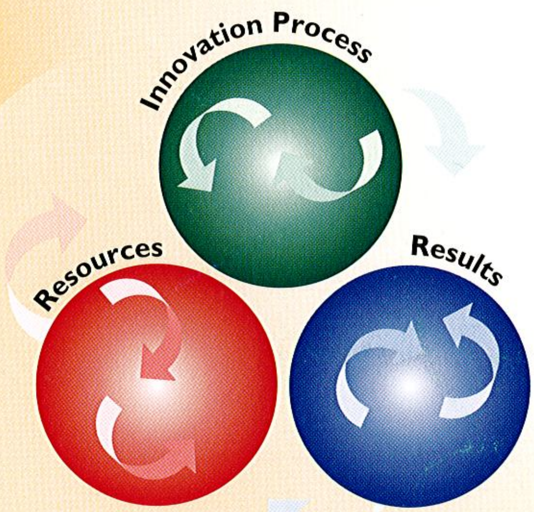
Massachusetts TECHNOLOGY Collaborative

Index of the Massachusetts INNOVATION Economy



1998

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MASSACHUSETTS TECHNOLOGY COLLABORATIVE

The Massachusetts Technology Collaborative (MTC) was created to foster sustainable economic growth by promoting a better understanding of the forces that shape the state's economy and by enabling greater collaboration among the diverse enterprises involved in the Innovation Economy.

MTC was established in 1994 by the Board of Directors of the Massachusetts Technology Park Corporation, a publicly chartered independent authority of the State, created in 1982 to advance the growth of the technology sector of the Massachusetts economy. MTC is directed by a 23-member Board of Directors appointed by the Governor, representing senior officials from public and private colleges and universities, technology companies and state government.

Special thanks and acknowledgment to **Jennifer Montana,** PhD, MTC Director of Research, who directs the *Index of the Massachusetts Innovation Economy* project.

A GROWING INNOVATION ECONOMY CREATES A COMPETITIVE ADVANTAGE FOR MASSACHUSETTS IN A TIME OF ECONOMIC UNCERTAINTY

The Massachusetts economy is fundamentally different than it was a decade ago.
Not only has the economy grown in jobs and output, but its character has changed. A "boom-and-bust" economy once dependent on a few cyclical industries, especially Defense and Computer Hardware, is now more diverse with a much broader range of industries, including Software and Communications Services, Healthcare Technology, Postsecondary Education, and Financial Services. This diversity means that as Massachusetts enters a period of global economic uncertainty, our economy is better positioned to promote long-term growth and respond to the coming challenges.

The Massachusetts Technology Collaborative believes that the development of the Innovation Economy is the most prudent and effective strategy for promoting sustainable economic growth and weathering economic cycles.

What is the Innovation Economy, and what makes it different?
The Innovation Economy is based on intellectual capital and the ability to translate new ideas into competitive products and services faster than the competition can. The 1998 *Index* shows that Massachusetts is a leader in idea generation and new product commercialization. Our state is a national leader in each element of the innovation process, including research and development, patents, and new products, in a variety of knowledge-based industries. It is this ability to generate new ideas, products, and services that makes Massachusetts a leading Innovation Economy. The results are growing jobs in high-wage industries as well as a more diverse economy.

What could go wrong?
Clearly, volatility and uncertainty in the international environment create risks for our economy. Declining exports and slower economic growth will affect industries such as Healthcare Technology, Computer and Communications Hardware and Financial Services, which depend on demand from outside of Massachusetts for continued growth.

Although we will continue to be affected by economic cycles, the Innovation Economy can drive the longer-term economic prosperity of our region if we continue to focus on the fundamentals.

What are the fundamentals that drive the Innovation Economy?
The foundations are a skilled workforce, a strong R&D base, and a flow of venture funds. We must continue to promote an education and training system that prepares our workforce for the jobs of the future. In this regard, the foundation has some cracks. The number of engineering and computer science graduates from our colleges and universities has been declining. Some of our K-12 students are not being adequately prepared in math and science to be competitive in the Innovation Economy. This is especially problematic given the state's relatively slow growth in population and in labor force. Massachusetts continues to be dependent on an inflow of immigrants to fill highly skilled positions. Even so, many engineering and scientific jobs in the state remain vacant, restricting the capacity to innovate and grow. More generally, a strong network of education and retraining programs are essential to provide the human resources needed in a dynamic innovation and technology-based economy.

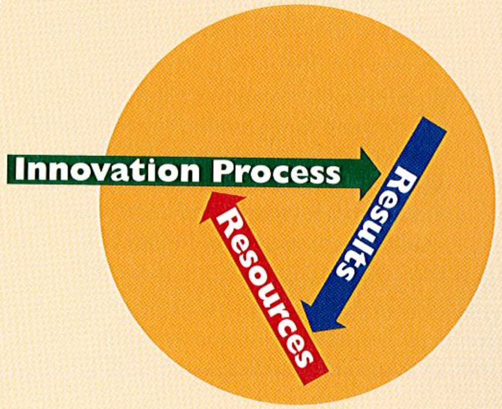
Massachusetts continues to lead in federal R&D, especially in health R&D, but other states are gaining on us. We need to continue to ensure that the public and private R&D base remains strong and competitive.

Venture capital fuels the Innovation Economy, and venture financing in Massachusetts is high and rising. This should bode well for the Massachusetts Innovation Economy of the future. However, translating small technology-based start-ups into significant numbers of jobs in the state will pose some new challenges. The market value of emerging growth firms in Massachusetts is expanding well below average, and initial public offerings in-state trail national and state historical patterns. Mergers and acquisitions are on the rise.

An environment that fosters and supports innovation and change underlies the Massachusetts competitive advantage. Our educational institutions, businesses, financial institutions, and government are all vital players in the Massachusetts Innovation Economy.

The 1998 *Index* shows that the Massachusetts Innovation Economy is growing and delivering results for businesses and the people of our Commonwealth. By paying attention to the fundamentals, we can ensure that Massachusetts residents will gain from this new economy, and that we can create long-term prosperity in the face of short-term economic cycles.

Massachusetts
INNOVATION
Economy



This year's *Index* continues to:

- Describe how the Massachusetts Innovation Economy is performing
- Examine how the Innovation Economy works
- Assess the resources that fuel the Innovation Economy

This system-wide view of the Innovation Economy enables us to look at the performance of the economy and its underlying structure and dynamics. This approach makes it possible to identify early warning signs of weakness in the innovation process and in the resources that this process translates into high-performance results. As a next step, this year's *Index* links warning trends to policy directions by highlighting implications of the Innovation Economy for both public policy and the private sector.

MEASURING RESULTS

How Is the Massachusetts Innovation Economy Performing?

The Massachusetts economy has been doing well, with especially strong growth in leading-edge service sectors.

- The Software and Communications Services cluster added more than 9,800 jobs between 1996 and 1997—the largest absolute and relative employment increase of the nine key industry clusters (see page 9 for list of clusters).
- Financial Services, which added 3,185 jobs, remains the largest of the industry clusters with 128,000 jobs. Massachusetts leads the nation in the value of mutual fund assets managed.
- Traditional manufacturing clusters of Defense as well as Textiles and Apparel continued their employment contraction, shedding 556 and 420 jobs, respectively, from 1996 to 1997.
- Overall, net employment in nine key industry clusters grew 3.5% from 1996 to 1997, compared to an overall state employment increase of 2.7%.
- Innovation Services surpassed Software and Communication Services as the cluster with the highest average wage, $58,532. In total, seven of the nine industry clusters pay an average annual wage greater than $40,000.

Both manufacturing and services exports are growing, with services exports playing an increasingly important role in the Innovation Economy. International market penetration is positive for long-term growth, but it increases vulnerability during cyclical downturns.

- After several years of lackluster export performance, Massachusetts exported $17.4 billion worth of manufactured goods in 1997, an increase of 10% from 1996.
- Among services exports, Massachusetts consistently ranks among the top tier of Leading Technology States (LTS) in Software and Communications Services, Innovation Services, and Financial Services (see page 8 for list of LTS).

Massachusetts workers on average have gained from the growth in the Innovation Economy, but growing income inequality and skills shortages are points of vulnerability.

- Inflation-adjusted pay per worker in Massachusetts increased 8% from 1991 to 1997, compared with a 4.8% average increase in the other LTS.
- In 1997, the median earnings for the top 20% and middle 20% of Massachusetts working families rose 5.2% and 8.9%, respectively, after adjusting for inflation. Earnings for the lowest 20% declined by 4.7%.
- According to a May 1998 MTC survey, 10.6% of scientist positions and 8.4% of engineering positions remained unfilled at technology-intensive firms.

MEASURING THE INNOVATION PROCESS

How Does the Innovation Economy Work?

The Index explores the central linkages in the innovation process between R&D and patents, technology licenses, and commercial applications.

- Massachusetts leads the six other LTS in patents per capita, an important measure of idea generation within the state.
- The number of invention disclosures received annually by Massachusetts institutions increased 18% in the most recent year, almost twice the percentage increase in the prior four years.
- The value of technology licenses issued from Massachusetts institutions tripled in 1996. The number of new licenses issued increased in 1996 for the first time in four years.

The Index shows that the Innovation Economy has a substantial number of small-sized companies. The growth of small, technology-intensive firms shows some weakness relative to the nation.

- On a per capita basis, Small Business Innovation Research (SBIR) awards to Massachusetts firms are almost four times higher than those of California firms.
- The market value of Massachusetts-based companies listed on the NASDAQ stock exchange grew at an average annual rate of 16% from 1993 to 1998. This trails behind the 24% annual growth of all NASDAQ firms.
- The number of initial public offerings (IPOs) dropped 71% from a 1996 high of 52 to 15 in 1997. Nationally, IPOs were down 33%. Massachusetts mergers and acquisitions are an increasingly important source of liquidity and intellectual assets for entrepreneurs and investors.

Services clusters lead in value-added per employee. However, value-added per employee for most of the state's clusters lags behind that of other LTS.

- In 1997, services clusters, including Software and Communications Services, Financial Services, and Innovation Services, posted the highest levels of value-added per employee at $107,996, $105,252, and $100,037, respectively.
- However, six of the nine Massachusetts industry clusters trail the value-added averages of clusters in the other LTS.

MEASURING RESOURCES

What Resources Fuel the Innovation Economy?

Massachusetts remains the national leader in federal R&D spending, especially in health-related R&D.

- At $137 per capita, federal R&D spending at Massachusetts academic institutions is almost twice that of academic institutions in the next-closest LTS, which is Colorado at $70 per capita. Between 1993 and 1996, five of the LTS experienced per capita growth in federal R&D. Massachusetts and New York did not.
- Massachusetts substantially outpaces the other six LTS in per capita federal health R&D expenditures—more than three times greater than the next-closest LTS. Federal health R&D expenditures also continue to increase faster in Massachusetts than in the other LTS.

Venture capital investments continue to grow, fueling emerging-growth firms.

- In 1997, venture capital investment in Massachusetts companies surpassed the $1 billion level, reaching $1.4 billion, a 40% increase from the 1996 level.
- Among the LTS, Massachusetts ranks second in the share of venture capital investment flowing into new emerging-growth companies, at 43%.

Signs indicate that Massachusetts is not producing the growing, skilled workforce required by the Innovation Economy. The state's population and labor force exhibit relatively slow growth, and the state's Innovation Economy is dependent upon the in-migration of skilled workers.

- Massachusetts continues to experience domestic out-migration. International immigration explains why overall net migration turned positive in 1995 through 1997.
- The number of undergraduate engineering and computer science degrees awarded by Massachusetts institutions continues to decline. Engineering degrees are down 37% from 1987 to 1997, compared with a 14% decline nationally. The number of computer science graduates also declined faster than the national average.
- Eighth grade math and science test scores show a wide disparity in student success across race and ethnicity. White and Asian/Pacific Islander students score between 14% and 30% higher than Hispanic and African-American students.

IMPLICATIONS

What Does the Innovation Economy Mean for Public Policy and the Private Sector?

The term *Innovation Economy* is a shorthand way of characterizing the new fundamentals of the Massachusetts economy, such as R&D, venture capital, and high skills. Only good fundamentals can serve as a good defense against cyclical change and global volatility. If Massachusetts continues to invest in the fundamentals, the state can weather change and can continue to strengthen over time. The state's resilience is a function of these fundamentals historically and today.

The state should recognize the changing workforce needs of the Innovation Economy and focus policy on creating a skilled workforce. Success in this area will be achieved through collaborative practices that involve the public and private sectors.

- ✔ As the economy continues to restructure toward knowledge-based industry clusters, Massachusetts needs to create and maintain a flexible and skilled workforce supported by a dynamic and innovative continuous education and training system. This system needs to be designed to upgrade present workforce capabilities to meet short-term needs, as well as to prepare workers for and provide them with the lifelong learning opportunities necessary in a technology-intensive workplace. Close relationships between businesses and community and technical colleges will be essential to achieve this goal. Special attention needs to be focused on helping disadvantaged people overcome barriers to accessing education, training, and quality jobs.
- ✔ Education is a key factor in economic and social mobility. There is a direct relationship between educational attainment and income level. The state should promote policies that help to ensure that all individuals graduate from high school and have access to postsecondary school education and training. Partnerships between secondary schools and corporations should emphasize the tangible benefits of staying in school. Exposure to Innovation Economy industries through mentoring programs, cooperative education, and internships can promote successful school to work linkages that foster long-term economic well-being.
- ✔ Because the Massachusetts Innovation Economy needs scientific and technical workers, the state should help prepare young people with the science and math skills essential to engineering and other technology-intensive education and career opportunities. Merit-based scholarship programs and student loan incentives should be considered to increase qualified enrollment. Programs that bolster completion rates, especially among female and minority engineering and computer science degree candidates, should be considered. A majority of new entrants to the workforce will be women and minorities by the year 2000.

The state should focus policy on building a strong foundation of R&D resources and promoting effective linkages in the innovation process.

- ✔ State policy should seek to foster an environment conducive to maintaining and increasing its share of federal R&D, and to translating this investment into patents, licenses, and commercial products and services. The state can act as a catalyst, facilitating collaboration between Massachusetts-based research institutions and businesses to bolster federal and corporate R&D funding. Competitive, peer-reviewed, "opportunity-driven" decision making in the allocation of federal R&D funds will benefit Massachusetts. The state's education reform goals in math and science education will further foster the Innovation Economy.

The private sector should continue to make investments in corporate R&D and in the skills of the workforce, while working to speed up the innovation process.

- ✔ Continued increases in productivity will require continuous upgrading of workforce skills and increased investment in R&D by the private sector. Groups such as the Massachusetts industry councils are in a unique position to engage in skills needs assessment and act as a catalyst for increasing training activities in identified shortage areas. Corporations can also take advantage of and help to shape tax-incentive structures promoting R&D activities.
- ✔ Increasing technology licensing requires close cooperation between research universities, hospitals, and businesses. Businesses need to be active participants in their community to strengthen the local networking culture that facilitates an entrepreneurial environment. In addition, a cooperative licensing program serving multiple clients could achieve the economies of scale that make participation possible for smaller players who seek technology licenses.
- ✔ Increasing the speed of FDA approvals will require cooperation between business and the federal government, and a recognition by the FDA about the importance of a timely approval process. Businesses can facilitate this process by taking a client-based view of their relationship with the FDA and implementing knowledge-management processes that help to prioritize and communicate information during the review of a product, procedure, or device.
- ✔ Achieving higher levels of effective venture capital financing will depend on close relationships between entrepreneurs and venture firms that operate within networks of innovation. Industry councils should continue to play a vital role in linking ideas with dollars. Additionally, since SBIR award winners have been effectively screened for proof-of-concept, strengthening the links between the SBIR network and the venture capital community can lead to further growth and development.

The state and the private sector should collaborate to address some of the pressing economic and policy research issues that will increase understanding of the Massachusetts Economy and that can translate into informed action.

These areas should include:

- ✔ Data collection and analysis of earnings mobility, services exports and productivity
- ✔ Special analysis of key employment clusters, such as software
- ✔ Small company growth analysis: their nature and role in the economy, and identification of the environmental determinants of their growth
- ✔ Capital formation and liquidity: the function of mergers and acquisitions and their relation to initial public offerings and venture capital funding in the Massachusetts Innovation Economy

SPECIAL ANALYSIS—THE DYNAMICS OF INNOVATION

THE DYNAMICS OF INNOVATION

The innovation process links investment in idea generation to patents, technology licenses, intellectual capital, and the new products that drive fast-growing businesses. The linkages within this process are formed by innovation networks, which are crucial for success in the Innovation Economy.

