

# The MASSACHUSETTS INNOVATION ECONOMY ANNUAL INDEX

Massachusetts Technology Collaborative

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**THE INNOVATION INSTITUTE**

at the MasTech Collaborative

**MASSTECH.ORG**

The Index of the Massachusetts Innovation Economy, published annually since 1997, is the premier fact-based benchmark for measuring the performance of the Massachusetts knowledge economy.

To view the Index online visit our  
Innovation Index portal at:  
**[index.masstech.org](http://index.masstech.org)**

For more information on the  
Massachusetts innovation economy  
visit our website at:  
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# Massachusetts USA

## Leading the Innovation Revolution

**Dear Friends,**

It is my pleasure to welcome you to the 2013 Index of the Massachusetts Innovation Economy. Published annually by the MassTech Collaborative, the Index is one of the Commonwealth's key instruments for assessing the performance of the key industry sectors that make up the innovation economy. While Massachusetts has recovered from the recession stronger and better than many states, the Commonwealth now confronts the challenge of accelerating innovation and job growth in the face of growing competition from other states and uncertain federal policy. A collaborative, strategic approach to innovation-based economic development in Massachusetts is critical to our state's future prospects.

Since 1997, MassTech has produced the Index, analyzing the growth and sustainability of the Innovation Economy in the Commonwealth. The Index examines not only the strengths of the Massachusetts Innovation Economy, but also areas of concern that need to be addressed if we are to remain at the forefront of innovation and economic development.

The Index is a valuable tool in this endeavor, as it stimulates a rich dialogue that helps us to better understand the performance of the state's research and innovation ecosystem, its impact on the competitiveness of industries, and its ability to generate shared prosperity and opportunity in regions throughout the Commonwealth.

A central goal of the Patrick Administration's economic development plan has been to encourage effective partnerships between universities, industry and government. These partnerships impact the local economy, resulting in business growth and attracting the best talent the world has to offer. In this year's edition, we have taken a forward-looking approach to the issue of talent development and retention. Talent is a key factor meeting a major role in the competitiveness of the Commonwealth in the future, so it is our hope that this analysis will create an awareness that will lead to action that enables Massachusetts to remain at the forefront of talent development, feeding the needs of industry for generations to come.

I invite you to read the Index and join the conversation.

A handwritten signature in black ink, appearing to read 'Gregory Bialecki'.

**Gregory Bialecki**

*Chair, Board of Directors, Massachusetts Technology Collaborative  
Secretary, Executive Office of Housing and Economic Development*



## MassTech: Who We Are

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**, **Massachusetts eHealth Institute** and the **Massachusetts Broadband Institute** - 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.

## MassTech: Our Mission

Our mission is to strengthen the innovation economy in Massachusetts, for the purpose of generating more high-paying jobs, higher productivity, greater economic growth and improved social welfare.

## 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 that promotes understanding and informs policy development.

The Innovation Institute convenes with and invests in academic, research, business, government and civic organizations which share the vision of enhancing the Commonwealth's innovation economy.

Using an innovative, stakeholder-led process, we have been implementing 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.

The Institute manages programs which focus on Advanced Manufacturing in the state, driving support for emerging sectors such as Big Data and Robotics and spurring programs which keep talented workers in the Commonwealth, whether through the Intern Partnership program or on entrepreneurship mentoring. Our mission is to strengthen the innovation economy in Massachusetts, for the purpose of generating more high-paying jobs, higher productivity, greater economic growth and improved social welfare.

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## INTRODUCTION

Massachusetts has had a stronger recovery from the Great Recession than most other states and its innovation economy continues to grow, led by scientific, technical and management services, software and healthcare. Massachusetts' innovation economy sectors generally produce more output per capita than their counterparts in the Leading Technology States (LTS) and the Commonwealth's innovation economy wages have continued to grow in the wake of the recession. Massachusetts continues to perform well above the LTS average in measures of research inputs and outputs and its rate of technology licensing and start-up formation is at the top of the LTS. A highly educated labor force and robust Research and Development (R&D) environment have kept Massachusetts at the leading edge of innovation.

However, you will see in this year's Index that other states are catching up to and even exceeding Massachusetts on key measures. States are beginning to innovate better and competition is increasing in areas in which Massachusetts has been historically strong. Though Massachusetts maintains a strong commitment to public K-12 education funding, it has fallen into the bottom half of the LTS in higher education funding per student and has experienced a faster rate of decline in this measure than any other LTS. The Patrick Administration has recently reversed a years-long trend of declining public support for public higher education through increased funding. Massachusetts produces more college graduates per capita and has a higher percentage of college educated workers than any other state, but has seen declining high school attainment over the last three years while other states have seen increases. The innovation economy is continually in flux and Massachusetts will need to adapt to shifting trends if it is to maintain its highly competitive position.



*The Kariotis building on the MassTech campus. Photography by Dan Mushrush.*

## HIGHLIGHTS



### ECONOMIC IMPACT

Massachusetts sees greater economic impact from the innovation economy than any other state. Nearly 40% of the state's workforce is employed within an innovation economy sector, a much higher percentage than any other state. Innovation economy wages are typically much higher than average wages and Massachusetts innovation economy employees earn more than their counterparts in the average LTS. That said, wages are stagnant in many sectors and non-innovation economy employment is growing faster than innovation economy employment in Massachusetts.

### TECHNOLOGY & BUSINESS DEVELOPMENT

The number and value of Small Business Innovation and Research/Technology Transfer (SBIR/STTR) awards has decreased over the last two years. However, Massachusetts remains a clear leader in award dollars as a percentage of GDP, with more than twice the level of the next closest LTS. Massachusetts continues to see strong growth in patents and remains the leader in patents issued per capita. Massachusetts ranks second in patent growth per capita and placed in the top 4 of the LTS in each category of technology patents per capita. Massachusetts' research institutions and universities have seen sustained growth in revenue from technology licensing and execute more licenses and options than any other LTS.

## HIGHLIGHTS

### RESEARCH

Massachusetts remains a leader in R&D across multiple metrics.

The Commonwealth receives more R&D funding per capita, more National Institutes of Health (NIH) funding as a percentage of GDP, and produces more academic science & engineering articles per capita than any of the LTS. Massachusetts' academic article output compares favorably to the rest of the world as well, ranking ahead of countries like Switzerland, Sweden and Denmark.

### TALENT

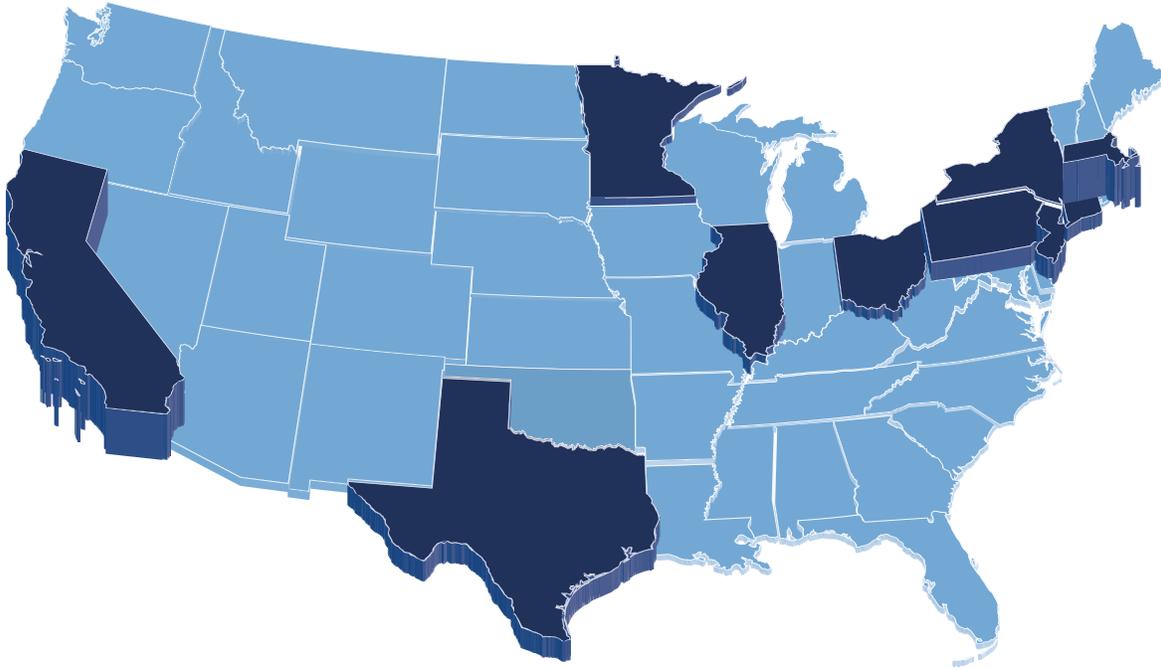
Massachusetts continues to have one of the most educated workforces in both the U.S. and the world, with 66% of working age adults having at least some college education. 45% have bachelor's degrees, placing Massachusetts ahead of all other LTS. Massachusetts confers more postsecondary degrees per capita than any other LTS and is a leader in public K-12 funding per pupil. Massachusetts' commitment to public higher education funding is much lower than the average of the LTS. The state remains a popular relocation destination for college educated adults, although cost of living is a concern.



### CAPITAL

Massachusetts is a top destination for federal R&D funding both in absolute and per capita terms. Among the LTS, only California receives more federal R&D funding for universities and other non-profits. Massachusetts is a top destination for venture capital (VC) as well, ranking behind California in absolute terms, but ranking first in VC as a percent of GDP. Biotechnology and software attract the vast majority of Massachusetts VC funding. Massachusetts VC firms raised around a third of all U.S. VC in 2013, tripling the amount raised in 2012.

## SELECTION OF THE LEADING TECHNOLOGY STATES



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 make up the Innovation Economy in Massachusetts. This year, we have taken a fresh look at how we measure the innovation economy, a review that has resulted in a number of new LTS against which Massachusetts is being compared. These changes reflect not only an improvement in how we define the innovation economy, but also the increased competition we are facing as states evolve strengths similar to those of the Commonwealth. In previous editions of the Index, the LTS were selected based on the number of innovation economy sectors with above average employment concentration using metrics such as overall innovation economy employment concentration as a tie breaker. This year’s edition 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 2013 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 level percentage and is a measure of the overall intensity of a state’s innovation economy.
- Total innovation economy employment-**  
 This simply 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.

State	Score
<b>Top Ten</b>	
Massachusetts	2.27
California	2.16
Pennsylvania	1.93
New York	1.67
Connecticut	1.66
Illinois	1.66
Ohio	1.58
New Jersey	1.53
Texas	1.51
Minnesota	1.47
<b>Next Five</b>	
North Carolina	1.38
Wisconsin	1.28
Maryland	1.24
Virginia	1.23
New Hampshire	1.21

A score is then applied to all of the states in order to determine the top 10. This methodology has resulted in the inclusion of three new states (Illinois, Ohio and Texas), causing Maryland, North Carolina and Virginia to fall outside the top ten of the LTS. The states that dropped out of the LTS still performed quite well, but additional metrics, and the fact that none of these states was a standout in any of them, was enough for three other states to score higher.

## LEADING TECHNOLOGY STATES (LTS)

**CALIFORNIA:** California is a leader in 5 of the 11 sectors used to define the innovation economy and easily has the highest number of innovation economy employees, despite having a slightly below average overall concentration of employees. California contains both San Francisco and Silicon Valley, home to well-known companies such as Google, Apple and Facebook in addition to a robust start-up community. California is also home to top research universities such as Cal Tech, Stanford, UC Berkley and UCLA.

**CONNECTICUT:** Despite its small size, Connecticut is a leader in 6 of 11 key sectors and has the second highest overall concentration of innovation economy employees. The state's defense, financial services, and diversified industrial manufacturing industries are particularly strong, represented by companies such as Pratt & Whitney, The Hartford Insurance and United Technologies. Connecticut is also home to numerous top-tier colleges and universities including Yale and the University of Connecticut.

**ILLINOIS:** Illinois is a leader in 5 of 11 key sectors, has a relatively large number of innovation economy employees, and an above average overall innovation economy employment concentration. Illinois is particularly strong in manufacturing (John Deere & Caterpillar) and financial services (Chicago Mercantile Exchange) and is home to well-known universities and colleges including Northwestern University, University of Chicago and University of Illinois.

**MASSACHUSETTS:** Massachusetts is a leader in 9 of the 11 sectors used to define the innovation economy and has the highest overall concentration of innovation economy employees. Massachusetts is home to a large concentration of research institutions, biotech firms, and software firms. In addition to a diverse array of start-ups, Massachusetts is home to the headquarters or major operations of State Street Bank, EMC, Microsoft, Genzyme, Cisco and Raytheon. The state is home to many universities, colleges and research institutions including Harvard, Massachusetts Institute of Technology (MIT), Tufts and the University of Massachusetts system.

**MINNESOTA:** Despite its relatively small population, Minnesota is a leader in 5 of 11 key sectors and has a high concentration of innovation economy employees. The state is particularly strong in biopharma & medical devices, manufacturing and financial services. Representative companies include the Mayo Clinic, Medtronic, 3M and U.S. Bancorp.

**NEW JERSEY:** New Jersey is a leader in 5 of 11 key sectors and has an above average employment concentration. The state is home to many pharmaceutical companies and their R&D facilities and has strong financial services and software industries. The state is home to many universities and colleges including Princeton, Rutgers and Stevens Institute of Technology.

**NEW YORK:** New York has a large number of innovation economy employees, a high overall employment concentration, and is a leader in 3 of 11 sectors that make up the innovation economy. As the home of Wall Street, the state's financial services sector is particularly strong. New York is also a leader in postsecondary education with universities such as Cornell, Columbia, Syracuse University, New York University and the State University of New York system.

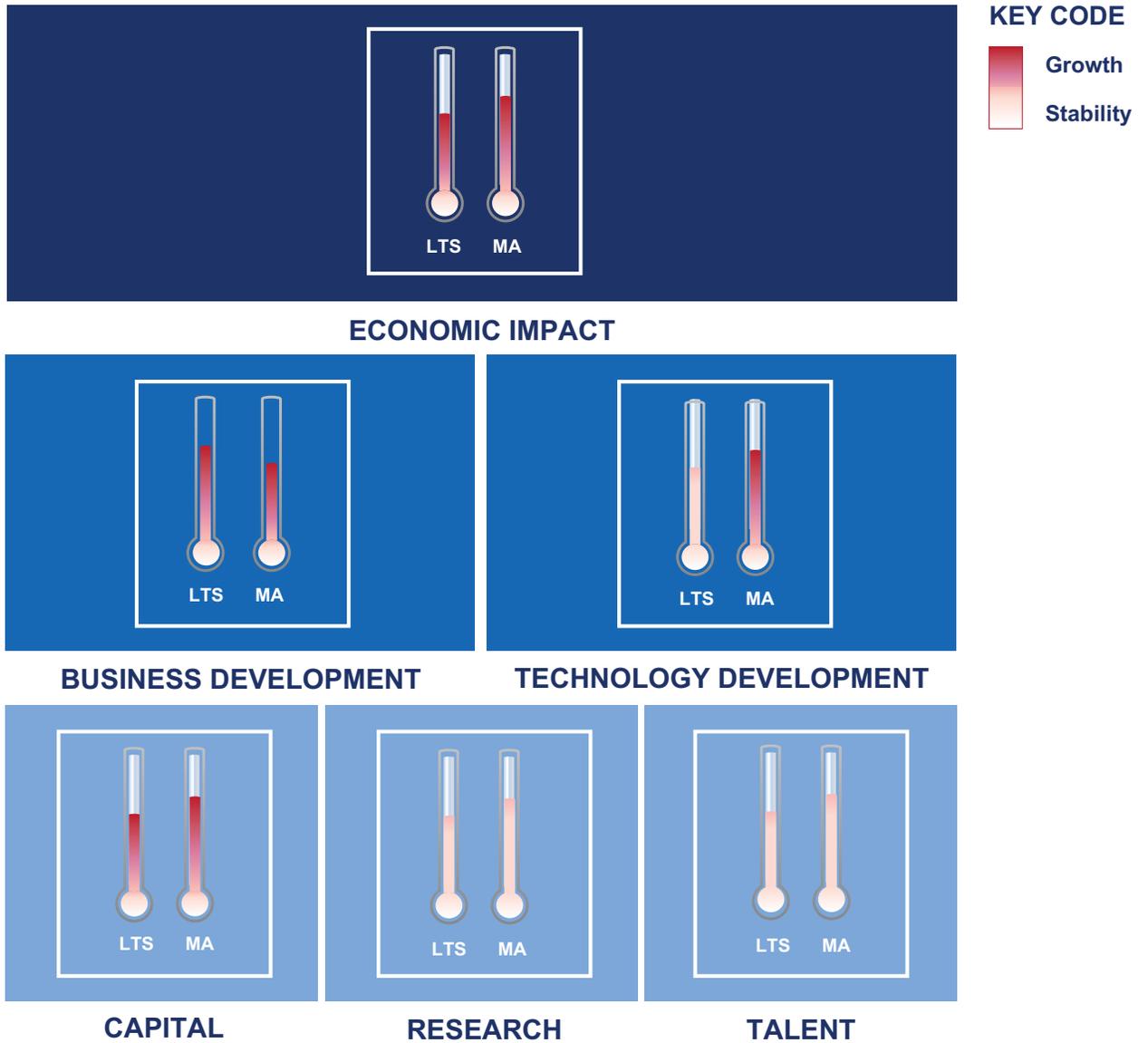
**OHIO:** Ohio is a leader in 5 of the 11 key sectors, has a relatively large number of innovation economy employees, and has an above-average innovation economy employment concentration. Ohio's strengths lie in manufacturing, business services and healthcare delivery, represented by companies such as GE Aviation and Cleveland Clinic. The state is also home to many universities including Ohio State and Case Western Reserve.

**PENNSYLVANIA:** Pennsylvania is a leader in 7 of the 11 sectors used to define the innovation economy, in addition to a large number of innovation economy employees and a high overall employment concentration. Companies representative of Pennsylvania's diversity within the innovation economy include PNC Financial, GE Transportation Systems, Comcast and Wyeth Pharmaceuticals. Pennsylvania is home to many research universities including Penn State, Carnegie Mellon, University of Pennsylvania and University of Pittsburgh.

**TEXAS:** While Texas is a leader in only 2 key sectors, it has the second highest number of innovation economy employees. Texas' strengths lie in computer & communications hardware and defense, and is home to companies including Dell, Texas Instruments and NASA's Johnson Space Center. The state is also home to research universities including Rice, University of Houston and University of Texas.

