ANNUAL INDEX OF THE MASSACHUSETTS INNOVATION ECONOMY

Issued December 2012

Massachusetts Technology Collaborative

THE INNOVATION INSTITUTE
at the MassTech Collaborative

www.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.

For more information on the Massachusetts innovation economy visit our website at:
www.masstech.org

Massachusetts USA
Leading the Innovation Revolution

Dear Friends,

It is my pleasure to welcome you to the 2012 Index of the Massachusetts Innovation Economy. Published annually by the Mass Tech Collaborative, the Index is one of the Commonwealth's key instruments for assessing the performance of the major industry sectors that make up the innovation economy. This year's assessment is particularly well-timed. While Massachusetts has weathered the worst of the economic storm, the recovery is slow going and will require a robust public-private effort to leverage the resources and opportunities we have here in the Commonwealth.

The Index is a valuable tool 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 effect on the prosperity of communities throughout the Commonwealth.

Since 1997, Mass Tech 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 understandings that this analysis brings are essential as we seek innovative and creative ways to catalyze the growth of high quality jobs and a sustained economic recovery. A central goal of the Patrick-Murray Administration's economic development plan is to foster economic opportunity throughout the state through effective partnerships between universities, industry and government. The Index highlights key trends and themes affecting these efforts and helps inform fact-based decision-making among Massachusetts' policymakers, industry practitioners, and academic leaders.

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

Secretary Gregory Bialecki
Executive Office of Housing and Economic Development
Commonwealth of Massachusetts

Massachusetts Technology Collaborative

The Massachusetts Technology Collaborative is an innovative public economic development agency working to support a vibrant, growing economy across Massachusetts. MassTech's strength stems from partnerships and industry insights. The Massachusetts Technology Collaborative develops meaningful collaborations across industry, academia and government which serve as powerful catalysts, turning good ideas into economic opportunity.

The rich history of MassTech reaches back to 1982, when the Legislature created the Massachusetts Technology Park Corporation to develop a "partnership of government industry and education" for the tech sector. As the state's economy has evolved over the past thirty years, MassTech has adapted while sustaining a strong foundation on the core values of innovation, insight, collaboration, and accountability.

Through three major divisions, the Innovation Institute at MassTech, the Massachusetts eHealth Institute and the Massachusetts Broadband Institute, MassTech is fostering innovation and advancing global competitiveness across the state.

The Innovation Institute at MassTech

The Innovation Institute at MassTech implements a strategic model for the state to spur economic growth, working hand-in-hand with industry leaders, academic researchers and policymakers. As an agent of the Commonwealth, the Innovation Institute uses this model to further the state's economic development goals. The Innovation Institute strategy is based on the 'industry cluster' concept developed at Harvard Business School. By working to increase global competitiveness within key industry clusters of the Massachusetts Innovation economy, the Innovation Institute identifies opportunities to strengthen the state's overall innovation ecosystem.

The Innovation Institute promotes innovation and economic growth through the following:

- Enhance and improve our collective understanding at the intersection of economic development and innovation
- Convene industry, government and academia as a primary means to enhance the economic competitiveness of recognized economic sectors
- Strengthen and support institutions focused on growing the innovation economy
- Support and sponsor civic entrepreneurs
- Intervene opportunistically in close collaboration with industry, academia and public sector stakeholders, especially in instances where, but for the intervention, a competitive advantage for the Massachusetts economy could be diminished.

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HIGHLIGHTS

Emerging from the recession, much of the Massachusetts innovation economy is growing. Most of its cluster industries are adding jobs--some of them faster than their counterparts in other leading technology states (LTS), while some industries are not faring as well. However, important indicators of economic health, such as wages, productivity and exports, are on the rise. Massachusetts' research and development (R&D) assets, which help fuel innovation, remain strong. And, the Commonwealth continues to be a leader in turning R&D funding into ideas, technologies and companies, with strong performances on indicators such as technology licensing, patents and business formation.

At the same time, as this year's Special Analysis suggests, there are broader changes underway that may have important implications for the future of the Massachusetts innovation economy: the rising level of competition from other LTS; the shifting landscape for capital to fund innovation; and the emergence of new innovation drivers, diverse groups of companies spanning multiple clusters and value chain stages. All of these trends raise questions about how we measure and understand the opportunities and challenges facing the Massachusetts innovation economy.

ECONOMIC IMPACT

The Massachusetts innovation economy is rebounding from the recession.

Employment rose in seven of the eleven clusters of the innovation economy, with six clusters growing faster than total state employment in 2011. However, four clusters--advanced materials, bio-pharma & medical devices, financial services and business services--fared worse in 2011 than 2010. Real wages are higher than before the recession in nine of the eleven clusters--with wages of most clusters rising faster than those for all Massachusetts industries. Productivity also increased in three of five major manufacturing sectors in 2011 and manufacturing exports were up in both 2010 and 2011. Massachusetts is growing faster than most LTS in computer & communications hardware; software & communications services; scientific, technical, & management services and postsecondary education employment.

However, other states are growing faster in some areas.

Most LTS are adding jobs (or cutting job loss) faster than Massachusetts in seven of the eleven clusters. Productivity in three of five major manufacturing sectors lagged behind the LTS average. And, manufacturing exports as a share of gross domestic product (GDP) are rising much faster among the other top five LTS and the U.S. as a whole. More broadly, Massachusetts has not kept pace with the LTS average increase in median household income and has experienced a slower rate of GDP growth per employed resident than the U.S. average.

TECHNOLOGY AND BUSINESS DEVELOPMENT

Massachusetts continues to be a leader in turning R&D funding into ideas, technologies and companies.

Massachusetts remains the top LTS in the production of science and engineering academic articles per R&D dollar, as well as in patents granted per capita--and in both cases continues to keep pace with other LTS in terms of growth rate. The Commonwealth's leadership is broad-based, as the only state to rank among the top three LTS in five major patent fields. It also moved into the leadership position in technology licensing among LTS; was the top LTS in Small Business Innovation Research (SBIR) and Technology Transfer (STTR) award funding per capita and per dollar of GDP; and was among the top three LTS in medical device pre-market approvals and notifications. Massachusetts was second among LTS in net change in business establishments in key industry sectors per employee. In addition the state was also second in start-up companies initiated from universities, which had by far the fastest growth rate among LTS between 2010 and 2011.

RESEARCH

Massachusetts R&D assets remain strong, while some other states are gaining ground.

Across multiple indicators, the message is clear: Massachusetts remains one of the country's leading centers of federally-funded research and development. It had both the highest level and fastest growth rate among LTS in federal expenditures for academic and nonprofit R&D and the highest level of funding from National Institute of Health per dollar of GDP than any other LTS. It ranks second among LTS in industry funding of academic R&D per capita, although recorded the fourth fastest growth rate among LTS over the 2005-2010 period. It had the second highest level of overall R&D spending as a share of GDP among LTS, but the slowest growth rate among the top five LTS over the 2001-2008 period.

TALENT

Massachusetts continues to have a strong talent base.

Massachusetts is the top LTS in percentage of its working age population with a bachelor's degree or higher. It ranks well above the LTS average in post-secondary degrees conferred per capita and fourth when compared to countries worldwide. In addition, Massachusetts had the highest pre-school enrollment among the LTS in 2011; per pupil spending for public elementary and secondary school systems is the fourth highest among the LTS and grew at the third fastest rate in 2010. However, state higher education appropriations per full time equivalent student dropped almost seven percent between 2010 and 2011. In addition, relocations of college educated adults to Massachusetts ebbed in 2011, while growing in many LTS.

CAPITAL

The nature of capital investment that fuels the Massachusetts innovation economy, helping turn ideas and technologies into products, companies and jobs, is undergoing significant change.

Massachusetts is the top LTS in venture capital (VC) investment per dollar of GDP, but overall VC investment has dropped 28 percent since before the recession (2007-2011). Between 2009 and 2012, the level of VC investment dropped substantially at the start-up/seed stage, grew substantially at the early and expansion stages and declined at the later stage. At the same time, angel investment has begun to play a larger role, particularly in the start-up/seed stage, but also in the early and expansion stages. See the Special Analysis for more discussion of this shifting landscape for capital to fund innovation.

SPECIAL ANALYSIS

Three Shifts Defining the Future of the Massachusetts Innovation Economy

Emerging from the recession, it is not business as usual for the Massachusetts innovation economy. This year's Special Analysis explores three important shifts that undoubtedly create new challenges, but also open up new possibilities. Each shift is the product of forces beyond Massachusetts as well as actions taken within the Commonwealth's innovation economy. Going forward, each one can be shaped by decisions made by Massachusetts companies, investors, and governments. But, these shifts will likely continue to grow in importance in any case. The question is: will Massachusetts respond to these changes as opportunities, leveraging them to strengthen its innovation economy and, in turn, grow prosperity for the people and communities of the Commonwealth?

The Emergence of New Innovation Drivers

In the face of rising competition and a changing landscape for capital investment, the next wave of Massachusetts' innovation is already emerging. In areas such as robotics and "Big Data" (i.e., database management and analytics), the Commonwealth is already home to diverse concentrations of companies that span multiple clusters and value chain stages – ranging from R&D to manufacturing to sales/installation and maintenance. Robotics and Big Data have been identified as important new drivers of innovation in Massachusetts. While not the only drivers, they help illustrate why it is important to understand the changing nature of innovation in Massachusetts. To shed more light on these drivers, Collaborative Economics started with lists of companies provided by the Massachusetts Technology Leadership Council (MTLC), and conducted further searches using the proprietary National Establishment Time-Series (NETS) database, which tracks the evolution of individual firms over time.

This analysis revealed evidence of dynamic growth in the number of business establishments and jobs in these areas in recent years. In fact, employment growth has outpaced that of the entire Massachusetts economy as well as the eleven clusters identified as the innovation economy (see Figure 1). The establishments Collaborative Economics was able to identify in robotics generated a five percent gain in employment between 2007 and 2010, while Big Data's employment increased 21 percent.

While this dynamism might not be surprising – and is generally consistent with results from MTLC surveys – Collaborative Economics also found these drivers difficult to measure because they defy traditional definitions and industry coding schemes. In other words, there are real barriers to systematically and comprehensively understanding how important innovation drivers such as robotics and Big Data are evolving in Massachusetts.

Between 2007 and 2010, we found that 136 robotics establishments spanned 53 industry codes across eight of Massachusetts' 11 key industry clusters. In addition, 41 percent of them actually resided outside the 11 clusters. Similarly, we found that 114 Big Data establishments spanned 22 industry codes across five of Massachusetts 11 key industry clusters, and 32 percent of them resided outside the 11 clusters.

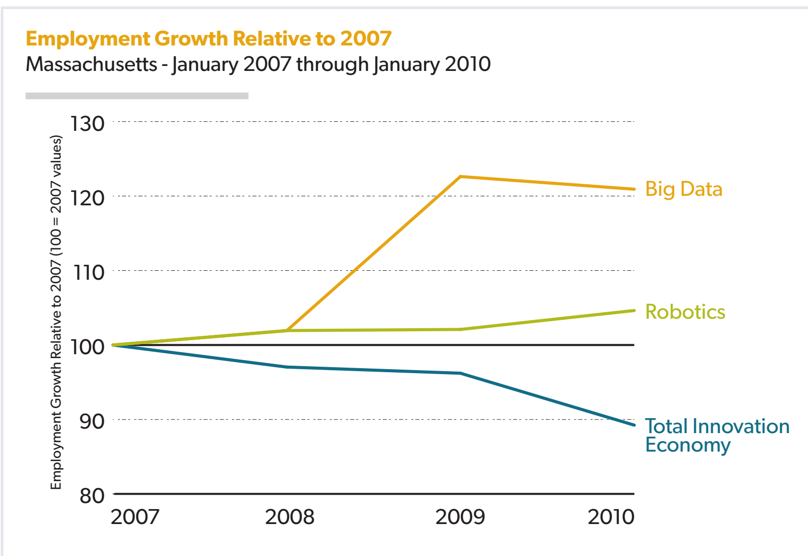
Robotics and Big Data firms defy categorization because they are emerging from many sources and serving diverse markets, enabling innovation at the intersections of technologies and industries. Robotics firms are found in sectors such as defense instrumentation, engineering services, R&D in the physical and engineering sciences, computer systems design services, and a host of others. They create intelligent automation products and services that not only serve federal government defense needs, but a growing variety of markets including healthcare, education, life sciences, materials handling, logistics, and marine and other transportation.

Big Data firms are found in sectors such as data infrastructure, data integration tools, data management solutions, analytics and visualization, and a host of specialized service providers. They, too, serve a growing array of markets, including end users such as government, healthcare, financial services, life sciences, consumer products, and the media – all of whom have business opportunities that depend on their ability to collect, store, access, analyze, package, and apply large volumes of customer and other data.

Robotics and Big Data are, of course, just two important innovation drivers at the intersections of technologies and industries. As Figure 2 suggests, there are many areas in which innovation is growing in Massachusetts – and this is just a partial list.

The story of the dynamic evolution of innovation drivers in Massachusetts is important to understand because it can inform those who would fund, support, and benefit from breakthroughs in those fields. Massachusetts can purposely leverage its leadership position in innovation and capture the ensuing economic, social, and community benefits.

Figure 1



Data Source: National Establishment Time-Series Database (NETS)
Analysis: Collaborative Economics

Figure 2 **Examples of Innovations at the Intersection of Technologies and Industries***

	MEDICAL DEVICES	ANALYTICAL INSTRUMENTS	ELECTRONICS & SEMICONDUCTORS	DEFENSE & AEROSPACE
ROBOTICS	• Precision manufacturing • Testing/monitoring	• Precision manufacturing • Testing	• Precision manufacturing • Testing	• Precision manufacturing • Testing
BIG DATA	• Analytics • Visualization	• Applications • Data solutions	• Analytics • Visualization	• Data integration • Data management/security • Security
MODELING & SIMULATION	• Drug development • Clinical trials design and analysis • Advanced therapeutics • R&D instrumentation	• Concept definition and analysis-of-alternatives • Rapid prototyping • Manufacturing process modeling	• Rapid prototyping • Manufacturing process modeling • Test and evaluation support	• Concept definition and analysis-of-alternatives • Rapid prototyping • Manufacturing process modeling for process improvement/control
MATERIAL SCIENCES	• Nano materials • Nano manufacturing • High-performance composites	• Nanosensors • Nano materials • Nano manufacturing	• Nano materials • Nano manufacturing • High-performance composites	• High-performance composites • Propulsion systems
ENERGY & ENVIRONMENTAL TECHNOLOGY	• Environmental science	• Climate monitoring • Environmental sensors • Smart grid components • Smart transportation/infrastructure	• Renewable energy components	• Directed energy (lasers, microwaves)
BIOTECHNOLOGY	• Translational genomics/medicine • Biomanufacturing	• Health monitoring systems • Environmental monitoring systems		
ENGINEERING SYSTEMS TECHNOLOGY	• Process design • Product engineering	• Systems integration • Process design • Product engineering • Process engineering	• Manufacturing technology • Process design • Product engineering	• Systems integration • Computation • Process design • Product engineering

* *This figure depicts just a few areas of innovation at the intersections of technologies and industries in Massachusetts. It is meant to be illustrative, rather than comprehensive, but nonetheless shows both a breadth and depth of opportunities for the Commonwealth.*

The Changing Capital Landscape

The nature of capital investment that fuels the Massachusetts innovation economy, helping turn ideas and technologies into products, companies, and jobs, is undergoing significant change. While this new reality needs to be better understood, it could open up more sources of capital and increase overall levels of investment in innovation in Massachusetts in the future.

Today, the Commonwealth starts from a position of strength when it comes to capital for innovation; it is at the top of the LTS in terms of VC investment per dollar of GDP. However, overall VC investment dropped 26 percent since before the recession (2007-2011). Between 2009 and 2011, the level of VC invested dropped substantially at the start-up/seed stage (down 45%), while growing for the early, expansion and later stages at 89, 30 and six percent respectively. At the same time (2009 - 2011), angel investment has begun to play a larger role, particularly in the start-up/seed stage (up 84%), but also in the early (up 139%) and expansion stages (up 103%). These are signs of a changing landscape for capital investment.

The emerging landscape can be described from the point of view of a new company trying to find the ingredients it needs to thrive (see Figure 3). If the company is a seedling, then it needs sun (market demand), water (sources of capital), and nutrients from the soil (access to specialized expertise and diverse sources of support). All three must be present for the seedling to survive and grow. Today, all three are changing

Figure 3

simultaneously: markets are transforming with new competitors, partners, and customers; capital sources and investment combinations are expanding; and sources of expertise and support are proliferating.

In terms of markets, new opportunities are emerging for entrepreneurs to pursue innovation with smaller capital requirements than in the past (e.g., software applications across many industries). Increasingly, there is also a "virtualization" of company functions that saves time and money. Fledgling firms are tapping consulting expertise, using facilities owned by others, and outsourcing basic organizational functions rather than building their own.

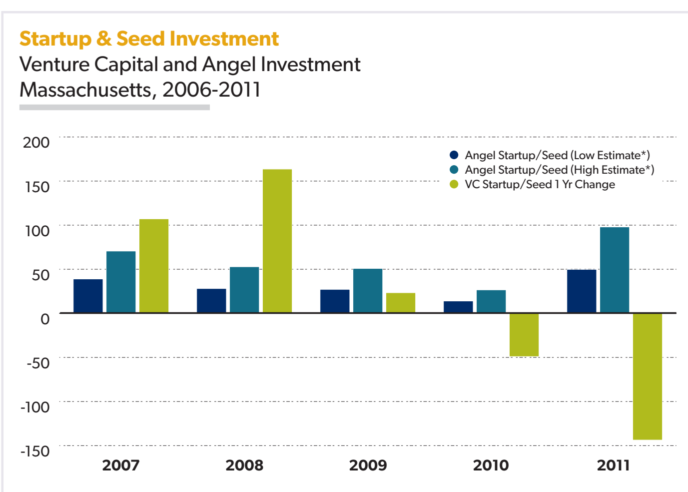
In terms of capital, options are growing with the rapid increase in angel investment (see Figure 4). Angel investment in Massachusetts nearly doubled between 2009 and 2011, from an estimated $27 to $51 million to $50 to $100 million. In fact, angel investment is now estimated to be as much as 40 percent of the level of VC invested at the start-up/seed stage in Massachusetts. It is also taking many forms – from individual angel investors to organized groups of investors, to emerging models of "crowd-sourcing" or "crowd-funding" that utilize internet-based platforms to reach potential investors who are interested to discover and help fund the ideas and business plans of entrepreneurs and innovators in Massachusetts.

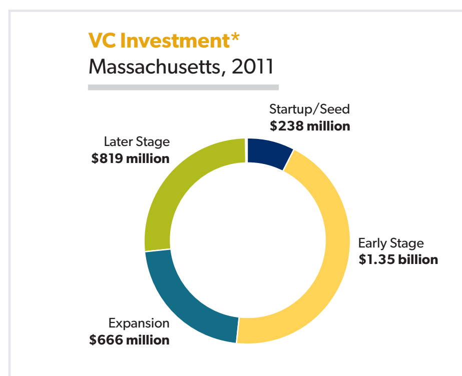
Not only are the sources of capital increasing, but so too are the different combinations of funding sources that companies are assembling. Today, companies (see examples on page 13) that are cobbling together varying combinations of VC, self-funding, angel investment, corporate venture funding from large companies, and government grants and loan guarantees are neither uncommon nor limited to specific technology niches. And, it appears that we are just in the early stages of this transformation.

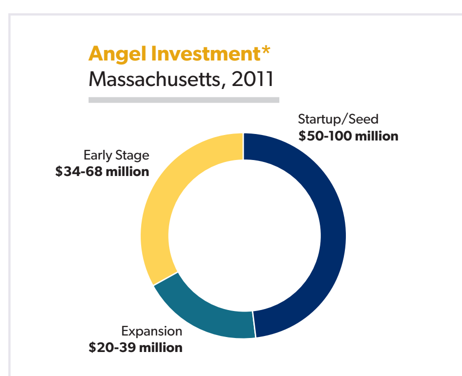
The sources of support available for fledgling companies are also undergoing significant change in Massachusetts. The past few years have witnessed the emergence of new networks, incubators, accelerators, and competitions – either stand-alone efforts or new offerings from existing industry and technology organizations. Many of these new sources of support are private-sector based, supplementing local, state, and federal government assistance focused on new and small companies. Massachusetts universities and other institutions are also a tremendous asset to companies, providing valuable intellectual capital to the business environment. For example, Worcester Polytechnic Institute offers an undergraduate degree specifically in robotics, Northeastern University has a strong experimental learning program and three of the top four ranked entrepreneurship programs are located in Massachusetts [1] (Babson College, Harvard University, Massachusetts Institute of Technology), preparing students to work at a fast-growing company and to be key contributors in the innovation of new technologies. This web of support amplifies the already-strong base of specialized technical expertise and experienced entrepreneurs who act as "connectors" to resources and expertise in their industries.