- ✔ *Role of Innovation Networks.* Innovation networks help link resources such as R&D and human and financial resources to the active commercialization processes essential for developing new products and services. The *Index* underscores the value of these networks, which are exemplified by linkages between industry clusters and research institutions, especially within Healthcare Technology.
- ✔ *Proximity and the Innovation Process.* The *Index* finds that proximity is important in Massachusetts—patents issued by local firms tend to cite scientific research conducted within the region at a rate twice the national average. The personal interaction between researchers and engineers, as well as the strong relationships among firms within an industry cluster such as Healthcare Technology, helps to speed the commercialization process. The benefits of proximity can also be seen increasingly in inter-industry cluster synergies, e.g., bioinformatics, telemedicine and multimedia.
- ✔ *Finding the Critical Hinge Points.* The *Index* demonstrates critical "hinge points" in the innovation process. These hinge points include the links between R&D and patents, patents and commercial applications, and early product development and venture capital funding. Each of these links in the innovation chain should be well developed to ensure successful product commercialization and enterprise development. Critical hinge points help to identify the best opportunities for effective policy intervention.

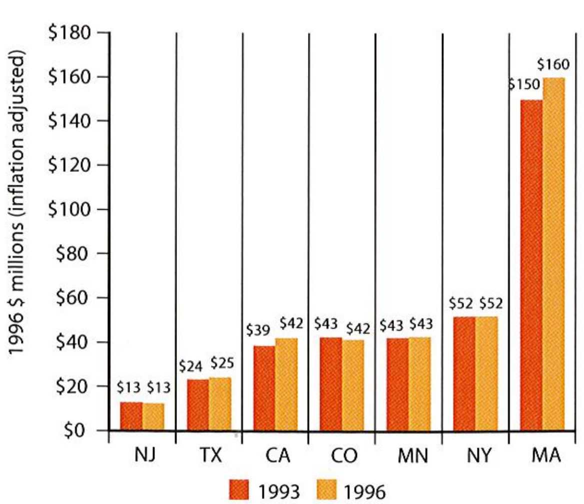
SPECIAL ANALYSIS

The innovation process involves many interrelated steps that link resources to results. Understanding the connections and interactions are key to understanding the Innovation Economy.

This special analysis, which uses the Healthcare Technology cluster as an example, illustrates many of the links in the innovation process and among the indicators. This analysis highlights how strengths and weaknesses in one indicator can be reflected in others.

Chart A
Massachusetts ranks highest of the LTS in per capita health R&D and is gaining ground

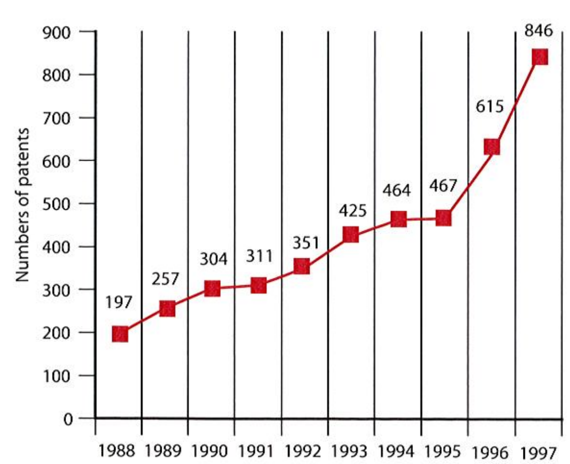
HEALTH-RELATED R&D FUNDING



Source: National Science Foundation

Chart B
Number of Healthcare Technology-related patents issued in Massachusetts

PATENTS



Source: CHI Research

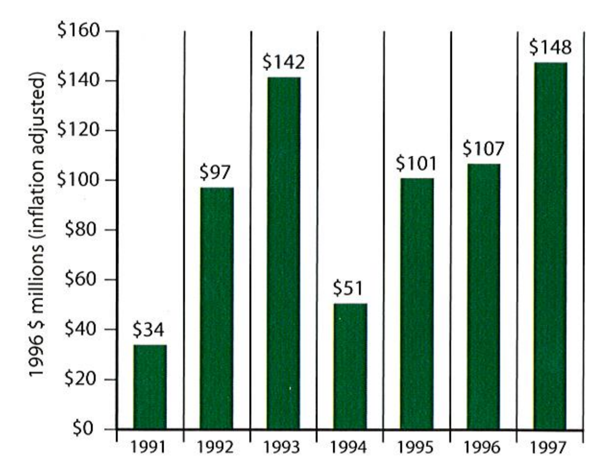
AS ILLUSTRATED BY HEALTHCARE TECHNOLOGY

Massachusetts leadership in health R&D (Chart A) is reflected in the rapid growth in Healthcare Technology-related patents (Chart B). Proximity appears to matter, because the concentration of healthcare research translates into a high number of related patents. In turn, the number of FDA approvals for medical devices has been increasing in the past two years.

The growing pipeline of new healthcare products and the entrepreneurial firms seeking to bring those products to market attract increases in venture capital funding (Chart C). This funding, expanded development, and entrepreneurial activity, in turn, have been generating high value-added and growing average pay in the healthcare cluster, as well as increasing employment (Chart D).

Chart C
Venture capital investments in Massachusetts Healthcare Technology are increasing

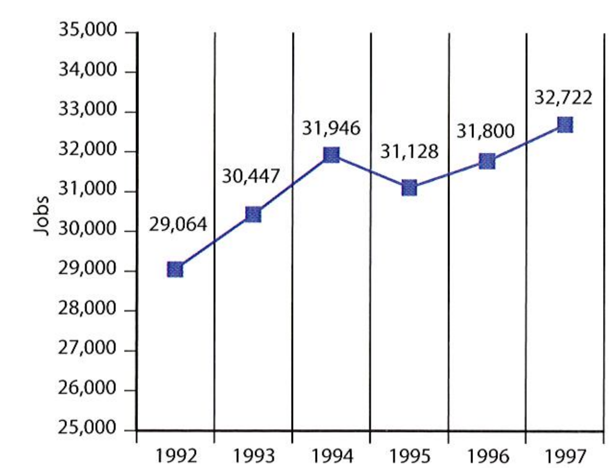
VENTURE CAPITAL $ IN HEALTHCARE TECHNOLOGY



Source: Venture Economics

Chart D
Massachusetts Healthcare Technology cluster employment increasing

HIGH EMPLOYMENT IN HEALTHCARE TECHNOLOGY



Source: Regional Financial Associates, Collaborative Economics, Massachusetts Division of Employment and Training

A FRAMEWORK FOR INNOVATION

The *Index* measures progress of three key components of the Massachusetts Innovation Economy. It is based on a dynamic conceptual framework that links **resources** to economic **results** through an innovation **process**. The framework measures Massachusetts progress in leveraging its resources through innovation to create higher levels of economic performance. In a vital cycle, high economic performance supports ongoing investment and reinvestment in the key resources required to sustain the Innovation Economy.

The Massachusetts Innovation Economy has three interrelated and interactive components:

- **Results**: Outcomes for people and business—job growth, rising average wages, and export sales
- **Innovation process**: Dynamic interactions that translate resources into results—idea generation, commercialization, entrepreneurship, and business innovation
- **Resources**: Critical public and private inputs to the Innovation Economy—human, technology, and investment resources, plus infrastructure

The format of this document reflects the relationship among these components. The *Index* begins by presenting the economic **results** of the Massachusetts Innovation Economy and follows with measures of the state's **innovation process**. It concludes by setting out a number of **resources** of the Massachusetts Innovation Economy.

SELECTING INDICATORS

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

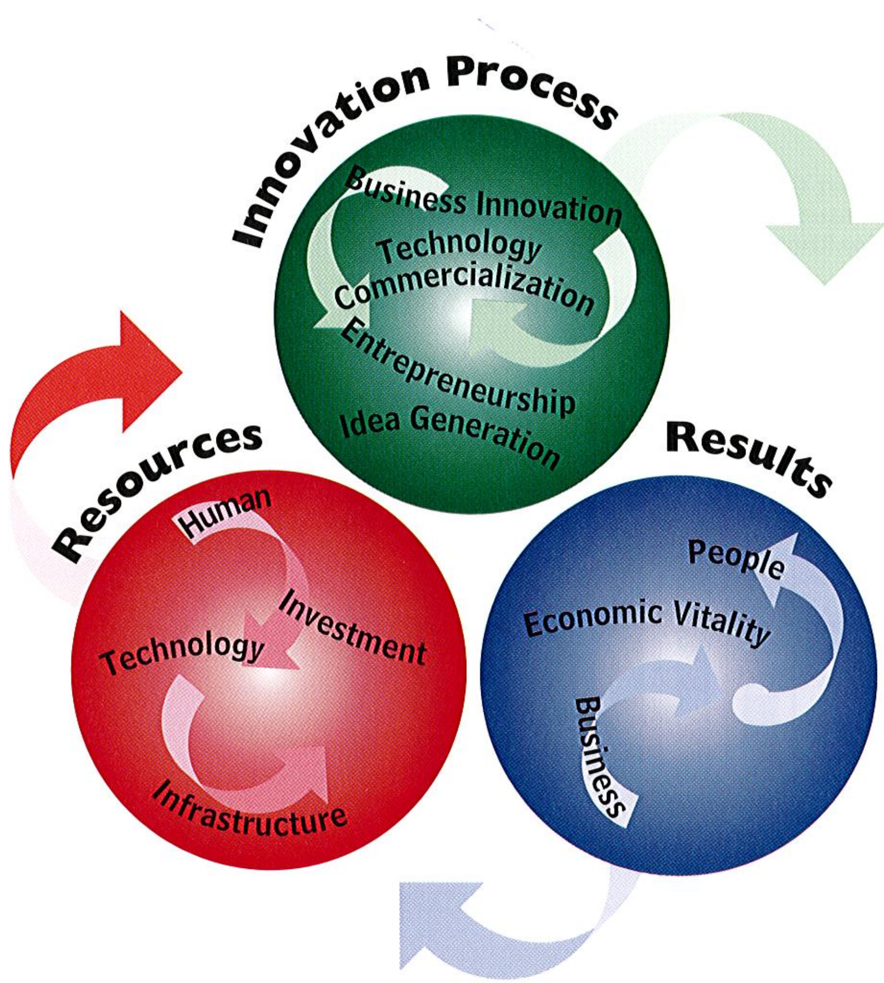
A rigorous set of criteria was applied to all potential indicators. Each of the selected indicators:

- Is derived from objective and reliable data sources
- Is statistically measurable on an ongoing basis
- Is a bellwether that reflects the fundamentals of economic vitality
- Can be understood and accepted by the community
- Measures conditions in which public interest is active

BENCHMARK COMPARISONS: LEADING TECHNOLOGY STATES

MTC believes that Massachusetts should be able to track the Innovation Economy over time. This monitoring capacity is crucial for regularly assessing its strength and resilience.

At the same time, benchmark comparisons can provide an important context for understanding how Massachusetts is doing in a relative sense. Thus, in some 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 throughout the 1998 *Index* are California, Colorado, Minnesota, New Jersey, New York, and Texas. Appendix A describes the methodology for selecting the LTS.



NINE KEY INDUSTRY CLUSTERS

The *Index* monitors the impact of innovation through key industry clusters critical to the state's economy. Nine industry clusters have been identified that significantly affect the state and are linked uniquely to the Innovation Economy. These clusters range from the long established—such as Postsecondary Education, Defense, and Textiles and Apparel—to relative newcomers such as Software and Communications Services and Innovation Services (a combination of highly technical and professional fields such as engineering services and management consulting). The other four clusters are Computers and Communications Hardware, Financial Services, Healthcare Technology, and Diversified Industrial Support. Appendix B provides a detailed definition for each of these clusters.

Together, these nine clusters account for 24% of nongovernment employment in Massachusetts and 35% of total private-sector payroll. At $48,600, the average wage paid by the nine key industry clusters is 47% higher than that of the rest of the Massachusetts economy.

NINE KEY INDUSTRY CLUSTERS

Computers & Communications Hardware
Defense
Diversified Industrial Support
Financial Services
Healthcare Technology
Innovation Services
Postsecondary Education
Software & Communications Services
Textiles & Apparel

DATA AVAILABILITY

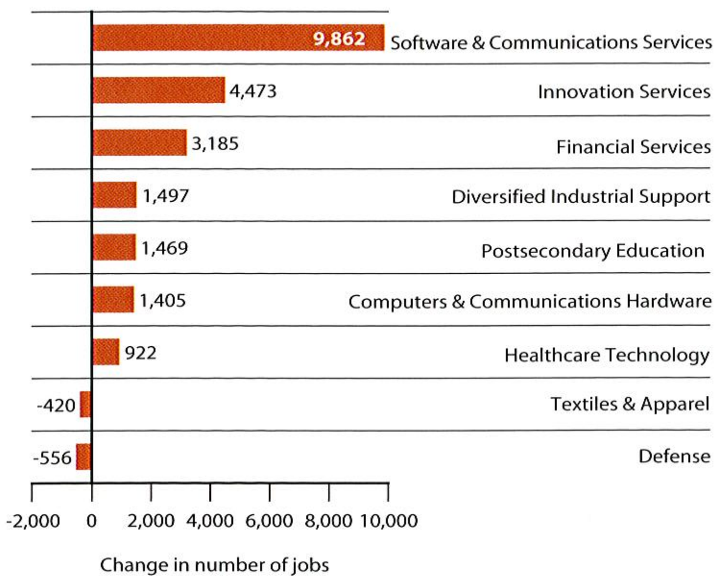
For the 1998 *Index*, most indicators were developed from existing secondary sources. The exceptions are primary data gathered by MTC on the retention of engineering graduates within the state, an occupational needs survey developed by MTC and distributed by Massachusetts industry councils to their members, and a survey of universities and research institutions on technology commercialization. In most cases, indicators from secondary sources required the reconfiguration of existing datasets. These groupings of data are derived from a wide range of sources; consequently, some unavoidable variations exist in the time frames used and in the specific variables that define the indicators being measured. Appendix A provides notes on data sources for each indicator.

I. RESULTS INDICATORS

Important outcomes of the Innovation Economy are increases in the number of jobs, standard of living, and export sales. They result from ongoing innovation and improvements in productivity that promote competitiveness and rising wages in the global economy. These results are essential to the economic well-being of people and businesses in Massachusetts.

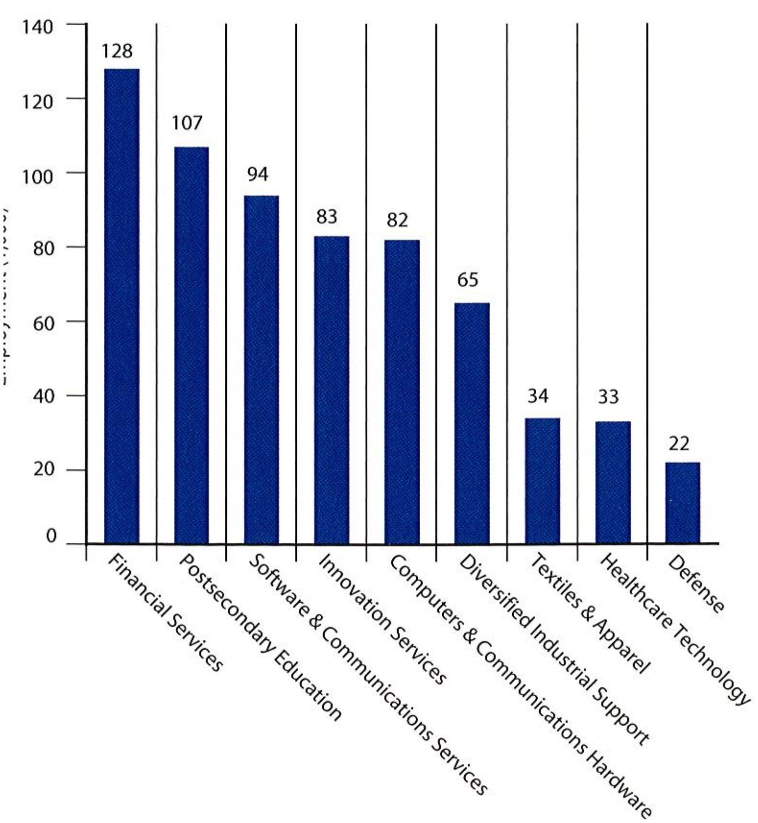
1. Industry Clusters— Knowledge-Intensive Services Dominate Growth

Net employment change, nine key industry clusters, Massachusetts, 1996-1997



Source: Regional Financial Associates, Collaborative Economics, Massachusetts Division of Employment and Training

Total employment, nine key industry clusters, Massachusetts, 1997



WHY IS IT SIGNIFICANT?

Nine key industry clusters, defined as geographic concentrations of interdependent industries, account for 24% of all nongovernment jobs in Massachusetts. These clusters are more highly concentrated in Massachusetts than in the nation overall and are potential sources of competitive advantages for the state's economy.

