC funding for the state. This reflects the Commonwealth's strengths in these sectors as well as their broader appeal to investors.

Angel investors provide an increasingly important source of seed capital for start-ups around the state. Massachusetts is home to 14 different groups of angel investors, more than the 10 found in Texas, although New York (17) and California (20) have more. Angel funds are critical as start-up/seed financing from VC firms in Massachusetts has declined more than 50% since 2009 when it peaked at $417 million. Seed funding from VC in 2015 dropped to $197 million, a drop of 38 million from 2014, the lowest amount of seed funding since 2012 when it bottomed out at $115 million. Early stage financing is now the largest category of VC funding in the state and has grown 104% since 2012, highlighting interest in younger start-up firms. Expansion financing by VC firms in Massachusetts has also been on the rise, growing 52% from the previous year to a 10 year peak.

VC Investment by Sector
Massachusetts
Millions of 2015 $

Biotechnology	$ 2,201
Software	$ 1,623
Medical Devices	$ 562
Media & Entertainment	$ 412
Telecommunications	$ 258
Industrial & Energy	$ 174
IT Services	$ 171
Electronics & Instrumentation	$ 107
Semiconductors	$ 80
Computers & Peripherals	$ 35
Healthcare Services	$ 33
*Other	$ 17

*Consumer Products, Retail Distribution, Business Products, Other

Venture Capital Investment
Massachusetts & LTS, 2009-2015
Millions of 2015 $

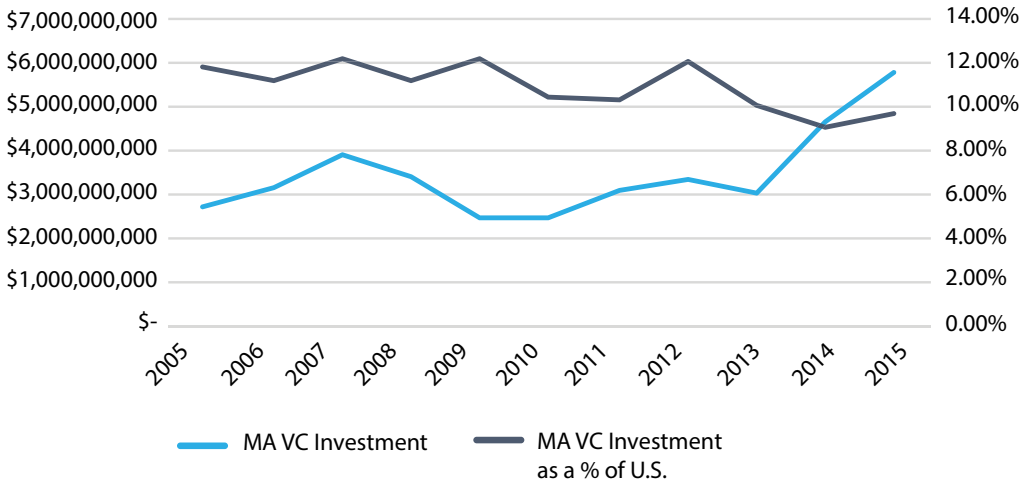
State	2015	2014-2015 % Change	2009-2015 % Change	2015 VC Investment per $1000 GDP
CA	$ 34,265	16%	233%	$ 13.99
NY	$ 6,298	42%	458%	$ 4.33
MA	$ 5,823	25%	135%	$ 12.16
TX	$ 1,188	-17%	71%	$ 0.72
IL	$ 1,063	3%	317%	$ 1.38
NJ	$ 980	156%	60%	$ 1.69
PA	$ 878	-11%	78%	$ 1.28
NC	$ 712	93%	190%	$ 1.40
CT	$ 449	-20%	225%	$ 1.72
MN	$ 395	7%	29%	$ 1.18
OH	$ 263	-9%	142%	$ 0.66
MO	$ 249	47%	857%	$ 0.86
NH	$ 160	43%	125%	$ 2.25
WI	$ 96	34%	208%	$ 0.32
RI	$ 15	-87%	-48%	$ 0.28

Data Source for Indicator 16: Kauffman Foundation, PricewaterhouseCoopers MoneyTree Report, CPI, BEA, NVCA

VENTURE CAPITAL

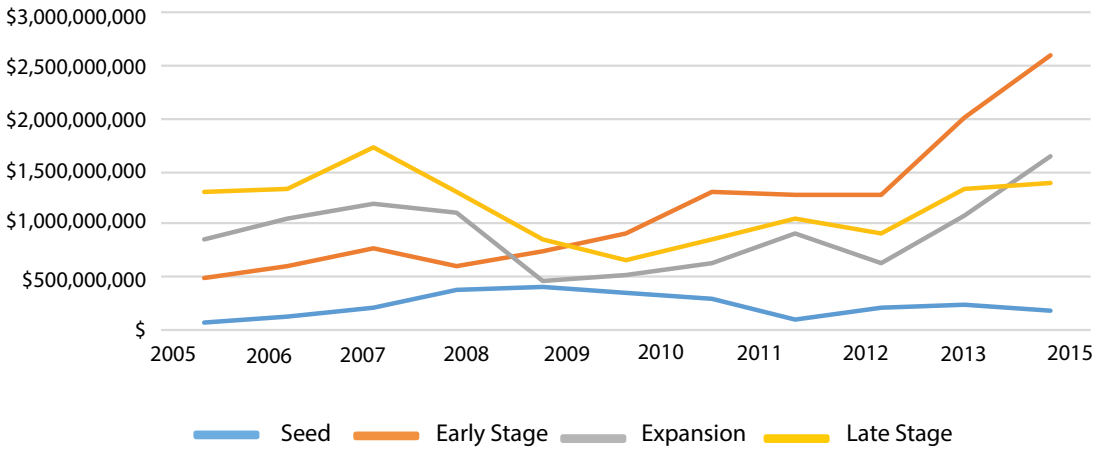
VC Investment

Massachusetts, 2005-2015



VC Investment by Stage

Massachusetts, 2005-2015



Data Source for Indicator 16: Kauffman Foundation, PricewaterhouseCoopers MoneyTree Report, CPI, BEA, NVCA

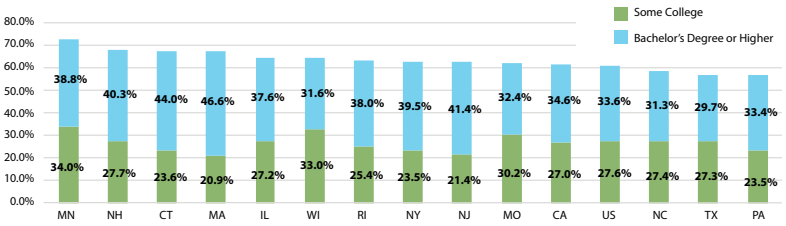
INDICATORS 17-22: TALENT

Innovation may be about technology and business outcomes, but it is a social process. As such, innovation is driven by the individuals who are actively involved in science, technology, design, and business development. The concentration of men and women with post-secondary and graduate education, complemented by the strength of the education system, provides the Commonwealth with competitive advantages in the global economy. Investment in public education helps sustain quality and enhance opportunities for individuals of diverse backgrounds to pursue a high school or college degree. Students and individuals with an interest or background in science, technology, engineering, and math (STEM) are particularly important to the innovation economy. Massachusetts benefits from an ongoing movement of people across its borders, including some of the brightest people from around the world who chose to live, study, and work in the Commonwealth. Housing affordability also influences Massachusetts' ability to attract and retain talented individuals.

EDUCATIONAL ATTAINMENT

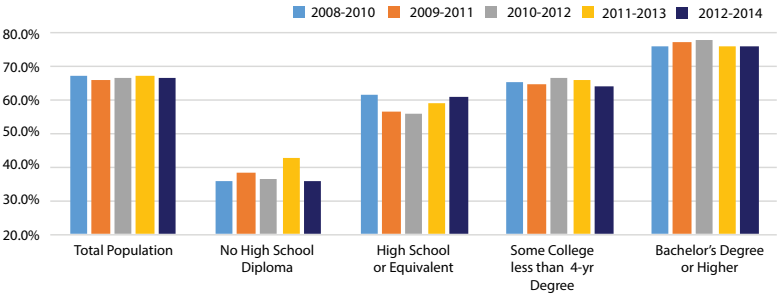
Educational Attainment of Working Age Population

Massachusetts, LTS & U.S., Three Year Rolling Average, 2013-2015



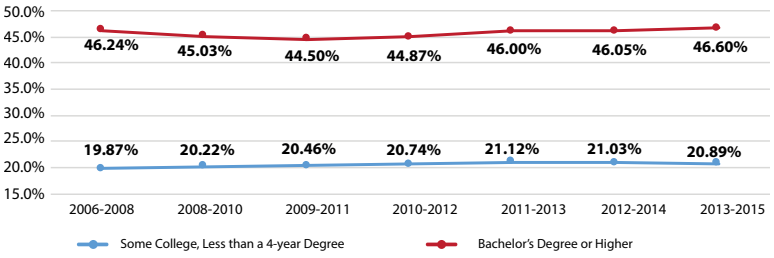
Employment Rate by Educational Attainment

Massachusetts, Three Year Rolling, 2008-2014



College Attainment of Working Age Population

Massachusetts, Three Year Rolling Average, 2006-2015



Why Is It Significant?