# DASHBOARD

## How Massachusetts is Doing | Relative to the Leading Technology States



- **Economic Impact:** The innovation economy has a greater impact in Massachusetts than in any other state. Compared to the LTS, the Commonwealth has both the largest share of its employment within the innovation economy and the highest number of innovation economy sectors with significantly above average employment concentration.
- **Business Development:** Both Massachusetts and the LTS are experiencing growth in business formation, although some states are seeing much faster growth than the Commonwealth.
- **Technology Development:** Massachusetts continues to lead in overall patents per capita and is among the leaders in most categories of technology patents.
- **Capital:** Massachusetts is a top state for attracting capital, whether it is public R&D funding or private venture capital. Private capital is growing in both the Commonwealth and the LTS.
- **Research:** Cutbacks in some categories of federal funding means both Massachusetts and many LTS have experienced a stabilization in research activity. However, the Commonwealth continues to attract a large share of research activity, especially in per capita terms.
- **Talent:** Massachusetts is still a magnet for highly educated adults. Educational attainment within the state appears to have levelled off somewhat, albeit at a very high level.



## SPECIAL ANALYSIS: TALENT IN THE COMMONWEALTH'S INNOVATION WORKFORCE

Developing, attracting, and retaining talent is as crucial for the future of the Massachusetts Innovation Economy as any other determining factor, from infrastructure and quality of life to the cost of doing business and availability of venture capital.

Compared to the Index's other Leading Technology States (LTS), Massachusetts is at or near the top when it comes to having a highly educated workforce and strong talent pipeline. Sixty-six percent of the working age population have at least some college education and forty-five percent hold a bachelor's degree or higher, a larger percentage than any other state. Massachusetts is also a leader in domestic and international rankings (second only to Singapore) in 8th grade science skills.

The breadth and depth of the Massachusetts talent pool is one of the primary reasons so many multinational firms, from Amazon and Autodesk, to Novartis and Dassault Systemes, choose to have a presence here. The state's highly-educated human capital also fuels its tremendous research enterprise, so that the ratio of R&D spending to GDP is higher here than any other of the LTS. Furthermore, talent attracts financial capital which enables the most robust, cutting-edge ideas to transform into some of the world's most exciting startups. Massachusetts is second only to California in the number of startups initiated by licensing technology from universities, research institutions, hospitals and technology investment firms.

For the Massachusetts innovation economy to continue thriving in all of these ways, it is essential for the state to respond to, keep pace with and preferably stay ahead of evolving trends that might impact future human capital development. For example, the Patrick Administration recently renewed the Commonwealth's commitment to funding public higher education, thereby reversing a long-term trend of declining public support, and better enabling the development of a broad and deep pool of skilled and knowledgeable talent across the state.

This year's Special Analysis section further explores issues around talent, both for the state's tech sector specifically and for the broader innovation economy more generally. In the pages that follow, several knowledgeable commentators share their views about tech talent needs over the next five-ten years, whether in their own companies or the sector at-large. Their comments add to an ongoing public discourse about the state's tech talent that reaches at least as far back as the Tech Hub Collaborative that Governor Patrick launched four years ago. It also includes, among other venues, last year's roundtable series between Economic Development Secretary Bialecki and the business leadership of emerging tech sectors; a recent Mass Technology Leadership Council report on tech workforce constraints and solutions; and a forthcoming big data industry analysis from MassTech and the Mass Competitive Partnership.

The Index commentators are:

- **John Barrett**, a Managing Director at the executive search firm Cook Associates and a member of the Index Advisory Committee, who observes that inevitable demographic and social trends will increasingly require that technical expertise be married to high-quality "soft skills" for communicating and relating in a diverse global population.
- **Siobhan Dullea**, Chief Client Officer at Communispace and **Brian Halligan, CEO** and Co-founder of Hubspot—represent two of the state's fastest growing digital tech companies, they reflect on how they grow their workforces to balance specific tech expertise with the 'right' attitude, along with foundational skillsets so they can shape the sort of business cultures they want to promote over the long term.
- **Jim Stanton**, Executive Director of the Massachusetts Computing Attainment Network and Senior Project Director at the Education Development Center describes a relatively new coalition of organizations championing better computer science education to ensure that the students making up the future workforce universally have some grounding in the computing-related skills that tech and other industries need to create next-generation innovations.

**Taken together, the set of commentaries emphasizes that the talent that fuels tech innovation in Massachusetts cannot be narrowly defined neatly into a single box. Many lines are blurring between the skills demanded for technical innovation and "traditional" economy jobs, and the star hires of the modern workplace carry multiple skillsets, cultural perspectives, or lines of expertise, from creative and artistic, to technical and managerial.**

Taking a step back, the talent needs of the innovation economy do not seem so different from those of the region's local sports teams which have cultivated the specific skills of individual athletes and built up their collective team talent pool and culture to win one or more championships over the last decade. The 2013 Boston Red Sox, for example, are noted for evolving a culture that enabled them to go from "worst" to "first" by developing all-star talent internally (e.g., outfielder Jacoby Ellsbury and pitcher John Lester), as well as attracting high-end outside talent to their roster (e.g., pitcher Ryan Dempster and shortstop Stephen Drew). Similarly, the talent that fuels tech innovation in Massachusetts comes from combining superb technical expertise with the right attitude; fostering the growth of existing workers while welcoming new players; and setting baseline expectations for foundational skills. It is a strategy to keep the Massachusetts economy, the Red Sox and other teams at a championship caliber for years to come.

## COMMENTARIES



*Cook Associates Executive Search provides executive search services to clients ranging from early-stage and venture-funded companies to the Fortune 100. Industry-focused practice areas include: technology, digital media and entertainment, business and financial services, consumer and industrial markets, higher education and private equity.*

### Cook Associates, Inc. Executive Search: Renewed Emphasis On “Soft Skills”

We have every reason to be optimistic about the talent outlook for Massachusetts' technology sector. We have the two most important ingredients that will underpin our locally grown talent pool: 1) a great education system and 2) a large number of already successful technology companies. With that said, the competition from other states and even other countries is not slowing down and we should look at evolving our education curriculum in significant ways in our secondary schools and at the college level. There are several game changing trends taking place nationally and locally that will require new skills in the future tech workforce in the Commonwealth of Massachusetts. A few of these trends include: 1) continued availability of lower cost computing; 2) an aging population as baby boomers grow older and all of us generally live longer; 3) individuals staying in the workforce past the traditional retirement age of 65; 4) the continued global competition from emerging economies and 5) the increased use of mobile devices. While tech grads will obviously need to stay on the cutting edge of newer technologies, we believe the deeper implications of these macro trends will be on the need for stronger “soft” skills in our talent pool. Soft skills are not typically something we think much about when we talk about our tech workforce. However, employers have a rapidly advancing need for future tech graduates to develop strengths in their ability to collaborate with colleagues and customers along progressively complex dimensions defined by:

- 1) Generational diversity
- 2) Geographic diversity
- 3) Cultural diversity

While it might not seem particularly new to talk about the need to work in an increasingly diverse world, trends such as lower cost computing and the growth of mobile computing are greatly accelerating the velocity of human interaction across these dimensions, hastening the need to focus on these “soft” skills.

There is already wide agreement that the Commonwealth needs to invest more in education to encourage more students to pursue careers in the STEM (Science, Technology, Engineering and Math) fields. That is certainly a key requirement for our future tech workforce, but that's not enough. We will need to develop tech workers who are equipped to succeed in a workforce that is getting older, working increasingly on a virtual basis and becoming more global. A holistic approach that teaches both “hard” and “soft” skills is generally ignored in the current curriculums at most public schools and universities. While the curriculum can be modified to reflect this growing diversity that our tech workers will face, we also believe that soft skills can increasingly be taught through internships and greater partnering between the public and private sectors. The longstanding entrepreneurial culture in our state has spawned thousands of technology companies who are in a position to play a more prominent role in strengthening our future work force. In this way, more cooperation between the corporate world and schools can provide tech graduates of the next 10 years with the soft skills they need to compete more effectively in a world that is growing more complex by the day.



**John Barrett, Managing Director**  
Cook Associates, Inc. Executive Search

## COMMENTARIES



*Communispace builds, manages and facilitates private branded communities that aim to deliver the voice of the customer to businesses so they can generate continuous insights, drive faster innovation and expand revenue. The company partners with more than 100 of the world's most admired brands to create 500+ online communities, with members in more than 96 countries and through a mix of technologies and methodologies.*

### Communispace: Two Types Of Talent

Over our 13 years of business growth (double digit growth in most years), acquiring and retaining top talent is a challenge that has stayed consistent. However, the specific challenges around this issue have morphed and changed at every stage in our maturity.

In the early years of our organization, we looked for generalists in all parts of the organization – people who were smart, flexible, and could step up to any challenges, even if they have never encountered the challenge before. They could learn as they went along. We called them “athletes” – they were not necessarily the best baseball players or best swimmers, but their overall athleticism allowed them to do well at whatever was thrown their way. These types of employees are smart hires for organizations early in their life stage.

Our shift to hiring specialists in the last few years has allowed us to scale faster, especially in the professional services area of our business. Specialist hires allow us to minimize the time needed for new employees to become fully productive. The challenge with hiring too many “specialists” is the impact you can have on the culture when you are prioritizing experience over attitude.

Our current hiring practices use a blend of what we learned from the Athlete and Specialists approaches. We still consider relevant experiences but are less focused on “specialism” and more focused on hiring someone with great foundational skills and attitudes. We train them on the specific skills required. Some of those foundational skills and qualities we look for are curiosity, passion, optimism, strong listening skills, empathy, resilience, business acumen, problem solving, team orientation and communication skills.

When hiring leaders, in addition to the foundational skills, we look for people who can collaborate, connect, orchestrate resources, consult and inspire others. They should have a track record of strong leadership at another organization or they need to build that experience at Communispace before leading or managing others. Each employee's experience is too important to risk having an inexperienced manager getting in the way.

As a growing professional services firm, the ability to hire ahead of the curve is our biggest challenge and one that we have found impossible to overcome. Backfilling openings from promotions or attrition takes too long and predicting a tidal wave of business is difficult to foresee. One challenge specific to the Greater Boston area is finding dual-language hires, which are so important to a growing global business like Communispace.

We do not expect it to be easy, but we hope our renewed focus on attitude and foundational skills over specialism will serve our culture, employees and clients best.



**Siobhan Dullea, Chief Client Officer**  
Communispace

## COMMENTARIES



*HubSpot is an all-in-one inbound marketing software that helps businesses generate inbound leads through search engine optimization, blogging, social media, marketing automation and marketing analytics. This software provides marketers tools needed to drive more traffic, convert more website visitors to leads and turn those leads into sales. Over 10,000 companies in 56 countries use HubSpot's technology.*

### Hubspot: Wide Variety of Adaptable Creative Talent Desired

At HubSpot, our goal is to transform how business is done by replacing loud, interruptive tactics like spam email and cold-calling with software that empowers companies to attract prospects, leads and customers with an integrated approach that mirrors how people currently work, live, shop and buy. We want to build a once-in-a-generation company and to do so we need to hire and retain truly remarkable people for every function of our business.

Specifically, we'll be looking for:

- **People Who Can Write Code, Content or Both:** The death of effective writing and of U.S.-based development needs have both been grossly exaggerated. We will continue to hire exceptional marketers who can craft and edit remarkable content to engage our audience. We will always be eager to hire smart and entrepreneurial developers and engineers who love to write and ship code and want to be part of one of the world's best and most innovative product organizations.
- **Candidates Who Embrace Change:** Next-generation workplaces will be predicated on speed. Everything, from decision-making to sales cycles to meetings, will move at a rapid pace, and people who want to overplan and overstrategize everything will be left behind. We do not need candidates who want to consult on TPS reports, Office Space style, we need people who are not just comfortable with change, they crave it.
- **Rapid Adopters:** We sell to marketers, which means we have to be on the bleeding edge of new networks, channels and mediums to experiment with for messaging and lead generation. As a result, we need employees who are not afraid to try a beta version of a new product, who started on Instagram the week it launched, and who are true digital natives. Sales reps, c-level executives, marketers, developers and accountants alike all benefit from understanding and adopting the latest and greatest trends in the cloud, social media and beyond.

As far as challenges go, the onus is on all of us to continue to expand Boston as a destination for tech and entrepreneurship. Doing so is the only way we will be able to attract and engage the top candidates in the world and encourage them to stay in Boston to launch their companies or pursue a career in the tech space. We are already home to some of the best universities, hospitals and research institutions in the world, now we have the opportunity to reclaim a position of power to become a destination in the tech space.

**Brian Halligan, CEO and Co-Founder  
HubSpot**



## COMMENTARIES



*The Massachusetts Computing Attainment Network (MassCAN) is a coalition of organizations collaborating to inspire and educate Massachusetts students in the field of computer science and to prepare them to lead and innovate in a future economy that will be dependent on and driven by computer technology.*

### MassCAN: Expanding Computing Education

Across Massachusetts—indeed, the nation—tech sector leaders are becoming increasingly vocal about the need for more computer science (CS) skills and training all along the talent pipeline. The future of their companies depends on a workforce not just adept at using the latest hardware, software and internet tools, but also capable of creating and developing the technology that the next generation will use.

While knowledge of programming, coding, and computational thinking serve as fundamental starting points for technology careers generally, it is also true that these same skills will continue to increase in importance for all other sectors of the economy as well. Future growth and innovation in industries such as finance, retail and energy among others depends in large part on how well they integrate into a digital world and apply technology solutions.

Expanded computer science education is urgently important when considering the talent outlook for the Massachusetts tech sector and tech-based innovation economy. Indeed, concerns about the CS talent pipeline have reached enough of a critical mass over recent months to fuel new efforts seeking to advance computer science education across the state. The Massachusetts Computing Attainment Network (MassCAN) is broadly supported by industry, foundation, and government to serve as an overarching umbrella that brings together the many different stakeholders committed to the ultimate goal of ensuring that every child in Massachusetts has access to quality computer science education.

MassCAN recognizes that boosting the CS talent pipeline requires a multi-year, systemic effort focused on providing a full spectrum of support to K-12 teachers to ensure they are enthusiastic, empowered and qualified when it comes to teaching CS in the classroom. It is an endeavor that demands the engagement of multiple stakeholders at both the state and school district levels. In terms of program support for teachers, MassCAN is involved in efforts to advance grade-appropriate CS tools, curriculum, modules and courses across the K-12 system. Already MassCAN partners are involved in two new professional development activities for CS teachers in Massachusetts. They are also pursuing a public awareness campaign, business partnerships and resources to enhance equity across the student population.

With regard to policy support for teachers, MassCAN is bringing together stakeholders to consider how best to develop new CS voluntary standards and curriculum frameworks for K-12 education, and encourage that CS be counted as math or science credit for student graduation and admission to state higher education institutions. In addition, MassCAN is working with relevant leaders on developing CS licensure for in-service teachers and CS training courses for pre-service teachers.

By linking, leveraging, and aligning various CS champions and their efforts, MassCAN seeks to maximize their potential for positive impact. Working as a coalition, MassCAN believes that Massachusetts can lead the nation in a CS education transformation.



**Jim Stanton, Executive Director, MassCAN**  
Senior Project Director, Education Development Center

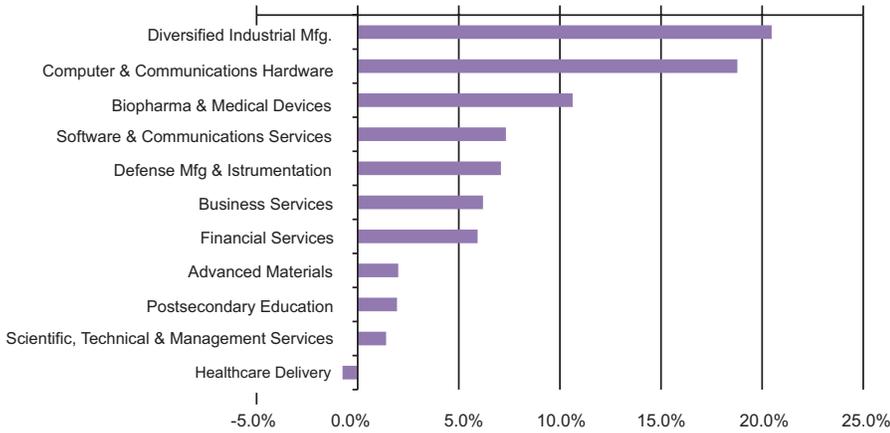


## **ECONOMIC IMPACT**

A key goal of the Index is to convey how innovation impacts the state'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 and create and sustain high-paying jobs.

# INDUSTRY CLUSTER EMPLOYMENT AND WAGES

**Percent Change in Average Annual Wage by Sector**  
Massachusetts, 2009-2012



**\* Four of the top six sectors have grown employment since the end of the recession**

**\* Innovation economy employment grew slower than total employment in Massachusetts**

## Why Is It Significant?

Increased employment concentration in technology and knowledge intensive industry clusters can indicate competitive advantages for the Massachusetts innovation economy and potential for future economic growth. Typically, these clusters provide some of the highest paying jobs in Massachusetts.

## How Does Massachusetts Perform?

In half of the LTS, including Massachusetts, the innovation economy actually experienced slower employment growth than the economy as a whole. Massachusetts innovation economy employment grew by 1%, while total employment in the Commonwealth grew by 1.2%. In Connecticut, the innovation economy appears to have shrunk by 0.4% between Q1 2011 and Q1 2013. This finding can be partially explained by a reduction in defense spending due to budget cutbacks and uncertainty since the defense industry has a large presence in that state.

Not all states experienced negative growth in the Defense Manufacturing & Instrumentation sector. Massachusetts(3%), Minnesota(3.4%), and to a lesser extent, Texas(1.8%) experienced employment growth within the sector. However, it is possible that the time frame examined has not fully captured the negative effects of sequestration on the defense industries of these three states.

Wage growth has been particularly strong in a few industries since 2009. Interestingly, the three sectors with the fastest wage growth have also seen stagnant or even declining employment figures over the same period (Diversified Industrial Manufacturing, Computer & Communications Hardware and Biopharma & Medical Devices). Healthcare Delivery, the Commonwealth’s leading sector by employment, actually experienced a slight decline in wages, even though employment growth was relatively strong (6.2%).

Healthcare Delivery, Postsecondary Education, Software & Communications Services and Scientific, Technical & Management Services are the sectors that have experienced the most consistent employment growth since 2009.

