Executive Index of the Massachusetts Innovation Economy 2003

MASSACHUSETTS
TECHNOLOGY
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The Massachusetts Innovation Outlook Series

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Dear Reader:

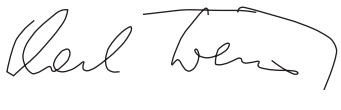
This year, we are pleased to present the *Executive Index of the Massachusetts Innovation Economy*, a report based on a set of 15 quantitative indicators that track the performance of the state's Innovation Economy. Since 1997, the Massachusetts Technology Collaborative (MTC) has produced an annual *Index* report analyzing the innovation process, and capital and human resources that grow and sustain the Innovation Economy in the Commonwealth.

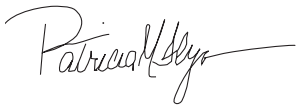
This year, the *Index* is part of a new MTC Innovation Outlook Series that consists of several reports that bring to the forefront emerging technologies and processes that will influence the state's economy. The *Index* for 2003, which is called an *Executive Index*, has a reduced number of indicators from earlier years. These indicators are those most aligned with the innovation process and the resources that support it. Instead of a Special Analysis within the *Index*, key areas of growth and development are now provided in separate reports in the MTC Innovation Outlook Series. Page 27 of the Executive Index includes a description of these reports.

The *Executive Index* examines not only the strengths of the Massachusetts Innovation Economy, but also areas of concern that need to be addressed by the state if it is to remain at the forefront of innovation and economic development. The 2003 report shows that Massachusetts has numerous strengths that include relatively high levels of venture capital and federal investments, a well-educated workforce and substantial innovation outputs such as patents and invention disclosures.

However, the state continues to face several challenges which the Commonwealth must address if it is to remain a leader in the Innovation Economy. Important issues include the creation of more affordable housing to retain the state's current population and attract new residents; the development of ways to compete with other states that have launched extensive marketing and incentive campaigns to lure companies and talent; and encouraging all residents to participate in the Innovation Economy through novel and widely available educational and training programs.

We hope that this *Index* stimulates discussion and action in the community. We welcome your insights and suggestions.





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The Massachusetts Innovation Economy was struck a blow in 2002 as the state's economy was greatly affected by the fall out in the telecommunications industry; decreased spending in Information Technology (IT); layoffs and closings by several local employers; and local government budget cuts.

While the 2003 *Executive Index* shows that total key industry cluster employment decreased by more than 6% from 2001 to 2002 in the state, most of the key industry clusters have had relatively stable employment over the past five years, and continue to represent 1 in 4 of all private sector jobs in Massachusetts. Several key industry clusters in Massachusetts have experienced noticeable declines in employment over time, including Computer & Communications Hardware; Defense Manufacturing & Instrumentation; Diversified Industrial Support; and Textiles & Apparel. The chart below shows the average annual growth rate in each of the nine key industry clusters from 1998 to 2002, as well as the total employment in each cluster in 2002.

In addition to the changes in key industry cluster employment, the *Executive Index* notes several shifts in key components of the overall Massachusetts economy. These include:

Idea Generation and Business Performance

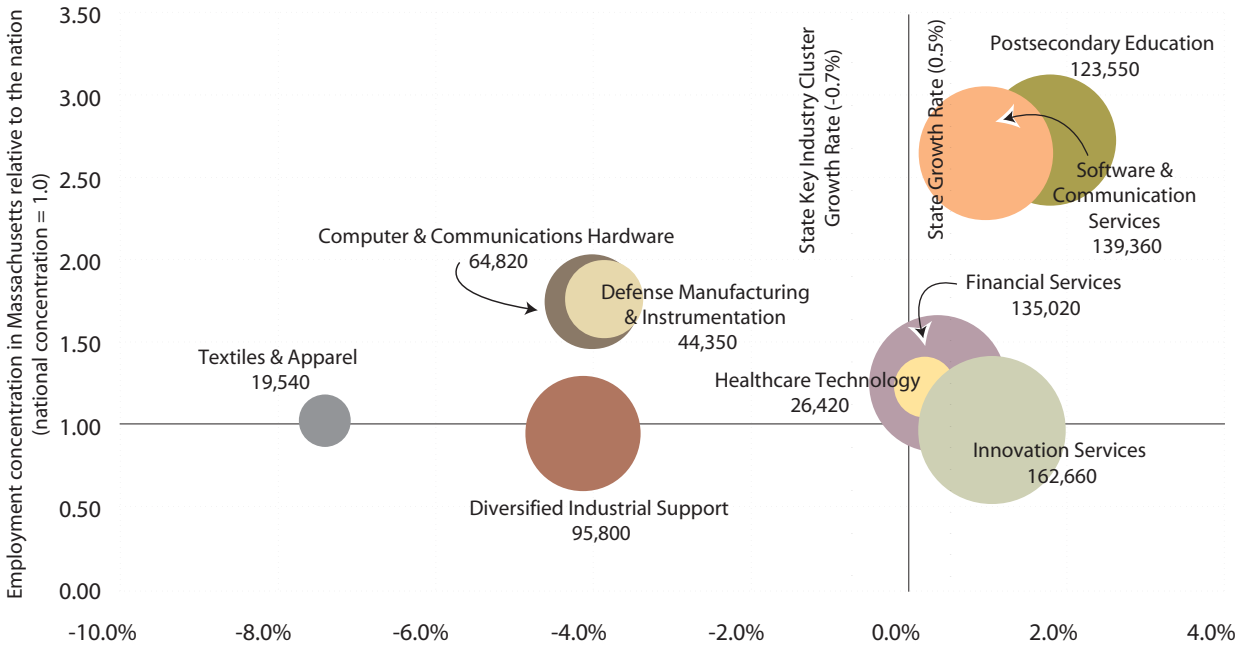
⇔ Although Massachusetts continues to be one of the leaders in the country in per capita Small Business Innovation Research Awards (SBIRs), Massachusetts has experienced a decline in its total number of SBIR awards since 1999.

⇑ There were 26,770 new business incorporations registered in Massachusetts in 2002, a 26.6% increase from the previous year, and the largest one year increase in over nine years.

⇓ From 1998 to 2002, Massachusetts had the largest decrease in total number of "Tech Fast 500" companies when compared to the Leading Technology States (LTS).

⇓ The state also had the largest percent decline in total number of corporate headquarters with 500 or more employees from 2001 to 2002 when compared to the LTS. Massachusetts has lost several of these corporate headquarters to California, North Carolina, and Virginia.

Portfolio of nine key industry clusters by employment concentration and growth, Massachusetts, 1998–2002



Note: Numeral below name of industry cluster is 2002 total employment

Source: Economy.com

Labor Force and Population

⇓ In 2002, more than 28,000 people moved out of Massachusetts, a 35.3% increase from the previous year. Domestic out-migration has been steadily increasing each year since 1998.

⇔ While the total number of engineering degrees granted in Massachusetts institutions increased from 2001 to 2002, the total number of PhD degrees awarded in the state declined by over 15%, which was the largest decline since the 1998–1999 time period.

⇓ The median price of a single-family home in Massachusetts was $268,000 in 2002, the third-highest among the LTS and considerably higher than the U.S. average of $185,000. From 1998 to 2002, the median price of a single-family home in the state has increased at an annual average rate of 7.1%, the third highest percentage increase among the LTS and higher than the U.S. (5.0%).

Education

⇔ High school student interest in pursuing health and biology majors in college has declined in Massachusetts from 1998 to 2002. There has been increased student interest in the fields of Education, Engineering, Computer and Information Science, and Mathematics.

⇓ From 1990 to 2000, Massachusetts enrollments in public degree granting institutions fell by 1.5%, compared to an 8.4% increase nationwide, and a 21% increase in California.

⇓ For FY2003, Massachusetts ranked last among the LTS in per capita appropriations to public higher education at $155, and had a 2.8% decrease in funding from the previous fiscal year. Massachusetts was the only LTS to experience a decline in per capita funding for this period.

Capital Investments

⇔ Total venture capital investments in Massachusetts have decreased 50% from 2001 to 2002 ($4.8 billion to $2.4 billion), consistent with a nationwide decline in venture capital financing. However, the state continues to receive approximately 10% of all venture capital investments in the U.S. over time, and is second only to California in total dollars.

⇑ On a per capita basis, Massachusetts universities, academic health centers, and nonprofit research institutions had the highest federally-funded R&D expenditures ($403) of the LTS in 2001. Total federal healthcare R&D expenditures in Massachusetts were approximately $1.7 billion in 2001, placing the state second among the LTS in total federal healthcare R&D funding (California ranked first with just over $2.2 billion).

Although many components of the Massachusetts Innovation Economy have experienced noticeable declines over the past couple of years, several of the indicators have returned to performance levels achieved in the mid to late 1990s, such as venture capital. However, the *Executive Index* does show numerous signs of struggle in Massachusetts and the state must not assume that its historic strengths in the Innovation Economy are impenetrable, for there has been increased competition from other states and countries for innovative businesses and a talented labor force. As the economy continues to slowly recover and regain strength, it is critical that the Commonwealth takes action towards addressing several of its chronic, long-term growth issues if it is to remain at the forefront of the Innovation Economy.

The direction of the arrow reflects the performance of the Massachusetts Innovation Economy in the *2003 Index*:

⇑ Denotes a strength

⇔ Indicates mixed progress

⇓ Denotes a sign of weakness

What is the *Index* and the Massachusetts Innovation Economy?

This is a report on the Massachusetts economy. Like most such reports, it uses statistics to illustrate how the state's economy performs, and compares its performance to that of other high technology state economies throughout the country. These states are referred to as the Leading Technology States (LTS), and they include: California, Colorado, Connecticut, Minnesota, New Jersey, and New York.

But unlike many other economic studies, the *Executive Index* does not report on the entire economy of Massachusetts. The *Executive Index* does not cover all the industries active in the state, or all the jobs in the state. Instead, the *Executive Index* focuses on interrelated industry groups—or "clusters"—that are significant in Massachusetts, and fifteen statistical indicators that shed light on the state of innovation in Massachusetts.

Why does the *Index* do this?

The *Executive Index* is based upon the premise that innovation is a critical factor in the growth of the state's economy. The industry clusters featured in this report represent industries that are heavily concentrated in Massachusetts compared to the U.S. economy as a whole. The *Executive Index* focuses on key industry clusters to better understand how the state's climate for innovation influences the growth of these clusters, and to help gain important insights into the entire Massachusetts economy.

Why Is Innovation Important?

Innovation is one of the most important factors behind economic growth in today's global economy. With the United States competing against countries with lower costs, innovation may be the most important factor in generating future economic growth. Some economists estimate that as much as two-thirds of U.S. economic growth during the 1990s was due to the introduction of new technologies, particularly information technologies (IT).

Many people tend to think that innovation and technology are the same thing, but businesses innovate all the time, with and without new technology. Boston's financial services industry has steadily grown for decades, thanks in part to the creation of the mutual fund—not a technology, but an innovative way of purchasing and holding stocks on behalf of investors. Economists now speak of innovation as the result of a series of inter-related processes that range from basic scientific research to methods of finance and business strategy. Increasingly they speak of these processes as part of a national innovation system.

Why Does Innovation Matter to Massachusetts?

If innovation is extremely important to the U.S. economy, it is critically important to the Massachusetts economy. For 150 years or more in Massachusetts, new industries with new technologies have supplanted older, shrinking industries with older technologies. Recently, the state's Internet and data communications hardware and software companies picked up the economic slack left by the decline of minicomputer and defense electronics firms during the late 1980s.

Innovation not only creates new products and processes, it also creates new industries, which in turn generate new jobs in the state. Innovation creates a competitive edge for Massachusetts firms, which increasingly compete with companies all over the world. Just as important, innovation fosters productivity—increased economic output from workers in Massachusetts. Higher productivity cuts the cost of doing business: an important result, because the state's costs of doing business have been historically high relative to the rest of the U.S. Sustained productivity creates the conditions for increased wages and living standards.

Harvard University Professor Michael Porter and Monitor Group recently summed up the process this way in their report for business and government leaders: "The central economic goal. . . should be to attain and sustain a high and rising standard of living for. . . citizens. The ability to earn a high and rising standard of living depends on increasing productivity which in turn depends on innovation. The central challenge then in enhancing prosperity is to create the conditions for sustained innovation output."**

For a complete description of the data and analysis utilized in the *Executive Index*, see page 23.

***Clusters of Innovation: Regional Foundations of U.S. Competitiveness, Professor Michael E. Porter, Harvard University and Monitor Group, for The Council on Competitiveness, 2001.*

About the 2003 *Executive Index*

The Framework for Innovation

The 2003 *Executive Index* measures the progress of 15 indicators related to the Massachusetts Innovation Economy. The *Executive Index* includes the following components:

- Employment: Job growth in key industry clusters.
- Innovation Processes: Dynamic interactions that translate ideas and resources into results—idea generation, commercialization, and entrepreneurship.
- Resources: Critical public and private inputs to the Innovation Economy—human and investment resources.

The format of this document reflects the relationship among these indicators. The *Executive Index* begins by presenting key industry cluster employment in the Massachusetts Innovation Economy and follows with indicators that focus on the state's innovation processes. It concludes by presenting a number of resources that fuel the Innovation Economy.

Selecting Indicators

Indicators are quantitative measures that tell us how well Massachusetts is doing: whether we are going forward or backward, getting better, worse, or staying the same.

A rigorous set of criteria was applied to all potential indicators. All of the selected indicators:

- Are derived from objective and reliable data sources;
- Are statistically measurable on an ongoing basis;
- Are bellwethers that reflect the fundamentals of economic vitality;
- Can be understood and accepted by the community; and
- Measure conditions in which there is an active public interest.

Historical Trends and Comparisons with Leading Technology States

Tracking the Massachusetts Innovation Economy over time is crucial for regularly assessing its strength and resilience.

In addition, benchmark comparisons provide an important context for understanding how Massachusetts is doing in a relative sense. Thus, in many cases, the Massachusetts indicator is compared with the national average or with a composite measure of six competitive Leading Technology States (LTS). The six LTS chosen for comparison in the 2003 *Executive Index* are California, Colorado, Connecticut, Minnesota, New Jersey, and New York. The LTS were selected based on similar industry clusters employment to Massachusetts and higher than average employment in several of the nine industry clusters relative to the U.S. average. Appendix A describes the methodology for selecting the LTS.

Key Industry Clusters

The impact of innovation on key industry clusters is critical to the state's economy. Nine industry clusters that significantly affect the state and are linked uniquely to the Innovation Economy are highlighted. These clusters range from the long established, such as Postsecondary Education and Defense Manufacturing & Instrumentation, to the relatively new clusters, such as Innovation Services and Software & Communication Services. Starting this year, the *Index* has moved from the four-digit Standard Industrial Classification (SIC) to the four-digit North American Industry Classification System (NAICS) to study and track the performance of the nine key industry clusters. Appendix B provides a detailed definition for each of these clusters.

Together, these nine clusters account for 25% of non-government (private) employment in Massachusetts. Government employment includes Federal, State and local workers, postal workers, and education workers at the state and local level.

The Innovation Imperative

For the third consecutive year, the *Index of the Massachusetts Innovation Economy* benchmarks a struggling Massachusetts economy.

Fortunately, signs now abound that an economic recovery is underway. The important question for Massachusetts become: Just what will recover, and how fast?