What are the implications of this shifting landscape? Massachusetts already starts from a position of relative strength. It has a pool of investors and specialized talent, as well as a mix of organizations and networks that are actively looking for better ways to support entrepreneurs and innovators. However, current investment levels suggest that Massachusetts has only begun to unlock the capital that could fuel the next wave of innovation across the Commonwealth's industry clusters.

Figure 4







*Data provided by the University of New Hampshire, Center for Venture Research are based upon Angel Group Data. It is estimated that angel groups represent 5-10% of the general angel population in MA.
Data Source: Pricewaterhouse Coopers Money Tree Report, University of New Hampshire Center For Venture Research
Analysis: Collaborative Economics

[1] U.S. News. *Education, Grad Schools, Business, Entrepreneurship*. 2012. Web.

Massachusetts Companies Navigating the Changing Capital Landscape

DataXu, Inc.
DataXu helps some of the world's largest brands optimize their digital marketing activities. DataXu is commercializing a technology for which it has an exclusive license from the Massachusetts Institute of Technology (MIT). The MIT technology research team is now part of the DataXu team and, as a shareholder, MIT provides ongoing advising and mentorship services. DataXu received private financing to launch the company, beginning with about $1 million in angel investment from local investors and entrepreneurs. Less than a year later, it received $6 million from two local Boston-area venture capital firms, Atlas Ventures and Flybridge Capital Partners. The next year, DataXu added California-based Menlo Ventures to its investor portfolio and raised an additional $11 million.

Firefly BioWorks, Inc.
Firefly BioWorks has developed an open technology platform for biomarker detection, allowing industrial, academic and clinical scientists to develop and use multiplexed assays on standard laboratory instrumentation. The company has used a lean start-up approach, releasing the minimum viable product to customers, then revising the product and scaling up according to customer feedback and market demand. This approach has allowed it to start operations with less capital than traditional technology-based companies. The company's funding tapped into several sources. Initial funding was provided by two Phase I SBIR grants, for a total of $425,000, followed by a $1 million private seed financing round, including a $600,000 Super Angel investment. The second round of financing was similarly catalyzed by a $2 million Phase II SBIR grant. The company then pitched to private investors that their funding would be met dollar for dollar by public financing, allowing it to raise another $2 million in private financing. In addition, the company received a $500,000 grant from the state of Massachusetts via the Massachusetts Life Sciences Center.

Harvest Automation
Harvest Automation produces intelligent mobile robots to work autonomously in outdoor environments with laborers to perform the most physically demanding parts of their jobs, helping reduce costs and increase safety. The company has utilized private investment to test and develop its technologies, rather than pursuing grants that have a long application process and specific terms. Harvest received its first investment commitment of $500,000 from MassVentures, which was crucial in attracting further investment. The company's Series A funding round closed in December 2009 at $5.5 million, and Series B closed in November 2011 with nearly $8 million. Harvest is also beginning to reach out to universities to test sensors and future products.

iRobot
iRobot designs and builds robots that are used in diverse settings, including homes, defense and public safety, maritime, and in education for applications ranging from vacuum cleaning to diffusing bombs. iRobot started as a bootstrap company and gained financial stability through strategic partnerships with large companies such as Halliburton and John Deere. iRobot received its first venture capital funding in 1997, which allowed the company to launch its first major consumer product. In total, iRobot has received over $7million in SBIR Phase I and II and $1.6 million in STTR Phase I and II awards, and its success has won the company a SBIR Hall of Fame Award. In total, iRobot raised $28 million in five venture capital rounds before becoming a publicly traded company in 2005.

Springpad
Springpad builds consumer apps that let people create smart notebooks full of ideas from anywhere – on the web and on the go – and share them with their friends. Springpad's co-founders had a strong relationship with venture capital firm Fairhaven Capital at their previous company, Third Screen Media, which was acquired by AOL. Therefore, it was a logical choice to continue that partnership. Fairhaven Capital organized a $10 million investment in the company and also provides connections, leadership, and mentorship support. In the past few years in particular, Springpad's co-founders have found that the entrepreneurial environment has flourished as the cost of starting a technology-based business has decreased and access to capital has become easier.

Vecna Technologies
Vecna Technologies focuses on developing advanced technologies for the healthcare industry, including hardware and software solutions. Since its inception in 1999, Vecna has helped hospitals, including the military's TRICARE program and the Veterans Health Administration, automate services through solutions such as web portals or patient check-in kiosks. Vecna is a privately held company without any outside investors or debt. The company has received numerous SBIR grants since 2000, as well as other research and Federal grants, which have played a critical role in developing new products. The company was awarded a Tibbet Award for exemplary SBIR performance.

The Rising Level of Competition

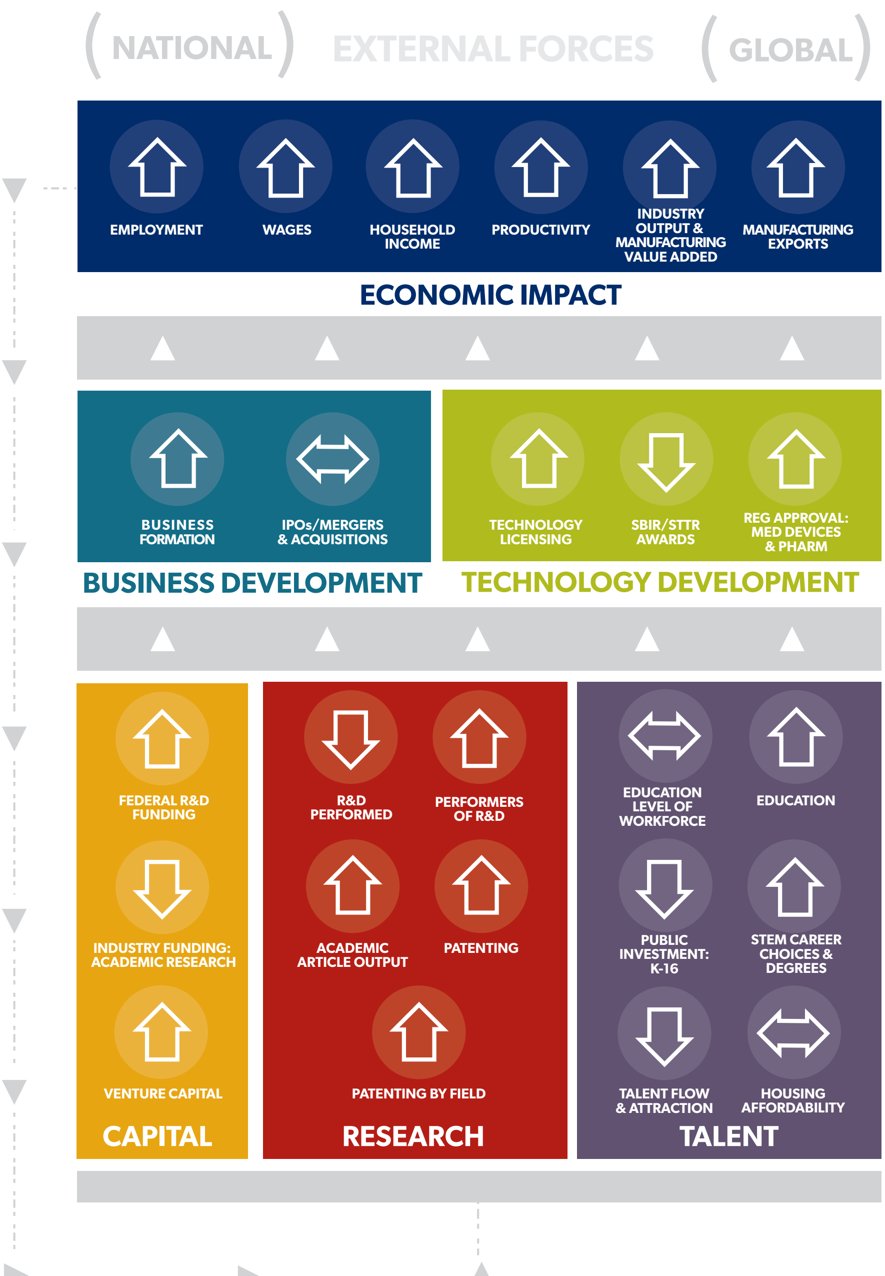
Massachusetts is among the top of the leading technology states (LTS) in most innovation indicators – and has been among the leaders for a long time. Coming out of the recession, the Commonwealth is rebounding across the board, showing absolute gains across a majority of indicators in this Index. Massachusetts is achieving improved economic impact outcomes, enhancing innovation processes that create businesses and technology development, and building stronger fundamental assets that fuel innovation including capital, research, and talent.

On several indicators, however, other LTS are gaining ground (see Figure 6). Most striking is that on every economic impact measure in this Index, Massachusetts made gains relative to itself but either lost ground or only kept pace with the gains of other top LTS. For example, most LTS are adding jobs (or cutting job losses) faster than Massachusetts in seven of its eleven key industry clusters. In addition, productivity in three out of five major manufacturing sectors lagged behind the average of the LTS and manufacturing exports as a share of GDP is rising much faster among the other top five LTS and the U.S. as a whole. More broadly, Massachusetts has not kept pace with the top states in median household income, nor among other countries in GDP per employed resident.

At the same time, Massachusetts is keeping pace or improving

Figure 5

How Massachusetts is Doing | Relative to Its History



From bottom to top, this figure shows how Massachusetts is doing on important innovation assets--capital, research, and talent--which help drive technology and business development. These innovation processes produce economic impacts, which in turn can help strengthen the Commonwealth's innovation assets in a positive cycle of prosperity. Global and national forces, as well as state and local actions, affect all these measures.

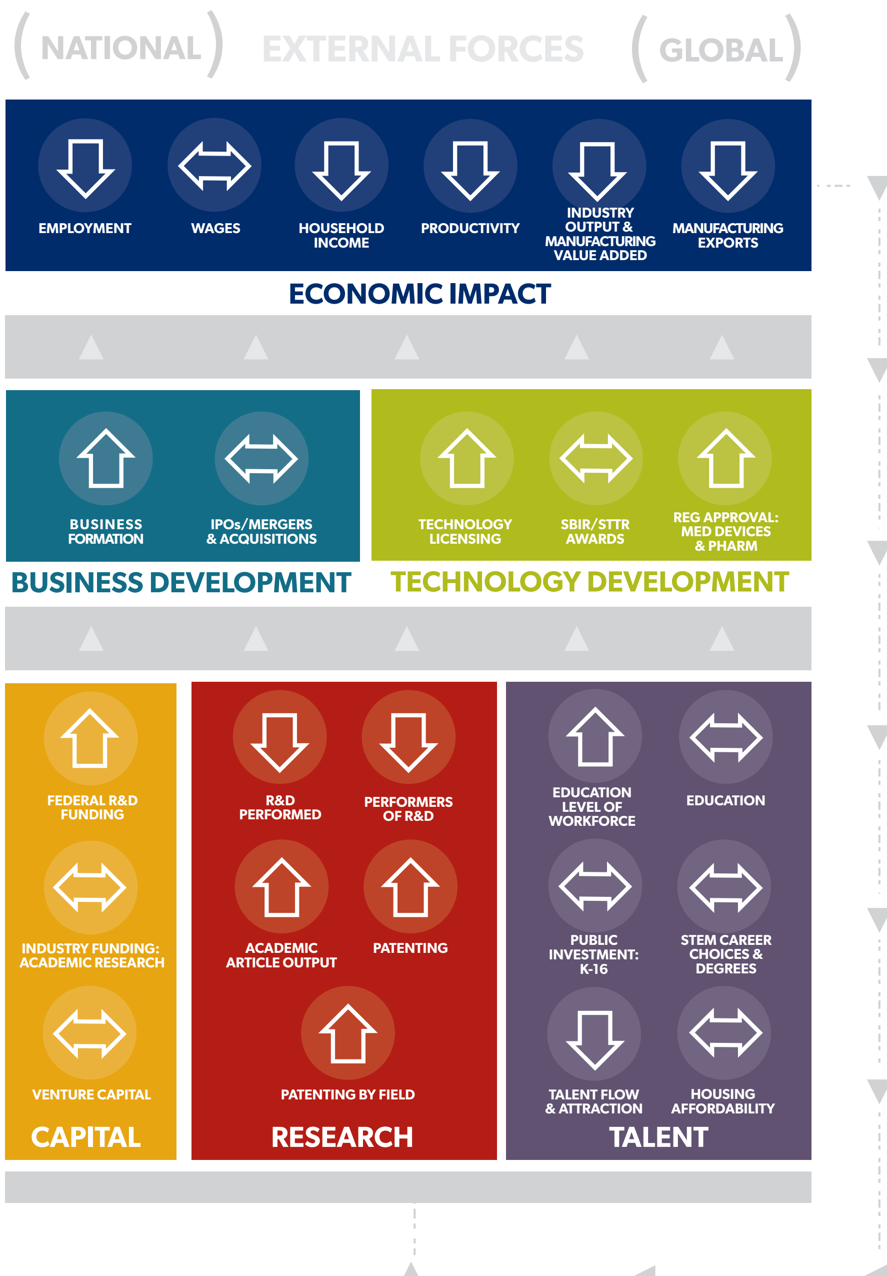
on many measures of the underlying processes and assets that fuel innovation. It continues to be a leader in turning R&D funding into ideas, technologies, and companies, with strong performances on indicators such as technology licensing, patents, and business formation. For example, Massachusetts moved into the lead in technology licensing among LTS, and was second among these states in net change in business establishments in key industry sectors per employee. Massachusetts was also second in the number of start-up companies initiated from universities, with the fastest growth rate by far among LTS between 2010 and 2011.

Nonetheless, there are signs of possible slippage. For example, while Massachusetts ranks second among LTS in industry funding of academic R&D per capita, three other LTS grew at a faster rate over the 2005-2010 period. Massachusetts had the second highest level of overall R&D spending as a share of GDP among these states, but one of the slowest growth rates among the top five LTS over the 2001-2008 period. State higher education appropriations dropped at the same time relocations of college educated adults to Massachusetts ebbed in 2011, while growing in many LTS. Taken together, these trends are not definitive signs of comparative decline, but are signals that may require greater scrutiny in the future.

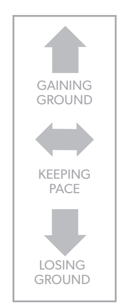
There remains the question of, "Why is Massachusetts gaining in absolute terms in most areas and losing ground in relative terms on some key measures?" It is possible that the complex

Figure 6

How Massachusetts is Doing | Relative to the LTS



From bottom to top, this figure shows how Massachusetts is doing compared to other leading technology states on important innovation assets--capital, research, and talent--which help drive technology and business development. These innovation processes produce economic impacts, which in turn can help strengthen the Commonwealth's innovation assets in a positive cycle of prosperity. Global and national forces, as well as state and local actions, affect all these measures.



mix of national and global economic forces may be having a deeper impact on Massachusetts than other states. The data suggest that it was not because other states fell further than Massachusetts during the recession and are now gaining back lost ground faster. Nor is there any evidence that something dramatic happened in some states in terms of policy or technology that left other states behind. And it certainly was not because somehow Massachusetts forgot how to innovate during the recession.

More likely, it is because innovation and its positive benefits are not primarily limited to a few historic technology leaders, but are becoming more broadly-based across many states and communities in the United States and worldwide. For Massachusetts, this means that the Commonwealth has company. It will continue to have a growing number of competitors, but also more potential partners and customers worldwide.

The good news is that this competition can be a positive-sum, rather than a zero-sum game with only winners and losers. Innovation is increasingly democratic in the sense that it can happen in more places, under different conditions, in more ways, with greater mutual benefits than ever before. It also means that the processes and assets for innovation – areas in which the Commonwealth has historically been strong – will be even more important in the years ahead. Massachusetts has the opportunity to capitalize on the growing worldwide innovation economy – to understand the changing competitive environment and to nurture the state's distinctive advantages and unique contributions to this global enterprise.

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 that 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

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.

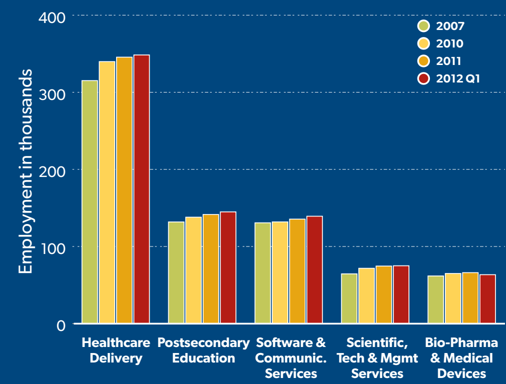
HOW DOES MASSACHUSETTS PERFORM?

The Healthcare Delivery sector continues to grow, employing more than double Financial Services, the second highest industry. Over half of Massachusetts' key industry sectors reported growth between 2011 and the first quarter of 2012, with the greatest percentage growth showing in Software & Communications Services (2.8%), Postsecondary Education (2.4%), and Business Services (1.7%). Four of the top eight sectors also increased their wages between 2007 and 2011. Financial Services remains the most highly compensated key industry sector with average salaries of roughly $121,600, despite lower employment and lower wages in 2011 than in 2007. Average annual wages for all industries have increased slightly since 2010, to over $56,100 in 2011.

Total Employment across all LTS has increased from Q1 2011 to Q2 2012. The state had the fastest growing Computer & Communications Hardware sector, while Software & Communications Services grew the second fastest, behind North Carolina.