**INDICATOR 1**

# INDUSTRY CLUSTER EMPLOYMENT AND WAGES

## Percent Change in Cluster Employment

Massachusetts & LTS, Q1 2012-Q1 2013

	CA	CT	IL	MA	MN	NJ	NY	OH	PA	TX
Advanced Materials	-1.5%	-0.9%	0.5%	-0.2%	-1.2%	-3.3%	-0.8%	2.2%	0.1%	1.3%
Biopharma & Medical Devices	1.6%	-2.4%	1.0%	0.4%	-0.1%	0.8%	1.2%	2.0%	-3.4%	3.2%
Business Services	3.3%	-0.6%	1.5%	1.0%	2.4%	1.5%	2.7%	1.8%	1.4%	1.6%
Computer & Communication Hardware	-2.1%	-0.8%	-3.6%	-2.0%	-2.9%	-3.7%	-3.4%	-3.9%	-2.5%	-1.5%
Defense Manufacturing & Instrumentation	-1.1%	-2.7%	-1.6%	3.0%	3.4%	-4.7%	-1.4%	-1.5%	-0.1%	1.8%
Diversified Industrial Manufacturing	1.3%	-1.2%	0.4%	-1.9%	2.2%	0.0%	-0.2%	2.1%	-0.4%	3.6%
Postsecondary Education	0.2%	-2.2%	0.1%	1.7%	1.9%	0.3%	-0.2%	2.3%	-0.8%	2.0%
Financial Services	-1.9%	-0.4%	0.1%	-0.5%	2.0%	-0.4%	1.3%	-0.1%	1.9%	5.1%
Healthcare Delivery	2.4%	1.3%	0.9%	1.3%	3.0%	1.4%	2.7%	1.6%	1.0%	1.9%
Scientific, Technical & Management Services	2.9%	2.5%	3.3%	2.6%	7.3%	1.4%	2.8%	2.0%	4.2%	4.5%
Software & Communications Services	5.1%	-1.1%	4.0%	2.0%	3.0%	0.1%	1.1%	2.1%	1.6%	4.2%
All Innovation Economy Sectors	1.7%	-0.4%	1.0%	1.0%	2.3%	0.6%	1.6%	1.5%	0.8%	2.6%
<b>All Sectors</b>	2.9%	0.5%	0.9%	1.2%	2.1%	1.2%	1.1%	0.9%	0.3%	3.0%



**Defense Manufacturing & Instrumentation employment growth accelerated to 3% in Massachusetts, while most of the LTS reported losses**

## Employment by Industry Sector

Massachusetts, 2009-2012

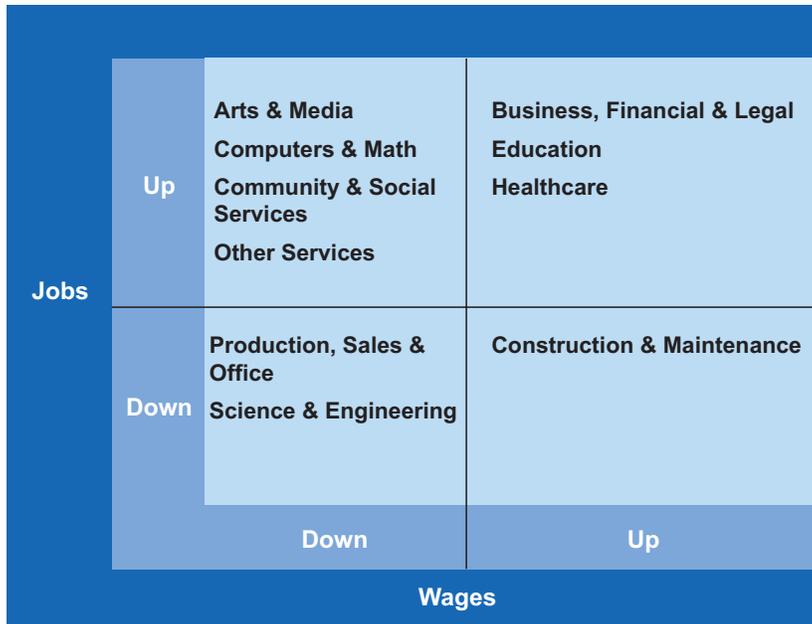
Sector	Healthcare Delivery	Financial Services	Business Services	Postsecondary Education	Software & Communication Services	Scientific, Technical & Management Services	Biopharma & Medical Devices	Diversified Industrial Mfg.	Computer & Communications Hardware	Defense Manufacturing & Instrumentation	Advanced Materials
2012 Total Employment	351,445	155,033	146,258	144,642	141,662	76,911	63,830	39,659	37,095	37,429	29,904
% Change in Employment 2009-2012	6.3%	-4.9%	-1.2%	5.1%	8.3%	12.7%	-1.9%	-3.6%	-7.4%	-2.1%	-5.1%

INDICATOR 1

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

# OCCUPATIONS AND WAGES

## Massachusetts Wages & Employment 2008-2012



### Why Is It Significant?

The Massachusetts innovation economy supports middle- and high-wage jobs, thereby contributing to a higher standard of living throughout the Commonwealth. Changes in occupational employment and wages suggest shifts in job content and skill utilization, as well as in the overall skill mix of the workforce across all industries.

### How Does Massachusetts Perform?

Social Services and Computers & Math were the fastest growing occupational categories in Massachusetts in 2012. Social Services pays roughly average wages, however Computers & Math pays significantly above average wages. They are also highest in terms of employment concentration relative to the rest of the U.S. Business, Financial & Legal and Healthcare are also growing sectors in Massachusetts, both of which pay above average wages. Science & Engineering was the only technology oriented sector that shrank; however, its decrease was slight at -0.1%.

Massachusetts saw its fastest employment growth since the recession in Computer & Math and Social Service occupations. Both grew at a faster rate than the LTS and U.S. averages. Science & Engineering experienced negative employment growth in Massachusetts, the LTS and the U.S., however Massachusetts saw the slowest rate of decline.

Healthcare, Education, Business and Financial & Legal occupations experienced positive annual pay growth in the years since the recession in Massachusetts. All other occupations averaged negative pay growth. This contrasts with both the LTS and the U.S., which saw positive annual wage growth rates in Science & Engineering and Computer & Math related occupations.

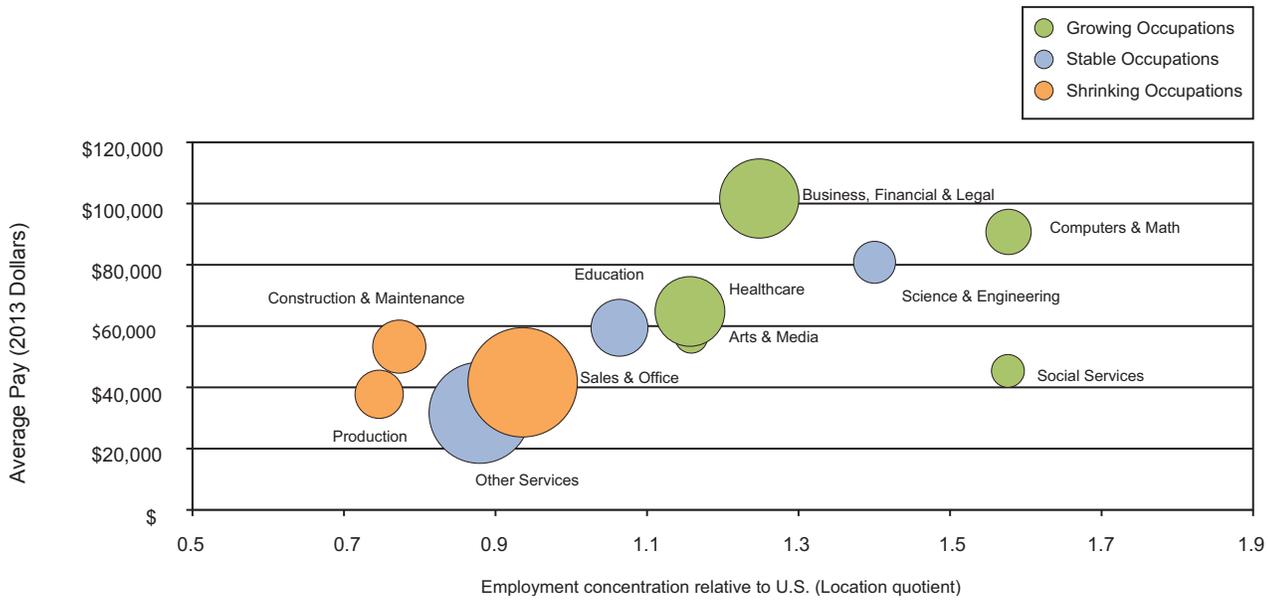
Science & Engineering occupations make up 6.5% of all occupations in Massachusetts, a higher percentage than any other LTS and one that has been increasing since 2003.



**Employment is growing and shifting into Healthcare, Business, Financial & Legal and Computers & Math, occupations where employees generally earn wages well above the national average**

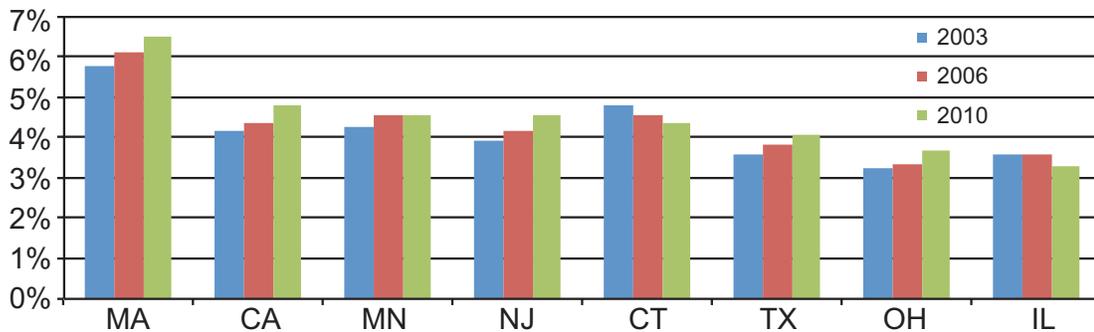
# OCCUPATIONS AND WAGES

## Occupations by Employment Concentration & Annual Pay Massachusetts, 2012



## Individuals in Science & Engineering Occupations

As % of the Workforce  
 Massachusetts & LTS, 2003, 2006 & 2010

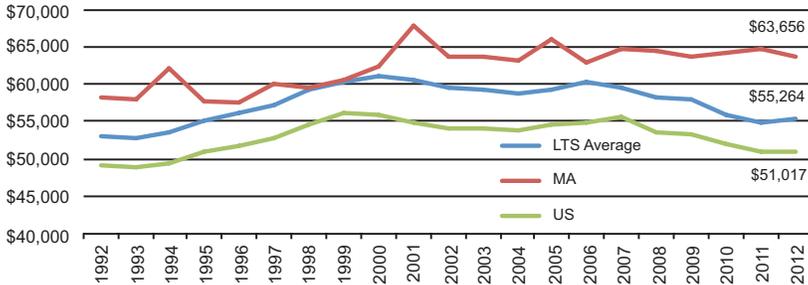


Data Source for Indicator 2: BLS Occupational Employment Statistics, Consumer Price Index (CPI)

# HOUSEHOLD INCOME

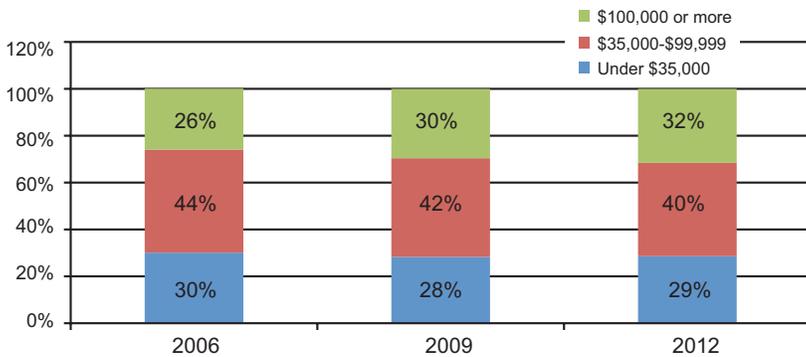
## Median Household Income

Massachusetts, LTS & U.S., 1992-2012



## Distribution of Households by Income Range

Massachusetts, 2006, 2009 & 2012



## Year Over Year Percentage Change in Median Household Income

Massachusetts, LTS & U.S., 2010-2012



## 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 higher living standards. The distribution of income also provides an indication of which Massachusetts economic groups are benefiting.

## How Does Massachusetts Perform?

Massachusetts continues to have a higher median household income than both the LTS average and the U.S. as a whole. Since 1992, incomes in Massachusetts, the LTS and U.S. have not changed substantially. Incomes in all three rose during the 1990s, with Massachusetts seeing greater volatility. However, since 2000, incomes have remained flat and even declined in some cases. The 2008 financial crisis might explain some of this, but income stagnation began much earlier.

Massachusetts has seen the number of middle income households continue to shrink over the last three years. This is due to the growing share of households that earn more than \$100,000 per year, which increased by 6 percentage points from 2009-2012.

Median income has been volatile in both Massachusetts and the LTS, with Massachusetts seeing gains in 2011 and losses in 2012 and vice versa in the LTS. The U.S. saw a decline in median household income in both years, but the decline was significantly less in 2012.

INDICATOR 3

**\***

Middle and low income households in Massachusetts have decreased while high income households have increased since 2006

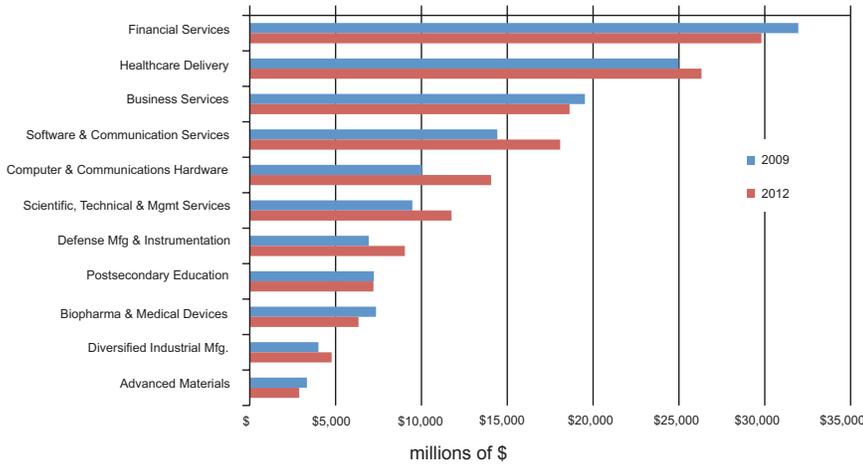
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Massachusetts household income has exceeded the LTS & U.S. average for the past 20 years

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

# PRODUCTIVITY

## Industry Output Massachusetts, 2009 & 2012



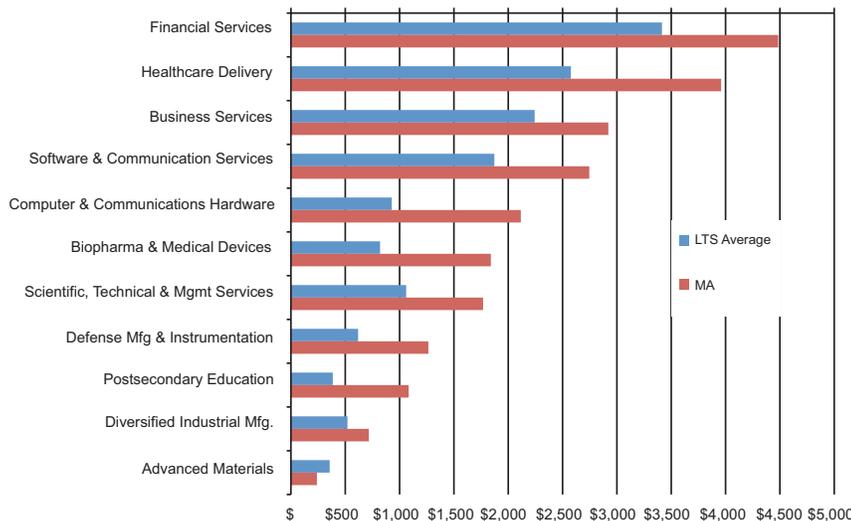
### Why Is It Significant?

Industry Output is an important measure of the value of the goods and services produced by each sector of the innovation economy. GDP per employed worker is a measure of labor productivity, which is a key driver of wage growth within an economy.

### How Does Massachusetts Perform?

Massachusetts industry output increased in 6 of the 11 key sectors between 2009 and 2012, substantially so in the case of Software & Communications Services and Computer & Communications Hardware. Output remained flat in Postsecondary Education and fell in 4 out of the 11 key sectors. Two of Massachusetts' three largest sectors, Financial Services and Business Services, saw declining output over the period.

## Sector Output per Capita Massachusetts & LTS, 2012



In per capita output, Massachusetts outperforms the average of the LTS in all key sectors with the exception of Advanced Materials, the Commonwealth's smallest innovation sector. The performance gap between Massachusetts and the average of the LTS was striking in some cases with Massachusetts having 4 sectors where per capita output was more than double the average of the LTS (Computer & Communications Hardware, Bio-Pharma & Medical Devices, Defense Manufacturing & Instrumentation and Postsecondary Education).