A well-educated workforce constitutes an essential component of a region's capacity to generate and support innovation-driven economic growth. Without a trained workforce, business will not expand or relocate to an area and, in some cases, may move away. Challenges to maintaining a suitably trained labor force in Massachusetts include the need to continually increase skill levels and the technical sophistication of workers. A highly educated workforce often results in a lower-than-average unemployment rate.

Education plays an important role in preparing Massachusetts residents to succeed in their evolving job requirements and adapt to shifting career trajectories. A strong education system also helps attract and retain workers who want excellent educational opportunities and skills for themselves and their children. Economic growth in Massachusetts is highly dependent upon maintaining a high level of skills, as well as diverse skills, within the workforce.

How Does Massachusetts Perform?

Massachusetts remains competitive among the LTS in workforce educational attainment with 67.5% of its working age population having achieved at least some college (4th in the LTS) and is virtually tied with 2nd and 3rd ranked New Hampshire and Connecticut. Minnesota leads in overall educational attainment, due largely to its strong performance in students with a less than four-year' degree. One possible explanation for this is the continued strength of advanced manufacturing in the Midwest, as many of these jobs require post-secondary credentials, but not a full bachelor's degree. Midwest peer Wisconsin posts similarly strong percentages with such students.

Massachusetts was the 'best in class' when it comes to the percentage of adults with a bachelor's degree or higher (46.6%) when compared to the LTS average (35.77%) or that of the U.S. (33.58%) during the 2013-2015 timeframe. The employment rate among adults with at least a bachelor's degree in Massachusetts has remained comparatively high, remaining 16 percentage points above that of those with only a high school diploma and more than double that of those without a high school diploma.

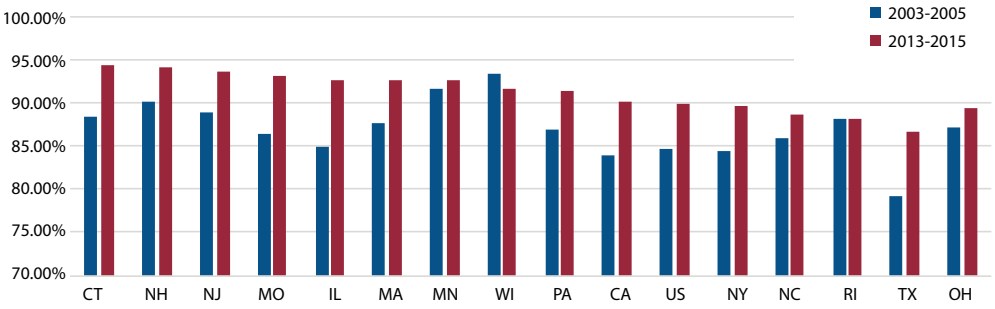
Since the onset of the Great Recession, Massachusetts has maintained a lower unemployment rate than the U.S. as a whole for all but November 2013-January 2014 and as of December, 2016, the unemployment rate stood at a 16-year low of 2.8%. Meanwhile college attainment has remained relatively stable in Massachusetts since 2006 with 65.0%-67.5% of the state's working age population having at least some college education.

Data Source for Indicator 17: Census Bureau Current Population Survey (CPS) , National Center for Education Statistics (NCES), American Community Survey (ACS)

EDUCATIONAL ATTAINMENT

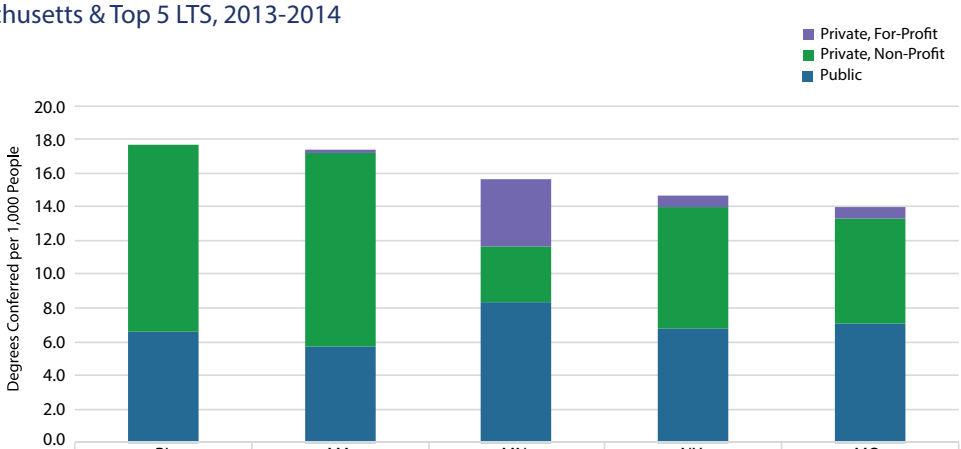
High School Attainment of Persons 19-24

Massachusetts, LTS & U.S., Three Years Rolling
2005 & 2015



Post-Secondary Degrees Conferred per 1,000 People

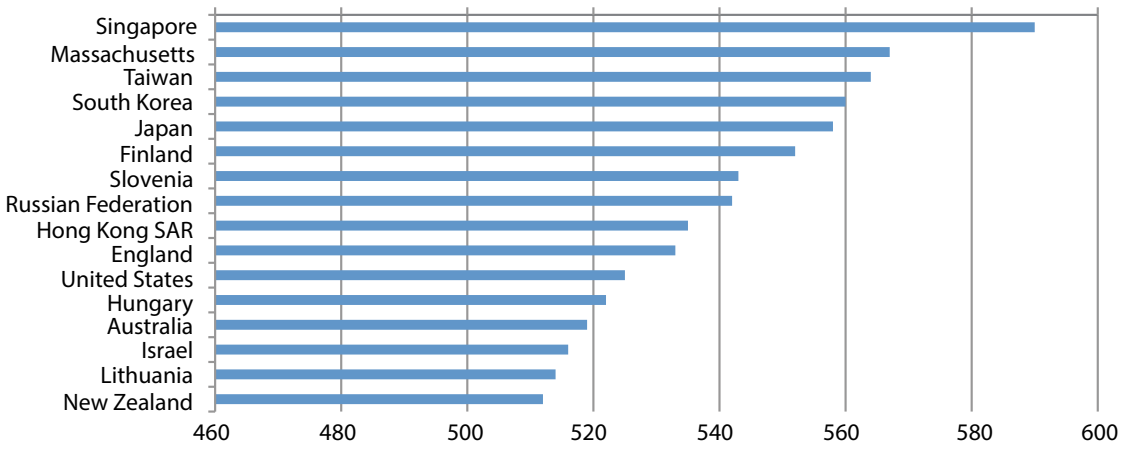
Massachusetts & Top 5 LTS, 2013-2014



	RI	MA	MN	NY	MO
Private, For-Profit	0.0	0.2	3.9	0.7	0.6
Private, Non-Profit	11.1	11.5	3.3	7.1	6.3
Public	6.6	5.7	8.4	6.8	7.0

International

Massachusetts & Top 15 Nations Participating in 8th Grade
TIMSS Science Evaluation, 2011



Data Source for Indicator 17: Census Bureau Current Population Survey (CPS) , National Center for Education Statistics (NCES), American Community Survey (ACS)

PUBLIC INVESTMENT IN EDUCATION

Per Pupil Spending

Public Elementary/Secondary School Systems
Massachusetts, LTS & U.S., 2014

State	Per Pupil Spending
New York	$ 20,610
New Jersey	$ 17,907
Connecticut	$ 17,745
Massachusetts	$ 15,087
Rhode Island	$ 14,767
New Hampshire	$ 14,335
Pennsylvania	$ 13,961
Illinois	$ 13,077
Minnesota	$ 11,464
Ohio	$ 11,354
Wisconsin	$ 11,186
U.S.	$ 11,009
Missouri	$ 9,875
California	$ 9,595
Texas	$ 8,593
North Carolina	$ 8,512

State Higher Education Appropriations

Per Full-Time Equivalent Student
Massachusetts, LTS & U.S., 2015

State	2015	2008-2015 % Change
Illinois	$ 11,518	38.2%
North Carolina	$ 8,894	-20.0%
New York	$ 8,830	-2.6%
California	$ 8,522	-5.6%
Connecticut	$ 8,090	-18.6%
Texas	$ 7,748	-18.8%
U.S.	$ 6,966	-15.3%
Massachusetts	$ 6,728	-16.2%
Missouri	$ 6,102	-18.5%
Wisconsin	$ 5,991	-16.3%
New Jersey	$ 5,766	-25.7%
Minnesota	$ 5,695	-20.3%
Ohio	$ 5,078	-9.8%
Rhode Island	$ 4,785	-23.2%
Pennsylvania	$ 3,758	-36.2%
New Hampshire	$ 2,591	-27.6%

Why Is It Significant?

Investments in elementary, middle and high schools are important for preparing a broadly educated and innovation-capable workforce. Investments in public, post-secondary education are critical to increase the ability of public academic institutions to prepare students for skilled and well-paying employment. In addition, well-regarded, public higher education programs enhance Massachusetts' distinctive ability to attract students from around the globe, some of whom choose to work in the Commonwealth after graduation.

How Does Massachusetts Perform?