In many ways, the recession that began in 2000 was a perfect storm that lashed out at precisely those industry sectors that grew most rapidly in Massachusetts in the 1990s: financial services, software, and computer and communications hardware (See Indicator 1). The proportion of jobs lost in these industry clusters far outpaced those lost in the state's overall economy.

Most economic projections now find market demand in all these sectors firming up. For example, overall international spending on Information Technology (IT) is now expected to grow to upwards of 8 to 9 percent per year over the next two years.

Even so, growth in IT and other markets important to Massachusetts are not expected to grow at anywhere near the rates of the 1990s. The Massachusetts Innovation Economy will not pick up where it left off in 2000. It must compete in a changed and very challenging global environment.

Highly innovative industry clusters in Massachusetts grew rapidly in the 1990s because highly innovative products fueled demand: the economic pie got bigger, and innovative products commanded a premium. As "irrational exuberance" gave way to recession and slow recovery, industry clusters have been forced to compete more on cost. The state's comparatively high costs of doing business are a drag on competitiveness that is offset, in better times, by high productivity in the state's workforce and high rates of innovation in goods and services. Meanwhile, high costs of living continue to challenge the state's ability to retain younger, talented workers: in 2002, the median price of housing in Massachusetts was as much as $83,000 above the U.S. median (See Indicator 15), and contributed to continued domestic out migration (See Indicator 10).

Cost competition has intensified as some technologies mature and low-cost locations around the world become increasingly competitive. The well-reported examples are in Information Technology (IT); analysts expect that as many as 3.3 million IT jobs in the U.S., or even more, will be outsourced to locations such as India over the next decade. [1]

Industry clusters that grew rapidly in Massachusetts in the 1990s were among those U.S. industries that enjoy extraordinarily high rates of productivity, due primarily to the absorption of IT. While high productivity is the foundation of the state's long-term competitiveness, and of long-term wage gains, in the short-term, the economic slowdown and high productivity combine to reduce demand for workers. At mid-year, University of Massachusetts economist Alan Clayton-Matthews estimated that ongoing productivity gains could result in a further 10 percent job loss in computer hardware and related sectors, even if production rates stabilized. [2]

Like many states, Massachusetts has continued to lose major corporate headquarters. (It will lose FleetBoston Financial and John Hancock Financial Services in coming months.) Few firms have emerged to replace them; the EMC Corporation is the only Massachusetts-based firm to join the Fortune 500 in a decade or more. In 2002, the decrease in major corporate headquarters in Massachusetts was faster than in competitor states (See Indicator 8). In the past, major Massachusetts-based corporations not only brought a level of stability to the state and its workers; they also served as training grounds for local entrepreneurs, as a source of investment in innovative research, and as sources of philanthropy that supported education and civic institutions.

In the absence of such "mother ship" firms, Massachusetts' prosperity becomes even more dependent on new venture creation and the growth of early-stage firms. Unfortunately, the number of young, high-growth firms in Massachusetts has also trailed that of competitor states in recent years (See Indicator 8).

The state's reliance on new ventures and young, high-growth firms underscores the critical role that innovation plays in the long-term health of the Massachusetts economy. The private investors and venture capitalists who fund new ventures seek high returns on investments, which are often associated with firms that have disruptive or radically innovative products and services. High rates of innovation generate the premiums that create value-added jobs that draw on the education and skill levels of the state's workforce, and offset the state's high costs.

The best example is the state's last economic recovery and expansion in the mid-1990s. The Massachusetts economy grew rapidly on the basis of new and radical innovations in telecommunications products and services, the rise of the commercial Internet, and the explosive growth of the World Wide Web.

1 For example, see Katherine Mieszkowski, "Gone in the blink of an eye," Salon, November 5, 2003.

2 See Alan Clayton –Matthews, "Economic currents," Benchmarks Summer 2003 edition, University of Massachusetts Donahue Institute, p. 6.

The Prognosis for Innovation in Massachusetts

Many of the signs for innovation in Massachusetts are good.

This year's *Executive Index* shows that Massachusetts continues to attract high levels of research funding from the federal government. The state has benefited in particular from the large increase in federal life science funding in recent years (See Indicator 13). Massachusetts also benefits from major federal programs such as the National Nanotechnology Initiative; three Massachusetts-based institutions (Massachusetts Institute of Technology, Harvard University, and the University of Massachusetts-Amherst) lead the list of universities that have won NNI support over the last three years. [3]

Patents and licenses generated by university researchers have continued to increase at healthy rates, and in a wide range of fields that provide welcome diversity to the state's R&D portfolio (See Indicator 3).

For its size, Massachusetts continues to receive more Small Business Innovation Research (SBIR) awards than any state in the country (See Indicator 6).

In 2002, Massachusetts recorded the largest one year increase in new business incorporations in nine years (See Indicator 5).

While venture capital invested in Massachusetts firms has dropped 50 percent from 2001 to 2002, the state has moderately improved its overall share of total U.S. venture capital investment (See Indicator 14).

In today's globally competitive economy, Massachusetts cannot take its innovative advantage for granted any more than it can take its overall competitiveness for granted. While the state enjoys continued high levels of federal R&D support, its overall "market share"of support continues to decrease as other states build up their research capabilities. (Background in MTC's Innovation Outlook: R&D Funding Scorecard—Federal Investments and the Massachusetts Innovation Economy at www.masstech.org/innovationoutlook)

Looking Ahead

Massachusetts rises or falls on its Innovation Economy.

The state is heavily dependent upon the success of industry clusters that are globally competitive, and must therefore succeed on their ability to bring innovative, high value- added products and services to market. [4] These clusters create the high value-added jobs that draw on the state's workforce skills and its high productivity. The success of innovation and industry clusters depends on the success of private initiative and investment, but the state can do much more to strengthen the fundamental conditions for continued innovation. For example:

High costs

A decade of fiscal policy, including tax incentives and cuts, has reduced the state's image as inhospitable to business. Massachusetts should now look for opportunities to bring broad innovation strategies to the task of managing the state's relatively high costs. The Massachusetts Technology Collaborative's Innovation Outlook Report on advanced health care technology outlines one such strategy to address the state's high health care costs. (See "Advanced Technologies to Lower Health Care Costs and Improve Quality" at www.masstech.org/innovationoutlook). A second major target for innovation is the state's relatively high housing costs; in 2002, Massachusetts had the third highest median home price when compared to the Leading Technology States (LTS).

Long-term investment

The strengthening position of other states in R&D is often correlated with increasing investment and increasing enrollments in public and private universities. Massachusetts has lagged in investment in its public universities and is losing market share in enrollments in both public and private sector colleges and universities (See Indicator 11). As Massachusetts recovers from the recession, it should look to resume long-term investment in education, particularly public higher education. New investments in training are particularly vital, given the fact that the "creative destruction" of firms, now intensified by global competition and rapidly-maturing technologies, creates a constant need for skill upgrades among the state's workers. Finally, limited, targeted investments in research facilities and research centers are also necessary, given the intensifying competition among states and foreign countries for new research and development investment.

Capturing jobs from the development of innovative new products

Massachusetts needs to take actions that will improve its chances of harvesting the good jobs that emerge from its immense base of R&D research and development. Initiatives by the state's universities to expand outreach to business and to improve technology transfer are very important, as are steps to streamline permitting and regulation of production facilities for the biotechnology, medical device, and other high-technology firms. For example, the Massachusetts Biotechnology Council estimates that as much as 8 percent of the current "pipeline" of new pharmaceuticals under review at the U.S. Food and Drug Administration emanate from Massachusetts-based firms—an historic high. Yet the manufacturing jobs that may be created as a result are the object of fierce competition among states. [5]

3 Statistics compiled by Dr. M. Roco, National Science Foundation; view at Massachusetts Nanotechnology Initiative, www.masstech.org/nano.

4 Recent rankings compiled by the Corporation for Economic Development (CED) find the Massachusetts economy more dependent than any other state on 'traded' clusters, or clusters that primarily create goods and services for export outside state borders. See "2003 Development Report Card for the States," at http://drc.cfed.org

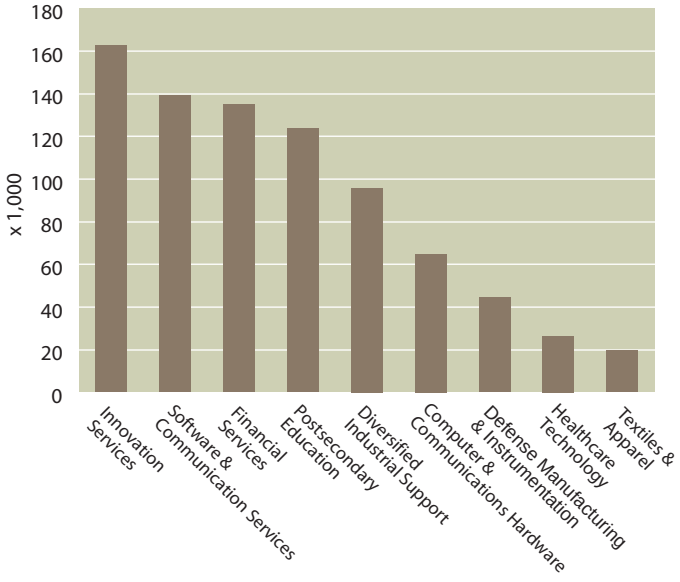
5 See "Mass Biotech 2010," Massachusetts Biotechnology Council and the Boston Consulting Group, January 2003.

INDICATOR 1

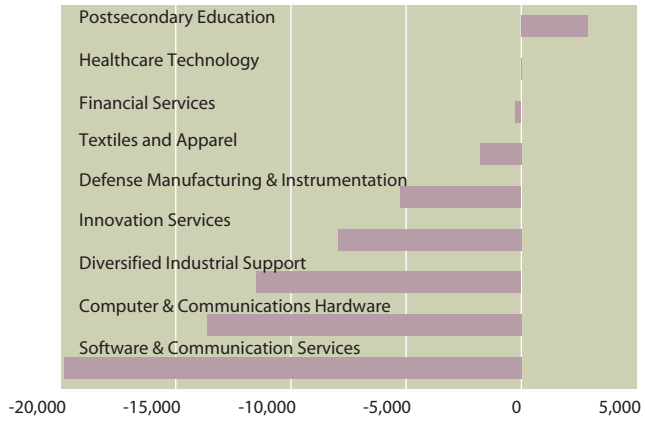
Industry Clusters Employment

Total employment, and employment in nearly all key industry clusters, decreases in 2002, the first decline in employment in five years. Computer & Communications Hardware and Software & Communication Services clusters experience highest job loss among the key industry clusters.

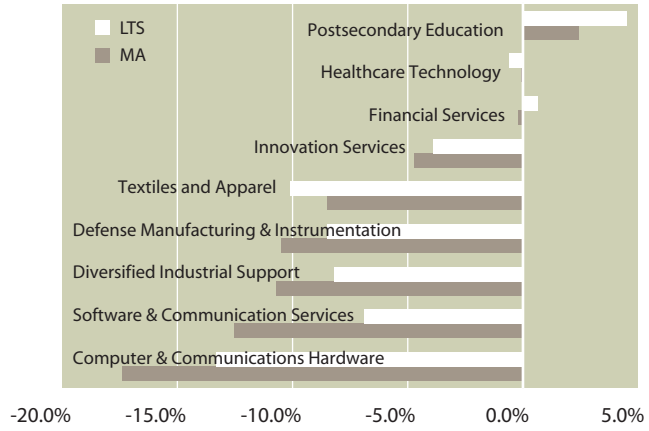
Employment in nine key industry clusters, Massachusetts, 2002



Net employment change, nine key industry clusters, Massachusetts, 2001–2002



Percent change in employment, nine key industry clusters, Massachusetts and LTS average, 2001–2002



Source of all data for this indicator: Economy.com

Why Is It Significant?

Industry clusters are important to the Massachusetts economy. Nine key industry clusters comprise 25 percent of all non-government jobs in Massachusetts. Each cluster is more highly concentrated within the Massachusetts economy than in the U.S. economy as a whole. Such high concentration is a reflection of current or past competitive advantage that helped the cluster grow in Massachusetts.

How Does Massachusetts Perform?

From 2001 to 2002, total employment in the nine key industry clusters decreased 6.6% to approximately 811,000 people. This was the highest decrease in key industry cluster employment in over five years. The decrease in total jobs statewide was 2.3%, compared to a 0.2% increase the previous year. The Innovation Services cluster was the largest employer among the nine key industry clusters in 2002 with 162,660 people, and Textiles & Apparel remained the smallest at 19,540.

Clusters closely linked to the Telecommunications and Information Technology (IT) industries experienced the largest decreases in total employment from 2001 to 2002. The Massachusetts Software & Communication Services cluster shed over 19,000 jobs (a decrease of 12.5%); it had added over 20,000 new jobs from 1999 to 2000. Among the Leading Technology States (LTS), all but New York experienced a decrease in Software & Communication Services cluster employment. The Massachusetts Computer and Communications Hardware cluster lost 13,640 jobs from 2001 to 2002 (a decrease of 17.4%). All the LTS and the U.S. experienced a double-digit decrease in Computer & Communications Hardware cluster employment.

The state's Postsecondary Education cluster was the only cluster to register an increase in jobs (2,890 new jobs, a 2.4% increase) from 2001 to 2002. This growth, however, lagged behind the LTS average (4.5%) and U.S. (4.9%) in this cluster. The Massachusetts Healthcare Technology and Financial Services clusters experienced modest decreases in total employment (-30 and -240 jobs, respectively) for the same period.

What Does this Trend Mean for Massachusetts?

In 2002, seven of the nine key industry clusters either lagged or had a higher percent decrease in growth rate than similar clusters in the LTS. In Massachusetts, only the Postsecondary Education cluster added jobs, but it did so at a slower rate than the other LTS. While there are many reasons for the reverses suffered by the key clusters (including the bear market in stocks and industry overcapacity) the rapid growth of these clusters in the 1990s was sparked in no small part by profound innovations such as the World Wide Web. Going forward, the introduction of similarly profound innovations will be a critical factor in returning high rates of growth to the state's key clusters.

INDICATOR 2

Number and Type of Patents Issued, Invention Disclosures and Patent Applications

Massachusetts and California lead in patents per capita, but its total number of patents decreases from 2000 to 2001. Patent portfolio is diverse in Massachusetts. Invention disclosures and patent applications activity continues to increase in the Commonwealth.

Why Is It Significant?

Patents reflect the discovery of innovative ideas. Strong patent activity usually reflects a strong base of commercially-relevant research and development.

Massachusetts universities, hospitals, and research institutions are important sources of innovative ideas. Individual inventors formally disclose innovations to their employing institutions to initiate the complex process toward patent protection. The next major step following disclosure is formal patent application to the U.S. Patent and Trademark Office.

How Does Massachusetts Perform?

In 2002, Massachusetts innovators were granted 60 patents per 100,000 residents, placing the state first along with California among the LTS in patents per capita. However, the absolute number of patents in Massachusetts decreased 3.4% from 2001 to 2002. Among the LTS, only California (3.1%) and Connecticut (1.0%) experienced a growth in total number of patents for the same period.

Patents in Massachusetts span a wide range of sectors. From 1998 to 2002, Healthcare was the most active area, with 24% of all patents, as compared to 20% between 1993 and 1997. Miscellaneous Industry & Transportation/ Aerospace was second with 19% of all patents from 1998 to 2002, followed by Computers (14%). Massachusetts leads the LTS in healthcare patents as a share of all patents; Minnesota ranked second (21%), followed by New Jersey (17%).