Employment by Industry Sector

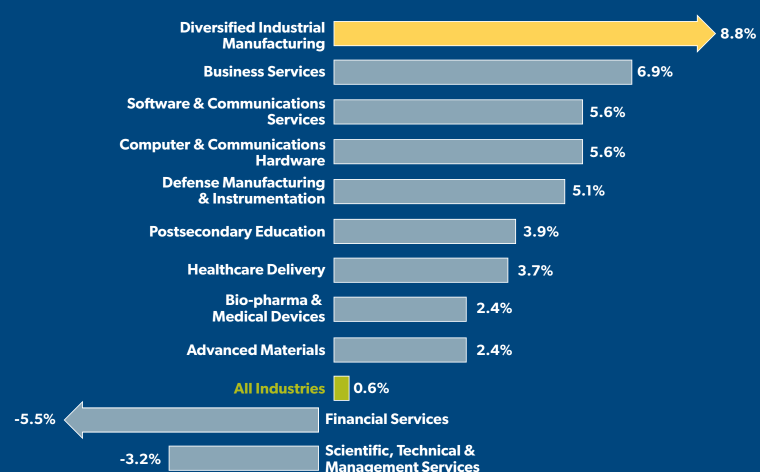
Massachusetts - 2007, 2010, 2011 and 2012 Q1



Five of the top seven sectors grew in employment during the recession *

Percent Change in Average Annual Wage by Sector

Massachusetts, 2007-2011



Percent Change in Cluster Employment

Massachusetts and LTS, 2011 Q1 - 2012 Q1

Industry Cluster (Leader among LTS)	MA	CA	CT	MD	MN	NJ	NY	NC	PA	VA
Advanced Materials (CT)	-2.6%	-1.1%	2.7%	-21.8%	1.5%	-3.7%	-0.9%	2.1%	-0.3%	-1.0%
Bio-Pharma & Medical Devices (VA)	-2.8%	1.8%	-6.5%	1.7%	-0.3%	-5.9%	1.1%	2.8%	-4.0%	2.9%
Business Services (NC)	-2.8%	1.4%	5.1%	3.8%	3.2%	0.4%	1.7%	4.3%	4.0%	0.8%
Computer & Communications Hardware (MA)	3.2%	1.4%	-3.3%	-5.5%	-1.6%	-4.4%	-1.2%	-0.3%	0.2%	2.0%
Defense Manufacturing & Instrumentation (NC)	1.8%	-1.2%	1.9%	-16.1%	2.8%	-0.3%	0.7%	8.0%	2.4%	6.0%
Diversified Industrial Manufacturing (MN)	0.4%	1.1%	0.1%	-2.6%	9.4%	-2.0%	1.4%	2.2%	3.1%	1.3%
Postsecondary Education (NJ)	2.8%	0.9%	-0.5%	3.1%	1.0%	3.3%	2.5%	0.6%	0.5%	1.6%
Financial Services (CA)	-1.4%	2.3%	-3.1%	-0.6%	1.3%	-1.0%	-0.3%	0.9%	-2.0%	-0.4%
Healthcare Delivery (MN)	1.8%	2.0%	1.8%	4.0%	2.7%	2.1%	0.8%	2.3%	1.9%	2.3%
Scientific, Technical & Management Services (CA)	3.8%	6.7%	4.2%	2.4%	3.0%	3.6%	4.8%	3.8%	2.9%	0.7%
Software & Communication Services (NC)	4.3%	4.0%	1.6%	1.1%	1.3%	3.7%	3.3%*	4.4%	1.3%	1.7%
Total State Employment	1.5%	1.8%	1.3%	1.6%	1.9%	1.3%	1.6%*	1.8%	1.0%	1.4%
% of Total in Key Sectors, 2012 Q1	37.1%	26.8%	33.9%	27.4%	30.4%	30.2%	30.2%	26.3%	31.5%	27.8%

*Note for NY: Due to undisclosed data by BLS, only January and February's data was used for Q1 2011 and Q1 2012.
Data Source for Indicator 1: Bureau of Labor Statistics' Quarterly Census of Employment and Wages
Analysis: Massachusetts Technology Collaborative

Total employment in Computer & Communications Hardware grew 3.2 percent during Q1 2011 - Q1 2012, while some LTS reported losses *

INDICATOR 1

OCCUPATIONS AND WAGES

Growth of Employment and Real Annual Pay by Occupation
Massachusetts, 2006-2011

Employment is growing and shifting into the Healthcare, Business, Financial & Legal, and Computer & Mathematical occupations where employees earn wages well above the national average

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.

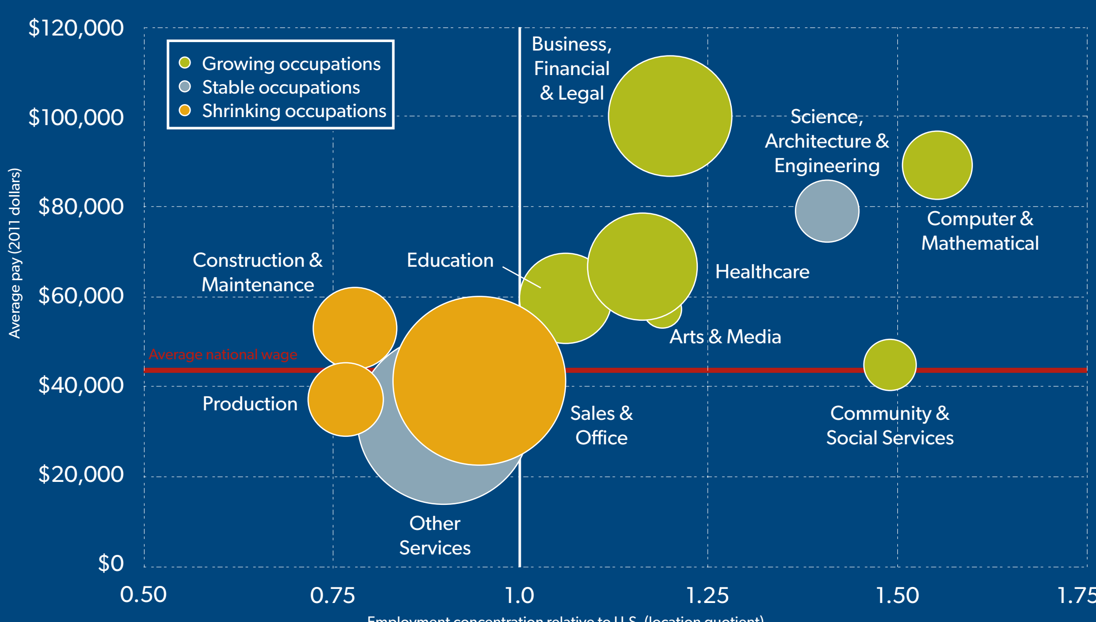
HOW DOES MASSACHUSETTS PERFORM?

Despite the impact of the most recent recession, Massachusetts experienced positive annual employment growth across seven of the eleven key occupational categories between 2006 and 2011. Strongest growth was seen in Community & Social Services, increasing employment 3.6 percent on average each year, outpacing the LTS and the U.S.

Healthcare employees in Massachusetts saw the largest increase in annual pay with an average 1.63 percent rise each year between 2006 and 2011, more than double the LTS and the U.S. In contrast to the U.S. and the LTS averages, wages slipped in four Massachusetts occupations.

While employing the most people, Sales & Office is a shrinking occupational category, paying salaries below the national average.

Occupations by Employment Concentration and Annual Pay
Massachusetts, 2011



Note: Circle size represents total employment.

Data Source for Indicator 2: Bureau of Labor Statistics, Occupational Employment Estimates, Consumer Price Index
Analysis: Massachusetts Technology Collaborative

INDICATOR 2

HOUSEHOLD INCOME

WHY IS IT SIGNIFICANT?

Median household income tracks changes in the general economic condition of middle-income households and are 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?

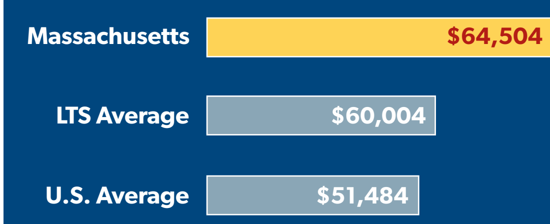
In 2011, median household income has continued to decline in all LTS and the U.S. compared to the previous year.

In both 2010 and 2011, Massachusetts reported a higher median household income than the LTS and U.S. averages. At roughly $64,500 in 2011, Massachusetts' median household income was $13,000 and $4,500 greater than the U.S. and LTS average respectively.

Since 2005, the proportion of middle income households (earning $35,000 - $99,999) has shrunk by over four percentage points, while the percent of households earning more than $100,000 per year grew six percentage points to 30 percent. Meanwhile, the share of households earning less than $35,000 has decreased slightly to 30 percent in 2011.

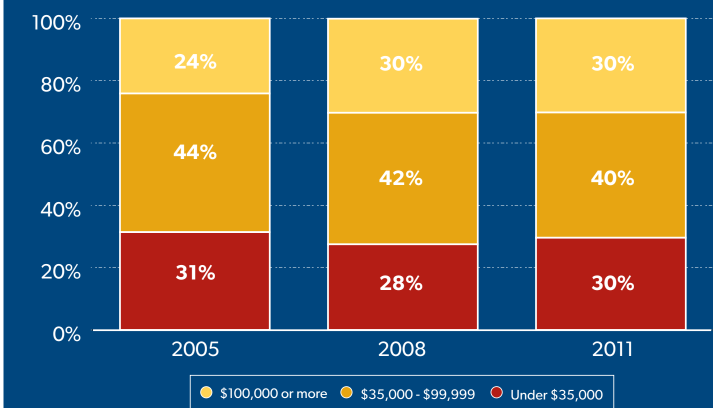
Total wages and salaries paid have increased over the past three quarters, reaching $203 billion in the second quarter 2012 and are nearing pre-recession levels ($208 billion).

Median Household Income
Massachusetts, LTS and U.S. Average - 2011



MA had a higher median household income than the LTS and U.S. average in 2011 *

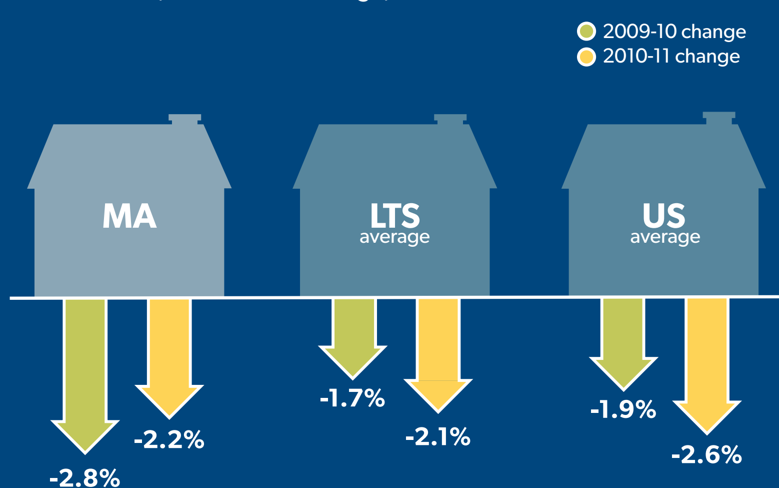
Distribution of Households by Income Range
Massachusetts - 2005, 2008 and 2011



MA was one of four LTS to slow its decrease in median household income *

In the second quarter of 2012, total wages and salaries paid have rebounded close to their pre-recession level, reaching $203 billion

Year Over Year Percent Change in Median Household Income
Massachusetts, LTS and U.S. Average, 2009-2011

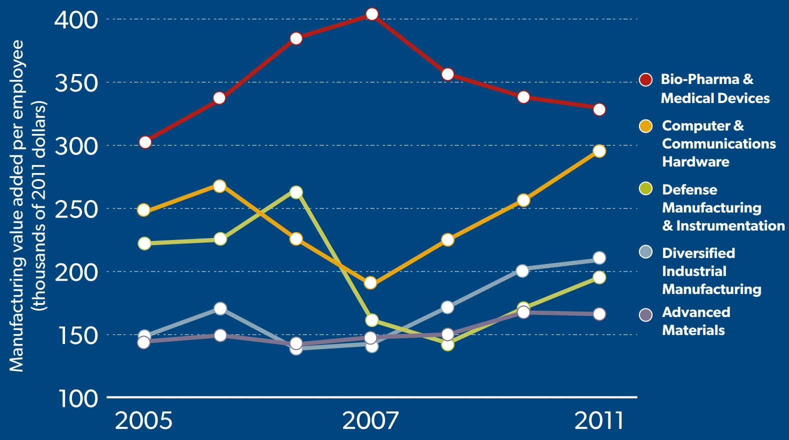


INDICATOR 3

Data Source for Indicator 3: U.S. Census Bureau, Bureau of Economic Analysis
Analysis: Massachusetts Technology Collaborative

PRODUCTIVITY

Manufacturing Labor Productivity by Sector
Massachusetts, 2005-2011



Manufacturing Labor Productivity by Sector
In Thousands of 2011 Dollars
Massachusetts, LTS Average and U.S. - 2011

Bio-Pharma & Medical Devices	Advanced Materials	Defense Manufacturing & Instrumentation
MA $330	**MA** $166	**MA** $195
LTS $452	**LTS** $191	**LTS** $237
US $395	**US** $237	**US** $221

Productivity in three of the five manufacturing sectors lagged behind the LTS and U.S. in 2011
*

WHY IS IT SIGNIFICANT?

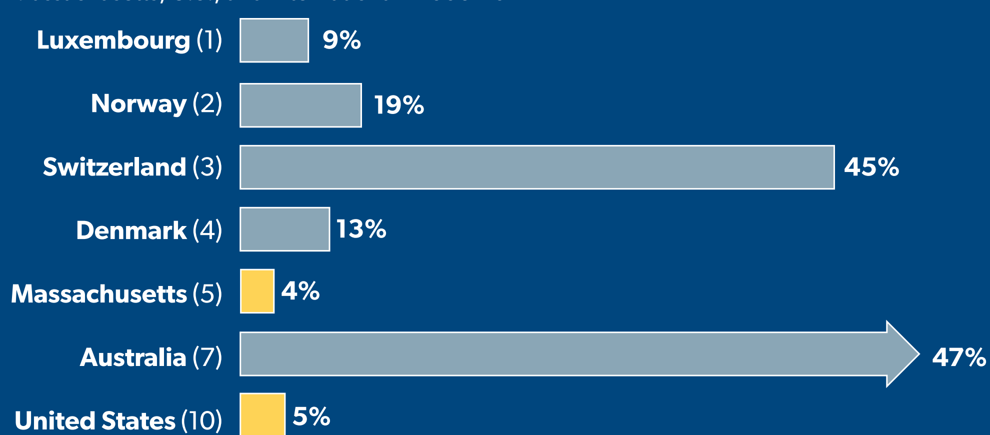
Heightened productivity fosters increasing wages. Firms with high labor productivity (value added per employee) create comparatively higher levels of commercial value and/or employ fewer individuals. In order to achieve increased labor productivity, organizations must innovate in ways that increase the value of their products or services, or make their business processes more efficient. Increased manufacturing productivity is essential to avoid a 'race to the bottom' of the level of manufacturing wages among competitors or the loss of jobs to overseas production.

HOW DOES MASSACHUSETTS PERFORM?

From 2004 to 2010, Diversified Industrial Manufacturing experienced the fastest productivity growth (35%) and had the highest productivity relative to the LTS average in 2010. However, productivity in three of the five manufacturing sectors in Massachusetts lagged behind the LTS and U.S. averages in 2010, with the lowest productivity in the Bio-pharma & Medical Devices sector. Relative to the U.S. overall, Massachusetts had a manufacturing labor productivity advantage in one sector, Diversified Industrial Manufacturing.

Massachusetts ranks high (5th) internationally in terms of productivity, measured by GDP per employed resident. Luxembourg and Norway had the highest productivity in 2011, as well as in 2010. Productivity grew the fastest in Switzerland and Australia from 2006 to 2011.

Rank and Growth Rate in GDP per Employed Resident
Massachusetts, U.S., and International - 2006-2011



MA ranks 5th internationally in GDP per resident, but many countries have had faster growth rates in recent years
*

INDICATOR 4

Data Source for Indicator 4: U.S. Census Bureau, World Bank, International Labor Organization, Bureau of Labor Statistics
Analysis: Massachusetts Technology Collaborative

INDUSTRY CHURN AND MANUFACTURING VALUE ADDED

WHY IS IT SIGNIFICANT?

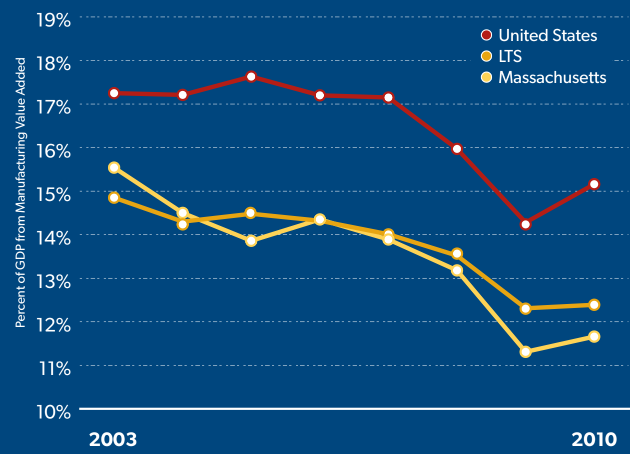
Manufacturing value-added is a measure of the economic value created by manufacturers across industry sectors. It is calculated by subtracting the costs of primary factor inputs for manufacturing from the value of the final product. Employment churns (the result of startups, expansions, closures, and firms moving in and out) provide some insight into how employment is shifting within a cluster.

HOW DOES MASSACHUSETTS PERFORM?

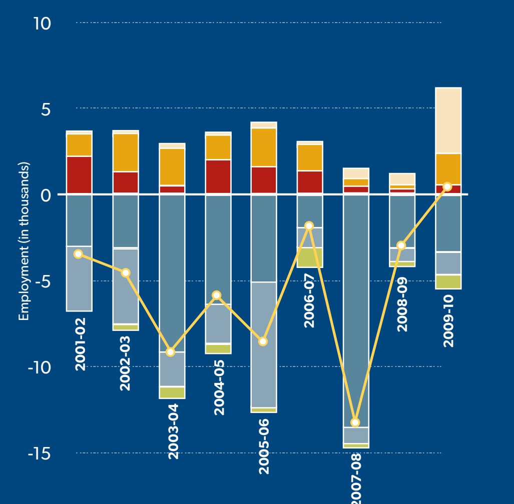
Manufacturing value added as a percentage of GDP rose in 2010 for the first time in three years, increasing 0.3 percentage points in Massachusetts to 11.6 percent. The state continues to report less value added compared to the LTS average and the U.S., although it increased at a faster rate than the LTS average in 2010.

Between 2002 and 2010, the opening and closing of business establishments had a larger impact on employment in the innovation economy than the expansion and contraction (or relocation) of existing firms. However, key industries of the innovation economy have different patterns of employment churn (e.g. Advanced Materials and Computer & Communications Hardware).

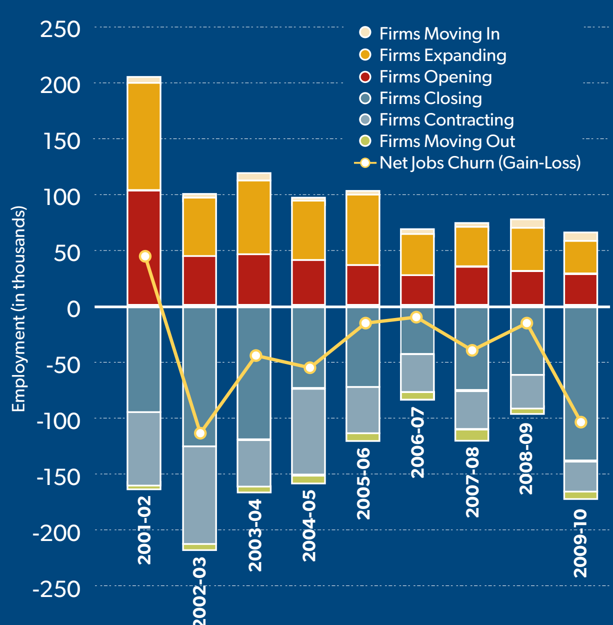
Manufacturing Value Added
Massachusetts, LTS and U.S., 2003-2010



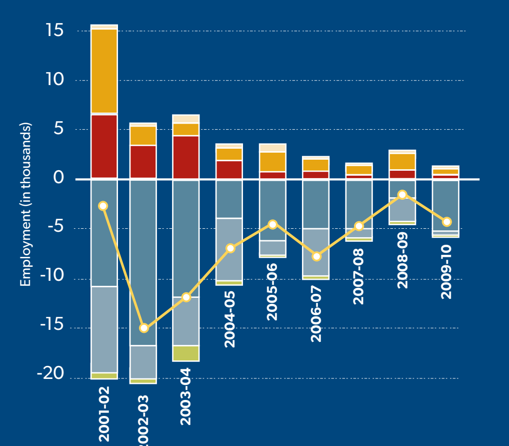
Advanced Materials Job Change by Source
Massachusetts, 2001-2010



Total Innovation Economy Job Change by Source
Massachusetts, 2001-2010



Computer & Communications Hardware Job Change by Source
Massachusetts, 2001-2010

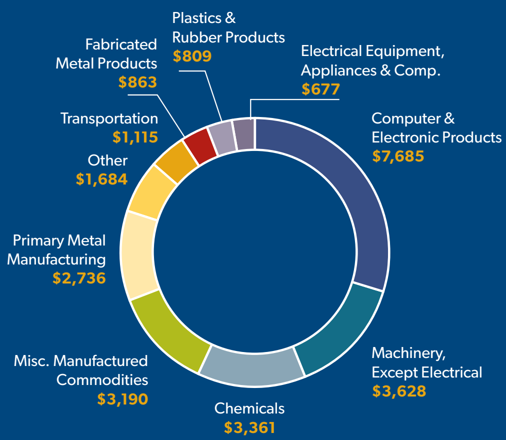


Data Source for Indicator 5: U.S. Census Bureau, Annual Survey of Manufacturers, Bureau of Economic Analysis, National Establishment Time Series Database (NETS)
Analysis: Collaborative Economics

