2010 Index of the Massachusetts Innovation Economy

MASSACHUSETTS
TECHNOLOGY
COLLABORATIVE
John Adams Innovation Institute

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.

Cover design inspired by the chart "R&D performed as a percent of GDP, international and Massachusetts, 2002-2007" (Indicator 7, Research and Development Performed).

2010

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The Massachusetts Technology Collaborative

The Massachusetts Technology Collaborative is a public economic development agency chartered by the Commonwealth to promote new economic opportunity and foster a more favorable environment for the formation, retention, and expansion of technology-related enterprises in Massachusetts.

MTC serves as a catalyst in growing the knowledge- and technology-based industries that comprise the state's Innovation Economy. It is working with major healthcare organizations to implement e-health solutions that save lives and reduce costs. The agency is aggressively pursuing federal funding to support economic development in Massachusetts through the American Recovery and Reinvestment Act of 2009. MTC's rich history of successfully managing complex projects that involve significant public and private investment have positioned the agency to serve as an important conduit for infusions of funding into the Commonwealth.

Working through its major divisions—the John Adams Innovation Institute, the Massachusetts e-Health Institute, and the Massachusetts Broadband Institute—the agency is strengthening the innovation economy.

John Adams Innovation Institute

The John Adams Innovation Institute, a division of the Massachusetts Technology Collaborative, is the Commonwealth's leading agent fostering innovation-based economic development.

The Innovation Institute's mission is to enhance the capacity of the Massachusetts economy to sustain the ongoing flow of innovation crucial to create, attract, and grow innovative businesses and entire new industries.

Through facilitation, partnerships, strategic investments, and direct services, we convene and mobilize individuals in academic, research, business, government, and civic organizations throughout Massachusetts in the context of initiatives and projects that enhance innovation, cluster emergence and growth, and industrial competitiveness.

We work region by region and sector by sector to accelerate, amplify, and leverage the self-organizing capacity of individuals and organizations and foster greater collaboration throughout industry, academia, and government. We do this to cultivate the vitality and capacity for self-renewal in the Massachusetts Innovation Economy in order to improve conditions for prosperity for all citizens and regions of the Commonwealth.

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Introduction and Highlights

Introduction

Through 25 indicators, the **Index of the Massachusetts Innovation Economy** provides a comprehensive view of multiple dimensions that affect the performance of the Commonwealth's innovation ecosystem and its impact on the state's economic prosperity. Using a rich set of data sources, the **Index** benchmarks Massachusetts against nine Leading Technology States (LTS) to reveal relative strengths and weaknesses and do a comparative assessment of the state's competitive position. Appendix A describes the LTS selection criteria. The nine LTS chosen for comparison in the **2010 Index** are California, Connecticut, Illinois, Maryland, Minnesota, New Jersey, New York, North Carolina, and Pennsylvania.

Highlights

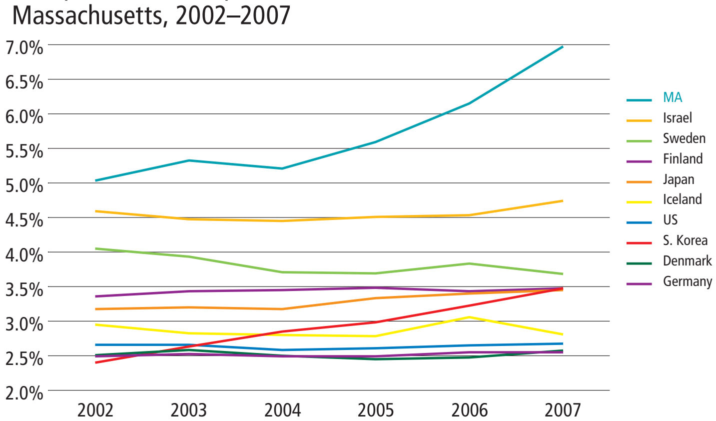
The share of Massachusetts' total employment concentrated in the eleven key sectors of the Innovation Economy increased to 38.6% in 2010.

Typically, these sectors provide some of the highest paying jobs in Massachusetts. Total wages paid in these key sectors were 26% higher in 2009 than in 2004, a larger increase than the 15% gain in total wages in the economy as a whole. The largest employer in these sectors in 2009 was Healthcare Delivery, with more than double the employees than the next closest sector, Financial Services. The Bio-pharma & Medical Devices sector saw the largest percent change in employment from 2005 to 2009 with a 31.7% increase.

Massachusetts is a national and global leader in research and development (R&D).

R&D intensity in Massachusetts, is on the rise. With 7% of GDP accounted for by R&D in 2007, the Commonwealth had the most R&D intensive economy of the LTS and one of the most R&D intensive economies in the world. In Israel, the leader among countries, R&D accounted for 4.7% of GDP, compared to 2.7% of GDP in the United States as a whole. Massachusetts also leads the LTS in industry-performed R&D as a percent of private industry output.

R&D performed as a percent of GDP, international and Massachusetts, 2002–2007



Source: United Nations Educational, Scientific and Cultural Organization (UNESCO) and the National Science Foundation

Federal funding is a key enabler of R&D in Massachusetts.

Whether in total dollars or on a per capita basis, universities and nonprofit research institutes in Massachusetts were among the top in the LTS for attracting federal R&D dollars. Academic and nonprofit research institutes in the Commonwealth received $2.9 billion federal R&D dollars in 2007, accounting for 9% of the US total. At $447 per capita, federal expenditures for academic and nonprofit R&D were more than four times larger in Massachusetts than in the United States as a whole (per capita). The Commonwealth also maintained its leadership position among all LTS in funding from the National Institutes of Health (NIH). Massachusetts's small businesses attracted 12.6% of all federal funding invested through the Small Business Innovation Research (SBIR) Program, which funds proof-of-concept research and prototype development.

Massachusetts' universities and colleges are dynamic contributors to the state's Innovation Economy.

Universities and colleges attract and educate the highly-skilled and creative talent that gives the state a key competitive advantage in the global economy. Universities and colleges also contribute to employment, knowledge creation and dissemination, and new business formation. With approximately 141,000 employees (Q1 2010), the postsecondary education sector was the third largest employer among the 11 key sectors. Universities and colleges in Massachusetts performed nearly $2.17 billion dollars of R&D in 2007, or 43% of all non-business R&D in the Commonwealth. In 2008 Massachusetts led the LTS in the amount of industry funding of academic research per capita, with a narrow lead over North Carolina. Also in 2008, universities in Massachusetts reached a 12-year high in licensing and options revenue, bringing in $151.3 million. While university spin-outs account for only a small fraction of overall new business formation, Massachusetts' universities perform exceptionally well in this measure. Sixty-seven businesses spun out from universities in Massachusetts in 2008, second only to California with 86. Per capita, Massachusetts maintains a substantial lead.

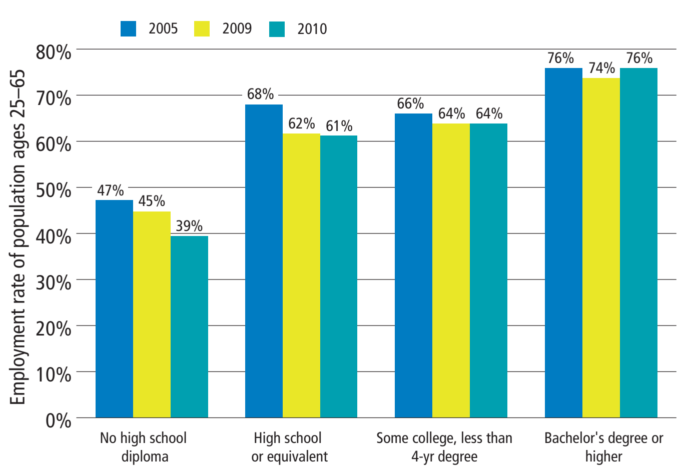
Entrepreneurship has remained vibrant and well-supported in Massachusetts even amidst economic uncertainty and a slowdown in business establishment openings.

As expected during a recession, all of the LTS had fewer business establishments openings in 2009 than 2008. Yet, entrepreneurial activity, estimated by the Kauffman Foundation as the percentage of businesses started by people who did not previously own a business, increased in Massachusetts and nationwide. This estimate increased nationally from 0.17% of the population during 1997-1999 to 0.28% during 2007-2009. That same year entrepreneurial activity in Massachusetts reached an estimated 0.33%. New businesses in Massachusetts were also being relatively well-funded. In 2009 and 2010, venture capital going to startup, seed, and early stage businesses in Massachusetts reached its highest level since the height of the 2000 tech bubble, with $1.7 billion invested.

Jobs created in the Massachusetts economy increasingly require advanced degrees.

Compared to the 2005 average, the Massachusetts economy as a whole showed a net loss of 88,000 jobs in the first quarter of 2010. In the same period employment in the key sectors of the Innovation Economy had a net increase of 40,000 people. Employment gains specific to these sectors suggest that jobs are being created in industries that normally require postsecondary education. Not surprisingly, full-time employment rates in Massachusetts show that more highly educated individuals are more likely to be employed. Between 2005 and 2010, the full-time employment rate of the working-age population in Massachusetts hovered at around 75% for individuals with a bachelor's degree or higher. At the other end of the spectrum, the full-time employment rate for individuals without a high school diploma shows a downward trend from 47% to 39%, over the same period.

Full-time employment rate by education, Massachusetts, 2005, 2009, and 2010



Source of all data for this indicator: US Census Bureau, Current Population Survey

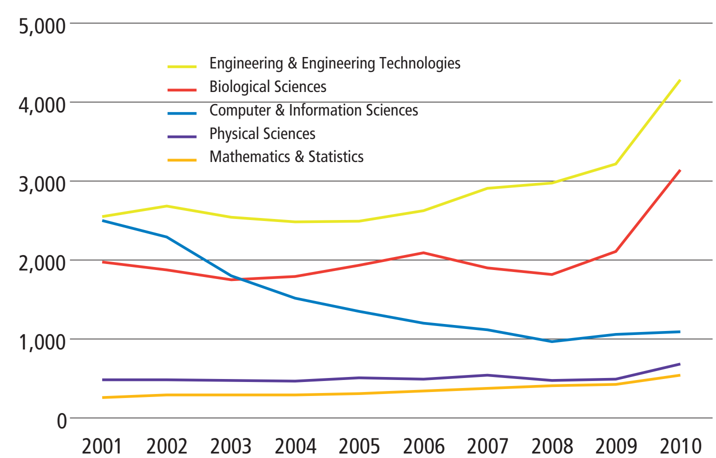
Massachusetts' appropriations for public higher education continue to decline, whether viewed per student, per capita, or relative to the size of the economy.

Massachusetts' appropriations per student in public higher education were 19% below the US average in 2009, compared to 2003 when they were 23% above. From 2008 to 2009 appropriations in Massachusetts fell 19.3% while enrollment rose 5.6%, resulting in a 23.7% decline in appropriations per student. Among the fifty states, the size of this decline is second only to South Dakota.

Interest in Science, Technology, Engineering, and Math (STEM) fields is increasing among Massachusetts' high school students, but the state is still 8% below the national average.

In science and mathematics, Massachusetts' high school students outperform their US peers and are highly competitive internationally. Their interest in STEM careers had remained notoriously low when compared to the LTS, but a comparison between 2005 and 2010 shows the gap between ability and interest has narrowed. While in 2005 the percent of high school students intending to major in STEM fields was lowest in Massachusetts among the LTS, by 2010 the state had moved up the rankings to sixth out of ten. Also in 2010, the percentage of Massachusetts' high school students intending to major in STEM fields in college reached the highest level since record keeping began ten years ago. This increase was driven largely by interest in engineering and engineering technology majors and biological sciences majors. Interest in computer and information sciences declined steadily between 2003 and 2008, but started to rebound in 2008 and 2010.

Intended major of high school seniors, Massachusetts, 2001–2010



Source: The College Board

Massachusetts Performance at a Glance

The **Index** examines the Massachusetts Innovation Economy through 25 indicators. This chart provides an overview of the direction of year-over-year change for Massachusetts.

The chart also depicts Massachusetts' performance on each indicator relative to the performance of the Leading Technology States (LTS). It shows Massachusetts' performance as a fraction of the US average.

MA and the LTS compared to the US Average

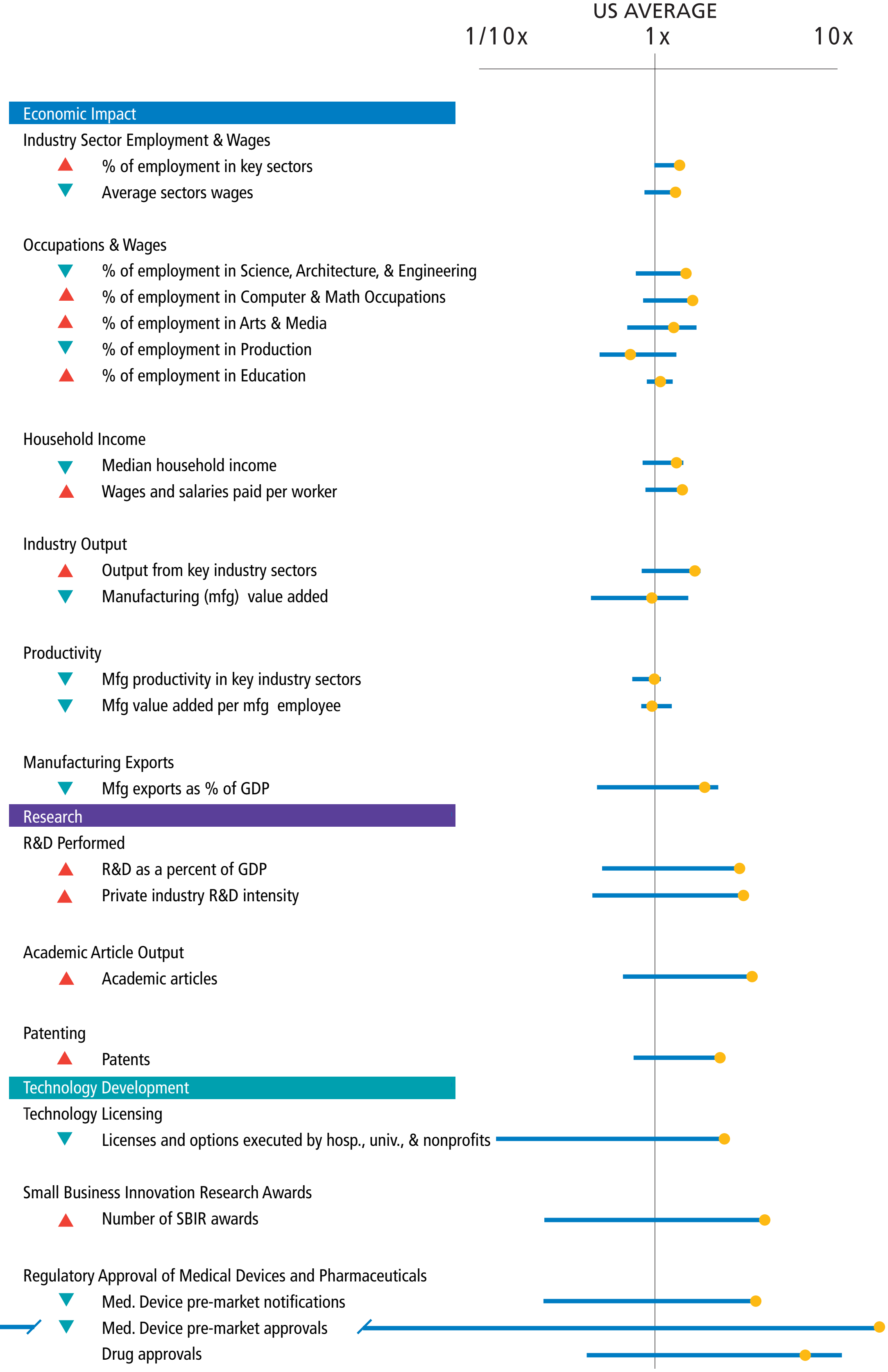
- LTS Range
- MA

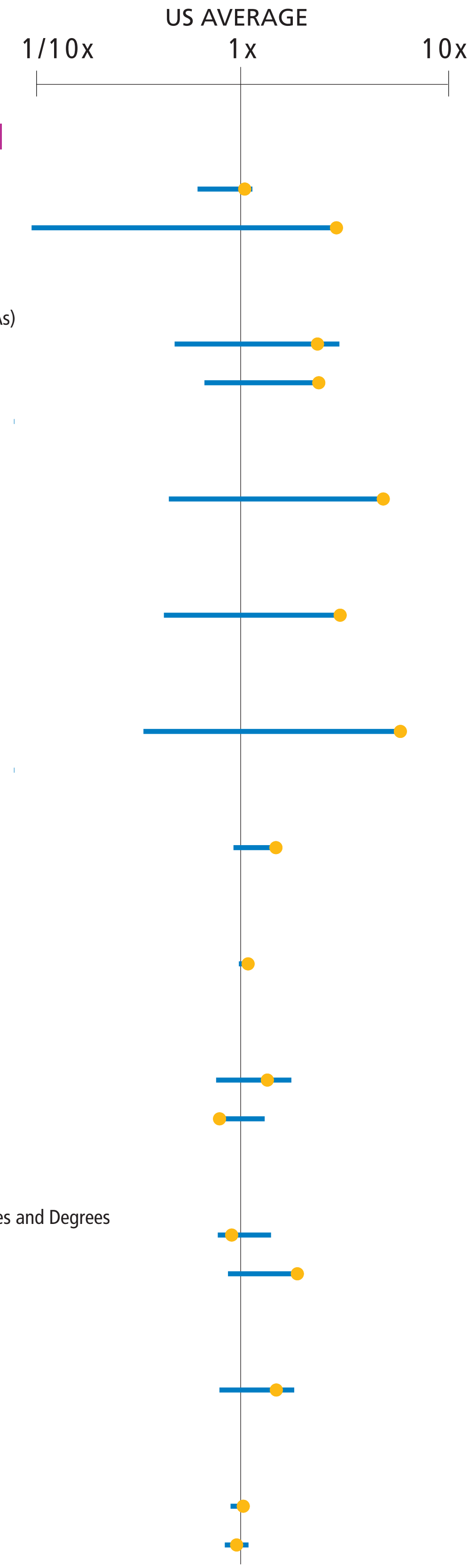
Direction of Year-Over-Year Change for Massachusetts

- ▲ up
- ▼ down

Massachusetts may rank at the top of the LTS on an indicator, but still has declined in the most recent year of data.

All comparisons are per capita except where otherwise indicated.





Business Development

Business Formation
- ▼ New business openings
- ▲ University spin-outs

Initial Public Offerings (IPOs) and Mergers and Acquisitions (M&As)
- ▲ IPOs
- ▲ M&As

Capital

Federal Funding for Academic, Nonprofit, and Health R&D
- ▲ Federally funded academic & nonprofit R&D

Industry Funding of Academic Research
- ▲ Industry funding of academic R&D

Venture Capital
- ▲ Venture capital

Talent

Education Level of the Workforce
- ▼ Working age population w/ bachelor's or higher

K-16 Education
- ▲ High school attainment of persons ages 19-24

Public Investment in K-16 Education
- ▲ Investment in public K-12 per pupil
- ▼ Investment in public higher education per pupil

Science, Technology, Engineering, and Math (STEM) Career Choices and Degrees
- ▲ High school seniors interested in STEM degrees
- ▲ Bachelor's or higher degrees granted in STEM fields

Talent Flow and Attraction
- ▼ Attraction of college-educated adults

Housing Affordability
- ▲ Rent affordability
- ▲ Mortgage affordability

Massachusetts: A Resilient Economy

Innovation is a constitutive feature of Massachusetts' character. Well before the word "innovation" became common currency, Massachusetts' inventors and entrepreneurs have been creating revolutionary technological and business platforms that have led to the creation, emergence and growth of entire industries. From textile mills to semiconductors and analytical instruments, this creative churn has been an engine for success and the means by which businesses and industries have taken root across the Bay State, transforming urban and regional economies.

But the same regions and industries that once were beacons of prosperity have also suffered the consequences of industrial and economic decline. Whole industries have nearly or completely vanished after being made obsolete by a technological development that escaped them. Businesses that failed to adapt to changing market conditions and globalization have been outcompeted. Jobs disappeared as companies migrated to locations offering lower labor or energy costs. Once vibrant cities and regions now host urban, economic and social wounds that will remain potent and visible for years to come.

But amidst this tension between creative and destructive forces that is characteristic of an evolving economy, innovation has been a pillar of resilience for Massachusetts. The most recent recession data and anecdotes suggest that many of the companies that started hiring early in the recovery and have continued, are either young start-ups or established enterprises in science- and technology-based sectors. This trend has allowed the Commonwealth to weather the recession better than most of the country. In fact, throughout the recession and the ongoing recovery, the Massachusetts state unemployment rate has consistently remained below the national rate.

Resilience and reinvention in the Massachusetts economy are the keys to its sustenance and growth. The **Index** reminds us of the two pillars on which much of the state's economic resilience rests upon: technological and industrial diversity and a vibrant innovation ecosystem.

Massachusetts is no one-hit wonder. We have a diversified portfolio of highly competitive innovation-based sectors and industry clusters, both established and emerging. The **Index** examines eleven of them that together account for 38% of employment in the state. How does economic diversity contribute to resilience? Different sectors are subject to different market and technological pressures: decline or distress in one sector may be offset by growth and progress in another. While one industry may be vanishing another is reinventing itself and yet one more is nascent in novel start-ups and small businesses. Importantly, different sectors operate on different time horizons and have different degrees of stickiness. For example, healthcare delivery and postsecondary education, both among the state's largest employers, are slow to hire and fire. In addition, universities and hospitals rarely collapse and do not move.