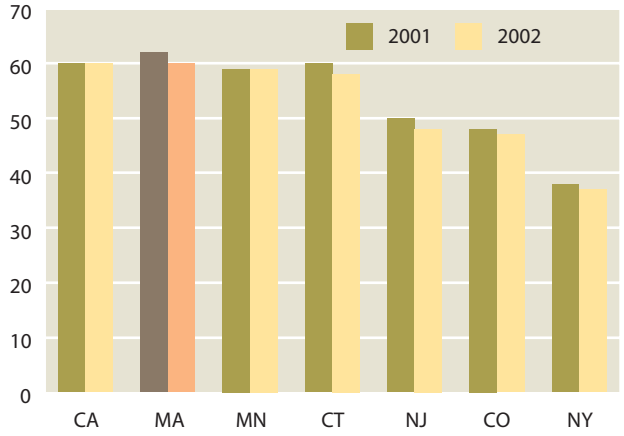
The number of invention disclosures reported annually by Massachusetts academic and nonprofit institutions increased 11.2% from 1,238 in 2000 to 1,377 in 2001. Since 1992, over 60 percent of these invention disclosures originated at universities, with the remainder based in hospitals and other nonprofit research institutions. Of the hospitals and research institutions, Massachusetts General Hospital (MGH) accounted for the highest number of invention disclosures (43.0%) in 2001. Among the universities, the Massachusetts Institute of Technology (MIT) was responsible for just over half of all the inventions disclosed for the same year.

Massachusetts universities, hospitals and research institutions filed 749 patent applications in 2001, a 27.2% increase from the previous year, and the largest one year increase in over five years. Patent applications filed by hospitals and research institutions increased by 19.4% from 2000 and 2001, while patent applications by universities soared 31.6% during this period. MIT and Harvard University accounted for two-thirds of all patent applications filed by universities.

What Does this Trend Mean for Massachusetts?

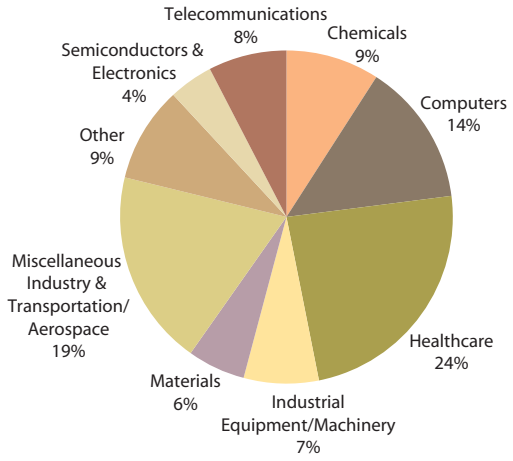
The diversity of the state's patent portfolio could serve as the basis for similar diversity among new firms in the future. However, Massachusetts experienced a decrease in total number of patents while several competitor states continue to increase their patent activity. Massachusetts can no longer take its leading position in research and development for granted. Steps by government and industry to enhance the state's R&D capabilities are a competitive necessity.

Number of patents issued to state residents, per capita, Massachusetts and other LTS, 2001 and 2002



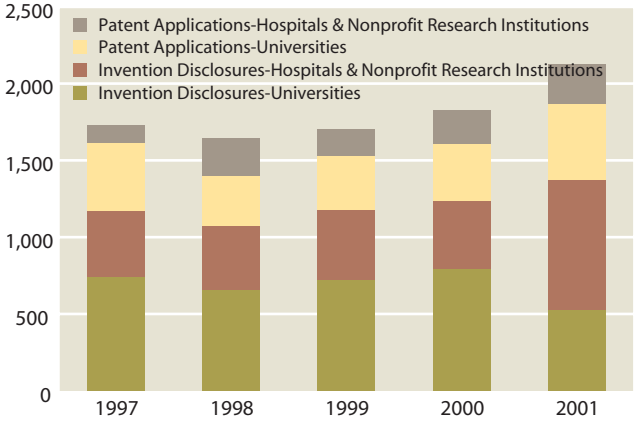
Source: U.S. Patent and Trademark Office, U.S. Census Bureau

Distribution of patents issued, Massachusetts, 1998–2002



Source: CHI Research, Inc.

Total number of new patent applications and invention disclosures filed by Massachusetts universities and hospitals & nonprofit research institutions, 1997–2001



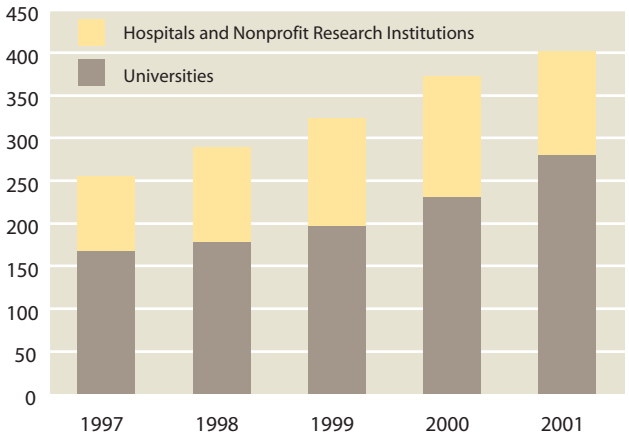
Source: Association of University Technology Managers (AUTM)

INDICATOR 3

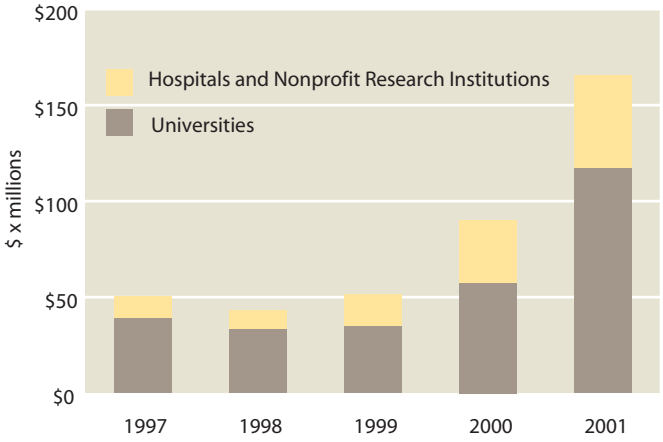
Technology Licenses and Royalties

Massachusetts universities increase number of technology licenses, but hospitals and nonprofit research institutions experience a decline in licenses from 2000 to 2001. Technology license royalties experience a sharp increase for same period.

Number of technology licenses issued by major universities, hospitals, and other nonprofit research institutions, Massachusetts, 1997–2001



Value of gross licensing income received by major universities, hospitals and nonprofit research institutions, Massachusetts, 1997–2001



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

Why Is It Significant?

Technology licenses provide a vehicle for the transfer of intellectual property (e.g., patents, trademarks) from universities, hospitals, and other research organizations to companies that will commercialize the technology. Royalties from these licenses reflect the perceived value of the intellectual property in the commercial marketplace. Royalties and license fees also flow back to the institutions to support further research activities.

Licensing revenues are affected by the disciplines in which the research is undertaken and by the degree to which university and other institutional research is focused on marketable products. The number of new technology licenses, and gross royalties derived, are indicators of the success of technology-transfer efforts by universities, hospitals, and research institutions.

How Does Massachusetts Perform?

New technology licenses issued by major universities, hospitals and research institutions in Massachusetts increased 7.8% from 373 in 2000 to 402 in 2001. The Massachusetts Institute of Technology (MIT) and Harvard University together generated more than 50% of all licenses in 2001 among universities, hospitals, and research institutions.

Gross royalties received from institutional licensing in Massachusetts jumped 84.3%, from approximately $90 million in 2000 to $166 million in 2001. In 2001, the four institutions in Massachusetts receiving the highest amount of royalties were, in descending order: MIT, Massachusetts General Hospital, Harvard University, and the University of Massachusetts (all campuses).

What Does this Trend Mean for Massachusetts?

The number of technology licenses and value of gross licensing income received by Massachusetts hospitals and universities is evidence of the commercial relevance of the state's basic research, and its continued strength in this area of the Innovation Economy. This activity highlights the importance of universities in the innovation process, as a large amount of licensing revenues are recycled back into additional research at the institution. The decline in licensing activity at the state's hospitals and nonprofit research institutions is an area of concern. Total U.S. licensing activity has also experienced a decrease from 2000 to 2001. The declines in Massachusetts and the U.S. as a whole are due in large part to the slowdown in the economy. The economy has affected Massachusetts hospitals and nonprofit institutions more severely than the universities.

INDICATOR 4

FDA Approval of Medical Devices and Biotech Drugs

Massachusetts remains one of the leaders among the LTS in number of 510(k) medical device approvals; the rate of FDA approvals for Massachusetts biotech drugs compares favorably to the LTS.

Why Is It Significant?

In the U.S. Food and Drug Administration (FDA) approval process, one of the three application categories used to classify medical devices is 510(k), which is a pre-marketing submission made to the FDA to demonstrate that the device to be marketed is as safe and effective (substantially equivalent) to a legally marketed device that is not subject to pre-market approval. [The other application categories used for medical devices are: investigational device exemptions (IDEs) and premarket approvals (PMAs).] Approval rates reflect successful product development in medical device manufacturing and important linkages to the teaching hospitals, where many of these instruments undergo clinical investigation.

The FDA's Center for Drug Evaluation and Research (CDER) approves all drugs to the U.S. market. The new drug approval (NDA) process is comprehensive, involving clinical trials and an extensive review process. Biotech drug approvals indicate successful product development in health research and pharmaceutical manufacturing as well as strong connections to the biotechnology and healthcare technology industry sectors.

How Does Massachusetts Perform?

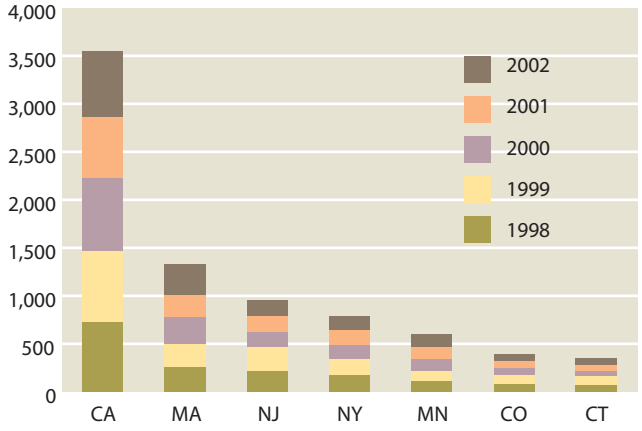
In 2002, Massachusetts received 317 510(k) approvals for medical devices, a 37.8% increase from the previous year (230), and the largest one-year increase when compared to the LTS. Colorado, Minnesota, and New York all experienced a decrease in 510(k) medical device application approvals for the same period. Among the LTS, California ranked first in 510(k) approvals with 682, while Connecticut was last with 67 510(k) approvals in 2002. Massachusetts has consistently ranked second to California over time with regards to 510(k) approvals. According to MassMEDIC, the association of medical device manufacturers in the state, there are 264 medical device companies based in Massachusetts; these firms account for 4.5% of the state's total manufacturing base.

From 1999 to 2003, Massachusetts companies received a total of 14 biotech drug approvals, placing the state third among the LTS in biotech drug approval activity. Among the LTS, California ranked first with 42 biotech drug approvals, followed by New Jersey with 27. Colorado and Minnesota each had one biotech drug approval for this period, while Connecticut had no biotech drug approvals.

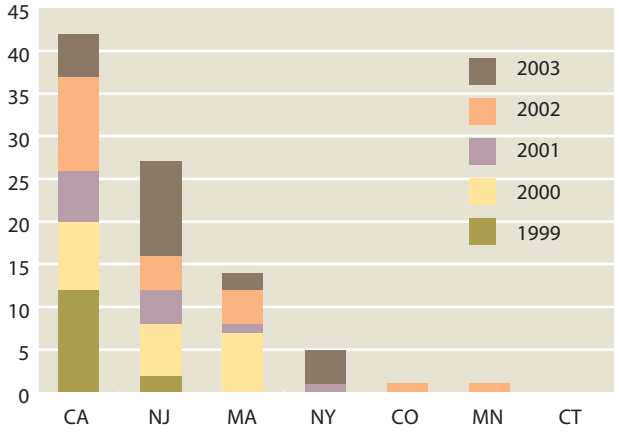
What Does this Trend Mean for Massachusetts?

Massachusetts continues to be a strong performer among the LTS in 510(k) medical device approvals and new biotech drug approvals. This creates an opportunity for the state to capture jobs associated with the manufacture of new pharmaceuticals and medical devices. Thus, the ongoing debate in Massachusetts regarding new forms of incentives for life science industry growth is very timely, as the competition for life science jobs among the states remains intense.

Total number of 510(k) approvals, Massachusetts and other LTS, 1998–2002



Total number of biotech drug approvals by the FDA, Massachusetts and other LTS, 1999–2003



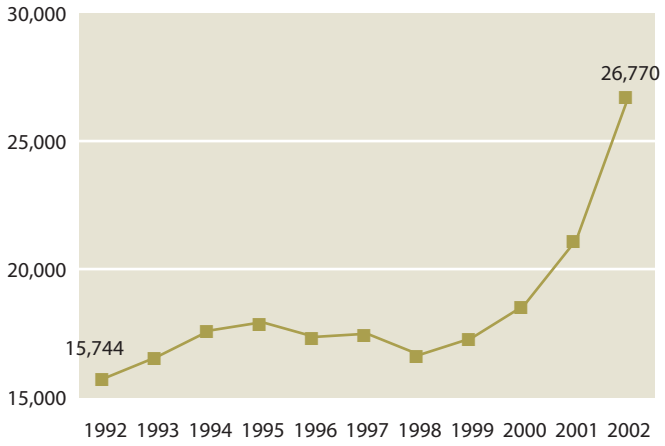
Source of all data for this indicator: Food and Drug Administration (FDA)

INDICATOR 5

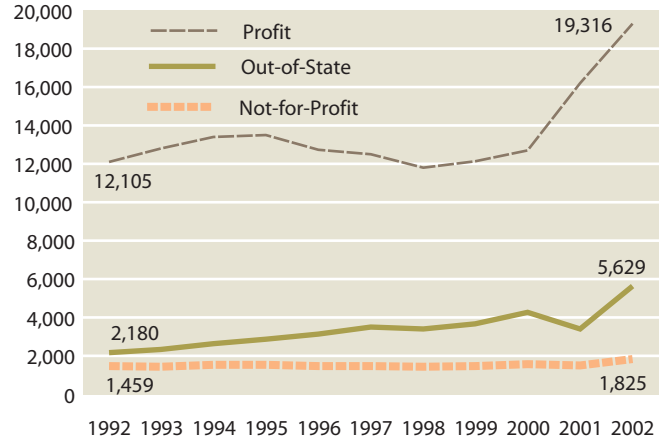
New Business Incorporations

New business incorporations increase in the state in 2002; sharp rise in number of new out-of-state business incorporations from 2001 to 2002.

Number of new business incorporations, Massachusetts, 1992–2002



Number of new business incorporations by category, Massachusetts, 1992–2002



Source of all data for this indicator: Secretary of the Commonwealth

Why Is It Significant?