INDICATOR 5

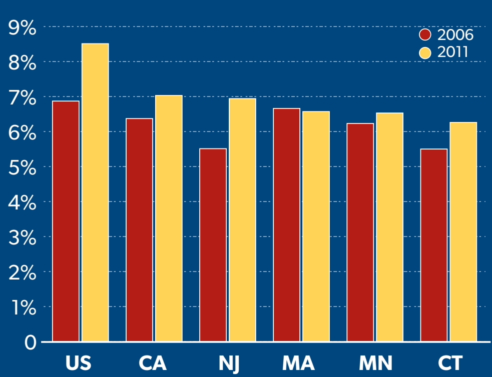
MANUFACTURING EXPORTS

Distribution of Manufacturing Exports in Millions
Massachusetts - 2011



Manufacturing exports increased ten percent in 2010 and one percent in 2011 to a total of $25.7 billion

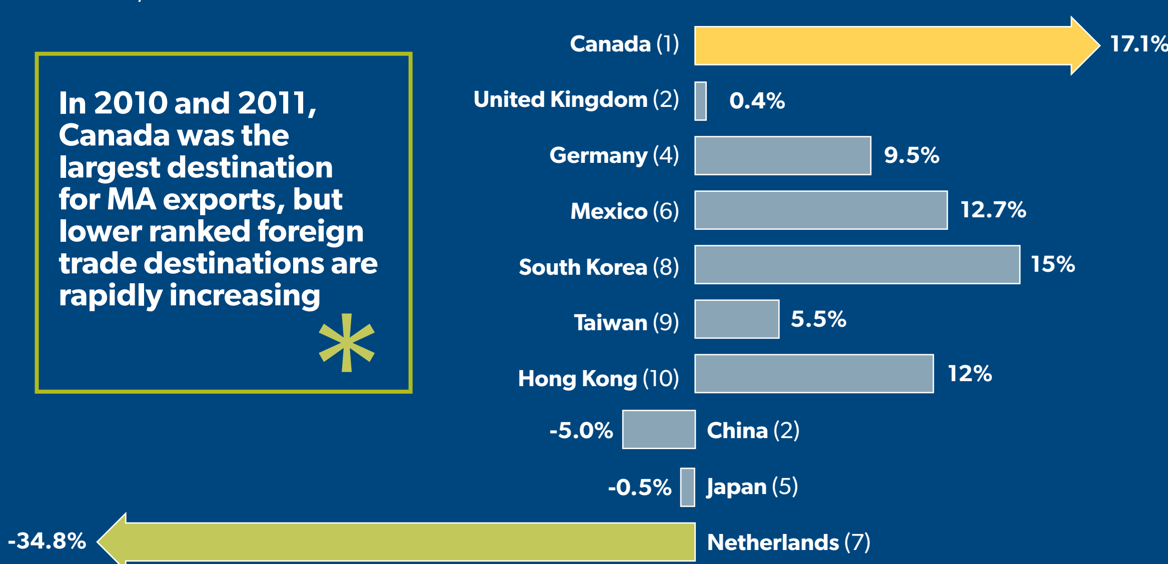
Manufacturing Exports as Percent of GDP
Massachusetts, LTS and U.S. - 2006 and 2011



MA maintains a higher than LTS average of manufacturing exports as percent of GDP at 6.6 percent

Rank and Percent Change in Export Value by Top Foreign Trade Destinations
International, 2010-2011

In 2010 and 2011, Canada was the largest destination for MA exports, but lower ranked foreign trade destinations are rapidly increasing



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 ten percent of all private sector jobs in the state and approximately 20 percent of manufacturing jobs are tied to exports.

HOW DOES MASSACHUSETTS PERFORM?

Massachusetts' manufacturing exports continue to rebound in 2011, after suffering a 15 percent drop in 2009. Manufacturing exports increased ten percent in 2010 and one percent in 2011 to a total $25.7 billion. All sectors except Chemicals and Computer & Electronic Products exports increased in 2011, although Computer & Electronic Products continue to dominate, comprising nearly a third (30%) of all exports.

Massachusetts ranks third among the LTS in manufacturing exports as a percent of GDP at 6.6 percent in both 2010 and 2011, behind only California (7.0%) and New Jersey (6.9%). However, all other LTS have increased manufacturing exports relative to GDP in recent years, while Massachusetts has remained relatively flat.

In both 2010 and 2011, Canada was the largest destination for Massachusetts' exports, followed by the United Kingdom and China. Massachusetts exports to the Netherlands fell the most from 2010 to 2011, with a 34.8 percent decline, while exports to Canada grew the largest (17.1%) over the same period. The top ten foreign destinations for Massachusetts' exports in 2011 remained the same as in 2010.

INDICATOR 6

Data Source for Indicator 6: WISER, U.S. Census Bureau, Foreign Trade Division
Analysis: Massachusetts Technology Collaborative

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

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 defined R&D efforts, R&D data provide a sense of a region's capacity for knowledge creation.

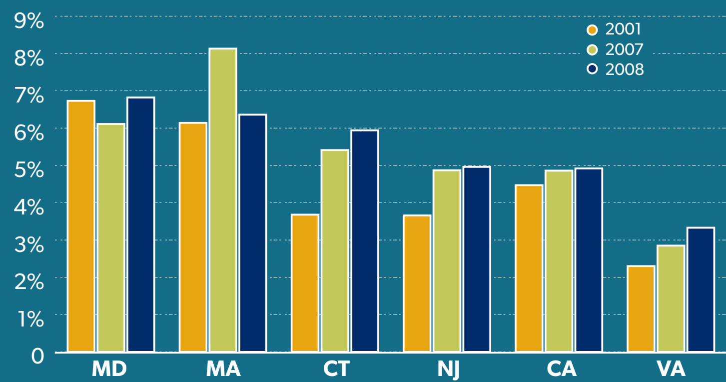
HOW DOES MASSACHUSETTS PERFORM?

Measuring R&D as a percent of GDP, Massachusetts remains the second-most R&D-intensive economy among the LTS at 6.4 percent of GDP in 2008, though this is a significant drop from 2007. Massachusetts also had the second slowest growth rate (behind Maryland) of the top six LTS states between 2001 and 2008.

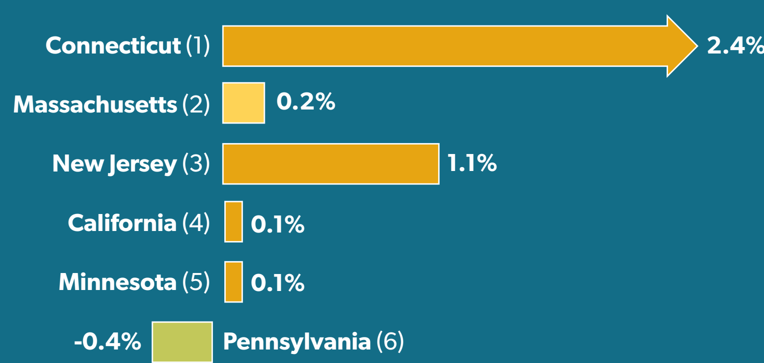
The drop in R&D funding between 2007 and 2008 can mostly be attributed to a large decline in R&D expenditures from federally funded sources in the business sector, which dropped from $6.9 billion to $1.6 billion from 2007 to 2008. In 2008, businesses, universities and non-profits spent a total of $21.4 billion on R&D in Massachusetts. This represents a 21 percent drop ($5.8 billion) from 2007 levels.

Massachusetts ranks second among the LTS in industry-performed R&D as a percent of private industry output. In 2000, Massachusetts led the LTS in this metric, but in 2004 Connecticut rose to first place.

R&D Spending as Percent of GDP
Massachusetts and LTS - 2001, 2007 and 2008



Rank and Percentage Point Change in Industry-Performed R&D
Percent of Private Industry Output
Massachusetts and LTS, 2000-2008



R&D Expenditures
Massachusetts, 2008

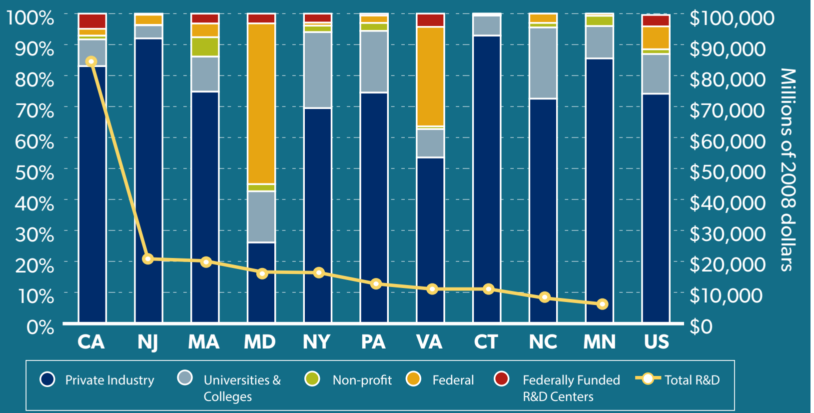
Performing sector	Source of funding	Expenditures
Federal	Federal	$947,000,000
Federally Funded R&D Centers	Federal	$678,000,000
	Non-federal	$4,000,000
Business	Own funds	$13,419,000,000
	Federal	$1,565,000,000
	Non-federal	$990,000,000
Universities and Colleges	Federal	$1,830,000,000
	Other Government	$18,000,000
	Business	$179,000,000
	Universities & Colleges	$148,000,000
	Non-profit	$240,000,000
Non-profit Institutions	Federal	$1,337,000,000
Total R&D expenditures = $21,355,000,000		

Data Source for Indicator 7: National Science Foundation, U.S. Bureau of Economic Analysis, Consumer Price Index
Analysis: Collaborative Economics

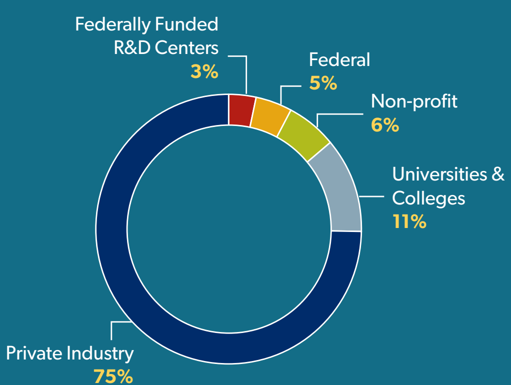
INDICATOR 7

PERFORMERS OF R&D

Distribution of R&D by Performer
Massachusetts, LTS and U.S., 2008



Distribution of R&D by Performer
Massachusetts, 2008



75 percent of R&D was performed by private industry, ranking fifth among the LTS

*

WHY IS IT SIGNIFICANT?

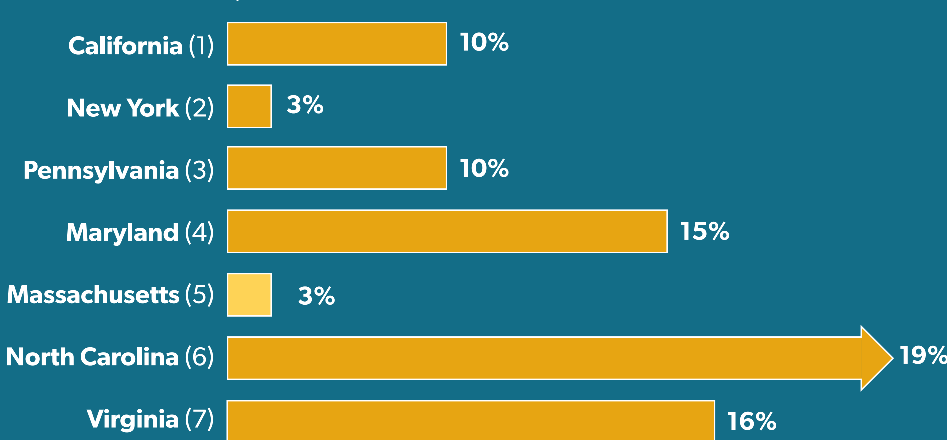
The distribution of R&D expenditures by type of performer illustrates the relative importance of diverse organizations performing R&D in an innovation ecosystem. Nationally, universities and colleges conduct mostly (75%) basic research, whereas industry provides mostly (76%) development research. Federal agencies tend to perform more applied research, and non-profits tend to perform more basic and applied research.

HOW DOES MASSACHUSETTS PERFORM?

In 2008 the majority of R&D was performed by private industry across all LTS except Maryland, where R&D was performed largely by federal institutions. In Massachusetts, private industry accounted for 75 percent of total R&D, the fifth highest share among the LTS.

LTS rankings in total R&D performed at universities, colleges and non-profits stayed relatively stable over the last five years. Massachusetts posted modest gains for universities, colleges, and non-profits, increasing R&D expenditures in the five-year period, for a total $2.6 billion dollars spent in 2008.

Rank and Percent Change in R&D Performed
Universities, Colleges and Non-profit Research Institutions
Massachusetts and LTS, 2003-2008



MA posted modest gains for universities, colleges and non-profits, increasing R&D expenditures by three percent between 2003 and 2008

*

INDICATOR 8

Data Source for Indicator 8: National Science Foundation, Consumer Price Index
Analysis: Collaborative Economics

ACADEMIC ARTICLE OUTPUT

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 measures the productivity of research activity in Massachusetts.

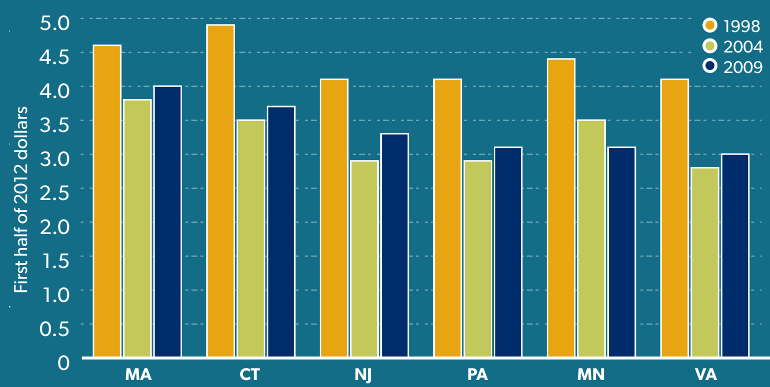
HOW DOES MASSACHUSETTS PERFORM?

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 and nearly double that of the second-ranked LTS state (Maryland).

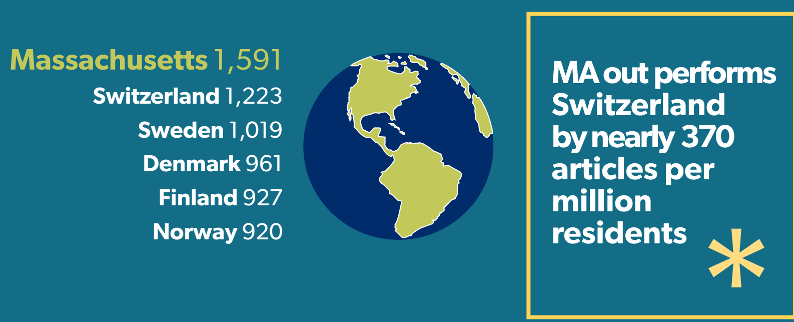
Massachusetts also ranks highly in terms of academic productivity. In 2004 and 2009, Massachusetts produced more S&E academic articles per R&D dollar than the other LTS and the nation overall. In 2009, the state reported four articles per million academic R&D dollars spent.

Massachusetts also 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.

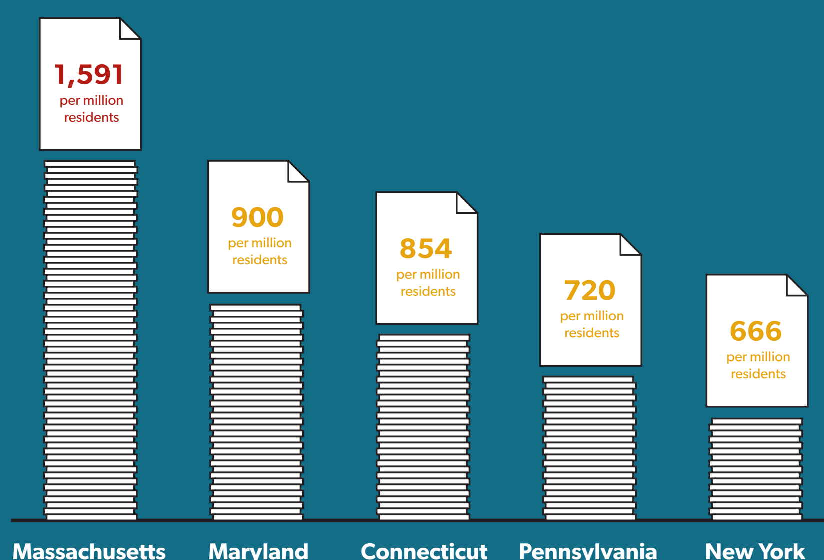
Science and Engineering (S&E) Academic Article Output per Million Academic R&D Dollars
Massachusetts and LTS - 1998, 2004, and 2009



S&E Academic Article Output per Million Residents
Massachusetts and International, 2009



S&E Academic Article Output per Million Residents
Massachusetts and LTS, 2009

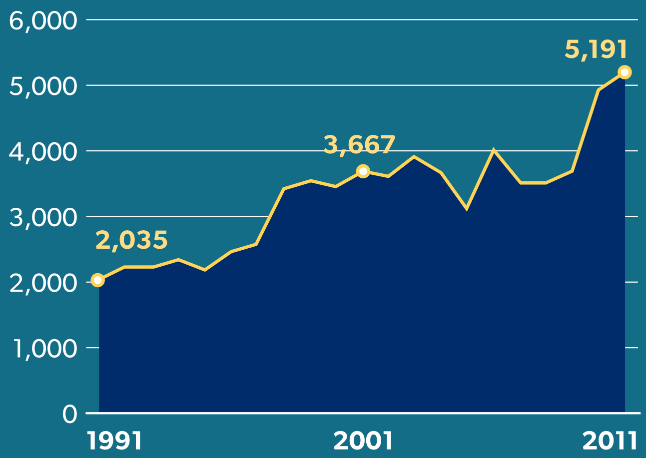


Data Source for Indicator 9: National Science Foundation
Analysis: Collaborative Economics

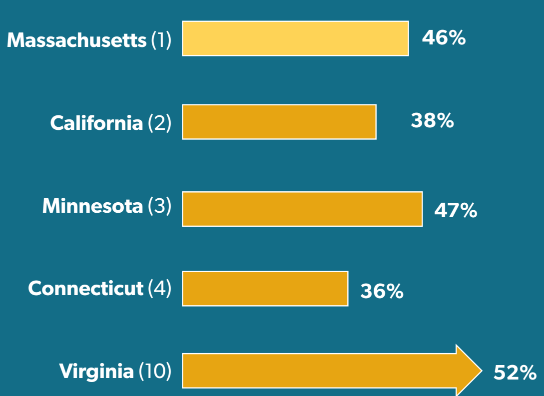
INDICATOR 9

PATENTING

U.S. Patent and Trademark Office Utility Patents Issued
Massachusetts, 1991-2011



Rank and Percent Change in Utility Patents Issued
per Million Residents
Massachusetts and LTS, 2007-2011



MA surpassed CA to lead the LTS in number of patents granted per capita

WHY IS IT SIGNIFICANT?

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

HOW DOES MASSACHUSETTS PERFORM?

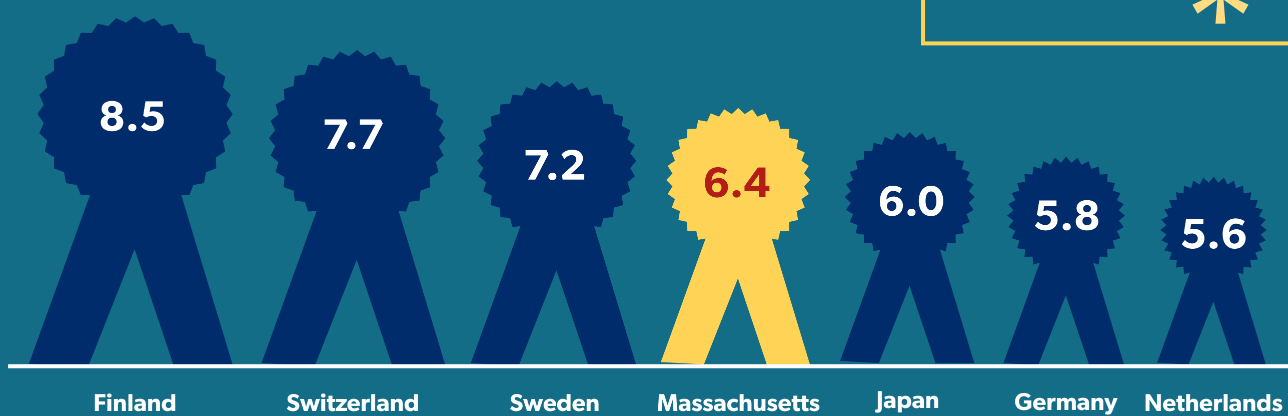
In 2011, patents granted reach historical high in number (5,191) and share of U.S. total (4.8%).