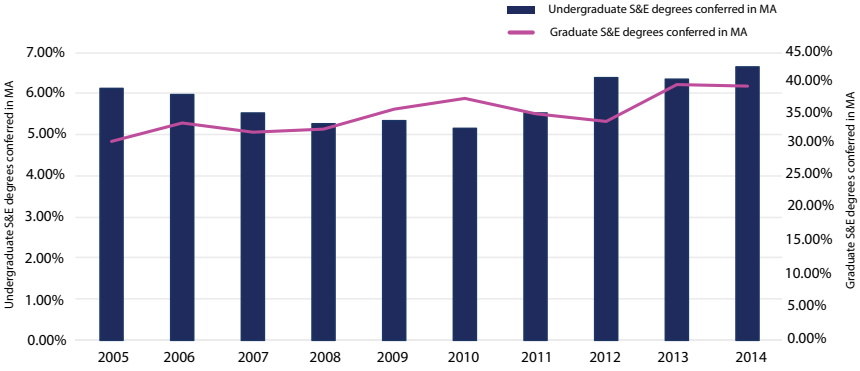
Massachusetts continues its above-average spending per pupil on public elementary and secondary school systems. Of the LTS, New York, New Jersey, and Connecticut spend more per student than Massachusetts, which spends approximately $4,000 more per student than the national average. In terms of higher education appropriations per full-time-equivalent student (FTE), Massachusetts ($6,728) is slightly above the LTS average ($6,669) but remains below the U.S. average ($6,966). In this measure, of the 15 LTS, Massachusetts places 7th among the 15 LTS. Decreases in state-higher education appropriations since 2005 have become a national trend, averaging a 15.3% decrease over the given time span which tends to increase the cost of attendance for students and families. During that timespan Massachusetts state higher education appropriations fell 16.2%. Illinois had the highest level of state higher education appropriations per student in 2015, leading the LTS at $11,518, 38.20% more than in 2008.

Data Source for Indicator 18: State Higher Education Office, Census Bureau, ACS

STEM CAREER CHOICES AND DEGREES

S&E Degrees Conferred to Temporary Non-permanent Residents

Universities in Massachusetts, 2005-2014



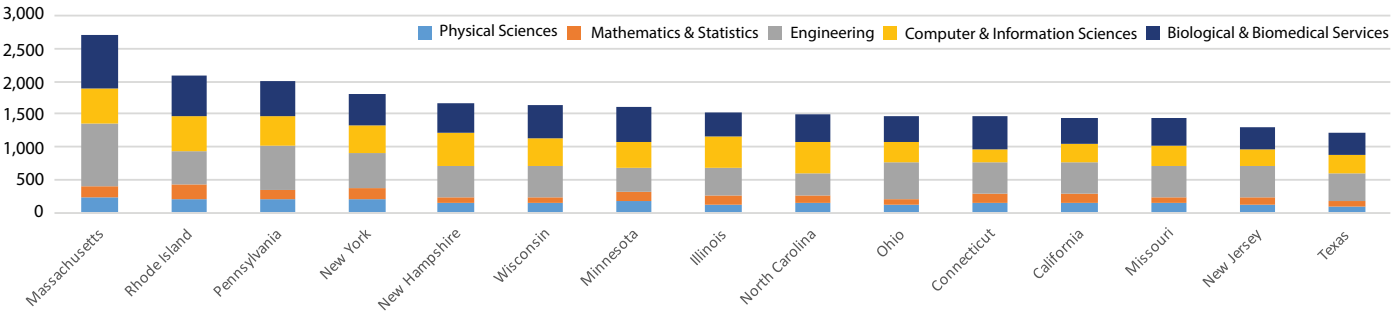
Life-Science Major Graduates

per 1 Million Residents
MA & LTS, 2014-2015

	Graduates
Massachusetts	774
Rhode Island	742
Wisconsin	569
Minnesota	550
Pennsylvania	527
Connecticut	517
New Hampshire	498
New York	484
North Carolina	462
Missouri	452
Ohio	403
California	397
Illinois	383
Texas	360
New Jersey	355

Degrees Granted in STEM Fields All Degree Levels

per 1 Million Residents
Massachusetts & LTS, 2013-2014



Why Is It Significant?

Science, technology, engineering, and math (STEM) education provides the skills and know-how that can help increase business productivity, create new technologies and companies, and establish the basis for higher-paying jobs. STEM degree holders are also important to the wider economy as nearly 75% of them hold non-STEM occupations.

How Does Massachusetts Perform?

Massachusetts leads the LTS in degrees (graduate & undergraduate) granted in STEM fields per 1 million residents (2,698) and that number is 28.2% greater than the second state, Rhode Island. Among the STEM fields, engineering and biological & biomedical science are the most popular majors, together compiling 65.1% of STEM degrees granted in Massachusetts and 58.6% on average in the LTS. Computer and Information Sciences was the third most popular degree granted in STEM, accounting for 19.9% in Massachusetts and 23.9% on average in all of the LTS. Degrees granted in STEM fields to non-permanent residents in Massachusetts rose in all fields except for Engineering, where it fell slightly over the period from 2005-2014. Total STEM degrees granted from 2003-2014 in Massachusetts rose over 42%.

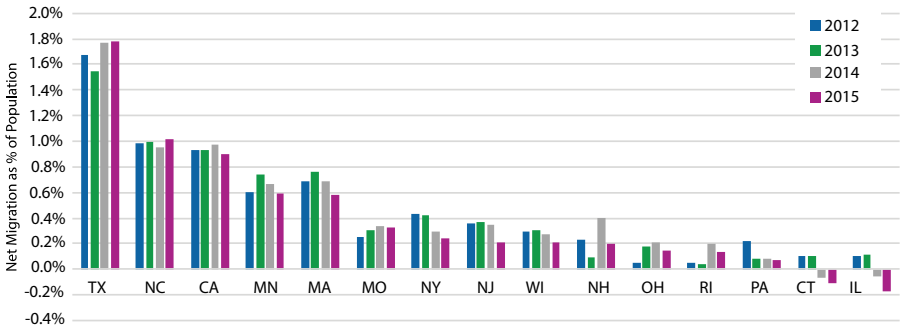
Massachusetts leads the LTS in Life Science major graduates per one million residents (774), followed by Rhode Island (742) and Wisconsin 569). Foreign students attracted to the Commonwealth's high quality universities and colleges are an important source of STEM talent for Massachusetts' companies and research institutions. After rising to 38.0% in 2010, graduate degrees granted in S&E to temporary, non-permanent residents has continued to climb to a 10 year peak in 2014 to 39.87%. Undergraduate S&E degrees conferred to temporary, non-permanent residents matched a ten- year peak in 2014 (6.66%). However, these are comparably small numbers with Massachusetts institutions granting 80 additional undergraduate degrees to foreign students in science and engineering (S&E) in 2014 for a total of 724. This is in contrast to the 2,544 graduate S&E degrees granted to foreign students in 2014, which increased by 702 students between 2013 and 2014.

Data Source for Indicator 19: College Board, ACS, NCES, IPEDS

TALENT FLOW AND ATTRACTION

Net Migration as a % of Population

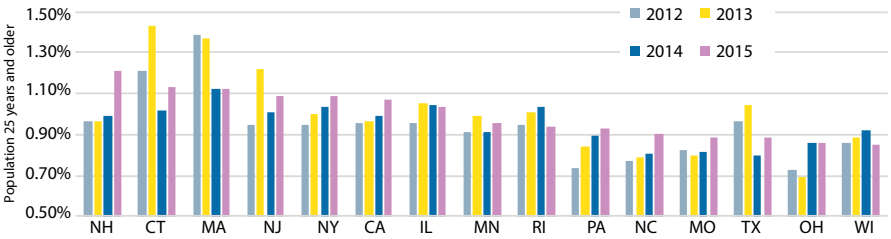
Massachusetts & LTS, 2012-2015



Relocation by College Educated Adults

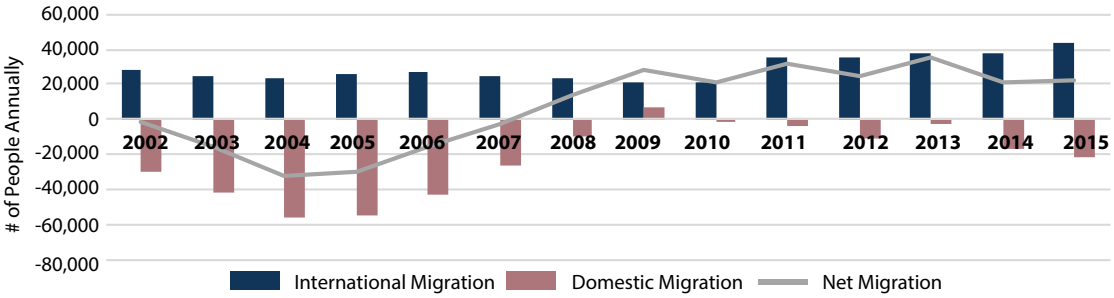
To the LTS from Out of State or Abroad

Massachusetts & LTS, 2012-2015



Domestic & International Migration

Massachusetts, 2002-2015



Why Is It Significant?

Migration patterns are a key indicator of a region's attractiveness. Regions that are hubs of innovation have high concentrations of educated, highly-skilled workers and dynamic labor markets refreshed by inflows of talent. In-migration of well-educated individuals fuels innovative industries by bringing in diverse and high-demand skill sets.

How Does Massachusetts Perform?