The formation of new businesses is a key indicator of a robust economy. High numbers of new business starts typically indicate an economic environment capable of fostering risky and innovative ideas. Successful new companies provide new jobs, ideas, goods, and services.

How Does Massachusetts Perform?

In 2002, 26,770 new business incorporations were registered with the Secretary of State—a 26.6% increase from 2001 (21,151). Of all new business incorporations registered in 2002, 72% were for-profit businesses; 7% were not-for-profit businesses; and 21% were out-of-state corporations (which includes profit and not-for-profit).

The total number of new out-of-state business incorporations in Massachusetts increased 65% from 2001 to 2002, the largest one-year increase recorded in more than ten years. The number of new for-profit business incorporations in Massachusetts increased 19% from 2001–2002, which was a slightly smaller percent increase than not-for-profit incorporations, which experienced a 21% increase in the state.

What Does this Trend Mean for Massachusetts?

Massachusetts experienced a strong increase in new business incorporations registered with the state from 2001 to 2002, which shows the attractiveness of the Commonwealth to start a business. Since 1998, there has been a steady increase in the total number of new businesses forming in Massachusetts—a promising sign that the climate for entrepreneurial activity in the state remains strong.

INDICATOR 6

Small Business Innovation Research (SBIR) Awards

Although total number of awards decreases for second consecutive year, the total value of awards continues to rise.

Why Is It Significant?

The Small Business Innovation Research (SBIR) Program provides competitive grants to entrepreneurs seeking to conduct "Phase I" proof-of-concept research on the technical merit and feasibility of their ideas, and "Phase II" prototype development to build on these findings. The federal SBIR program is the world's largest seed capital fund for development of new products and processes, and often provides the initial revenue stream for start-up companies. Nationally, companies that receive funding from Phase II of the SBIR program significantly outperform similar companies that do not receive such support. Participants in the SBIR program are often able to use the credibility and experimental data developed through their research to attract strategic partners and outside capital investment.

How Does Massachusetts Perform?

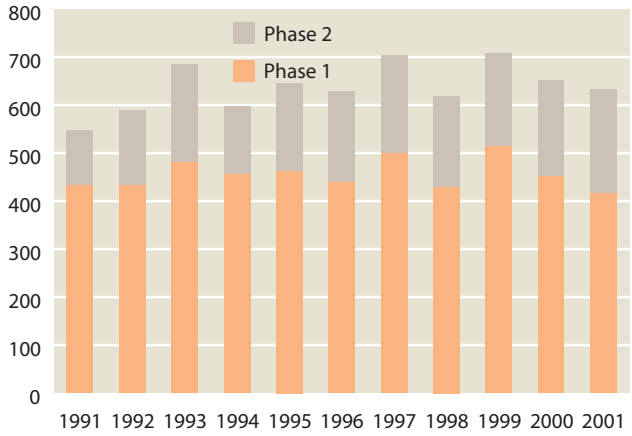
Since the inception of the program in 1983, Massachusetts has consistently ranked second behind California in total number of awards and dollar amounts received from the SBIR program. Massachusetts received a total of 633 SBIR awards in 2001, a 2.9% decrease from 2000. While Phase I awards declined by 7.3%, there was a 7.0% increase in Phase II development awards for the state. On a per capita basis, Massachusetts had the highest award rate in 2001 (9.9 awards per 100,000 people) when compared to the LTS. Massachusetts received twice as many awards per capita as Colorado (4.9 awards), its closest competitor among the LTS, and more than three times that of California (2.7 awards) in the same time period.

In 2001, the total dollar value of SBIR awards to Massachusetts companies was $167 million. Phase II awards are significantly larger in dollar value than Phase I awards. While Phase I awards represented 25.4% ($42 million) of the SBIR awards in Massachusetts in 2001, Phase II awards accounted for 74.6% ($125 million) of the total dollar value in the state.

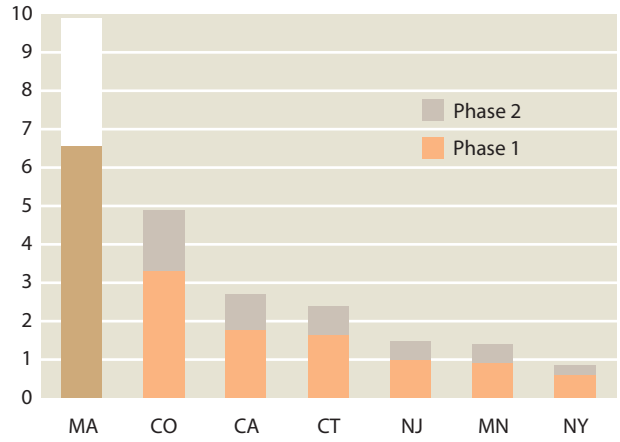
What Does this Trend Mean for Massachusetts?

On a per capita basis, Massachusetts continues to be a national leader in SBIR activity, both in total number and value of awards. While SBIR awards overall have declined, Phase II awards involving technologies that are closer to commercialization have increased in the state. This is a good indicator of the strength of the pipeline for new goods and services for the state's Innovation Economy.

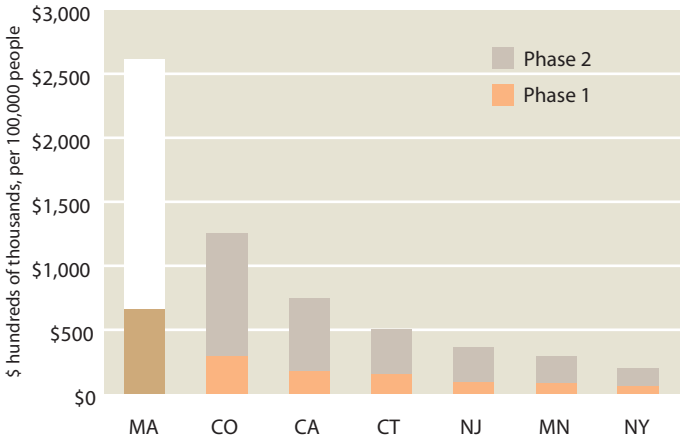
Number of SBIR awards to Massachusetts companies by phase, 1991–2001



Number of SBIR awards to Massachusetts and other LTS companies by phase, per 100,000 people, 2001



Value of SBIR awards to Massachusetts and other LTS companies by phase, per 100,000 people, 2001



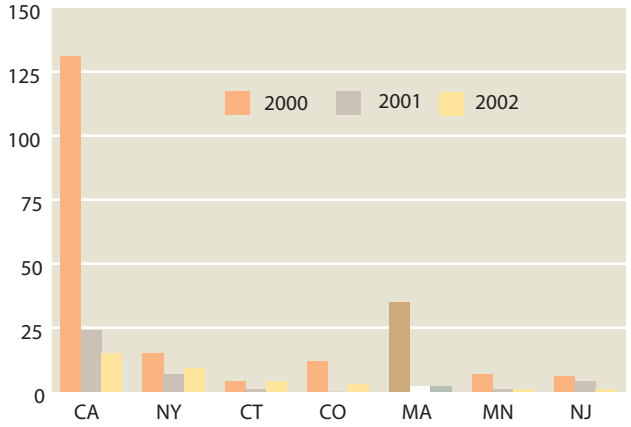
Source of all data for this indicator: Small Business Administration

INDICATOR 7

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

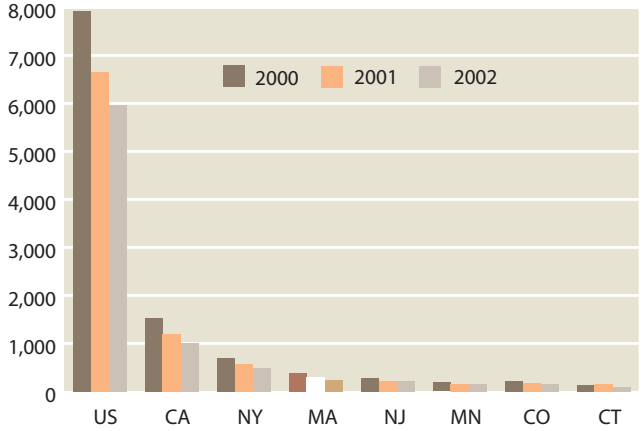
IPO market for Massachusetts and the U.S. remains flat in 2002; total number of M&As decreases for second consecutive year in the state and U.S.

Total number of initial public offerings (IPOs), Massachusetts and other LTS, 2000–2002



Source: IPO.com

Total number of mergers and acquisitions (M&As) activity of acquired companies located in Massachusetts, other LTS and US, 2000–2002



Source: Mergerstat

Why Is It Significant?

The number of initial public offerings (IPOs) is one indicator of future high-growth companies. "Going public" raises significant capital to invest and stimulate next-stage growth in a company. A successful IPO reflects confidence by investors that a company can generate increases in value, sustain growth, and produce satisfactory returns on investment. Mergers and acquisitions (M&As) are another important avenue to liquidity and expansion for entrepreneurs and investors in rapidly growing companies. Innovation-based niche companies may be attractive to other firms seeking to diversify, expand sales or market share, and create an integrated service model that can further develop technologies and products.

How Does Massachusetts Perform?

Massachusetts had two IPOs in 2002, the same as in 2001. Nationwide, the IPO market also continued to be weak, with a total of 64 IPOs in 2002, a 12.3% decrease from 2001, and an 84.8% decrease from 2000. In 2002, Massachusetts was fifth among the LTS, with California leading in IPO activity with 15 IPOs, followed by New York with 9. From 2001 to 2002, New York, Connecticut, and Colorado were the only LTS to experience an increase in total number of IPOs. More than half of all the IPOs in the U.S. in 2002 were located in the seven LTS.

Both IPOs in Massachusetts in 2002 were in the Financial Services industry cluster (Heritage Property Investment Trust, Inc. and Safety Insurance Group, Inc.). For the LTS as a whole, the industries with the most IPO activity included: Entertainment, Financial Services, Food Services, Healthcare, and Software & Communications Services.

The total number of M&As in Massachusetts decreased 22.7% to 239 in 2002, which was the second highest percent decline of the LTS. Among the LTS, Connecticut experienced the largest decrease (-36.4%) in the number of M&As from 2001 to 2002, while New Jersey was the only LTS to have an increase in total number of M&As (214 to 220). Nationally, the number of M&As dropped 10.4% during this period. Approximately 40% of all M&A activity in the United States occurred in the seven LTS.

What Does this Trend Mean for Massachusetts?

IPO activity in the U.S. and in Massachusetts remained depressed in 2002, at least by 1990s standards. Low IPO activity in Massachusetts remains a concern, as access to public capital is limited, and much private capital remains locked up in existing investments, thus inhibiting the formation and the growth of new firms. The state's large venture capital industry is an enormous boon to its Innovation Economy, so as the U.S. economy recovers, the Commonwealth should watch carefully for signs of renewed investment by local investors in new Massachusetts-based firms.

The decrease in M&A activity in Massachusetts and almost all of the LTS, which began in 2000, reflected the overall economic slowdown experienced in the nation. Historically, Massachusetts and several other LTS (including California, New York, and New Jersey) have ranked in the top ten in the U.S. in total number of acquired companies, so the data do not necessarily mean bad news for the state. However, it is important to track M&A activity in Massachusetts and its benefits to the state. The Commonwealth should continue to support activities that foster growth and expansion within the state so that it does not lose companies to out-of-state competitors.

INDICATOR 8

Corporate Headquarters and Number of "Tech Fast 500" Firms

Number of corporate headquarters in Massachusetts decreases in 2002; state experiences second largest decline in number of "Tech Fast 500" firms compared to LTS for same period.

Why Is It Significant?

Corporate headquarters are important "anchors" of industry clusters. They spawn and acquire new businesses, and corporations typically keep their key strategists and development-related activities near their headquarters. Corporate headquarters tend to have greater community ties, including philanthropic support, than do branch offices.

The "Tech Fast 500" list is one measure of the state's success in hosting high-growth firms. The list is compiled by the firm of Deloitte and Touche, and includes firms that devote a significant proportion of revenues to R&D and show significant revenue growth over five years.

How Does Massachusetts Perform?

In 2002, Massachusetts was home to the corporate headquarters of 210 firms with 500 or more employees, a 14.3% decrease compared to the previous year (245). From 2001 to 2002, all the LTS experienced a decrease in corporate headquarters, but Massachusetts had the largest percent decline. There were several contributing factors in the Massachusetts decline. A majority of firms (59%) that were no longer on the corporate headquarters list in 2002 still resided in the state, but had downsized to below 500 employees. However, 30% of the companies had either moved to another state or were acquired by a company based outside of Massachusetts. California, North Carolina, and Virginia were the most popular states for relocation. The remainder of the companies no longer on the corporate headquarters list had either closed (7%) or had been acquired by a Massachusetts-based company (4%).

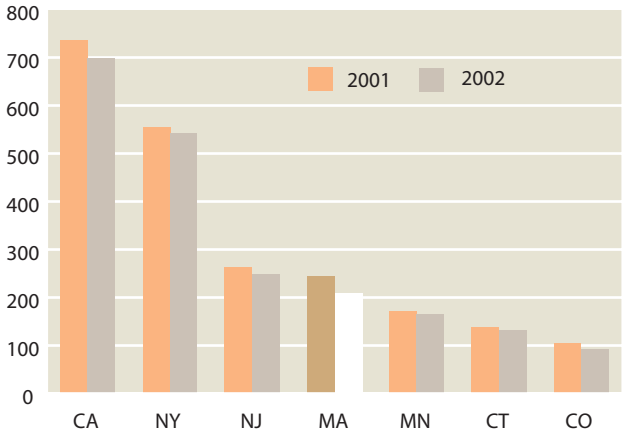
Massachusetts was home to 28 "Tech Fast 500" companies in 2002, ahead of most of the LTS, including New York (24), Colorado (14), Minnesota (13), and Connecticut (10). In Massachusetts, Software companies comprised 57% of all "Tech Fast 500" firms, followed by Life Sciences (18%) and Internet (11%) companies. California was first among the LTS with 151 companies, followed by New Jersey (33). Over 50 percent of all "Tech Fast 500" firms in the U.S. are headquartered in the seven LTS.

Despite having the third highest number of "Tech Fast 500" companies of the LTS, Massachusetts has experienced the largest decrease (50%) in the number of these firms from 1998 to 2002. However, the majority of Massachusetts firms (86%) that did not make the "Tech Fast 500" list over time from 1998 to 2002 remained in the state, but no longer met the revenue criteria established by Deloitte and Touche. The remainder of the firms (14%) either closed or were acquired by an out-of-state company.

What Does this Trend Mean for Massachusetts?

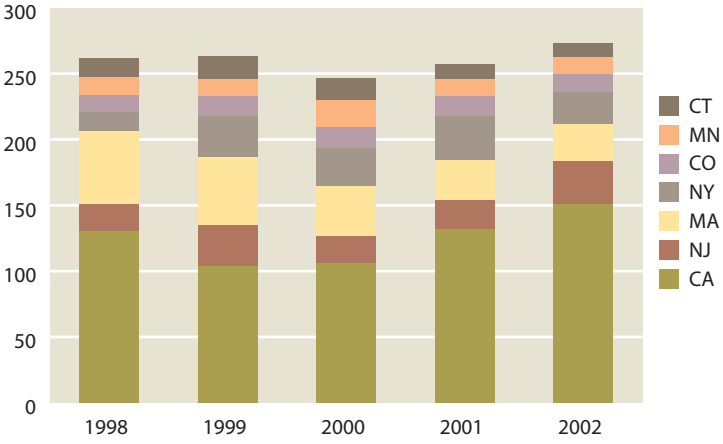
In 2002, corporate headquarters of firms with 500 or more employees in Massachusetts and all the LTS decreased for the first time since the *Index* began tracking this data in 1998. While the majority of downsized firms remained in Massachusetts, almost a third of the firms relocated to other states. Several of these states have begun aggressive marketing and other incentive packages to lure businesses to their area. Here again, the current debate in Massachusetts over economic development and the attraction and retention of firms is very timely.