The total number of patents granted by the USPTO to Massachusetts increased 46 percent from 2007 to 2011, representing the third highest growth rate of the LTS. Only Virginia (52%) and Minnesota (47%) grew at faster rates than Massachusetts over the same period.

Between 2010 and 2011, Massachusetts was one of the four LTS (including California, Minnesota and Connecticut) to register gains in patents granted per capita, increasing five percent.

In 2011, MA rose from 7th to 4th in the world in patents relative to GDP

Patents Published Under the Patent Cooperation Treaty
per Billion Dollars of GDP
Massachusetts and International, 2011



INDICATOR 10

Data Source for Indicator 10: U.S. Patent and Trademark Office (USPTO), U.S. Census Bureau, World Intellectual Property Organization, U.S. Department of Commerce, World Bank
Analysis: Massachusetts Technology Collaborative

PATENTING BY FIELD

WHY IS IT SIGNIFICANT?

Measuring 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 among LTS in Analytical Instruments & Research Methods patents, with 80 patents per million residents, nearly 50 percent more than the next highest state, California.

Massachusetts had the most activity in Computer & Communications with 242 patents per million residents, though the state ranked second in this category to California (335 per million residents).

Massachusetts recorded 153 Drug & Medical patents per million residents, second highest among the LTS, while first-ranked Minnesota recorded just over 200 patents per million residents in this category.

Business Method patents per million residents in Massachusetts were lower than in the top state, Connecticut, and the state's Advanced Material patents per million residents were third behind Connecticut and Minnesota at 33, 29 and 28 respectively.

Massachusetts was the only state to rank among the top three LTS in the five patent fields in 2011

INDICATOR 11

Analytical Instruments & Research Methods Patents
Massachusetts, 2011

80
Patents per million residents

MA is first among the LTS in Analytical Instruments & Research Methods patents *

Computer & Communications Patents
Massachusetts, 2011

242
Patents per million residents

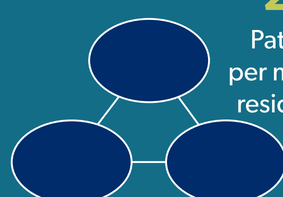
MA is second among the LTS, Computer & Communications Patents account for the most patents *

Drug & Medical Patents
Massachusetts, 2011

153
Patents per million residents

Drug & Medical patents ranked second highest among LTS *

Business Method Patents
Massachusetts, 2011



21
Patents per million residents

Business Method patents ranked second among LTS *

Advanced Materials Patents
Massachusetts, 2011

28
Patents per million residents

Advanced Materials patents ranked third among LTS *

Data Source for Indicator 11: U.S. Patent and Trademark Office (USPTO), U.S. Census Bureau
Analysis: Massachusetts Technology Collaborative

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

INDICATOR 12

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?

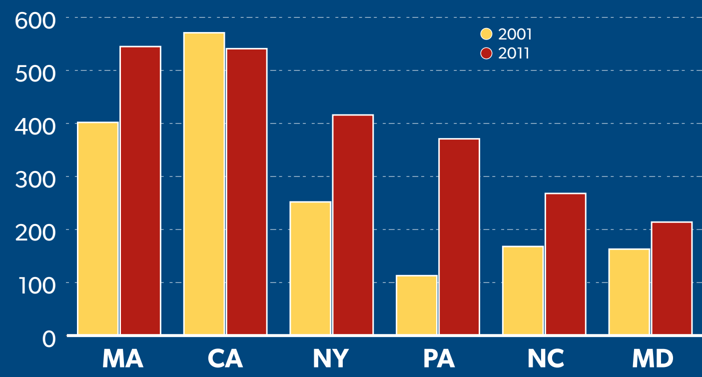
Between 2001 and 2011 Massachusetts moved into first place in total technology licenses and options executed by universities and research institutes, eclipsing California, a state almost six times its size. This leadership shift is a combination of Massachusetts' own strong gains and California's decline. Massachusetts increased its total number of licenses executed by 36 percent while California saw its licenses drop five percent.

Despite a few drops, over the past fifteen years, the technology licenses executed by Massachusetts' universities, hospitals and other non-profit research institutions have grown steadily. Between 1996 and 2007, the majority of licenses and options executed came from the academic sector, since 2008 however, the majority of licenses executed have come from research institutions and hospitals. In the past ten years (2001-2011), licenses from research institutions and hospitals have increased 143 percent, while licenses from universities have decreased 11 percent.

Total revenues from IP licenses have remained steady the last four years. Revenue from licenses fell sharply in 2008, due almost entirely to the drop from a two year spike in revenues from Massachusetts General Hospital.

Despite a drop after a two-year spike, annual revenues have continued to be much higher than in the past

Technology Licenses and Options Executed
Massachusetts and LTS, 2001 and 2011

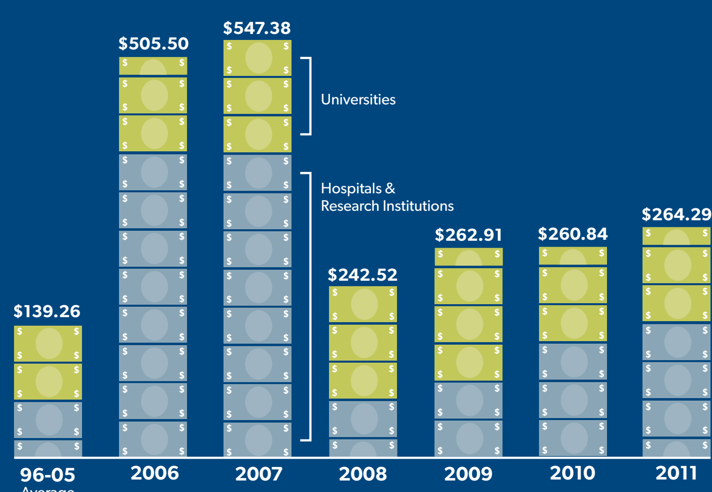


Technology Licenses and Options Executed
Universities, Hospitals and Other Non-profit Research Institutions
Massachusetts - 2001 and 2011

	2001	2011
Research Institutions and Hospitals	121	294
Universities	281	251

Between 2001-2011, there was a 143 percent increase in licenses for research institutions and hospitals

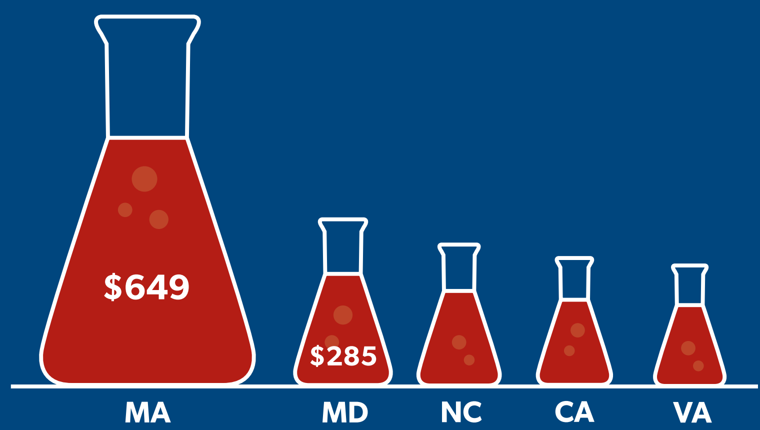
Revenues from Technology Licenses and Options Executed
Universities, Hospitals and Other Non-profit Research Institutions
In Millions of 2011 Dollars
Massachusetts, 2007-2011



Data Source for Indicator 12: Association of University Technology Managers, Consumer Price Index
Analysis: Collaborative Economics

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

SBIR and STTR Awards Funding per $1 Million in GDP
Massachusetts and LTS, 2011

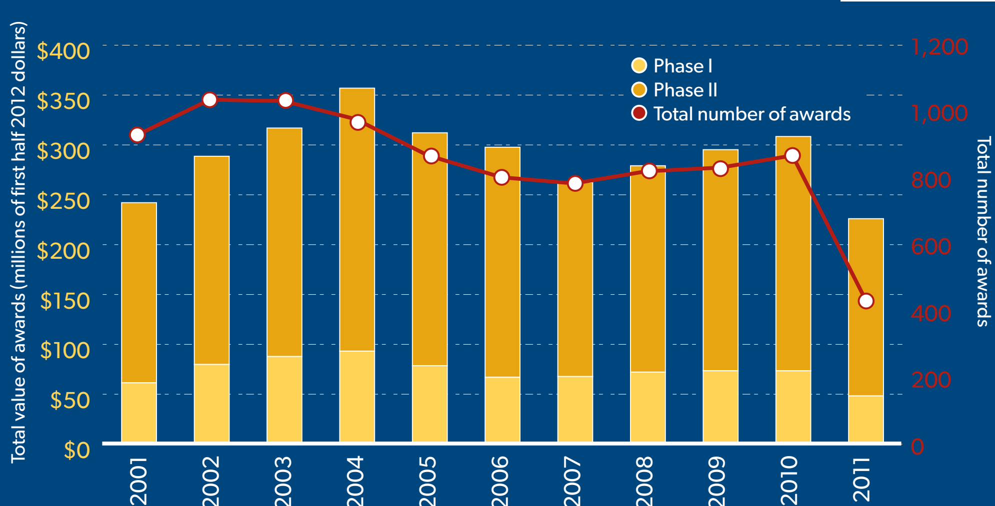


SBIR and STTR Awards by Agency
Massachusetts, 2011

	Funding	Count
Health & Human Services	$130,136,897	154
Department of Defense	$30,090,345	121
Department of Energy	$26,429,927	46
National Aeronautics & Space Administration	$20,538,511	77

Health & Human Services is the largest source (58%) of SBIR and STTR award funding in MA providing $130.1 million of funding in 2011

SBIR and STTR Awards
Total Number and Value (By Phase) of Awards Granted
Massachusetts, 2001-2011



Data Source for Indicator 13: U.S. Small Business Administration, Consumer Price Index
Analysis: Collaborative Economics

WHY IS IT SIGNIFICANT?

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

HOW DOES MASSACHUSETTS PERFORM?

The number of SBIR and STTR grants awarded overall in the United States fell by more than 50 percent, as did the majority of the LTS, between 2010 and 2011. Massachusetts' number of SBIR and STTR awards fell by only 44 percent during the same period, suggesting that the state continues to outperform the U.S. average. However, the state's share of total awards was 11.8 percent in 2011, compared to 13.9 percent in 2002.

Massachusetts remains the leader among the LTS in terms of award funding per $1 million GDP and funding per capita. Though the state ranks second to California in absolute terms (dollar value and number of awards), Massachusetts has more than two times the value of SBIR and STTR awards per $1 million GDP, and nearly three times more award value per capita than the next highest state, Maryland.

In 2011, MA is the LTS leader in funding per capita ($34.32) and funding per million GDP ($649)

INDICATOR 13

REGULATORY APPROVAL OF MEDICAL DEVICES AND PHARMACEUTICALS

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.

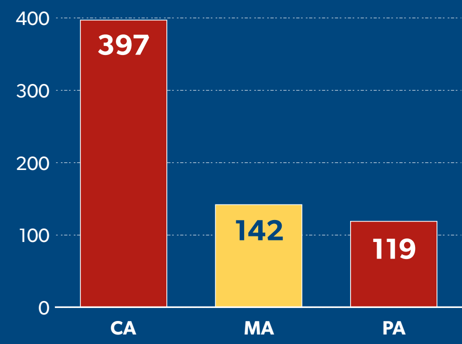
HOW DOES MASSACHUSETTS PERFORM?

Massachusetts maintains its strong hold on second place among LTS in both PMAs and 510(k)s. The state reported five PMAs in 2011, following California with ten PMAs. However, on a per capita basis Massachusetts registered more medical device PMAs per ten million residents (7.6) than California (2.7).

In medical device 510(k)s, California continues to dominate the market with roughly 3,600 since 2006, followed by Massachusetts (1,500). The annual number of 510(k)s in Massachusetts, as well as nearly all LTS, has slipped since 2006. In 2012 (through September), Massachusetts applicants acquired 142 510(k)s, trailing California with 397. On a per capita basis, Massachusetts earned the most (21.6) 510(k)s per million residents in 2012 (through September).

While Massachusetts does well in PMAs and 510(k)s, the state does not rank high in actual NDAs. In 2010 and 2011, Massachusetts was in the middle of the pack in the LTS in terms of NDAs, reporting 6.5 for those two years.

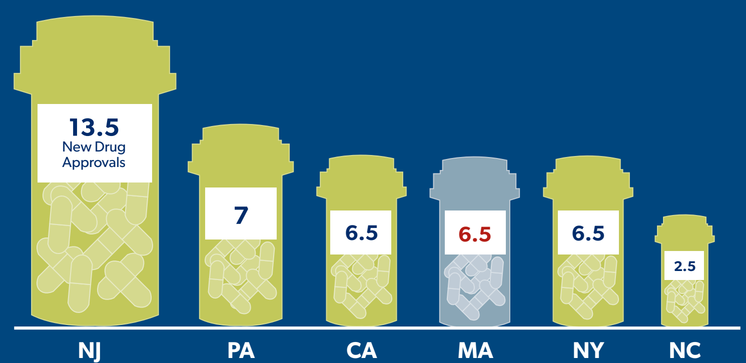
Medical Device Pre-Market Notifications (Releasable 510(k)s)
Massachusetts and LTS, 2012*



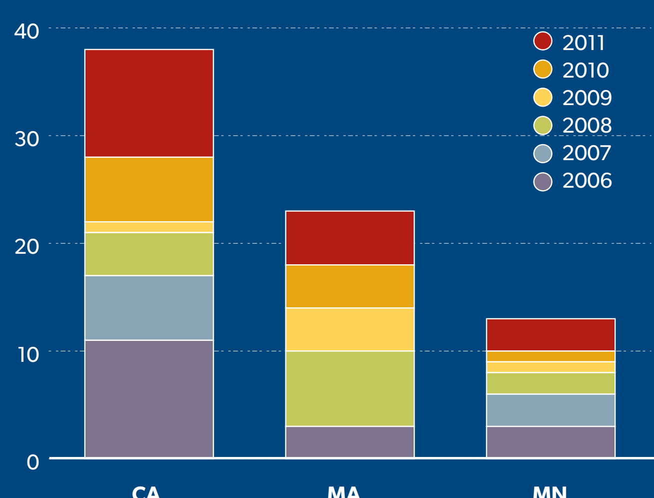
*Data through September 2012.

Ranking first, MA had 21.6 pre-market notifications per million residents in 2012 (through September) while CA earned 10.5 and PA 9.3 *

New Drug Approvals
Massachusetts and LTS, 2010 and 20 11



Medical Device Pre-Market Approvals (PMAs)
Massachusetts and LTS - 2006-2011



MA has 23 PMAs since 2006, second only to CA while the remaining LTS has a combined total of 33 *

INDICATOR 14

Data Source for Indicator 14: U.S. Food and Drug Administration, Pharmaceutical Research and Manufacturers of America (PhRMA)
Analysis: Collaborative Economics

THE INNOVATION INSTITUTE at the MassTech Collaborative

BUSINESS DEVELOPMENT

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

BUSINESS FORMATION

WHY IS IT SIGNIFICANT?

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

HOW DOES MASSACHUSETTS PERFORM?

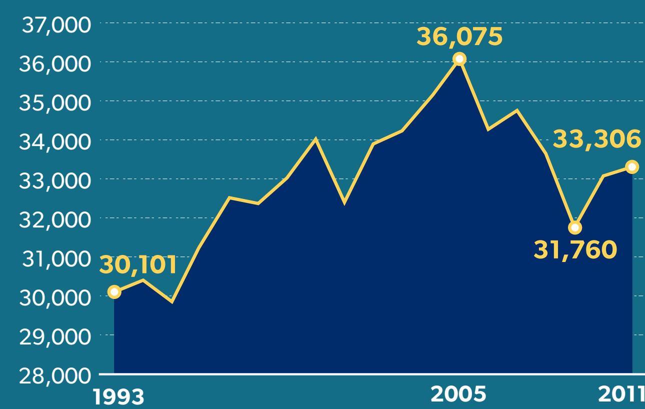
From 1993 to 2005, business establishment openings increased 20 percent to a decade high of 36,075. After falling seven percent between 2006 and 2009, establishment openings rebounded, increasing to 33,306 openings in 2011. In 2010 and 2011, for the first time in seven years, Massachusetts experienced two consecutive years of growth in new business formations.

Massachusetts maintained second place for the number of start-ups out of universities, following only California. In 2010, 0.32 percent of the population in Massachusetts started a business, placing the state fourth among the LTS, behind California, New York and North Carolina.

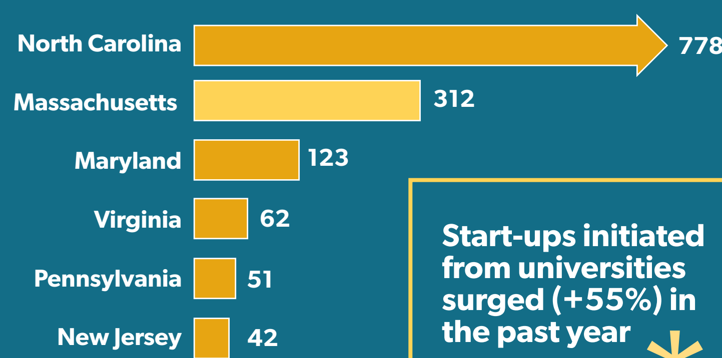
For the first time in seven years, Massachusetts experienced two consecutive years of growth in new business formations in 2010 and 2011

INDICATOR 15

Business Establishment Openings
Massachusetts, 1993-2011

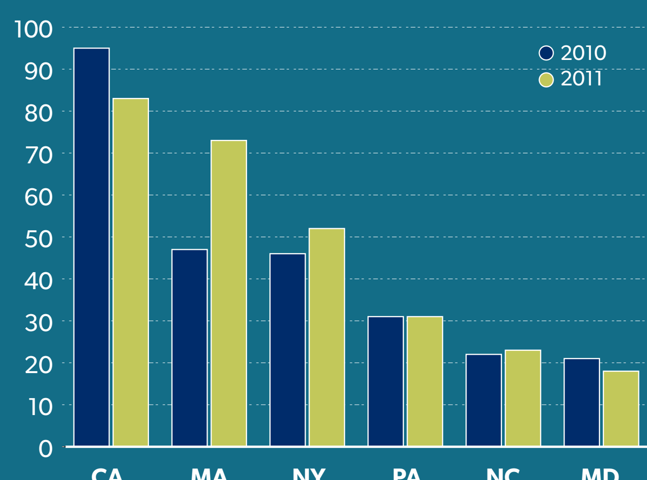


Net Change in Number of Business Establishments in Key Industry Sectors per Million Employees
Massachusetts and LTS, 2009-2011



Start-ups initiated from universities surged (+55%) in the past year *

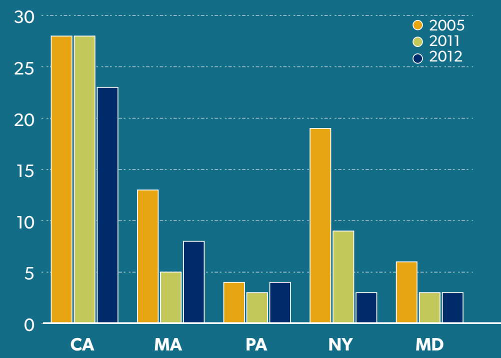
Start-Up Companies Initiated from Universities
Massachusetts and LTS, 2010-2011



Data Source for Indicator 15: Bureau of Labor Statistics' Business Employment Dynamics, Bureau of Labor Statistics' Quarterly Census of Employment and Wages, U.S. Census Bureau, Association of University Technology Managers, The 2010 Kauffman Index of Entrepreneurial Activity
Analysis: Collaborative Economics

INITIAL PUBLIC OFFERINGS AND MERGERS & ACQUISITIONS

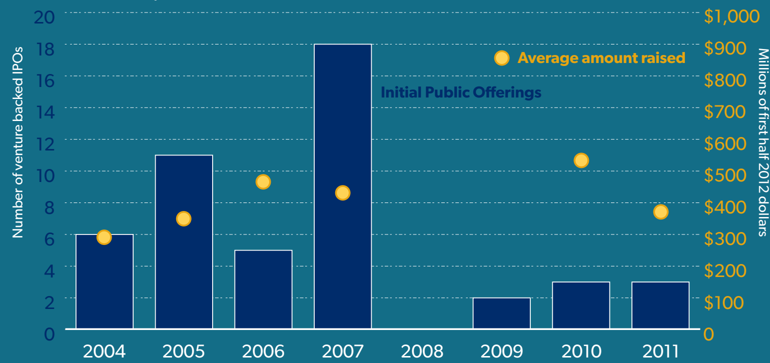
Number of Initial Public Offerings (IPO)
Massachusetts and LTS - 2005, 2011 and 2012*



*Data through September 2012.