The state's unparalleled innovation ecosystem is vital to Massachusetts' ability to adapt to changing market conditions and is a source of technological and industrial dynamism. Its anchor is the massive concentration of research and development activity in universities, hospitals, and businesses, sustained by public and private investment in R&D. And just as our economy is no one-hit wonder, our research and educational institutions are amazingly diverse in both their character and in the number of fields in which they excel. Thousands of creative and talented men and women of all ages and backgrounds drive research and innovation. Business services, venture capital, and a supportive culture and networks inspire entrepreneurs and enable them to translate ideas into new businesses. In addition to rooting natives here, this ecosystem is also a powerful magnet for entrepreneurs, enterprises, investment, and talent. Individuals and businesses move and stay here to be part of it.

Massachusetts has witnessed how collaboration builds up resilience and the capacity to adapt to a changing environment and opportunities. Enterprises that used to be vertically integrated now work with small companies and sometimes with competitors to remain competitive. Experienced entrepreneurs and investors are coming together to mentor startups and accelerate their growth. Roundtables and industry-led groups are breathing new life to industries – such as textiles and manufacturing – that had been written off by skeptics. They have also placed a spotlight on those that have been growing yet hidden right before us, like the design sector. Interdisciplinary and cross-sector collaboration is positioning Massachusetts at the forefront of emerging fields like digital entertainment, ocean exploration, neurotechnology, and sports analytics.

We need to acknowledge, however, that the state's innovation ecosystem is concentrated in Greater Boston and that the benefits of innovation-driven economic prosperity have yet to reach further regions of the Commonwealth. Still, a closer look at these regions shows how many of them are building on their unique capabilities and assets to pursue new pathways. The Pioneer Valley is an example where several cities suffer the consequences of de-industrialization and economic decline. The region mobilized in 2010 to attract the Massachusetts Green High Performance Center to Holyoke. Existing assets, including hydroelectric power at a competitive cost in Holyoke, were important magnets. Motivated by this catalytic event, a coalition of stakeholders has been working to create an Innovation District in downtown Holyoke.

Behind the transformative potential of these collaborative efforts in industries and regions is a novel form of dialogue between higher education and research institutions, state government, and industry. Stakeholders recognize that it takes a good-faith, informed partnership between the public and private sectors to strengthen and grow an innovation ecosystem. Most importantly, they find value in working together to identify challenges in real time and launching the projects and initiatives that will address such issues.

Massachusetts Innovation Ecosystem

Taken together, the 25 indicators in the **2010 Index** examine the performance of the Commonwealth's innovation ecosystem through several lenses. To help organize and navigate these indicators, the **Index** classifies them in three categories: economic impact, innovation activities, and innovation capacity. The sequencing and logic of indicators suggest how performance in one arena may affect performance in others, as well as overall results.

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 the key industry clusters [Indicator #1]. Jobs created in the innovation economy are often high paying [Indicator #2], which directly and indirectly sustains a high standard of living throughout the Commonwealth [Indicator #3]. This capacity hinges on the ability of individual firms to utilize innovative technologies and processes that improve productivity [Indicator #4] and support the creation and commercialization of innovative products and services. Industry output is a measure of economic activity [Indicator #5]. An export-orientation is becoming an increasingly important driver of business and overall economic growth [Indicator #6]. Success in the national and global marketplaces brings in the revenue that enables businesses to survive, prosper, and create and sustain high-paying jobs.

Innovation Activities

In the **Index**, innovation is defined as the capacity to continuously translate ideas into novel products, processes and services that create, improve, or expand business opportunities. The **Index** assesses innovation by examining three categories of activities that underlie this complex and interactive process.

Research

The massive and diversified research enterprise concentrated in Massachusetts' universities, teaching hospitals, and government and industry laboratories [Indicators #7 and #8] is a major source of the new ideas that fuel the innovation process. Research activity occurs within 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 [Indicator #9] and patenting activity [Indicators #10 and #11] reflect both the intensity of new knowledge creation and the capacity of the Massachusetts economy to make these ideas available for dissemination and commercialization.

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 product development by businesses and entrepreneurs is through technology licensing [Indicator #12]. Small Business Innovation Research (SBIR) grants enable small companies to test, evaluate, and refine new technologies and products [Indicator #13]. 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 [Indicator #14].

Massachusetts Innovation Ecosystem

Business Development

Business development involves commercialization, new business formation [Indicator #15], 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) [Indicator #16]. Technical, business, and financial expertise all play a role in the process of analyzing and realizing business opportunities, which result after R&D outcomes are translated into processes, products, or services. Business model innovation also creates value but is not measured by the **Index** due to difficulties in quantification.

Innovation Capacity

The performance of the Massachusetts innovation ecosystem is greatly enhanced by a number of factors that increase the capacity for innovation by scientists, engineers, entrepreneurs, and firms in the Commonwealth.

Capital

Massachusetts attracts billions of dollars of funding every year for research, development, new business formation, and business expansion. The ability to attract public funds sustains the unparalleled capacity of individuals and organizations in the state to engage in the most cutting-edge and forward-looking research and development efforts [Indicator #17]. Universities in Massachusetts benefit from industry's desire to remain at the cutting edge of research and product development through university-industry interactions [Indicator #18]. For new business formation and expansion, Massachusetts' concentration of venture capitalists and angel investors is critical [Indicator #19]. Private sector investors in these areas, capable of assessing both the risk and opportunities of new technologies and entrepreneurial ventures, are partners in the innovation process and vital to its success.

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 postsecondary and graduate education [Indicator #20], complemented by the strength of the education system [Indicator #21] 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 [Indicator #22]. Students and individuals with an interest or background in science, technology, engineering, and math [Indicator #23] are particularly important for the Innovation Economy. Massachusetts also 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 [Indicator #24]. Housing affordability influences Massachusetts' ability to attract and retain talented individuals [Indicator #25].

Massachusetts Innovation Ecosystem *continued*

There are a number of aspects of a region's capacity for innovation that are important, but are not directly measured in the **Index**:

Institutional Framework

The work of innovators in Massachusetts occurs within, and is supported by, an outstanding constellation of organizations that are critical for the innovation process. These include research universities, mission-oriented national laboratories, corporate laboratories, and research-based commercial ventures. Civic organizations, trade groups, and funding organizations operating across industries and regions are also an important part of the institutional framework for innovation. Finally, service providers such as patent lawyers, management consultants, and scientific and technical consultants make vital contributions throughout the innovation process.

Connections, Interactions, and Mobility

Ongoing interaction among the people involved in research, development, and entrepreneurship sustains the flow of new ideas and the discovery of opportunities that fuel the innovation process. These interactions include formal and informal conversations, joint projects, student internships, and many other relationships that span organizational—and often geographic—boundaries. The mobility and communication of people across such boundaries, affected by cultural factors and the density of relationships, are crucial for the creation and transfer of new ideas. In Massachusetts, connections and interactions between innovators and end users are extremely important to inspire new R&D and discover opportunities to apply R&D outcomes.

Innovation Infrastructure

This category includes the physical spaces in which innovators work and interact, such as laboratories, incubators, and venues which allow innovators from across the economy to come together. Innovation infrastructure also refers to the technologies and instruments that support R&D activities, including: high-speed Internet access and bandwidth and computing capacity; as well as the analytical instruments that support R&D activities in universities, hospitals, industries, and mission-oriented laboratories.

Demand

Demand for new capabilities is an important driver of innovation. In this context, we distinguish demand for new capabilities from the traditional marketplace demand for existing products and services (captured as Impacts). In Massachusetts, demand for innovative products, processes, and services comes from two sources. Firstly, and most importantly, is the marketplace. Comprised of businesses and consumers around the state, nation, and world, buyers of products and services created and sold by Massachusetts companies are vital sources of demand. The "demanding customer" both stimulates and motivates entrepreneurs and businesses to keep creating new or improved products, processes, and services. Secondly, the Federal government, particularly through its mission-oriented agencies such as the Department of Defense and the Department of Energy, is a crucial source of challenges as well as funding that sustains viability and pushes the technological frontier of many Massachusetts businesses.

Construction of the Indicators

About the Indicators

The indicators in the **Index of the Massachusetts Innovation Economy** are quantitative measures that allow performance comparisons with other leading regional innovation economies. The indicators examine long-term changes and trends in regional economic fundamentals, such as the education level of the workforce and manufacturing productivity, in addition to variables that are subject to short-term fluctuations of economic activity, such as initial public offerings and venture capital funding. Indicators are selected to be measurable on an ongoing basis and derived from objective and reliable data sources. Appendix A describes in detail the construction of each indicator.

Benchmark Comparisons

Benchmark comparisons provide the context for understanding how Massachusetts is performing. The **Index** benchmarks Massachusetts against nine Leading Technology States (LTS) and the national average. The nine states chosen for comparison in the **2010 Index** are: California, Connecticut, Illinois, Maryland, Minnesota, New Jersey, New York, North Carolina, and Pennsylvania. Appendix A describes the methodology for selecting the LTS. To advance our understanding of Massachusetts' place in the global economy, the **Index** benchmarks Massachusetts against top performing nations where high quality international data are available.

Eleven Key Industry Clusters

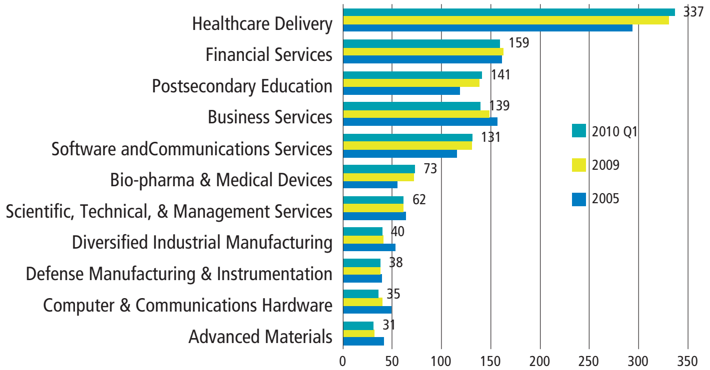
The **2010 Index** monitors 11 industry clusters of the Commonwealth's Innovation Economy:

- Advanced Materials
- Bio-pharma & Medical Devices
- Business Services
- Computer & Communications Hardware
- Defense Manufacturing & Instrumentation
- Diversified Industrial Manufacturing
- Financial Services
- Healthcare Delivery
- Postsecondary Education
- Scientific, Technical, & Management Services
- Software & Communication Services

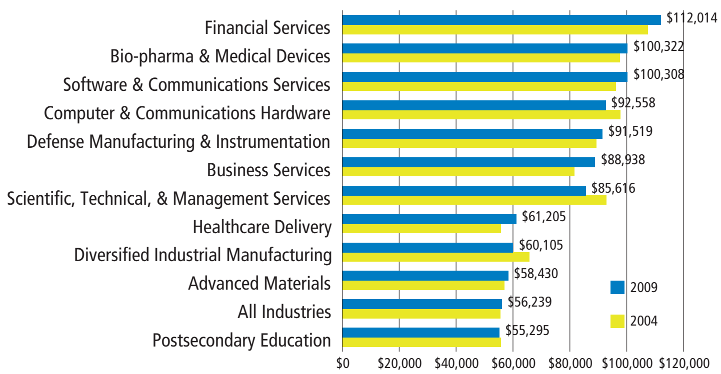
Appendix B offers detailed industry cluster definitions. Together, these 11 sectors account for 38.6% of employment in Massachusetts, including most of the highest paying jobs in the Commonwealth. Counting direct and indirect jobs, these industry clusters support more than half of all state employment. For purposes of the **Index** analysis, indirect employment effects are not considered.

Industry Cluster Employment and Wages

Total employment by industry sector, Massachusetts, 2005, 2009, and 2010 Q1



Average annual wage by sector (in 2009 dollars), Massachusetts, 2004 and 2009



Percent change in sector employment, 2009 Q1–2010 Q1

	CA	CT	IL	MD	MA	MN	NJ	NY	NC	PA
Advanced Materials	-8.2%	-6.0%	-6.6%	-5.7%	-5.0%	-5.2%	-6.1%	-7.3%	-6.9%	-4.8%
Bio-pharma & Medical Devices	0.9%	-4.8%	-0.8%	-0.4%	1.5%	-1.3%	-3.7%	-0.8%	-1.0%	-2.4%
Business Services	-5.7%	-2.1%	-3.8%	-4.8%	-7.1%	-2.4%	-4.9%	-4.0%	-3.5%	-0.7%
Computer & Comm Hrdwe	-6.8%	-8.7%	-12.1%	7.1%	-15.0%	-13.6%	-7.3%	-10.6%	-15.0%	-8.5%
Def Mfg & Instrumentation	-6.5%	-4.7%	-11.5%	-40.5%	-2.3%	-9.9%	-5.1%	-9.0%	-9.7%	-5.5%
Diversified Ind Mfg	-10.2%	-9.9%	-12.4%	-10.6%	-8.9%	-9.7%	-9.1%	-7.7%	-11.3%	-9.6%
Financial Services	-7.6%	-3.2%	-3.2%	-5.1%	-4.2%	-1.9%	-3.7%	-5.3%	-2.8%	-2.6%
Healthcare Delivery	2.1%	0.7%	1.1%	1.3%	2.7%	-0.2%	1.4%	1.7%	1.5%	0.0%
Postsecondary Education	-0.9%	0.3%	2.4%	0.9%	1.9%	1.5%	-0.3%	1.6%	0.3%	1.8%
Scientific, Techl, & Mgmt Svcs	-1.4%	-6.6%	-1.8%	0.3%	0.0%	-0.6%	-2.7%	-2.5%	1.3%	-3.5%
Software & Comm Svcs	-5.9%	-11.8%	-4.9%	-1.7%	-1.8%	-3.0%	-5.1%	-4.7%	-3.6%	-6.0%
Total State Employment	-3.7%	-3.9%	-3.3%	-2.4%	-1.4%	-2.5%	-2.1%	-1.7%	-3.3%	-2.0%
% of Total in Key Sectors, 2010 Q1	29.1%	35.8%	31.5%	29.4%	38.6%	32.1%	31.7%	32.1%	29.9%	32.7%

Source of all data for this indicator: Bureau of Labor Statistics' Quarterly Census of Employment and Wages
Note: Aqua-shaded cells indicate job growth

- Massachusetts maintained its lead among the LTS with a 38.6% share of total employment concentrated in the 11 key sectors of the Innovation Economy.
- From the first quarter of 2009 to the first quarter of 2010, Massachusetts lost 1.7% of employment in the key industry sectors of the Innovation Economy, the smallest loss of any of the LTS in these sectors.
- Total wages paid in the key industry sectors of the Massachusetts Innovation Economy were 26% higher in 2009 than in 2004, a much larger increase than the 15% gain in total wages in the economy as a whole.

Why Is It Significant?

Increasing employment concentration in technology and knowledge-intensive industry clusters points to 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?

Year-over-year employment in the Massachusetts economy was down 1.4% in the first quarter of 2010. This was the smallest percent loss of all US states. Only North Dakota and Alaska added jobs over that same period. In the key industry sectors of the Innovation Economy, Massachusetts lost 1.7% of employment, the smallest loss of any of the LTS. Despite the losses, Massachusetts kept its lead among the LTS as having the largest share of employment in these sectors, at 38.6%.

Looking at the five-year comparison, the key industry sectors of Massachusetts' Innovation Economy employed 40,000 more people in the first quarter of 2010 than the 2005 average. The largest employment gains were made in Healthcare Delivery, Postsecondary Education, Bio-pharma & Medical Devices, and Software & Communications Services. Jobs were lost in Diversified Industrial Manufacturing, Advanced Materials, and Computer & Communications Hardware.

Inflation-adjusted wages declined in most sectors at some point between 2004 and 2009. A mixed picture emerges when comparing only 2004 and 2009 data sector by sector. Inflation-adjusted wages increased in Healthcare Delivery (9.5%) and Business Services (9.0%), while over that same period these wages declined in Diversified Industrial Manufacturing (-8.8%); Scientific, Technical, & Management Services (-7.7%); and Computer & Communications Hardware (-5.5%). Total wages paid in the key industry sectors of the Massachusetts Innovation Economy were 26% higher in 2009 than in 2004, a much larger increase than the 15% gain in total wages in the economy as a whole.

Occupations and Wages

- In 2009, Massachusetts had the highest employment concentrations among the LTS in Healthcare and in Science, Architecture, & Engineering occupations.
- Employment and average wages in Production occupations continue to fall more rapidly in Massachusetts than LTS and US averages.

Why Is It Significant?

The Massachusetts Innovation Economy supports middle- and high-wage job retention and growth and contributes to a rising standard of living throughout the Commonwealth. In specific occupational categories, employment concentrations higher than the national average indicate skill strengths particular to Massachusetts. Changes in occupational employment and wages suggest shifts in job quality, as well as in the skill mix of the workforce across all industries.

How Does Massachusetts Perform?

In 2009, Massachusetts had the highest employment concentrations among the LTS in Healthcare and in Science, Architecture, & Engineering occupations. Massachusetts also ranked high in the concentration of Computer & Mathematical; Community & Social Services; Arts & Media; and Business, Financial, & Legal occupations.

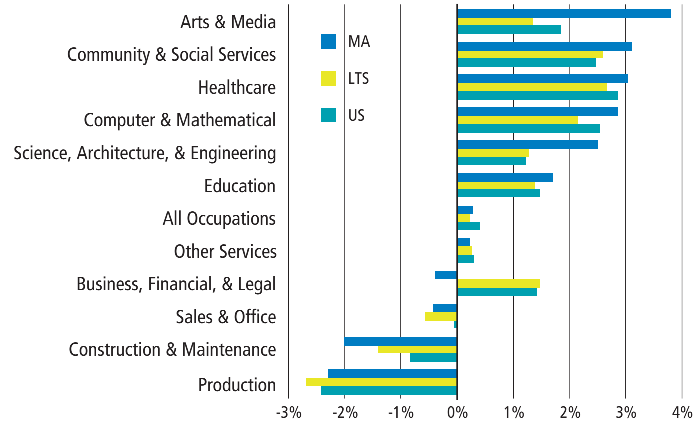
A few occupations experienced slight employment increases in Massachusetts from 2008 to 2009 even as total employment declined. This occurred in Healthcare; Education; Arts & Media; and Computer & Mathematical occupations.

Between 2004 and 2009, net employment in Arts & Media occupations grew at the highest rate, followed by Healthcare; Community & Social Services; Computer & Mathematical, and Science; Architecture & Engineering occupations. In terms of total jobs created, Healthcare occupations come out on top with a positive net change of 44,750 jobs between 2004 and 2009.

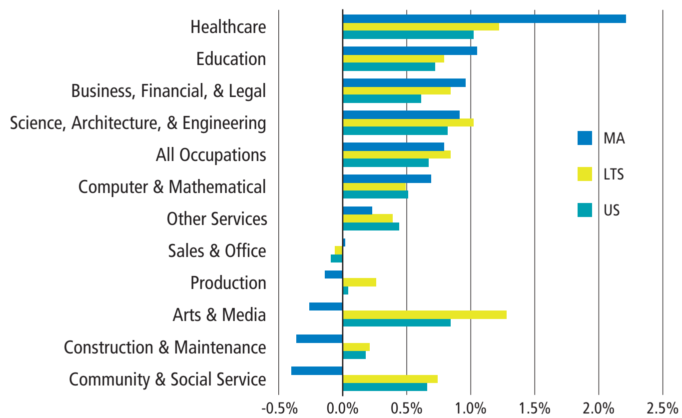
In terms of occupational wages, Massachusetts has a high concentration of employment in occupations that earn well above the national average. This occupational mix contributes to Massachusetts above-average median household income. With the exception of Arts & Media, all of the occupational groups are better paid in Massachusetts than in the LTS on average. This advantage is greatest for employees in Healthcare occupations, who make 10% more on average than counterparts in other LTS. This occupational group witnessed the largest increase in inflation-adjusted wages between 2004 and 2009, growing by 11% in net terms.

Source of all data for this indicator: US Bureau of Labor Statistics, Occupational Employment Estimates

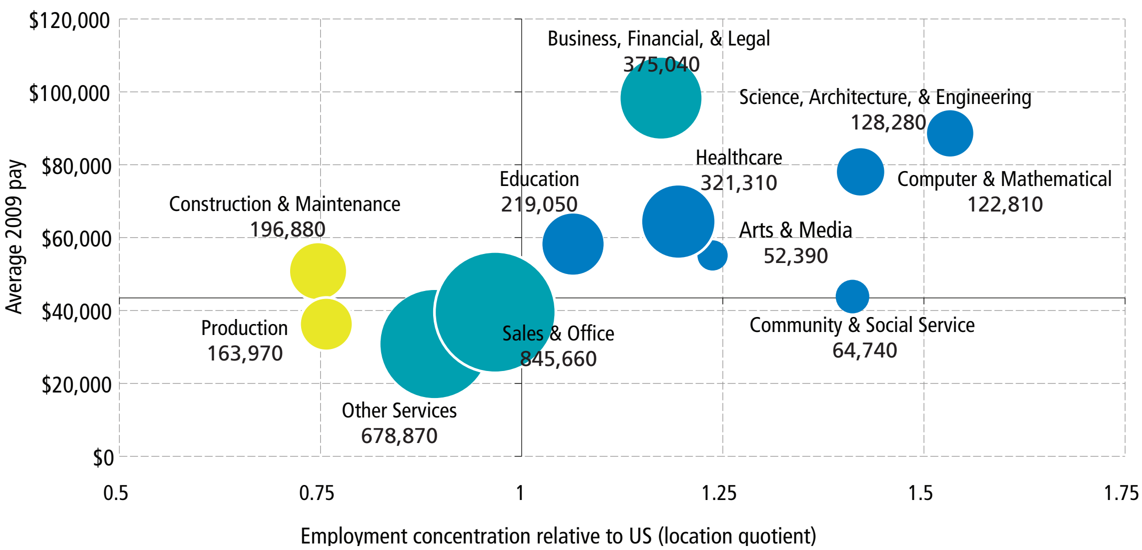
Average annual employment growth by occupation, Massachusetts, LTS, and US, 2004–2009



Average annual growth rate of real annual pay by occupation, Massachusetts, LTS, and US, 2004–2009



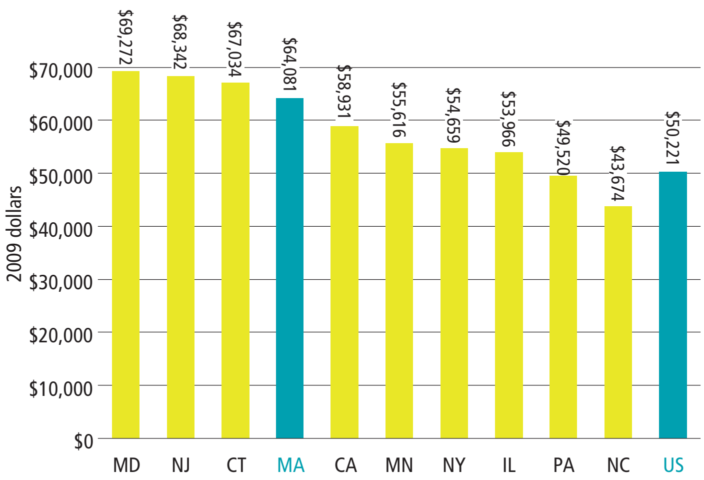
Occupations by employment concentration and annual pay, Massachusetts, 2009



Circle size represents total employment
Solid horizontal line represents average national wage
Circle color represents year-over-year trend. Growing occupations appear in blue, shrinking in green, and stable in yellow.