Number of corporate headquarters located in Massachusetts and other LTS, corporations with more than 500 employees, 2001 and 2002



Source: Reference USA

Total number of "Tech Fast 500" firms located in Massachusetts, other LTS, 1998–2002



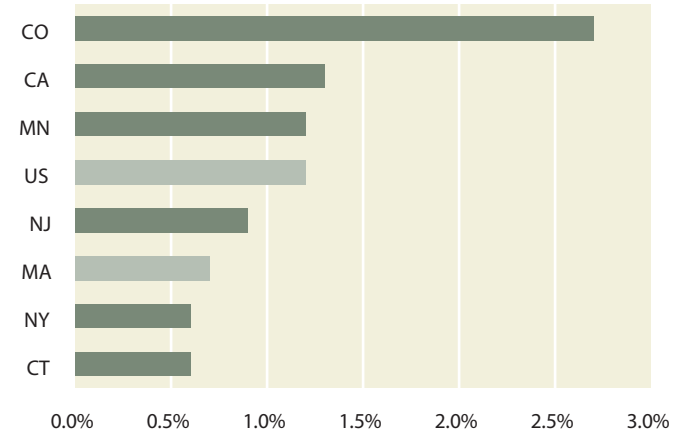
Source: Deloitte and Touche

INDICATOR 9

Population Growth Rate, Unemployment Rate, and University Enrollments

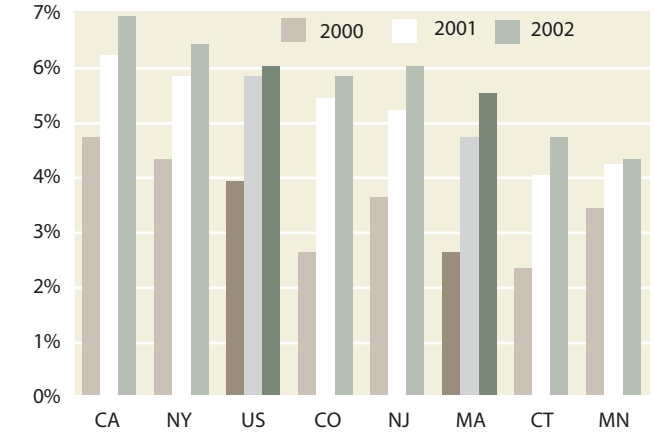
State and U.S. unemployment rates have been increasing significantly since December 2000. Enrollments in the state's public higher education institutions decrease over time, while private higher education experiences modest increases in enrollment compared to the LTS and U.S. Meanwhile, Massachusetts continues to have relatively low population growth.

Average annual population growth rate, Massachusetts, other LTS, and US, 1992–2002



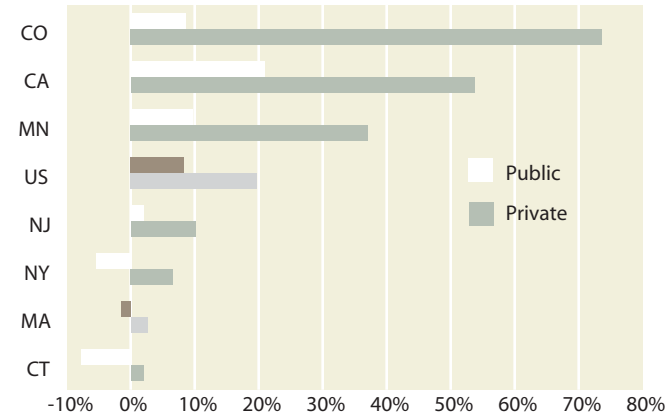
Source: U.S. Census Bureau

Unemployment rate, seasonally adjusted, Massachusetts, other LTS, and US, December 2000–2002



Source: U.S. Bureau of Labor Statistics

Percent change in total enrollment public and private degree granting institutions, Massachusetts, other LTS, and US, 1990–2000



Source: National Center for Education Statistics

Why Is It Significant?

The state's population growth rate represents changes in births, deaths, and movement from state-to-state or to other countries. Population trends affect the pool of workers available as well as the pool of potential students. The unemployment rate is also an important measure for the Innovation Economy, indicative of the state's capability to employ residents, and of its untapped pool of potential workers. The quantity and quality of institutions of higher education in a region are critical in developing and attracting talent and skills of people both in state and out-of-state. Students often choose to reside and work in the region where they received their degree.

How Does Massachusetts Perform?

From 1992 to 2002, Massachusetts experienced an average annual population growth rate of 0.7%, which was the third lowest among the LTS (Connecticut and New York had the lowest rate, each at 0.6%). The nation grew at 1.2% annually during the same period. Among the LTS, Colorado had the highest average annual population growth rate at 2.7%, followed by California at 1.3%.

As of December 2002, Massachusetts had an unemployment rate of 5.5%—the third-lowest unemployment rate among the other LTS and the nation (6.0%). Minnesota had the lowest unemployment rate of 4.3%. California had the highest rate among the LTS with 6.9%. Since December 2000, all the LTS and the nation have experienced significant increases in the unemployment rate. As of September 2003, Massachusetts' unemployment rate had increased to 5.7%, while the U.S. unemployment rate rose slightly to 6.1%.

From 1990 to 2000, Massachusetts enrollments in public degree granting institutions decreased 1.5%, compared to an 8.4% increase for the nation. Massachusetts was one of three LTS to experience a decrease (Connecticut and New York also declined at 7.8% and 5.4%, respectively). Among the LTS, California had the highest increase at 20.9%, followed by Minnesota at 9.7%, and Colorado at 8.6%.

Private degree granting institutions in Massachusetts experienced a 2.6% increase from 1990 to 2000. Among the LTS, only Connecticut was lower at 2.0%. The national increase during this period was 19.7%. Colorado (73.6%) and California (53.7%) experienced the largest increases in enrollment in private degree granting institution enrollments during the decade. These two states have also led the LTS in population growth rates over the past ten years.

What Does this Trend Mean for Massachusetts?

Massachusetts' population growth rate is slow and is expected to be so for many years to come. This helps keep unemployment rates relatively low even in the face of widespread layoffs. Since the majority of students in Massachusetts are state residents, the relatively slow population growth impacts enrollments in higher education. Massachusetts has been a vital hub of higher education, which attracts high tech companies and professionals. The state should work toward increasing the share of the population that is enrolled in higher education institutions, and ensuring access to affordable educational programs to help individuals of all ages in the state reach their full potential. In addition, recruiting more students from other states will help bolster enrollments in higher education in Massachusetts and expand the base of talented workers. The Innovation Economy is highly dependent on colleges and universities and on a well-educated workforce—key factors of Massachusetts competitive strengths historically. Massachusetts must do all it can to support and strengthen these resources if it is to remain a leader in innovation and technology.

INDICATOR 10

Migration

While Massachusetts experiences an increase in domestic out-migration, international in-migration jumps to its highest level in more than ten years. Individuals from Asia and Central America comprise over one-third of all immigrants intending to reside in Massachusetts in 2001.

Why Is It Significant?

Labor-force expansions can help to sustain the economic growth of a region as employers have a larger pool of workers from which to hire. Alternatively, labor shortfalls, particularly in areas of high demand, can constrain economic growth as employers experience staffing shortages. The immigrant workforce population has been important to the Massachusetts Innovation Economy for a state that has been constrained by low domestic population growth rates for more than a decade.

How Does Massachusetts Perform?

Massachusetts has experienced annual domestic out-migration since 1990. In 2002, more than 28,000 moved out of Massachusetts, a 35.3% increase from the previous year (20,751). Massachusetts international in-migration continues to offset domestic out-migration. During the same period, 32,244 immigrants moved into the state from other countries, a 55.8% increase from the previous year, and the highest international in-migration experienced in the state in over ten years. International in-migration explains why overall net migration turned positive in 2002 (4,170), for the first time since 1998–1999.

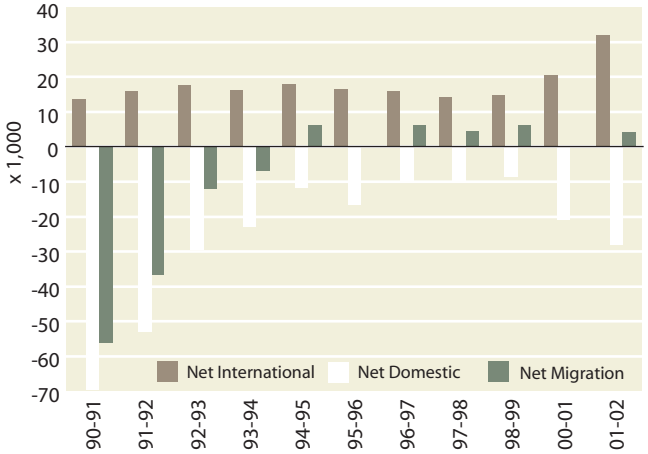
In 2001, close to 29,000 immigrants entering the U.S. indicated Massachusetts as their intended state of residence. This represented 2.7% of all immigrants coming to the U.S., and a 23.3% percentage point increase from the year before for the state. Immigrants from Asia had the highest percentage (26%) intending to reside in Massachusetts, followed by Central America (11%) and the Caribbean and Eastern Europe (each at 8%). A recent study by Northeastern University's Center for Labor Market Studies showed the wide range of educational experiences of immigrants in the New England region. From 1990–2001, while 31% of the region's new immigrant workers held a bachelor's degree or higher, approximately 25% of New England's new immigrants lacked a high school diploma or GED. The study reported 34% percent of the native population in New England held a bachelor's degree or higher, and only 9% did not hold a high school diploma or GED for the same period.

What Does this Trend Mean for Massachusetts?

The continuing and increasing domestic out-migration from the state is a major cause for concern, and potentially a significant impediment to the state's Innovation Economy. Many of these individuals are college graduates. The cost of living and relatively high housing costs are partly to blame, but further study should be done on the reasons for, and ways to reduce, this exodus of talented individuals.

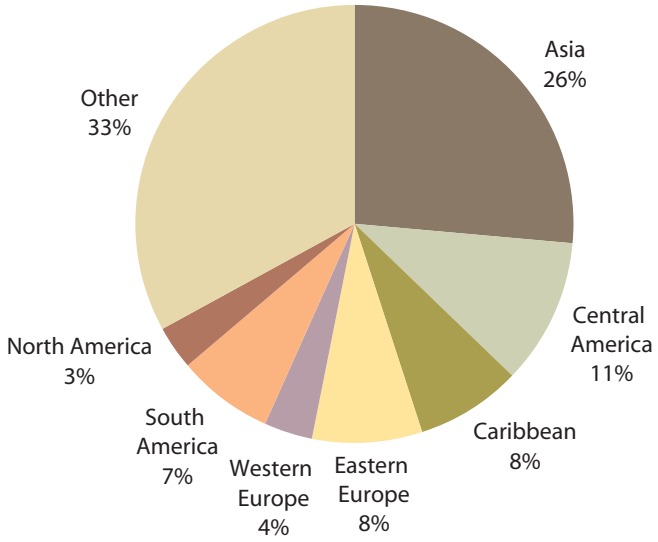
International in-migration has helped offset the thousands who have left the state, but in-migration alone should not be viewed as the long-term solution to generating and nurturing the workforce needed to attract and retain high technology and innovative companies. Massachusetts companies have historically been active users of the H1-B visa program to fill highly-skilled vacancies. However, use of the program has been called into question as an increasing number of technical jobs are outsourced to foreign countries. The state needs to work with the less educated and low skilled immigrants to prepare them for employment in the state's economy. Massachusetts must also continue to work to retain its talented workforce.

International in-migration and domestic out-migration, Massachusetts, July 1990–July 2002



Source: U.S. Census Bureau

Distribution of immigrants intending to reside in Massachusetts, 2001



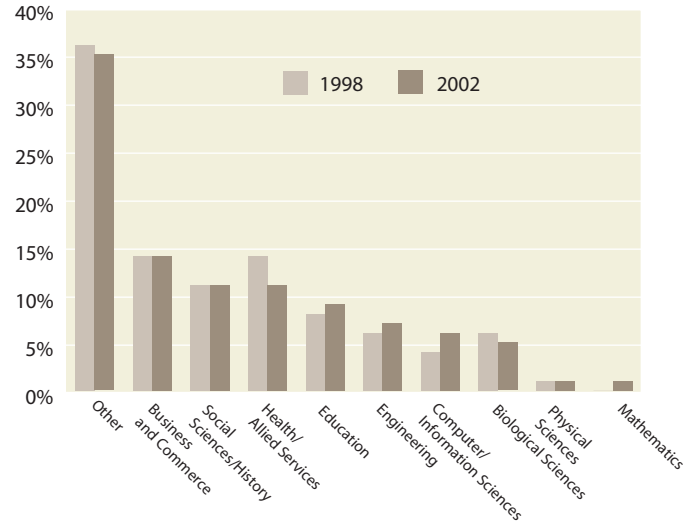
Source: Immigration and Naturalization Services

INDICATOR 11

High School and College Education

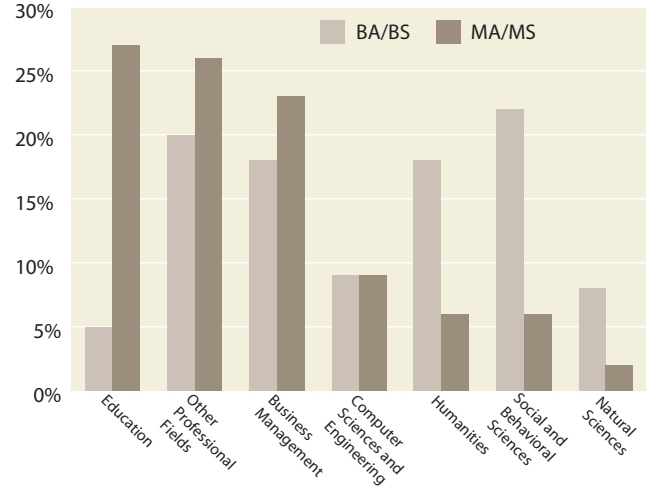
Massachusetts high school students show interest in diverse college majors; highest number of bachelor's degrees in state are in fields of Social & Behavioral Sciences and Humanities, while Education and Business Management fields comprise largest number of master's degrees. Massachusetts has lowest per capita state appropriations to operational expenses at public universities among the LTS.