HOW DOES MASSACHUSETTS PERFORM?

About 650,000 people are employed within these nine key industry clusters in Massachusetts (see Appendix B for definitions of the nine key industry clusters). The largest cluster, Financial Services, employs 128,000; the smallest, Defense, employs 22,000. The net increase in new employment in these nine clusters from 1996 to 1997 was 21,837, or 3.5%, compared to a 2.7% increase in total statewide employment.

Clusters in the knowledge-intensive services continue to gain jobs; those in traditional manufacturing industries do not. Software and Communications Services registered the largest absolute and relative increase in jobs since 1996: 9,862 new jobs (11.7% increase). Other strong gainers were Innovation Services (4,473 new jobs) and Financial Services (3,185 new jobs). Since 1996, Computer and Communications Hardware reversed its prior job loss by regaining 1,405 jobs. The Defense and the Textiles and Apparel clusters continued to contract, shedding 556 and 420 jobs, respectively, from 1996 to 1997.

WHAT DOES THIS TREND MEAN FOR MASSACHUSETTS?

The rapid, continuous change in the Massachusetts industry clusters highlights the dynamic nature of the state's economy. As the state continues its economic restructuring toward knowledge-intensive services, it needs a flexible and skilled workforce and a dynamic education and training system to support growth. Retooling workers displaced from sectors in decline is also essential if the benefits of growth are to be widely shared by Massachusetts residents.

2. Employment Diversification— Employment Growth Is Tied to a Diverse Portfolio of Clusters

WHY IS IT SIGNIFICANT?

Successful economies consist of specialized industry clusters that display exceptional employment concentrations, yet do not rely on just one or two of these clusters. Over-reliance on a particular cluster can leave a state vulnerable to economic shifts and reduce its resilience. Areas exhibiting strong, long-term economic growth tend to have a diverse portfolio of industry clusters.

HOW DOES MASSACHUSETTS PERFORM?

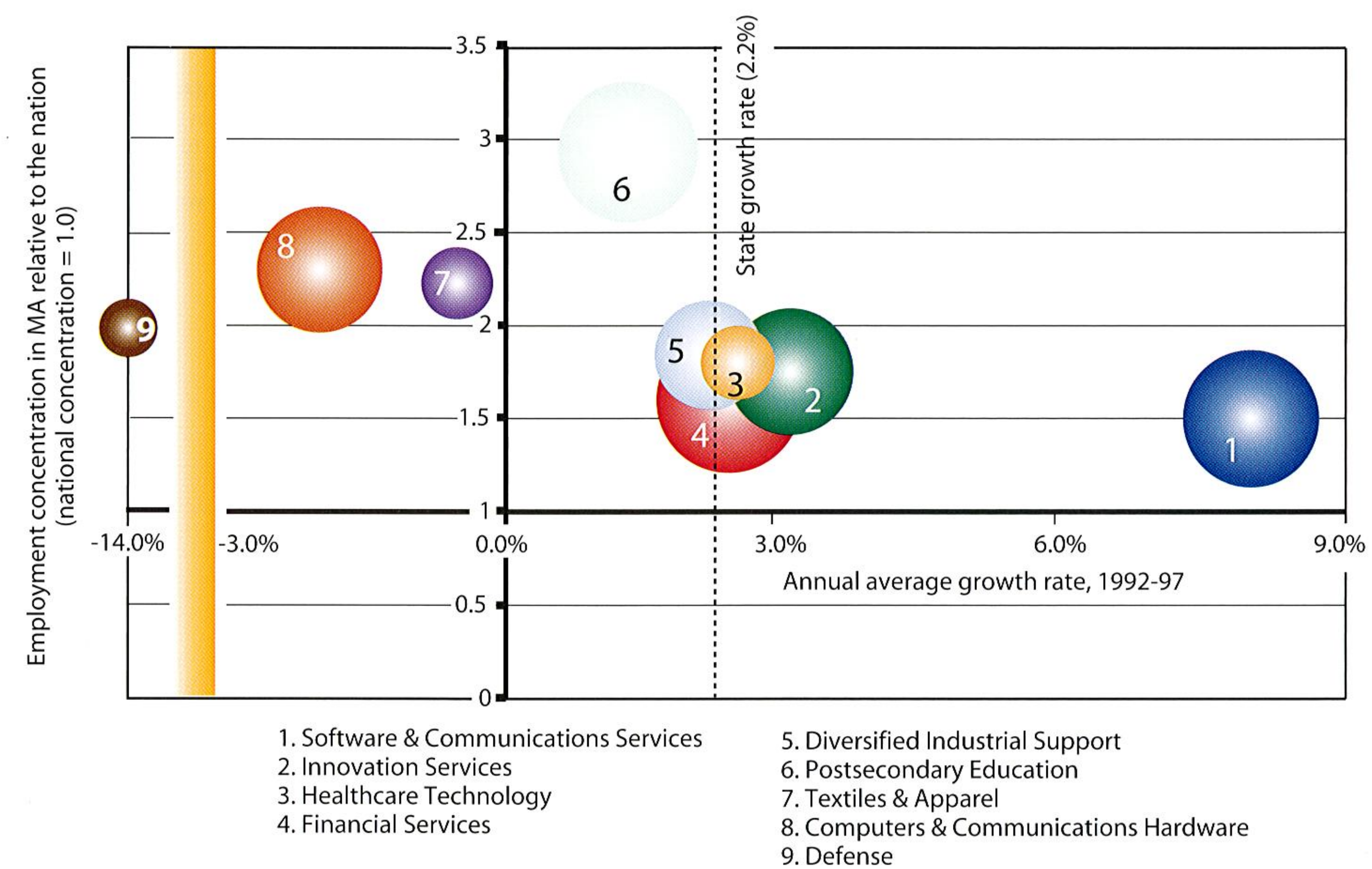
The industry clusters that are most concentrated in Massachusetts relative to the nation are Postsecondary Education (3.0 times), Computers and Communications Hardware (2.3 times), and Textiles and Apparel (2.2 times). (On the chart, these clusters are highest on the vertical axis.)

Of the nine key industry clusters, Financial Services is the largest, with 20% of total employment. The Postsecondary Education, Computers and Communications Hardware, and Software and Communications Services clusters have 17%, 13%, and 13% of the cluster employment total, respectively. The Defense cluster is the smallest at 4%. (The size of each circle on the chart reflects the relative size of the cluster's employment in Massachusetts.)

WHAT DOES THIS TREND MEAN FOR MASSACHUSETTS?

Unlike ten years ago when the state's economy was highly dependent on Defense and Computer Hardware, the Massachusetts portfolio of specialized clusters is now more diverse. This diversity provides a broader base of employment and an economy better able to weather a variety of economic and structural changes.

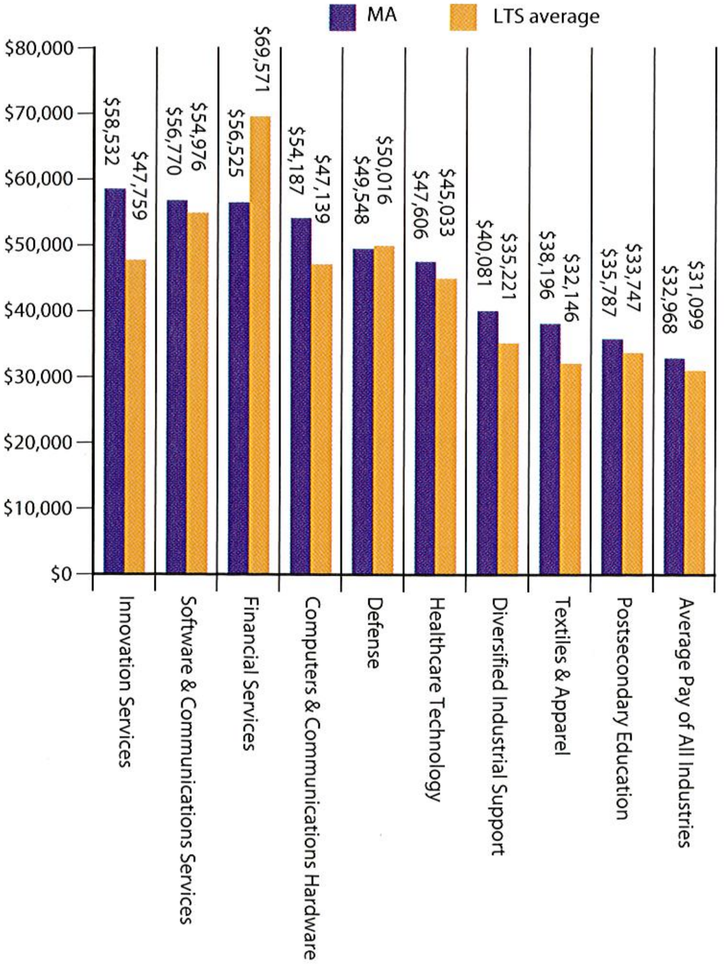
Portfolio of nine key industry clusters by employment concentration and growth, Massachusetts, 1992-1997



Source: Regional Financial Associates, Collaborative Economics

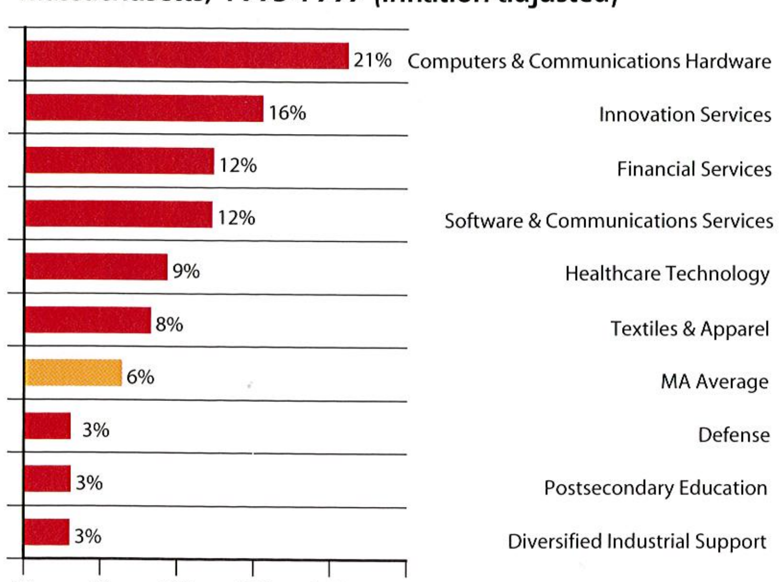
3. Average Pay—Knowledge-Intensive Services Clusters Continue to Lead in Average Pay

Average pay per worker, nine key industry clusters, Massachusetts and other LTS average, 1997



Source: Regional Financial Associates, Collaborative Economics, Massachusetts Division of Employment and Training

Growth of industry cluster wages, Massachusetts, 1993-1997 (inflation adjusted)



WHY IS IT SIGNIFICANT?
Key industry clusters generate wealth through national and international sales of their innovative processes, products, and services. Their relatively high levels of value-added allow these cluster firms to afford greater pay for their highly skilled workers.

HOW DOES MASSACHUSETTS PERFORM?
Workers in the fast-growing, knowledge-intensive services clusters tend to earn the highest wages. The Innovation Services cluster has the highest average pay at $58,532 per year. Software and Communications Services ranks a close second, at $56,770, followed by Financial Services at $56,525 per year.

The average wage for each of the state's nine key clusters is higher than the average annual pay per worker of $32,968 in the state. Compared to clusters in the other Leading Technology States (LTS), seven of the nine Massachusetts industry clusters have higher average wages.

From 1993 to 1997, wages in Computers and Communications Hardware increased the most of all clusters—21% in inflation-adjusted terms. Wages in Innovation Services increased 16%, followed by wages in Software and Communications Services and Financial Services at 12% each. Tight labor markets for skilled personnel drive these wage increases.

WHAT DOES THIS TREND MEAN FOR MASSACHUSETTS?
Massachusetts job growth is concentrated in relatively well-paying industries. This concentration helps to raise the average standard of living of the state's residents. The immediate challenge is to provide the necessary supply of well-qualified workers to these growth fields.

4. Pay per Worker— Increases in Pay per Worker Continue to Outpace Inflation

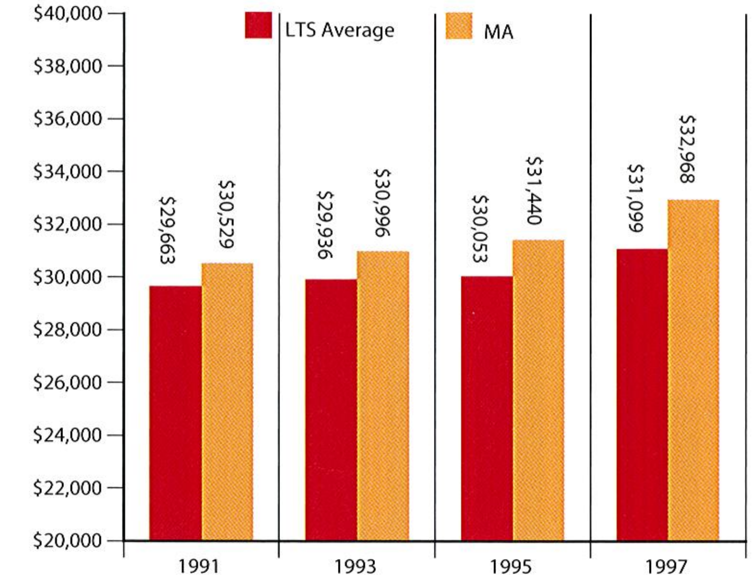
WHY IS IT SIGNIFICANT?
Growth in pay per worker, adjusted for inflation, is a measure of job quality and a key determinant of standard of living.

HOW DOES MASSACHUSETTS PERFORM?
Between 1991 and 1997, average annual pay of Massachusetts workers increased 8.0% in inflation-adjusted terms, compared with 4.8% nationally and in the other Leading Technology States (LTS). In comparison with the six LTS, Massachusetts consistently reports the third-highest average annual pay per worker, just behind New York and New Jersey, and above California.

In 1997, average annual pay in Massachusetts was $32,968 compared to an LTS average of $31,099. From 1996 to 1997, average annual pay per worker increased 2.9%, compared to 2.0% in the other LTS, and 2.4% nationally.

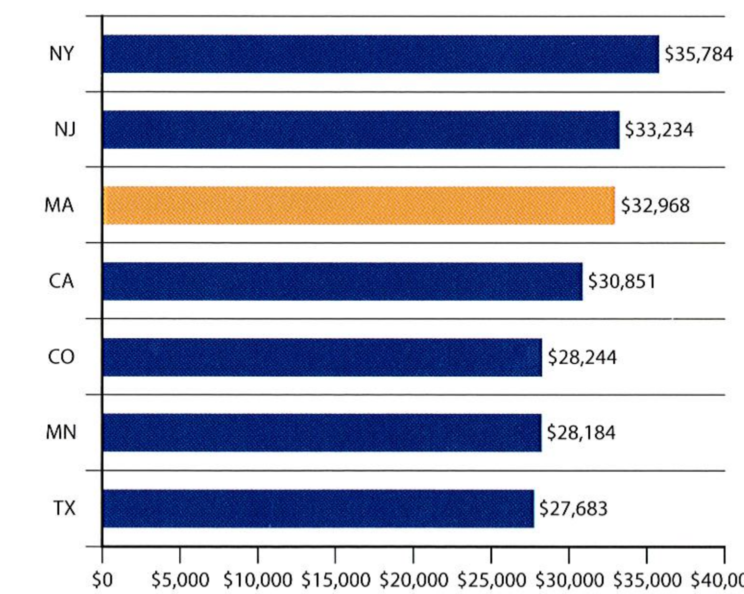
WHAT DOES THIS TREND MEAN FOR MASSACHUSETTS?
Rising pay per worker indicates that on average Massachusetts workers are benefiting from the economic growth occurring in the state. In the long run, Massachusetts industries need to increase their productivity faster than wage growth to ensure competitiveness.