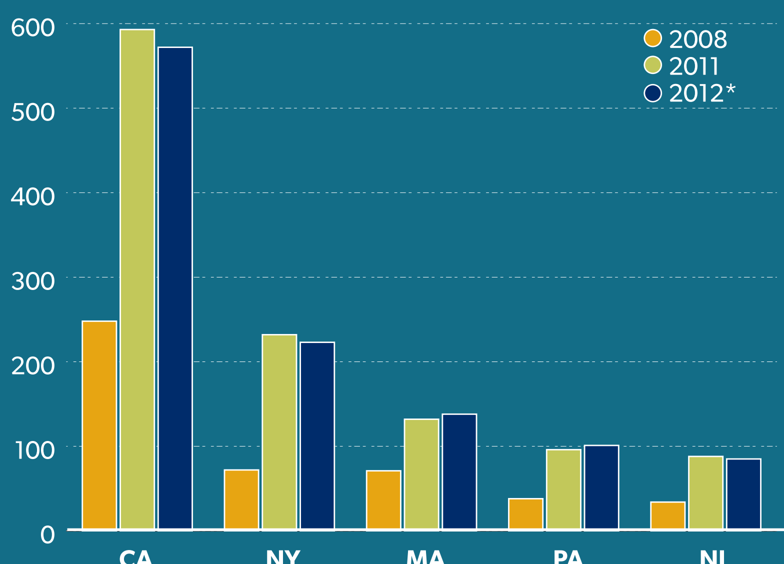
MA ranks 2nd to CA in total IPOs *

Venture-Backed Initial Public Offerings
Massachusetts, 2007- 2011



*There were zero venture-backed IPOs in 2008.

Mergers and Acquisitions
Number of Deals
Massachusetts and LTS, 2008-Q3 2012*



*Data is through the third quarter of 2012.

Data Source for Indicator 16: Renaissance Capital, IPO Home, National Venture Capital Association, CB Insights
Analysis: Collaborative Economics

WHY IS IT SIGNIFICANT?

Initial Public Offerings (IPOs) and Mergers and Acquisitions (M&As) represent important business strategies 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 market.

HOW DOES MASSACHUSETTS PERFORM?

IPOs grew from five to eight between 2011 and 2012 (as of September) in Massachusetts, which ranks second to California.

Since 2008 when venture-backed IPOs were absent, Massachusetts has remained well below pre-recession levels. The average amount of capital raised from all IPOs declined between 2010 and 2011 after a spike in 2009.

Acquisitions of Massachusetts based companies increased five percent between 2011 and Q3 2012 to reach 138 deals.

INDICATOR 16

CAPITAL

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

FEDERAL FUNDING FOR ACADEMIC, NON-PROFIT AND HEALTH R&D

WHY IS IT SIGNIFICANT?

Universities and other non-profit research institutions are critical to the Massachusetts innovation economy. They advance basic science and create technologies and know-how that can be commercialized by the private sector. This R&D also contributes to educating the highly-skilled individuals who constitute one of Massachusetts' greatest economic assets. Funding from the Federal Government is essential for sustaining academic, non-profit and health-related research. 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.

HOW DOES MASSACHUSETTS PERFORM?

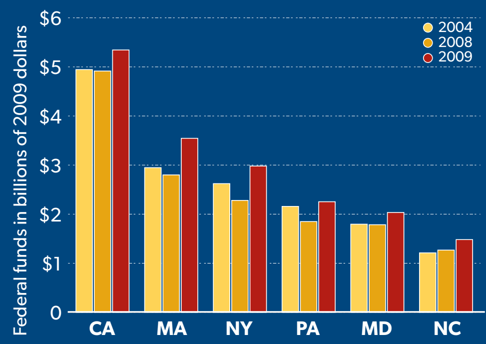
For federal R&D dollars, Massachusetts' universities and non-profit research institutions are ranked second among the LTS, receiving $3.5 billion in funding in 2009. All LTS saw improvement in federal R&D funding from 2004 to 2009. The state had a 21 percent gain in federal R&D funding for universities and non-profit research institutions, between 2008 and 2009.

Massachusetts maintains a large lead in terms of federal funding for R&D per $1,000 GDP. Between 2008 and 2009, Massachusetts' federal R&D funding increased 21 percent, widening the gap between Massachusetts and the second ranked state, Maryland.

Massachusetts' research institutions continue to attract the largest share of the National Institute of Health (NIH) funding at $6.40 per $1,000 GDP in 2011. NIH funding decreased for all of the LTS and the U.S. overall between 2010 and 2011.

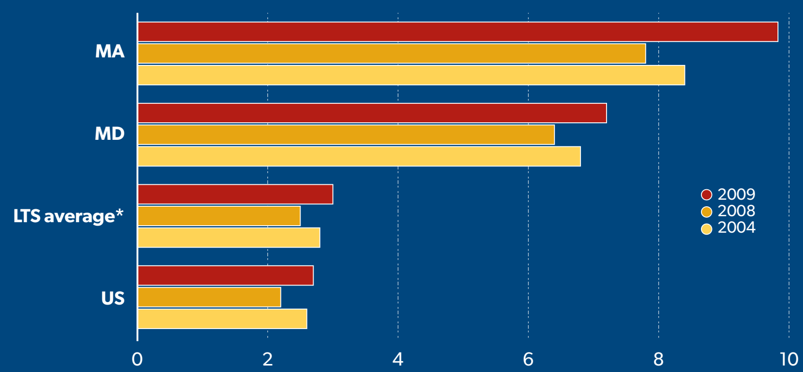
INDICATOR 17

Federal Funding for R&D
Universities and Colleges, and Non-profit Organizations
Massachusetts , LTS and U.S. Average- 2004, 2008 and 2009



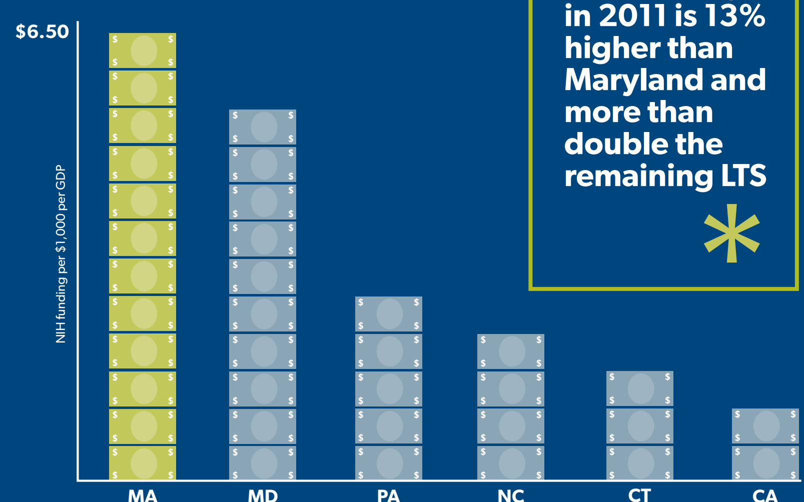
MA Federal R&D funding grew 20 percent in from 2004-09 *

Federal Funding for R&D per $1,000 GDP
Universities and Colleges, and Non-profit Organizations
Massachusetts, LTS and U.S. - 2004, 2008 and 2009



*Remaining LTS average is calculated averaging the remaining LTS not including Massachusetts & Maryland

National Institute of Health (NIH) R&D Funding
per $1,000 GDP
Massachusetts and LTS, 2011

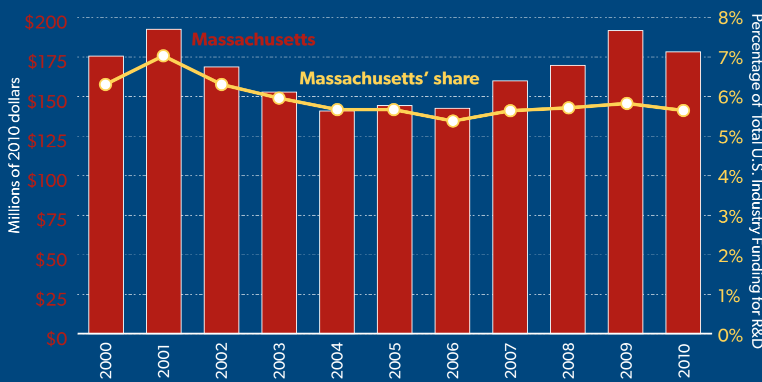


NIH funding in 2011 is 13% higher than Maryland and more than double the remaining LTS *

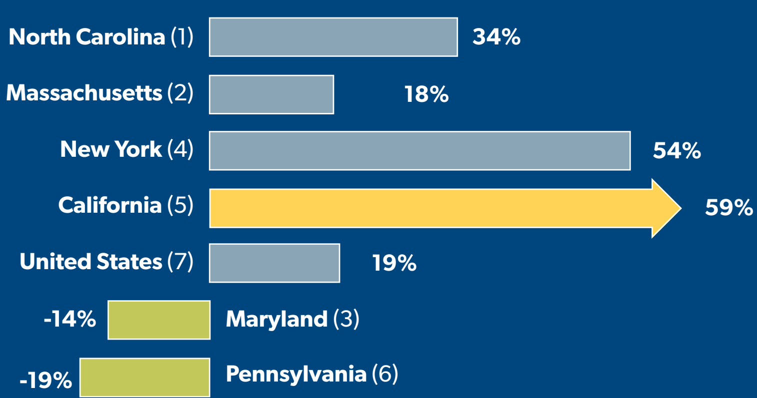
Data Source for Indicator 17: National Science Foundation, Federal Funds for Research and Development by state and performer, U.S. Bureau of Economic Analysis, National Institute of Health, U.S. Census Bureau
Analysis: Collaborative Economics

INDUSTRY FUNDING OF ACADEMIC RESEARCH

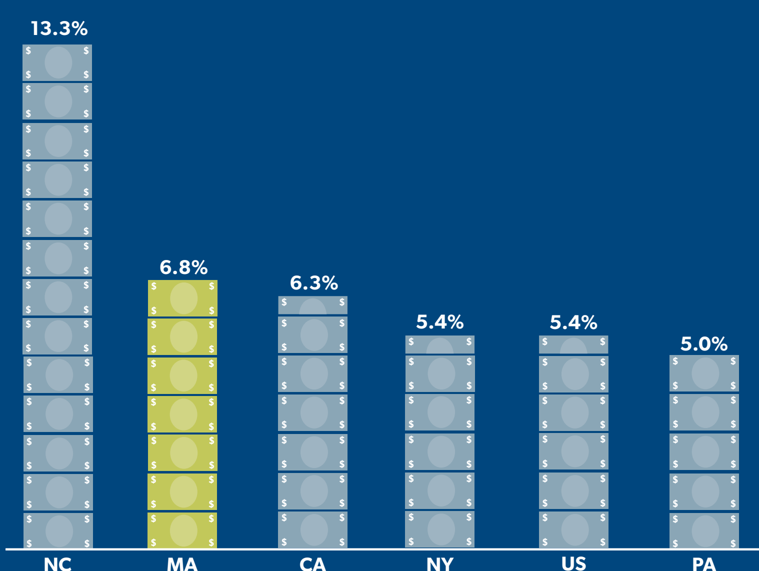
Industry Funding for Academic Research in S&E
Massachusetts, 2000-2010



Rank and Growth Rate in Industry Funding for Academic Research in S&E per $100,000 GDP
Massachusetts, LTS and U.S., 2005-2010



Industry Share of States' Total Academic R&D Funding in S&E
Massachusetts and LTS, 2010



Data Source for Indicator 18: National Science Foundation, U.S. Bureau of Labor Statistics, U.S. Census Bureau
Analysis: Massachusetts Technology Collaborative, Collaborative Economics

WHY IS IT SIGNIFICANT?

Industry funding of academic research is one measure of industry-university relationships and their relevance to the marketplace. University-industry 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?

Industry funding for academic research and development in science and engineering (S&E) in Massachusetts weakened in 2010 after several years of growing participation, though the state remains a national leader in business participation in higher education research. Massachusetts' share of total U.S. industry funding for academic research in S&E has held relatively steady around 5.7 percent over the 2005 to 2010 period.

On a per capita basis, the Commonwealth ranked second among the LTS in the amount of industry funding for academic research for S&E in 2010, and grew 22 percent from 2005 to 2010, growing faster than the LTS average (20 percent over the same period). Massachusetts also had the second highest level of industry funding for academic S&E research compared to its GDP in 2010, and saw an increase of 18 percent from 2005 to 2010.

Business funding as a share of total funding to S&E academic research declined in Massachusetts in 2010 from 2009 levels, though it remained above the majority of the LTS at 6.8 percent.

MA is ranked second among the LTS in amount of industry funding per capita at $27

*

INDICATOR 18

VENTURE CAPITAL

WHY IS IT SIGNIFICANT?

Venture capital (VC) firms are an important source of funds for the creation and development of innovative new companies. VC firms also typically provide valuable guidance on strategy as well as oversight and governance. Trends in venture investment can indicate emerging growth opportunities in the innovation economy.

HOW DOES MASSACHUSETTS PERFORM?

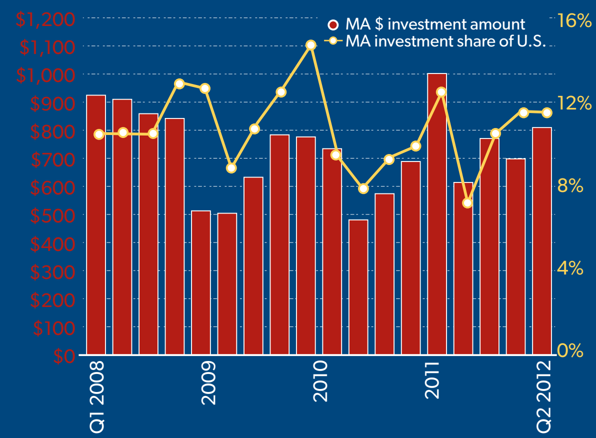
Massachusetts' venture capital investment has varied over the past eight years. Strong gains have been made since Q3 2010, propelling venture capital investment to just over $1 billion in Q2 2011. In Q2 2012, investment totals in Massachusetts decreased to $809 million, but still represented eleven percent of the nation's total investment.

Since 2004, there has been a shift in the composition of investments by stage of venture capital. Since Q1 2009, early stage funding has increased $267 million to $360 million, securing its position above other financing stages. In contrast, later stage funding has fallen $505 million since its high point in Q1 2006. Although all stages were roughly equal in Q3 2009, they have since diverged substantially. Expansion funding surged three-fold in Q2 2012 from the prior quarter, approaching the level of early stage financing.

Massachusetts ranks first in the nation for venture capital investment per GDP. Venture capital investment in the state has dropped 28 percent since 2007, to just under $7.71 per $1,000 GDP.

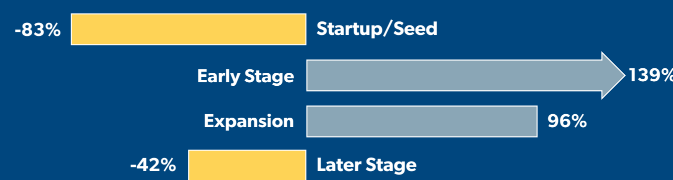
VC Investment

Massachusetts as a Share of Total VC Investment in the U.S., Q1 2004-Q2 2012



Percent Change in VC Investment by Stage of Financing

Massachusetts, 2009 Q3-2012 Q2



VC Investment - Top 6 Industries

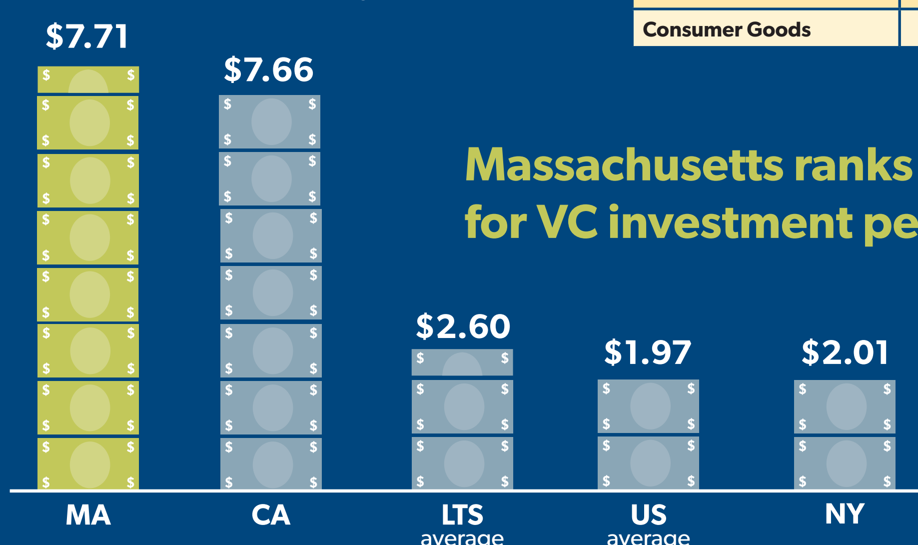
In Millions of 2012 Dollars

Massachusetts, 2010 and 2011

	2011	% Change 2010-11
Biotechnology	$1,084	24%
Software	$522	28%
Industrial/Energy	$330	15%
Medical Equipment	$329	9%
IT Services	$217	86%
Consumer Goods	$178	421%

Venture Capital (VC) Investment per $1,000 GDP

Massachusetts, LTS and U.S. Average - 2011



Massachusetts ranks 1st in the nation for VC investment per GDP

INDICATOR 19

Data Source for Indicator 19: PricewaterhouseCoopers MoneyTree Report, Consumer Price Index, U.S. Bureau of Economic Analysis
Analysis: Collaborative Economics

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

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 increase skill levels and technical sophistication of workers.

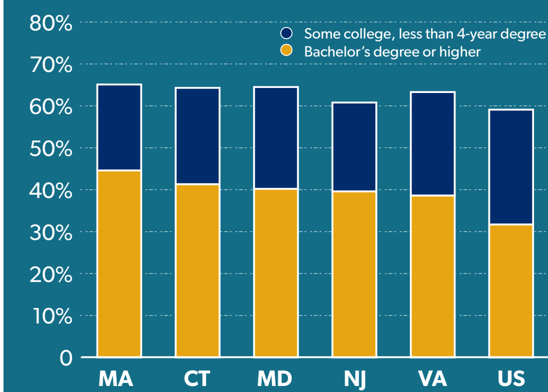
HOW DOES MASSACHUSETTS PERFORM?

Despite a slight decline (2.4%) from its peak in 2009, Massachusetts' educational attainment of the working age population remains strong, ranking first in the LTS in percent of the working age population with a bachelor's degree or higher (45%).