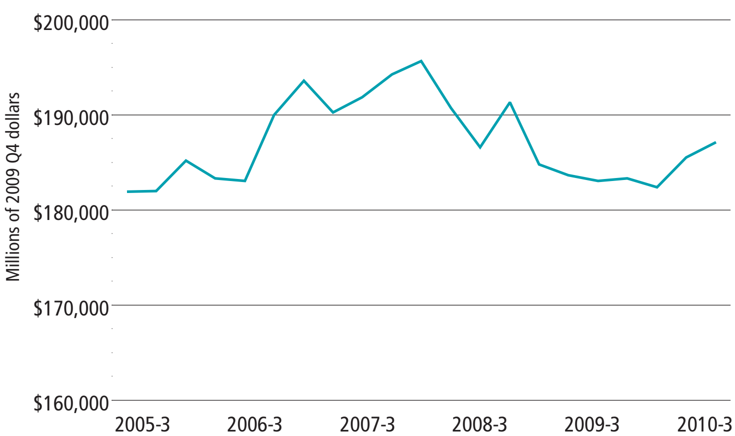
Household Income

Median household income, LTS and US, 2009



Source: US Census Bureau

Total wages and salaries paid, Massachusetts, 2005 Q3–2010 Q3



Source: Bureau of Economic Analysis

- Real median income in Massachusetts declined less than half as much as this measure nationally in 2009.
- Wages and salaries paid in the Commonwealth have been recovering since the first quarter of 2009.

Why Is It Significant?

Household incomes that rise in inflation-adjusted dollars enable increases in standards of living. Median household income tracks changes in the general economic condition of middle-income households in Massachusetts and other LTS. The Bureau of Economic Analysis' estimates of wages and salaries for Massachusetts-based jobs complement median income data by providing a more timely measure of changes in earnings.

How does Massachusetts perform?

Median household income fell in each of the LTS and the US from 2008 to 2009. In Massachusetts, median household income fell 1.7% to $64,081. Maryland recorded the smallest decline of the LTS while North Carolina recorded the largest decline at 5.8%. Over the past eight years, the median income of Massachusetts' households has remained above the LTS average. In 2009, median household income in Massachusetts was 23% above the US.

Quarterly estimates of wages and salaries provide more detail on the impact of the recession on incomes over time. After declining for four consecutive quarters beginning in early 2008, total wages and salaries paid in the Commonwealth and in the US stabilized in 2009 and increased during the second and third quarter of 2010.

Productivity

- Manufacturing productivity increased the fastest in Massachusetts in Advanced Materials and in Bio-pharma & Medical Devices.
- Computer & Communications Hardware was the only one of the five sectors to see a negative five-year change in labor productivity.
- Despite four of the five sectors having a negative five-year change in employment, only one sector saw a negative change in labor productivity.

Why Is It Significant?

Increasing productivity enables wage growth. It is defined as the value added per employee (labor productivity) or per unit of capital goods (capital productivity). Firms that have high labor productivity create comparatively high levels of commercial value, have relatively few employees, or a combination of the two. In order to achieve increases in the level of labor productivity, people and organizations must innovate in ways that increase the value of their products or services, or make the business processes more efficient.

Value added per manufacturing employee is a measure of manufacturing labor productivity. Increases in manufacturing productivity are essential to avoiding the "race to the bottom" of manufacturing wages or the loss of manufacturing jobs to overseas production.

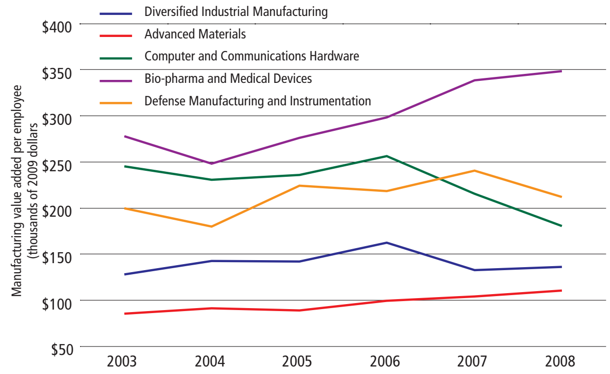
How Does Massachusetts Perform?

From 2003 to 2008, the key industry sector in Massachusetts that had the fastest manufacturing labor productivity growth was Bio-pharma & Medical Devices, in which productivity grew by 25%. The next closest sector was Advanced Materials, in which productivity grew by 18%. Only in Computer & Communications Hardware did productivity decline. This was because manufacturing value added declined faster than manufacturing employment. In 2008, this sector also had the lowest productivity relative to the LTS.

Despite Bio-pharma & Medical Devices' fast growing productivity in Massachusetts, in 2008 productivity in this sector lagged the LTS and US averages. Sectors in which Massachusetts had a manufacturing labor productivity advantage over the LTS and US are Defense Manufacturing & Instrumentation and Diversified Industrial Manufacturing.

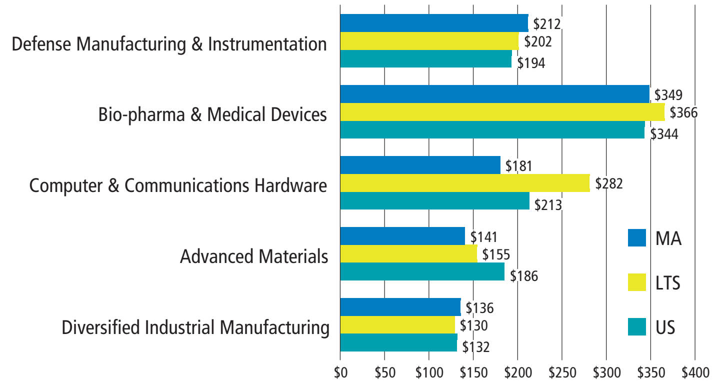
Internationally, Massachusetts ranks fifth in productivity as measured by GDP per person in the labor force. This measure grew the fastest in Norway, which also has the most productive labor force.

Manufacturing labor productivity by sector, Massachusetts, 2003 to 2008



Source: US Census Bureau, Annual Survey of Manufactures

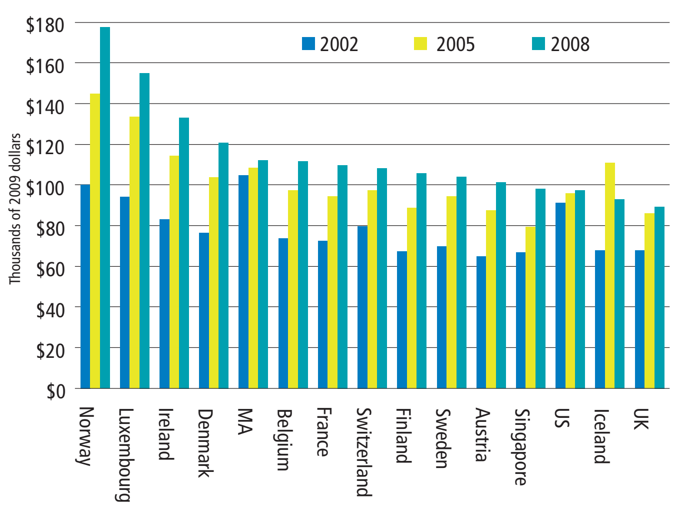
Manufacturing labor productivity by sector, Massachusetts, LTS, and US, 2008



Source: US Census Bureau, Annual Survey of Manufactures

INTERNATIONAL

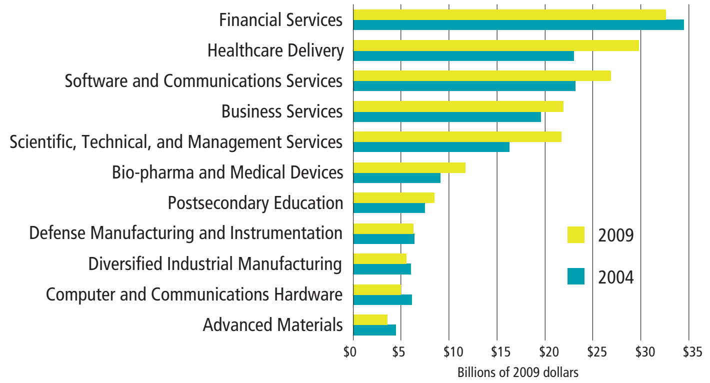
GDP per employed resident, international, 2002, 2005 and 2008



Source: Bureau of Labor Statistics, the World Bank, and the International Labor Organization

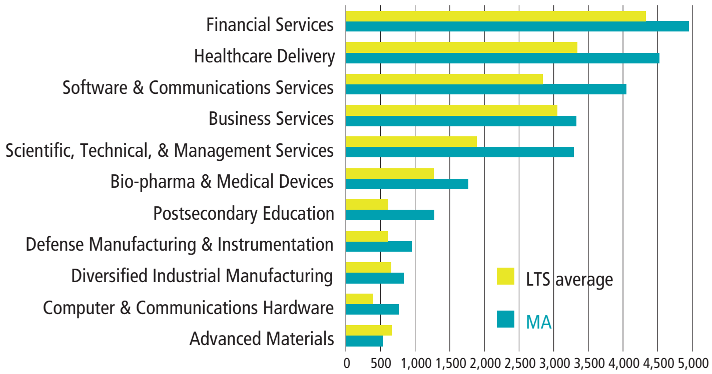
Industry Output and Manufacturing Value Added

Industry output by sector, Massachusetts, 2004 and 2009



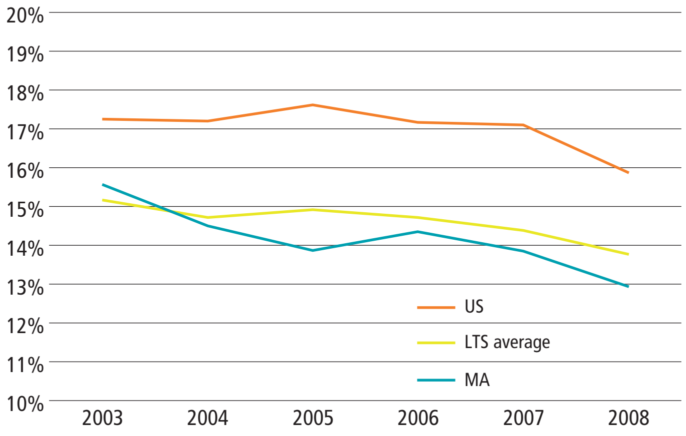
Source: Moody's Economy.com

Industry output per capita, Massachusetts and LTS, 2009



Source: Moody's Economy.com

Manufacturing value added as a percent of GDP, LTS, and US, 2003-2008



Source: US Census Bureau, Annual Survey of Manufactures

- Between 2004 and 2009 increases in the output of six of Massachusetts' key industry sectors outweighed decreases in the remaining five, resulting in a positive net change of $17.4 billion.
- Massachusetts outperformed the LTS average in industry output per capita in 10 of the 11 key industry sectors.
- Between 2003 and 2008, manufacturing value added decreased by 3.6% in Massachusetts, while it declined 1.8% in the LTS and 4.9% in the US (without adjusting for inflation).

Why Is It Significant?

Industry output provides insight into the performance of industry sectors over time and between different states. Due to inherent differences in the way industry output is calculated in different sectors, this measure should not be interpreted as an assessment of the importance of one industry relative to another. Manufacturing value-added is a measure of output that captures 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.

How Does Massachusetts Perform?

The largest increases of this measure occurred in Scientific, Technical, & Management Services (33%), followed closely by Healthcare Delivery (30%) and Bio-pharma & Medical Devices (28%). Declines in industry output were greatest in Advanced Materials (-20%) and Computer & Communications Hardware (-18%). Overall, the increases in the output of Massachusetts' key industry sectors outweighed the decreases, resulting in a positive net change of $17.4 billion.

On a per capita basis, in 2009 Massachusetts outperformed the LTS average in industry output in all of the key industry sectors except Advanced Materials. Moreover, the Commonwealth ranked first among the LTS in per capita industry output in five sectors: Computer & Communications Hardware; Software & Communications Services; Scientific, Technical, & Management Services; Postsecondary Education; and Healthcare Delivery.

With respect to manufacturing value added, Massachusetts experienced declines from 2003 to 2008 (the latest year for which data are available for this measure), from 15.7% to 12.9% of GDP. The decline observed between 2007 and 2008 appears particularly steep partly as a result of adjusting for inflation, since there was also a decline in the Consumer Price Index. However, even without adjusting for inflation, manufacturing value added decreased by 3.6% in Massachusetts, while it declined 1.8% in the LTS and 4.9% in the US.

Manufacturing Exports

- After rising each year since 2002, manufacturing exports declined in 2009 in all of the LTS.
- A large increase in exports to Great Britain makes that country Massachusetts' top export destination.

Why Is It Significant?

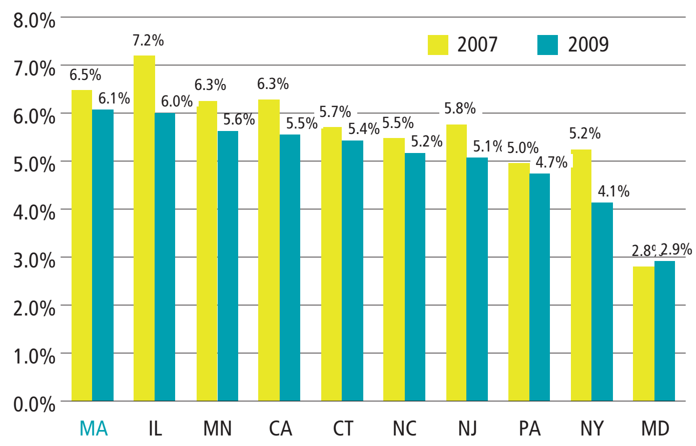
Manufacturing exports are an indicator of the Commonwealth's global competitiveness. Supplying global markets can help bolster growth in employment and sales, and increase the market share for innovation-intensive companies in Massachusetts. In addition, diversity in terms of export markets and product categories may create a countercyclical hedge against an economic downturn in any particular region in the world. Also, considering that manufacturing represents 9.5% of all private sector jobs in the Commonwealth, it is noteworthy that two out of every nine manufacturing jobs are tied to exports.

How Does Massachusetts Perform?

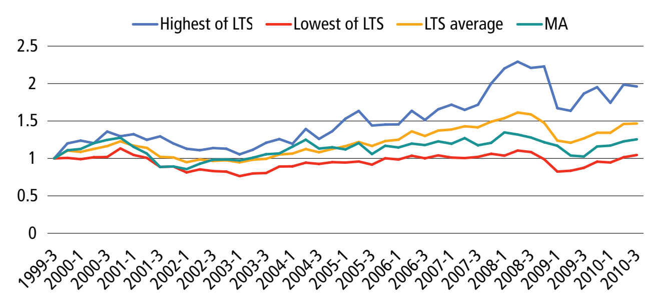
After decreasing by $1.6 billion from the first quarter of 2008 to the third quarter of 2009, exports from Massachusetts rebounded by $1.2 billion in the following four quarters. This trend was seen across the LTS. Exports increased the fastest in Illinois at 24%, followed closely by Massachusetts at 23%. Relative to state GDP, in 2009 Massachusetts was the largest exporter of the LTS after placing second to Illinois in 2007 and 2008.

The distribution of Massachusetts' top export categories have held mostly steady from 2004 to 2009. In 2009, the majority of manufacturing exports from Massachusetts were once again Chemicals and Computer & Electronic products, which together comprised nearly half of manufacturing exports for 2009. One noteworthy adjustment in the distribution was related to the high price of gold, which caused a 33% increase in the export value of primary metal manufacturing. The inflated price of gold also caused Canada to lose its designation as the top destination country for exports from Massachusetts. The top spot was taken over by Great Britain where there was a large increase in the demand for gold.

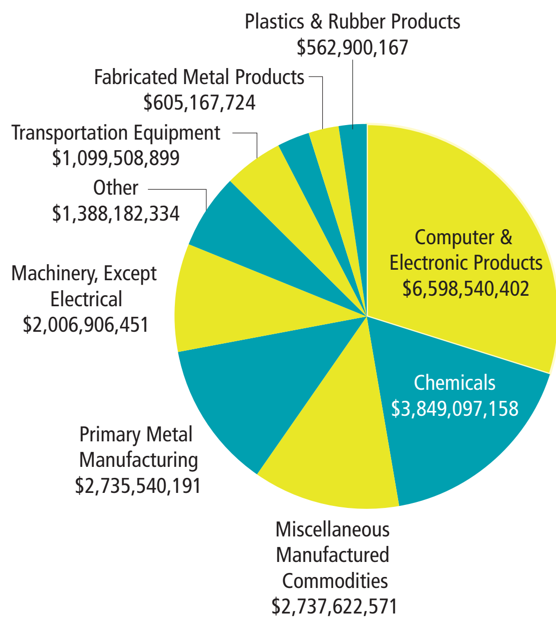
Manufacturing exports as a percent of GDP, 2007 and 2009



Change in manufacturing exports relative to 1999 Q3, LTS, 1999 Q3 to 2010 Q3



Distribution of manufacturing exports, Massachusetts, 2009



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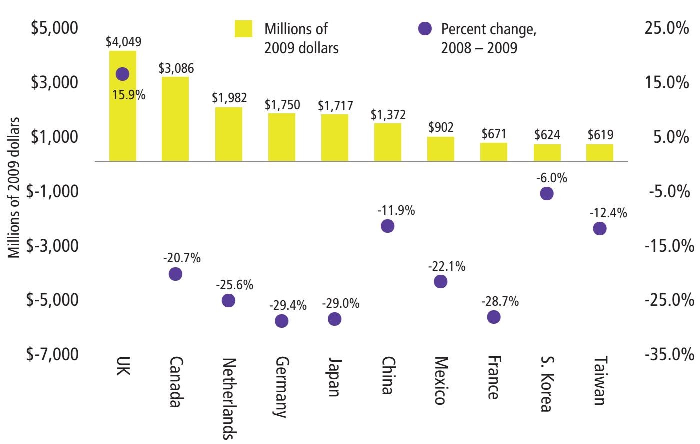
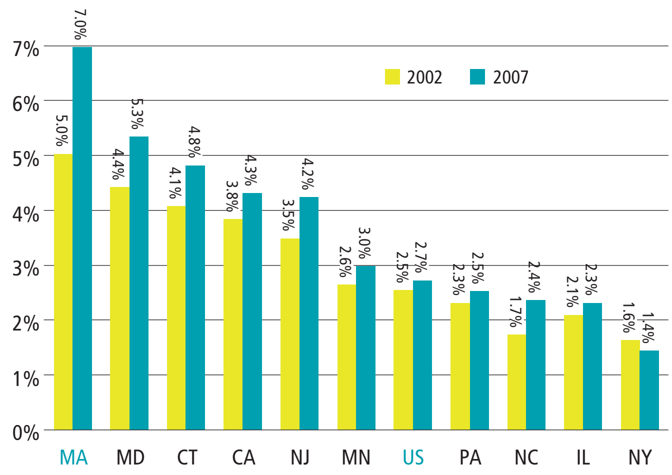
Export value by top foreign trade destination, Massachusetts, 2009



Source of all data for this indicator: WiserTrade

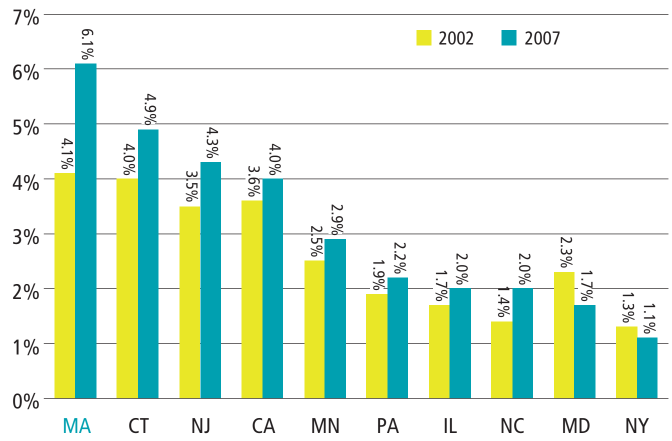
Research and Development Performed

R&D as a percent of GDP, LTS, 2002 and 2007



Source: National Science Foundation

Industry-performed R&D as a percent of private-industry output, LTS, 2002 and 2007



Source: National Science Foundation and the Bureau of Economic Analysis

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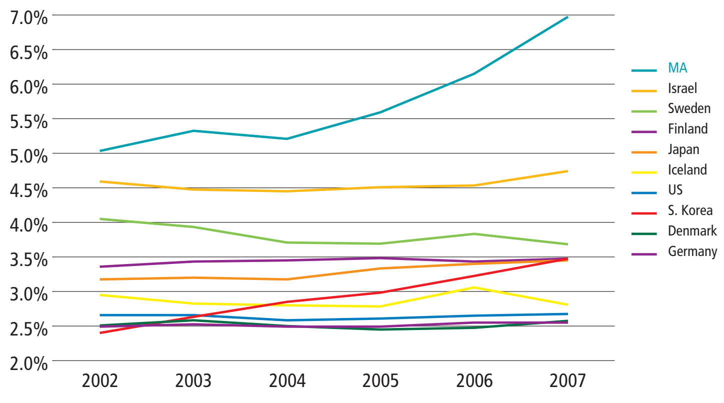
R&D performed as a percent of GDP, international and Massachusetts, 2002–2007



Source: United Nations Educational, Scientific and Cultural Organization (UNESCO) and the National Science Foundation

- Massachusetts has the highest and fastest growing R&D intensity among the LTS and R&D-leading countries, as measured by R&D as a percent of GDP.
- Massachusetts leads the LTS in industry-performed R&D as a percent of private industry output.