Average annual pay per worker, Massachusetts and other LTS average, 1991-1997



Source: Regional Financial Associates

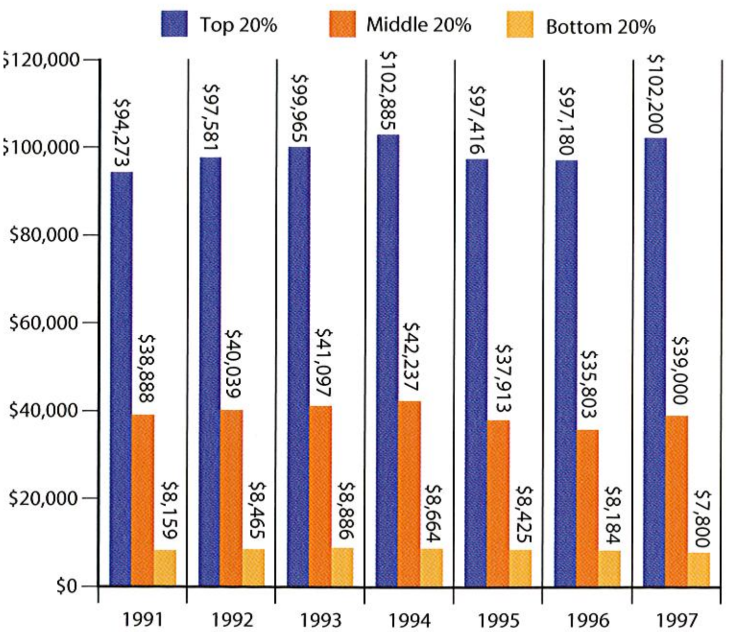
Average annual pay per worker, Massachusetts and other LTS, 1997



Source: Regional Financial Associates

5. Earnings Distribution—Earnings Growth of Bottom 20% of Working Families Lags That of Middle and Top Earners

Earnings of the top, middle, and bottom 20% of Massachusetts working families, 1991–1997



Source: Current Population Survey, U.S. Census Bureau

WHY IS IT SIGNIFICANT?

Successful economies create opportunity for all families to move ahead. They promote a rising standard of living for the lowest group and a stable or narrowing gap between the highest and lowest groups.

This indicator compares the annual earnings of families at the top, middle, and bottom of the earnings distribution. Over time, individuals and families move both up and down the distribution of earnings. Good data on earnings mobility in Massachusetts are not currently available, suggesting an important area for future work.

HOW DOES MASSACHUSETTS PERFORM?

In 1997, the median earnings for the top 20% and middle 20% of Massachusetts families rose 5.2% and 8.9%, respectively, after adjusting for inflation—the first increase since 1994. Earnings for the bottom 20% of families, however, dropped 4.7% in 1997, continuing a decline that began in 1994. Since 1994, median earnings of families in the bottom 20% have dropped 12.2%. The overall effect on income distribution: the ratio of the top 20% of family earnings to the bottom 20% has changed from a ratio of 11 to 6 to a ratio of 13 to 1.

Median earnings for the middle 20% tend to parallel the changes of the top 20% of family earnings. The ratio of median family earnings for the top 20% to middle 20% increased from 2.4 to 2.6.

Many factors are associated with rising earnings inequality, including changing family structure, the growing wage premium paid for college education, and economic cycles.

WHAT DOES THIS TREND MEAN FOR MASSACHUSETTS?

Although the average pay per worker in Massachusetts is increasing, all are not sharing in these gains. Individuals lacking skills and access to jobs with advancement potential are likely to be bypassed as the state and its residents overall prosper. In the Innovation Economy, people should be prepared for the lifelong learning necessary to keep their skills relevant in the changing economy, providing them the opportunity to access higher paying jobs. Massachusetts should further address issues of basic skills development, retraining, and other barriers to upward mobility. Community colleges, vocational schools, businesses, and other partners have vital roles in shaping and implementing education and training programs that foster continuous learning.

6. Skills Needs—Many Vacancies Exist in Technology-Intensive Firms, Especially for Scientists and Engineers

WHY IS IT SIGNIFICANT?

The occupational structure of Massachusetts technology-intensive industries contains a significant concentration of technical and professional talent. Increasingly, Massachusetts corporations cite the limited availability of these skilled workers as an impediment to continued success.

HOW DOES MASSACHUSETTS PERFORM?

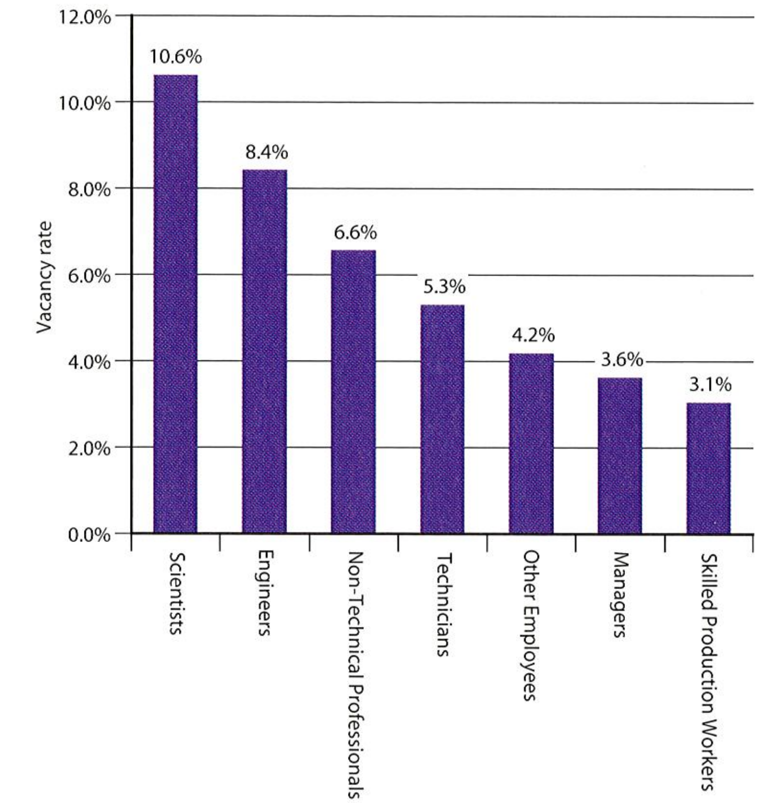
In May 1998, the Massachusetts Technology Collaborative surveyed companies in a range of industries important to the Innovation Economy. The memberships of the Massachusetts Biotechnology Council, the Massachusetts High Technology Council, the Massachusetts Medical Device Industry Council, and the Massachusetts Software Council participated in the survey. Approximately two-thirds of the respondents' employees were in professional, technical, or skilled production work occupations. In addition, 39% of the contract/temporary employees worked in these firms as engineers, technicians, or skilled production workers.

According to survey respondents, the vacancy rates for scientists and engineers are the highest at 10.6% and 8.4%, respectively. Within the software industry, more than half (53%) of the vacant payroll positions are in engineering.

WHAT DOES THIS TREND MEAN FOR MASSACHUSETTS?

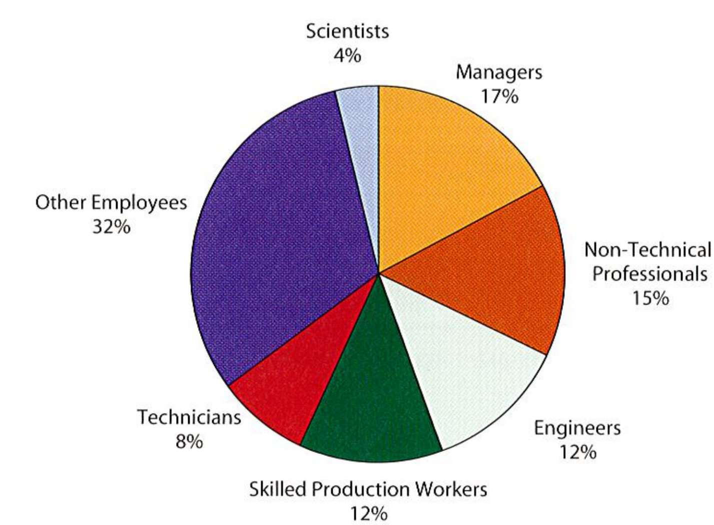
A shortage of skilled workers can slow the growth of the Massachusetts economy and exert upward pressure on labor costs, thereby undermining the state's competitiveness. In the short term, both retraining of existing workers and in-migration of skilled talent are important policy issues. The state needs effective and adequately financed programs for retraining the current workforce. In the longer term, education and retooling of skilled workers are essential to continued prosperity of workers, companies, and communities.

Vacancy rate by occupation within technology-intensive companies surveyed, Massachusetts, 1998



Source: Massachusetts Technology Collaborative Workforce Needs Survey

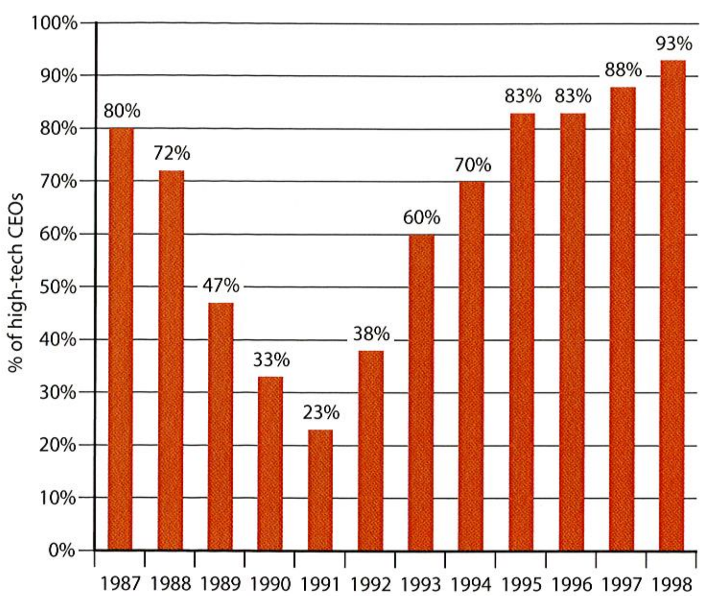
Distribution of current occupations within technology-intensive companies, Massachusetts, 1998



Source: Massachusetts Technology

7. Business Climate— Business Leaders Give Record Approval for Doing Business in the State

Percentage of high-tech CEOs rating the business climate as "good" or "outstanding," Massachusetts, 1987-1998



Source: Massachusetts High Technology Council

WHY IS IT SIGNIFICANT?

Confidence in a region not only reflects current conditions but also influences its future. Positive or negative perceptions of a state affect investment patterns. The perception by high-technology business leaders of how Massachusetts rates as a place in which to create, operate, or expand businesses is a bottom-line indicator of the overall innovation climate.

HOW DOES MASSACHUSETTS PERFORM?

The attractiveness of Massachusetts to technology-based business continued its upward climb in 1998. In 1991, only 23% of the executives responding to the Massachusetts High Technology Council annual survey rated the Massachusetts business climate as "good" or "outstanding." By 1998, 93% of these high-tech firms rated the Massachusetts business climate as "good" or "outstanding"—even more than at the height of the 1980s boom.

WHAT DOES THIS TREND MEAN FOR MASSACHUSETTS?

A positive business climate bolsters the attraction, expansion, and retention of firms and jobs in the state. Although perceptions of the business climate fluctuate significantly with economic and political conditions, the core components of a healthy business climate, such as the regulatory environment and the fiscal stability of the state, require sustained attention. Massachusetts should remain vigilant in maintaining a business climate which provides the predictability supportive of innovation and risk taking.

8. Manufacturing Exports— Growth of Manufacturing Exports Improves

WHY IS IT SIGNIFICANT?

Exports are an important indicator of global competitiveness. Serving growing global markets can bolster growth in employment, sales, and market share at innovation-based companies. Also, diversity of markets creates a counter-cyclical hedge against downturns in any single market. Importantly, measures that help to assess performance of the Innovation Economy must capture both products and services.

HOW DOES MASSACHUSETTS PERFORM?

In 1997, Massachusetts exported $17.4 billion worth of merchandise, an increase of 10.1% from exports in 1996, in inflation adjusted dollars, compared with a 7.6% increase for the United States. Only one of the Leading Technology States (LTS), Texas, fared better with 13.7% growth. However, from 1991 to 1997, manufactured exports increased only 34% in Massachusetts, compared to those in the top-ranking LTS, Colorado (60% increase) and California (52% increase).

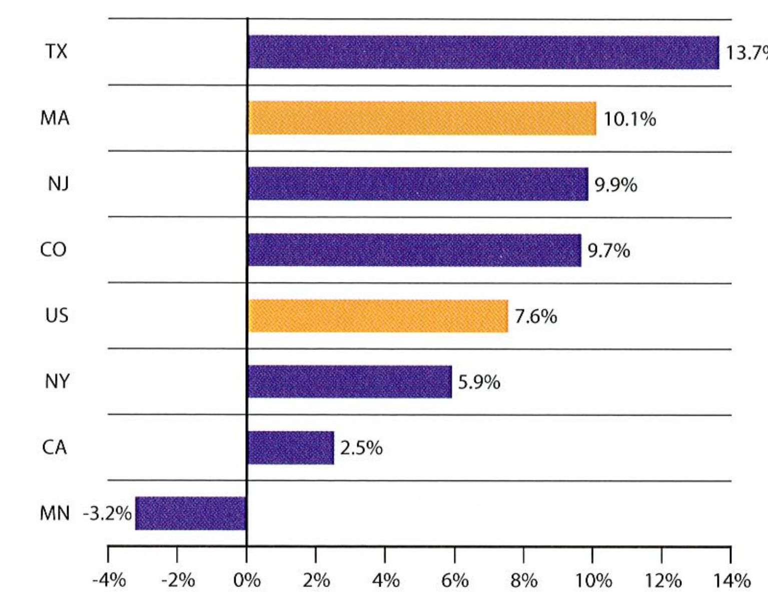
Per employee, Massachusetts manufacturing exports ($38,785) are low compared to those of the other LTS, and they rank just above the national average ($37,093). Within manufacturing, three technology-based industries accounted for more than two-thirds of all Massachusetts manufactured exports in 1997: industrial machinery and computers (29%), electronic and electric equipment (22%), and instruments and related products (16%).

The most recent data (first quarter of 1998) indicate that the state's manufacturing exports have slowed to an expected annual growth of only 2% over 1997 figures.

WHAT DOES THIS TREND MEAN FOR MASSACHUSETTS?

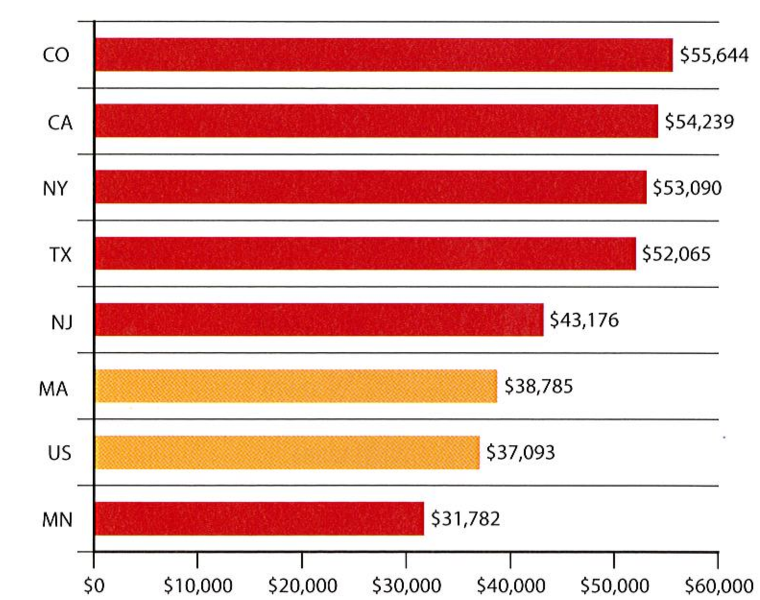
After several years of lackluster export performance relative to that of the other LTS, Massachusetts performed much better in 1997. It is too soon to say whether this improvement marks a turning point or major repositioning for the state. The Asian crisis has had some impact on exports in early 1998, but Massachusetts has fared relatively well given its emphasis on exports to Europe.