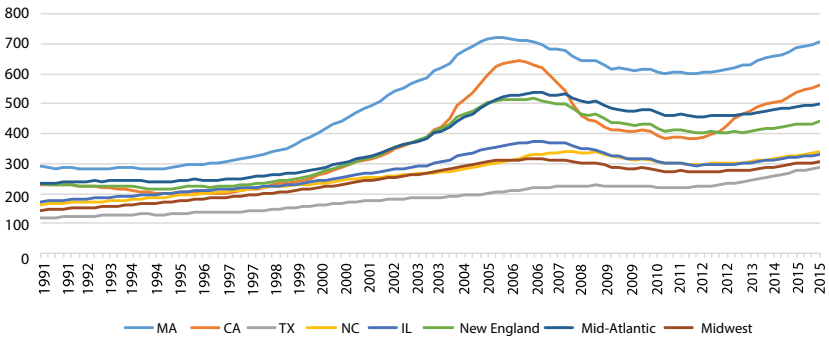
In recent years, most LTS have experienced low or negative net migration as a percentage of population, the exceptions being Texas, North Carolina, California, Minnesota, and Massachusetts. Net migration for these states is at least 0.5% of their respective populations. California and Texas are traditional migration destinations due, in part, to their weather; Texas also benefits from a low cost of living and abundant natural destinations. In the case of Massachusetts, the high quality of life, educational and cultural institutions, and relatively high-paying job opportunities draw people to the Commonwealth despite its cold climate and relatively high cost of living. In 2015, Massachusetts net migration levels were steady at around 21,000, after dropping substantially from their ten-year peak in 2013 (35,178). In 2015 international migration increased 16.6% compared to the previous year, reaching 43,508, while domestic migration worsened 33.3% from the previous year to -21,805. Despite the slowdown, **Massachusetts has had positive net migration every year since 2008, representing a strong rebound from the early-to mid 2000's when the state experienced six consecutive years of negative net migration**. In 2015, Massachusetts surrendered the top spot among the LTS for relocation for college-educated adults, with New Hampshire and Connecticut pulling ahead of Massachusetts.

Data Source for Indicator 20: Census Bureau, ACS

HOUSING AFFORDABILITY

Housing Price Index

MA, CA, IL, NC, TX, New England, Mid-Atlantic, Midwest
Q1 1991-Q2 2016



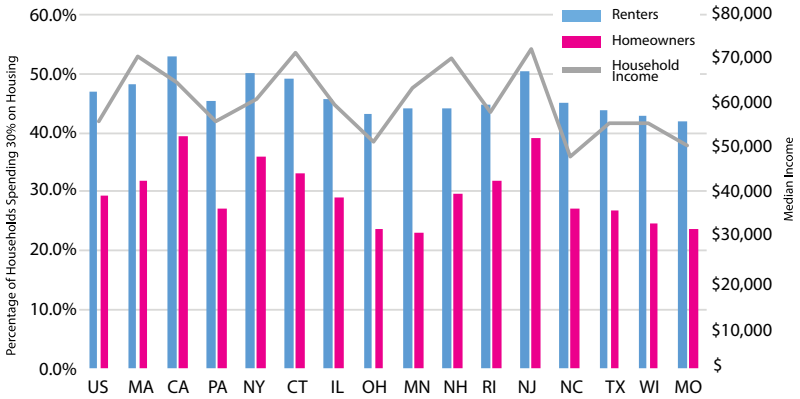
Percent of Households Spending at least 30% of Income on Housing

Massachusetts & U.S., 2010-2015

	2010	2011	2012	2013	2014	2015
MA Renters	47.8%	48.9%	46.8%	47.5%	47.8%	48.1%
U.S. Renters	48.9%	49.3%	48.1%	47.6%	47.9%	46.8%
MA Homeowners	39.0%	38.6%	35.1%	33.7%	32.5%	32.5%
U.S. Homeowners	37.8%	37.8%	33.7%	31.6%	30.7%	29.4%

Households Spending 30% or more of Income on Housing Costs

Massachusetts, LTS & U.S., 2015



Why Is It Significant?

Assessments of 'quality of life', of which housing affordability is a major component, influence Massachusetts' ability to attract and retain talented people. Availability of affordable housing for essential service providers and entry-level workers can enable individuals to move to the area, thus facilitating business' ability to fill open positions and fuel business expansion in the region.

How Does Massachusetts Perform?

The percentage of Massachusetts renters qualifying as "burdened" (spending more than 30% of their income on housing) by housing costs increased by 0.3% from 2014-2015, reaching 48.1%. Massachusetts ranks 8th in the U.S. for burdened renters and sits 5th in the LTS on this measure. California, New Jersey, New York, and Connecticut have less affordable housing, while the rest of the LTS is more affordable. Massachusetts and the U.S. as a whole have seen little change in this figure over the last five years. **Over 40% of renters spend more than 30% of their income on housing in every LTS.** The percentage of burdened homeowners in Massachusetts stayed at 32.5% while U.S. homeowners have become less burdened in the past three years with 29.4% of homeowners spending more than 30% of their income on housing, down from 37.8% in 2010.

Overall, homeowners are significantly less likely to be burdened by housing costs. Homeowners face differing rates of housing cost burden with roughly 40% of homeowners in California and New Jersey spending more than 30% of their income on housing, and fewer than 30% doing so in Pennsylvania, Ohio, Minnesota, and Texas. On the surface, the situation seems to be improving in Massachusetts, yet home prices and rents are increasing and incomes are still lower than they were prior to the recession. The situation for renters and potential buyers contains some good news, however, as demand for more housing is having a positive effect on the Commonwealth's economic growth and driving a boom in construction jobs. Nearly 11,000 construction jobs were created from December 2014-December 2015 in Massachusetts, an 8.0% increase in construction employment. Over the last three decades, housing prices have risen dramatically in Massachusetts, which currently has the highest Federal Housing Finance Authority Housing Price Index (HPI) among the LTS. While prices in the state haven't recovered to mid-2000s levels, they have risen by 16.5% from Q4 2012 to Q2 2016, from when the market bottomed out in 2012. California has experienced an especially sharp rise in prices (40.6%) within the same time period. Texas (28.1%) and Minnesota (18.1%) also experienced faster increases in the Housing Price Index, although both from much lower starting points.

Data Source for Indicator 21: Federal Housing Finance Agency, Census Bureau, The Boston Globe, U.S. Department of Labor, Corelogic

INFRASTRUCTURE

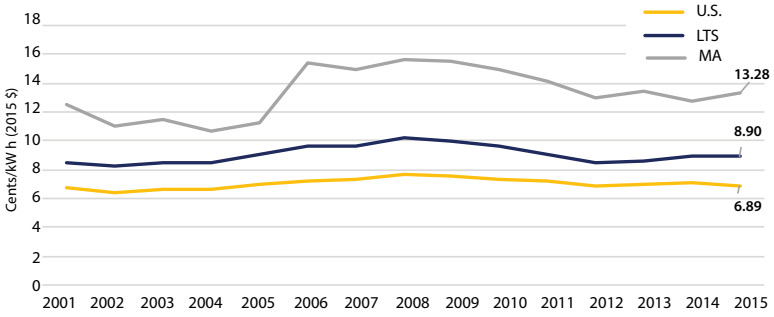
Broadband Speed and Access

Massachusetts & LTS, Q2 2015

State	Average Connection Speed (Mbps)	15 Mbps Broadband Access (% of Population)	Speed Rank (in U.S.)	Access Rank (in U.S.)
RI	19.6	52.4%	1	1
MA	19.0	47.5%	4	6
NJ	18.4	50.6%	7	2
NY	17.8	43.0%	9	8
PA	16.5	39.7%	11	9
CA	16.1	35.6%	13	17
CT	15.8	38.6%	15	11
NH	15.4	19.4%	17	12
US	15.3	34.5%	19	22
IL	15.0	32.7%	23	23
MN	14.7	32.7%	26	24
TX	14.7	30.9%	27	26
MO	14.1	29.9%	30	33
NC	14.0	30.0%	32	32
WI	14.0	30.0%	33	31
OH	11.0	19.4%	48	49

Industrial Electricity Prices

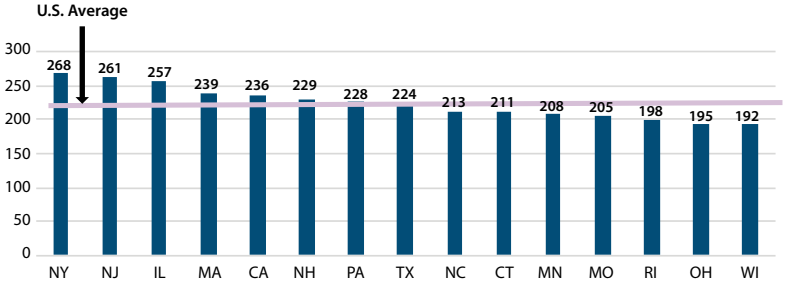
Massachusetts, LTS & U.S., 2001-2015



Average Metropolitan Commute Time
Large Metros (above 250K commuters)

Hours/Year

Massachusetts & LTS, 2014



Why Is It Significant?

A state's infrastructure is more than just the sum of its roads and bridges. Infrastructure is comprised of the transportation, communication, and energy systems within a state. It plays a crucial role in allowing goods and services to be moved into, within, and out of Massachusetts, whether physically or electronically. Energy is the unseen input that allows business to operate. Everything from data centers and offices to factories and hospitals consume it. Fast broadband connections increase business productivity and allow consumers to access a wider range of goods and services online. Additionally, the amount of time people spend commuting to and from work imposes a hidden cost on the economy, consuming time that could otherwise be spent productively elsewhere. The more productive workers become, the more the cost of this lost time increases.