Distribution of intended college majors, high school students taking the SAT, Massachusetts, 1998 and 2002



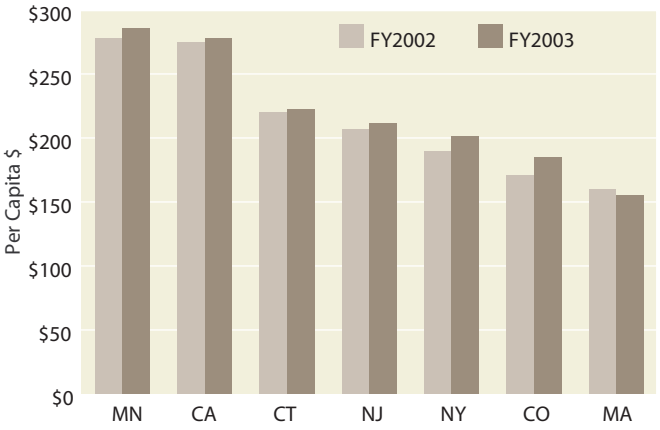
Source: College Board Online

Distribution of Bachelor's and Master's Degrees conferred by degree-granting institutions, by field of study, Massachusetts, 2000



Source: National Center for Education Statistics

Appropriations of state/local tax funds for operational expenses of public higher education per capita, MA and other LTS, fiscal years 2002 and 2003



Source: Grapevine Center for Higher Education

Why Is it Significant?

Strong mathematical, scientific, and communications skills are a prerequisite for many occupations in the Innovation Economy, many of which require a college degree or higher. Most colleges and universities require the Scholastic Aptitude Test (SAT) as part of the admissions requirement. The profile of intended majors of college-bound seniors who take the SAT is an important indicator of the interests that high school students have in those fields that are critical to the growth of the Innovation Economy.

The educational attainment level of the workforce is a fundamental indicator of how well a region can generate and support knowledge-based, innovation-driven economic growth. The fields of undergraduate and advanced degrees conferred at local institutions of higher education indicate a population's readiness and interest to enter professions that are important to the growth of the Innovation Economy.

How Does Massachusetts Perform?

In 2002, the most popular intended majors of Massachusetts high school students taking the SAT included Business & Commerce (14%), Health & Allied Services and Social Sciences & History (each at 11%), Education (9%), and Engineering (7%). Massachusetts students' interest in occupations related to Health and Allied Services was higher in 1998 (14%) compared to 2002, and there has been a slight decline in interest in the field of Biological Sciences (6% to 5%) for the same period. However, there has been an increase in student interest from 1998 to 2002 in the fields of Education, Engineering, Computer & Information Sciences, and Mathematics.

In 2000 (latest data available), Massachusetts degree-granting institutions conferred 42,308 bachelor's degrees and 24,819 master's degrees, which comprised 3.4% and 5.4%, respectively, of all such degrees conferred in the U.S. The most popular bachelor's degree fields of study were Social & Behavioral Sciences at 22%, followed by Humanities and Business Management, each at 18%. Education comprised the smallest percent (5%) of all bachelor's degrees conferred at Massachusetts academic institutions. Among master's degrees conferred in 2000 in Massachusetts institutions, the most popular degree fields were Education (27%) and Business Management (23%). Master's degrees conferred in the Natural Sciences comprised the smallest percentage (2%) of the total. Natural Sciences include the fields of biological sciences, physical sciences and science technologies, and mathematics.

From 1992 to 2002, Massachusetts appropriations to public universities have increased at an average annual rate of 5.6%, which is the highest percent increase when compared to the LTS during this period. For FY2003, however, Massachusetts ranked last among the LTS with appropriations of $155 per capita towards public higher education expenditures, a decrease of 2.8% from the previous fiscal year, and was the only LTS to experience a decrease in funding. Among the LTS, on a per capita basis, Colorado had the highest percent increase (8.0%) in public university expenditures from FY2002 to FY2003. Minnesota ranked first among the LTS in FY2003 at $285, followed by California at $278.

What Does this Trend Mean for Massachusetts?

The growing interest of high school students in pursuing engineering, computer & information science, and mathematics is good news for the state in generating a strong labor pool for the Innovation Economy. Students should continue to be encouraged to take more science courses. Massachusetts cannot become complacent with its educational outputs. A strong public sector higher education system is needed to complement private higher education. Low and declining support per capita threatens the Massachusetts Innovation Economy and its well-educated workforce strength.

INDICATOR 12

Scientists and Engineers as a Percent of the Total Labor Force; Engineering and Computer Science Degrees

Massachusetts continues to have a relatively high percentage of scientists and engineers in its workforce. The total number of engineering degrees from 2001 to 2002 continues to increase. However, the number of engineering and computer science PhDs sharply declines.

Why Is It Significant?

Regions that are well-served by postsecondary computer science and engineering programs have a strong workforce advantage in the creation of new products and ideas. The potential pool of new engineers and computer scientists for technology-related industries is an important indicator of future workforce resources for the state.

How Does Massachusetts Perform?

In 2001, 0.91% of Massachusetts' total labor force was comprised of scientists and engineers, the same as in 1999. The state had the highest percentage compared to the LTS, and double the national average (0.45%) in 2001. Connecticut was second with 0.62%, followed by Colorado at 0.58%. From 1999 to 2001, most of the LTS (Connecticut, Colorado, New York, and Minnesota) experienced a slight decrease in its percentage of scientists and engineers in the labor force. The scientists and engineers number constitutes all those that hold a doctorate degree.

Massachusetts experienced a 2.9% increase in total number of engineering degrees awarded, from 4,528 in 2001 to 4,660 in 2002, slightly below the U.S. increase of 3.0%. At the undergraduate level, the number of engineering degrees awarded by Massachusetts schools increased 6.9% (2,384 versus 2,548). Nationally, undergraduate engineering degrees increased 5.3% during the same period.

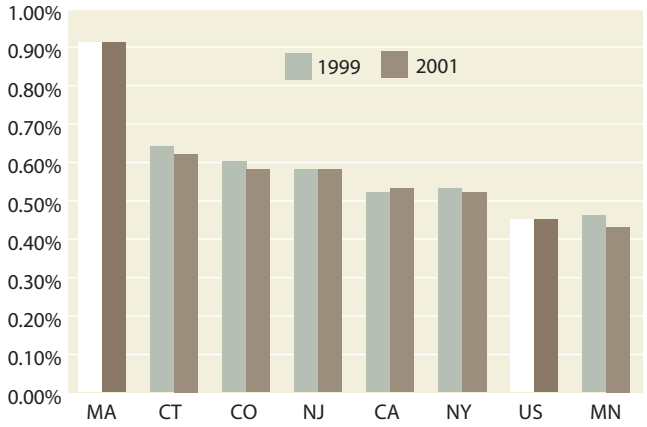
At the graduate level, the number of master's engineering degrees awarded by Massachusetts institutions increased by 1.4% in 2002, compared to a slight decline in the U.S. total (-0.1%). However, the total number of engineering PhDs awarded in Massachusetts decreased 15.1%, which was the largest percent decline since the 1998–1999 time period. Nationally, there was a 4.5% decrease in the number of engineering PhDs from 2001 to 2002.

In 2001, Massachusetts institutions granted 38 doctorates in computer science, the third-highest number among the LTS, and comprised approximately 5% of all computer science doctorates awarded in the U.S. However, Massachusetts experienced a 28.3% decrease from 2000 to 2001 in doctoral computer science degrees, which was the largest one year decline compared to the LTS and U.S. Among the LTS, New York (16.4%) and California (0.8%) were the only LTS to experience an increase in doctoral computer science degrees. More than 1 in 3 doctoral degrees in computer science was granted in an institution located in one of the seven LTS.

What Does this Trend Mean for Massachusetts?

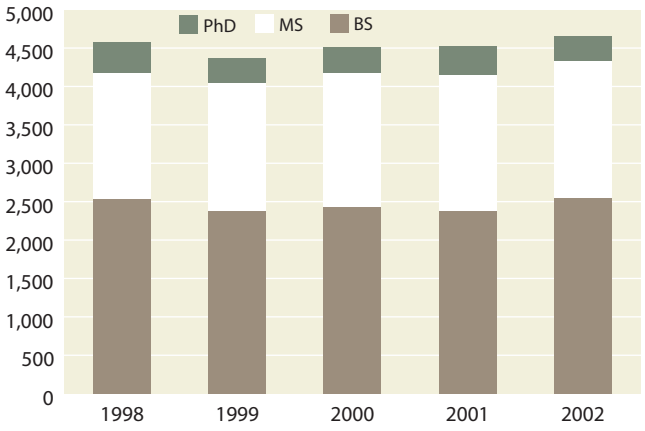
Engineering and computer science are key fields for the Innovation Economy. The modest increase in engineering degrees granted at the undergraduate level in Massachusetts is a good sign. Massachusetts also leads the LTS in its percent of the labor force that are PhD scientists and engineers. However, the state's sharp percent decline in both PhD computer science and engineering degrees awarded are areas of concern. The reasons behind the recent substantial decreases in advanced computer science and engineering degrees awarded in Massachusetts need to be explored as do ways the state can attract more students to pursue these degrees.

Scientists and engineers as a percent of the total labor force, MA, LTS, and US, 1999 and 2001



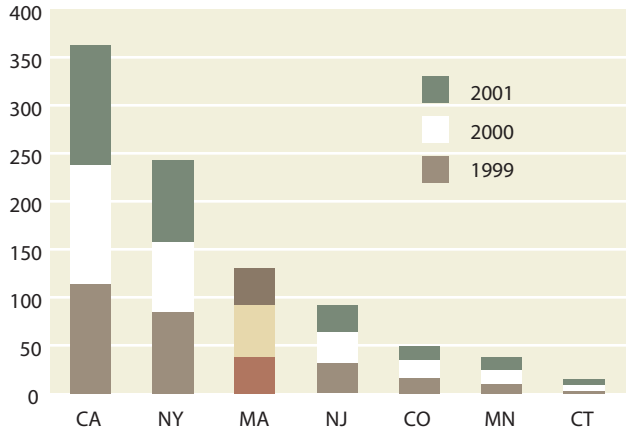
Source: National Science Foundation and Bureau of Labor Statistics

Number of engineering degrees awarded by Massachusetts institutions, by degree level, 1998–2002



Source: American Association of Engineering Societies

Total number of doctoral computer science degrees granted, Massachusetts and LTS, 1999–2001



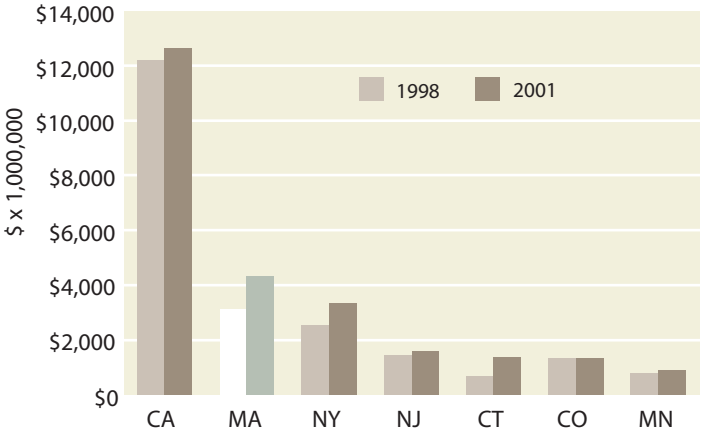
Source: National Science Foundation

INDICATOR 13

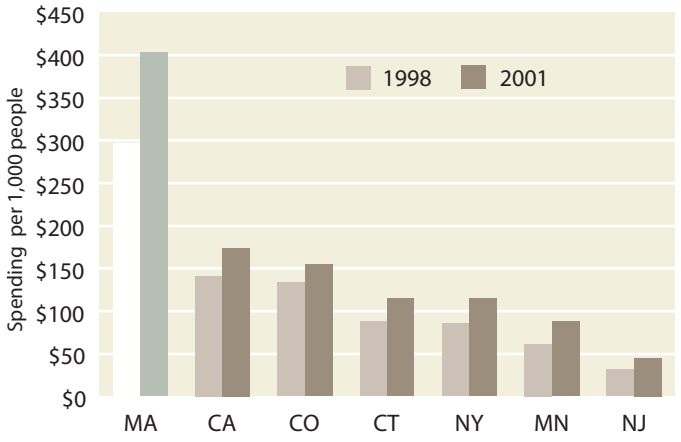
Federal R&D Spending and Health R&D Spending

Massachusetts is second only to California in total federal R&D expenditures.
Massachusetts ranks first among the LTS in per capita federal R&D expenditures.

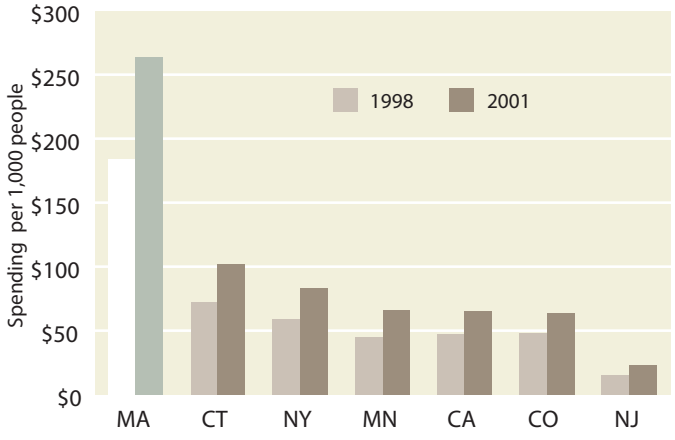
Total federal R&D expenditures in academic and nonprofit research institutions, Massachusetts and other LTS, 1998 and 2001



Federal R&D expenditures in academic and nonprofit research institutions per 1,000 people, Massachusetts and other LTS, 1998 and 2001 (2001 $ inflation adjusted)



US Department of Health and Human Services R&D expenditures, per 1,000 people, Massachusetts and other LTS, 1998 and 2001 (2001 $ inflation adjusted)



Source of all data for this indicator: National Science Foundation

Why Is It Significant?

Research universities and other academic centers are pivotal in the Massachusetts economy, and federal R&D spending is a primary source of their funding. R&D conducted by academic institutions also has a pronounced effect in stimulating private sector R&D investments.

The National Institutes of Health (NIH) is the major funder of health-related research in the United States. It is the largest source of federal funding for non-defense research. NIH-funded research is a critical driver for Massachusetts biotechnology, medical device, and health services industries. More than 95% of the U.S. Department of Health and Human Services (HHS) R&D expenditures occur through the NIH.

How Does Massachusetts Perform?

In absolute dollars, Massachusetts universities, academic health centers, and nonprofit research institutions received a total of just over $4.3 billion in federal R&D expenditures in 2001, which was second only to California ($12.6 billion) when compared to the LTS. From 1998 to 2001, total Massachusetts R&D dollars increased 38.7%, second only to Connecticut (98.9%). New Jersey experienced the smallest percent increase among the LTS (9.1%). Total federal R&D spending in Massachusetts academic and nonprofit research institutions was $2.6 billion in 2001, placing the state second among the LTS in absolute R&D spending (California ranked first in total R&D spending with $6.0 billion).

On a per capita basis, Massachusetts universities, academic health centers, and nonprofit research institutions had the highest federally-funded R&D expenditures ($403) of the LTS in 2001. The next closest LTS, California, was at less than half that amount ($174). From 1998 to 2001, per capita federally-funded R&D expenditures at Massachusetts academic institutions increased 35.7%. Among the LTS, Minnesota experienced the largest increase at 41.9%, while Colorado had the smallest increase at 15.7%.

In the field of health, Massachusetts had the highest per capita federally-funded R&D expenditures ($264) of the LTS in 2001. The state's health-related funding is more than double the closest LTS, Connecticut ($102). From 1998 to 2001, HHS funding per capita for Massachusetts increased 43.5%, which was the third highest percent increase among the LTS. New Jersey was first with a 48.8% increase, followed by Minnesota at 45.7%. Total federal healthcare R&D expenditures in Massachusetts were approximately $1.7 billion in 2001, placing the state second among the LTS in total federal healthcare R&D funding (California ranked first with just over $2.2 billion).