Why Is It Significant?

Research and Development (R&D) performed in Massachusetts is an indicator of the size of the science and technology enterprise. Even though 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?

Massachusetts has the most R&D intensive economy of the LTS and a more R&D intensive economy than leading countries, as measured by R&D as a percent of GDP. In 2007, $25.4 billion of R&D was performed in Massachusetts.

The average annual growth rate of R&D as a percent of GDP from 2002 to 2007 was highest among the LTS in Massachusetts growing an average of 6.9% annually, followed closely by North Carolina at 6.8%. Over these five years, R&D as a share of GDP rose in all of the LTS except New York.

Massachusetts also leads in industry-performed R&D as a percent of private industry output. Massachusetts' industry became increasingly R&D intensive from 2002 to 2007 during which time R&D intensity grew from 4.1% to 6.1% of output. This is the fastest growth among the LTS, once again followed closely by North Carolina, where the R&D intensity of industry grew from 1.4% to 2.0% of industry output.

Performers of R&D

- R&D expenditures in Massachusetts' industry increased by 64% in absolute terms between 2002 and 2007. Among the LTS, this growth is second to North Carolina, where there was a 72% increase. Industry is responsible for the bulk of R&D expenditures in Massachusetts.
- Massachusetts leads the LTS in R&D expenditures per capita by industry and nonprofit research institutions.

Why Is It Significant?

The distribution of R&D expenditures by type of performer illustrates the relative importance of different kinds of organizations performing R&D in an innovation ecosystem. In doing so, it provides insight into the mix of basic research, applied research, and development performed. Nationally, 75% of the research by universities and colleges is classified as basic, 21% as applied and only 4% as development. In contrast, 76% of research by industry is classified as development, 20% as applied and only 4% as basic. Federal agencies tend to perform more applied research and less development, while non-profits tend to perform more basic and applied research. A mix of R&D performers and types of research is required to cover the pathway from knowledge creation to commercialization in an innovation ecosystem.

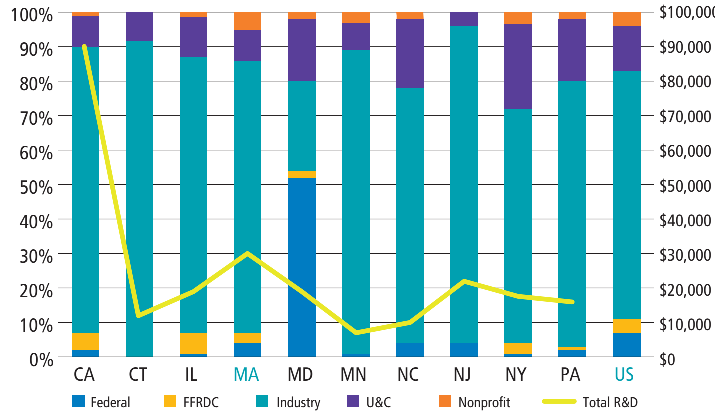
How Does Massachusetts Perform?

National data show that approximately 7% of all R&D is performed by federal agencies, 71% by industry, 13% by universities and colleges, 4% by non-profit organizations and 5% by Federally Funded R&D Centers (FFRDC's). Massachusetts follows the national pattern, as do all the LTS except Maryland, where the federal government conducts the bulk of R&D.

Both in absolute terms and as a proportion of the total, industry's expenditures in the state's R&D enterprise grew steadily between 2002 and 2007. It increased 64% in absolute terms, from 72% to 79% as a proportion of the total. In the same period, R&D expenditures by universities, colleges and non-profit institutions in Massachusetts grew by 10%.

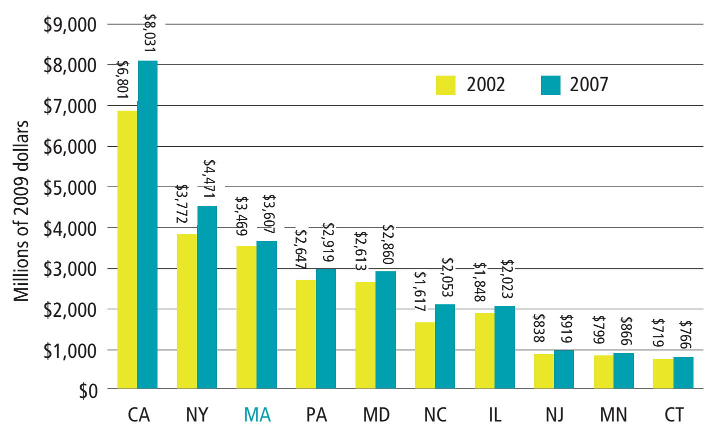
Among the LTS, Massachusetts is unique in the high proportion of R&D conducted by nonprofit institutions. In 2007, they conducted a total of $1.4 billion of research in Massachusetts, higher than in any other LTS, even without adjusting for the size of the economy. This is $209 per capita, more than five times higher than Maryland, second in this measure among the LTS. Nonprofit research institutions include the Commonwealth's health centers such as the Dana-Farber Cancer Institute, as well as organizations such as the Broad Institute, Charles Stark Draper Laboratories and the Woods Hole Oceanographic Institution.

Distribution of R&D by performer, LTS and US, 2007



Source: The National Science Foundation

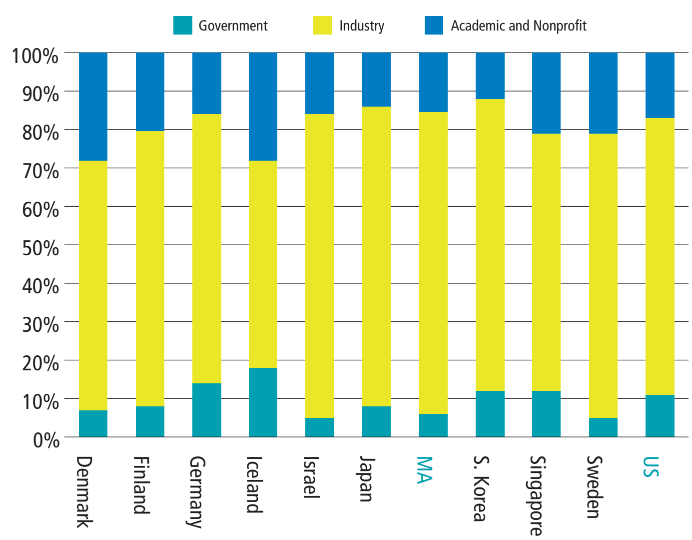
R&D performed by universities, colleges, and nonprofit research institutes, LTS, 2002 and 2007



Source: The National Science Foundation

INTERNATIONAL

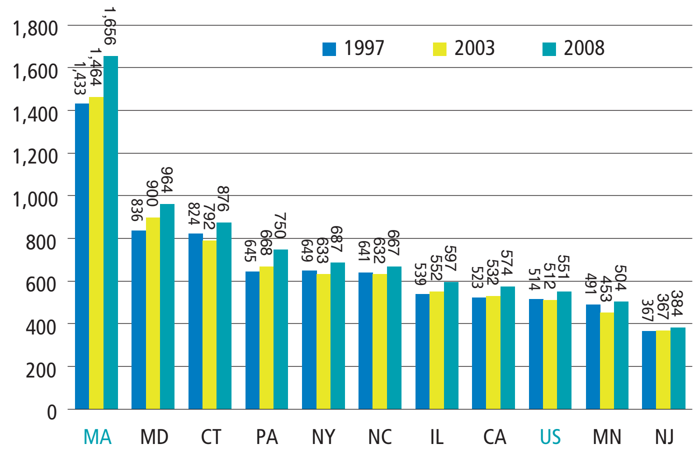
Distribution of R&D by performer, international and Massachusetts, 2007



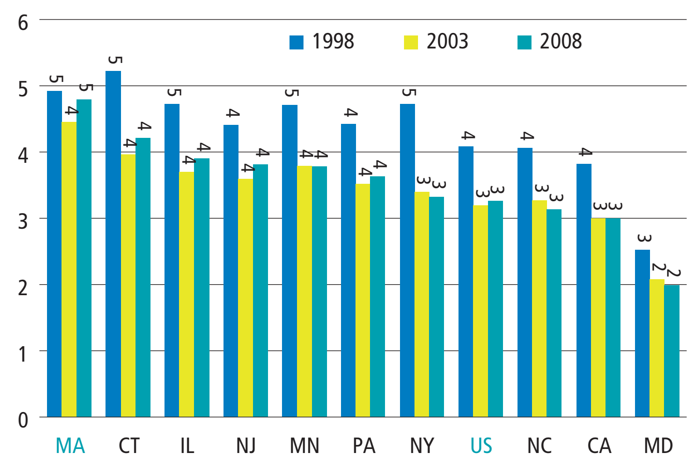
Source: United Nations Educational, Scientific and Cultural Organization (UNESCO)

Academic Article Output

Science and Engineering (S&E) academic article output per million residents, LTS and US, 1997, 2003, and 2008

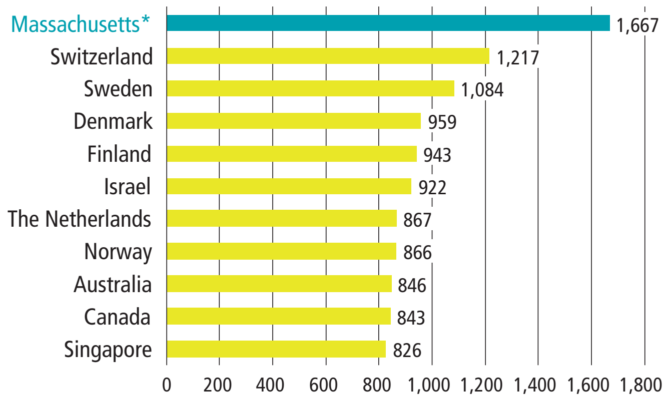


S&E academic articles per million academic R&D dollars, LTS and US, 1998, 2003, and 2008



INTERNATIONAL

S&E articles per million residents, international, 2007



*Only 2008 data available for Massachusetts, and 2007 data available for international comparison.
Source for all data for this indicator: The National Science Foundation

- In 2008 Massachusetts had the highest number of academic articles published per capita among the LTS and internationally.
- Productivity in academic articles (articles published per million academic R&D dollars) is higher in Massachusetts than the other LTS.

Why Is It Significant?

In contrast to R&D expenditures, which are an input to research, academic article publication is a measure of research output and represents the most common form of codified dissemination of research results. This is also an important productivity measure as well as an indicator of Massachusetts researchers' participation in the global science and engineering conversation.

How Does Massachusetts Perform?

Massachusetts had the highest number of academic articles published per capita among the LTS in 2008, a reflection of the intensity of knowledge production in the Commonwealth's research enterprise. This metric is 72% higher in Massachusetts than in Maryland, which is second among the LTS. Internationally, Massachusetts also has the highest per capita output of academic articles.

Measures of research productivity are less differentiated among the LTS. Nevertheless, Massachusetts researchers are among the most productive of the LTS, based on the number of academic articles published per academic R&D dollar.

Patenting

- Patents granted to Massachusetts inventors rose 5% from 2008 to 2009.
- Massachusetts led the LTS in the number of patents granted per capita in 2009.

Why Is It Significant?

Patents reflect the legal codification and protection of innovative ideas and products. A patent award is particularly important for R&D-intensive industries in which the success of a company depends on its ability to develop and protect competitive advantage resulting from investments in R&D. Strong patent activity typically suggests an effective R&D enterprise coupled with the ability to translate research outcomes into ideas with commercial potential. US Patent and Trademark Office (USPTO) patents represent one-fifth of global patents. To receive protection from imitators, a new patent must be filed with each country (or region) in which a company wishes to market an innovative product or service.

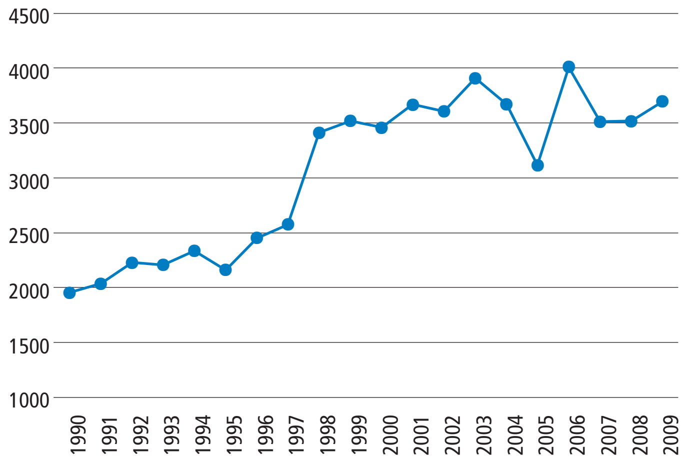
How Does Massachusetts Perform?

The total number of patents granted by the USPTO to Massachusetts inventors rose 5% from 2008 to 2009. Patenting has remained relatively high in Massachusetts since 1998 when the number of patents granted jumped from 2,575 to 3,413. The sharp decline in patents granted in 2005 is consistent with the rest of the nation and is most likely due to slowdowns in the processing of patent applications, especially since the number of applications for patents was on pace that year.

Massachusetts led the LTS in the number of patents granted per capita in 2009, narrowly ahead of California. Over the past ten years, patenting by California inventors rose the fastest, at an average annual growth rate of 2.3%, followed by Massachusetts and North Carolina at 1.5%.

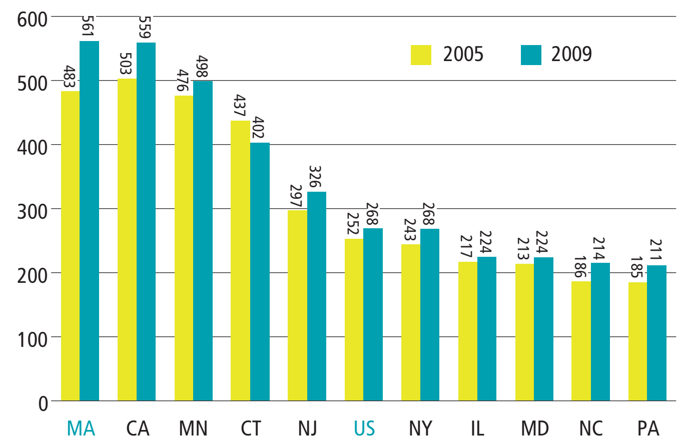
Compared internationally, Massachusetts ranks 3rd after Israel and Switzerland in the number of patents relative to GDP under the Patent Cooperation Treaty administered by the World Intellectual Property Organization. The United States as a whole ranks 12th. Taiwan is not included in this measure since it is not a member of the World International Property Organization (WIPO), but was the top ranked country in 2008 in USPTO patents per capita.

US Patent and Trademark Office patents issued, Massachusetts, 1990 – 2009



Source: US Patent and Trademark Office

US Patent and Trademark Office patents issued per million residents, LTS, 2005 and 2009



Source: US Patent and Trademark Office

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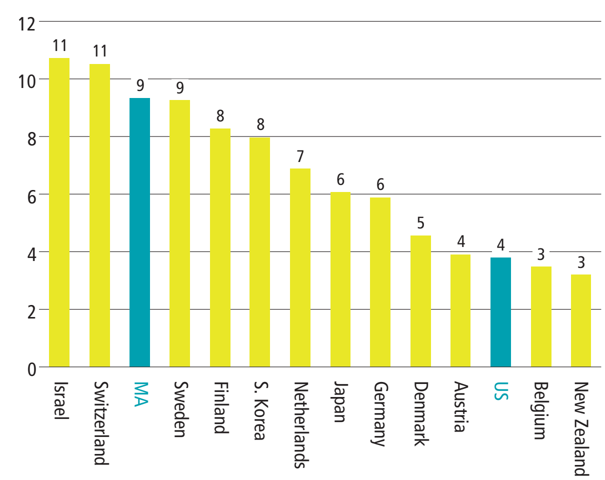
Patents published under the Patent Corporation Treaty per billion dollars of GDP, international and Massachusetts, 2009



Source: World Intellectual Property Organization

Patenting by Field

- Massachusetts excels in patenting per capita across a spectrum of patent classes relevant to key sectors of the Innovation Economy.
- Massachusetts leads the LTS in Analytical Instrument & Research Methods Patents, and ranks second in Business Methods, Computers & Communications, Drugs & Medical, and Advanced Materials Patents.

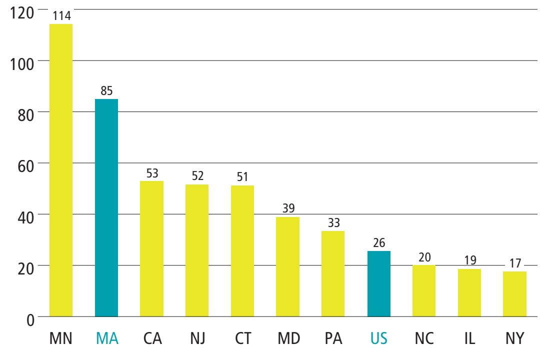
Why Is It Significant?

Measuring the amount of patenting per capita by technology class reveals information about the fields in which Massachusetts' inventors are most active and provides an indication of comparative strengths in knowledge creation. The patent categories in this comparison were selected and grouped on the basis of their relevance for key industries of the Massachusetts Innovation Economy.

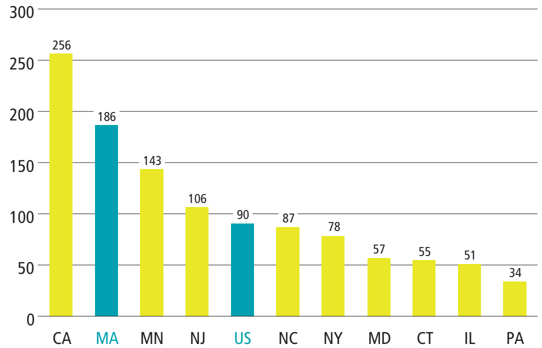
How Does Massachusetts Perform?

The breadth and depth of Massachusetts' strength in original knowledge creation is apparent from its first or second place ranking among the LTS for patents per capita across a broad range of fields. The Commonwealth ranks first among the LTS in Analytical Instruments and Research Methods Patents per capita and second among the LTS in Business Methods; Computers & Communications; Drugs & Medical; and Advanced Materials Patents per capita. None of the other LTS appear in the top three in all of the patent classes measured here.

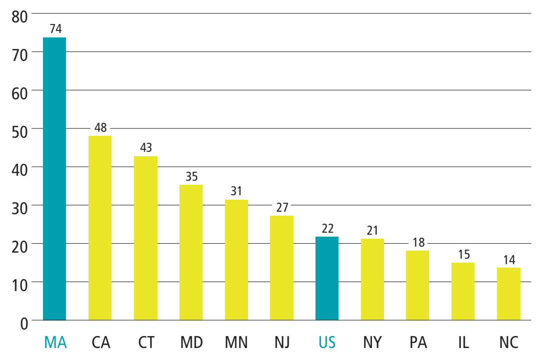
Drugs and Medical Patents per million residents, LTS, 2009



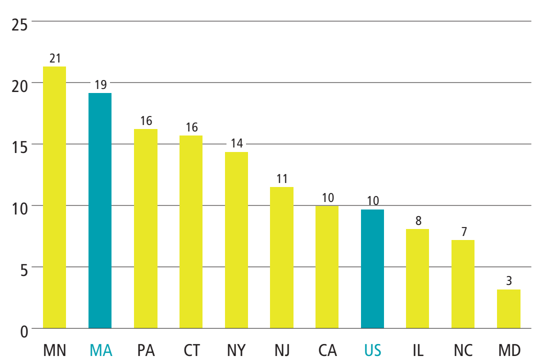
Computer & Communications Patents per million residents, LTS, 2009



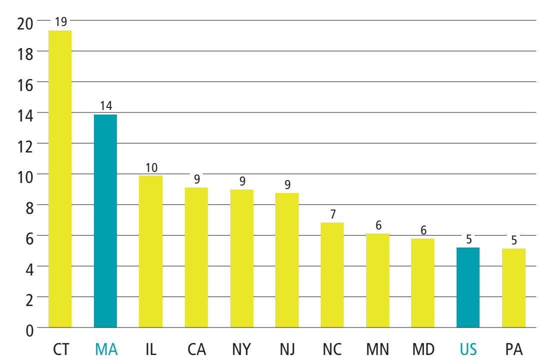
Analytical Instruments and Research Methods Patents per million residents, LTS, 2009



Advanced Materials Patents per million residents, LTS, 2009



Business Method Patents per million residents, LTS, 2009



Source of all data for this indicator: US Patent and Trademark Office

Technology Licensing

- While executing fewer licenses and options in 2008 than 2007, Massachusetts' universities, hospitals, and nonprofit research institutes nonetheless led the LTS in the number of licenses and options executed.
- Universities in Massachusetts reached a 12-year high in licensing and options revenue, bringing in $151.3 million in 2008.