How Does Massachusetts Perform?

Rhode Island (19.6 Megabits per second, or Mbps) is now outpacing Massachusetts (19.0 Mbps) for the fastest average broadband speeds in the LTS, a full 1.0 Mbps faster than New Jersey, the next closest state. Broadband speeds have increased dramatically since 2012 when Massachusetts, then the top ranked state among the LTS, had an average speed of 9.1 Mbps. Rhode Island has the fastest broadband speeds in the country as well as the highest level of access to broadband speeds above 15 Mbps among the LTS, a benchmark for high quality broadband (available to 52.4% of population). Access to broadband is improving, as Massachusetts has improved the access to connection speeds over 15Mbps by 14.5% relative to last year. Increases in access to faster broadband speeds is a pattern throughout the LTS, as every state increased their access to 15Mbps broadband in 2015.

Since 1990, Massachusetts has consistently maintained higher industrial electricity prices than either the LTS or the U.S. as whole. After a trend in declining prices from 1990-2006, Massachusetts experienced a relatively large increase in industrial electricity prices compared to the LTS and the U.S., and continues to maintain a premium of around 30%.

The difference in prices between Massachusetts and much of the country is due to a number of persistent factors, including the lack of generating capacity in New England, lack of interconnections with other regions, and a mix of energy sources with higher input costs. The other New England states also have higher prices than the LTS, with only Maine being below 10 cents/kWh.

Finally, Boston is well known for its heavy rush hour traffic and indeed, Massachusetts metropolitan areas with more than 250,000 commuters have longer commutes than those in California. However, New York, New Jersey, and Illinois commuters spend even more time in traffic. Metropolitan areas in Missouri, Rhode Island, Ohio, and Wisconsin have shorter commutes than the U.S. average. Massachusetts removed tollbooths from the Massachusetts Turnpike in 2016 which could improve commute times, especially in Greater Boston.

Data Source for Indicator 22: Census Bureau, ACS, Akamai, Energy Information Administration

SPECIAL UPDATE: COLLABORATIVE WORKSPACES

As more cities work to create economic development opportunity through prescribed initiatives, such as "Innovation Districts", collaborative workspaces can serve as anchors for neighborhood or regional economic development initiatives. Collaborative workspaces of different forms are becoming more prevalent across the Massachusetts innovation. In the 2015 *Index*, the MassTech Collaborative conducted a Special Analysis focused on the Commonwealth's collaborative workspaces, which touched on the distinctions between different types of spaces and provided a base estimate for the number of spaces that serve the Innovation Economy in Massachusetts. This year, MassTech has produced an update on our estimate from last year, which shows there are at least 115 such spaces in Massachusetts.

Fostering the growth of start-ups is an essential task for maintaining and growing a prosperous innovation economy. Start-ups often face a problematic gap between the formation of an idea and its maturation into a sustainable business. This gap exists both in terms of physical space when a traditional lease is not flexible enough or even feasible for many start-ups; as well as business acumen since many start-ups often lack well-defined business plans, knowledge of legal and accounting matters, and experience raising capital.

Collaborative workspaces can be one way to support the pipeline of new firms in a regional economy although not all collaborative workspaces are targeted at the Innovation Economy or start-ups with high growth potential. Collaborative workspaces rely on the exchange of ideas among companies and individuals within their shared workspace as a pull-factor for start-ups.

Cumulative Net Job Growth

Co-working facilities are meant for an individual or start-up seeking to maintain operational flexibility. Co-working spaces span from daily desk hourly rentals to monthly memberships for the facility. Co-working spaces occasionally offer business mentoring and networking events.

Amenities Offered

- Internet
- Print/Copy/Fax
- Phones
- Private Meeting Rooms
- Desk Rentals

Functional Examples

Cove (Boston, MA)
Clearly Coworking (Worcester, MA)
Cowork Springfield (Springfield, MA)

Makerspaces

Makerspaces provide shared-use tools and materials for patrons, defraying the cost of purchasing expensive machinery individually. Makerspaces, like co-working spaces, are generally a fee-for-service model, although there are makerspaces in municipal libraries and universities that are often freely available.

Amenities Offered

- Shared Machinery
  - Lathes
  - Drill Press
  - Laser Cutters
- Computer Lab
  - 3D Printer
  - Computer Aided Design (CAD)
- Woodshop
- Fiber Arts Equipment

Functional Examples

Danger!awesome (Cambridge,MA)
Technocopia (Worcester, MA)
Shire City Sanctuary (Pittsfield, MA)

Incubators

Incubators offer a workplace, basic business services, and entrepreneurship mentoring for tenant firms. Incubators are usually servicing early stage or seed stage firms. Incubators are often fee-based although some incubators may take equity exchange for services or even provide cash investments. Firms may remain in incubators for flexible time periods.

Amenities Offered

- Business Assistance
  - Marketing
  - Development
  - Legal
  - Human Resources
- Access to Specialized Tools & Software
- Entrepreneurship Educational Events

Functional Examples

Cape Ann Incubator (Gloucester, MA)
M2D2 (Lowell, MA)
Business Growth Center (Springfield, MA)

Accelerators

Accelerators include many of the same attributes as Incubators: they provide business mentorship, organize educational opportunities aimed at growing tenant firms, and may take an equity stake payment or provide a cash investment. Accelerators' major difference from other collaborative workspaces is the fixed structure of the program with beginning and end dates, as well as, the competitiveness of applying to the accelerator program.

Amenities Offered

- Business Assistance
  - Marketing
  - Development
  - Legal
  - Human Resources
- Entrepreneurship Educational Events
- Access to Capital
  - Mentorship from Entrepreneurs & Venture Capitalists

Functional Examples

E For All (Lowell, MA)
Cogo Labs (Cambridge, MA)
Spark (Holyoke, MA))

SPECIAL UPDATE: COLLABORATIVE WORKSPACES

Number of Collaborative Spaces
Services Offered
Massachusetts, 2016

	#	Shared Machinery	Capital	Mentoring	Life Sciences
Co-Working Spaces	42	1	-	12	-
Makerspaces	25	25	-	23*	-
Incubators	31	16	8	31	9
Accelerators	17	3	9	17	2

*Mentoring initiatives at makerspaces are focused on building technical proficiency with the equipment they provide access to, as opposed to the entrepreneurship-focused mentoring found at incubators and accelerators.

APPENDIX

The *Index* tracks a selection of 22 indicators that MassTech and its "Index Advisory Committee" (see pg 72) view as being the most comprehensive set of data for benchmarking the Innovation Economy. Indicators can change from year-to-year as new data sources become available and best-practices in tracking economic data are updated. MassTech and the "Index Advisory Committee" review the selection of indicators each year to determine whether indicators need to be added or removed and whether or not there is a better source of data available.

DATA SOURCES FOR INDICATORS AND SELECTION OF LEADING TECHNOLOGY STATES (LTS)

I. Note on Data Availability

Indicators are calculated with data from proprietary and other existing secondary sources. In most cases, data from these sources were organized and processed for use in the *Index*. Since these data are derived from a wide range of sources, content of the data sources and time frames are not identical and cannot be compared without adjustments. This appendix provides information on the data sources for each indicator.

The *Index* always displays the most recent year of data available for each indicator at the time of writing.

II. Note on Price Adjustment

The *Index* uses inflation-adjusted figures for most indicators. Dollar figures represented in this report, where indicated, are 'chained' (adjusted for inflation) to the latest year of data unless otherwise indicated. Price adjustments are according to the Consumer Price Index for all Urban Consumers, U.S. City Average, All Items, Not Seasonally Adjusted. Bureau of Labor Statistics, U.S. Department of Labor (www.bls.gov/data).

III. Note on Per-Capita Comparisons

The *Index* makes frequent use of per-capita metrics in order to make meaningful comparisons between states of vastly different sizes since the Leading Technology States range from roughly 1 million people to nearly 40 million. Per-capita or "as a % of" metrics allow the *Index* to make comparisons on density in certain measures, which MassTech views as crucial to cluster formation and growth. Where performance is less tied to a state's population, the *Index* includes absolute figures as well.

IV. Note on Selection of Leading Technology States (LTS) for Benchmarking Massachusetts Performance

The *Index* benchmarks Massachusetts performance against other leading states and nations to provide the basis for comparison. The LTS for this year's 20th anniversary includes the 10 states used every year since 2012; California, Connecticut, Illinois, Massachusetts, Minnesota, New Jersey, New York, Ohio, Pennsylvania, and Texas. This edition of the *Index* also includes five new states: Missouri, New Hampshire, North Carolina, Rhode Island, and Wisconsin. In 2015, the LTS were chosen using three criteria: (i.) by the number of select key industry sectors with a high concentration (10% above average) of employment, (ii.) the percent of employment in these sectors, and (iii.) the size of each states' innovation economy (measured by number of employees). The sectors used to represent the Innovation Economy include: Bio-pharma & Medical Devices, Computer & Communication Hardware, Defense Manufacturing & Instrumentation, Financial Services, Postsecondary Education, Scientific, Technical, & Management Services, and Software & Communications Services. The sector employment concentration for each state measures sector employment as a percent of total employment to the same measure for the U.S. as a whole. This ratio, called the 'location quotient' (LQ), is above average if greater than one. The three criteria are assessed simultaneously and with equal weighting. The score assigned to each state for each criterion is between 0 and 1, with 1 going to the leading state and 0 going to the bottom state. The scores for the rest of the states are determined by their relative position within the spread of data. The criteria scores are added together to get an overall score. The states with the 15 highest overall scores are then chosen for the LTS.