What Does this Trend Mean for Massachusetts?

Massachusetts continues to do well in attracting federal R&D funding. Strong R&D dollars reflect the collaborative effort taking place between the federal government and research institutions within the state. The high levels of health R&D expenditures attracted by Massachusetts institutions have contributed to the growth and strength of the Life Sciences cluster in the state. However, Massachusetts' position is vulnerable to other states gaining on the Commonwealth in attracting federal dollars for health-related research and development. State government and the private sector are well-advised to collaborate on new measures to sustain the state's leadership in science and technology.

INDICATOR 14

Venture Capital

Although Massachusetts venture capital investments remain relatively low in 2002, the state's share of total U.S. venture capital investments continues to remain strong.

Why Is It Significant?

Venture capital is one of the main sources of funding used to grow new companies. (Other sources include personal savings; investment by family, friends, and individual investors; and short-term debt, including credit cards.) The amount of venture capital invested and the types of industries supported are predictors of new products and services, job creation, and revenue growth in a region.

How Does Massachusetts Perform?

Massachusetts venture capital investments continued to remain at low levels in 2002. The amount of venture capital received by Massachusetts companies reached approximately $2.4 billion in 2002, down 50% from 2001 ($4.8 billion). Massachusetts received 11.4% of the total venture capital dollars invested in the United States in 2002, down slightly from 11.9% in 2001. The levels of venture capital funding coming into the state are comparable with the levels received during the mid to late 1990s, considering that the year 2000 was a record breaking year for venture capital investments.

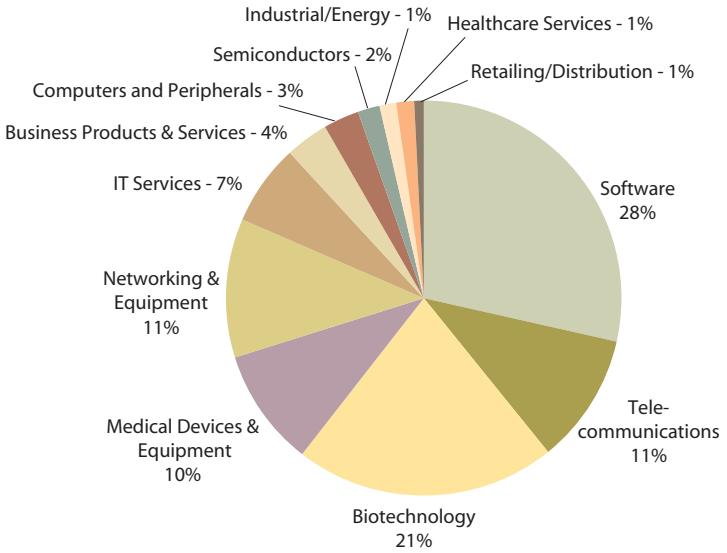
In 2002, the Software and Biotechnology industry sectors attracted the highest amounts of venture capital, with close to half of the total share ($648.3 million and $486.2 million, respectively) of the state's venture capital funding. Networking & Equipment and Telecommunications each comprised 11% of the total ($258.5 million and $242.1 million, respectively).

Massachusetts continues to attract a relatively large share of all venture capital investments in the U.S. During the first two quarters of 2003, Massachusetts received over $1 billion in venture capital funding, which was 12.6% of the U.S. total ($8.3 billion). Massachusetts continues to attract one of the largest shares of venture capital investments when compared to the LTS. The state has consistently ranked second to California in total amount of venture capital investments since 1995. In the first two quarters of 2003, Massachusetts and the LTS attracted 70% of all venture capital investments made in the U.S.

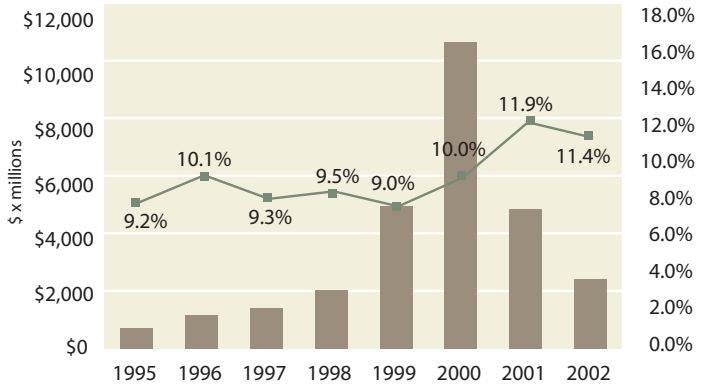
What Does this Trend Mean for Massachusetts?

Although Massachusetts experienced decreases in total venture capital investments in 2001 and 2002, the state holds up well versus the other LTS in light of steep overall declines in the venture capital market. From 1995 to 2002, Massachusetts companies have received an average of 10% of all U.S. venture capital on an annual basis, which shows that the state is attractive to investors and entrepreneurs. Moreover, the state's share of the total U.S. venture capital market increased during the first two quarters of 2003, which is good news for the state. The state's large venture capital industry and an experienced corps of angel (private) investors are a significant competitive advantage for the Massachusetts Innovation Economy, and the state should watch carefully for signs of renewed investment in Massachusetts-based firms.

Distribution of venture capital investments, Massachusetts, 2002



Venture capital investments received by companies and as percent of total US venture capital investments, Massachusetts, 1995–2002



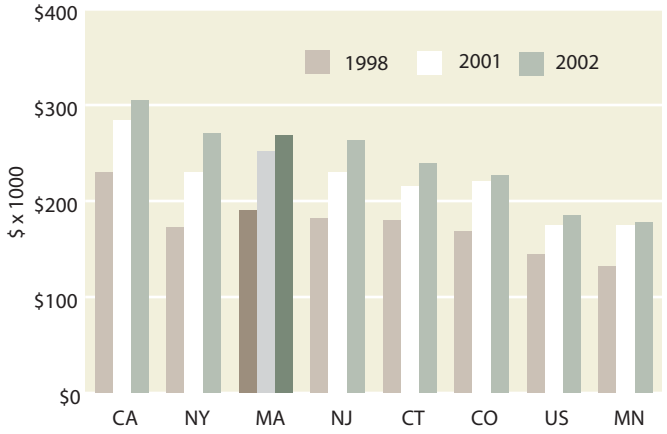
Source of all data for this indicator: PricewaterhouseCoopers, LLP, Venture Economics, and National Venture Capital Association Money Tree Survey

INDICATOR 15

Median Price of Single-Family Homes and Home Ownership Rates

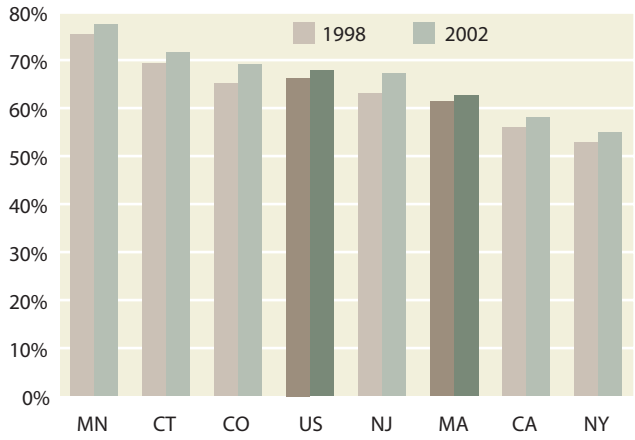
Massachusetts has third highest single-family home price compared to LTS and U.S. average; home ownership rate continues to be one of the lowest among the LTS.

Median price of single-family homes, Massachusetts, other LTS, and US, 1998, 2001 and 2002



Source: Federal Housing Finance Board

Home ownership rates, Massachusetts, other LTS, and US, 1998 and 2002



Source: U.S. Census Bureau

Why Is It Significant?

The availability and affordability of homes is a top indicator of maintaining a strong quality of life for a region. Affordable housing can help to attract and retain the often-mobile, highly skilled workforce. Home ownership rate is also a bellwether for a state's economy, since it indicates willingness of the population to live in the state over the long term.

How Does Massachusetts Perform?

In 2002, the median price of a single-family home in Massachusetts was $268,000, the third highest among the LTS and much higher than the U.S. average ($185,000). California topped the LTS and the U.S. with a median home price of $305,000, followed by New York at $270,000. Minnesota had the lowest median single-family home price at $178,000. From 2001 to 2002, Massachusetts' median price of a single-family home increased 6.3%, the third lowest percent increase in price among the LTS. New York had the highest percent increase in median home price (17.4%), followed by New Jersey (14.1%), and Connecticut (11.2%) for the same period.

Between 1998 and 2002 in Massachusetts, the median price of a single-family home increased 41.1%, the third highest percent increase among the LTS and above the U.S. average of 27.6%. New York was first with 57.0%, while California had the lowest percent increase among the LTS with 32.6%. From 1992 to 2002, the median price of a single-family home in Massachusetts has increased at an average annual rate of 6.2%, the third highest percentage increase among the LTS and the U.S. (4.0%). New York was first at 7.3%, followed closely by Colorado at 7.1%. Connecticut had the lowest average annual percent increase at 3.3% for the same time period.

In 2002, Massachusetts had a home ownership rate of 62.7%—the third lowest among the LTS and lower than the U.S. average (67.9%). Among the LTS, Minnesota had the highest percentage of home ownership at 77.3% in 2002. As noted above, Minnesota had the lowest median single-family home price during this period. New York had the lowest home ownership rate at 55.0%. Between 2001 and 2002, Massachusetts home ownership rate increased 3.5 percentage points, which was the highest percentage point increase when compared to the LTS average (0.8) and the U.S. (0.1). California and Connecticut were the only LTS to experience a decrease in home ownership (-0.3 percentage points) for the same period.

What Does This Trend Mean for Massachusetts?

The high cost of home ownership is a disincentive for would-be homeowners to stay in the state and for in-bound migration. In a time of workforce mobility and increased competition from other parts of the country to attract talented and highly-educated people, the cost of living is influential in where people want to live and work. Those who live in regions with relatively high housing costs and cannot afford to buy a home are often forced into a high rental market, settle for less housing (e.g., a smaller home), or move out of the state. Although interest and mortgage rates continue to be low, this does not offset relatively high housing costs. Innovative approaches to expanding housing supply in the state should be a high priority for state policymakers.

Data Availability

For the 2003 *Executive Index*, indicators are developed from existing secondary sources. Indicators from these sources usually required the reconfiguration of existing datasets. These groupings of data were derived from a wide range of sources; consequently, there are variations in the time frames used and in the specific variables that define the indicators being measured. This appendix provides notes on data sources for each indicator. We intend to continue updating and refining the *Index* report in future years, so that it can serve as an effective monitoring system.

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

To provide context, a goal of the *Executive Index* is to measure Massachusetts' performance on various indicators in comparison with appropriate benchmarks. Because the *Executive Index* focuses on the Massachusetts Innovation Economy, states with similar economic strengths were selected for comparison. The set of Leading Technology States includes Massachusetts and: California, Colorado, Connecticut, Minnesota, New Jersey, and New York.

The LTS are selected based on the total number of nine key industry clusters having an employment concentration above the national level. In this way, the selected LTS are comparable to Massachusetts in having the same breadth of innovative clusters.

On several indicators in the document Massachusetts is compared to an LTS average. This average is always the mean of each states' reported data, not including Massachusetts. It is not the mean of all LTS data aggregated together.

Employment Concentration

State	Computer/ Comm. Hardware	Financial Services	Healthcare Technology	Innovation Services	Software Comm. Services	2002 LTS	2003 LTS	No. of 9 key clusters above 1.0
MA	1.74	1.24	1.22	0.96	2.65	-	-	7
CA	1.77	0.87	1.29	1.14	1.04	x	x	6
CT	1.17	1.83	1.88	0.99	0.94	x	x	6
NY	0.83	1.22	1.04	1.10	1.72	x	x	6
MN	1.47	1.10	1.16	0.85	0.82	x	x	5
CO	1.30	1.00	0.73	1.23	1.75	x	x	4
NJ	0.59	1.11	2.89	1.22	1.25	x	x	4

II. Notes on Data Sources for Individual Indicators

Employment

1. Industry Clusters

Economy.com tracks industry employment at the state level using a methodology based upon individual corporations filings with State Employment Securities Agencies (SESA) and the U.S. Bureau of Labor Statistics (BLS). Data do not cover self-employment, employment of military personnel, or government employment. Definitions for each industry cluster are included in Appendix B.

http://www.economy.com

The Innovation Process

2. Number and Type of Patents Issued, Invention Disclosures and Patent Applications

Patents per capita data for Massachusetts and other LTS are provided by the U.S. Patent and Trademark Office (USPTO). Patent distribution by technology areas are from CHI Research, Inc. MTC groups 32 technology areas as defined by CHI Research into nine broad category designations.

Indicator data are from the Association of University Technology Managers' (AUTM) annual licensing survey of universities, hospitals, and research institutions. For this analysis the Massachusetts universities which provided information for the AUTM report include: Massachusetts Institute of Technology (MIT), Harvard University, Boston University, Brandeis University, University of Massachusetts (all campuses, including the Medical Center), Tufts University, and Northeastern University. Massachusetts hospitals/nonprofit research institutions include: Massachusetts General Hospital, Children's Hospital Boston, Brigham and Women's Hospital, Woods Hole Oceanographic Institute, Dana-Farber Cancer Institute, New England Medical Center, Beth Israel-Deaconess Medical Center, St. Elizabeth's Medical Center of Boston, and Schepens Eye Research Institute.

http://www.uspto.gov

http://www.chiresearch.com

http://www.autm.net

3. Technology Licenses and Royalties

Data on licensing agreements involving Massachusetts institutions are also from AUTM. These data are from the same institutions providing patent and invention disclosure information.

http://www.autm.net

4. FDA Approval of Medical Devices and Biotech Drugs

Information is provided by the U.S. Food and Drug Administration (FDA) via the Freedom of Information Act.

The Center for Devices and Radiological Health at the FDA states that, "A 510(k) is a premarketing submission made to the FDA to demonstrate that a device to be marketed is as safe and effective, that is, substantially equivalent (SE), to a legally marketed device that is not subject to premarket approval (PMA). Applicants must compare their 510(k) device to one or more similar devices currently on the U.S. market and make and support their substantial equivalency claims."