**Massachusetts Computer & Communications Hardware output per capita is 128% higher than the LTS average**



**The Commonwealth's Biopharma & Medical Device output per capita is 124% higher than the LTS average**

INDICATOR 4

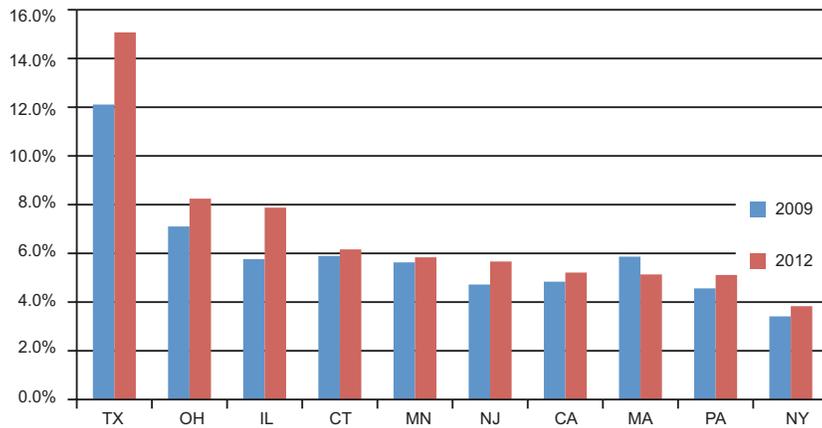
Data Source for Indicator 4: U.S. Census Bureau, Moody's, QCEW

# EXPORTS

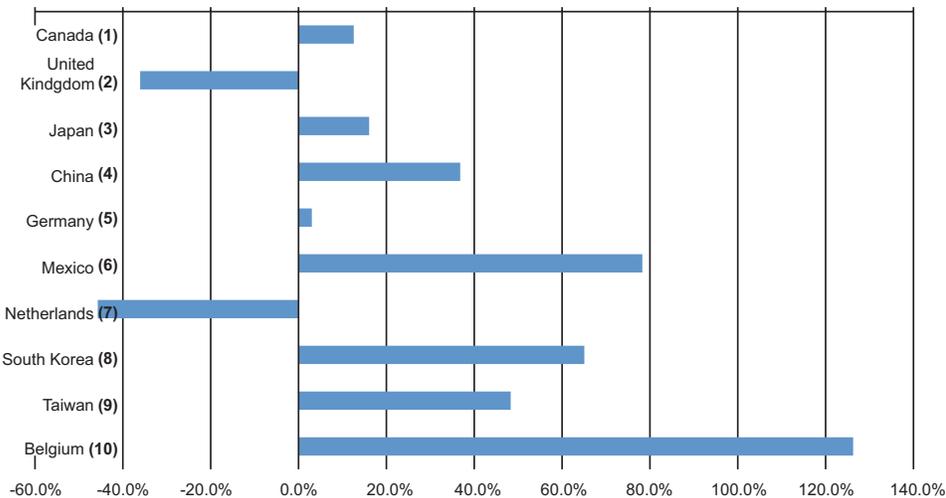
## Massachusetts Exports 2009-2012

	2009	2010	2011	2012
Value (\$ millions)	23,593	26,305	27,748	25,613
% of U.S. Exports	2.2	2.1	1.9	1.7

## Manufacturing Exports as Percent of GDP Massachusetts & LTS, 2009 & 2012



## Rank and Percent Change in Export Value by Top Foreign Trade Destinations Massachusetts, 2009-2012



## Why Is It Significant?

Manufacturing exports are an indicator of the Commonwealth's global competitiveness. Selling into global markets can bolster growth in sales and employment. In addition, diversity in export markets and products can offset economic downturns. Manufacturing represents approximately 8% of all private sector jobs in the state and approximately 28% of manufacturing jobs are tied to exports.

## How Does Massachusetts Perform?

After two years of export growth following the Great Recession, Massachusetts exports fell by nearly \$2 billion in 2012. Massachusetts' exports have grown more slowly over the period than total U.S. exports as seen by Massachusetts' declining share.

Massachusetts' manufacturing exports made up a smaller percentage of GDP in 2012 than in 2009, the only of the LTS to experience such a drop. The drop indicates that other sectors of the Commonwealth's economy are growing faster than manufacturing exports since such exports grew by around \$1 billion in absolute size from 2009-2012.

Massachusetts has seen some volatility in the destination of its exports between 2009-2012. Exports to the UK (# 2 export destination) fell by 36% while exports to Mexico, South Korea and Belgium grew by more than 50%. Overall, there seems to be a shift away from Western Europe, where exports are stagnant or falling (Belgium being the exception), towards East Asia and the rest of North America.

INDICATOR 5

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

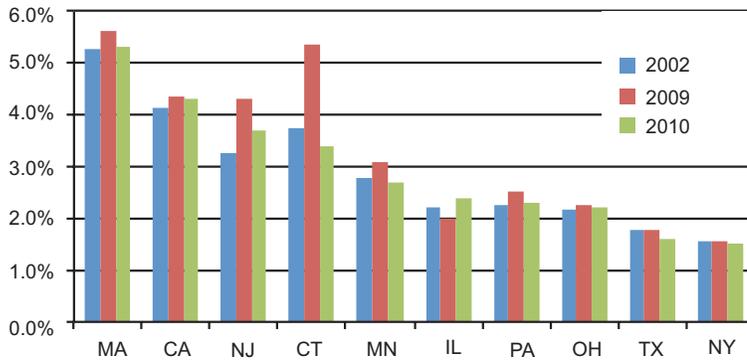


## **RESEARCH**

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 PERFORMED

## R&D Spending as Percent of GDP Massachusetts & LTS, 2002, 2009 & 2010



## Why Is It Significant?

R&D performed in Massachusetts is an indicator of the size of the science and technology enterprise. Although not all new ideas or products emerge from R&D efforts, R&D data provide a sense of a region's capacity for knowledge creation.

## How Does Massachusetts Perform?

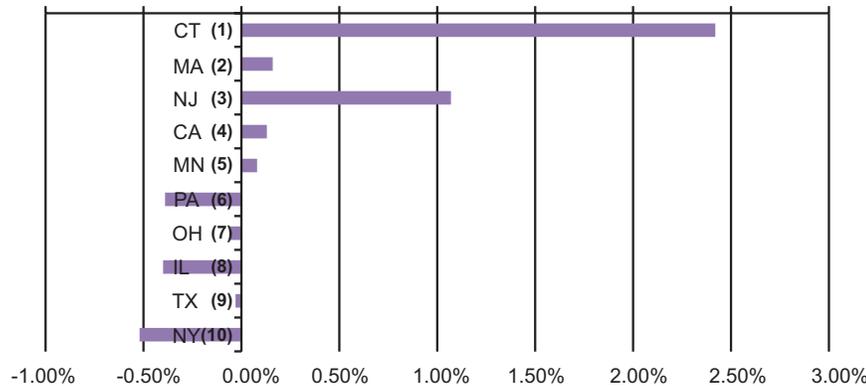
Massachusetts was the top state in terms of R&D as a percentage of GDP in 2010, even after a 5% decrease from 2009. While Massachusetts' R&D spending as a percentage of GDP has fluctuated somewhat over the period from 2002-2010, some states have seen large swings in either direction, especially Connecticut and New Jersey.

Half of the LTS experienced a decline in industry performed R&D as a percent of private industry output, while the other half experienced growth. Although Massachusetts ranks second overall, third place New Jersey is growing at a much faster rate.

Connecticut has a relatively low level of non-industry R&D and, given that it is home to many large corporations, industry R&D has a larger impact there than in most other states. Connecticut saw increases in industry R&D in the early 2000s and many of these large firms are now scaling back their R&D operations and expenditures. Connecticut's economy also grew by 2% from 2009-2010, which helped cause R&D as a share of GDP to drop even more.

## Rank & Percent Change in Industry Performed R&D

Percent of Private Industry Output  
Massachusetts & LTS, 2000-2008



## R&D Expenditures Massachusetts, 2010

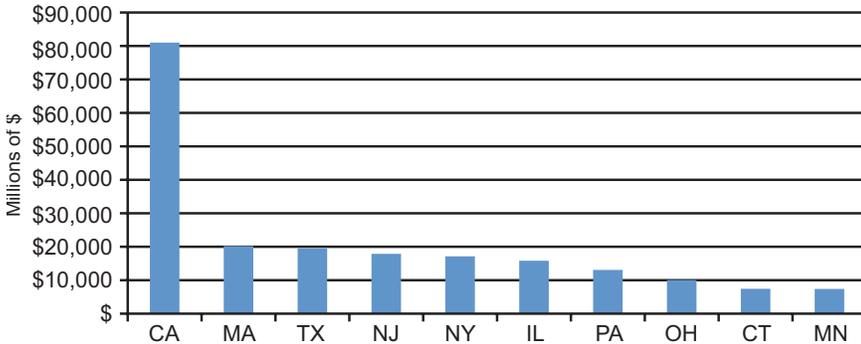
Performing Sector	Source of Funding	Expenditures
Federal	Federal	\$ 895,000,000
	Federally Funded R&D Centers	\$ 842,000,000
Business	Non-Federal	\$ 4,000,000
	Own Funds	\$ 11,933,000,000
	Federal	\$ 1,154,000,000
Universities & Colleges	Non-Federal	\$ 1,933,000,000
	Federal	\$ 2,153,000,000
	Other Government	\$ 26,000,000
	Business	\$ 198,000,000
Non-Profit Institutions	Universities & Colleges	\$ 257,000,000
	Non-Profit	\$ 312,000,000
	Federal	\$ 1,929,000,000
	Total	\$ 21,636,000,000

INDICATOR 6

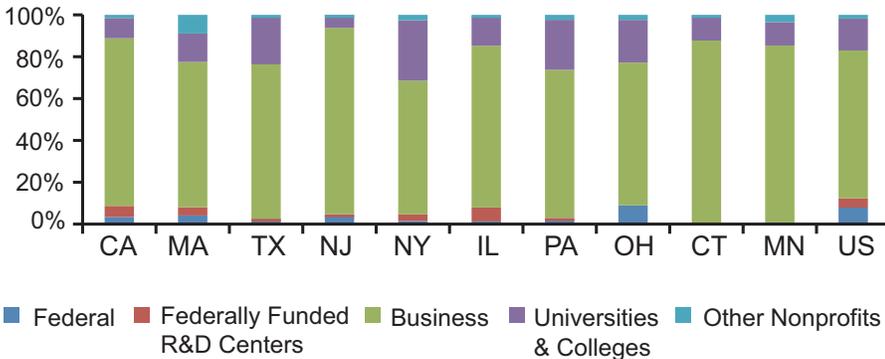
Data Source for Indicator 6: National Science Foundation (NSF), BEA, CPI, Hartford Business Journal

# PERFORMERS OF R&D

## Total R&D Expenditures Massachusetts & LTS, 2010



## Distribution of R&D by Performer Massachusetts, LTS & U.S., 2010



## Why Is It Significant?

The distribution of R&D expenditures by type of performer illustrates the relative importance of diverse organizations performing R&D in an innovation ecosystem. Nationally, universities and colleges conduct mostly basic research, whereas industry provides mainly development research. Federal agencies tend to perform more applied research while non-profits conduct mainly basic and applied research.

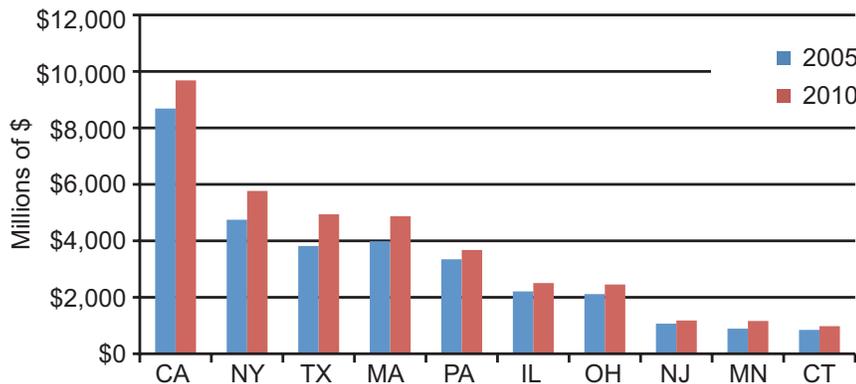
## How Does Massachusetts Perform?

The majority of R&D in 2010 was performed by private industry in all LTS. 69% of R&D in Massachusetts is performed by private industry; however, this is a decline from 75% in 2008 and places Massachusetts behind all but two of the LTS.

Massachusetts had the second highest overall level of R&D funding in the country in 2010, slightly ahead of Texas. California still maintains a significant lead in total R&D funding. Massachusetts' strong performance is even more impressive due to the larger size of both California and Texas, comparatively.

Massachusetts ranks fourth among the LTS in terms of R&D performed by universities, colleges and non-profits. The Commonwealth also saw a 22% increase in R&D performed by these institutions from 2005-2010, placing it third among LTS. The American Recovery and Reinvestment Act (ARRA) is largely responsible for the large gains seen in R&D expenditures at the end of the 2000s. The combination of private industry, universities, colleges and non-profits account for over 90% of all R&D performed in Massachusetts.

## R&D Expenditures from Non-Profits & Academia Massachusetts & LTS, 2005 & 2010



Data Source for Indicator 7: NSF, CPI

# ACADEMIC ARTICLE OUTPUT

## Science and Engineering (S&E) Academic Article Output per Million Residents Massachusetts & International, 2009

Massachusetts	1,591
Switzerland	1,223
Sweden	1,019
Denmark	961
Finland	927
Norway	919
Netherlands	899
Australia	862
Canada	860
Israel	842
Singapore	839

### Why is it Significant?

In contrast to R&D expenditures, which are inputs to research, academic article publication is a measure of research output. In addition, the ratio of articles produced per dollar spent on research and per researcher measures the productivity of research activity.

### How Does Massachusetts Perform?

Massachusetts maintains a high rate of science and engineering academic article output relative to its population. This rate increased substantially (11%) between 2004 and 2009. In 2009, S&E academic article output climbed to nearly 1,600 academic articles per million residents, about three times the U.S. average.

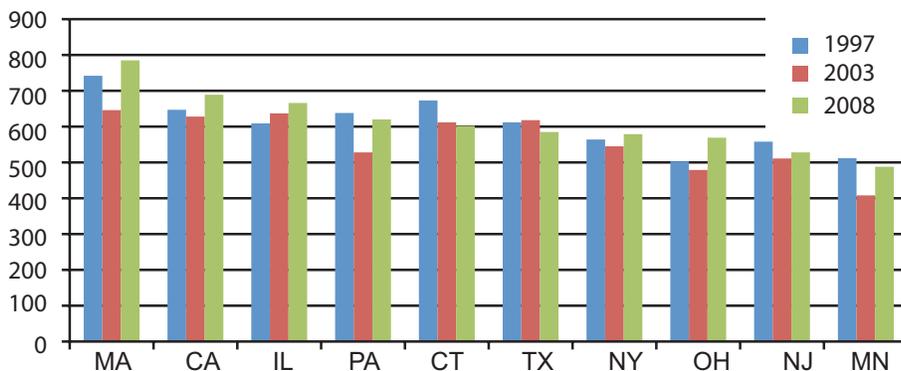
Massachusetts also ranks highly in terms of academic productivity. In 2004 and 2009, Massachusetts produced more S&E academic articles per R&D dollar than the other LTS and the nation overall. In 2009, the state reported four articles per million academic R&D dollars spent.

Massachusetts is also the leader on the second measure of research productivity, articles per 1,000 S&E doctorate holders. California, the next closest state, produces 12% fewer articles per 1,000 S&E doctorate holders. In addition, Massachusetts stands out internationally as the forerunner in S&E articles relative to population. In 2009, Massachusetts outperformed second-place Switzerland by roughly 370 articles per million residents.

## S&E Academic Article Output Per Million Academic R&D \$ Massachusetts & LTS, 2000, 2004, 2009



## S&E Academic Article Output Per 1000 S&E Doctorate Holders Massachusetts & LTS, 1997, 2003, 2008

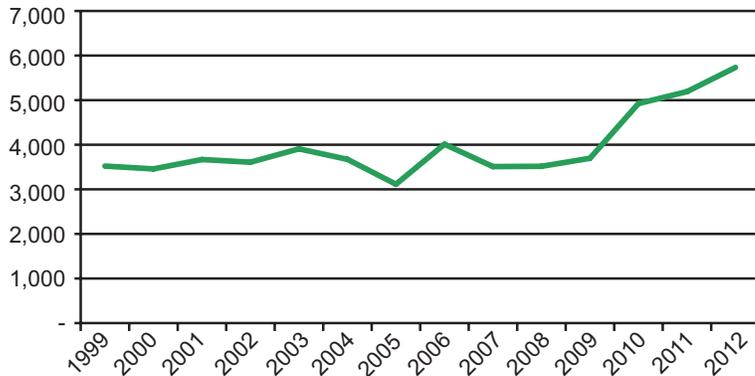


INDICATOR 8

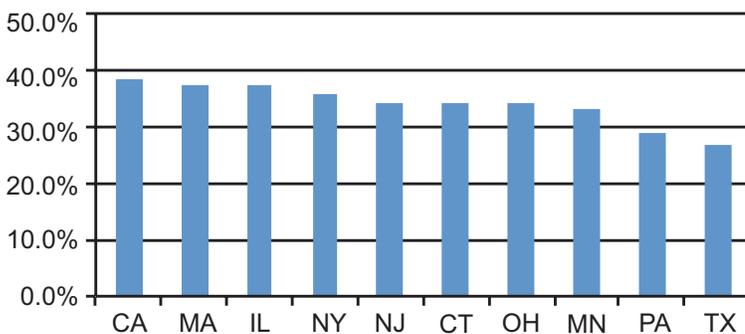
Data Source for Indicator 8: NSF

# PATENTS

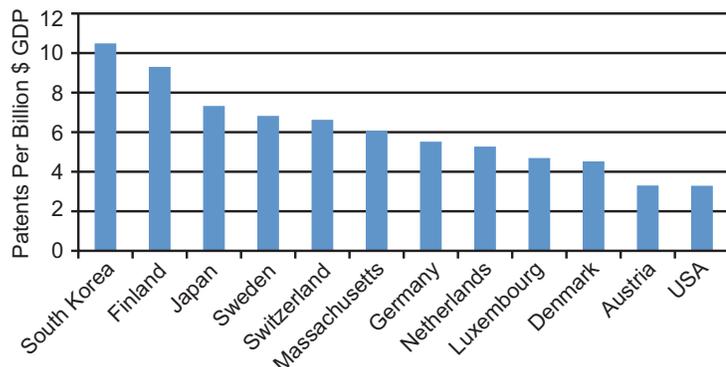
## U.S. Patent & Trademark Office Utility Patents Issued Massachusetts, 1999-2012



## Percent Change in Utility Patents Issued Per Million Residents Massachusetts & LTS, 2008-2012



## Patents Published Under the Patent Cooperation Treaty Per Billion Dollars GDP Massachusetts & International, 2012



## Why is it Significant?

Patents are the leading form of legal codification and ownership of innovative thinking and its application. Inventions that result from a patent award are particularly important for R&D-intensive industries when the success of a company depends on its ability to develop and commercialize 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. To protect invention from imitators, a new patent must be filed with each country (or global region) in which a company wishes to market a new product or service. The Patent Cooperation Treaty ('PCT') is an international agreement that streamlines the process of obtaining a patent in multiple countries.

## How Does Massachusetts Perform?

Massachusetts again saw record numbers of patents granted in 2012, reaching a total of 5,734. Its share of U.S. patents, however, dropped slightly to 4.7% from 4.8%. Massachusetts growth rate in patents granted from 2008-2012 was 37%, placing it second among the LTS after California's 38% growth. Massachusetts ranks fourth among the LTS in terms of total numbers of patents granted, behind California, New York and Texas. However, Massachusetts retains the top ranking for patents per capita. Massachusetts fell from fourth to sixth in the world in the number of patents filed under the PCT. Massachusetts' patents per billion dollars GDP declined slightly while other countries saw large gains, especially South Korea. PCT filings represented less than half of all Massachusetts patents in 2012.