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 nonprofit research organizations to companies and entrepreneurs seeking to commercialize the technology. License royalties are evidence of both the perceived value of IP in the commercial marketplace and the actual revenue generated by the sales of products and services embodying the licensed IP. The increase in royalties collected is important, because a portion of this revenue is often reinvested in R&D and creates further incentives to commercialize research outcomes at universities, teaching hospitals, and nonprofit research institutes.

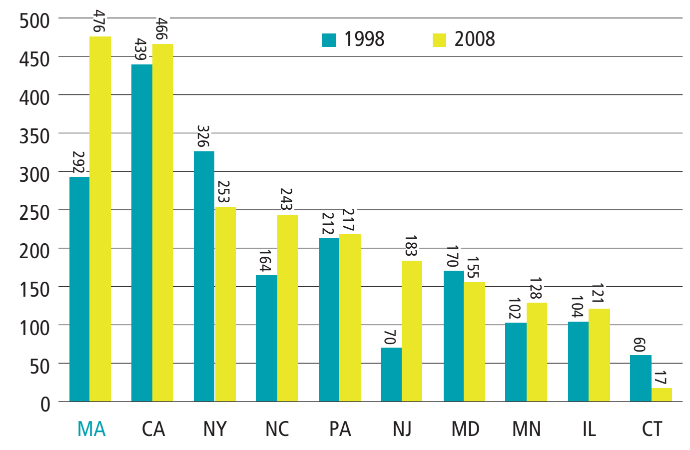
How Does Massachusetts Perform?

Massachusetts' universities, hospitals, and other nonprofit research institutes have a long-standing strength in executing IP licenses and options and have experienced long-term growth in both the number and dollar value of these agreements. Even without adjusting for the size of the LTS's respective economies, Massachusetts' universities, hospitals, and nonprofit research institutes once again led in the number of licenses and options executed in 2008.

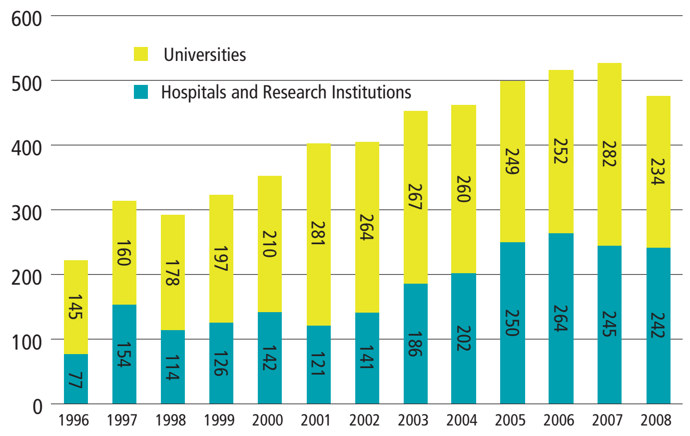
During the ten-year period from 1998 to 2008, IP licensing grew fastest in New Jersey where the number of licenses increased at an average yearly rate of 21% (from 70 to 183), followed by North Carolina with an average yearly increase of 12% (from 164 to 243). In Massachusetts, the number of licenses increased at an average annual growth rate of 6%, but from 2007 to 2008 the number of licenses dropped 10% from 527 to 476. Most of the decrease in licensing activity occurred at universities.

Licensing revenue at Massachusetts' universities increased 20% in 2008 to $151 million – reaching a twelve-year high. After spiking in 2006 and 2007, licensing revenue at hospitals and research institutions dropped back to 2003 levels. Ninety-nine percent of the spike from 2005 to 2007 was attributed to Massachusetts General Hospital (MGH). In 2007, MGH sold its rights to royalties on foreign sales of the arthritis drug Enbrel, resulting in a windfall of $284 million.

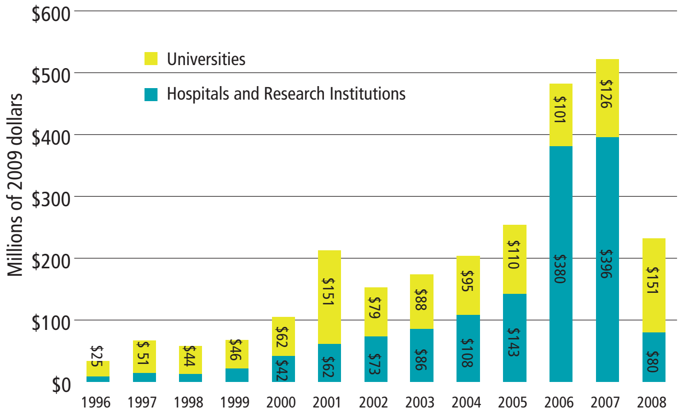
Technology licenses and options executed, LTS, 1998 and 2008



Technology licenses and options executed by major universities, hospitals, and other nonprofit research institutions, Massachusetts, 1996–2008



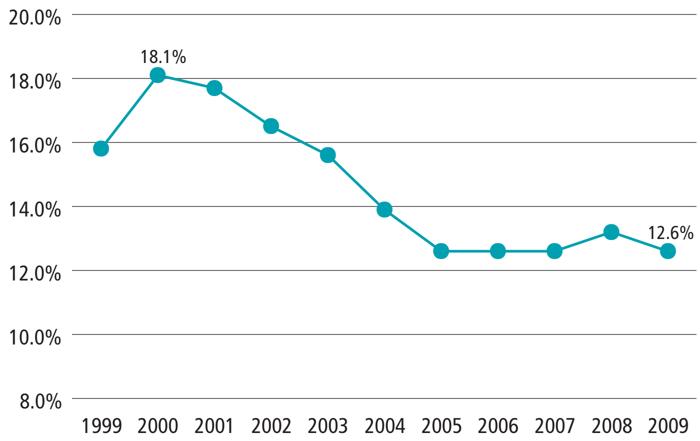
Technology licensing revenue received by major universities, hospitals, and nonprofit research institutes, Massachusetts, 1996–2008



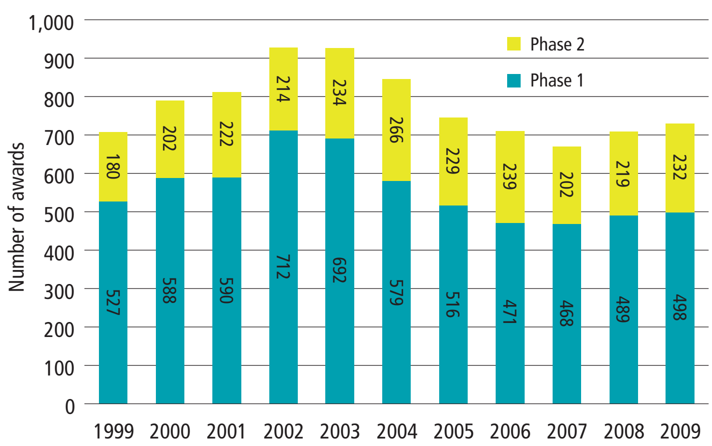
Source of all data for this indicator: Association of University Technology Managers

Small Business Innovation Research Awards

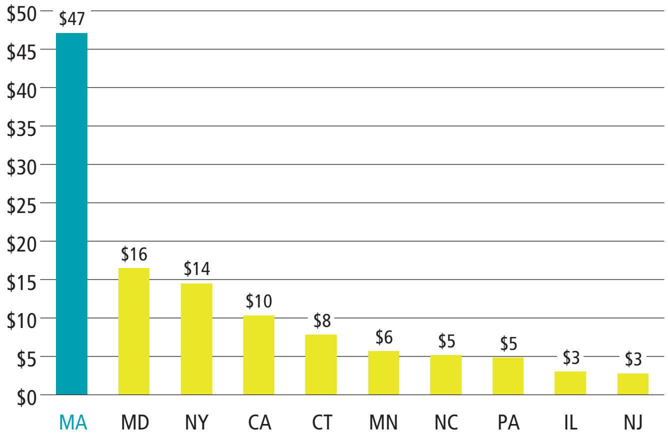
Massachusetts' share of SBIR awards, 1999–2009



SBIR awards to companies by phase, Massachusetts, 1999–2009



Dollar value of SBIR awards per capita, LTS, 2009



Source for all data for this indicator: US Small Business Administration (SBA)

- Small companies brought $268 million into the Commonwealth for technology development in 2009 by competing for SBIR awards – an increase of $41 million over 2008.
- Massachusetts small companies continue to excel in competing for funding across almost every SBIR funding agency.

Why Is It Significant?

The Small Business Innovation Research (SBIR) 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 grants are reserved for applicant teams led by for-profit companies with fewer than 500 employees. The program is intended to address the technology needs of federal agencies while encouraging companies to profit from the commercialization of research. Participants in the SBIR program are often able to use the credibility and experimental data developed through their research to develop commercial products and to attract strategic partners and outside capital investment.

How Does Massachusetts Perform?

In 2009, Massachusetts' small businesses were awarded 12.6% of SBIR funds. Massachusetts' businesses won 22 more SBIR awards in 2009 than 2008. Total awards nationally increased even faster, causing the share of awards coming to Massachusetts to dip slightly. Massachusetts continues to rank second to California in absolute terms (dollar value and number of awards), but in terms of the amount of funding per capita, Massachusetts is by far the leader.

From 2007 to 2009, both Phase I and Phase II awards to Massachusetts companies increased. The number of Phase II awards grew faster, at an average annual growth rate of 7% compared to 3% for Phase I awards. The Department of Defense (DOD) and Health and Human Services (HHS) are the largest sources of SBIR awards for the Commonwealth. Massachusetts companies ranked either first or second in the nation in terms of the number of Phase I awards granted by each major (granting at least 50 Phase I awards) SBIR funding agency.

Regulatory Approval of Medical Devices and Pharmaceuticals

- Massachusetts companies received four Medical Device Pre-market Approvals in 2009, more than any other state.
- Massachusetts ranks second in total number of New Drug Approvals, and is in a three-way tie for first in number of biologic approvals.

Why Is It Significant?

The US Food and Drug Administration (FDA) classifies Medical Devices into 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 for simple improvements to existing products or functional equivalents. These approvals reflect innovation in medical devices design and manufacturing and often indicate important relationships with teaching and research hospitals where many of these devices undergo clinical investigation and trial.

New Drug Approvals (NDAs) reflect a commercially important outcome of years of research and development. Biologics are of particular importance in today's market and include drugs, vaccines, blood products, and therapies created through biological processes. They hold the promise of new approaches to treat cancer, infectious diseases, autoimmune disorders, and other medical conditions.

How Does Massachusetts Perform?

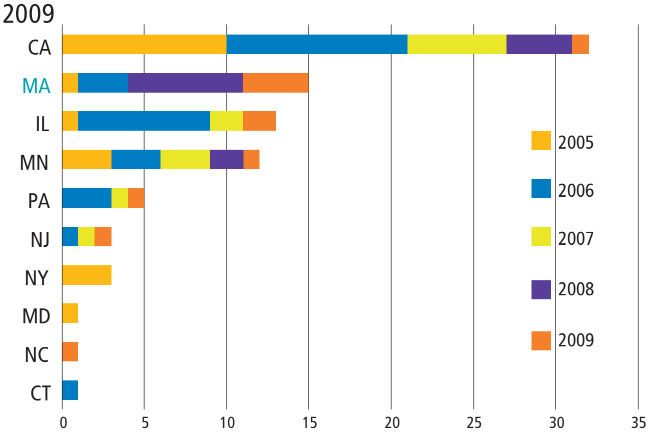
Massachusetts regularly ranks high among the LTS, in both absolute and relative terms, in Medical Device Approvals and Notifications and New Drug Approvals. This reflects the Commonwealth's strong Life Sciences and Healthcare Technology sectors.

Massachusetts companies received four medical device pre-market approvals in 2009, more than any other state. In the last 15 years, Massachusetts companies have remained relatively consistent on this measure, averaging between three and four PMA Approvals per year. Two other top performers, California and Minnesota, have seen a significant decline in PMAs over that time period.

Massachusetts companies came second to California in the number of Medical Device Pre-market Notifications in 2009. Per capita, Massachusetts ranked first, followed by Minnesota.

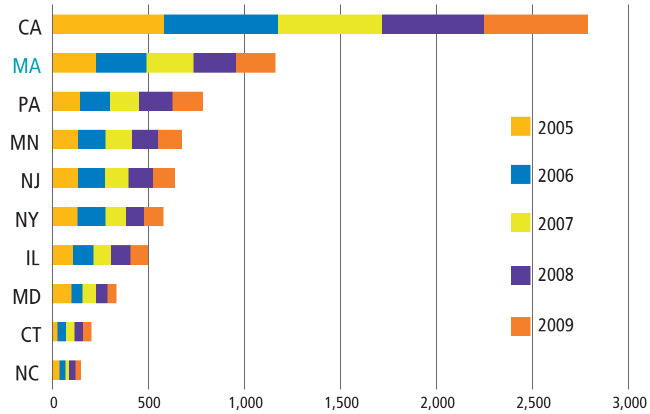
Among the LTS, Massachusetts and Pennsylvania tied for second behind New Jersey in new drug approvals in 2009. Half of the Drug Approvals for Massachusetts companies were for biologic products.

Medical Device Pre-market Approvals (PMAs), LTS, 2005–2009



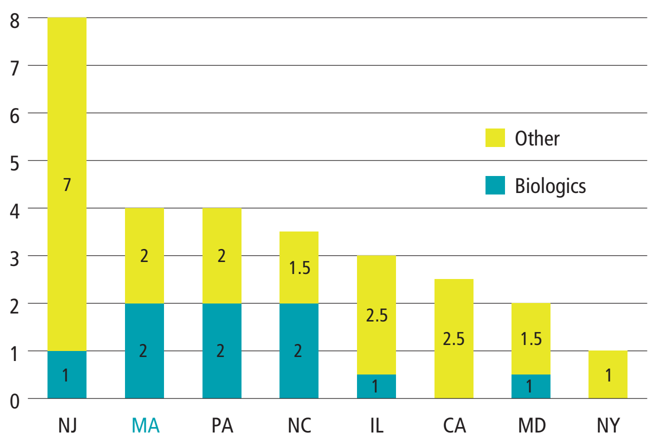
Source: US Food and Drug Administration

Medical Device Pre-market Notifications (releasable 510(k)s), LTS, 2005–2009



Source: US Food and Drug Administration

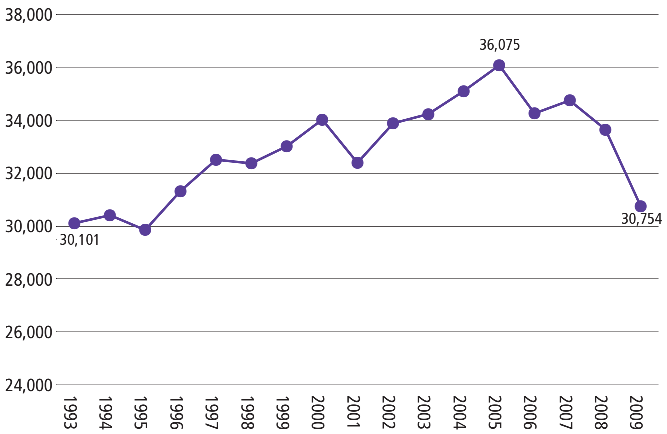
New Drug Approvals, LTS, 2009



Source: Pharmaceutical Research and Manufacturers of America (PhRMA)

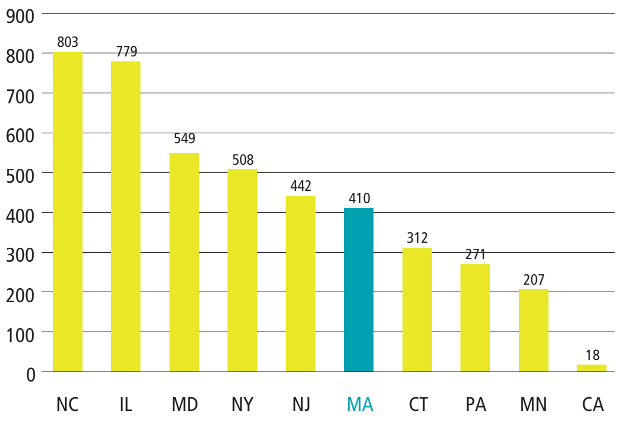
Business Formation

Business establishment openings, Massachusetts, 1993–2009



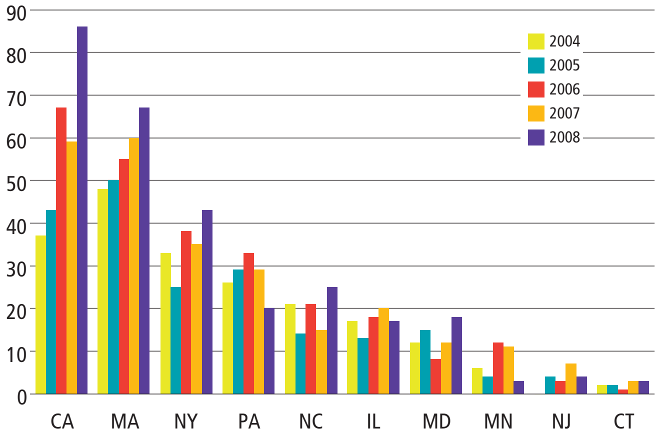
Source: Bureau of Labor Statistics' Business Employment Dynamics

Net change in number of business establishments in key industry sectors per million residents in the labor force, LTS, 2007–2009



Source: Bureau of Labor Statistics' Quarterly Census of Employment and Wages

Spin-out companies from universities, hospitals, and nonprofit research institutes, LTS, 2004–2008



Source: Association of University Technology Managers

- Business establishment openings have slowed since 2005, but the number of individuals becoming entrepreneurs has continued to climb through 2009.
- Among the key sectors in Massachusetts, the largest net increases in establishments were in Software & Communications Services, followed closely by Scientific, Technical, & Management Services.

Why Is It Significant?

New business formation is a key element of job creation and cluster growth—typically accounting for 30-45% of all new jobs in the US. In the Innovation Economy, new business formation plays a particularly important role in developing and commercializing emerging technologies.

The number of spinout companies from universities, teaching hospitals, and nonprofit research institutes is a proxy for the translation of research outcomes into commercial applications.

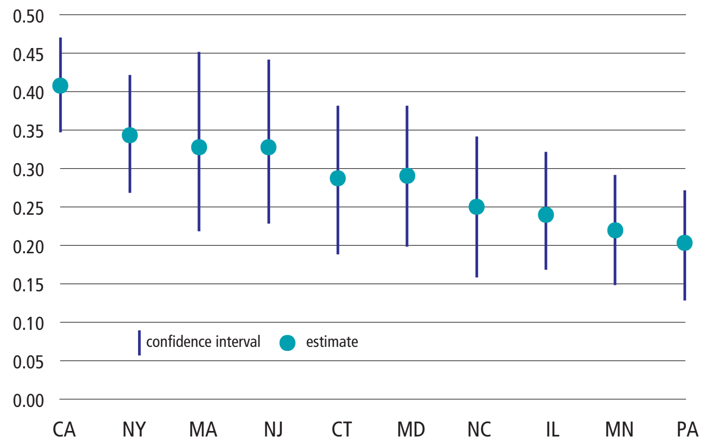
How Does Massachusetts Perform?

As might be expected during a recession, the number of business establishments opening in Massachusetts fell to the lowest level since 1995. Not surprisingly, all of the LTS had fewer business establishments opening in 2009 than 2008. However, entrepreneurial activity (measured by the Kauffman Foundation as businesses started by people who did not previously own a business) increased in Massachusetts and nationwide. This measure increased nationally from 0.17% of the population during 1997-1999 to 0.28% during 2007-2009. In 2009, entrepreneurial activity in Massachusetts reached an estimated 0.33%.

From 2007 to 2009, the number of business establishments in the key industry sectors increased by 1,424 in Massachusetts. Relative to the size of the labor force, this places Massachusetts sixth among the LTS. The largest increases in Massachusetts were in Software & Communications Services, followed closely by Scientific, Technical, & Management Services.

California surpassed Massachusetts in the number of spin-out companies from universities, hospitals, and nonprofit research institutes in 2008. Massachusetts maintains a substantial lead in the number of spin-outs per capita.

Percent of population on starting business, LTS, 2009



Source: The 2010 Kauffman Index of Entrepreneurial Activity

Initial Public Offerings and Mergers and Acquisitions

- After bottoming out in 2008, there were three IPOs of Massachusetts-based companies in 2009, which is 4.7% of all IPOs in the US that year.
- For the first time since 2002, more Massachusetts companies were acquisition targets than acquiring companies.

Why Is It Significant?

Initial Public Offerings (IPOs) and Mergers and Acquisitions (M&As) represent important avenues through which emerging companies can access capital to sustain operations and support growth. IPOs and M&As also are opportunities for early-stage investors to achieve liquidity for their financial investments. Some M&As enhance research outcomes by bringing together technological expertise and enhancing efficiency. However, other M&As can decrease the incentive to innovate within a business by softening the competition or by making innovation something that is essentially outsourced through the acquisitions of startup companies with proven technologies.

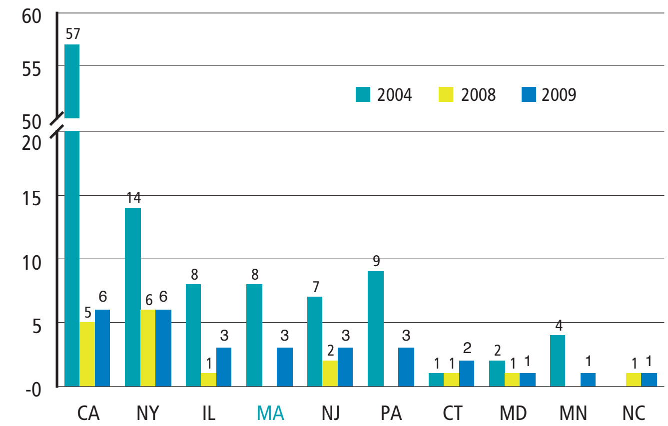
How Does Massachusetts Perform?

The number of IPOs issued in Massachusetts picked up slightly in 2009. Only 12 venture-backed companies went public in the US, as many venture firms were deterred by valuation multiples that had not yet risen to pre-recession levels. As a result, M&As remained high as a percent of all venture-backed liquidity events.