Change in value of manufacturing exports, Massachusetts and other LTS, 1996-1997 (inflation adjusted)



Source: U.S. Department of Commerce, International Trade Administration

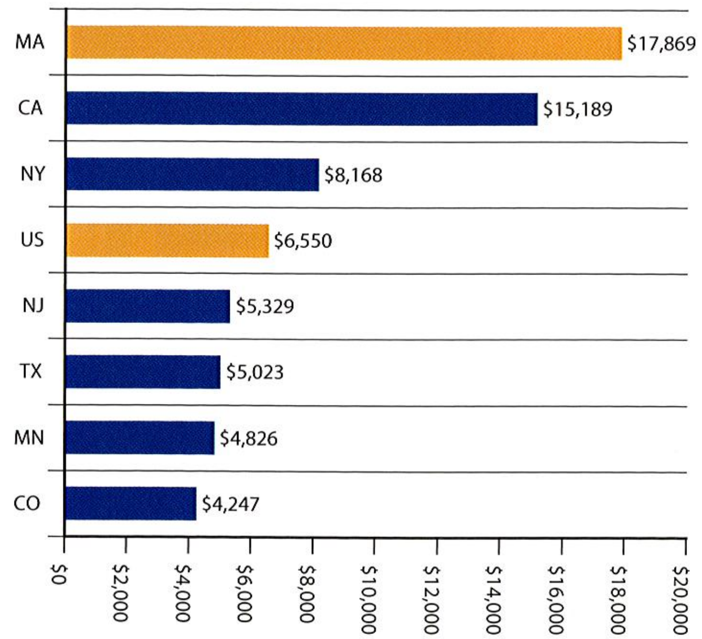
Value of manufacturing exports per employee, Massachusetts and other LTS, 1997



Source: U.S. Department of Commerce, International Trade Administration

9. Services Exports—Software and Innovation
Services Exports Are Highest among the Leading Technology States

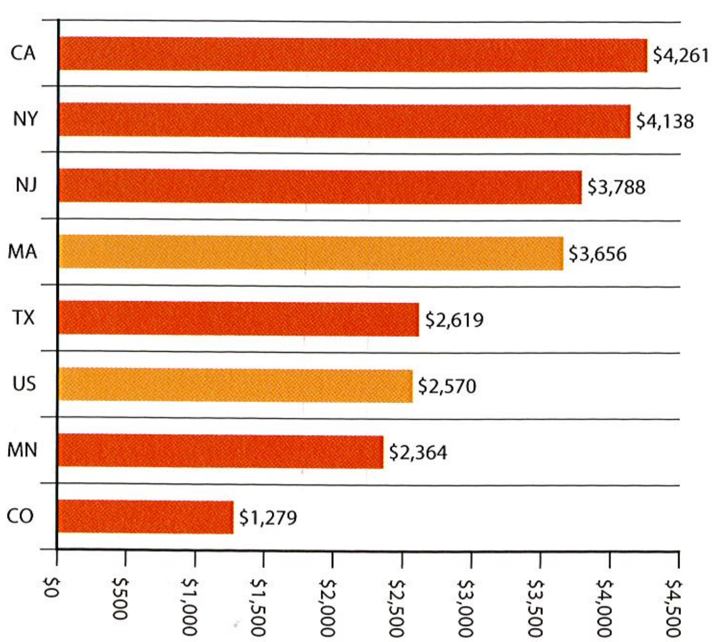
Export revenue per employee for Software and Communications Services industry cluster, Massachusetts and other LTS, 1997*



Source: U.S. Census Bureau, Collaborative Economics, Bureau of Economic Analysis

*Estimate

Export revenue per employee for Innovation Services industry cluster, Massachusetts and other LTS, 1997*



Source: U.S. Census Bureau, Collaborative Economics, Bureau of Economic Analysis

*Estimate

WHY IS IT SIGNIFICANT?

Service sectors have been growing in economic importance. Nationally, approximately 28% of U.S. exports (estimated value $258 billion) are in the service sectors. From 1988 to 1997, the percentage of services employment jumped from 24% to 29% of total national employment, and from 28% to 35% of total Massachusetts employment.

Many technical and financial obstacles exist in tracking growth in services exports, especially at the state level. This indicator estimates the growth in value of service exports.

HOW DOES MASSACHUSETTS PERFORM?

In software exports, Massachusetts ranked the highest among the Leading Technology States (LTS) in terms of export revenue per employee. Its $17,869 export revenue per employee is almost three times the national average of $6,550 per employee. In 1997, the software establishments in the state received an estimated $1.34 billion from international sales of their software products.

In the Innovation Services sector, Massachusetts ranked fourth at $3,656 in export revenue per employee, compared to top-ranked California's $4,261. The national average export revenue per employee in Innovation Services in 1997 is estimated to be $2,570.

WHAT DOES THIS TREND MEAN FOR MASSACHUSETTS?

The state's relatively high proportion of employment in services and the growth of export services revenue per employee highlight the key role of services in the Massachusetts economy. Tracking services exports helps provide a better understanding of the state's global competitiveness. As the Massachusetts economy becomes more services-intensive, the importance of tracking services exports rises.

10. Mutual Fund Exports—
State Leads in Mutual Fund Assets Managed

WHY IS IT SIGNIFICANT?

In the 1990s, mutual funds emerged as a major financial investment instrument for many individual and institutional investors. The total value of mutual fund assets managed by investment companies within a state can serve as a proxy to gauge the competitiveness of the state's mutual fund services. In addition, the percentage of total mutual fund assets managed, that are domestic but from out-of-state or from international investors, indicates the degree of "export orientation" of the state's investment companies. The relatively high salaries paid to professionals creating such products and services have economic multiplier effects on the local economy.

HOW DOES MASSACHUSETTS PERFORM?

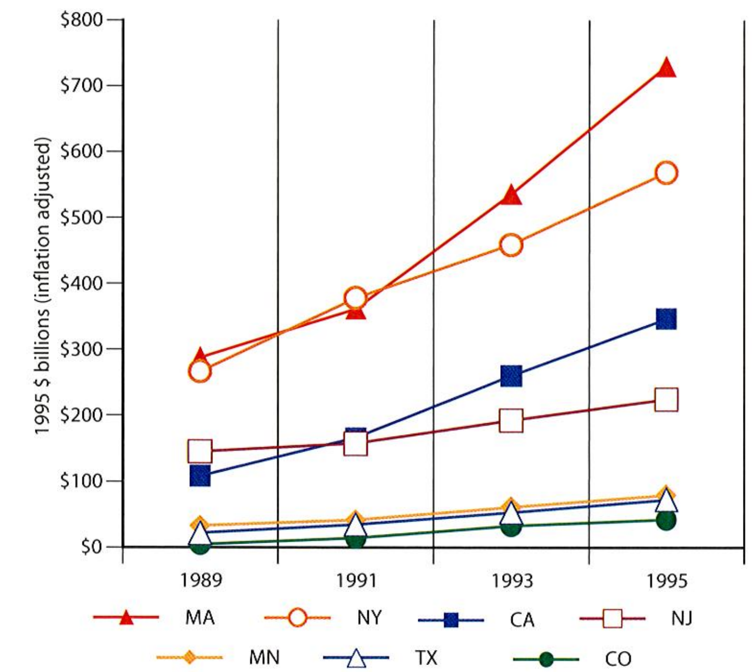
Massachusetts dominates the national mutual fund industry. In 1995, the latest year for which state-level data are available, investment companies in Massachusetts managed a total of $731 billion worth of mutual fund assets. New York ranked second of the Leading Technology States (LTS), managing $569 billion.

Massachusetts is also among the top tier in mutual fund services "exported" outside the state. In 1995, the state's investment companies exported $662 billion worth of mutual fund services, 90.6% of the total. Although both Colorado and Texas have a higher export percentage at 93.9% and 91.5%, respectively, the total amount of mutual fund assets managed by the firms in those states is relatively small at $43 billion and $73 billion, respectively.

WHAT DOES THIS TREND MEAN FOR MASSACHUSETTS?

Despite recent fluctuations in the stock market, the financial services sector is an increasingly important driver of the Massachusetts economy. As the largest and one of the fastest-growing clusters, the state needs to consider the types of talent, from information systems developers to customer service representatives, that will best foster the cluster's growth. In a rapidly changing global environment, what policies and environment will help this cluster maintain and bolster its competitiveness?

Total amount of mutual fund assets managed by all investment companies in each state, 1989-1995



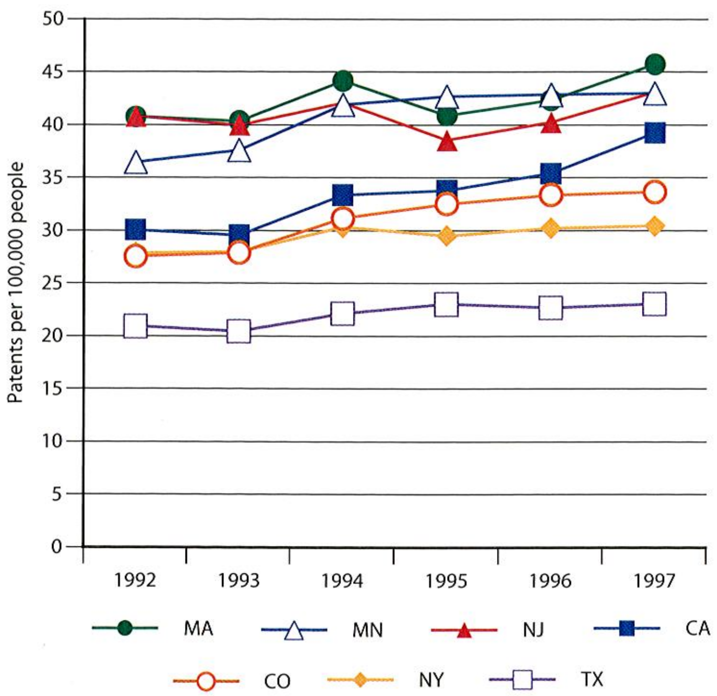
Source: Investment Company Institute

II. INNOVATION PROCESS INDICATORS

The innovation process is reflected in idea generation, technology commercialization, and entrepreneurship, as well as in innovation in established businesses. This dynamic innovation process is an essential component of a competitive economy, because it translates ideas into high-value products and services. Positive results are created for both business and people. The innovation process has different stages, and strong linkages among them are critical for success.

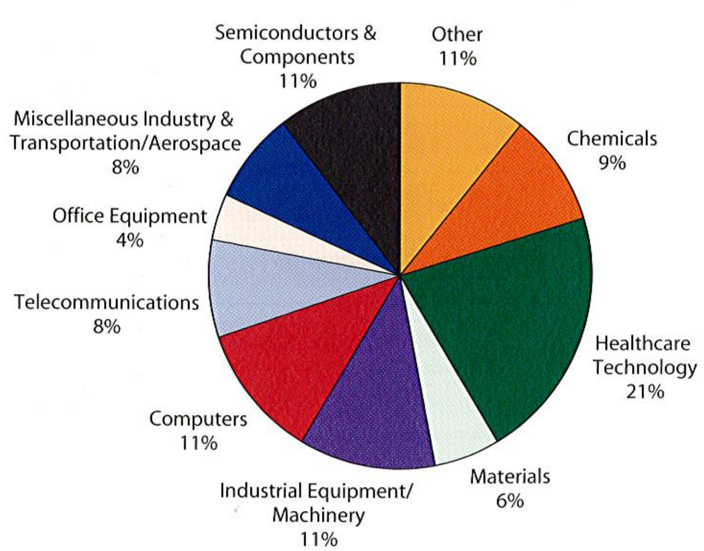
11. Patents per Capita— State Leads in Patents per Capita; Others Are Gaining Ground

Number of patents issued to state residents, per capita, Massachusetts and other LTS, 1992-1997



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

Distribution of patents issued, Massachusetts, 1993-1997



Source: CHI Research

WHY IS IT SIGNIFICANT?

Patents reflect the initial discovery and registry of innovative ideas. Strong patent activity usually reflects significant applied research and development activities. A key motivator to get patent protection is the potential relevance to a marketable product or process. Patent activity can trigger high-impact discoveries that lead to new innovations. Patents citation activity is an indicator of innovation benefits that derive from geographically close relationships between research institutions and companies.

HOW DOES MASSACHUSETTS PERFORM?

Massachusetts ranks first in patents per capita among the Leading Technology States (LTS). In 1997, innovators in Massachusetts were granted 45.8 patents per 100,000 residents. This rate is slightly higher than that of the next closest states, New Jersey (43.1) and Minnesota (43.0). In terms of growth and patent activity on a per capita basis, California and Colorado have led the LTS in the growth of patent activity—increasing 31% and 22%, respectively. This compares to a 12% increase in Massachusetts. The absolute number of new patents issued each year in Massachusetts has increased from 2,445 in 1992 to 2,799 in 1997.

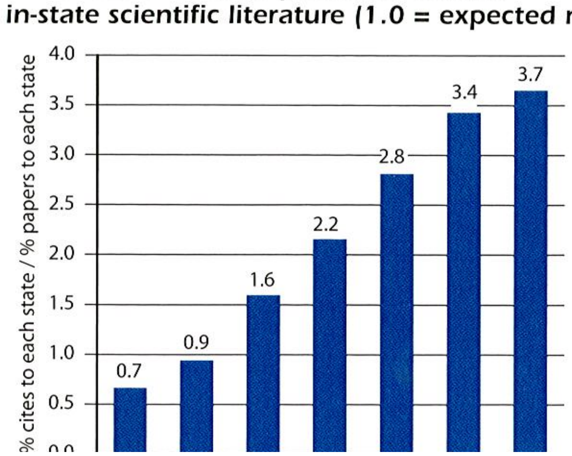
From 1993 to 1997, patents in Massachusetts were distributed across a wide range of sectors. Healthcare Technology was the most active area with 21% of all patents. Computers and the Semiconductors/Components sectors combined for another 22% of all patents during this period.

Patents citation data provide evidence that Massachusetts companies benefit from geographic proximity to institutions that conduct scientific research. Relative to the other LTS, Massachusetts ranks in the middle in patents citation of in-state research. Massachusetts patents cite the literature of in-state research at more than twice the expected rate; New Jersey leads the LTS citing in-state research at 3.7 times the expected rate. (See Appendix A for additional information about the expected rate.)

WHAT DOES THIS TREND MEAN FOR MASSACHUSETTS?

Strong patent activity is crucial to breakthrough product development and process improvements. If it is to remain a leader in patents per capita, Massachusetts must not become complacent about the need to fund innovative applied research. Corporations and other research institutions must continue to recognize and promote their interrelatedness within this innovation process, which begins with idea generation and results in new products and processes.

Indexed rate of in-state patent references to in-state scientific literature (1.0 = expected rate)



12. Invention and Patent Applications— Patent Applications and Invention Disclosures Are Rising

WHY IS IT SIGNIFICANT?

Massachusetts universities, hospitals, and research institutions are important sources of innovative ideas. To start the process of moving an innovation toward patent protection, individual inventors formally disclose innovations to their sponsoring institutions. Following disclosure, formal patent application to the U.S. Patent and Trademark Office is the next major step to patent protection. The level of invention disclosures and formal patent applications reflect the initial registry of innovative ideas or inventions with commercial potential.

Research conducted by universities, hospitals, and research institutions has a twofold "spillover" effect in the state's economy. First, institutional research induces private research to capitalize on innovations. Later, the new companies, goods, and services created downstream spur economic vitality and jobs.

HOW DOES MASSACHUSETTS PERFORM?

The number of invention disclosures received annually by Massachusetts institutions increased 18% from 876 in 1995 to an estimated 1,032 in 1996. Since 1991, an average of 63% of the invention disclosures were received by universities, with the remainder at hospitals and research institutions.

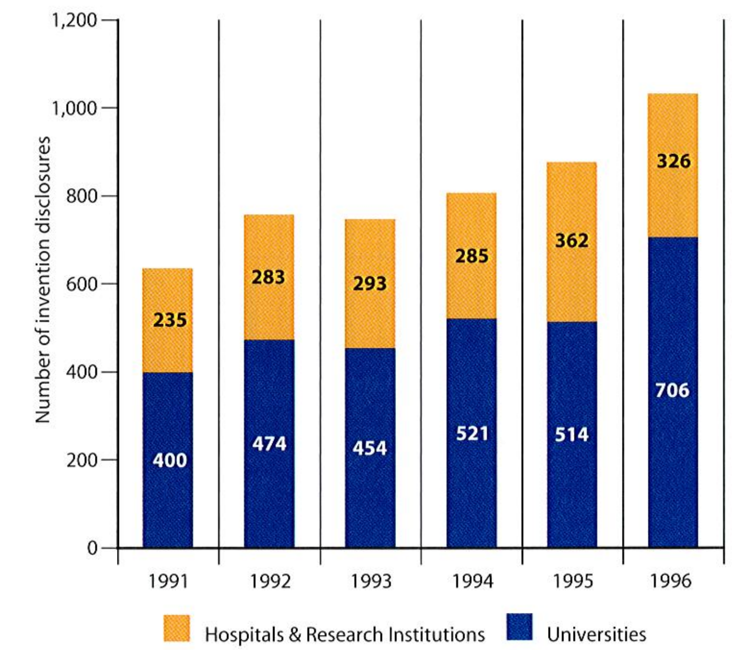
Of the hospitals and research institutions, Massachusetts General Hospital (MGH) accounted for the most invention disclosures (43%). Among the universities, Massachusetts Institute of Technology (MIT) and Harvard University were consistently responsible for about 70% of all inventions disclosures.

The number of new patent applications filed by Massachusetts institutions increased to 337 in 1996 from 316 in 1995. Growth in 1996 was driven by new patent applications from Massachusetts hospitals. Massachusetts General Hospital, Children's Hospital, and Brigham and Women's Hospital all saw increases of at least 20% over their 1995 levels. Patent applications from Massachusetts universities edged down 2.5% in 1996.