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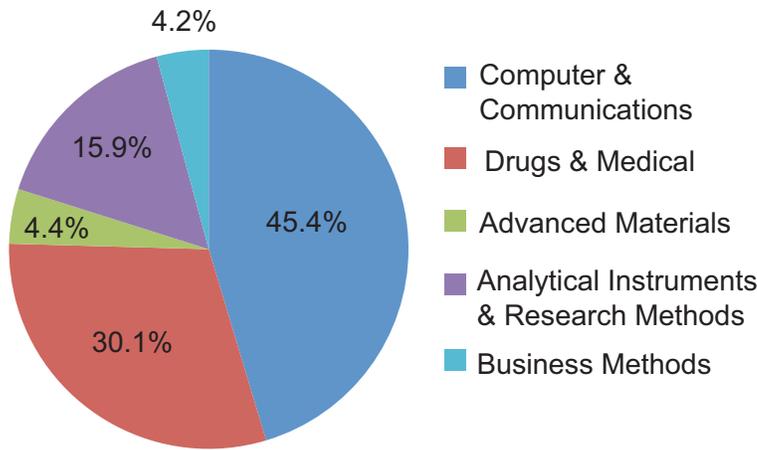
Massachusetts organizations were awarded 37% more patents in 2012 than in 2008

INDICATOR 9

Data Source for Indicator 9: 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**  
Percent Massachusetts, 2012



**\* Massachusetts is second in Technology Patents per Capita**

## Why is it Significant?

The amount of patenting per capita by technology class indicates those fields in which Massachusetts' inventors are most active and suggests comparative strengths in knowledge creation, which is a vital source of innovation. 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?

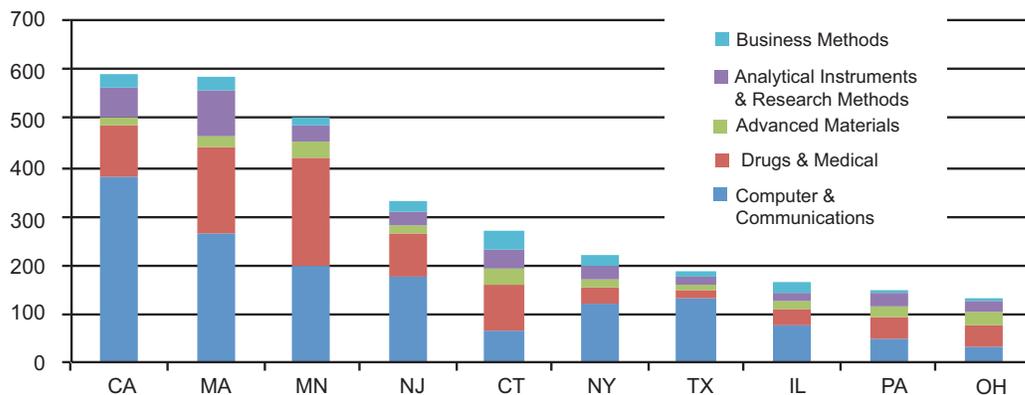
Massachusetts ranked first in Analytical Instrument & Research Methods patents for the fourth year in a row with 93 per million residents, about 50% more than the next highest state, California. California and Massachusetts are home to some of the world's most prolific research universities and institutions which helps explain their strong performance on this metric relative to the other LTS.

Massachusetts again placed second in Computer & Communications Hardware and Drug & Medical patents with 265 and 175 patents per million residents respectively. California and Minnesota retained their leads, although Massachusetts saw an increase in both categories.

Massachusetts also increased its Business Method patents and remained in second place among the LTS, still trailing Connecticut. Advanced Materials was the only category where Massachusetts experienced a drop in the number of patents per million residents, declining from 28 to 26. However, the state did retain its fourth place ranking in Advanced Materials patents.

The combination of Computer & Communications patents and Drugs & Medical patents account for 75% of all Massachusetts technology patents in 2012.

**Technology Patents per Million Residents by Field**  
Massachusetts & LTS, 2012



Data Source for Indicator 10: USPTO, Census Bureau

INDICATOR 10

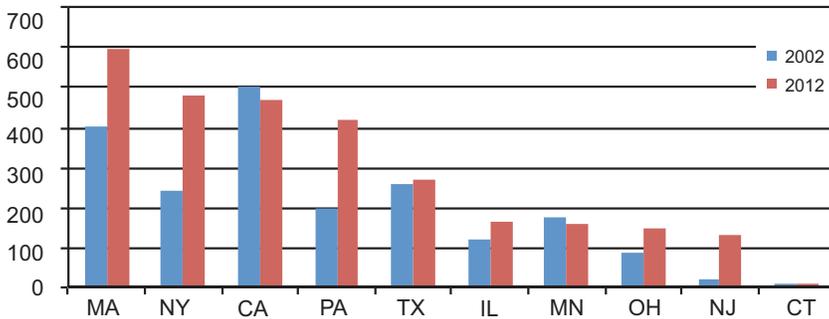


## **TECHNOLOGY DEVELOPMENT**

In close interaction with research activities, but with a clearer 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 2002 & 2012



## Technology Licenses and Options Executed Research Institutions, Hospitals & Universities 2002 & 2012

	2002	2012
<b>Research Institutions &amp; Hospitals</b>	<b>141</b>	<b>355</b>
<b>Universities</b>	<b>264</b>	<b>248</b>

## 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 perceived 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 of commercialization. Increases in royalty revenue are important, validating the original research and innovation and can be reinvested in new or follow-on R&D.

## How Does Massachusetts Perform?

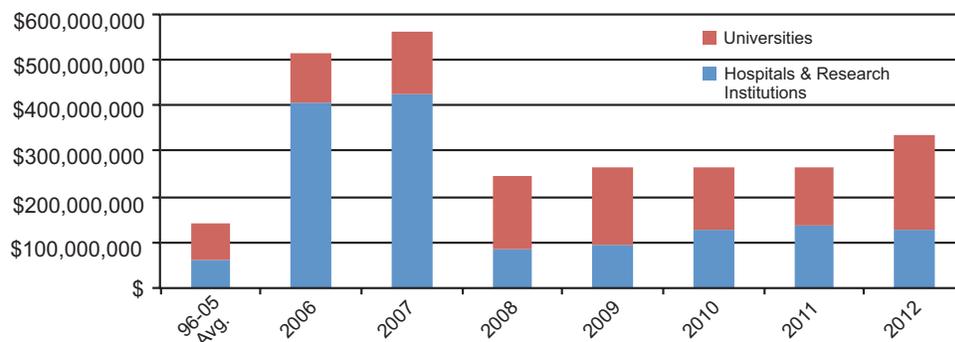
Over the last 10 years, Massachusetts has moved ahead of California in terms of total technology licenses and licenses options executed. New York and Pennsylvania were also big movers more than doubling the number of licenses and options executed.

While Massachusetts more than doubled the number of license and license options executed by hospitals and research institutions, there was a slight drop in those executed by universities. This represents a shift from universities accounting for the majority of licenses and license options a decade ago to the current situation where research institutions and hospitals comprise a majority.

Revenue from IP licenses in Massachusetts, after remaining steady over the period from 2008-2011, grew by 26% between 2011 and 2012, with the growth coming from universities. The precipitous drop seen between 2007 and 2008 is primarily due to a two-year spike in revenues from Massachusetts General Hospital, which resulted from a legal settlement.

**\* Over the past 10 years, Massachusetts has surpassed California to become number one in technology licenses and license options executed**

## Revenues from Technology Licenses and Options Executed Universities, Hospitals & Non-Profit Research Institutions Massachusetts, 2006-2012 (2012 Dollars)



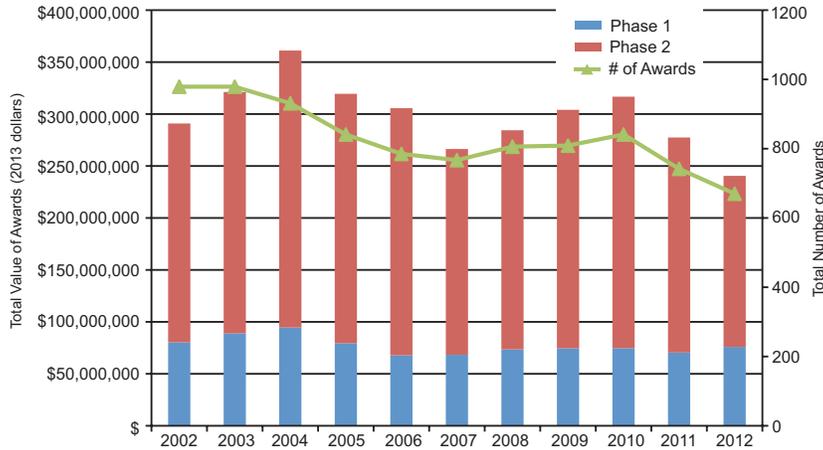
Data Source for Indicator 11: Association of University Technology Managers (AUTM), CPI

INDICATOR 11

# SBIR/STTR AWARDS

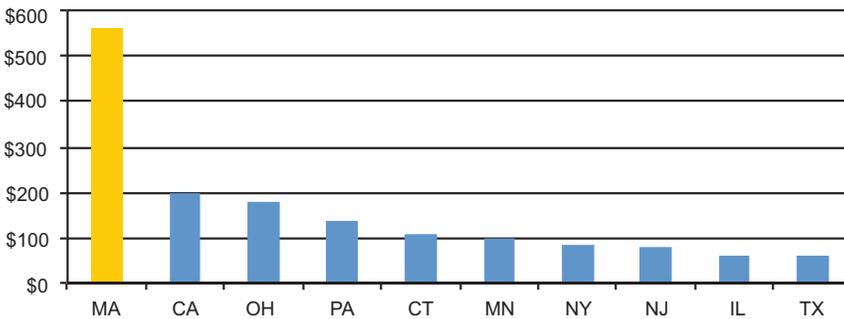
## SBIR & STTR Awards

Total Number and Value (by Phase) of Awards Granted Massachusetts, 2002-2012



## SBIR & STTR Awards Funding per \$1 Million GDP

Massachusetts & LTS, 2012



## SBIR & STTR Awards by Agency

Massachusetts, 2012

Agency	Funding	# of Awards
Department of Defense	\$110,135,546	384
Health & Human Services	\$79,982,455	132
Department of Energy	\$21,321,960	50
National Science Foundation	\$11,706,332	38



**SBIR and STTR awards continue to decline, but Massachusetts is still a clear leader in funding as a percentage of GDP**

## Why Is It Significant?

The Small Business Innovation Research (SBIR) and Technology Transfer (STTR) Programs are highly competitive federal grant programs. These programs 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 programs 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?

The decline in the number of SBIR and STTR awards that began in 2010 continued in 2012, with the total value of Massachusetts' awards falling by 13% between 2011 and 2012, roughly the same rate as between 2010 and 2011. The decline in awards nationwide between 2011 and 2012 was even larger at 16%.

Massachusetts remains the leader among the LTS in terms of SBIR and STTR award funding per \$1 million GDP. Although California receives nearly double the amount of funding that Massachusetts receives (\$420 million vs. \$240 million), the state's smaller size means its SBIR and STTR funding per \$1 million GDP is nearly triple that of California, the next highest state.

SBIR and STTR awards have seen a drop in recent years due to budgetary cutbacks and uncertainty. The end of ARRA funding may be a factor in the drop in awards and total funding level.

INDICATOR 12

Data Source for Indicator 12: U.S. Small Business Administration, CPI

# REGULATORY APPROVAL OF DRUGS AND MEDICAL DEVICES

## Medical Device Pre-Market Notifications (Releasable 510(k)s)

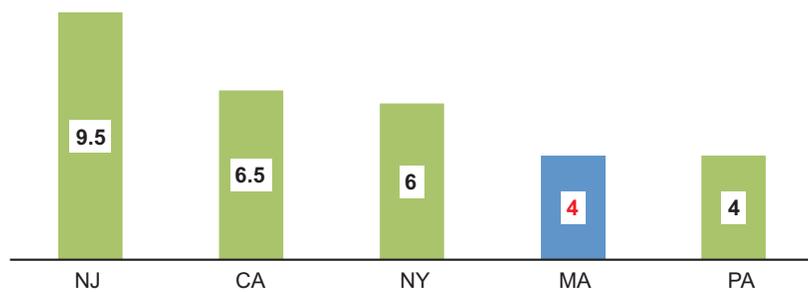
Massachusetts & LTS, 2013\*



\*510(k) data are through August, 2013

## New Drug Approvals

Massachusetts & LTS, 2012\*

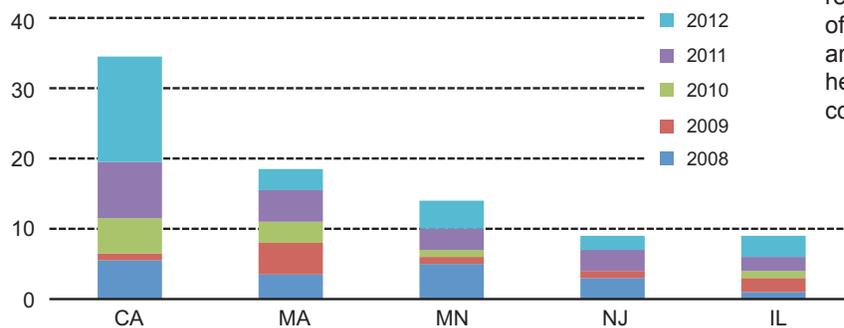


\*Drugs developed in more than one state were split between each state

## Medical Device Pre-Market Approvals (PMA's)

Massachusetts & LTS, 2008-2012

INDICATOR 13



Data Source for Indicator 13: U.S. Food and Drug Administration, Pharmaceutical Research and Manufacturers of America

## Why Is It Significant?

The U.S. Food and Drug Administration classifies medical devices by two categories during the approval process: pre-market approvals (PMAs) and pre-market notifications, known as 510(k)s. PMA is the designation for the more sophisticated, newly-developed devices, while 510(k) is a classification for less sophisticated instruments or improvements to existing products or functional equivalents. New Drug Applications (NDAs) measure a commercially important outcome from years of research and development.

## How Does Massachusetts Perform?

Massachusetts continues to rank second overall among the LTS in both Pre-Market Approvals and Pre-Market Notifications. In 2012, the state reported three medical device pre-market approvals. Massachusetts companies have remained relatively consistent on this measure, averaging around four PMAs per year in the last five years. California leads this category with 34.5 PMAs in the last five years, nearly double that of Massachusetts. When controlling for population, however, Massachusetts ranked second to Minnesota and California ranked third.

Massachusetts companies also came in second to California in the number of medical device 510(k)s, where California continues to dominate. Massachusetts acquired 115 in 2012 (through August), while California leads with 307. On a per capita basis, Massachusetts ranked first, followed by Minnesota.

Among the LTS, Massachusetts and Pennsylvania tied for fourth in new drug approvals in 2012. New Jersey continues to lead this category with 9.5 new approvals. Not all drugs or devices credited to a state are necessarily developed there, as in many cases only the corporate headquarters is listed and research may be conducted elsewhere. Seven of the top 20 global pharmaceutical companies are based in New Jersey or maintain their U.S. headquarters there, for instance, but they do not conduct all research activities within the state.



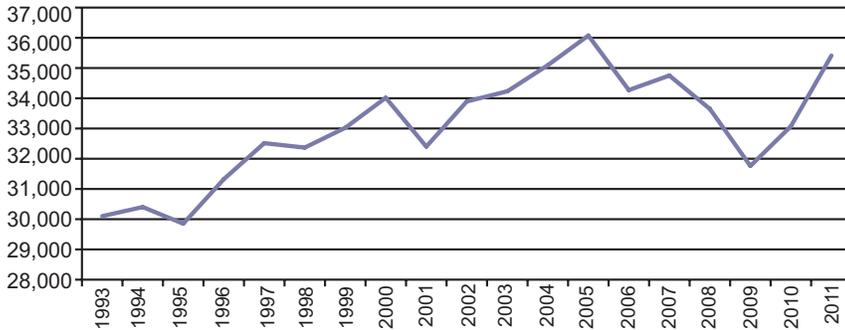
## **BUSINESS DEVELOPMENT**

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 DEVELOPMENT

## Business Establishment Openings

Massachusetts, 1993-2011



## 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 by start-up companies. 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?

Massachusetts has experienced three consecutive years of business establishment growth. By 2011, Massachusetts had surpassed its pre-recession level in 2007 and was nearing the peak seen in 2004, when more than 36,000 business establishments were opened in the state.

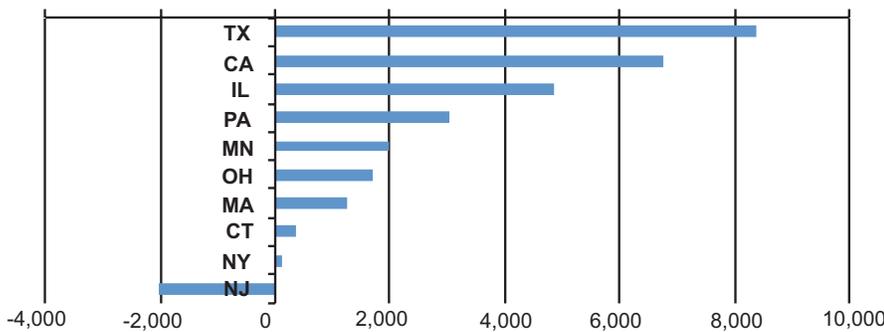
Over 1,200 net new business establishments were created in the Commonwealth's innovation economy sectors from 2010-2012. However, this places Massachusetts behind six of the other LTS.

Start-up formation from universities, hospitals, research institutions and technology investment firms has declined relative to 2011. However Massachusetts is still second only to California, a state with a much larger economy and population.