After bottoming out in 2008, there were three IPOs of Massachusetts-based companies in 2009, which is 4.7% of all IPOs in the US that year. The three IPOs place Massachusetts third among the LTS, which is the most common rank for the state over the past ten years. Two of the three IPOs in Massachusetts in 2009 were venture-backed companies.

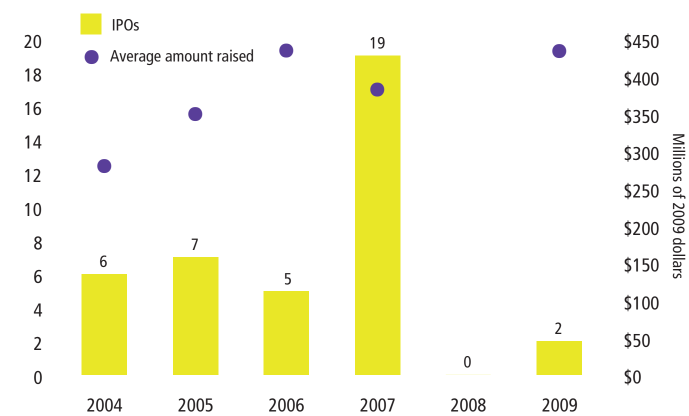
There were 256 acquisitions of Massachusetts-based companies in 2009. This is 14% less than the ten-year average. For the first time since 2002, more Massachusetts companies were acquisition targets than acquiring companies.

Number of IPOs, LTS, 2004, 2008, and 2009



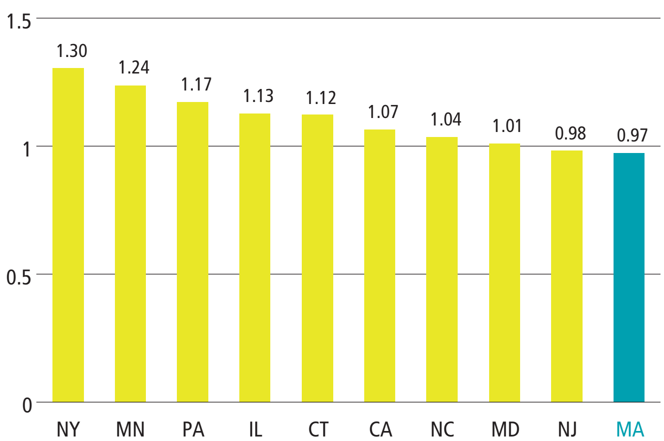
Source: Renaissance Capital, IPO Home

Venture-backed IPOs, Massachusetts, 2004–2009



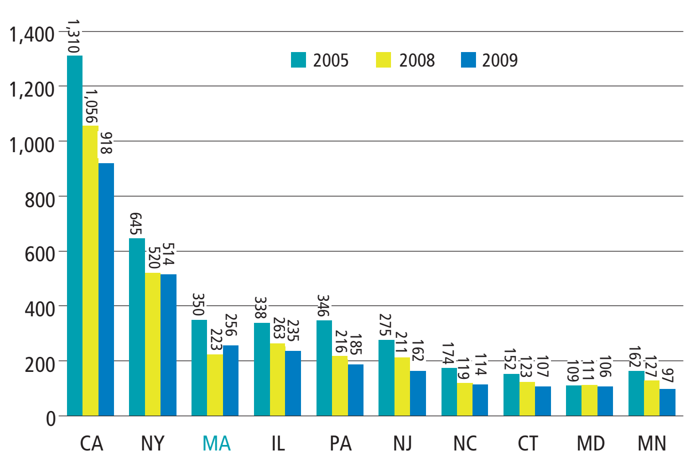
Source: The Boston Globe, PRNewswire.com, Thomson Reuters, Renaissance Capital, and the National Venture Capital Association

Number of companies bought per company sold, LTS, 2009



Source: FactSet MergerStat, LLC

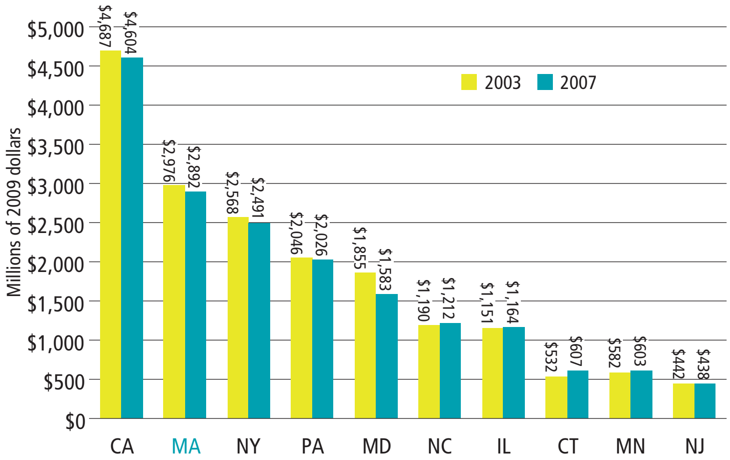
M&As by location of acquired company, LTS, 2005, 2008, and 2009



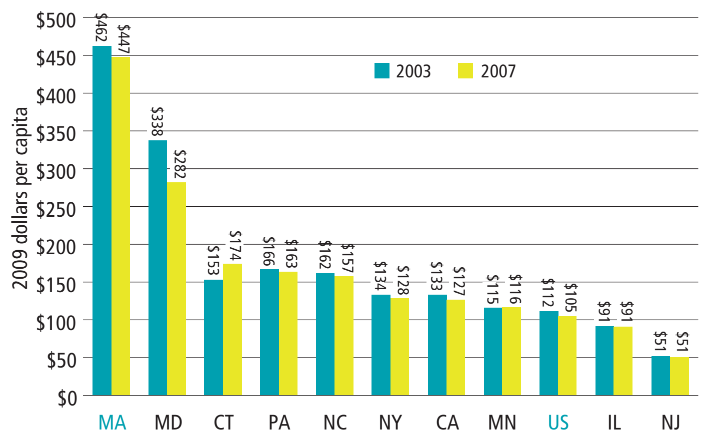
Source: FactSet MergerStat, LLC

Federal Funding for Academic, Nonprofit, and Health Research

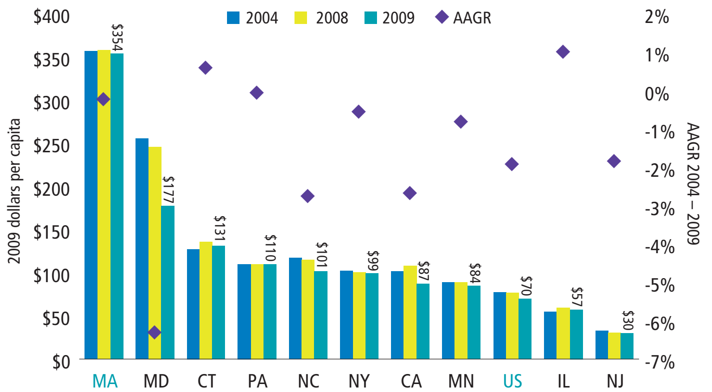
Federal expenditures for academic and nonprofit R&D, LTS, 2003 and 2007



Per capita federal expenditures for academic and nonprofit R&D, LTS, 2003 and 2007



NIH funding per capita and average annual growth rate (AAGR), LTS and US, 2004, 2008 and 2009



Source of all data for this indicator: The National Science Foundation

- Massachusetts universities and nonprofit research institutes are among the top in the LTS for attracting federal R&D dollars, receiving $2.9 billion in 2007.
- Massachusetts' research institutions continue to attract the largest share of the National Institutes of Health (NIH) funding per capita.

Why Is It Significant?

Research universities and other academic centers are pivotal in the Massachusetts Innovation Economy because they advance basic science, create technology that can be commercialized in the private sector, and contribute to educating the highly-skilled individuals that constitute one of Massachusetts' greatest strengths. Funding from the federal government is critical to sustain academic, nonprofit, and health-related research. For example, funding from the National Institutes of Health (NIH) is a driver of the Commonwealth's biotechnology, medical device, and health services industries, which together comprise the Life Sciences cluster.

How Does Massachusetts Perform?

Whether in total dollars or on a per capita basis, universities and nonprofit research institutes in Massachusetts are among the top in the LTS for attracting federal R&D dollars. Academic and nonprofit institutes in Massachusetts received 2.9 billion federal R&D dollars in 2007, accounting for 9% of the US total.

The Commonwealth also maintains its leadership position among all LTS in NIH funding. While funding from the NIH decreased 7% across the nation from 2008 to 2009, the share of funding going to Massachusetts increased 7%. In 2009, the Commonwealth was second to California in total dollars received, but first in dollars per capita. Ninety-seven percent of the $2.3 billion going to Massachusetts institutions was allocated for research and development, with the rest going to fellowships, training, and other purposes. Massachusetts institutions also received 10% of the American Recovery and Reinvestment Act (ARRA) funds administered by the NIH in 2009, bringing in an additional $502 million. These additional funds will no longer be available once ARRA-related NIH funding is exhausted.

Industry Funding of Academic Research

- The proportion of academic research funded by industry in Massachusetts increased from 6.1% in 2004 to 7.7% in 2009.
- Massachusetts leads the LTS in the amount of industry funding of academic research per capita, with a narrow lead over North Carolina.

Why Is It Significant?

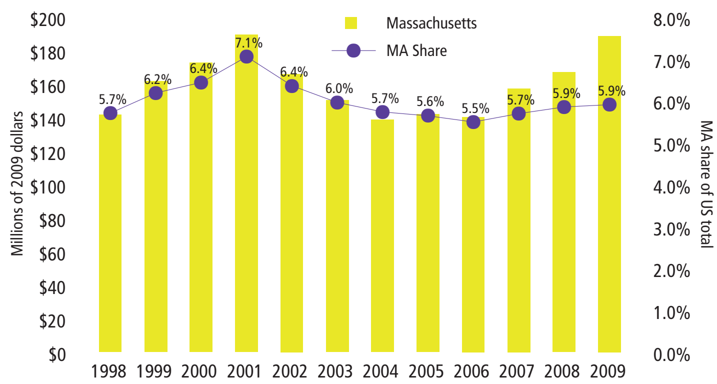
Industry funding of academic research is one measure of industry-university relationships and the relevance that industry places on academic research. University-industry research partnerships may result in advances across low, medium, and high technology industries. Moreover, university research occurring in the context of projects funded by industry helps educate individuals in areas directly relevant to industry needs.

How Does Massachusetts Perform?

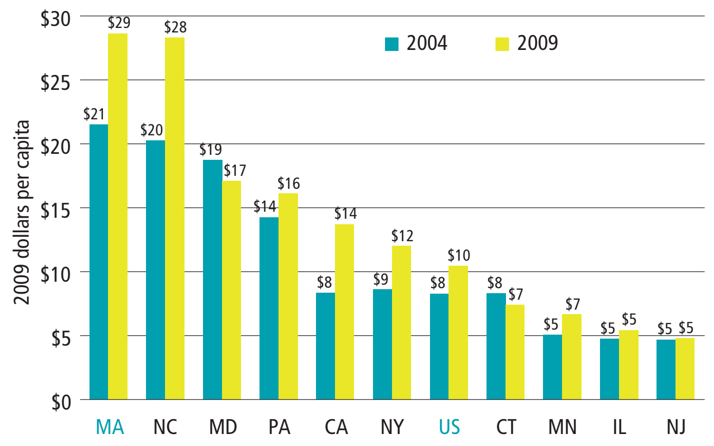
The proportion of academic research in Massachusetts funded by industry increased from 6.1% in 2004 to 7.7% in 2009. Such funding grew 13.3% between 2008 and 2009, the third annual increase in a row and the most significant increase in five years. The share of total industry funding for academic research in the US going to Massachusetts increased modestly between 2004 and 2009, from 5.6% to 5.9%. In the same period, 14.4% of the increase in academic research expenditures at Massachusetts' colleges and universities came from industry sources. With 12% of academic R&D funded by industry in 2009, North Carolina far exceeds all of the LTS on the proportion of research funded by industry. Duke University and its leadership as a center for clinical trials is a major factor in North Carolina's ranking.

The Commonwealth leads the LTS in the amount of industry funding of academic research per capita. North Carolina follows closely and had faster growth than Massachusetts from 2004 to 2009.

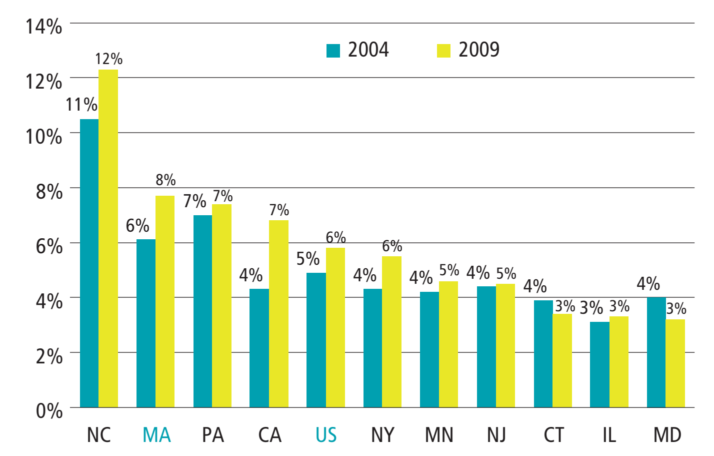
Industry-funded academic research, Massachusetts and Massachusetts' share of US total, 1999–2009



Industry funding of academic R&D per capita, LTS and US, 2004 and 2009



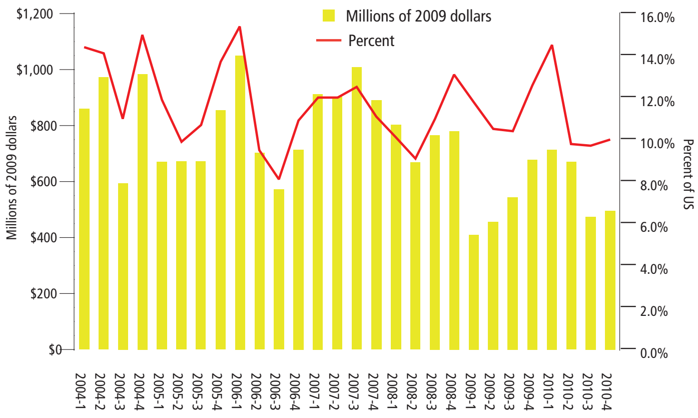
Percent of academic R&D funded by industry, LTS and US, 2004 and 2009



Source of all data for this indicator: The National Science Foundation

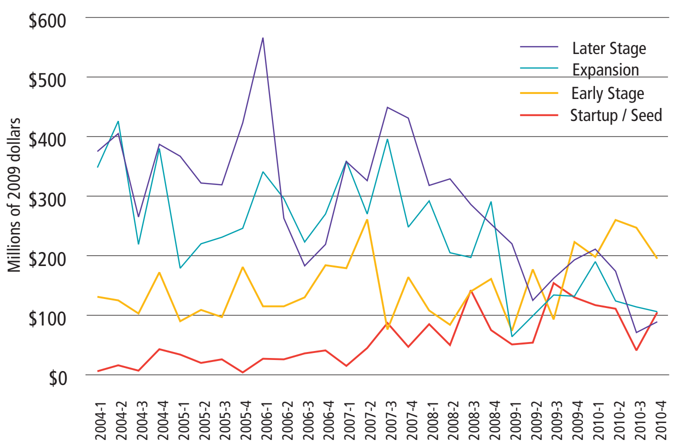
Venture Capital

VC investment in Massachusetts and as a share of total VC investment in the US, 2004 Q1–2010 Q4



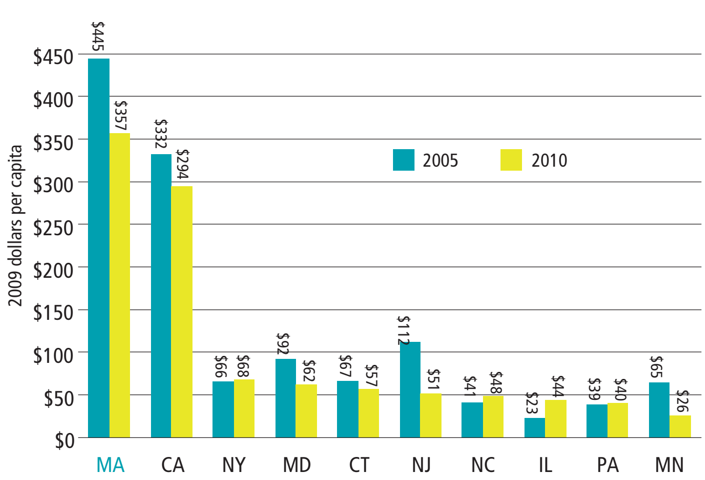
Source: PricewaterhouseCoopers MoneyTree Report

VC investment by stage of financing, Massachusetts, 2004 Q1–2010 Q4



Source: Thomson Reuters and National Venture Capital Association

Venture capital investment per capita, LTS, 2005 and 2010



Source: PricewaterhouseCoopers MoneyTree Report

- VC going to startup, seed, and early stage businesses in Massachusetts was the highest since the height of the 2000 tech bubble, with $1.7 billion invested.
- Despite a significant decrease in the absolute amount of VC investments since 2004, Massachusetts still leads the LTS in VC investment per capita.

Why Is It Significant?

Venture Capital (VC) firms are an important source of funds for the creation and development of innovative new companies. In addition, VC firms often provide valuable business strategy guidance. Trends in VC investment can be predictive of emerging growth opportunities in the Innovation Economy. Private investment capital derived from sources such as angel investors are also important, but harder to measure and not included in these data.

How Does Massachusetts Perform?

Despite continued decline in fund raising by venture funds in the US in 2010, the amount invested by VC firms between 2009 and 2010 grew by 13% in Massachusetts and 18% nationally. Massachusetts companies received 11% of the $21.6 billion invested across the country in 2010 and also accounted for 11% of all deals. Massachusetts still leads the LTS in VC investment per capita, notwithstanding a decline in total investment from 2005 to 2010 that was larger than in California.

During 2009 and 2010, VC going to startup, seed, and early stage businesses in Massachusetts was the highest since the height of the 2000 tech bubble, with $2.2 billion invested. 52% of this amount was invested in new biotechnology firms.

The sectors in Massachusetts that raised the most VC in 2010 across all stages of financing were Biotechnology, Software, Medical Devices, and Industrial/Energy. Recent increases in Industrial/Energy investment were largely driven by the clean technology sector. According to the National Venture Capital Association, investment in clean technology increased 76% in the US from 2009 to 2010. California, Massachusetts, and Texas are the states with the largest number of venture-backed clean tech companies.

Education Level of the Workforce

- Massachusetts continues to rank first among the LTS and US in the percent of the working age population with a bachelor's degree or higher.
- From 2009 to 2010, the employment rate of the working age population in Massachusetts increased for residents with a bachelor's degree or higher while it remained stable or continued to fall for residents with less education.

Why Is It Significant?

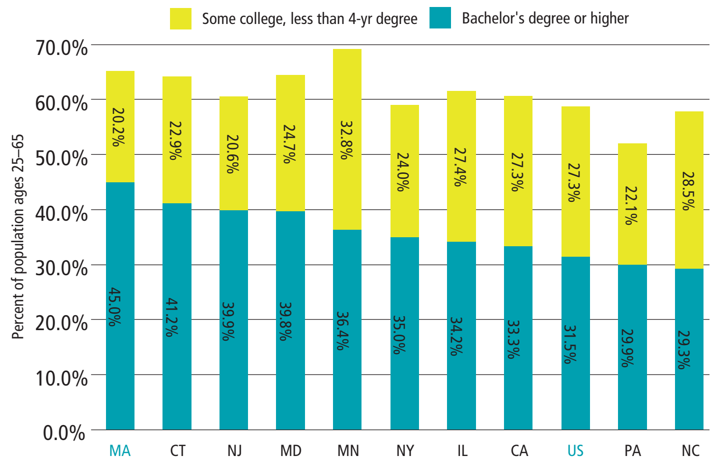
The educational attainment of the workforce contributes directly to a region's ability to generate and support innovation-driven economic growth. Both the increasing technical skill demands of employment and the aging of the baby-boom generation contribute to concerns about the growth of the pool of educated working-age people.

How Does Massachusetts Perform?

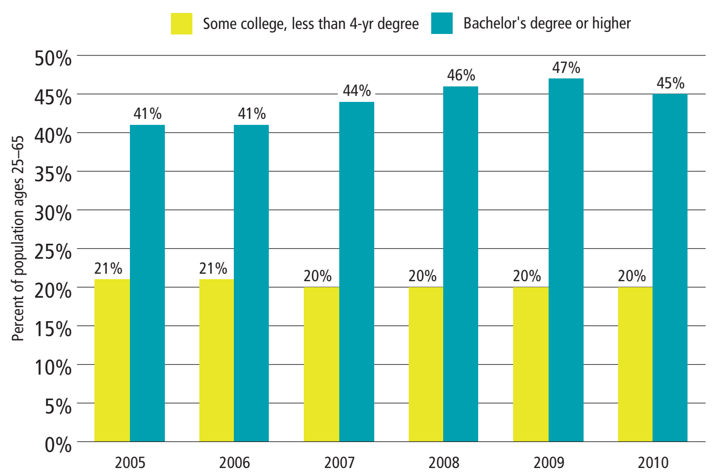
Massachusetts continues to rank first among US states in the percent of the working age population with a four-year college degree or higher. In 2010, 45% of the working age population in Massachusetts had a bachelor's degree or higher, compared to 31% nationwide. Massachusetts maintains this position despite a small decline from 2009 to 2010.

Employment rates during the current economic recovery demonstrate the importance of a college education in the Massachusetts labor market. From 2009 to 2010, full-time employment continued to fall for the working age population with only a high school education. In contrast, employment held steady for the working age population with some college and rose back to 2005 levels for those with a bachelor's degree or higher. In the US as a whole, the employment rate of the working age population continued to fall across the educational spectrum, but fell faster at lower educational attainment levels.