WHAT DOES THIS TREND MEAN FOR MASSACHUSETTS?

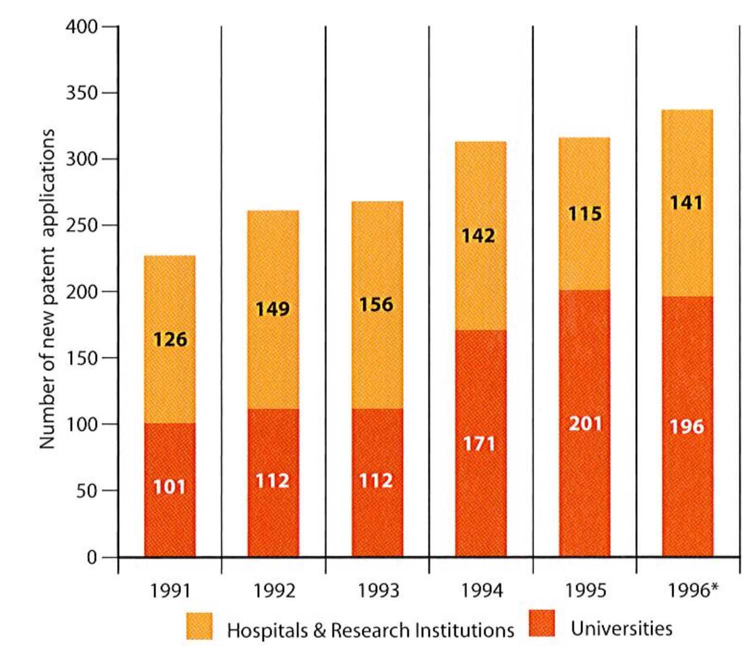
Massachusetts continues to demonstrate significant levels of idea generation as measured by both invention disclosures and new patent applications. This idea generation is an important long-term competitive advantage. However, to realize the full potential of these ideas, they must be closely linked to active commercialization efforts. Maintaining strong innovation networks between key industry clusters and research institutions is critical to this process.

Number of invention disclosures received by major universities, hospitals, and research institutions, Massachusetts, 1991-1996



Source: Association of University Technology Managers, Massachusetts Technology Collaborative

Number of new patent applications filed each year by major universities, hospitals, and research institutions, Massachusetts, 1991-1996

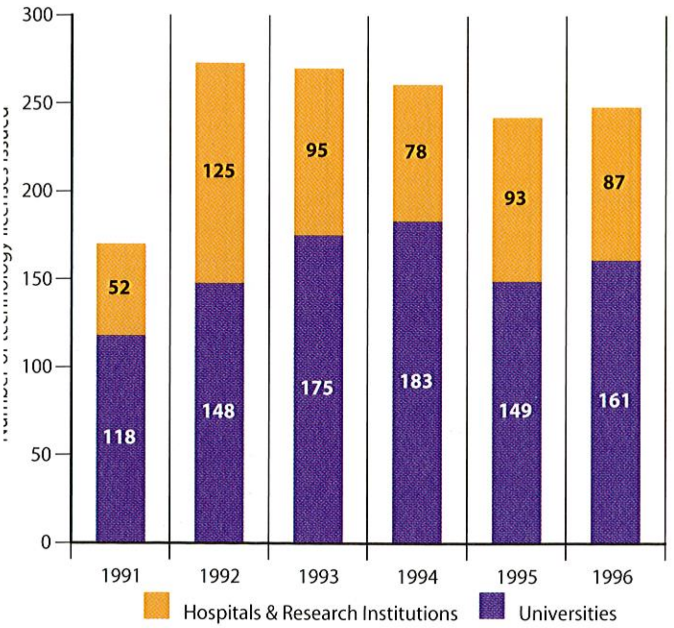


Source: Association of University Technology Managers, Massachusetts Technology Collaborative

*Estimate

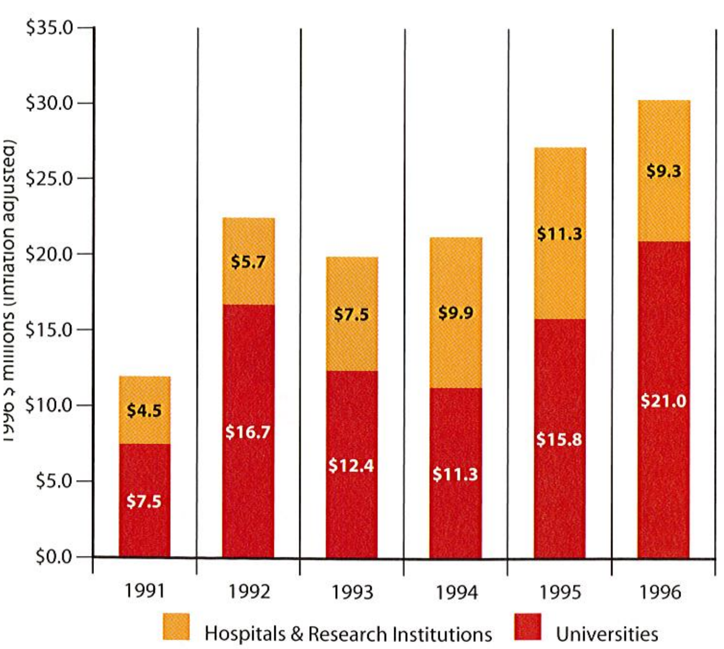
13. Technology Licenses and Royalties—Number of Recent New Licenses Grows; Royalties Show Rapid Growth

Number of technology licenses issued by major universities, hospitals, and research institutions, Massachusetts, 1991-1996



Source: Association of University Technology Managers, Massachusetts Technology Collaborative

Value of technology licenses outstanding, Massachusetts, 1991-1996



Source: Association of University Technology Managers, Massachusetts Technology Collaborative

WHY IS IT SIGNIFICANT?

Once a university, hospital, or research institution has a patent, it can enter into a licensing agreement with a company and receive a negotiated fee. This agreement is a step toward commercializing the new idea as a marketable product. The time lag between receipt of a patent and execution of a licensing agreement may be significant, however.

Licensing revenues are affected by the fields 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 the 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 rose 2.5% to 248 in 1996 from its 1995 level. The Massachusetts Institute of Technology (MIT) and Harvard University together generated 80% of the technology licenses.

In the last two years, the number of new technology licenses issued annually appears to be trending upward. Gross royalties received from licensing have increased, in inflation-adjusted terms, from $22.4 million in FY 1992 to $30.3 million in FY 1996. In 1996, the institutions in Massachusetts receiving the highest amount of royalties were, in descending order, MIT, Harvard University, Brigham and Women's Hospital, Boston University, and the Dana-Farber Cancer Institute.

WHAT DOES THIS TREND MEAN FOR MASSACHUSETTS?

The number of new technology licenses at major research institutions in Massachusetts rose in 1996, and financial returns resulting from outstanding licenses have grown significantly in recent years. The strengthening of linkages between universities, hospitals, and businesses is important to maintaining and increasing technology-transfer efforts.

14. FDA Approval— FDA Approval of Medical Device Applications Remains Strong

WHY IS IT SIGNIFICANT?

The U.S. Food and Drug Administration (FDA) approval process uses three application categories to classify medical devices: investigational device exemptions (IDEs), premarket approvals (PMAs), and 510(k)s for less sophisticated instruments or product improvements. The most complex, the highest-risk, and the newest technologies tend to be classified as IDEs or PMAs. Approval rates reflect innovation in medical device manufacturing and important linkages to the teaching hospitals, where many of these instruments undergo clinical investigation.

HOW DOES MASSACHUSETTS PERFORM?

Massachusetts has consistently ranked among the top states in the nation for approval of IDEs. After a significant decline from 1990 to 1993, IDE approvals more than doubled in the state from 8 in 1995 to 18 in 1997.

The number of PMAs in Massachusetts reflects the concentration of the latest developments in medical device manufacturing. Among the Leading Technology States (LTS), Massachusetts (with 40 approvals) ranks fourth behind California (121), Minnesota (101), and Texas (45) in the number of PMAs approved in 1997.

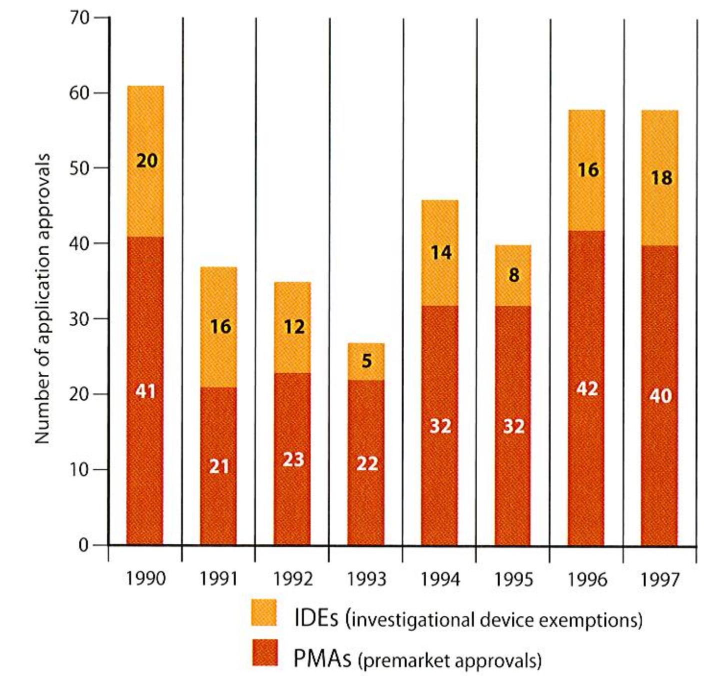
The Massachusetts medical device industry received 376 approvals of 510(k)s in 1997. Massachusetts ranks a distant second behind California, which had 1,003 such approvals.

According to MassMEDIC, the association of medical device manufacturers in the state, more than 200 medical device companies are based in Massachusetts. These firms account for 5% of the state's total manufacturing base and employ more than 18,000 people.

WHAT DOES THIS TREND MEAN FOR MASSACHUSETTS?

FDA approval for advanced medical devices is a critical step in moving from innovative ideas to commercial products in the healthcare field. Timely approval of medical devices enhances the state's competitiveness by expediting time to market.

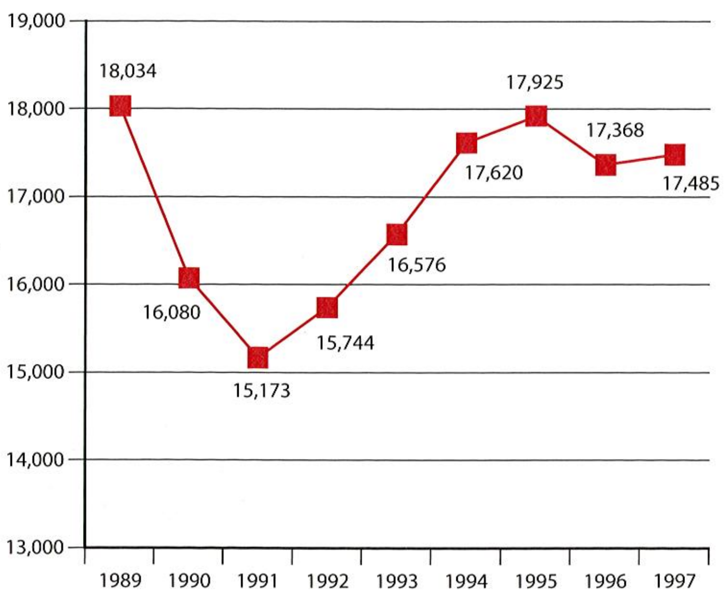
Number of FDA application approvals for advanced medical devices, Massachusetts, 1990-1997 (fiscal years)



Source: MassMEDIC, U.S. Food and Drug Administration

15. New Business Incorporations— New Business Incorporations Increase

Number of total new business starts, Massachusetts, 1989-1997



Source: Secretary of the Commonwealth

WHY IS IT SIGNIFICANT?

The formation of new companies speaks to the entrepreneurial spirit and innovative thinking in Massachusetts. Increasing numbers of new business ventures are an indicator of an economic environment that encourages innovation and risk taking. New businesses provide not only new jobs but also new products, services, and ideas.

HOW DOES MASSACHUSETTS PERFORM?

In 1997, 17,485 new business incorporations were registered with the Secretary of State, an increase of 15% from 1991. Since 1991, a total of 117,891 new business incorporations have been registered. In 1997, on a per capita basis, 28.6 new business ventures were started for every 10,000 residents.

One way to understand the role of industry clusters in new business formation is to look at net increases in the number of establishments. The increase in the number of business establishments is concentrated in two industry clusters: Software and Communications Services, and Innovation Services. Since 1996, these two clusters added 523 and 359 establishments, respectively. These clusters have been key creators of new jobs in Massachusetts in recent years.

WHAT DOES THIS TREND MEAN FOR MASSACHUSETTS?

It is important to nurture environments throughout the state where entrepreneurial ventures can incubate and grow. New businesses must have timely access to a supportive network of advisers, financiers, researchers, and employees.

16. SBIR Awards— Small Business Innovation Research Awards Hold Steady

WHY IS IT SIGNIFICANT?

The Small Business Innovation Research (SBIR) program provides competitive grants to entrepreneurs seeking to do "Phase I" proof-of-concept research on the technical merit and feasibility of their ideas, and "Phase II" commercialization work to build on these findings and further develop their ideas. Nationally, companies that receive funding from Phase II of the SBIR program significantly outperform similar companies that do not receive support. In addition, success in the SBIR program attracts outside capital investment.

HOW DOES MASSACHUSETTS PERFORM?

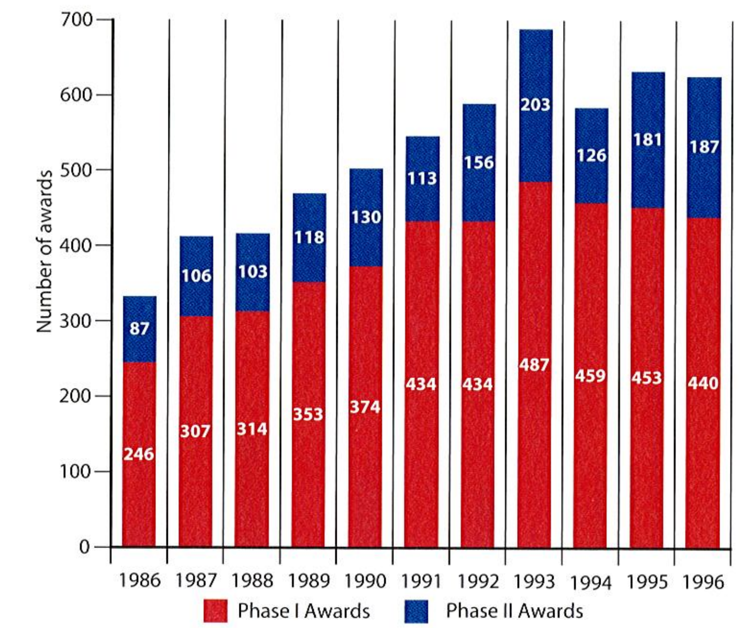
In 1996, Massachusetts held relatively steady as a recipient of SBIR awards, receiving 627 awards, with a slight shift toward more Phase II awards. Since the inception of the program, in 1983, Massachusetts has consistently ranked second in the total number of SBIR awards received behind California, which had a total of 906 awards in 1996. On a per capita basis, SBIR awards to Massachusetts were almost four times those of California.

In 1996, the total dollar value of SBIR awards to Massachusetts companies was $148 million—a record level. Phase II awards are significantly larger in dollar value than Phase I awards and constitute about 75% of all SBIR funding in the state.

WHAT DOES THIS TREND MEAN FOR MASSACHUSETTS?