## Net Change In Number of Business Establishments

Key Industry Sectors

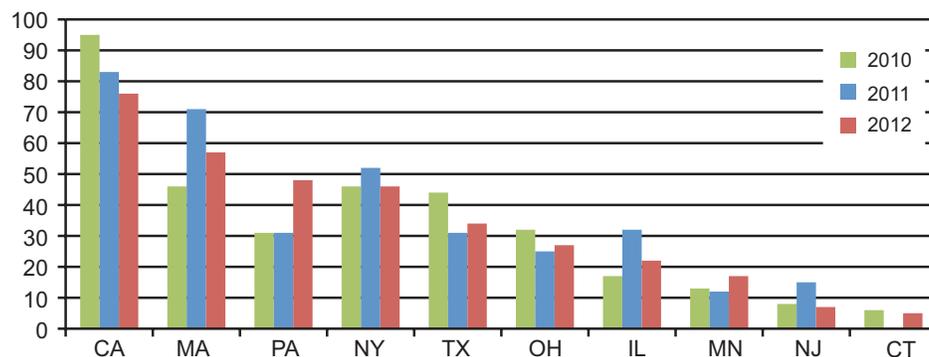
Massachusetts & LTS, 2010-2012



## Start-up Companies Initiated

From Universities, Hospitals, Research Institutions & Technology Investment Firms

Massachusetts & LTS, 2010-2012



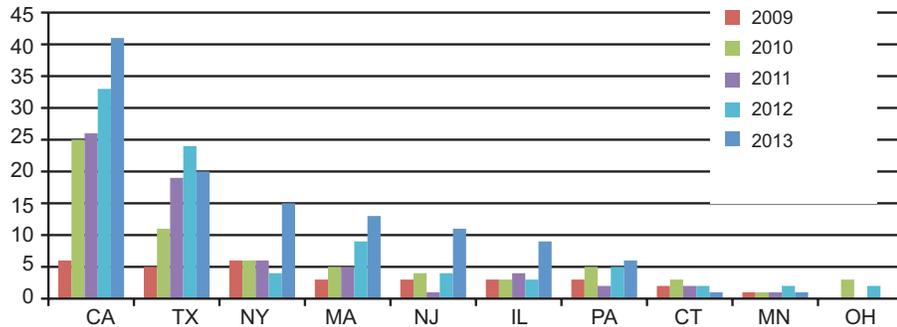
INDICATOR 14

Data Source for Indicator 14: BLS Business Employment Dynamics, QCEW, Census Bureau, AUTM, 2010 Kauffman Index of Entrepreneurial Activity

# INITIAL PUBLIC OFFERINGS AND MERGERS & ACQUISITIONS

## Number of Initial Public Offerings (IPO)

Massachusetts & LTS, 2009-2013

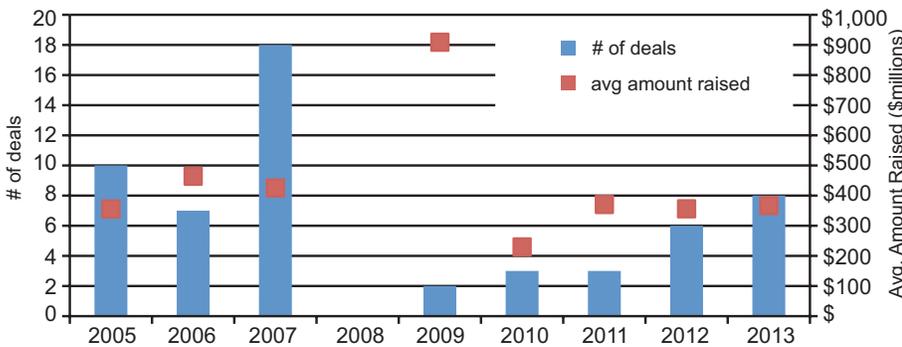


## Why Is It Significant?

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. Venture-backed IPOs specifically track companies previously funded primarily by private investors and can reflect investor confidence in the industry.

## Venture-Backed Initial Public Offerings

Massachusetts, 2005-2013 Q3



## How Does Massachusetts Perform?

IPOs, which are heavily concentrated in a few states, seem to have recovered from lows in 2009. California, Texas and Massachusetts are traditionally major generators of IPOs due to their strength in technology and in the case of Texas, the additional strength of the petroleum industry. After remaining stagnant post-2009, IPOs increased substantially in 2013 in New York, New Jersey and Illinois, more than tripling in New York's case.

Although nowhere near pre-recession highs, the number of venture-backed IPOs has continued to grow since 2009.

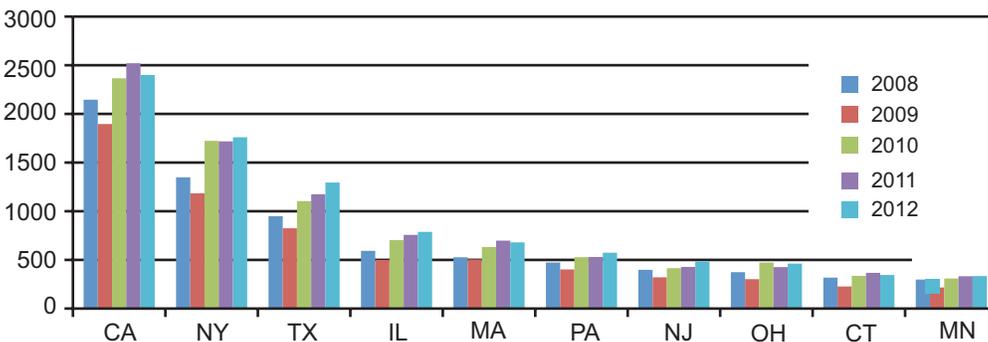
There has also been an uptick in M&As, with the top states seeing the most pronounced recoveries. Massachusetts, although higher than 2008, saw fewer companies participating in M&As in 2012 than 2011.

In all of the LTS, except Texas, there were more acquiring companies than there were companies being acquired.

## Number of Participating Companies

Mergers & Acquisitions

Massachusetts & LTS, 2008-2012



INDICATOR 15

Data Source for Indicator 15: Renaissance Capital, IPO Home, National Venture Capital Association (NVCA), Mergerstat



**Entrepreneurs gather  
for the Startup Showcase  
at the 2013 MassChallenge  
in Boston, Massachusetts.**



*MassChallenge 2013. Photo's courtesy of MassChallenge.*



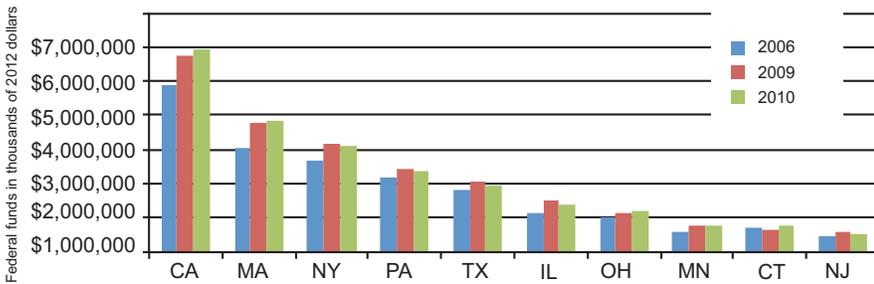
## **CAPITAL**

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 R&D

## Federal Funding for R&D

Universities, Colleges, and Non-Profit Organizations  
Massachusetts & LTS, 2006, 2009 & 2010

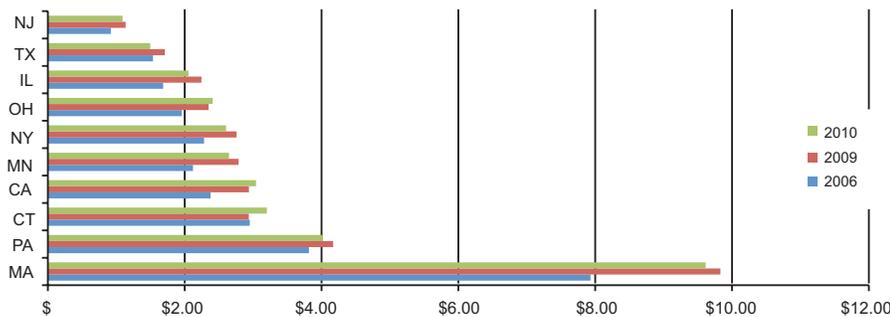


## Why Is It Significant?

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 who constitute one of Massachusetts' greatest economic assets. Awards from the National Institutes of Health (NIH) help fund the Commonwealth's biotechnology, medical device and health services industries which together comprise the Life Sciences cluster. Funding from the Federal Government is essential for sustaining academic, non-profit and health-related research; however, federal budget sequestration poses a risk to R&D funding in all states.

## Federal Funding for R&D per \$1,000 GDP

Universities, Colleges and Non-Profit Organizations  
Massachusetts, LTS & U.S., 2006, 2009 & 2010

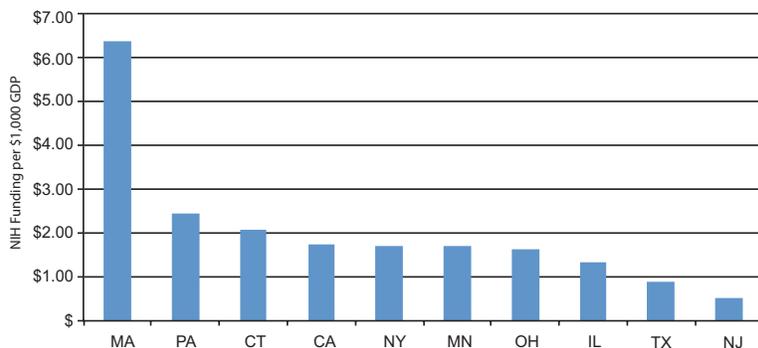


## How Does Massachusetts Perform?

Massachusetts remains second in federal R&D funding for universities and non-profit institutions following California. Funding was stagnant between 2009 and 2010 in Massachusetts and many of the other LTS with only Ohio, Connecticut, and California experiencing growth in this measure. At \$3.8 billion, Massachusetts trails California by roughly \$2 billion; however, California's population is nearly six times that of Massachusetts. All of the LTS saw an increase in federal funding relative to 2006, although the degree varied, with most states seeing only a slight increase. Massachusetts saw the largest relative increase, having grown 26% since 2006; it also had the second largest absolute increase at nearly \$800 million.

## National Institutes of Health (NIH) R&D Funding per \$1,000 GDP

Massachusetts & LTS, 2012



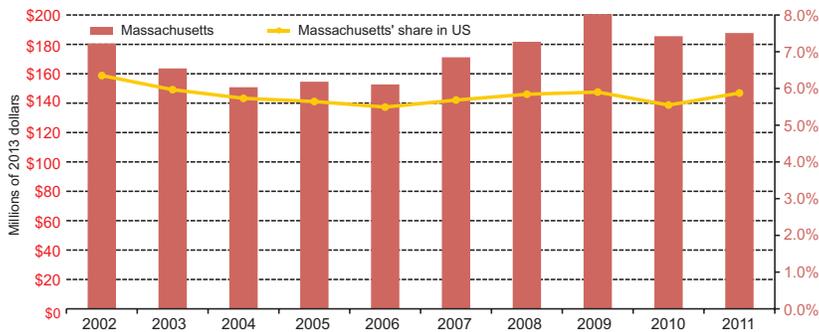
Massachusetts maintains a large lead in federal funding for R&D per \$1,000 of GDP. Although there was a slight decrease relative to 2009, most of the LTS also experienced a decrease. California, Connecticut and Ohio were the only states to see an increase; however, their funding per \$1,000 of GDP was less than a third of Massachusetts.

Massachusetts continues to attract the largest share of the National Institutes of Health (NIH) funding per \$1,000 of GDP. Although it declined slightly to \$6.34 per \$1,000 of GDP in 2012, Massachusetts still receives more than twice as much NIH funding as any of the other LTS.

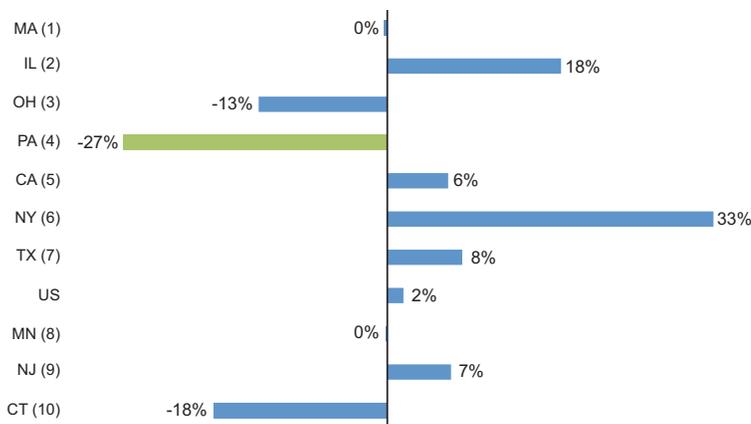
Data Source for Indicator 16: NSF, BEA, National Institutes of Health (NIH), Census Bureau

# INDUSTRY FUNDING OF ACADEMIC RESEARCH

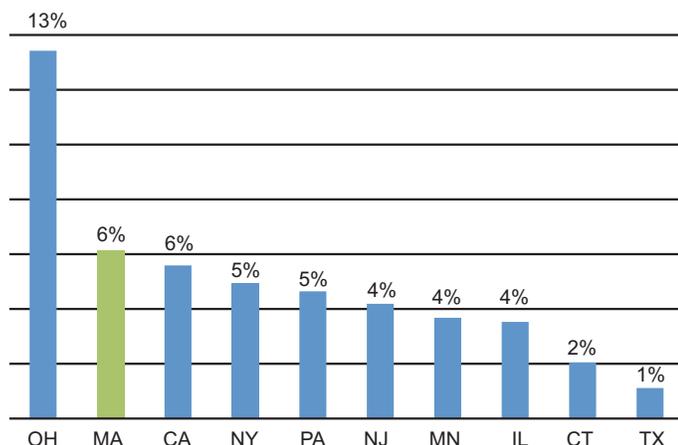
## Industry Funding for Academic Research in S&E Massachusetts, 2002-2011



## Rank in 2011 & Growth Rate in Industry Funding for Academic Research in S&E per \$100,000 GDP Massachusetts, LTS & U.S., 2008-2011



## Industry Share of States' Total Academic R&D Funding in S&E Massachusetts & LTS, 2011



Data Source for Indicator 17: NSF, BLS, Census Bureau

## Why Is It Significant?

Industry funding of academic research is one measure of industry-university relationships and their relevance to the marketplace. Industry-university research partnerships may result in advances in technology industries by advancing 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 R&D in S&E recovered slightly in 2011 to \$188 million, although it is still lower than the level in 2009. Massachusetts has recovered its share of the U.S. total, rising back to 5.9% after dropping to 5.5% in 2010. Over the last 5 years, Massachusetts' share of the U.S. total has remained relatively steady, averaging 5.8% each year.

Although Massachusetts ranks first among the LTS in industry funding for academic research in S&E per \$100,000 of GDP, it was relatively stagnant between 2008-2011. Three LTS experienced significant declines, with Pennsylvania seeing the largest decline at -27%. Five of the LTS and the U.S. as a whole saw growth over this period. New York was the clear leader among the LTS with a 33% growth in industry funding for academic research in S&E per \$100,000 of GDP.

Industry funding, as a share of total academic S&E research funding, declined in Massachusetts by 0.8 percentage points relative to 2010. However it is still greater than the majority of the LTS at 6%. Ohio is the leader at 13%, more than twice the share seen in Massachusetts. It is possible that Ohio's higher relative share of industry funding is the result of its traditional strength in manufacturing, normally the corporate funders of R&D. States strong in defense and medical research, traditionally funded by the federal government, will have lower industry shares of total academic R&D funding. Ohio State University is also one of the top recipients of industry funding for R&D.

INDICATOR 17

# VENTURE CAPITAL

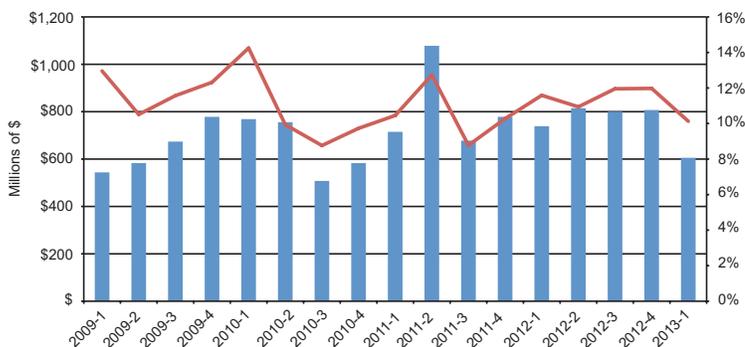
## VC Technology Investment

Massachusetts, 2012 - Millions of \$

Software	\$928
Biotechnology	\$860
Medical Equipment	\$417
Industrial/Energy	\$314
IT Services	\$174
Consumer Products	\$120
Media & Entertainment	\$109
Semiconductors	\$78
Electronics	\$59

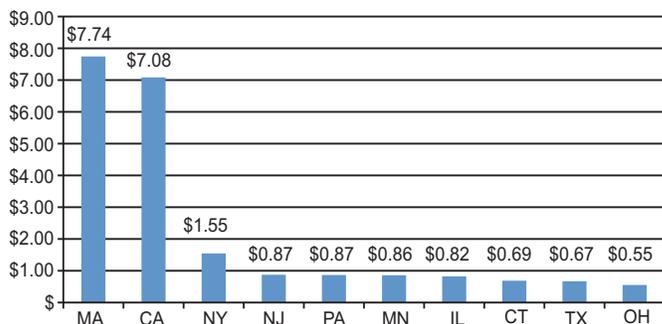
## VC Investment

Massachusetts as a Share of Total VC Investment in the U.S.  
Q1 2009-Q1 2013



## VC Investment per \$1,000 GDP

Massachusetts & LTS, 2012



## 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 opportunities in the innovation economy. There has been some empirical research to suggest that the amount of VC in a region has a positive effect on economic growth.

## How Does Massachusetts Perform?

Software and Biotechnology were the largest target industries for VC funding by far in 2012, attracting more capital than the next five sectors combined. This reflects the Commonwealth's strengths in these sectors as well as their current popularity among investors. Software start-ups are also attractive due to their relatively low upfront costs when compared with energy or semiconductor firms.

Start-up/seed financing from VC firms has steadily declined in Massachusetts since 2008, falling by more than 50%. However, early stage financing has doubled since 2008, highlighting investors' interest in younger firms. Expansion financing by VC firms, after declining substantially between 2008-2009, has risen back towards its 2008 level. Late stage financing declined substantially between 2008-2010; however, it has stabilized over the past three years.