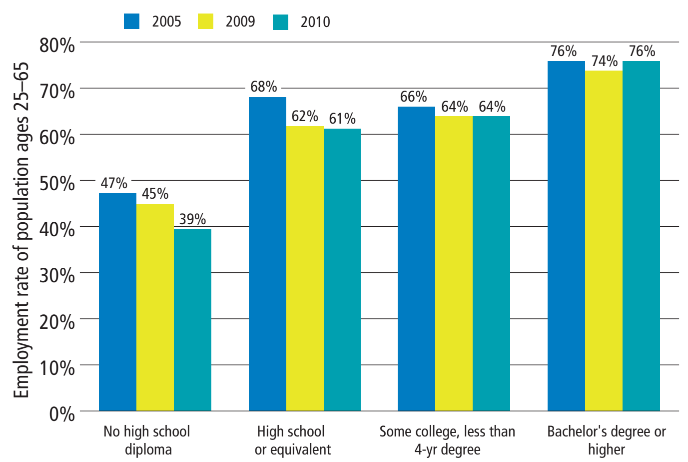
Educational attainment of working age population, LTS and US, 2008–2010 average



College attainment of the working age population, Massachusetts, 2005–2010 three-year rolling averages



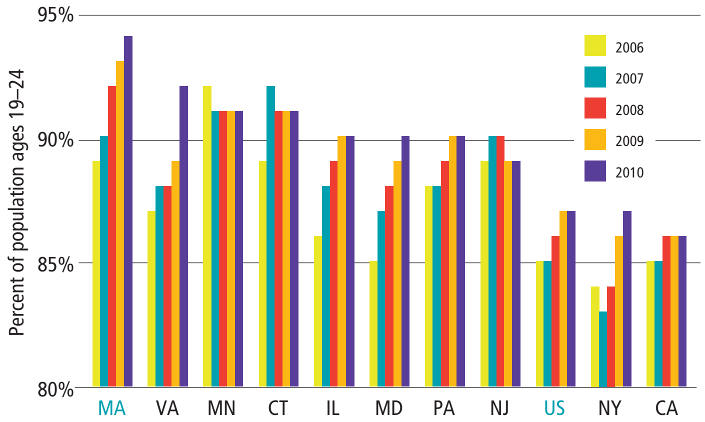
Full-time employment rate by education, Massachusetts, 2005, 2009, and 2010



Source of all data for this indicator: US Census Bureau, Current Population Survey

K–16 Education

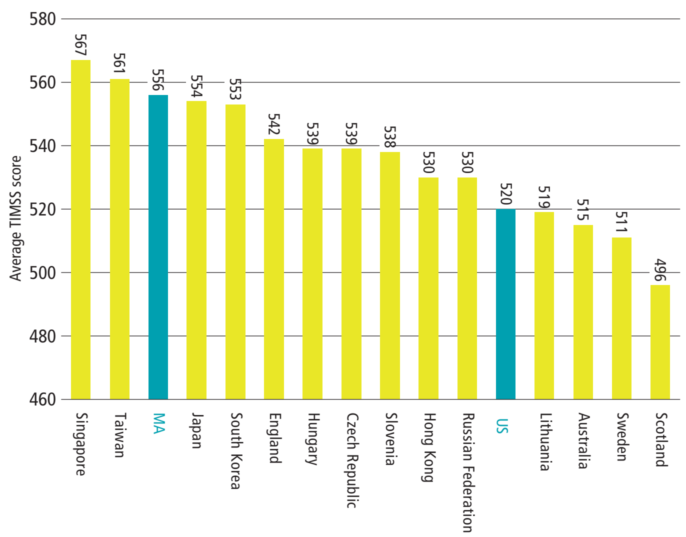
High school attainment of persons ages 19–24, three-year rolling averages, LTS, 2006–2010



Source: US Census Bureau, Current Population Survey

INTERNATIONAL

Top 15 nations participating in the 8th grade TIMSS science evaluation, with Massachusetts, 2007



Source: International Association for the Evaluation of Educational Achievement

INTERNATIONAL

Degrees conferred per thousand residents, all levels, international, 2007

Source: United Nations Educational, Scientific and Cultural Organization (UNESCO) and the National Center for Education Statistics

- Only 6% of young adults in Massachusetts lacked a high school credential in 2010, down from 11% in 2006.
- In science and mathematics, Massachusetts students outperform their US peers and are highly competitive internationally.

Why Is It Significant?

Education plays a very important role in preparing Massachusetts' residents to succeed in their evolving roles and career trajectories. A strong education system also helps attract and retain skilled individuals who want excellent educational opportunities for themselves and their children. Economic growth in Massachusetts is heavily dependent upon improving the skill mix of the population, especially because of relatively slow population growth. Some of the key metrics of talent development are mathematics ability, high school diploma attainment, and college degrees conferred.

How Does Massachusetts Perform?

Massachusetts has the highest high school attainment rate among the LTS as measured by the percent of the population ages 19-24 with at least a high school diploma or GED. The progress achieved by the K-12 education system is evident in rising educational attainment among the youngest adults. The percent of the Massachusetts population ages 19–24 who have not yet completed high school dropped from 11% in 2006 to 6% in 2010. Over the last five years, Massachusetts has improved more than twice as fast on this measure than the nation as a whole.

In science and mathematics, Massachusetts' students outperform their US peers and are highly competitive internationally. Massachusetts' eighth-grade students taking the Trends in International Math and Science Study (TIMSS) science assessment in 2007 ranked third behind Singapore and Taiwan. The state ranked fourth in mathematics.

In higher education, the Commonwealth ranks sixth globally in degrees conferred per capita. The US, in comparison, ranks 20th.

Public Investment in K–16 Education

- During the last five years, Massachusetts increased per pupil support for K-12 education. Meanwhile, per pupil support for public higher education in Massachusetts fell to 19% below the national average.

Why Is It Significant?

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

Forty-eight percent of Massachusetts' high school graduates enroll in public higher education institutions, while 32% enroll in private institutions. Massachusetts is unusual in that 43% of college students are in public institutions, compared to 72% nationally.

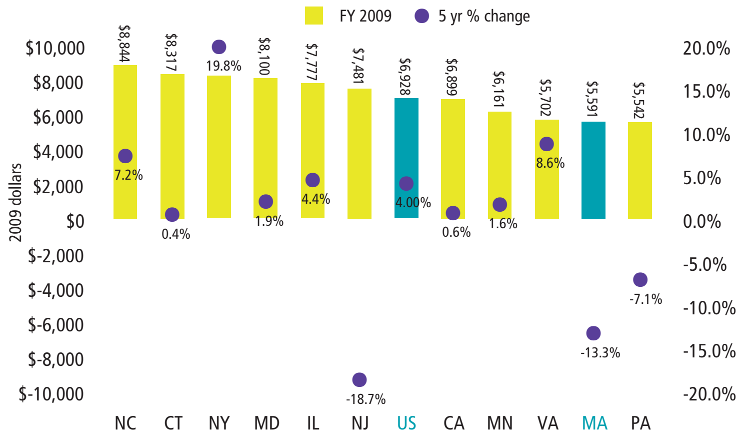
How Does Massachusetts Perform?

From 2002 to 2008, per pupil support for K-12 education in Massachusetts rose at an average annual rate of 2.2%. From 2007 to 2008, it rose 5.6%, maintaining the state's fourth place rank among the LTS.

Massachusetts' appropriations for higher education have declined significantly since the late 1980s, whether viewed student, per capita, or relative to the size of the Massachusetts' economy. In 2003, Massachusetts' appropriations per student were 23% above the US average; in 2009 they were 19% below. From 2008 to 2009, per pupil support for higher education declined significantly. Enrollment rose 5.6% while appropriations fell 19.3%, leading to a 23.7% decline in per pupil appropriations. Among the 50 states the size of this decline is second only to South Dakota.

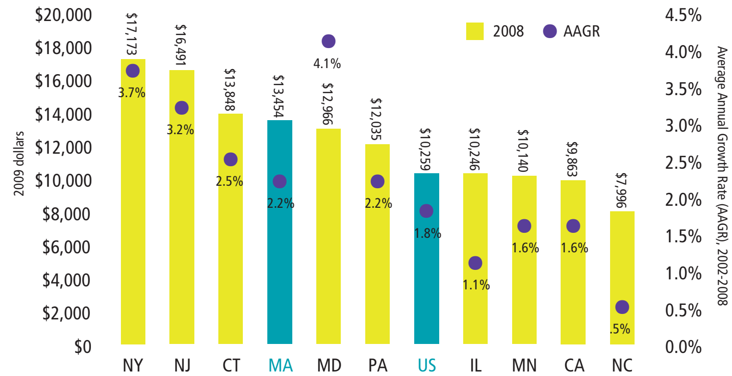
In 2006, Massachusetts ranked 13th compared to high-income nations in per pupil public investment in education (inclusive of all levels) relative to per capita GDP. Massachusetts held steady on this measure from 2002 to 2006. The US ranks 18th on this measure, just after the United Kingdom. In order to make comparisons based on GDP per capita, the nations selected were all high income as defined by the World Bank. See appendix for more information.

State higher education appropriations per full-time equivalent student, LTS, 2009



Source: State Higher Education Executive Officers

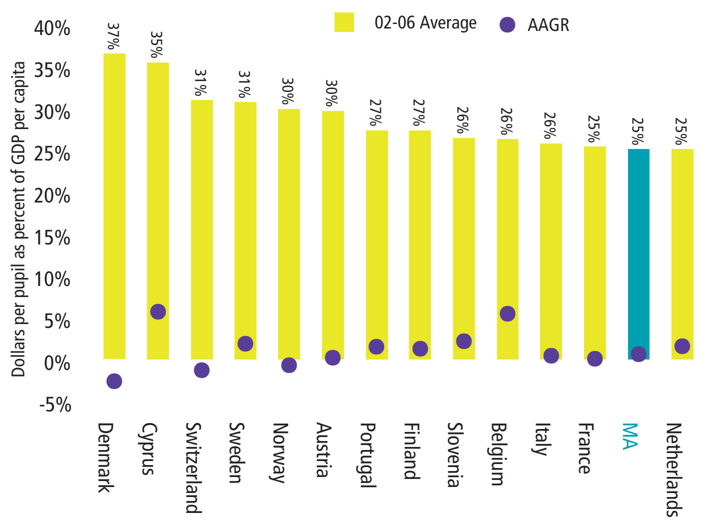
Per pupil spending of public elementary/secondary school systems, LTS, 2008



Source: US Census Bureau

INTERNATIONAL

Per pupil investment in public education, all levels, international, 2002–2006

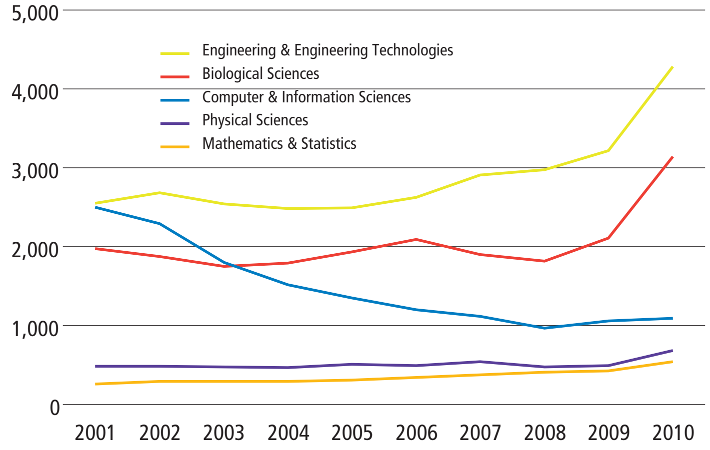


Source: United Nations Educational, Scientific and Cultural Organization (UNESCO), Bureau of Economic Analysis, the National Center for Education Statistics, State Higher Education Executive Officers (SHEEO) and the Census Bureau

INDICATOR 23

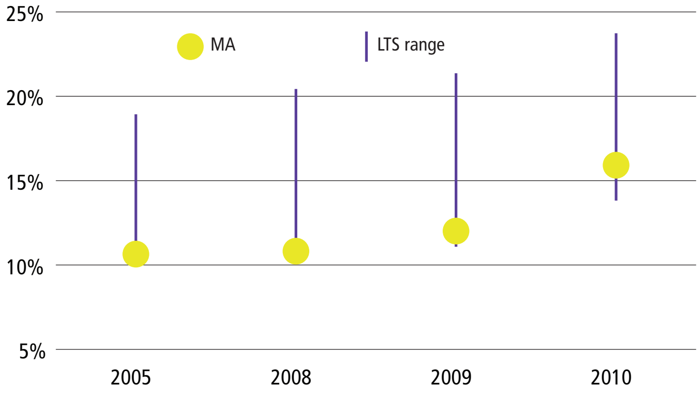
Science, Technology, Engineering, and Math Career Choices and Degrees

Intended major of high school seniors, Massachusetts, 2001–2010



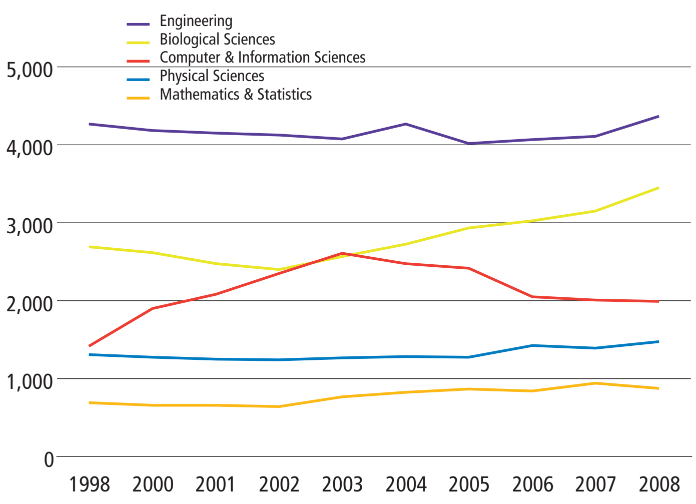
Source: The College Board

Percent of high school seniors taking the SATs intending to major in a STEM field, Massachusetts and LTS range, 2005, 2008–2010



Source: The College Board

Degrees granted in STEM fields, Massachusetts, 1998–2008



Source: Integrated Postsecondary Education Data Systems

- In 2010, interest among Massachusetts' high school students in STEM fields reached the highest level in at least ten years; it,however, is still 8% below the national average.

Why Is It Significant?

Science, Technology, Engineering, and Math (STEM) fields offer promise in improving incomes and quality of life by driving productivity growth across sectors and contributing to the creation of whole new industries. Massachusetts' high earnings and quality of life have been achieved, in large part, through innovations and applications in these fields.

Demand for professionals in STEM fields is particularly high in Massachusetts. Business leaders in the Commonwealth are highlighting the "STEM pipeline issue" because the number of students majoring in these critical fields is not sufficient to fill the vacancies expected as baby boomers retire over the coming decade.

How Does Massachusetts Perform?

In 2010, the number of students in Massachusetts' high schools showing interest in majoring in a STEM field reached the highest level in at least ten years, when record keeping began. Interest in mathematics grew the fastest, doubling since 2001. In terms of total students, interest in Engineering & Engineering Technologies grew the most. From 2001 to 2008, interest in Computer & Information Science declined, but interest started to rebound in 2009 and 2010.

From 2005 to 2010, interest in STEM fields increased among all of the LTS and the US, but grew fastest in Massachusetts. As a result, Massachusetts moved from ranking last among the LTS in 2005 to sixth out of ten in 2010. However, the state is still 8% below the national average.

Bachelor's and graduate degrees granted in STEM fields rose steadily in Massachusetts from 10,361 in 1998 to 12,153 in 2008. During the five-year period from 2003 to 2008, degrees granted in biological sciences grew the most (23.5%), adding 612 degrees. Computer & Information Science was the only field in which degrees granted declined, although the number of doctorate degrees awarded in this field doubled.

A relatively high percentage of all degrees granted in Massachusetts are doctorates in STEM fields—a sign of the high research intensity of Massachusetts' institutions of higher education.

Talent Flow and Attraction

- While overall mobility declined in 2009, Massachusetts still experienced positive net migration for the second straight year.
- Massachusetts ranks second among the LTS in the combined flow of college educated adults from other states and abroad.

Why Is It Significant?

Migration patterns are one indicator of a region's attractiveness. Regions that are hubs of innovation have high concentrations of educated, high-skilled workers and dynamic labor markets refreshed by flows of talent. In-migration of well-educated and highly skilled individuals fuels innovative industries by bringing in diverse and high-demand skill sets. While a positive net talent flow is important, Massachusetts benefits from talent flows in both directions connecting Massachusetts institutions and businesses to other regions.

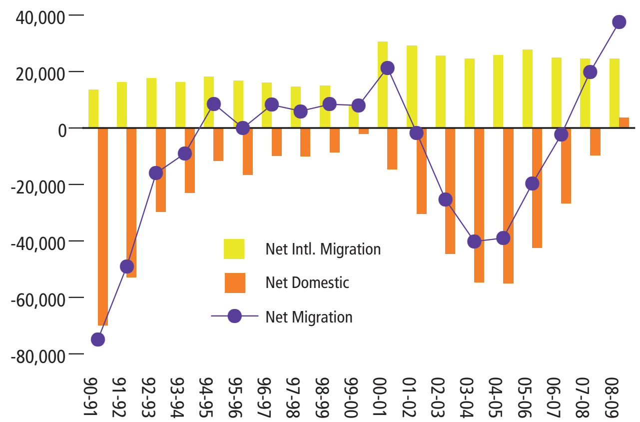
How Does Massachusetts Perform?

The economic and housing crises have dampened mobility in the US, with state-to-state migration down 5% in the US in 2009. International immigration declined 11% that year. The impact on Massachusetts has been a 7% decline in new residents moving into the state. However, far fewer people left Massachusetts, thus net migration in the state was positive. After six years of population losses from 2002 through 2007, Massachusetts turned the tide and recorded domestic migration gains in 2008 and 2009. As a share of population, net migration had the greatest positive impact in North Carolina and Massachusetts in 2008 and 2009.

Massachusetts leads all other states in the percent of in-migrants with a bachelor's degree or higher at 56%. College attainment among international immigrants to Massachusetts has risen over the last five years from 42% to 54%.

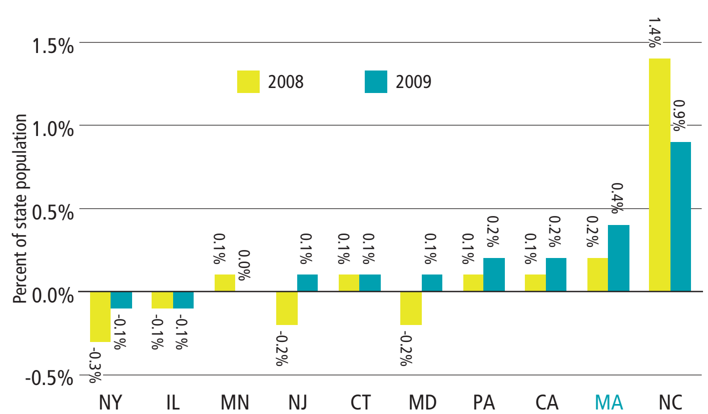
State-to-state and international relocations by college educated adults declined in eight of the ten LTS from 2008 to 2009, with Maryland and, to a lesser extent, Pennsylvania bucking the downward trend. Maryland and Massachusetts gained more college-educated workers per capita through migration than the other LTS in 2008 and 2009.

Net international and domestic migration, Massachusetts, 1990–2009



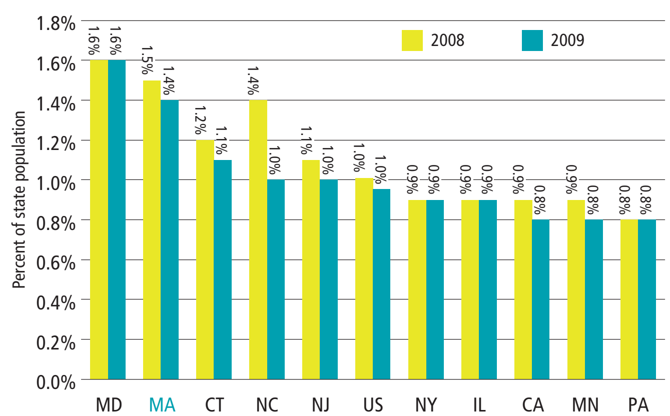
Source: US Census Bureau

Net migration per capita, LTS and US, 2008 and 2009



Source: US Census Bureau

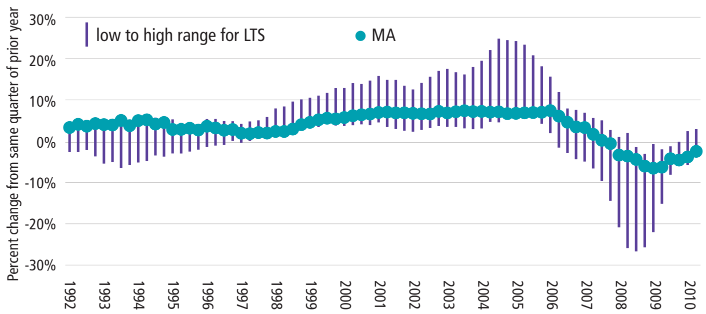
Relocations by college educated adults moving from out of state or abroad, LTS and US



Source: US Census Bureau, Current Population Survey

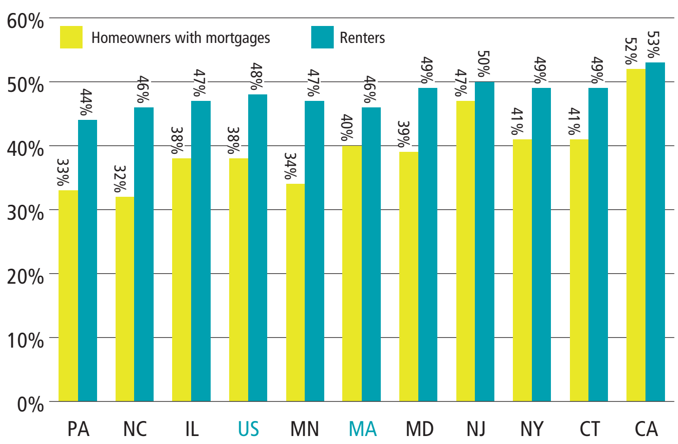
Housing Affordability

Housing price index, Massachusetts and low to high range for LTS, 1992–2010



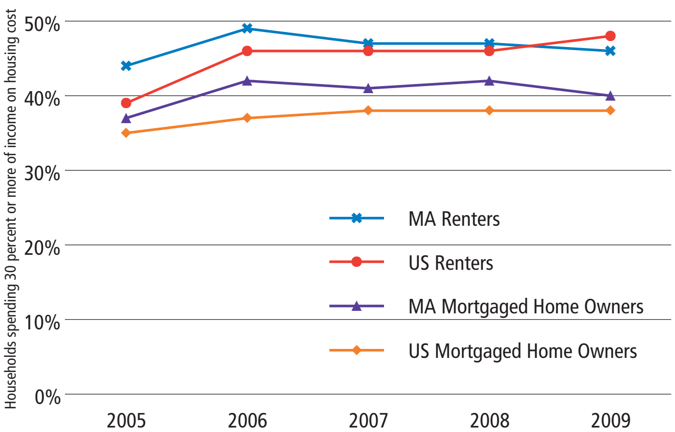
Source: Federal Housing Finance Agency

Households spending 30 percent or more of income on housing costs, LTS and US, 2009



Source: US Census Bureau, American Community Survey

Housing affordablility trends for renters and home owners with mortgages, Massachusetts and US, 2005–2009



Source: US Census Bureau, American Community Survey

- The number of renters and homeowners with mortgages spending more than 30% of income on housing costs in Massachusetts declined slightly in 2009.
- California and Massachusetts have the highest median home prices of the LTS, both of which were above $300,000 in Q2 2010.