Full-time employment continues to grow for the working age population with some college education. Residents with at least some college education have the highest likelihood of finding employment in Massachusetts' economy; 77 percent of the working age population with a bachelor's degree or higher and 72 percent of residents with some college education are employed. Residents with some college or an associates' degrees saw the largest increase in employment rates of the education categories, rising eight percent between 2009 and 2010. Employment levels in Massachusetts for those with a high school degree or equivalent and those without a high school diploma fell between 2009 and 2010.

Educational Attainment of Working Age Population

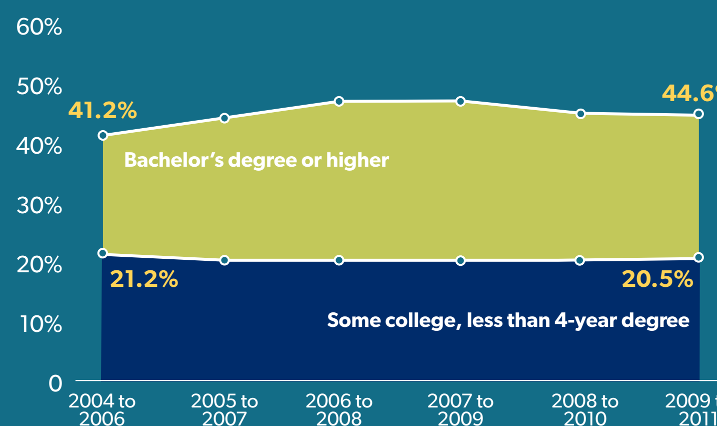
Massachusetts, LTS and U.S., 2009-2011 average



MA ranks 1st among the LTS for working population with a bachelor's degree or higher *

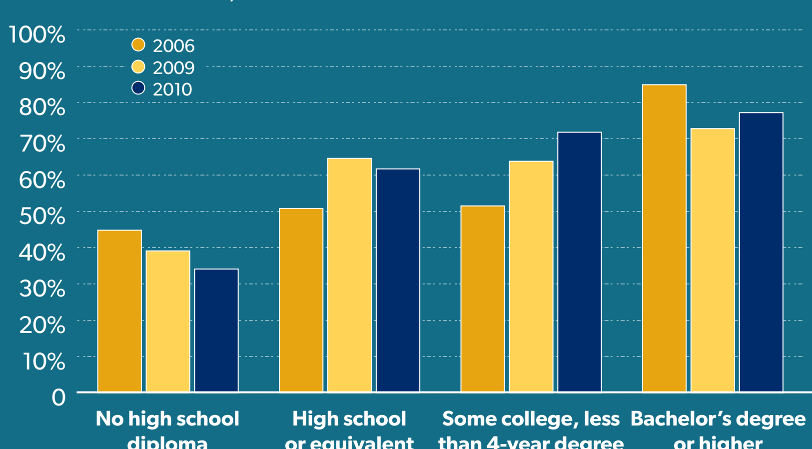
College Attainment of Working Age Population

Massachusetts, Three-year rolling average 2006-2011



Full-Time Employment Rate of Working Age Population by Education

Massachusetts - 2006, 2009 and 2010



Full-Time Employment Rate by Education

Massachusetts - 2010

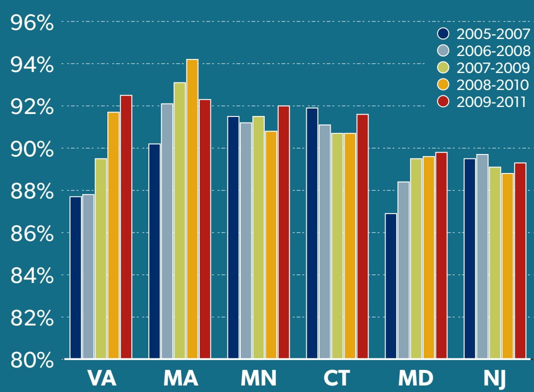
	2010	% Change 2009-10
No high school diploma	34%	-5%
High school or equivalent	62%	-3%
Some college, less than 4-year degree	72%	8%
Bachelor's degree or higher	77%	4%

INDICATOR 20

Data Source for Indicator 20: U.S. Census Bureau, Current Population Survey
Analysis: Collaborative Economics

EDUCATION

High School Attainment of Persons Ages 19-24
Massachusetts and LTS , Three years rolling - 2007-2011



From 2009-2011, MA ranked second highest among the LTS at 92.3 percent

Post-Secondary* Degrees Conferred per 1,000 People
Massachusetts, LTS Average, U.S. and International - 2010

Ukraine 14.3
Romania 14.2
Slovakia 14.1
Massachusetts 14.0
China 13.7
United States 9.7
LTS Average 8.4

Note: The U.S. ranked 12th in degrees conferred but was added to this chart for analysis purposes.

MA ranked fourth in post-secondary degrees conferred compared to all countries, up from eighth in 2009

WHY IS IT SIGNIFICANT?

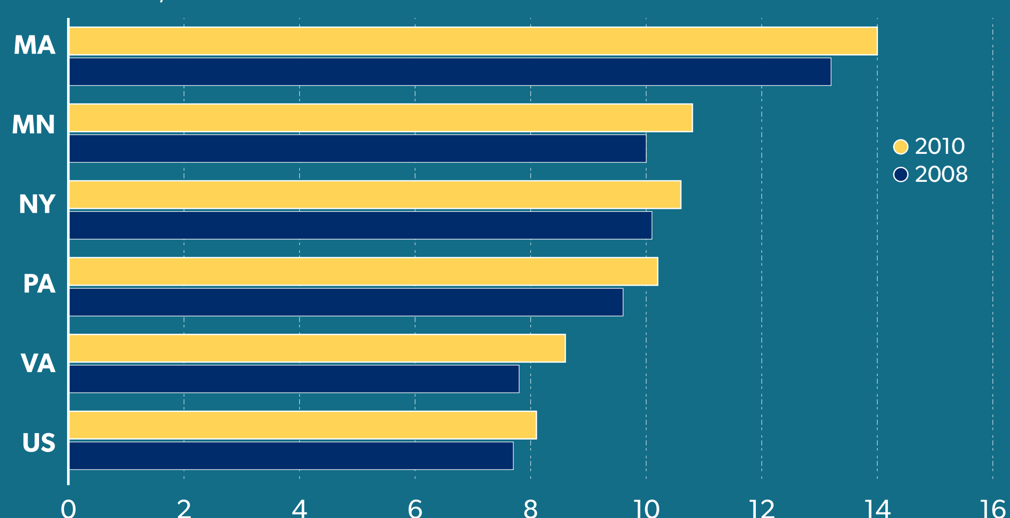
Education plays an important role in preparing Massachusetts' residents to succeed in their evolving job requirements and career trajectories. A strong education system also helps attract and retain workers who want excellent educational opportunities and skills for themselves and their children. Economic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

HOW DOES MASSACHUSETTS PERFORM?

From 2009 to 2011, the percentage of Massachusetts' 19 to 24 year olds with a high school degree equivalent or higher was the second highest among LTS at 92.3 percent. This was down nearly two percent from the previous three year average when Massachusetts outranked all of the other LTS. Virginia had the greatest increase in percentage of population with a high school degree or more, up 4.8 percent since 2005-2007, while Massachusetts increased 2.1 percent.

Massachusetts ranked fourth compared to all countries in the number of post-secondary degrees conferred per 1,000 people. Domestically, the state outperforms the U.S. and the LTS average by more than four degrees per 1,000 people. College attainment is particularly important to securing employment in Massachusetts. Massachusetts' residents with college degrees per 1,000 of the population increased 5.9 percent from 2008 to 2010, and continued to lead the LTS.

Post-Secondary* Degrees Conferred per 1,000 People
Massachusetts, LTS and Total U.S. - 2008 and 2010



MA ranked first in post-secondary degrees conferred per 1,000 residents

INDICATOR 21

* Post-secondary Degrees include Bachelor, Master, Professional and Doctoral degrees, the LTS Average does not include Massachusetts and countries that may previously have been in the Index were removed this year because no data was reported.

Data Source for Indicator 21: U.S. Census Bureau, Current Population Survey, United Nations Educational, Scientific and Cultural Organization (UNESCO) and the National Center for Education Statistics, American Community Survey
Analysis: Collaborative Economics

PUBLIC INVESTMENT IN EDUCATION AND PRESCHOOL ENROLLMENT

WHY IS IT SIGNIFICANT?

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

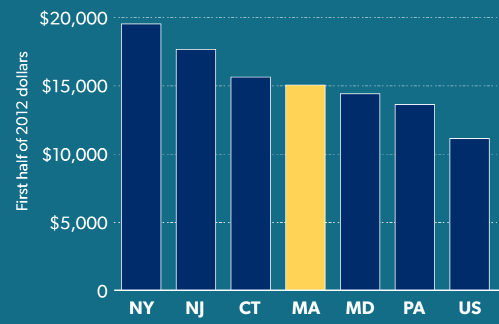
HOW DOES MASSACHUSETTS PERFORM?

State higher education appropriations per student remain relatively low in Massachusetts. In 2011, the state's allotment for higher education decreased 6.8 percent to just under $5,700, trailing behind the national average ($6,400) and a majority of the LTS.

Public elementary and secondary school spending in Massachusetts was $15,000 per pupil in 2010 below that of New York at ($19,500), New Jersey ($17,700) and Connecticut ($15,600). The average annual growth rate (AAGR) for Massachusetts was 2.7 percent, fourth place among the LTS behind Maryland (4.6%), New York (3.4%) and Connecticut (2.9%).

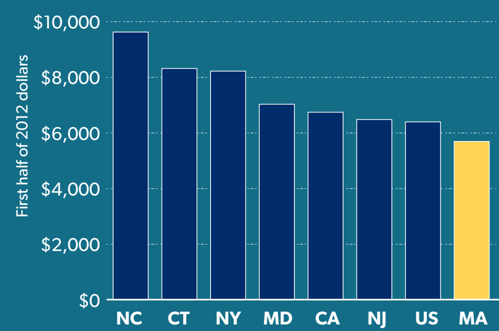
Massachusetts had the highest rate of preschool enrollment in 2011 compared to LTS and the U.S. overall. The state had the greatest increase in preschool enrollment rate from 2010 to 2011, increasing by about two percent, while all other LTS decreased or stayed about the same. Between 2006 and 2011, Massachusetts had a rate of preschool enrollment that was about ten percent higher than the national average.

Per Pupil Spending
Public Elementary/Secondary School Systems
Massachusetts, LTS and U.S. - 2010



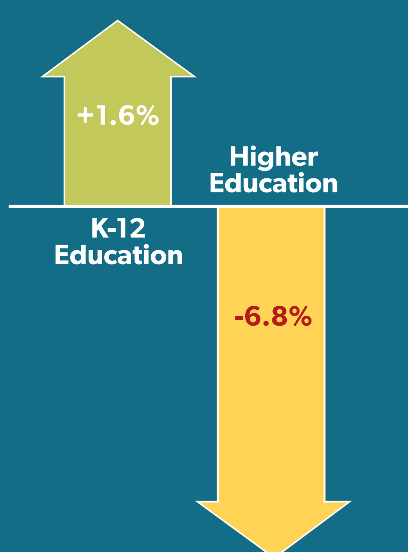
The average annual growth in per pupil spending for MA was 2.7 percent, the third highest of the LTS *

State Higher Education Appropriations
Per Full-Time Equivalent Student
Massachusetts, LTS and U.S. - 2011

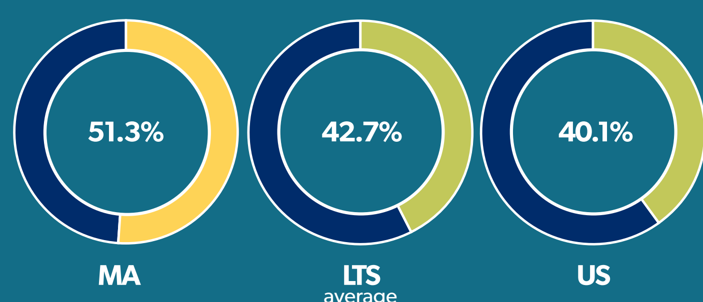


MA remains below the national average in state higher education appropriations at just under $5,700 per full-time equivalent student *

Percent Change in Funding
Massachusetts, 2010-2011



Percentage of the Population 3 to 5 Years of Age Enrolled in Preschool and Nursery School
Massachusetts, LTS Average and U.S. - 2011



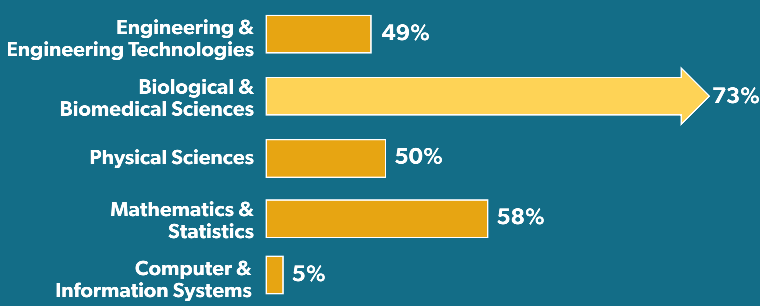
Massachusetts had the highest rate of preschool enrollment in 2011 at 51.3 percent - 10 percent higher than the national average

INDICATOR 22

Data Source for Indicator 22: State Higher Education Office, U.S. Census Bureau, American Community Survey
Analysis: Collaborative Economics

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

Percent Change in Intended Majors of High School Seniors
Massachusetts, 2008-2011



Degrees Granted in STEM Fields
Massachusetts, 2010

	2010	% Change 2000-10
Engineering	4,177	0%
Biological Sciences	3,507	34%
Computer & Information Systems	1,953	3%
Physical Sciences	1,167	-9%
Mathematics & Statistics	934	43%
TOTAL	11,738	10%

The total number of STEM degrees has increased 10 percent since 2000 *

STEM interest has increased across all majors since 2008

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?

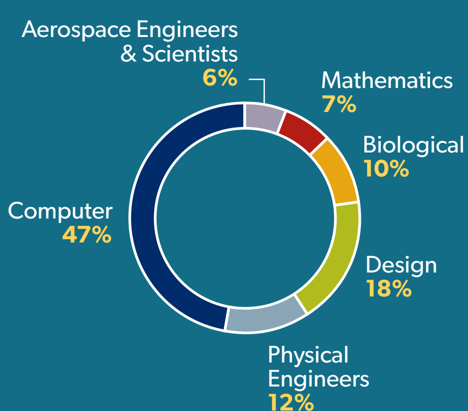
An increasing number of Massachusetts high school seniors are intending to major in STEM fields. Mathematics & Statistics increased the most (19%) in the past year and more than doubled since 2002. Intention to major in the Biological & Biomedical Sciences field remained relatively flat this past year, but has grown 68 percent since 2002. Computer or Information Sciences interest is dropping, with a six percent decrease in the past year, following a 55 percent decline since 2002.

The total number of degrees granted in STEM fields in Massachusetts has increased ten percent since 2000, with the largest growth in Biological Sciences and Mathematics & Statistics. However, nearly all STEM fields experienced a decrease in degrees granted from 2009 to 2010, with a four percent overall decrease.

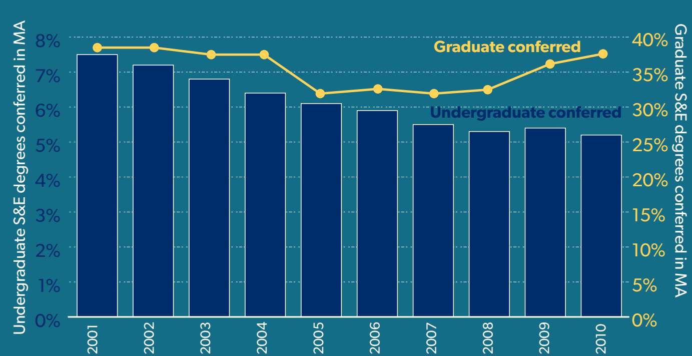
Though diminishing in number (-211) Computer professionals still hold the largest portion of S&E jobs (47%). Aerospace Engineers & Scientists and Design professionals witnessed the largest employment growth, increasing by 14,340 and 33,052 respectively.

The percentage of science and engineering degrees conferred to foreign undergraduate students has consistently declined since 2001, while the percentage of graduate degrees conferred to foreign individuals has grown steadily and reached 37 percent in 2010.

Science and Engineering (S&E) Talent
Massachusetts - 2011



S&E Degrees Conferred to Temporary Nonpermanent Residents
Universities in Massachusetts, 2001-2010



Note: Data based on first major and includes bachelors, masters and doctorate degrees.

INDICATOR 23

Data Source for Indicator 23: The College Board, American Community Survey PUMS, National Center for Educational Statistics, IPEDS
Analysis: Collaborative Economics

TALENT FLOW AND ATTRACTION

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?

Overall net migration increased from 2010 to equal 11,256 in 2011. Net international migration quadrupled, reaching 19,664 between 2010 and 2011, while net domestic migration continued to decline with a loss of 8,299 residents in 2011.

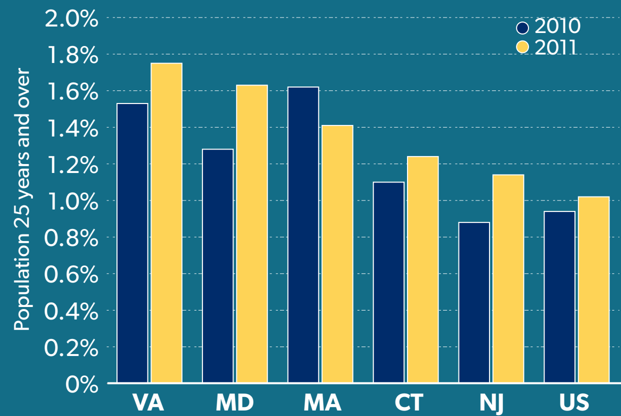
Massachusetts remained an attractive destination for college-educated adults, ranking third in 2011 among the LTS. While only 39.1 percent of Massachusetts' population had a bachelor's degree or higher in 2011, over half of the state's migrants held such degrees. International and state-to state relocations of college educated adults to Massachusetts slowed in 2011, while growing in many LTS.

Massachusetts ranked second after Connecticut among the LTS in 2011 in the percent of relocated population with a bachelor's degree or higher.

Massachusetts' total S&E talent increased six percent, in the last eleven years, from 256,200 to 272,600. Massachusetts has a diverse pool of S&E talent, with a nearly equal distribution of talent born in the state, outside the state and outside the U.S.

Outpacing national trends over the decade, Massachusetts' foreign-born talent increased from 21 to 26 percent in S&E fields, compared to a 15 to 20 percent rise across all occupations.

Relocations by College Educated Adults
To the LTS from Out of State or Abroad
Massachusetts, LTS and U.S. - 2010 and 2011

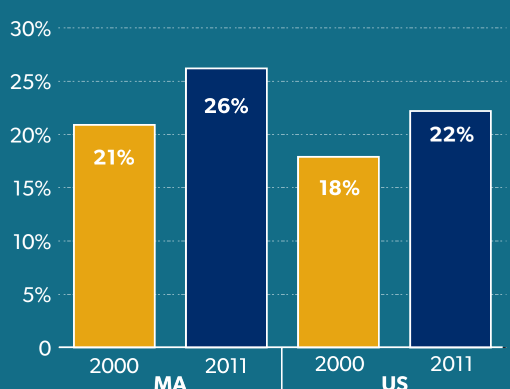


Percent Change in Migration of Individuals with a Bachelor's Degree
Massachusetts, LTS and U.S., 2010-2011

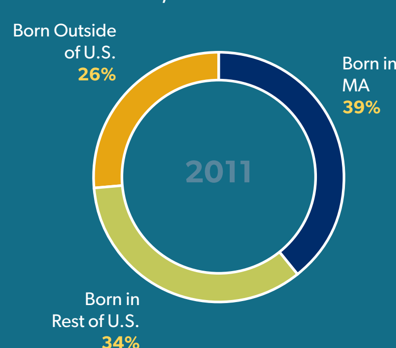
Relocations of college-educated adults to Massachusetts ebbed in 2011, while growing in many LTS

INDICATOR 24

Percent of Employed S&E Talent Who Are Foreign-Born
Massachusetts, 2011



S&E Talent by Place of Origin
Massachusetts, 2011



Total S&E talent increased 6 percent between 2000 and 2011, driven by a 33 percent increase in those born outside the U.S.