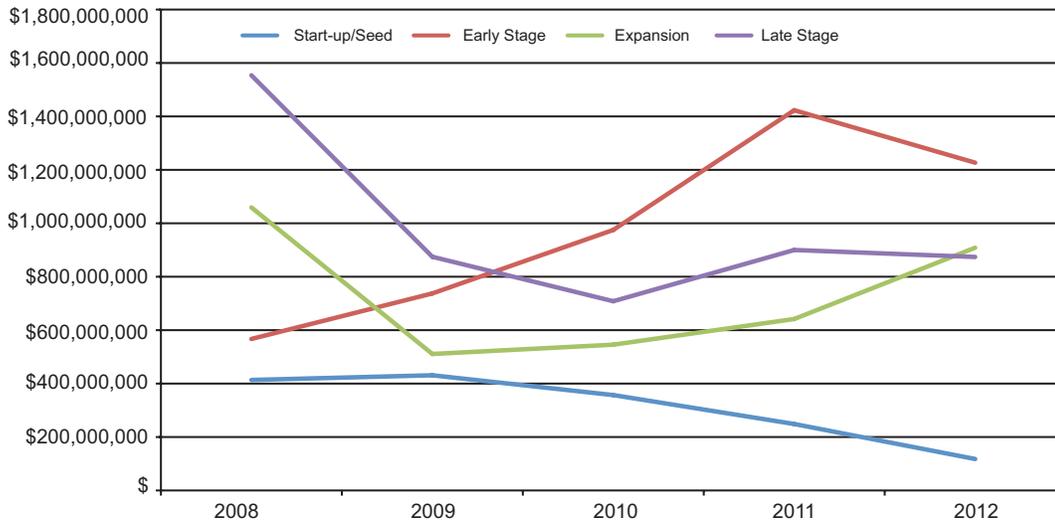
Massachusetts' share of U.S. VC investment has ranged from around 8% to 14% in recent years. After remaining roughly stable for much of 2012, Massachusetts VC funding and its share of the U.S. total both dropped in Q1 2013. However, the future looks bright as Massachusetts VC firms raised roughly a third of all VC in the U.S. in 2013, more than triple the 2012 amount, for a total of \$5.4 billion.

Massachusetts remains the leader in VC funding per \$1,000 of GDP. VC funding as a share of GDP grew by 0.4% between 2011 and 2012. California remained a close second with an investment level at 91% of Massachusetts', however Massachusetts VC funding per GDP is more than quadruple the next closest of the LTS. The importance of private "angel" investing has increased in recent years. Massachusetts has the second highest number of angel groups, 14, to California's 17, and more than the 10 groups in Texas. These groups represent at least 350 active individual investors.

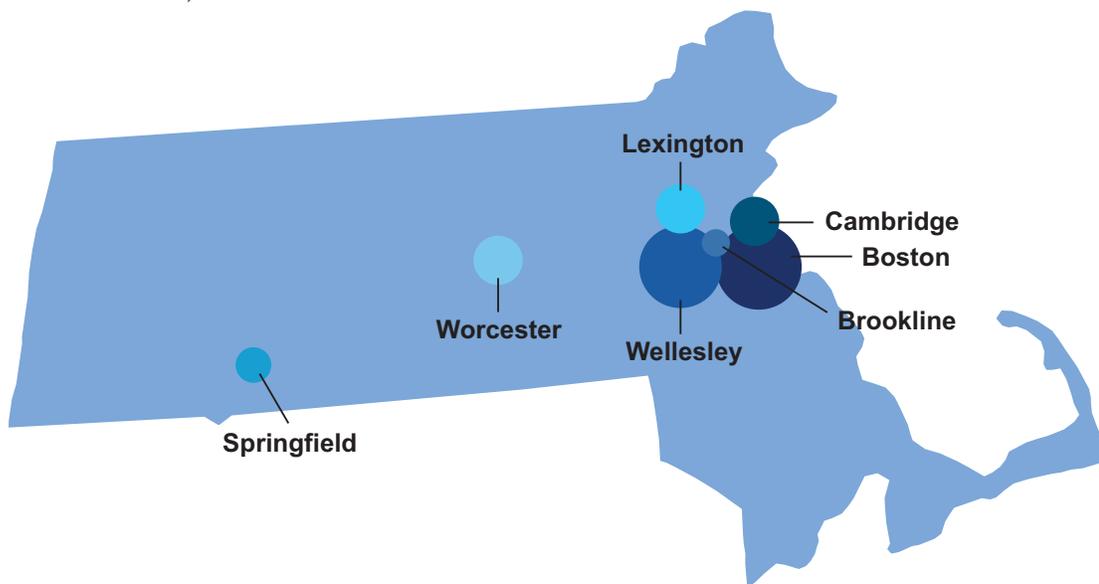
Data Source for Indicator 18: PricewaterhouseCoopers MoneyTree Report, CPI, BEA, The Boston Globe, NVCA

# VENTURE CAPITAL

**Change in VC Investment by Stage of Financing**  
Massachusetts, 2008-2012



**Angel Investors per Town**  
Massachusetts, 2013



**\* Massachusetts leads in venture capital investment as a percentage of GDP**

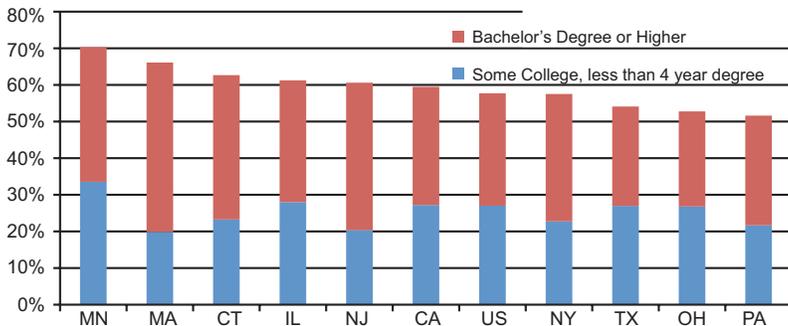


## **TALENT**

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 are particularly important to the innovation economy. Massachusetts benefits from an ongoing movement of people across its boundaries, including some of the brightest people from the nation and world who chose to live, study and work in the Commonwealth. Housing affordability also influences Massachusetts' ability to attract and retain talented individuals.

## EDUCATION LEVEL OF THE WORKFORCE

### Educational Attainment of Working Age Population Massachusetts, LTS & U.S., 2010-2012 Average



### Why Is It Significant?

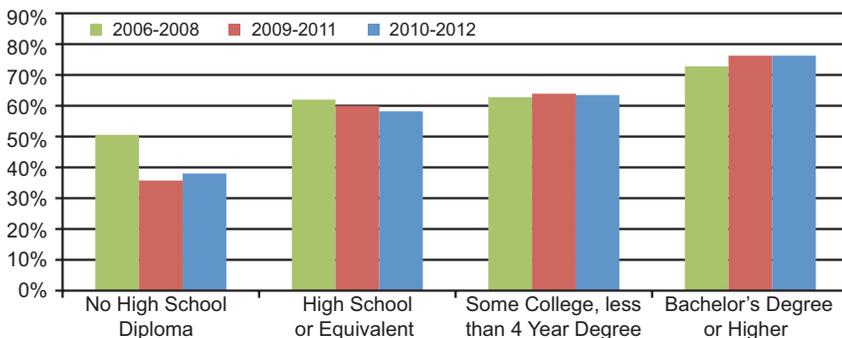
A well-educated workforce constitutes an essential component of a region's capacity to generate and support innovation-driven economic growth. Challenges to maintaining a suitably trained labor force in Massachusetts include the need to continually increase skill levels and technical sophistication of workers.

### How Does Massachusetts Perform?

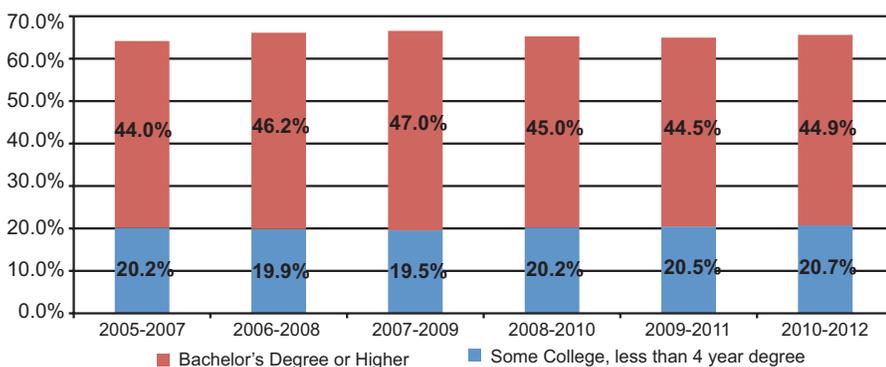
Massachusetts remains a leader among the LTS in terms of workforce educational attainment with the second highest overall level, as well as the highest percentage of adults with a bachelor's or higher (45%). While the percentage of adults with at least a bachelor's degree is still lower than it was at its peak in 2009 (47%), it is slightly higher than in 2011 (44.5%).

The employment rate among adults with at least a bachelor's degree has remained flat in Massachusetts from 2011-2012, while the employment rate of adults with less than a four-year degree and adults with a high school diploma or equivalent dropped slightly. At 76%, the employment rate for adults with at least a bachelor's degree remains much higher than the employment rate for adults with less education.

### Employment Rate by Educational Attainment Massachusetts, Three Years Rolling, 2006-2012



### College Attainment of Working Age Population Massachusetts, Three Year Rolling Average, 2007-2012

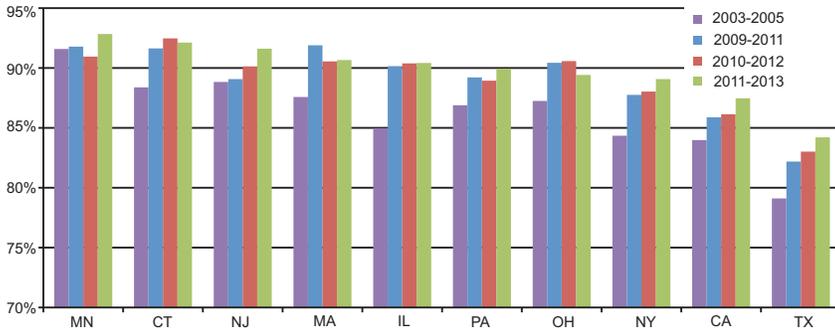


Data Source for Indicator 19: Census Bureau Current Population Survey (CPS)

# EDUCATION

## High School Attainment of Persons Ages 19-24

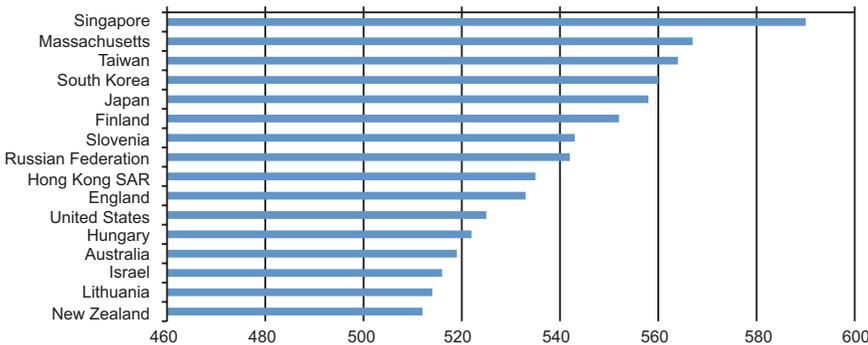
Massachusetts, LTS & U.S., Three Years Rolling, 2008-2012



**\* Massachusetts 8th graders rank second in the world in science achievement**

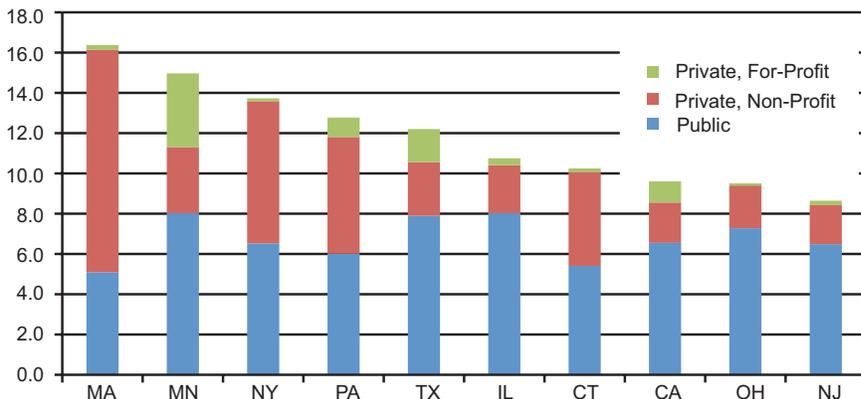
### International

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



## Postsecondary Degrees Conferred per 1,000 People Massachusetts & LTS, 2010-2011

INDICATOR 20



**\* Massachusetts confers more postsecondary degrees per capita than any other LTS**

## Why Is It Significant?

Education plays an important role in preparing Massachusetts' residents to succeed in their evolving job requirements and career trajectories. A strong education system also helps attract employers and retain workers who want excellent educational opportunities and skills for themselves and their children. Economic growth in Massachusetts is strongly dependent upon improving the skill diversity of the population.

## How Does Massachusetts Perform?

Three year rolling averages of high school attainment data show relative stability in Massachusetts over the last four years. Although recent attainment rates are down from the level seen in 2009-2011, they are still significantly higher than the period from 2003-2005, which was the earliest available data.

Massachusetts moved up to second place in the Trends in International Math and Science Study (TIMSS), an 8th grade science evaluation, while Singapore retained the top spot. Massachusetts' performance improved from the 2007 assessment and it remains significantly higher than the U.S. average.

Massachusetts continues to be the clear leader in the number of postsecondary degrees conferred per 1,000 residents. Although Minnesota is close, it gets a large share of its graduates from private, for-profit institutions. Minnesota is the headquarters of one of the nation's largest private for-profit institutions, so it gets credit for many graduates who take courses online and live in other states. Massachusetts is somewhat unusual in that the largest share of its graduates are from private, non-profit institutions.

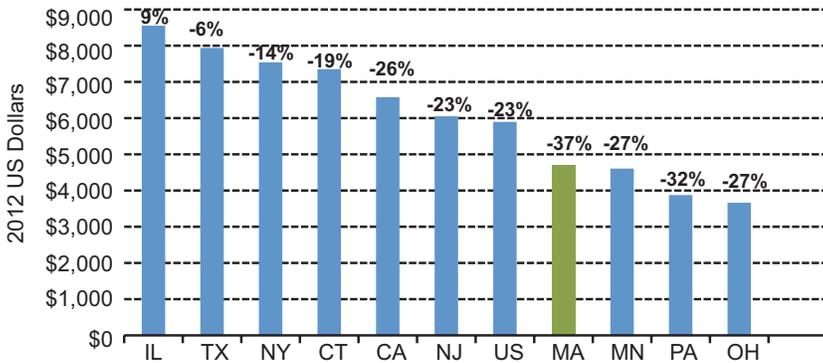
Data Source for Indicator 20: Census Bureau CPS, National Center for Education Statistics (NCES), American Community Survey (ACS)

# PUBLIC INVESTMENT IN EDUCATION AND PRESCHOOL ATTENDANCE

## State Higher Education Appropriations & 5 Year Rate of Change

Per FTE

Massachusetts, LTS & U.S., 2012



## Why Is It Significant?

Investments in elementary, middle and high schools are important for preparing a broadly educated and innovative workforce. Investments in public, postsecondary education are critical to increase the ability of public academic institutions to prepare students for skilled and well-paying employment. 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, only New York, New Jersey and Connecticut spend more per student and Massachusetts spends around \$3,000 per student more than the national average.

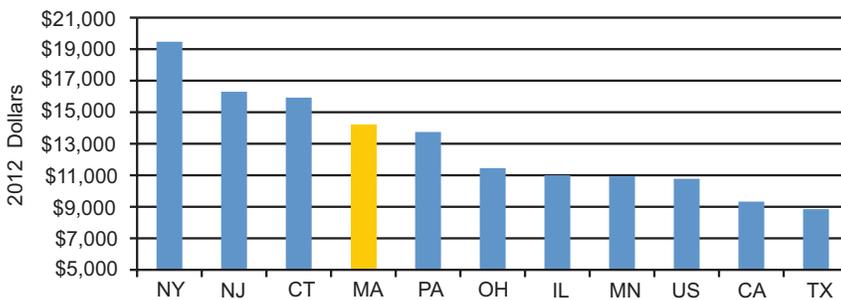
In terms of higher education appropriations per full-time-equivalent student (FTE), Massachusetts (\$4,712) continues to be lower than in most of the LTS (avg. \$6,087), as well as lower than the U.S. average (\$5,896). Of the LTS, only Pennsylvania, Minnesota and Ohio had a lower level of appropriations per student. Over the period 2007-2012, all of the LTS, except Illinois, and the U.S. as a whole, experienced a decline in higher education appropriations per student, which tends to increase the cost of attendance for students and families. In appropriations per student Massachusetts led the LTS with a 37% decline while the U.S. averaged a 23% decline.

Massachusetts continues to be a leader in pre-school attendance, sending a higher percentage of three and four year olds to school than the U.S. or the average LTS. Empirical research has indicated that pre-school programs can increase educational attainment later in life.

## Per Pupil Spending

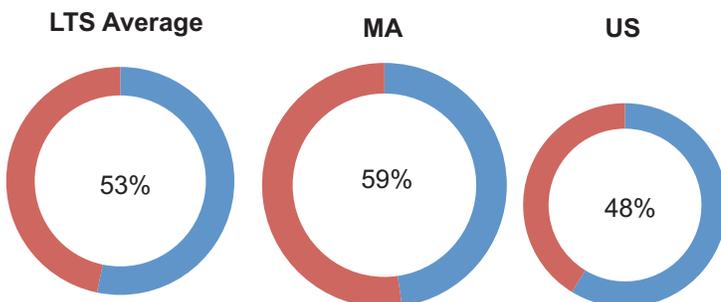
Public Elementary/Secondary School Systems

Massachusetts, LTS & U.S., 2011



## Percent of 3 & 4 Year Olds Enrolled in School

Massachusetts, LTS & U.S., 2012



Data Source for Indicator 21: State Higher Education Office, Census Bureau, ACS

# STEM CAREER CHOICES AND DEGREES

## Degrees Granted in STEM Fields

Massachusetts, 2011

	2011	% Change 2001-2011
Computer & Information Sciences & Support Services	2,139	-9%
Engineering	5,044	22%
Biological & Biomedical Sciences	4,008	56%
Mathematics & Statistics	995	55%
Physical Sciences	1,490	20%
<b>Total</b>	<b>13,676</b>	<b>25%</b>

## Why Is It Significant?

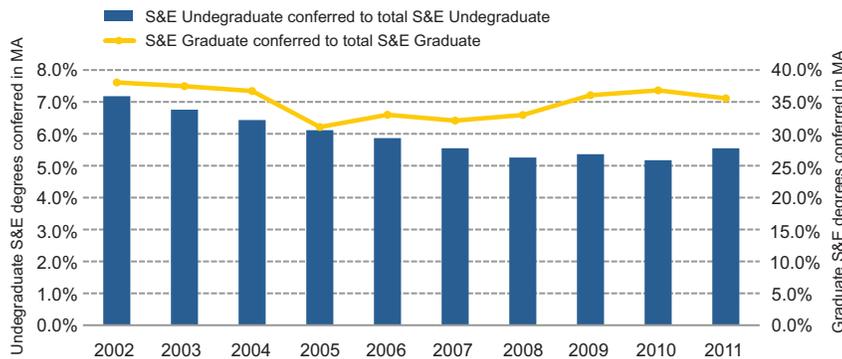
Science, technology, engineering and math (STEM) education provides the skills and know-how that can help increase business productivity, create new technologies and companies and form the basis for higher-paying jobs.