FDA approval of new drugs is comprehensive, requiring clinical trials and an extensive review process. Human drugs fall into two FDA classifications-prescription (RX) and over-the-counter (OTC). Since 1938, every new drug has been the subject of a new drug approval (NDA) process before U.S. commercialization.

http://www.fda.gov

5. New Business Incorporations

Data are provided by the Massachusetts' Secretary of the Commonwealth's Office.

http://www.state.ma.us/sec

6. Small Business Innovation Research (SBIR) Awards

Data are provided by the Small Business Administration (SBA) and U.S. Department of Commerce. Data are for the number and dollar value of awards distributed in each fiscal year. Phase I awards are for companies to research the technical merit and feasibility of their idea; Phase II awards build on these findings and further develop the proposal idea.

http://www.sba.gov

7. Initial Public Offerings (IPOs) and Mergers & Acquisitions (M&As)

The total number and distribution by industry sector of filed initial public offerings (IPOs) by state and for the U.S. are provided by IPO.com. IPO.com's industry classifications for IPOs are based upon the four-digit Standard Industrial Classification (SIC) system.

http://www.ipo.com

Data on total number of mergers and acquisitions (M&As) by state and the U.S. are provided by Mergerstat. M&A data represent all entities that have been acquired by another for all years presented in the indicator.

http://www.mergerstat.com

8. Corporate Headquarters and Number of "Technology Fast 500" Firms

Data on total number of corporate headquarters by state are provided by Reference USA.

http://www.referenceusa.com

Data on location of Technology Fast 500 companies (Tech Fast 500) located in Massachusetts and the LTS are provided by Deloitte and Touche, LLP. To be eligible for the Fast 500, a company must be a technology company, defined as follows: own proprietary technology that contributes to a significant portion of the operating revenues, or devote a significant proportion of revenues to R&D of technology; 1997 operating revenues must be at least $50,000 U.S. dollars (USD) or $75,000 Canadian dollars (CD); 2001 operating revenues must be at least $1 million USD and CD; be in business a minimum of five years; and be headquartered within North America.

http://www.public.deloitte.com/fast500

Resources

9. Population Growth Rate, Unemployment Rate, and University Enrollments

Data on population growth rate by state and the U.S. are derived from the U.S. Census Bureau.

http://www.census.gov

Data on unemployment rate by state and for the U.S. are provided by the U.S. Bureau of Labor and Statistics.

http://www.bls.gov

Data on percent changes in total public and private college and university enrollments for MA, LTS, and U.S. are derived from the National Center for Education Statistics (NCES). This survey, which is sent out to approximately 3958 schools in the U.S., has been part of NCES survey work since 1966. Degree granting institutions are defined as postsecondary institutions that are eligible for Title IV federal financial-aid programs and grant an associate's or higher degree. A private school or institution is one that is controlled by an individual or agency other than a state of, a subdivision of a state, or the federal government, which is usually supported primarily by other than public funds, and the operation of whose program rests with other than publicly elected or appointed officials. Private schools and institutions can be either not-for-profit and proprietary institutions. A public school or institution is one that is controlled and operated by publicly elected or appointed officials and derives its primary support from public funds.

http://nces.ed.gov

10. Migration

Total foreign and domestic migration data are provided by the U.S. Census Bureau.

http://www.census.gov

Data on distribution of immigrants for Massachusetts are derived from the U.S. Immigration and Naturalization Services (INS). Data include legal immigration from abroad, net undocumented immigration, emigration, and net movement from Puerto Rico and the United States mainland.

http://www.ins.gov/graphics/index.htm

11. High School and College Education

Data for intended majors of students taking the SAT in Massachusetts and the LTS are provided by The College Board Online, Profile of College Bound Seniors, 2002. The Profile of College-Bound Seniors presents data for 2002 high school graduates who participated in the SAT Program during their high school years. 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 a highly accurate description of the group.

http://www.collegeboard.com

Data on total number and distribution of bachelor's and master's degrees conferred by field of study in Massachusetts institutions are provided by the U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System (IPEDS), "Completions" survey, 2000. Humanities includes degrees in area and ethnic studies; English language, literature, and letters; foreign languages; liberal/general studies; multi/interdisciplinary studies; philosophy and religion; theology; and visual and performing arts. Social and Behavioral Sciences includes psychology and social sciences and history.

Natural Sciences includes biological sciences; physical sciences and science technologies; and mathematics. Computer Science and Engineering includes computer and information sciences; engineering; and engineering technologies. Other Professional Fields includes agriculture and natural resources; architecture and environmental design; communications and communications technologies; construction trades; consumer and personal services; health sciences; home

economics and vocational home economics; law; library and archival sciences; marketing operations/marketing and distribution; mechanics and repairers; military sciences; parks and recreation; protective services; public affairs; and transportation and material moving.

http://nces.ed.gov

Data on appropriations of state and local tax funds for operational expenses of public higher education for Massachusetts and the LTS are provided by Grapevine Center for Higher Education, Illinois State University. Grapevine reports on total state effort for higher education, including tax appropriations for universities, colleges, community colleges, and state higher education agencies.

http://coe.ilstu.edu/grapevine

11. Scientists and Engineers in the Labor Force; Engineering and Computer Science Degrees

Data on scientists and engineers as a percent of the total workforce are derived from data on scientists and engineers from the NSF and population data from the U.S. Census Bureau. The Division of Science Resources Studies (SRS) of the NSF publishes data on scientists and engineers in its annual Science and Engineering State Profiles. Data for state rankings and totals include the 50 States, District of Columbia, and Puerto Rico.

http://www.census.gov

http://www.nsf.gov

Data on total number of engineering degrees are provided by the American Association of Engineering Societies (AAES). The AAES tracks the number of engineering degrees awarded each year from over 300 accredited institutions throughout the United States.

http://www.aaes.org

Data on the total number of doctorate computer science degrees granted are provided by the National Science Foundation (NSF). The category of Computer Science includes Computer Science and Information Science and Systems.
http://www.nsf.gov

13. Federal R&D Spending & Health R&D Spending

Data on federal R&D spending at academic and nonprofit research institutions are provided by the NSF. This includes the NSF's university-associated federally funded research and development centers.

http://www.nsf.gov

Data on federal health R&D spending at academic and nonprofit research institutions are provided by the NSF. Data are for all R&D expenditures by the U.S. Department of Health and Human Services; more than 95% of these expenditures are funded by the National Institutes of Health.

http://www.nsf.gov

14. Venture Capital

Data for total venture capital investments in Massachusetts and the U.S., and venture capital investments by industry activity are provided by PricewaterhouseCoopers, LLP, Venture Economics, and the National Venture Capital Association Money Tree Survey. Industry category designations are determined by PricewaterhouseCoopers, LLP, Venture Economics, and the National Venture Capital Association.

http://www.pwcmoneytree.com

15. Median Sales Price of Single-Family Homes and Home Ownership Rates

The Federal Housing Finance Board provides data for median sales price of single-family homes that have been sold. Data are collected from the Finance Board's Monthly Survey of Rates and Terms on Conventional Single-Family Nonfarm Mortgage Loans. Single-family homes are defined in two ways. They can be unit structures detached from any other house, such as one-family homes and mobile homes or trailers to which one or more permanent rooms have been added; and, they can be unit structures attached to another structure, but with one or more walls extending from the ground to roof separating it from the adjoining structure, such as double houses or townhouses. The median statistic represents the value in the middle of a data set.

http://www.fhfb.gov

Homeownership rates data come from the U.S. Census Bureau.

http://www.census.gov

The North American Industry Classification System (NAICS) has replaced the U.S. Standard Industrial Classification (SIC) system. NAICS was jointly developed by the U.S., Canada, and Mexico to provide new comparability in statistics about business activity across North America. For more information about NAICS, please visit: http://www.census.gov/epcd/www/naics.html.

Starting this year, the *Index* has moved from the four-digit Standard Industrial Classification (SIC) to the North American Industry Classification System (NAICS) to study the key industry clusters. The analysis of key industry clusters within Massachusetts begins with a disaggregation and examination of all Massachusetts state industry activity to the four-digit NAICS code level. (NAICS was developed in cooperation with the U.S. Economic Classification Policy Committee, Statistics Canada, and Mexico's Instituto Nacional de Estadistica, Geografia e Informatica. These codes were last revised in 2002.) Industry data are analyzed through the following measures:

- Employment concentration relative to that of the nation
- Employment as a share of total state employment

Clusters are crafted from those interrelated NAICS code industries that showed themselves to be individually significant according to the above measures. In some instances, definitional changes have taken place in the SIC to NAICS conversion. Thus, several key industry cluster definitions and titles were revised to reflect changes both in industry definitions and in employment concentrations that have occurred within these 4 digit NAICS industry classifications. The nine key industry clusters as defined by the *Index* reflect the changes in employment concentration in the Massachusetts Innovation Economy that has occurred over time.

Computer & Communications Hardware

3341 Computer and Peripheral Equipment Manufacturing
3342 Communications Equipment Manufacturing
3343 Audio and Video Equipment Manufacturing
3344 Semiconductor and Other Electronic Component Manufacturing
3346 Manufacturing and Reproducing Magnetic and Optical Media
3351 Electric Lighting Equipment Manufacturing
3359 Other Electrical Equipment and Component Manufacturing

Defense Manufacturing and Instrumentation

3329 Other Fabricated Metal Product Manufacturing
3336 Engine, Turbine, and Power Transmission Equipment Manufacturing
3345 Navigational, Measuring, Electromedical, and Control Instruments Manufacturing
3364 Aerospace Product and Parts Manufacturing

Diversified Industrial Support

3222 Converted Paper Product Manufacturing
3259 Other Chemical Product and Preparation Manufacturing
3261 Plastics Product Manufacturing
3262 Rubber Product Manufacturing
3279 Other Nonmetallic Mineral Product Manufacturing
3314 Nonferrous Metal (except Aluminum) Production and Processing
3321 Forging and Stamping
3322 Cutlery and Handtool Manufacturing
3326 Spring and Wire Product Manufacturing
3328 Coating, Engraving, Heat Treating, and Allied Activities
3332 Industrial Machinery Manufacturing
3333 Commercial and Service Industry Machinery Manufacturing
3335 Metalworking Machinery Manufacturing
3339 Other General Purpose Machinery Manufacturing
3353 Electrical Equipment Manufacturing
3399 Other Miscellaneous Manufacturing

Financial Services

5211 Monetary Authorities - Central Bank
5221 Depository Credit Intermediation
5231 Securities and Commodity Contracts Intermediation and Brokerage
5239 Other Financial Investment Activities
5241 Insurance Carriers
5242 Agencies, Brokerages, and Other Insurance Related Activities
5251 Insurance and Employee Benefit Funds
5259 Other Investment Pools and Funds

Healthcare Technology

3254 Pharmaceutical and Medicine Manufacturing
3256 Soap, Cleaning Compound, and Toilet Preparation Manufacturing
3391 Medical Equipment and Supplies Manufacturing
6215 Medical and Diagnostic Laboratories

Innovation Services

5411 Legal Services
5413 Architectural, Engineering, and Related Services
5416 Management, Scientific, and Technical Consulting Services
5417 Scientific Research and Development Services
5418 Advertising and Related Services
5419 Other Professional, Scientific, and Technical Services
5614 Business Support Services

Postsecondary Education

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

Software & Communications Services

5111 Newspaper, Periodical, Book, and Directory Publishers
5112 Software Publishers
5171 Wired Telecommunications Carriers
5172 Wireless Telecommunications Carriers (except Satellite)
5173 Telecommunications Resellers
5174 Satellite Telecommunications
5175 Cable and Other Program Distribution
5179 Other Telecommunications
5181 Internet Service Providers and Web Search Portals
5182 Data Processing, Hosting, and Related Services
5415 Computer Systems Design and Related Services
8112 Electronic and Precision Equipment Repair and Maintenance

Textiles & Apparel

3132 Fabric Mills
3133 Textile and Fabric Finishing and Fabric Coating Mills
3141 Textile Furnishings Mills
3149 Other Textile Product Mills
3152 Cut and Sew Apparel Manufacturing
3161 Leather and Hide Tanning and Finishing
3162 Footwear Manufacturing
3169 Other Leather and Allied Product Manufacturing

MTC is proud to include the 2003 *Executive Index of the Massachusetts Innovation Economy* as one of five reports in the new MTC Innovation Outlook Series, a series that focuses on science, technology, innovation and economic growth in Massachusetts. A complimentary copy of any of these reports can be downloaded after publication from www.masstech.org/Innovationoutlook/index.htm.

A summary of these reports is provided below:

Advanced Technologies to Lower Health Care Costs and Improve Quality

What if we could lower health care costs and improve quality at the same time? The report identifies technologies with the potential to deliver higher quality at lower costs and outlines strategies Massachusetts and the nation should adopt to accelerate their use. MTC developed this initiative in conjunction with a group of experts from the state's major health insurers, providers and payers, as well as leading technology industry associations and policy analysts.
Fall 2003

Federal Funds for Massachusetts: R&D and Homeland Security

What are the opportunities for tapping the vast federal R&D resources and new possibilities presented by federal investment in homeland security? This report on federal R&D trends focuses on projections for future growth, including the likely impact of spending on major national R&D priorities, including biomedical research, advanced Internet and information technology (IT) research, nanotechnology, and R&D for homeland security. In recent years federal R&D funds awarded to Massachusetts institutions have reached or exceeded $4 billion per year, and Massachusetts has benefited from the doubling of the NIH budget. However, as federal budget surpluses turned to deficits, prospects for federal R&D funding have become more clouded. This report highlights the latest trends in federal R&D with a special analysis of spending by the new Department of Homeland Security.
Winter 2004

Clean Energy: An Emerging Cluster

This is a first-ever report on the fast growing number of firms in Massachusetts researching, manufacturing and exporting new renewable energy technologies in a global market. The report documents the size, strength and new opportunities that exist in the renewable energy and energy efficiency industry cluster. Driven by concerns over global climate change and energy security, by improvements in technology, and by aggressive implementation of renewable energy initiatives throughout the country, the renewable and clean energy markets are poised for unprecedented growth. The global market for fuel cells, wind, and solar photovoltaics (PV) is projected to grow from $6.7 billion annually in 2000 to $77 billion in 2010. The current global market for energy efficiency products is estimated at $115 billion, growing to over $150 billion by the end of the decade.
Spring 2004

Nanotechnology in Massachusetts

This report analyzes the nanotechnology revolution in Massachusetts. It explores the implications of these exciting technologies in the context of new and existing applications. MTC created the Massachusetts Nanotechnology Initiative (MNI) to focus on the scale and direction of nanotechnology research in Massachusetts, emerging industries in the field, and the state's position in the intensifying global competition for nanotechnology-related business development. The National Science Foundation predicts that the global market for nano-scale devices may top $1 trillion by the end of the decade. Massachusetts is host to a number of world-class nanotechnology research programs and a cadre of start-ups driving the commercialization process, including semiconductor, information technology (IT), biotechnology, medical devices, and specialty materials firms.
Spring 2004

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Additional copies of the *Executive Index of the Massachusetts Innovation Economy* are available for $20.00 per copy for individuals and corporations ($15.00 per copy for quantities over 20), and for $10.00 per copy for non-profit organizations and educational institutions ($7.50 per copy for quantities over 20). An interactive version of the *Executive Index* on CD-ROM is also available for $5.

Orders may be placed through the MTC web site at *www.masstech.org*, or by telephone.
To order additional copies or for additional information call 508-870-0312.

The *Executive Index* is available at no cost by downloading from *www.masstech.org*.

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Small Business Administration

University of Massachusetts, all campuses

U.S. Immigration and Naturalization Service

U.S. Patent and Trademark Office

Venture Economics

Massachusetts Technology Collaborative Board of Directors

The Massachusetts Technology Collaborative (MTC) is the state's development agency for renewable energy and the innovation economy, which is responsible for one-quarter of all jobs in the state. MTC works with cutting-edge companies to create new jobs and stimulate economic activity in communities throughout the Commonwealth.

Technology-driven innovation fuels the state's economy. MTC is uniquely positioned to provide solutions to the difficult challenges faced by the Governor and State Legislature. By forming dynamic partnerships with key stakeholders, the agency serves as a catalyst for growing the innovation economy.

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