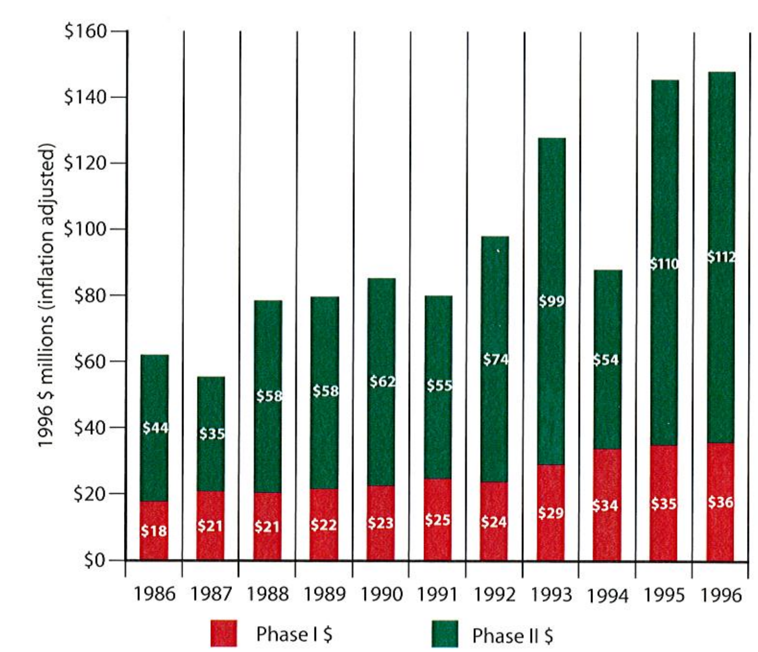
The success of Massachusetts in the SBIR program is an indicator of healthy entrepreneurship and of state and federal support of entrepreneurial activity in a state. By maintaining its strong support for the SBIR program, Massachusetts sets the stage for the continued growth and success of emerging companies.

Number of SBIR awards to Massachusetts companies by phase, 1986-1996



Source: Small Business Administration

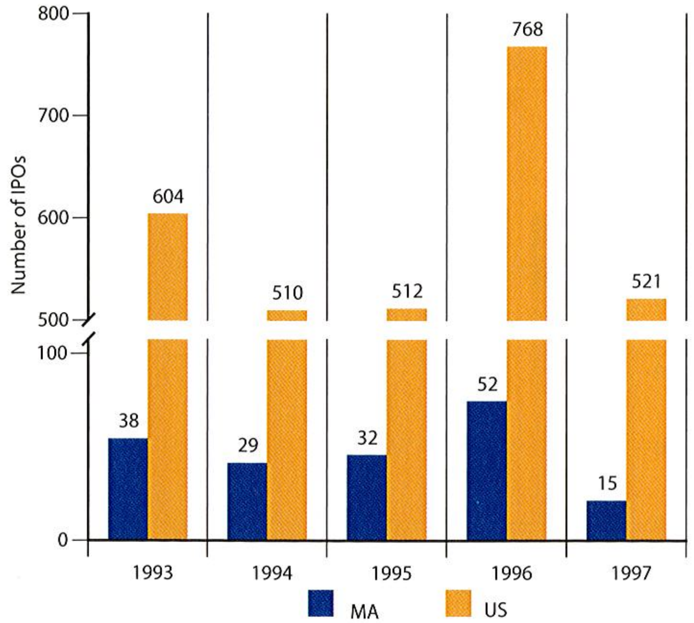
Dollar value of SBIR awards received by Massachusetts companies, 1986-1996



Source: Small Business Administration

17. Initial Public Offerings— Number of IPOs Drops Significantly; Average Size of IPO Is Relatively Small

Number of initial public offerings (IPOs), Massachusetts and United States, 1993-1997



Source: Hale and Dorr, LLP

WHY IS IT SIGNIFICANT?

The number of initial public offerings (IPOs) is an indicator of future high-growth companies. "Going public" can raise significant revenue to invest and stimulate growth in a company to its next level. A successful IPO reflects confidence by investors that the company can generate increases in value and can sustain growth.

HOW DOES MASSACHUSETTS PERFORM?

After an exceptional 1996 in Massachusetts and across the nation, IPO activity fell significantly. Massachusetts had only 15 IPOs in 1997, the lowest number since 1990. These IPOs were primarily in the Healthcare Technology area. The IPOs in Massachusetts in 1997 were 71% off the record 1996 pace. So far, in the first half of 1998, Massachusetts launched seven IPOs.

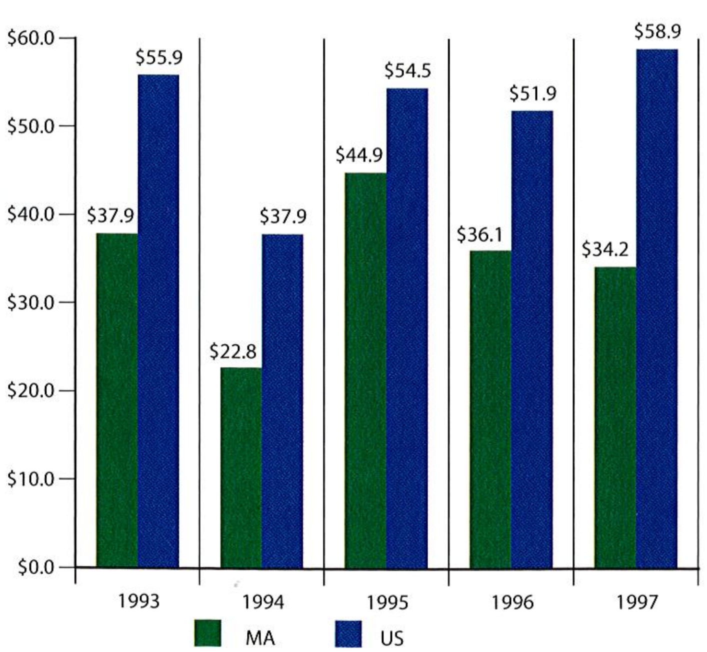
Across the United States, IPOs were down 32% from 1996 to 1997, a drop returning IPOs nationally to a level consistent with those of 1994 and 1995. So far in 1998, the national rate of IPOs is similar to the 1997 figure.

The average proceeds of Massachusetts IPOs have been considerably lower than those of the nation. In 1997, this gap increased, with Massachusetts IPOs generating on average less than 40% ($34.2 million) of the national figure ($58.9 million).

WHAT DOES THIS TREND MEAN FOR MASSACHUSETTS?

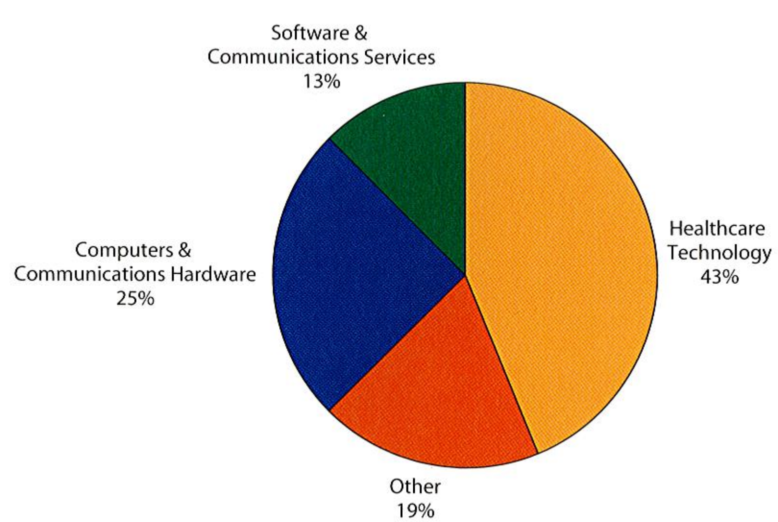
Although volatility in the securities market affects IPO levels, the relatively severe downturn in Massachusetts is cause for concern. Massachusetts needs to generate sound, growth-oriented firms continuously; fewer IPOs can lead to fewer fast-growth gazelle companies in the state. Issues that should be explored further include the factors behind the relatively small size of the average Massachusetts IPO and the role of mergers and acquisitions in the decline of IPOs.

Average dollar value of IPOs, Massachusetts and United States, 1993-1997



Source: Hale and Dorr, LLP

Distribution of IPOs by industry cluster, Massachusetts, 1997



Source: Hale and Dorr, LLP

18. Mergers and Acquisitions— Mergers and Acquisitions Are Increasingly Important

WHY IS IT SIGNIFICANT?

Mergers and acquisitions (M&As) are an important route to liquidity for entrepreneurs and investors in rapidly growing companies. Increasingly, an objective of new, innovation-based companies is to sell the company to another firm that can develop the technologies and products to the next level. The financial investment and entrepreneurial talent freed through the sale can then be recycled into new entrepreneurial ventures.

HOW DOES MASSACHUSETTS PERFORM?

In the Massachusetts information technology industry, M&As jumped from 72 to 121 between 1995 and 1996. In 1997, they increased slightly to 123. However, in the first half of 1998, Massachusetts has already seen more than 93 M&As. (Note: The dataset measures mergers and acquisitions in the broad category of "information technology." This category includes companies in the Software and Communications Services Cluster and in the Computers and Communications Hardware Cluster.)

One-half of the 1997 mergers and acquisitions were in software products and services, highlighting the desirability of Massachusetts software companies as acquisition targets.

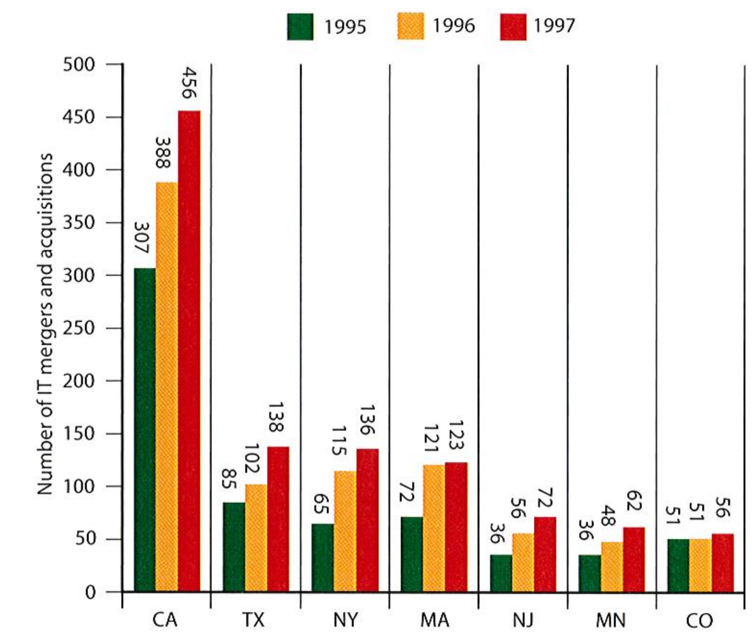
Stock market volatility is a key driver of growing M&A activity in technology sectors in Massachusetts and nationally. In 1997, Massachusetts had 123 M&As compared with 15 IPOs—a ratio of 8 to 1. Nationally the ratio was similar. In the first half of 1998, this ratio increased to 13 to 1 in Massachusetts compared to a national ratio of 12 to 1. A key contributor to M&A activity is the large number of companies that went public in 1995-1996. These corporations have the capacity to make acquisitions of smaller, privately held companies due to the inflow of capital from their IPOs.

All other Leading Technology States (LTS) experienced increases in M&A activity between 1996 and 1997, with California, Texas, and New York surpassing Massachusetts in the number of mergers and acquisitions.

WHAT DOES THIS TREND MEAN FOR MASSACHUSETTS?

Small, privately held entrepreneurial businesses increasingly tend to position themselves as attractive acquisition targets as a strategy to grow their business enterprises. Often, the acquiring companies in these situations are focused on obtaining the talent and technology of the small company. In these cases, the people, technology, and investment proceeds tend to stay within the state and benefit the state's economic vitality. However, it is also possible an acquiring company may be interested in assets that are transportable (e.g., a distribution network). In these cases, an acquisition is less likely to benefit the state. The local capture of investments and talent following a merger or acquisition is largely a function of the rationale behind the change as well as the locations of the headquarters of the firms. Further topics to explore: what are the driving motives of mergers and acquisitions in Massachusetts, and what are the experiences of Massachusetts business enterprises, once acquired?

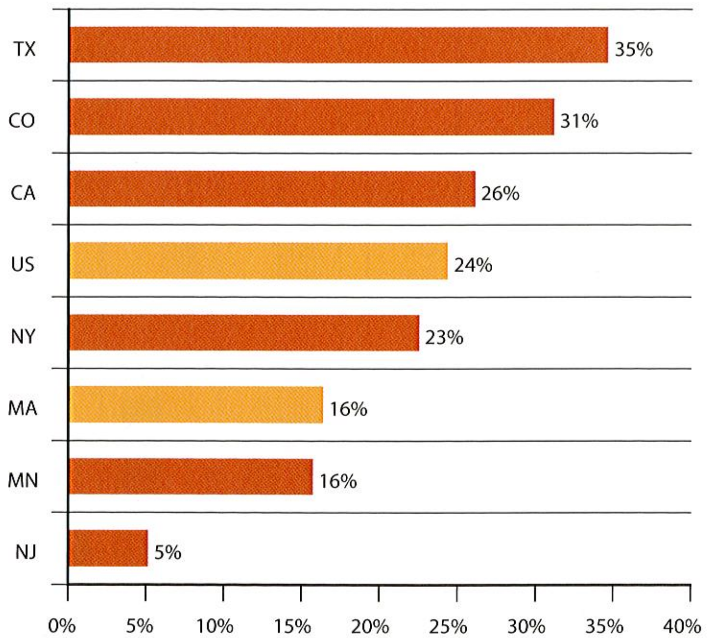
Number of information technology mergers and acquisitions, Massachusetts and other LTS, 1995-1997



Source: Broadview International LLC

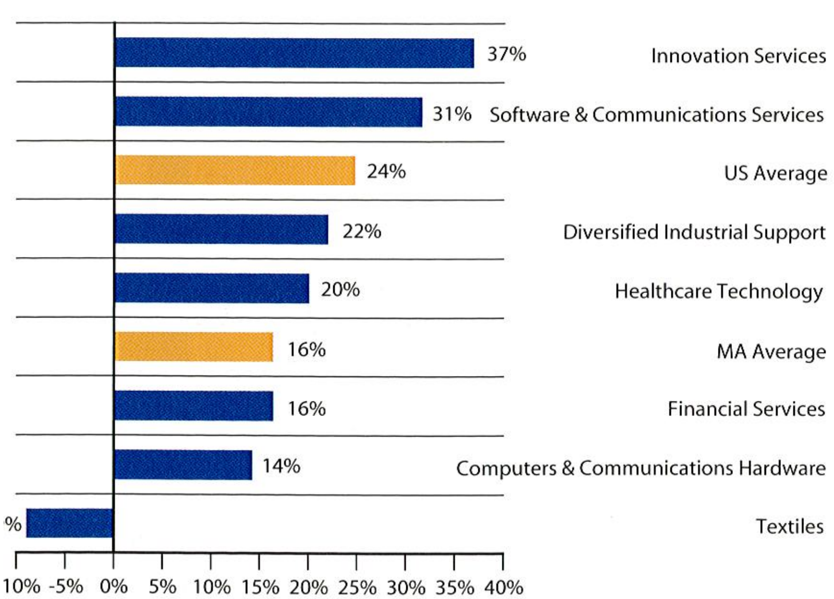
19. NASDAQ Firms' Market Value— NASDAQ Firms Post Below-Average Growth in Market Value

Annual average growth of NASDAQ companies' market value, Massachusetts and other LTS, 1993-1998 (inflation adjusted)



Source: NASDAQ, Collaborative Economics

Annual average growth of NASDAQ companies' market value by clusters, Massachusetts, 1993-1998 (inflation adjusted)



Source: NASDAQ, Collaborative Economics

WHY IS IT SIGNIFICANT?

The National Association of Securities Dealers' stock exchange, NASDAQ, is known for its innovative, emerging growth companies. Seventy percent of its listed companies are small, with market capitalization of less than $100 million. NASDAQ is home to some of the nation's fastest growing technology-based companies.

HOW DOES MASSACHUSETTS PERFORM?

The market value of Massachusetts-based NASDAQ companies grew from $31.4 billion in 1993 to $67.2 billion in 1998, when adjusted for inflation. This average annual growth rate of 16% trailed the 24% average annual growth rate of all NASDAQ firms in the United States and the 35% average annual growth rate of Texas, the top-ranked Leading Technology State (LTS).

The market value of Massachusetts NASDAQ companies in the Innovation Services cluster and that of companies in the Software and Communications Services cluster are exceptions, increasing significantly at 37% and 31%, respectively.

WHAT DOES THIS TREND MEAN FOR MASSACHUSETTS?

Massachusetts should explore why its small-capitalized companies are performing below-average market value. Does this performance reflect the entrepreneurial capabilities of managers or the industrial mix of emerging firms? Do fast-growth, start-up firms in Massachusetts have a greater propensity to "sell out" early rather than growing larger by going public? Is there a disconnect in the technology commercialization process among the research institutions, venture capitalists, and business owners? What collaborative efforts among concerned players might improve the market attractiveness of these Massachusetts firms?

20. Gazelle Companies— Number of Fast-Growth "Gazelle" Companies Continues to Grow

WHY IS IT SIGNIFICANT?