Why Is It Significant?

Quality of life, of which housing affordability is a major component, influences Massachusetts' ability to attract and retain talented people. A lack of affordable housing for essential service providers and entry-level workers can deter people from moving to the area, thus slowing business' ability to fill open positions and fuel expansion in the region. Spending 30% or more of income on housing costs is a common threshold to measure housing affordability.

How does Massachusetts perform?

Massachusetts, like the rest of the nation, has experienced housing price deflation over the last five years reversing a long period, starting in 2000, in which housing cost increases drastically outpaced income growth. Median prices in Massachusetts are currently hovering around $300,000 after peaking at over $350,000 in 2005. While this represents more than a 15% decline, median home prices decreased nationally by more than 23% from over $223,000 in 2006 to currently around $180,000.

Coupled with housing price declines, more homeowners with mortgages have housing costs that are considered affordable than in 2008. The number of homeowners with mortgages spending more than 30% of income on housing declined slightly from 2008 to 2009 from 42% to 40%. This is in contrast to the rest of the nation, as mortgage affordability remained static for three years beginning in 2007. Conditions for renters across the nation also failed to improve over the last year as the percent of renters spending more than 30% of their income on housing increased from 46% in 2008 to 48% in 2009.

California continues to maintain its status as the least affordable of the LTS with the highest percent of both renters and mortgaged homeowners spending more than 30% of monthly income on housing (52% and 53% respectively). California also has the highest median house price at just over $330,000.

APPENDIX A: DATA SOURCES FOR INDICATORS AND SELECTION OF LTS

Data Availability

Indicators use 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 groupings were derived from a wide range of sources, there are variations in the time frames and in the specific variables that define the indicators. This appendix provides notes on data sources for each indicator.

Price Adjustment

The **2010 Index** uses inflation-adjusted figures for most indicators. Dollar figures represented in this report, when indicated, are in chained 2009 dollars. Price adjustments are according to the Consumer Price Index for all Urban Consumers (CPI-U), US City Average, all Items.

Bureau of Labor Statistics, US Dept. of Labor. http://data.bls.gov/cgi-bin/surveymost

I. Selection of Leading Technology States (LTS) for Benchmarking Massachusetts Performance

The **Index** benchmarks Massachusetts' performance against other leading states and nations to provide context for interpretation. The Leading Technology States (LTS) list, which was updated in 2010, includes: California, Connecticut, Illinois, Maryland, Minnesota, New Jersey, New York, North Carolina, and Pennsylvania. 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 compares sector employment as a percent of total employment to the same measure for the US as a whole. This ratio, called the location quotient, is above average if it is 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.

2010 Industry Sector Employment Concentrations

2010 Sector Employment (LQ)	MA	PA	CT	MN	CA	NJ	IL	NC	NY	MD
Bio-pharma & Medical Devices	2.23	1.42	1.54	1.59	1.35	2.41	1.07	1.39	0.89	1.05
Computer & Com Hdw	1.96	0.96	1.10	1.44	2.07	0.63	0.83	1.50	0.87	0.55
Defense Mfg	1.32	0.73	3.06	0.67	1.28	0.52	0.90	0.68	0.52	0.87
Financial Services	1.40	1.18	1.83	1.26	0.84	1.22	1.21	0.90	1.39	0.80
Postsecondary Education	1.37	1.06	1.13	0.85	1.09	0.82	1.03	1.11	1.19	1.17
Scientific, Tech, & Mgt Serv	1.29	0.90	0.76	0.75	1.28	1.04	1.20	0.93	0.97	1.95
Software and Com Serv	1.48	0.88	1.04	1.00	1.11	1.27	0.93	0.80	0.98	1.43
Advanced Materials	0.86	1.39	0.81	0.89	0.60	1.00	1.36	1.49	0.60	0.38
Business Services*	1.09	1.12	0.91	1.17	0.95	1.14	1.03	0.92	1.17	0.90
Diversified Industrial Mfg.	1.19	1.26	1.69	1.43	0.83	0.70	1.64	0.90	0.79	0.34
Healthcare Delivery	1.17	1.11	0.99	1.03	0.83	0.98	0.95	1.06	1.08	0.96
Count of Sectors with LQ>1.1	9	6	5	5	5	4	4	4	3	3
Percent of Jobs in Key Sectors	38%	32%	35%	32%	29%	31%	31%	30%	32%	29%

Cells are shaded orange show industry sector concentrations more than 10% above the US average.

Source: Moody's economy.com and BLS CEW.

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 are selected high income nations as defined by the World Bank due to the small denominator effect. Countries not reporting data were excluded and vary depending on the measure.

III. Notes on international data sources

For countries where the school year or the finance year is spread across two calendar years, the year is cited according to the later year. For example, 2004/05 is presented as 2005. All international population estimates were 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 values 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 overview charts

The overview charts are created with the same sources used for the corresponding indicators. The definitions for each of the measures are also the same as defined in the indicators, except for mortgage and rent affordability, which are based on the number of renters and mortgage holders who do not have to spend 30% or more of income on housing as opposed to those who do. The measures are per capita comparisons unless otherwise indicated or unless based on an average or median. The up and down arrows represent the direction of change since the previous year measured in Massachusetts without indexing to the United States average or comparing to the LTS.

V. Notes on Data Sources for Individual Indicators

1. Industry Sector Employment and Wages

Data on sector wages are from the Bureau of Labor Statistics' Quarterly Census of Employment and Wages. This survey assembles employment and wage data derived 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. http://www.bls.gov/cew/

2. Occupations and Wages

The US Bureau of Labor Statistics' Occupational Employment Statistics (OES) 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. MTC aggregated the 22 major occupational categories of the OES into 10 occupational categories for analysis. http://www.bls.gov/oes/home.htm

The occupational categories in the **Index** are:

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

3. Median Household Income

Median household income

Median household income data are from the US Census Bureau, American Community Survey. For the **2010 Index**, data are one year estimates. http://www.census.gov

Wages and salaries paid

Data are from the Bureau of Economic Analysis series "State Personal Income, wage and salary disbursements by place of work for Massachusetts." http://www.bea.gov/regional/

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. http://www.census.gov/manufacturing/asm/index.html

Labor productivity (International)

Labor productivity for the overall economy is defined by the **Index** as gross domestic product (GDP) per employee. Data on GDP are from the World Bank. http://data.worldbank.org. Data on total employment are from the International Labour Organization (ILO). http://laborsta.ilo.org/

5. Industry Ouput and Manufacturing Value Added

Industry output
Industry output data are obtained from the Moody's Economy.com Data Buffet. Moody's estimates are based on industry output data for 2 and 3 digit NAICS produced by the Bureau of Economic Analysis (BEA). The BEA's calculations are value added estimates. The term value added indicates that output is 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) and returns to capital (as measured by gross operating surplus) and the returns to government (as measured by taxes on productions and imports less subsidies). The fraction of the 2 or 3 digit NAICS data are allocated by Moody's to 4 digit NAICS industries using the ratios of total wages paid between sectors and their parent industries http://www.economy.com.

Manufacturing value added
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." http://www.census.gov/manufacturing/asm/index.html

6. Manufacturing Exports

Manufacturing exports data are from the World Institute for Strategic Economic Research (WISER) at Holyoke Community College's Kittredge Business and Technology Center. http://www.wisertrade.org/

The export categories match up with the sectors as follows:

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

7. Research and Development Performed

Research and development (R&D) performed
Data are from the National Science Foundation's table of all R&D funds 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. http://www.nsf.gov/statistics

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. Data on industry output, defined as the state gross domestic product of the industrial sector, are from the Bureau of Economic Analysis. http://www.nsf.gov/statistics/http://www.bea.gov/regional/gsp/

Research and development (R&D) as a percent of gross domestic product (GDP)
International data on R&D as a percent of GDP are from the United Nations Educational, Scientific and Cultural Organization (UNESCO). The statistic measures the gross expenditure on R&D (GERD). GERD is the total intramural expenditure on R&D performed on the national territory during a given period (OECD, Frascati Manual, 2002). Data for Massachusetts' R&D as a percent of GDP are from the National Science Foundation and the Bureau of Economic Analysis. http://stats.uis.unesco.org

8. Performers of Research and Development

Data for the LTS are from the National Science Foundation's table of all R&D funds 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. http://www.nsf.gov/statistics. International data are from the United Nations Educational, Scientific and Cultural Organization.

9. Academic Article Output

Data are from the National Science Foundation's (NSF) Science and Engineering Indicators. The NSF obtained its information on science and engineering articles from the Thomson Scientific ISI database. http://www.nsf.gov/statistics/seind08/

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). The number of patents per year are based on the date patents were granted. http://www.uspto.gov.

Patents published under the Patent Cooperation Treaty
International patents published under the Patent Cooperation Treaty are from the World Intellectual Property Organization (WIPO). 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. http://www.wipo.net

11. Patenting by Field

The count of patents granted by state and patent class are from the US Patent and Trademark Office (USPTO).The number of patents per year are based on the date the patents were granted. Patents in "computer and communications" and "drugs and medical" are based on categories developed by Hall, B. H., A. B. Jaffe, and M. 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. http://www.uspto.gov

12. Technology Licensing

Data on licensing agreements are from the Association of University Technology Managers (AUTM). Institutions participating in the survey are AUTM members. The Massachusetts institutions included in the 2008 AUTM survey are listed below. http://www.autm.net

Hospitals and nonprofit research institutes	Universities
Beth Israel Deaconess Medical Center	Tufts University
Brigham and Women's Hospital	Univ. of Massachusetts
CBR Institute for Biomedical Research	Northeastern University
Children's Hospital Boston	Harvard University
Dana-Farber Cancer Institute	MIT
New England Medical Center	Boston U./Boston Medical Ctr.
St. Elizabeth's Medical Center of Boston	
Massachusetts General Hospital	
Schepens Eye Research Institute	
Tufts Medical Center	
Woods Hole Oceanographic Institution	

13. Small Business Innovation Research (SBIR) Awards

This indicator includes SBIR award data, not including Small Business Technology Transfer (STTR) awards. Data are accessed through the US Small Business Administration's Tech-Net database. http://tech-net.sba.gov/

14. Regulatory Approval of Medical Devices and Pharmaceuticals

Medical devices approvals
Data regarding medical device approvals in the US are provided by the US Food and Drug Administration. 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. http://www.fda.gov

Drug approvals
Data on the number of drug approvals are from the Pharmaceutical Research and Manufacturers of America's publication "New Drug Approvals in 2009." http://www.phrma.org

15. Business Formation

New business establishment openings
Data are from the Business Employment Dynamics database of the Bureau of Labor Statistics. http://www.bls.gov/bdm

Entrepreneurial activity
Data are from the Kauffman Foundation, as published in the 2009 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. http://www.kauffman.org/research-and-policy/kauffman-index-of-entrepreneurial-activity.aspx

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

Spinout companies
Data on spinout companies are from the Association of University Technology Managers (AUTM). Institutions participating in the survey are all AUTM members. http://www.autm.net

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 US are from Renaissance Capital's IPOHome.com. http://www.ipohome.com

Data on venture-backed IPOs for 2009 are from Thomson Reuters and the National Venture Capital Association (NVCA) via PRNewswire.com in the article "Venture-Backed Exit Market Continues to Face Challenges Despite Largest IPO in 2.5 Years" published October 1, 2009. http://www.prnewswire.com/. Data for 2004-2008 venture-backed IPOs are from Thomson Reuters and the NVCA via the Boston Globe in a graphic accompanying the article "Executives hope busy IPO week is precursor to rebound" by D.C. Denison published September 23, 2009. http://www.boston.com

Mergers and Acquisitions (M&As)
Data on total number of M&As are from FactSet Mergerstat, LLC. M&A data represent all publicly announced mergers and acquisitions. http://www.mergerstat.com

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's table of all R&D funds by state, performing sector, and source of funds. Data used are the entries for federal funding for universities and nonprofits, excluding university and nonprofit federally funded research and development centers (FFRDCs). http://www.nsf.gov/statistics

National Institutes of Health (NIH) funding per capita and average annual growth rate
Data on federal health R&D are from the NIH. 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. The figures also do not reflect health R&D spending by other federal agencies, such as Department of Defense, Department of Energy, Environmental Protection Agency, and Veterans Affairs. http://www.nih.gov

18. Industry Funding of Academic Research

Data are from the National Science Foundation's Survey of R&D Expenditures at Universities and Colleges. Since FY 1998, respondents have included all eligible institutions. http://www.nsf.gov/statistics/srvyrdexpenditures/

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) and the National Venture Capital Association (NVCA) in the MoneyTree Report. http://www.pwcmoneytree.com. Industry category designations are determined by PwC and NVCA. 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

Data on fundraising by venture funds are from the press release "Venture Capital Fundraising Declines Further IN 2010" by Thomson Reuters and the National Venture Capital Association on January 17, 2011. Datum on the increase in venture capital investment in clean technology is from the press release "Annual Venture Investment Increases for First Time since 2007, according to the Moneytree Report" by PricewaterhouseCoopers and the National Venture Capital Association on January 21, 2011. Data on the states with the highest number of venture-backed clean technology companies are from the document "NVCA's Spotlight on: Venture Investment in Clean Technology" by the National Venture Capital Association http://www.nvca.org

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, Current Population Survey, Annual Social and Economic Supplement, 2003 through 2009. Figures are three-year rolling averages. Data on employment rate by educational attainment are based on the full-time employment rate of the workforce. http://www.census.gov/hhes/www/cpstc/cps_table_creator.html

21. K-16 Education

TIMSS science scores
Trends in International Math and Science Study (TIMSS) is the product of a comparative assessment conducted every four years at the fourth and eighth grade levels. TIMSS is carried out by the International Association for the Evaluation of Educational Attainment and managed and directed by the International Study Center at Boston College. TIMMS involves 59 countries and eight benchmarking regions including Massachusetts. http://timss.bc.edu/.

High school attainment by the population ages 19-24
Data on high school attainment are from the US Census Bureau, Current Population Survey, Annual Social and Economic Supplement, 2003 through 2009. Figures are three year rolling averages. http://www.census.gov/hhes/www/cpstc/cps_table_creator.html

College degrees conferred
International data are from the United Nations Educational, Scientific and Cultural Organization 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 US states comes from the National Center for Education Statistics using the sum of all degrees conferred at the bachelor's level or higher.

22. Public Investment in K-16 Public Education

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 and secondary school finance data are from the US Census Bureau. Figures are presented in 2008 dollars. Data excludes payments to other school systems and non K-12 programs. http://www.census.gov/govs/www/school.html

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 Officers' State Higher Education Finance (SHEF). 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: http://www.sheeo.org/finance/shef-home.htm.

Per pupil investments in public education, international comparison
This indicator compares per pupil investments in education relative to per capita GDP. International data are from the United Nations Educational, Scientific, and Cultural Organization. The countries selected are the highest ranking for this measure among high-income nations as defined by the World Bank. According to the World Bank, "economies are divided among income groups according to 2008 gross national income (GNI) per capita, calculated using the World Bank Atlas method. The groups are: low income, $975 or less; lower middle income, $976–3,855; upper middle income, $3,856–11,905; and high income, $11,906 or more." For information on the World Bank Atlas method see http://go.worldbank.org/QEIMY0ALJ0.

State data were created by aggregating data on different educational levels. Per pupil spending on public K-12 was obtained from the US Census Bureau. The number of K-12 students enrolled in public school and spending on public higher education was obtained from the National Center for Education Statistics (NCES). The numbers of full-time equivalent postsecondary students in public schools are from the State Higher Education Executive Officers (SHEEO).

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. http://www.collegeboard.com

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 website. http://caspar.nsf.gov. Fields are defined by 2-digit Classification of Instructional Program (CIP), listed below.

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

24. Talent Flow and Attraction

Net population change
Data on population growth rate by state and the US as well as total foreign and domestic migration data are from the US Census Bureau's Population Estimates Program. This dataset is an annual release that reflects estimates of the total population as of July 1st for the respective calendar year. http://www.census.gov/popest/datasets.html http://www.census.gov/popest/archives/1980s/80s_st_totals.html

Relocations to LTS by college educated adults
Data on population mobility come from the American Community Survey table BO7009: "Residence one year ago by educational attainment, persons ages 25 and older." This is the number of people moving in and includes no information about the number moving out. It is a measure of churn and ability to attract talent. http://factfinder.census.gov

25. Housing Affordability

Housing Price Index
Housing price data are from the Federal Housing Finance Agency's Housing Price Index (HPI). 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 [technical description paper available here: http://www.fhfa.gov/webfiles/896/hpi_tech.pdf].

Housing affordability
Housing affordability figures are from the US Census Bureau, American Community Survey. The **Index** includes data from table R2515: "Percent of Renter-Occupied Units Spending 30 Percent or More of Household Income on Rent and Utilities," and R2513: "Percent of Mortgaged Owners Spending 30 Percent or More of Household Income on Selected Monthly Owner Costs." http://factfinder.census.gov

APPENDIX B

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. While 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 and Apparel" sector was removed and replaced with an experimental "Advanced Materials" sector. While "Advanced Materials" does not meet the most strict baseline criteria for analysis, it is included in an attempt to quantify and assess innovative and high-growing business activities from the former "Textiles and 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 as it represents activity that supplies critical support to other key sectors. In the 2009 edition, 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 & Medical Devices sector does not reflect any changes to the components that define the sector.

Advanced Materials

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

Bio/Pharmaceuticals, Medical Devices & Hardware

3254	Pharmaceutical & Medicine Manufacturing
3391	Medical Equipment & Supplies Manufacturing
6215	Medical & Diagnostic Laboratories
42345	Medical Equip. and Merchant Wholesalers
42346	Ophthalmic Goods Merchant Wholesale
54171	Physical, Engineering, & 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 Sciences1
334510	Electro Medical Apparatus Manufacturing[1]
334517	Irradiation Apparatus Manufacturing

Business Services

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

Computer & Communications Hardware

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

Defense Manufacturing & Instrumentation

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

1. Seven-digit NAICS are apportioned to this sector based on more detailed industry data from one of two U.S. Census Bureau sources: County Business Patterns or the Economic Census.

334518 Watch, Clock, & Part Manufacturing

334519 Other Measuring & Controlling Device Manufacturing

3364 Aerospace Product & Parts Manufacturing

Diversified Industrial Manufacturing

3279 Other Nonmetallic Mineral Product Manufacturing

3321 Forging & Stamping

3322 Cutlery & Handtool Manufacturing

3326 Spring & Wire Product Manufacturing

3328 Coating, Engraving, Heat Treating, & Allied Activities

3332 Industrial Machinery Manufacturing

3333 Commercial & 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 & Commodity Contracts Intermediation & Brokerage

5239 Other Financial Investment Activities

5241 Insurance Carriers

5242 Agencies, Brokerages, & Other Insurance Related Activities

5251 Insurance & Employee Benefit Funds

5259 Other Investment Pools & Funds

Healthcare Delivery

6211 Offices of Physicians

6212 Offices of Dentists

6213 Offices of Other Health Practitioners

6214 Outpatient Care Centers

6216 Home health care services

6219 Other ambulatory health care services

622 Hospitals

Postsecondary Education

6112 Junior Colleges

6113 Colleges, Universities, & Professional Schools

6114 Business Schools & Computer & Management Training

6115 Technical & Trade Schools

6116 Other Schools & Instruction

6117 Educational Support Services

Scientific, Technical, & Management Services

5416 Management, Scientific, & Technical Consulting Services

5417 Scientific Research & Development Services *

5419 Other Professional, Scientific, & Technical Services

Software & Communications Services

5111 Newspaper, Periodical, Book, & 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, & Related Services

5415 Computer Systems Design & Related Services

8112 Electronic & Precision Equipment Repair & Maintenance

With 2002 NIACS add 516110 Internet publishing & broadcasting and 518112 Web search portals

With 2007 NIACS add 51913 Internet publishing & broadcasting and web search portals

*Minus the portion apportioned to the Bio sector

Notes

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