## How Does Massachusetts Perform?

In most states, between 16% and 25% of college bound seniors intend to major in a STEM field while the Massachusetts rate is 19.5%. Five states were above 20%, with Illinois and Minnesota being the clear leaders with nearly 30% of their college bound students intending to major in a STEM field. Both of these states had much lower response rates relative to population on the survey used to collect this data, which could result in less accurate results.

## S&E Degrees Conferred to Temporary Nonpermanent Residents

Universities in Massachusetts, 2002-2011



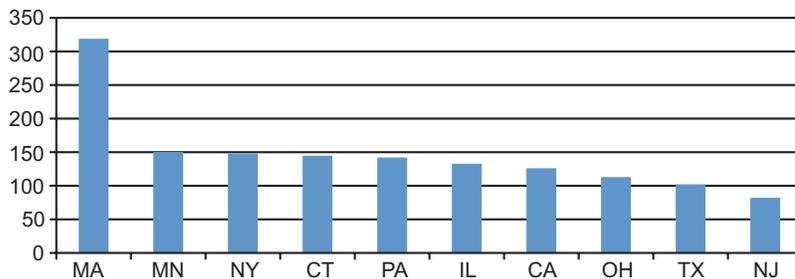
Degrees granted in STEM fields in Massachusetts rose in all fields except computer and information sciences and in support services over the period of 2001-2011. Total STEM degrees granted in Massachusetts rose 25% over the same period.

After rising in 2010, graduate degrees in S&E granted to temporary, non-permanent residents dropped slightly from 36.8% to 35.6% of all S&E degrees conferred in Massachusetts. At the same time, undergraduate S&E degrees conferred to temporary, non-permanent residents rose from 5.2% in 2010 to 5.5% in 2011, reversing a decline from 2009-2010.

Massachusetts is the clear leader in S&E doctorates granted per million residents, producing more than twice as many relative to its population as any of the other LTS. Not only does Massachusetts outperform the LTS on this measure, it also outperforms the rest of the country, with the exception of the District of Columbia.

## Science & Engineering Doctorates Granted

Per Million Residents  
Massachusetts & LTS, 2012



Data Source for Indicator 22: College Board, ACS, NCES, IPEDS

**\* Massachusetts universities & colleges granted 25% more STEM degrees in 2011 than 10 years prior**

INDICATOR 22

# TALENT FLOW AND ATTRACTION

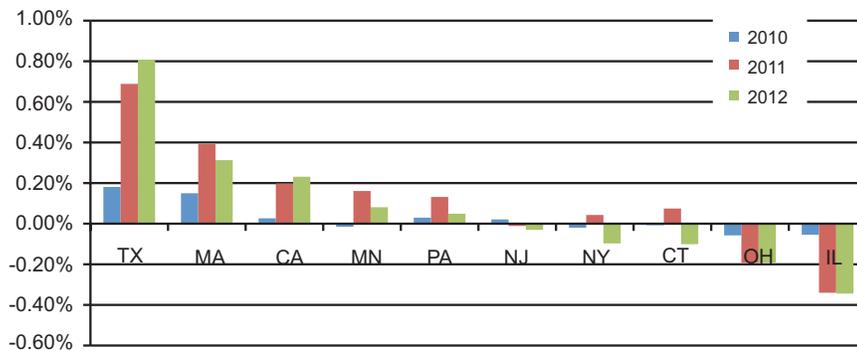
## Relocation by College Educated Adults

To the LTS from Out of State or Abroad  
Massachusetts & LTS, 2011-2012



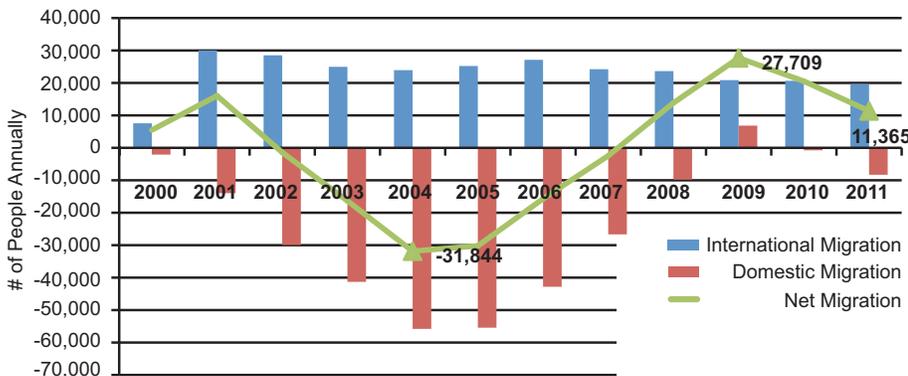
## Net Migration as % of Population

Massachusetts & LTS, 2010-2012



## Domestic & International Migration

Massachusetts, 2000-2011



## 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?

Massachusetts saw the highest rate of incoming migration from college educated adults among the LTS in 2011-2012. Relocation rates have remained relatively unchanged in the last two years and aside from Massachusetts and Connecticut on the high end and Pennsylvania and Ohio on the low end, most of the LTS have similar rates. Massachusetts and Connecticut, being home to a large number of research universities, institutions and R&D intensive industries relative to their populations, may explain their higher rates of inbound migration among college educated adults.

In recent years, most of the LTS have experienced lower or even negative net migration as a percentage of population, the exceptions being Massachusetts, California and Texas. 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 resources. The fact that Massachusetts finishes second among the LTS, even though it lacks these attributes, is certainly noteworthy. The high quality of life, cultural institutions and well-paying job opportunities may draw people to Massachusetts despite its cold climate and relatively high cost of living.

**\* Massachusetts was the top destination for the relocation of college educated adults in 2011-2012 in the U.S.**

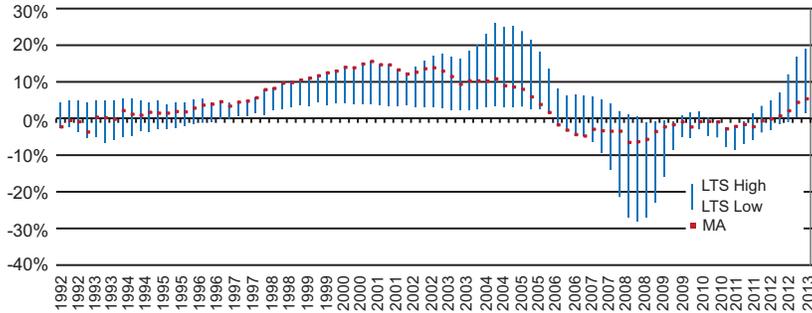
INDICATOR 23

Data Source for Indicator 23: Census Bureau, ACS

# HOUSING AFFORDABILITY

## Housing Price Index

Massachusetts & High to Low Range for LTS  
Q1 1992-Q2 2013



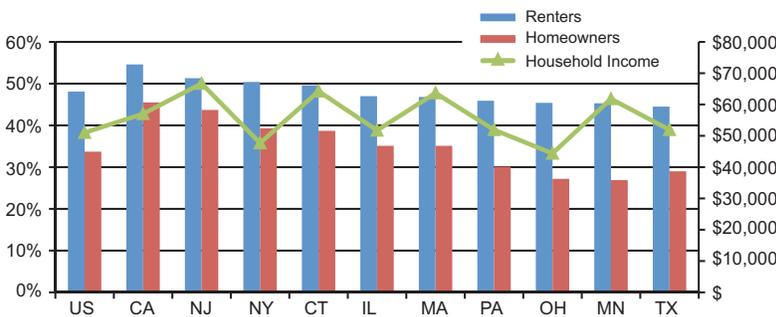
## Percentage of Households Spending 30% or More of Income on Housing Costs

Massachusetts & US, 2010-2012

	2010	2011	2012
MA Renters	47.8%	48.9%	46.8%
US Renters	48.9%	49.3%	48.1%
MA Homeowners	39.0%	38.6%	35.1%
US Homeowners	37.8%	37.8%	33.7%

## Households Spending 30% or More of Income on Housing Costs

Massachusetts, LTS & U.S., 2012



**\* Nearly 47% of Massachusetts renters qualify as housing burdened**

## 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 expansion in the region.

## How Does Massachusetts Perform?

After several years of decline and stagnation from 2005-2012, housing prices in Massachusetts have begun to rise again. The effects of the housing bubble were not as bad in Massachusetts and the LTS as they were in the U.S. as a whole. 11.5% of Massachusetts mortgaged properties held negative equity while the figure was 12.3% for the average of the LTS and 14.5% for the entire U.S.

More than 45% of Massachusetts renters qualify as "burdened" by housing costs, i.e. spending more than 30% of their income on housing. Although seemingly high, this is actually below the national average of 48%. Massachusetts and the U.S. as a whole have seen little change in this figure over the last three years. Over 40% of renters spend more than 30% of their income on housing in each of the LTS.

Homeowners in both Massachusetts and the U.S. have become less burdened in the past year with 3-4 percentage point decreases in the number of homeowners who spend more than 30% of their income on housing. Overall, homeowners are significantly less likely than renters to be burdened by housing costs. Homeowners face differing rates of housing cost burden with more than 40% of homeowners in California and New Jersey spending more than 30% of their income on housing. Fewer than 30% do so in Ohio, Minnesota and Texas.

On the surface, the situation seems to be improving, yet home prices and rents are increasing in Massachusetts and incomes are relatively stagnant. The bad news for renters and potential buyers contains some good news, however. Demand for more housing is having a positive effect on the Commonwealth's economic growth by driving a boom in construction jobs. Greater Boston last year created more construction jobs than perennially booming Houston and had a faster rate of growth than both Los Angeles and Houston.

INDICATOR 24

Data Source for Indicator 24: Federal Housing Finance Agency, Census Bureau, The Boston Globe, U.S. Department of Labor, Corelogic



**Entrepreneurs gather  
for the Startup Showcase  
at the 2013 MassChallenge  
in Boston, Massachusetts.**





# APPENDIX

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

### 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.

### Price Adjustment

The 2013 Index uses inflation-adjusted figures for most indicators. Dollar figures represented in this report, when 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, US Department of Labor ([www.bls.gov/data](http://www.bls.gov/data)).

### I. 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 2013 Index marks the adoption of a new method for selecting the Leading Technology States (LTS). The LTS list includes: California, Connecticut, Illinois, Minnesota, New Jersey, New York, Ohio, Pennsylvania, and Texas. In 2013 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 US 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 10 highest overall scores are then chosen for the LTS.

State	Score
<b>Top Ten</b>	
Massachusetts	2.27
California	2.16
Pennsylvania	1.93
New York	1.67
Connecticut	1.66
Illinois	1.66
Ohio	1.58
New Jersey	1.53
Texas	1.51
Minnesota	1.47
<b>Next Five</b>	
North Carolina	1.38
Wisconsin	1.28
Maryland	1.24
Virginia	1.23
New Hampshire	1.21

Source: BLS QCEW

## II. Notes 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.

## III. Notes 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.

## IV. Notes On The Creation Of The Data Dashboard

Determination of how Massachusetts was doing, relative to the LTS, is based upon a comparison with the LTS using previous time periods where possible (i.e., is Massachusetts growing faster on a certain measure than most LTS?).

## V. Notes On Data Sources For Individual Indicators

### Indicator 1: Industry Sector Employment And Wages

Data on sector wages are from the Bureau of Labor Statistics' Quarterly Census of Employment and Wages ([www.bls.gov/cew](http://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. Definitions for each key industry sector are in Appendix B.

### Indicator 2: Occupations And Wages

The U.S. Bureau of Labor Statistics, Occupational Employment Estimates (OES) ([www.bls.gov/oes/oes\\_dl.htm](http://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: Median Household Income

#### Median Household Income

Median household income data are from the U.S. Census Bureau, Current Population Survey Table H-8, 2012 using figures adjusted to 2012 dollars.

#### 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](http://www.bea.gov)).

#### Indicator 4: Industry Output

##### International Labor Productivity

Labor productivity for the overall economy is defined by the Index as gross domestic product (GDP) per employee. MA employment data source: Bureau of Labor Statistics. Nations employment data source: International Labour Organization, Employment Main statistics (monthly): employment general level - paid-employment in non-agricultural activities, in manufacturing (laborsta.ilo.org). MA GDP data source: U.S. Bureau of Economic Analysis, Nations GDP data Source: World Bank - Economic Policy & External Debt, GDP (Current U.S.\$) (data.worldbank.org).

##### Industry 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

Manufacturing exports data are, from U.S. Census Bureau, Foreign Trade Division.

#### Indicator 6: Research And Development Performed

##### 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: 2000, 2004 and 2008."

##### 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).

#### Indicator 7: Performers Of Research And Development (R&D)

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](http://www.nsf.gov/statistics).

#### Indicator 8: 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: 1998–2009" and "Table 8-48- Academic S&E Articles per 1,000 S&E Doctorate Holders in Academia by state: 1997, 2003 and 2008. International data is from the NSF. "Table 5-27 - S&E articles in all fields, by region/country/economy: 1999 and 2009". 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](http://www.census.gov/popest/data/index.html)).

#### Indicator 9: Patenting

##### United States Patent And Trademark Office (USPTO) Patents Granted

The count of patents granted by state are from the US 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](http://www.uspto.gov)). Population estimates are from the U.S. Census Bureau, Population Estimates Branch ([www.census.gov/popest/data/index.html](http://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](http://data.worldbank.org)).

### Indicator 10: Patenting By Field

The count of patents granted by state and patent class are from the U.S. Patent and Trademark Office ([www.uspto.gov](http://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](http://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 Hall, B. H., A. B. Jaffe, and M. Trajtenberg (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 MTC’s John Adams Innovation Institute. The “business methods” category has its own USPTO patent class.

### Indicator 11: Technology Licensing

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

### Indicator 12: 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](http://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](http://www.census.gov/popest/data/index.html)) and GDP Data is from U.S. Bureau of Economic Analysis ([www.bea.gov](http://www.bea.gov)).

### Indicator 13: Regulatory Approval Of Medical Devices And Pharmaceuticals

#### Medical Devices Approvals

Data regarding medical device approvals in the US are provided by the U.S. Food and Drug Administration ([www.fda.gov](http://www.fda.gov)). Medical device companies are required to secure premarket approvals (PMAs) before intricate medical devices are allowed market entry. A 510(k) is an approval sought by a company for a device that is already on the market and is looking for approval on components that do not affect the type of device, such as new packaging or new name.

#### Drug Approvals

Data on the number of drug approvals are from the Pharmaceutical Research and Manufacturers of America’s ([www.phrma.org](http://www.phrma.org)) publication “New Drug Approvals in 2012.”

### Indicator 14: 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](http://www.bls.gov/bdm)).

#### Entrepreneurial Activity

Data are from the Kauffman Foundation, as published in the 2010 Kauffman Index of Entrepreneurial Activity. Data represent the percent of the adult, non-business owner population that starts a business in the given time span. Data are calculated using the Census Bureau’s Current Population Survey.

#### 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](http://www.census.gov/econ/cbp/index.html)) Quarterly Census of Employment and Wages. Definitions for each key industry sector are in Appendix B.

#### 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](http://www.autm.net)).

## Indicator 15: Initial Public Offerings And Mergers And Acquisitions

## Initial Public Offerings (IPOs)

The number and distribution by industry sector of filed initial public offerings (IPOs) by state and for the U.S. are from Renaissance Capital's, IPOs Near You ([www.renaissancecapital.com/IPOHome/Press/MediaRoom.aspx#](http://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](http://www.nvca.org)).

## Mergers &amp; Acquisitions (M&amp;As)

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

## Indicator 16: Federal Funding For Academic, Nonprofit And Health R&amp;D

## Federal Expenditures For Academic And Nonprofit Research And Development (R&amp;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](http://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](http://bea.gov)), U.S. Department of Commerce.

## Indicator 17: 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 18: 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](http://bea.gov)), U.S. Department of Commerce.

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

## Indicator 19: Education Level Of The Workforce

For this indicator, the workforce is defined as the population ages 25-65. Data on educational attainment of this population are from the US 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.

## Indicator 20: Education

## 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, 2008 through 2012. 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 21: Public Investment In Education And Preschool Attendance

This indicator looks only at public investments in education, but it should be noted that Massachusetts is unusual in the size of the private education sector. Forty-three percent (198,000 of 463,000) of higher education students attend public institutions in Massachusetts compared to 72% nationally with the remainder attending non-public institutions. These figures are from the National Center for Education Statistics (NCES), Integrated Postsecondary Education Data System (IPEDS) Enrollment Survey using the NCES population of institutions available at [webcaspar.nsf.gov](http://webcaspar.nsf.gov). While private higher education is an export industry in Massachusetts, 48% of Massachusetts high school graduates indicate that they will attend public higher education institutions compared to 32% indicating they will attend private institutions, with the remainder not attending college. This difference is even more dramatic for Hispanics (50% and 18% respectively), a growing component of the Massachusetts population. These figures are from the Massachusetts Department of Education, Plans of High School Graduates, Class of 2008 (<http://www.doe.mass.edu/infoservices/reports/hsg/data.html?yr=08>).

#### 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: 2006-2011”.

Figures are presented in 2011 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.

#### Preschool Attendance

The data are from the United States Census Bureau, American Community Survey and the Supplementary Surveys. The population of children is age three to five years old.

### Indicator 22: Science, Technology, Engineering, And Math (STEM) Career Choices And Degrees

#### Intended Major Of High School Seniors

The intended majors of high school students are measured as the preference marked by students taking the Scholastic Aptitude Test (SAT) in Massachusetts and the LTS. Data are from The College Board, Profile of College Bound Seniors. Students are counted once no matter how often they tested and only their latest scores and most recent Student Descriptive Questionnaire (SDQ) responses are summarized.

#### 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.

### Indicator 23: Talent Flow And Attraction

#### Relocations To LTS By College Educated Adults

Data on population mobility come from the US 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 US Census Bureau's population estimates program using annual data.

### Indicator 24: 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.

Negative equity: Negative equity data is taken from the Corelogic Equity Report: Q2 2013.

## INDUSTRY SECTOR DEFINITIONS

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: "Bio-pharmaceuticals, 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

### Bio/Pharmaceuticals, 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

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
- 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

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