2016 Leading Technology States

State	Innovation Economy Score
Massachusetts	2.27
California	2.18
Pennsylvania	2.00
New York	1.71
Connecticut	1.69
Illinois	1.68
Ohio	1.63
Minnesota	1.52
New Hampshire	1.51
Rhode Island	1.49
New Jersey	1.43
North Carolina	1.43
Texas	1.39
Wisconsin	1.33
Missouri	1.32

The Innovation Economy (IE) Score is used only to select the LTS as described above, it does not reflect performance on all 22 indicators used in the *Index*.

Sources for the LTS Initiatives from pages 16-21:

1. http://www.masstech.org/innovation-institute/projects-and-initiatives/collaborative-research-matching-grant-program
2. http://www.masslifesciences.com/
3. http://boston.masschallenge.org/
4. https://biotechconnection-losangeles.org/about
5. http://www.sfmade.org/services/about-us/
6. http://www.connect.org/
7. http://www.catalystconnection.org/about/
8. http://www.sep.benfranklin.org/
9. https://www.sciencecenter.org/

Source: BLS QCEW

APPENDIX

10. https://buffalobillion.ny.gov/
11. http://www.sunycnse.com/Home.aspx
12. https://esd.ny.gov/nystar/centersforadvtechnolgy.asp
13. http://innovation.uconn.edu/tech-park/
14. http://ctnext.com/
15. http://ct.org/signature-event/connecticut-skills-challenge/
16. http://researchpark.illinois.edu/
17. http://www.illinoisinnovation.com/
18. http://www.illinoistreasurer.gov/Businesses/Technology_Development_Accounts
19. https://www.bioenterprise.com/
20. https://ewi.org/
21. http://www.competitiveworkforce.com/
22. https://mndrive.umn.edu/
23. http://www.enterpriseminnesota.org/
24. http://minnesota.uli.org/advisory-services/prospect-north-partnership/
25. http://www.nhirc.unh.edu/
26. http://livefreeandstart.com/get-informed/about/
27. https://nhhtc.org/nhhtc-events/techwomentechgirls/
28. http://www.underseatech.org/
29. http://commerceri.com/finance-business/taxes-incentives/innovation-vouchers/
30: http://stac.ri.gov/innovate-ri-fund/
31. http://njii.com/
32. http://www.njeda.com/real_estate/properties/tcnj
33. http://centers.njit.edu/njiac/students/challenge/index.php
34. http://www.rtp.org/
35. http://www.ncbioimpact.org/about_us.html
36. http://www.ncidea.org/content/about/945
37: http://gov.texas.gov/ecodev/guri/home
38. https://texaswideopenforbusiness.com/services/texas-enterprise-fund
39. http://biohouston.org/about/
40: http://inwisconsin.com/entrepreneurs/assistance/qualified-new-business-venture/
41. http://thewatercouncil.com/
42. http://uwmrealestatefoundation.org/innovationcampus/overview/vision.aspx
43. http://cortexstl.com/
44. https://missouriinnovation.com/
45. http://www.semo.edu/engage/mic.html

V. Note on Selection of Comparison Nations

For all the indicators that include international comparisons, countries displayed on the graph are the top performers for that measure. Some countries were excluded from comparison due to a lack of data reported for required years.

VI. Note on International Data Sources

For countries where the school year or the fiscal year spans two calendar years, the year is cited according to the later year. For example, 2004/05 is presented as 2005. All international population estimates are obtained from the World Bank. Total population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship—except for refugees not permanently settled in the country of asylum, who are generally considered part of the population of their country of origin. The numbers shown are mid-year estimates. The World Bank estimates population from various sources including census reports, the United Nations Population Division's World Population Prospects, national statistical offices, household surveys conducted by national agencies and Macro International.

APPENDIX

INDICATOR 1: INDUSTRY CLUSTER EMPLOYMENT AND WAGES

Data on sector wages are from the Bureau of Labor Statistics' Quarterly Census of Employment and Wages (www.bls.gov/cew). This survey derives employment and wage data from workers covered by state unemployment insurance laws and federal workers covered by the Unemployment Compensation for Federal Employees program. Wage data denote total compensation paid during the four calendar quarters regardless of when the services were performed. Wage data include pay for vacation and other paid leave, bonuses, stock options, tips, the cash value of meals and lodging, and contributions to deferred compensation plans.

INDICATOR 2: OCCUPATIONS AND WAGES

The U.S. Bureau of Labor Statistics, Occupational Employment Estimates (OES) (www.bls.gov/oes/oes_dl.htm) program estimates the number of people employed in certain occupations and wages paid to them. The OES data include all full-time and part-time wage and salary workers in non-farm industries. Self-employed persons are not included in the estimates. The OES uses the Standard Occupational Classification (SOC) system to classify workers. MassTech aggregated the 22 major occupational categories of the OES into 10 occupational categories for analysis.

The occupational categories in the *Index* are:

- Arts & Media: Arts, design, entertainment, sports and media occupations.
- Construction & Maintenance: Construction and extraction occupations; Installation, maintenance and repair occupations.
- Education: Education, training and library occupations.
- Healthcare: Healthcare practitioner and technical occupations; Healthcare support occupations.
- Computer and Mathematical: Computer and mathematical occupations.
- Science, Architecture and Engineering Occupations: Architectural and engineering occupations; life, physical and social science occupations.
- Business, Financial and Legal Occupations: Management occupations; Business and financial operations occupations; and
- Legal occupations.
- Production: Production occupations.
- Sales & Office: Sales and related occupations; Office and administrative support occupations.
- Community and Social Service: Community and social service occupations.
- Other Services: Protective service occupations; Food preparation and serving related occupations; Building and grounds cleaning and maintenance occupations; Personal care and service occupations; Transportation and material moving occupations; Farming, fishing and forestry occupations.

S&E Occupations as a Percent of the Workforce: Data taken from Table 8-33: Individuals in S&E Occupations as a Percent of the Workforce, NSF Science & Engineering Indicators.

INDICATOR 3: HOUSEHOLD INCOME

Median Household Income

Median household income data are from the U.S. Census Bureau, American Community Survey.

Income Distribution

Data for Distribution of Income are from the American Community Survey from the U.S. Census Bureau. Income is the sum of the amounts reported separately for the following eight types of income: wage or salary income; net self-employment income; interest, dividends, or net rental or royalty income from estates and trusts; Social Security or railroad retirement income; Supplemental Security Income; public assistance or welfare payments; retirement, survivor, or disability pensions; and all other income.

Wages and Salaries Paid

Wage and salary data from the Bureau of Economic Analysis, SQ7N Wage and salary disbursements by major NAICS industry, wage and salary disbursements by place of work (millions of dollars) (www.bea.gov).

INDICATOR 4: OUTPUT

Output

Industry output data are obtained from the Moody's economy.com Data Buffet. Moody's estimates are based on industry output data for 2 and 3 digit NAICS produced by the Bureau of Economic Analysis.

INDICATOR 5: EXPORTS

Exports data are from the U.S. Census Bureau, Foreign Trade Division. Currency data from xe.com.

APPENDIX

INDICATOR 6: RESEARCH AND DEVELOPMENT

Research and Development (R&D) Performed

Data are from the National Science Foundation (NSF), "Table: U.S. research and development expenditures, by state, performing sector and source of funding". Data used are the totals for all R&D, Federal, FFRDCs, Business, U&C and Other Nonprofit.

Industry Performed Research and Development (R&D) As a Percent of Industry Output

Data on industry performed R&D are from the NSF Science & Engineering Indicators, "Table 8-45: Business-performed R&D as a percentage of private-industry output, by state."

Research and Development (R&D) as a Percent of Gross Domestic Product (GDP)

Data for Massachusetts' R&D as a percent of GDP are from the NSF, "Table: U.S. research and development expenditures, by state, performing sector, and source of funding" and the Bureau of Economic Analysis (bea.gov).

Data for the LTS are from the NSF National Patterns of R&D Resources, "Table - Research and development expenditures, by state, performing sector, and source of funds". Data used are the totals for all R&D, Federal, FFRDCs, Business, U&C and Other Nonprofit. www.nsf.gov/statistics.

INDICATOR 7: ACADEMIC ARTICLE OUTPUT

LTS data are from the NSF "Table 8-49 - Academic science and engineering article output per $1 million of academic S&E R&D, by state and Table 8-48- Academic S&E Articles per 1,000 S&E Doctorate Holders in Academia by state". International data is from the NSF. "Table 5-27 - S&E articles in all fields, by region/country/economy". The NSF obtained its information on science and engineering articles from the Thomson Scientific ISI database. LTS population data are from the U.S. Census Bureau (www.census.gov/popest/data/index.html).

INDICATOR 8: PATENTS

United States Patent and Trademark Office (USPTO) Patents Granted

The count of patents granted by state are from the U.S. Patent and Trademark Office (USPTO). Patents granted are a count of Utility Patents only. The number of patents per year are based on the date patents were granted (www.uspto.gov). Population estimates are from the U.S. Census Bureau, Population Estimates Branch (www.census.gov/popest/data/index.html).