*

Data Source for Indicator 24: U.S. Census Bureau, 2000 Decennial PUMS, 2011 American Community Survey
Analysis: Massachusetts Technology Collaborative, Collaborative Economics

HOUSING AFFORDABILITY

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.

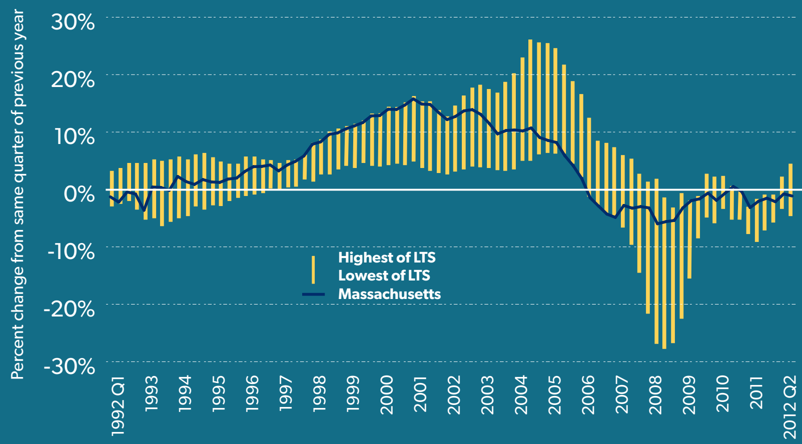
HOW DOES MASSACHUSETTS PERFORM?

Housing prices in Massachusetts began to decline in 2005, but have remained more stable than the LTS since 2008. In the past three years (Q2 2009-Q2 2012), the housing price index for the state has averaged about a one percent quarterly decrease, whereas the LTS average has reported roughly a three percent quarterly decrease.

In 2011, 39 percent of Massachusetts homeowners with mortgages spent 30 percent or more of their income on housing costs; 51 percent of renters were similarly burdened by their rent payments. Massachusetts' percent of households spending 30 percent or more of income on rent and mortgages is roughly equivalent to the LTS average. California has the highest percent of households in both categories, followed by New Jersey. Minnesota ranked lowest in both categories. By this measure, housing affordability has stayed relatively constant in Massachusetts and the U.S. since 2006.

Housing Pricing Index

Massachusetts and High to Low Range for LTS, 1992 Q1-2012 Q2



Households Spending 30% or More of Income on Housing Costs

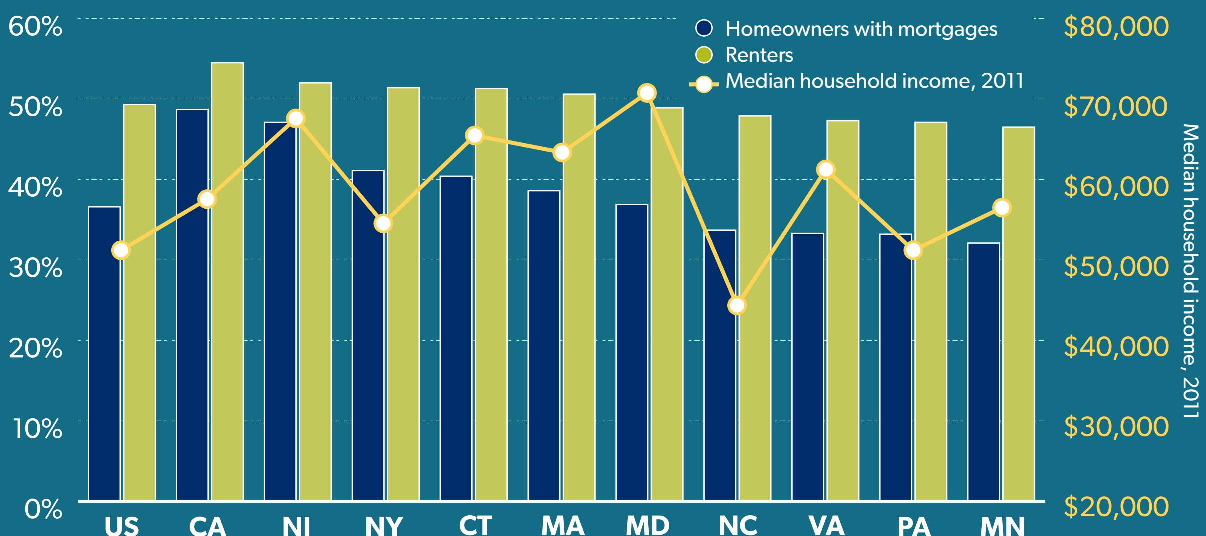
Massachusetts and U.S. - 2006, 2010 and 2011

	2006	2010	2011
U.S. Mortgaged Homeowners	36.9%	37.8%	36.6%
MA Mortgaged Homeowners	41.8%	39.0%	38.6%
U.S. Renters	46.0%	48.9%	49.3%
MA Renters	48.6%	47.8%	48.9%

Housing affordability has stayed relatively constant in MA and the U.S. since 2006 *

Households Spending 30% or More of Income on Housing Costs

Massachusetts, LTS and U.S. - 2011



INDICATOR 25

Data Source for Indicator 25: Federal Housing Finance Agency, U.S. Census Bureau
Analysis: Massachusetts Technology Collaborative

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 2012 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). Please refer to the "Underlying Data PDF" on our website, index.masstech.org, for the full comparison to all LTS states.

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 Leading Technology States (LTS) list, which was updated in 2011, includes: California, Connecticut, Maryland, Minnesota, New Jersey, New York, North Carolina, Pennsylvania, and Virginia. The LTS are chosen by the number of select key industry sectors with a high concentration of employment, the percent of employment in these sectors, and the size of each states' economy. The sectors used for this purpose are 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 LTS are the ten states with the greatest number of sectors with a location quotient greater than 1.1, ranked by the percent of jobs in the key sectors, excluding states with fewer than a half million jobs in the key sectors. The size threshold excludes states such as New Hampshire, Rhode Island, and Utah. This methodology yields a roster of LTS that is comparable to Massachusetts and has a similar composition of industry sectors.

In various indicators a comparison to all of the LTS was not necessarily needed. In these cases, depending on what the data was showing, a variety of comparisons were used including Massachusetts (MA) in comparison to the top LTS, MA in comparison to the LTS and U.S. averages or MA in comparison to similarly performing LTS states (i.e. growth rate, etc.). Please refer to the "Underlying Data PDF" on our website, index.masstech.org, for the full comparison to all LTS states.

	CA	CT	MD	MA	MN	NJ	NY	NC	PA	VA
Advanced Materials	0.58	0.84	0.35	0.82	0.92	0.94	0.57	1.48	1.39	0.78
Bio-Pharma & Medical Devices	1.36	1.39	1.15	2.12	1.62	2.00	0.85	1.41	1.26	0.55
Business Services	0.95	0.95	0.92	1.03	1.19	1.11	1.16	0.95	1.18	1.25
Computer & Communications Hardware	2.15	1.07	0.49	1.86	1.40	0.60	0.83	1.37	0.98	0.42
Defense Manufacturing & Instrumentation	1.22	3.03	0.41	1.26	0.67	0.50	0.50	0.72	0.73	0.16
Diversified Industrial Manufacturing	0.81	1.67	0.31	1.13	1.54	0.67	0.77	0.90	1.24	0.61
Postsecondary Education	1.02	1.15	1.19	1.37	0.87	0.85	1.23	1.08	1.05	0.97
Financial Services	0.82	1.78	0.78	1.35	1.30	1.22	1.39	0.93	1.14	0.64
Healthcare Delivery	0.85	1.00	0.98	1.18	1.01	0.99	1.07	1.05	1.10	0.81
Science, Technical & Management Services	1.39	0.81	1.82	1.40	0.75	1.24	1.00	1.00	0.93	1.90
Software & Communication Services	1.13	0.99	1.41	1.55	1.01	1.26	0.99	0.90	0.84	2.09
Count of sectors with LQ>1.1	5	5	4	9	5	5	3	3	5	3
Percent of jobs in Key Sectors	26.8%	33.9%	27.4%	37.1%	30.4%	30.2%	30.2%	26.3%	31.5%	27.8%

Cells are shaded to show industry concentrations more than 10% above the U.S. average
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. In some cases, the countries selected are high income nations as defined by the World Bank due to the small denominator effect. Categories of data not reported by excluded countries vary from category to category.

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 midyear 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. Statistics on China obtained from the United Nations Educational, Scientific, and Cultural Organization (UNESCO) do not include the two Special Administrative Regions of Hong Kong and Macao. All economic data, such as GDP, GNI, and exchange rates, used by UNESCO in the Index, are provided by the World Bank and are revised on a biannual basis.

IV. Notes on Data Sources for the Special Analysis

1. Cluster Employment
The National Establishment Time-Series (NETS) Database by Walls and Associates using Dun & Bradstreet establishment data, was purchased for jobs data and establishment counts. Due to the challenges of finding "Robotics" and "Big Data" industries based upon NAICS codes alone, Collaborative Economics created a composite database drawing information from sources such as Mass Tech Leadership Council, CB Insights and key word searches within the NETS database for the identification of establishments within both industries. A company was included only if, when researched, its primary activity involved either Robotics or Big Data. In the case of multi establishment companies, only the establishments involving Robotics and Big Data and not the establishments involving other activities (i.e. marketing, maintenance etc.) were included. In cases where results were uncertain and the activities of a business establishment could not be verified, the establishment was not included. Therefore, the database offers a conservative estimate, rather than a comprehensive accounting, of the employment growth in these two industries. NETS data reflect employment at establishment location in January of each year.

2. Startup & Seed Investment
Angel investment data provided by the University of New Hampshire Center For Venture Research. University of New Hampshire, Center for Venture Research data is based upon Angel Group Data, it is estimated that angel groups represent 5-10% of the general angel population in Massachusetts. Venture Capital Investment provided by Pricewaterhouse Coopers Money Tree Report.

3. How is Massachusetts Doing
Determination of how Massachusetts was doing, relative to itself, was based upon a comparison of the previous time periods data. Determination of how Massachusetts was doing, relative to the LTS, was based upon a comparison with the top three LTS average (not including Massachusetts if it ranked in the top three).

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). 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) 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.

Indicator 3: Median Household Income

Median household income

Median household income data are from the U.S. Census Bureau, American Community Survey table B19013 "Median Household Income in the Past 12 Months, 3 Year Estimate".

Income Distribution

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

Wages and salaries paid

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

Indicator 4: Productivity

Manufacturing productivity in key industry sectors
For this measure, productivity is defined as manufacturing value added per manufacturing employee. Industry definitions used are the manufacturing components of the key industry sectors (only NAICS codes beginning with the number 3). For information on the calculation of value added, see Indicator 5 below. Data are from the Census Bureau's Annual Survey of Manufactures (www.census.gov/manufacturing/asm/index.html).

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).

Indicator 5: Industry Churn and Manufacturing Value Added

Manufacturing value added
Industry output, the market value-added of goods and services produced in a sector, provides insight into the performance of industry sectors over time. However, due to inherent differences in the way industry output is calculated in various sectors, it is important not to interpret this measure as an assessment of the importance of one industry relative to another. The term "value added" defines output as final sales in a given sector less the value of intermediate goods and services purchased to facilitate their production. The main components of value added include the returns to labor (as measured by compensation of employees), returns to capital (as measured by gross operating surplus), and the returns to government (as measured by taxes on productions and imports less subsidies). Data are from the Census Bureau's Annual Survey of Manufactures. The Census Bureau defines value added as follows: "This measure of manufacturing activity is derived by subtracting the cost of materials, supplies, containers, fuel, purchased electricity, and contract work from the value of shipments (products manufactured plus receipts for services rendered). The result of this calculation is adjusted by the addition of value added by merchandising operations (i.e., the difference between the sales value and the cost of merchandise sold without further manufacture, processing, or assembly) plus the net change in finished goods and work-in-process between the beginning- and end-of-year inventories. For those industries where value of production is collected instead of value of shipments, value added is adjusted only for the change in work-in-process inventories between the beginning and end of year. For those industries where value of work done is collected, the value added does not include an adjustment for the change in finished goods or work-in-process inventories. 'Value added' avoids the duplication in the figure for value of shipments that results from the use of products of some establishments as materials by others." (www.census.gov/manufacturing/asm/index.html).

Industry Churn
The National Establishment Time-Series (NETS) Database by Walls and Associates using Dun & Bradstreet establishment data, was purchased for jobs data and establishment counts. Employment churns for all of the key industry sectors can be found at index.masstech.org

Indicator 6: Manufacturing Exports

Manufacturing exports data are from the World Institute for Strategic Economic Research (WISER) (www.wisertrade.org/naics/ftbegin), from U.S. Census Bureau, Foreign Trade Division.

The export categories match up with the sectors as follows:

- Computer and Electronic Products: Bio-Pharma & Medical Devices, Computer and Communications Hardware, and Defense Manufacturing and Instrumentation
- Chemicals: Advanced Materials and Bio-Pharma & Medical Devices
- Electrical Equipment, Appliances, and Components: Computer and Communications Hardware and Diversified Industrial Manufacturing
- Fabricated Metal Products: Defense Manufacturing and Instrumentation and Diversified Industrial Manufacturing
- Machinery, except electrical: Defense Manufacturing and Instrumentation and Diversified Industrial Manufacturing
- Miscellaneous Manufactured Commodities: Diversified Industrial Manufacturing
- Plastics and Rubber Products: Advanced Materials
- Primary Metal Manufacturing: Advanced Materials
- Transportation: Defense Manufacturing and Instrumentation

Indicator 7: Research and Development Performed

Research and development (R&D) performed
Data are from the National Science Foundation, "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 National Science Foundation, "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 National Science Foundation, "Table: U.S. research and development expenditures, by state, performing sector, and source of funding", and the Bureau of Economic Analysis (bea.gov).

Indicator 8: Performers of Research and Development
Data for the LTS are from the National Science Foundation, "Table - Research and development expenditures, by state, performing sector, and source of funds". Data used are the totals for all R&D, Federal, FFRDCs, Business, U&C, and Other Nonprofit. www.nsf.gov/statistics.

Indicator 9: Academic Article Output
LTS data are from the National Science Foundation "Table 8-49 - Academic science and engineering article output per $1 million of academic S&E R&D, by state: 1998–2009" and international data is from the National Science Foundation. "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).

Indicator 10: 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). Population estimates are from the U.S. Census Bureau, Population Estimates Branch (www.census.gov/popest/data/index.html).

Patents published under the Patent Cooperation Treaty
International patents published under the Patent Cooperation Treaty 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 Patent Cooperation Treaty, the Madrid System and the Hague System. The number of patents per year are based on the date of publication. GDP data is from the World Bank (data.worldbank.org).

Indicator 11: 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), Patenting By Geographic Region, Breakout by Technology Class. State population data come from the U.S. Census Bureau, Population Estimates Branch. (www.census.gov/popest/data/index.html).The number of patents per year are based on the date the patents were granted. Patents in "computer and communications" and "drugs and medical" are based on categories developed by in Hall, B. H., A. B. Jaffe, and M. Tratjenberg (2001). "The NBER Patent Citation Data File: Lessons, Insights and Methodological Tools." NBER Working Paper 8498. Patents in "advanced materials" and "analytical instruments and research methods" are based on categories developed by MTC's John Adams Innovation Institute. The "Business methods" category has its own USPTO patent class.

Indicator 12: Technology Licensing
Data on licensing agreements are from the Association of University Technology Managers website (AUTM) (www.autm.net). Institutions participating in the survey are AUTM members.

Indicator 13: Small Business Innovation Research (SBIR) and Technology Transfer (STTR) Awards
This indicator includes SBIR award Small Business Technology Transfer (STTR) award data. SBIR/STTR award data from U.S. Small Business Administration (www.sbir.gov/sbirsearch/technology), state population data come from the U.S. Census Bureau, Population Estimates Branch (www.census.gov/popest/data/index.html) and GDP Data is from U.S. Bureau of Economic Analysis (www.bea.gov).

Indicator 14: 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). 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) publication "New Drug Approvals in 2011."

Indicator 15: Business Formation

Business establishment openings
Data are from the Business Employment Dynamics database of the Bureau of Labor Statistics' Business Employment Dynamics (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 the Bureau of Labor Statistics' (BLS) (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).

Indicator 16: 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#) Data on venture-backed IPOs for 2010 are from the National Venture Capital Association (NVCA) (www.nvca.org).

Mergers & acquisitions (M&As)
Data on total number of M&As are from CB Insights (CBInsights.com), deals include acquired company by location.

Indicator 17: Federal Funding for Academic, Nonprofit, and Health R&D

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

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

Indicator 18: Industry Funding of Academic Research
Data are from the National Science Foundation (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 19: 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 is from Bureau of Economic Analysis (bea.gov), U.S. Department of Commerce.

Indicator 20: 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 21: 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, 2007 through 2011. Figures are three year rolling averages.

College degrees conferred

International data are from the United Nations Educational, Scientific and Cultural Organization (UNESCO) from the series “Total graduates in all programmes. Tertiary. Total.” Tertiary corresponds to higher education, the definition of which can be found in the International Standard Classification of Education. 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.

Indicator 22: 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. 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: 2005-2010”. Figures are presented in 2010 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 SHEF 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 is from the United States Census Bureau, American Community Survey and the Supplementary Surveys. The population of children is for children age three to five years old. The age of the population in preschool and nursery schools is from three years and older.

Indicator 23: Science, Technology, Engineering, and Math (STEM) Career Choices and Degrees

Intended major of high school seniors
The intended majors of high school students is 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. The college-bound senior population is relatively stable from year to year; moreover, since studies have documented the accuracy of self-reported information, SDQ information for these students can be considered an accurate description of the group.

STEM degrees
Data about degrees conferred by field of study are from the National Center for Education Statistics, Integrated Postsecondary Education Data System (IPEDS) Completions Survey using the National Science Foundation (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 the U.S. Bureau of Labor Statistics Occupation Employment Statistics (May 2009), both occupations represent almost 60 percent of employment in both Designers and Artists & Related Workers.

Indicator 24: 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.

Science & Engineering Talent by Place of Origin
State and regional data for 1995-2010 are from the National Center for Education Statistics. The academic disciplines include: computer and information sciences, engineering, engineering-related technologies, biological sciences/life sciences, mathematics, physical sciences and science technologies. Data were analyzed based on 1st major, citizenship, and level of degree (bachelors, masters or doctorate). Note that a new classification scheme for degrees awarded was adopted in 2009 and one or more degree categories were eliminated and others consolidated. The current category of Doctorate Degree- Professional Practice equates to the old First professional Degree. The old Doctorate Degree breakout equates generally to the sum of the other three doctorate degree categories. However, any re-categorization could result in measurement error when data are compared to previous years.

Indicator 25: 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 is from U.S. Census Bureau, American Community Survey, B19013: "Median Household Income in the Past 12 Months", 3-year estimate.

INDUSTRY SECTOR DEFINITIONS

The Index makes use of four- , five- and six-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 Equip. & Merchant Wholesalers
42346 Ophthalmic Goods Merchant Wholesale
54171 Physical, engineering, and biological research

With 2002 NAICS, apportioned based on 5417102 Biological R&D
With 2007 NAICS, apportioned based on 541711 R&D in Biotechnology and
5417122 R&D in Other Life Sciences

334510 Electro Medical Apparatus Manufacturing
334517 Irradiation Apparatus Manufacturing

Business Services

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

Computer & Communications Hardware

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

Defense Manufacturing & Instrumentation

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

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

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

Post-secondary 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 2002 NAICS add 516110 Internet publishing and broadcasting and 518112 Web search portals
With 2007 NAICS add 51913 Internet publishing and broadcasting and web search portals

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We would like to thank the following individuals for participating in interviews for the company profiles:

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Mike Baker, Chief Executive Officer, DataXu
Jeff Chow, Chief Executive Officer, Springpad
Charles Grinnell, Chief Executive Officer, Harvest Automation
David Marini, Chief Executive Officer, Firefly BioWorks
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MASSACHUSETTS
INNOVATION ECONOMY

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The Annual Index of the Massachusetts Innovation Economy was produced by the Innovation Institute in partnership with Collaborative Economics.

Published in USA for Massachusetts Technology Park Corporation