Patents Published Under the Patent Cooperation Treaty

International patents published under the Patent Cooperation Treaty (PCT) are from the World Intellectual Property Organization (WIPO) (http://patentscope.wipo.int/search/en/structuredSearch.jsf). Intellectual property data published in this report are taken from the WIPO Statistics Database, which is primarily based on information provided to WIPO by national/regional IP offices and data compiled by WIPO during the application process of international filings through the PCT, the Madrid System and the Hague System. The number of patents per year are based on the date of publication. GDP data is from the World Bank (data.worldbank.org).

INDICATOR 9: TECHNOLOGY PATENTS

The count of patents granted by state and patent class are from the U.S. Patent and Trademark Office (www.uspto.gov), Patenting By Geographic Region, Breakout by Technology Class. State population data come from the U.S. Census Bureau, Population Estimates Branch. (www.census.gov/popest/data/index.html).The number of patents per year are based on the date the patents were granted. Patents in "computer and communications" and "drugs and medical" are based on categories developed by in Hall, B. H., A. B. Jaffe, and M. Tratjenberg (2001). "The NBER Patent Citation Data File: Lessons, Insights and Methodological Tools." NBER Working Paper 8498. Patents in "advanced materials" and "analytical instruments and research methods" are based on categories developed by the Innovation Institute at MassTech. The "business methods" category has its own USPTO patent class.

INDICATOR 10: TECHNOLOGY LICENSING

Data on licensing agreements are from the Association of University Technology Managers website (AUTM) (www.autm.net). Institutions participating in the survey are AUTM members.

INDICATOR 11: SMALL BUSINESS INNOVATION RESEARCH (SBIR) AND TECHNOLOGY TRANSFER (STTR) AWARDS

This indicator includes SBIR award and Small Business Technology Transfer (STTR) award data. SBIR/STTR award data are from U.S. Small Business Administration (www.sbir.gov/sbirsearch/technology), state population data come from the U.S. Census Bureau, Population Estimates Branch (www.census.gov/popest/data/index.html) and GDP Data is from U.S. Bureau of Economic Analysis (www.bea.gov).

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INDICATOR 12: BUSINESS FORMATION

Business Establishment Openings

Data are from the Business Employment Dynamics database of the Bureau of Labor Statistics'(BLS) Business Employment Dynamics (www. bls.gov/bdm).

Net Change In Business Establishments In the Key Industry Sectors

The net change in business establishments was calculated using BLS (www.census.gov/econ/cbp/ index.html) Quarterly Census of Employment and Wages.

Start-up Companies

Data on spinout "start-up" companies are from the Association of University Technology Managers (AUTM). Institutions participating in the survey are all AUTM members (www.autm.net).

INDICATOR 13: INITIAL PUBLIC OFFERINGS AND MERGERS AND ACQUISITIONS

Initial Public Offerings (IPOs)

The number and distribution by industry sector of filed initial public offerings (IPOs) from 2015 on by state and for the U.S. are from IPO Monitor (https://www.ipomonitor.com/pages/ipo-filings.html). Data previous to 2015 are from Renaissance Capital's, IPOs Near You (www.renaissancecapital.com/IPOHome/Press/MediaRoom.aspx#). Data on venture-backed IPOs for 2012 are from the National Venture Capital Association (NVCA) (www.nvca.org).

Mergers & Acquisitions (M&As)

Data on total number of M&As are from Factset Mergerstat, deals include acquired company by location.

INDICATOR 14: FEDERAL FUNDING FOR ACADEMIC AND HEALTH R&D

Federal Expenditures For Academic And Nonprofit Research And Development (R&D)

Data are from the NSF, "Federal obligations for research and development for selected agencies, by state and other locations and performer" (www.nsf.gov/statistics). Data used are the entries for federal funding for universities and nonprofits, excluding university and nonprofit federally funded research and development centers (FFRDCs).

National Institutes of Health (NIH) Funding per Capita, per GDP and Average Annual Growth Rate

Data on federal health R&D are from the NIH (http://report.nih.gov/award/). The NIH annually computes data on funding provided by NIH grants, cooperative agreements and contracts to universities, hospitals and other institutions. The figures do not reflect institutional reorganizations, changes of institutions, or changes to award levels made after the data are compiled. Population data is from U.S. Census Bureau (http://www.census.gov/popest/data/index.html). GDP data is from Bureau of Economic Analysis (bea.gov), U.S. Department of Commerce.

INDICATOR 15: INDUSTRY FUNDING OF ACADEMIC RESEARCH

Data are from the NSF Survey of Research and Development Expenditures at Universities and Colleges and Survey of Research and Development Expenditures at Universities and Colleges, Business Financed Higher Education R&D Expenditures for S&E (http://www.nsf.gov/statistics/srvyrdexpenditures/). Since FY 1998, respondents have included all eligible institutions. Population data is from U.S. Census Bureau (http://www.census.gov/popest/data/index.html).

INDICATOR 16: VENTURE CAPITAL (VC)

Data for total VC investments, VC investments by industry activity, and distribution by stage of financing are provided by PricewaterhouseCoopers (PwC) in the MoneyTree Report (https://www.pwcmoneytree.com/MTPublic/ns/nav. jsp?page=historical). Industry category designations are determined by PwC. Definitions for the industry classifications and stages of development used in the MoneyTree Survey can be found at the PwC website (http://www.pwcmoneytree.com/moneytree/nav. jsp?page=definitions). GDP data are from Bureau of Economic Analysis (bea.gov), U.S. Department of Commerce.

PWC Stage Definitions: https://www.pwcmoneytree.com/MTPublic/ns/nav.jsp?page=definitions#stage

APPENDIX

INDICATOR 17: EDUCATIONAL ATTAINMENT

For this indicator, the workforce is defined as the population ages 25-65. Data on educational attainment of this population are from the U.S. Census Bureau (http://www.census.gov/cps/data/cpstablecreator.html), Current Population Survey, Annual Social and Economic Supplement, 2012. Figures are three-year rolling averages. Data on employment rate by educational attainment are based on the full-time employment rate of the workforce.

High School Attainment by the Population Ages 19-24

Data on high school attainment are from the US Census Bureau, Current Population Survey (http://www.census.gov/cps/data/cpstablecreator.html), Annual Social and Economic Supplement. Figures are three year rolling averages.

College Degrees Conferred

Data for the U.S. states comes from the National Center for Education Statistics using the sum of all degrees conferred at the bachelor's level or higher.

TIMSS 8th Grade Science data are from Trends in International Mathematics and Science Study 2011 International Results in Science, TIMSS and PIRLS International Study Center, Lynch School of Education, Boston College, 2012.

INDICATOR 18: PUBLIC INVESTMENT EDUCATION

Per Pupil Spending in K-12

Public elementary & secondary school finance data are from the U.S. Census Bureau, Table 19, "Per Pupil (PPCS) Amounts and One-Year Percentage Changes for Current Spending of Public Elementary-Secondary School Systems by State". Figures are presented in current dollars. Data excludes payments to other school systems and non K-12 programs.

State Higher Education Appropriations per FTE

Data on public higher education appropriations per full-time equivalent (FTE) student is provided by the State Higher Education Executive Office (http://www.sheeo.org/finance/shef-home.htm). The data consider only educational appropriations—state and local funds available for public higher education operating expenses, excluding spending for research, agriculture, and medical education and support to independent institutions and students. The State Higher Education Finance Report employs three adjustments for purposes of analysis: Cost of Living Adjustment (COLA) to account for differences among the states, Enrollment Mix Index (EMI) to adjust for the different mix of enrollments and cost among types of institutions across the states and the Higher Education Cost Adjustment (HECA) to adjust for inflation over time. More detailed information about each of these adjustments can be found on the SHEEO website.

INDICATOR 19: SCIENCE, TECHNOLOGY, ENGINEERING, AND MATH (STEM) CAREER CHOICES AND DEGREES

STEM Degrees

Data about degrees conferred by field of study are from NCES, IPEDS Completions Survey using the NSF population of institutions. Data were accessed through the NSF WebCASPAR (http://caspar.nsf.gov). Fields are defined by 2-digit Classification of Instructional Program (CIP), listed below.

- Science: 26 - Biological & Biomedical Sciences and 40-Physical Sciences
- Technology: 11 - Computer & Information Science & Support Services
- Engineering: 14 - Engineering
- Math: 27 - Mathematics & Statistics

Science & Engineering Talent by Categories

Data for Science & Engineering (S&E) Talent provided by the United States Census Bureau, Decennial Census and American Community Survey Public Use Microdata Samples (PUMS). A list of S&E occupations were divided into six categories: Computer, Physical Engineers, Design, Biological, Mathematics and Aerospace Engineers & Scientists. Design includes Designers and Artists & Related Workers. Both were added to the S&E occupations to try to capture the employment in Graphic Designers and Multi-Media Artists & Animators. According to BLS Occupation Employment Statistics (May 2009), both occupations represent almost 60 percent of employment in both Designers and Artists & Related Workers.

Science & Engineering Doctorates

Data for S&E doctorates comes from the Science and Engineering Doctorates report, table 9, published by the NSF.

Life Science Major Graduates

Data for life science major graduates was obtained from the National Center for Education Statistics College Navigator.

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INDICATOR 20: TALENT FLOW AND ATTRACTION

Relocations to LTS by College Educated Adults

Data on population mobility come from the U.S. Census Bureau, American Community Survey; Table B07009-Geographic Mobility in the Past Year by Educational Attainment, 1-year estimate. This is the number of people moving in and includes no information about the number moving out. It can be used as a measure of the ability to attract talent.

Net Migration

Net Migration figures are derived from the U.S. Census Bureau's population estimates program using annual data.

INDICATOR 21: HOUSING AFFORDABILITY

Housing Price Index

Housing price data are from the Federal Housing Finance Agency's Housing Price Index (HPI) (http://www.fhfa.gov/). Figures are four-quarter percent changes in the seasonally adjusted index. The HPI is a broad measure of the movement of single-family house prices. The HPI is a weighted, repeat-sales index that is based on repeat mortgage transactions on single-family properties whose mortgages have been purchased or securitized by Fannie Mae or Freddie Mac since January 1975.

Housing Affordability

Housing affordability figures are from the U.S. Census Bureau, American Community Survey, R2513: "Percent of Mortgaged Owners Spending 30 Percent or More of Household Income on Selected Monthly Owner Costs" and R2515: "Percent of Renter-Occupied Units Spending 30 Percent or More of Household Income on Rent and Utilities".

Median Household Income

Median household income data are from U.S. Census Bureau, American Community Survey, B19013: "Median Household Income in the Past 12 Months", 3-year estimate.

INDICATOR 22: INFRASTRUCTURE

Broadband Speed

Data is taken from Akamai Technologies State of the Internet report.

Industrial Electricity Rates

Data is taken from the United States Energy Information Administration.

Median Commute Time

Data is taken from the U.S. Census Bureau American Community Survey County Level Statistics. Metro area median commutes were determined using the median commute time of each component county and its proportion of total metro area commuters.

APPENDIX

The *Index* makes use of 4, 5 and 6 digit North American Industry Classification System (NAICS) codes to define key industry sectors of the Massachusetts Innovation Economy. The *Index's* key industry sector definitions capture traded-sectors that are known to be individually significant in the Massachusetts economy. Consistent with the innovation ecosystem framework, these sector definitions are broader than 'high-tech'. Strictly speaking, clusters are overlapping networks of firms and institutions which would include portions of many sectors, such as Postsecondary Education and Business Services. For data analysis purposes the *Index* has developed NAICS-based sector definitions that are mutually exclusive.

Modification to Sector Definitions

The eleven key industry sectors as defined by the *Index* reflect the changes in employment concentration in the Massachusetts Innovation Economy over time. For the purposes of accuracy, several sector definitions were modified for the 2007 edition. The former "Healthcare Technology" sector was reorganized into two new sectors: "Biopharmaceuticals, Medical Devices and Hardware" and "Healthcare Delivery." The former "Textiles & Apparel" sector was removed and replaced with the "Advanced Materials" sector. While "Advanced Materials" does not conform to established criteria, it is included in an attempt to quantify and assess innovative and high-growing business activities from the former "Textiles & Apparel" sector.

With the exception of Advanced Materials, sectors are assembled from those interrelated NAICS code industries that have shown to be individually significant according to the above measures. In the instance of the Business Services sector, it is included because it represents activity that supplies critical support to other key sectors. In the 2009 *Index*, the definition of Business Services was expanded to include 5511-Management of Companies and Enterprises. According to analysis by the Bureau of Labor Statistics, this category has at least twice the all-industry average intensity of technology-oriented workers. All time-series comparisons use the current sector definition for all years, and, as such, may differ from figures printed in prior editions of the Index. The slight name change in 2009 of the Bio-pharma and Medical Devices sector does not reflect any changes in the components that define the sector.

Advanced Materials

3133 Textile and Fabric Finishing and Fabric Coating Mills
3222 Converted Paper Product Manufacturing
3251 Basic Chemical Manufacturing
3252 Resin, Synthetic Rubber and Artificial and Synthetic Fibers and Filaments Manufacturing
3255 Paint, Coating and Adhesive Manufacturing
3259 Other Chemical Product and Preparation Manufacturing
3261 Plastics Product Manufacturing
3262 Rubber Product Manufacturing
3312 Steel Product Manufacturing from Purchased steel
3313 Alumina and Aluminum Production and Processing
3314 Nonferrous Metal (except Aluminum) Production and Processing

Biopharmaceuticals, Medical Devices & Hardware

3254 Pharmaceutical and Medicine Manufacturing
3391 Medical Equipment and Supplies Manufacturing
6215 Medical and Diagnostic Laboratories
42345 Medical Equipment and Merchant Wholesalers
42346 Ophthalmic Goods Merchant Wholesale
54171 Physical, Engineering and Biological Research

With 2007 NAICS, apportioned based on 541711 R&D in Biotechnology

334510 Electro Medical Apparatus Manufacturing
334517 Irradiation Apparatus Manufacturing

Business Services

5411 Legal Services
5413 Architectural, Engineering and Related Services
5418 Advertising and Related Services
5511 Management of Companies
5614 Business Support Services

Computer & Communications Hardware

3341 Computer and Peripheral Equipment Manufacturing
3342 Communications Equipment Manufacturing
3343 Audio and Video Equipment Manufacturing
3344 Semiconductor and Other Electronic Component Manufacturing
3346 Manufacturing and Reproducing Magnetic and Optical Media
3359 Other Electrical Equipment and Component Manufacturing

Defense Manufacturing & Instrumentation

3329 Other Fabricated Metal Product Manufacturing
3336 Engine, Turbine and Power Transmission Equipment Manufacturing
334511 Search, Detection, Navigation, Guidance, Aeronautical and Nautical System and Instrument Manufacturing
334512 Automatic Environmental Control Manufacturing for Residential, Commercial and Appliance Use
334513 Instruments and Related Products Manufacturing for Measuring, Displaying and Controlling Industrial Process Variables
334514 Totalizing Fluid Meter and Counting Device Manufacturing
334515 Instrument Manufacturing for Measuring and Testing Electricity and Electrical Signals
334516 Analytical Laboratory Instrument Manufacturing
334518 Watch, Clock and Part Manufacturing
334519 Other Measuring and Controlling Device Manufacturing
3364 Aerospace Product and Parts Manufacturing

Diversified Industrial Manufacturing

3279 Other Nonmetallic Mineral Product Manufacturing
3321 Forging and Stamping
3322 Cutlery and Handtool Manufacturing
3326 Spring and Wire Product Manufacturing
3328 Coating, Engraving, Heat Treating and Allied Activities
3332 Industrial Machinery Manufacturing
3333 Commercial and Service Industry Machinery Manufacturing
3335 Metalworking Machinery Manufacturing
3339 Other General Purpose Machinery Manufacturing
3351 Electric Lighting Equipment Manufacturing
3353 Electrical Equipment Manufacturing
3399 Other Miscellaneous Manufacturing

Financial Services

5211 Monetary Authorities - Central Bank
5221 Depository Credit Intermediation
5231 Securities and Commodity Contracts Intermediation and Brokerage

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5239 Other Financial Investment Activities
5241 Insurance Carriers
5242 Agencies, Brokerages and Other Insurance Related Activities
5251 Insurance and Employee Benefit Funds
5259 Other Investment Pools and Funds

Healthcare Delivery

6211 Offices of Physicians
6212 Offices of Dentists
6213 Offices of Other Health Practitioners
6214 Outpatient Care Centers
6216 Home Health Care Services
6219 Other Ambulatory Health Care Services
622 Hospitals

Postsecondary Education

6112 Junior Colleges
6113 Colleges, Universities and Professional Schools
6114 Business Schools and Computer and Management Training
6115 Technical and Trade Schools
6116 Other Schools and Instruction
6117 Educational Support Services

Scientific, Technical & Management Services

5416 Management, Scientific and Technical Consulting Services
5417 Scientific Research and Development Services*
*Minus the portion apportioned to the Bio sector
5419 Other Professional, Scientific and Technical Services

Software & Communications Services

5111 Newspaper, Periodical, Book and Directory Publishers
5112 Software Publishers
5171 Wired Telecommunications Carriers
5172 Wireless Telecommunications Carriers (except Satellite)
5174 Satellite Telecommunications
5179 Other Telecommunications
5182 Data Processing, Hosting and Related Services
5415 Computer Systems Design and Related Services
8112 Electronic and Precision Equipment Repair and Maintenance

With 2007 NAICS add 51913 Internet publishing and broadcasting and web search portal

ABOUT MASSTECH

The *Index of the Massachusetts Innovation Economy*, has been published by the Innovation Institute at the MassTech Collaborative annually since 1997. The *Index* is the premier fact-based benchmark for measuring the performance of the Massachusetts knowledge economy. To view the *Index* online and for more information on the Massachusetts Innovation Economy, visit us at: masstech.org/index.

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Thomas O'Donnell, Visiting Faculty at UMass Lowell's Manning School of Business, Director, Innovation Hub

INDEX STAFF

Content Creation

Project Director: James F. Byrnes, Jr., Senior Operations Manager, Innovation Institute at Massachusetts Technology Collaborative
Lead Researcher: William R. A. Fuqua, Program Research Analyst, Innovation Institute at Massachusetts Technology Collaborative
Assistant Researcher: Vaske Gjino, Research & Analysis Intern, Innovation Institute at Massachusetts Technology Collaborative

Report Design

Kathryn A. Murphy, Digital Media Specialist, Massachusetts Technology Collaborative

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