As the United States transitions toward a knowledge-based economy, a new generation of growth-oriented companies is emerging. One benchmark of such growth is the number and distribution of "gazelles," i.e., publicly traded companies whose sales have grown at an annual average compound rate of 20% or more for the last four years. By generating accelerating increases in output and jobs, gazelles stimulate growth of other businesses and personal spending.*

HOW DOES MASSACHUSETTS PERFORM?

The number of publicly traded gazelles in Massachusetts continued to rise in 1997 reaching 101 firms–up from 99 in 1996. Gazelle firms have increased substantially from 1992, when only 38 companies demonstrated this high level of growth. In 1997, 20% of the state's publicly traded companies were classified as gazelles. This figure compares favorably with 17% in Silicon Valley. (Silicon Valley had 64 gazelles in 1997 and 73 in 1996.)

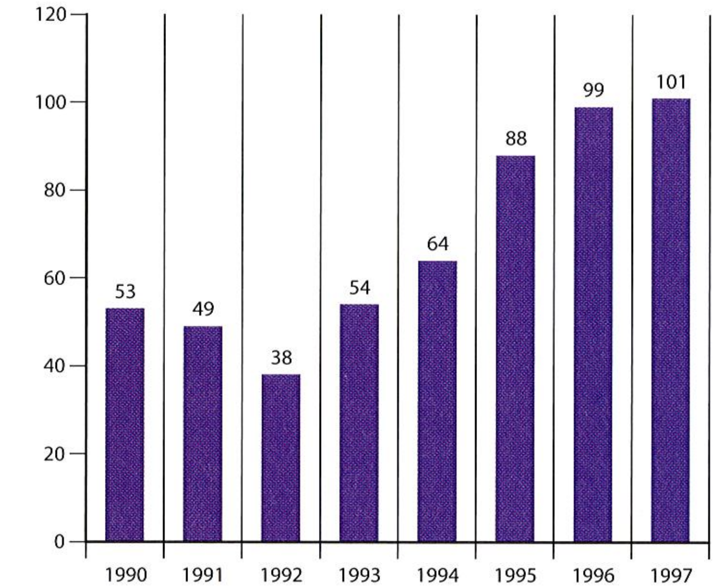
The sector spawning the largest share of gazelles in Massachusetts in 1997 was Healthcare Technology, with 24% of the total. Computers and Communications Hardware made up the next major component with 21%. Twenty-four percent of gazelles fall into the "other" category, which spans retail, restaurants, waste management, healthcare, and other diverse services and products.

WHAT DOES THIS TREND MEAN FOR MASSACHUSETTS?

Massachusetts must attend to the fundamentals of its Innovation Economy to grow increasing numbers of fast-growth companies. The number of gazelles is a function of entrepreneurial and technical talent and networks of people and organizations that support idea generation, technology commercialization, entrepreneurship, and ongoing business innovation.

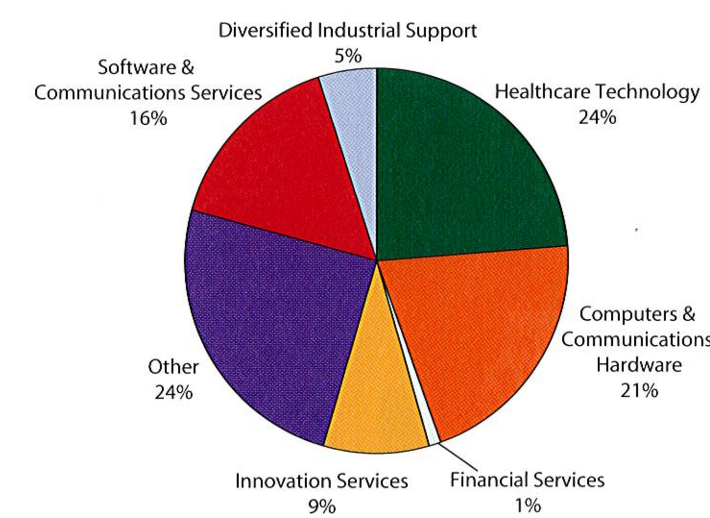
*David Birch of Cognetics, Inc., in Cambridge, coined the term *gazelle*.

Number of publicly traded "gazelle" companies, Massachusetts, 1990-1997



Source: Compustat, Global Researcher, Collaborative Economics, Securities and Exchange Commission

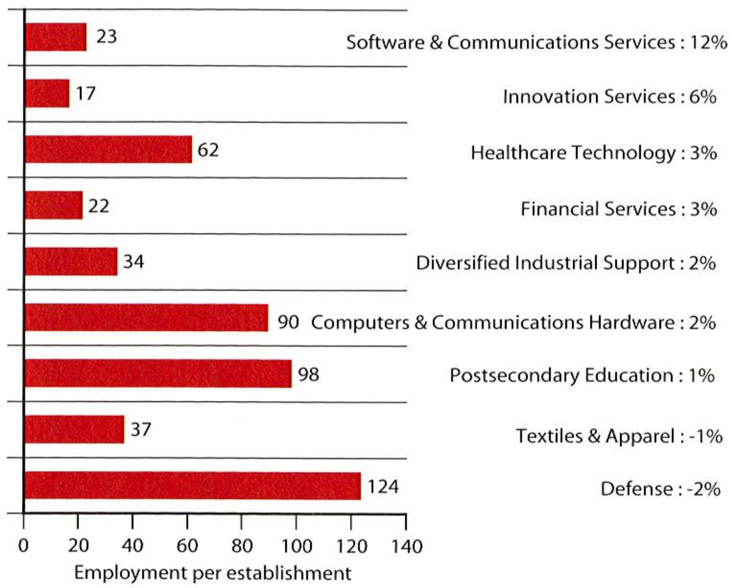
Distribution of publicly traded "gazelle" companies, Massachusetts, 1997



Note: Portions may not sum to 100% due to rounding
Source: Compustat, Global Researcher, Collaborative Economics, Securities and Exchange Commission

21. Average Establishment Size— Largest and Fastest-Growing Clusters Have Smallest Establishment Size

Employment per establishment ordered by 1996-97 growth rate, nine key industry clusters, Massachusetts, 1997



Source: Regional Financial Associates, Collaborative Economics

WHY IS IT SIGNIFICANT?

The average establishment size by employment reflects the structure and stage of evolution of a cluster. In the Innovation Economy, companies can be small and can be competitive. The emerging, knowledge-intensive companies tend to be smaller and more agile than those in more established industries. This indicator shows the number of establishments per cluster.

(Note: An individual company may have multiple establishments.)

HOW DOES MASSACHUSETTS PERFORM?

When ordered by 1996–97 employment growth rate, the faster-growing, mostly service-oriented clusters also have a smaller average establishment size. Newer, high-growth clusters, such as Software and Communications, Financial Services, and Innovation Services, average about 20 employees per establishment. The Healthcare Technology cluster is an exception, with 62 employees per establishment.

The largest difference in average Massachusetts establishment size, compared to establishment size in the other Leading Technology States (LTS), occurs in the Postsecondary Education cluster, where Massachusetts averages 98 employees by establishment, compared to 36 employees for the other LTS educational organizations. This difference reflects the predominance in Massachusetts of older, more established educational institutions.

WHAT DOES THIS TREND MEAN FOR MASSACHUSETTS?

The small-firm structure of emerging clusters requires innovative ways to organize action among these companies. For growing, smaller, and service-oriented clusters, what efforts can the public-sector or related industry associations undertake to stimulate collaboration and encourage further growth? Because Massachusetts manufacturing clusters tend to be larger, more established, and more mature, in what ways can the state promote innovation and implementation of new technologies in these sectors?

22. Corporate Headquarters—Number of Corporate Headquarters Increases, although State Still Lags Most Leading Technology States

WHY IS IT SIGNIFICANT?

Corporate headquarters are important "anchors" for industry clusters. They spawn new businesses and corporations. Typically, key strategists and development-related activities are located in or near headquarters. Corporate headquarters tend to have greater community ties, including philanthropic support, than do branch facilities.

HOW DOES MASSACHUSETTS PERFORM?

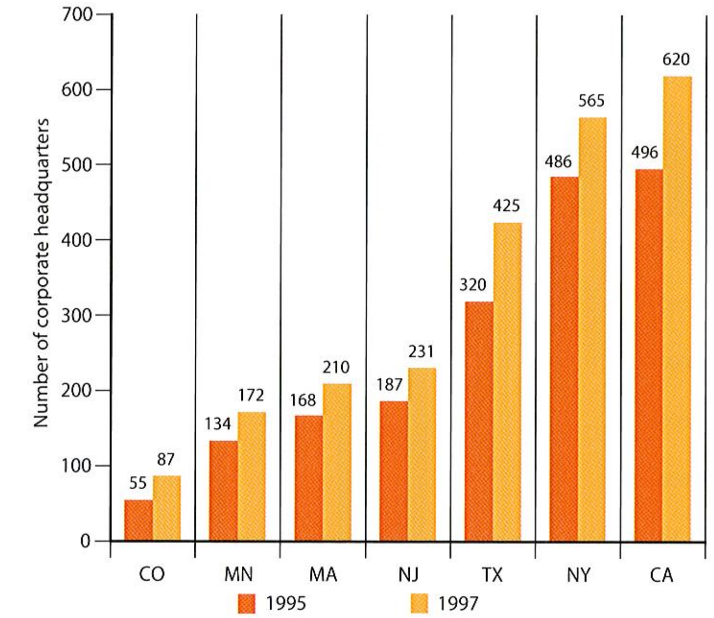
In 1997, Massachusetts was home to the corporate headquarters of 210 firms, each with more than 500 people. This number marks a 25% increase in the number of headquarters in the state since 1995 (up from 168). Twenty-seven percent of these companies have annual revenues of more than $500 million dollars. On a per capita basis, Massachusetts ranks third in the number of corporate headquarters with 34 per one million residents—behind Minnesota with 37, and ahead of New York with 31.

With 81 corporate headquarters in its key industry clusters, Massachusetts ranks third among the other Leading Technology States (LTS) in the number of corporate headquarters in the nine key clusters.

WHAT DOES THIS TREND MEAN FOR MASSACHUSETTS?

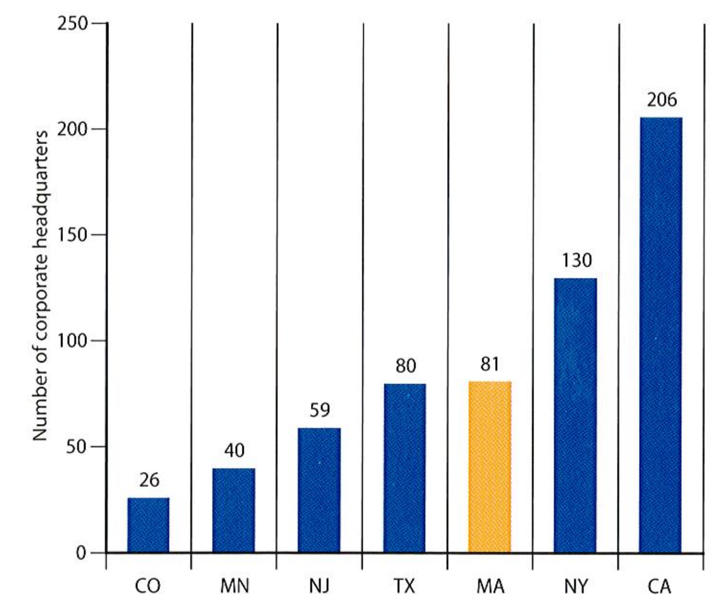
Although some large corporate headquarters in Massachusetts have been lost through mergers and acquisitions, in recent years the number of significantly sized companies headquartered in Massachusetts has increased. With its excellent business climate, wealth of highly skilled professional and technical workers and quality of life, Massachusetts is an attractive site for corporate headquarters, which are often the primary location for the firm's research and entrepreneurial activities. The spillover benefits to the larger community are also valuable. Massachusetts should actively seek to retain the headquarters of newly emerging firms as well as promote itself to other R&D and headquarters facilities outside the state.

Number of corporate headquarters located in Massachusetts and the other LTS, corporations with more than 500 employees, 1995 and 1997



Source: American Business Information

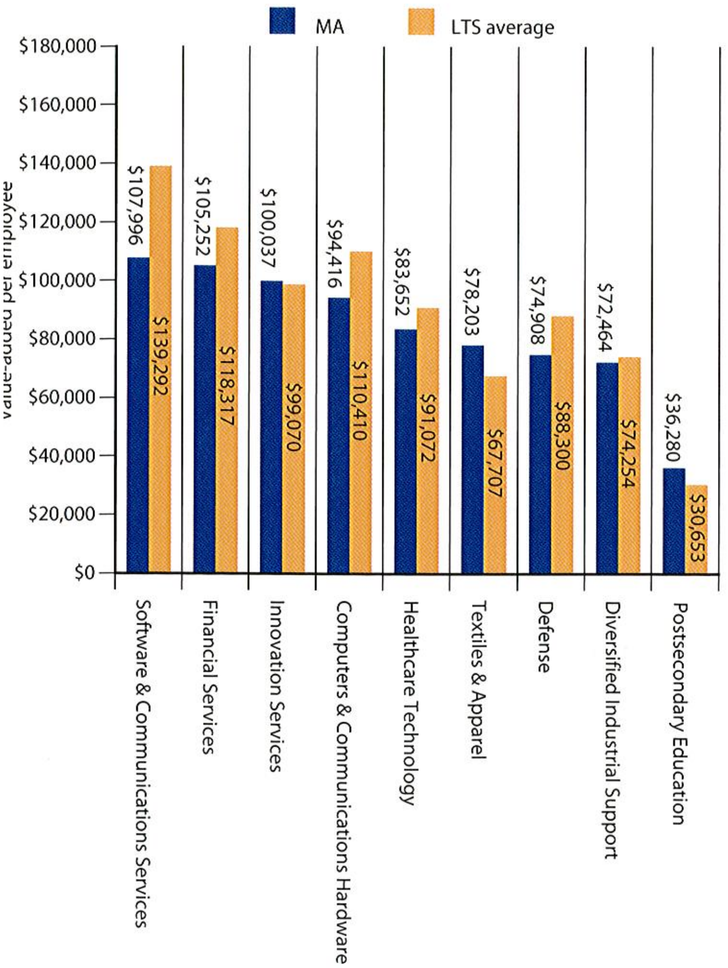
Total number of key industry cluster corporate headquarters located within Massachusetts and other LTS, 1997



Source: American Business Information

23. Value-Added per Employee—
Most Clusters Trail Leading Technology States Average in Value-Added per Employee

Value-added per employee, nine key industry clusters, Massachusetts and other LTS average, 1997



Source: Regional Financial Associates, Collaborative Economics

WHY IS IT SIGNIFICANT?

High and increasing value-added per employee in companies fosters high and increasing income for workers. Value-added, derived by subtracting the costs of a company's materials, inputs, and contracted services from the final revenue of its outputs, indicates how much economic value is created by the company. (See Appendix B for a more detailed definition.) Increased innovation—more efficient processes that lead to the development of more high-value goods and services or that reduce production costs—is an important factor driving enhancements in value-added.

HOW DOES MASSACHUSETTS PERFORM?

In 1997, service clusters such as Software and Communications, Financial, and Innovation Services had the highest value-added per employee at $107,996, $105,252, and $100,037, respectively, among the nine key clusters in the state. However, only the Innovation Services, Textiles and Apparel, and Postsecondary Education clusters in Massachusetts had higher value-added per employee than the other Leading Technology States (LTS) averages.

From 1992 to 1997, these three clusters as well as Financial Services and Healthcare Technology experienced gains in value-added in Massachusetts that outpaced those of the other LTS by an average of 14%. In contrast, increases in value added per employee in Massachusetts lagged the LTS in the Communications segment of Software and Communications Services, and in Computers and Communications Hardware, Defense and Diversified Industrial Support.

WHAT DOES THIS TREND MEAN FOR MASSACHUSETTS?

This indicator could be an important warning sign that, although Massachusetts clusters are performing well compared to past performance, they are not yet generating the same level of value-added per employee as competitor states. Low or slow-growing value-added can have negative implications for the competitiveness of the clusters and the wage levels for employees. This finding raises a number of issues that could be addressed by looking more closely at the specific industrial and occupational mixes within these clusters, specific factor costs, and the nature of the work being done.

III. RESOURCE INDICATORS

Critical resources include human resources, technology, investment, and infrastructure. These resources provide the fuel for productivity growth and are the foundation of the Innovation Economy. Private investment decisions and public policies affect the level and nature of available resources.

24. Migration—
International Immigrants Continue to Bolster Labor Supply

WHY IS IT SIGNIFICANT?

Labor force expansion 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, higher wages, or both. The size of the Massachusetts labor force in 1997, 3.20 million, has just topped its 1988 high of 3.13 million people.

HOW DOES MASSACHUSETTS PERFORM?

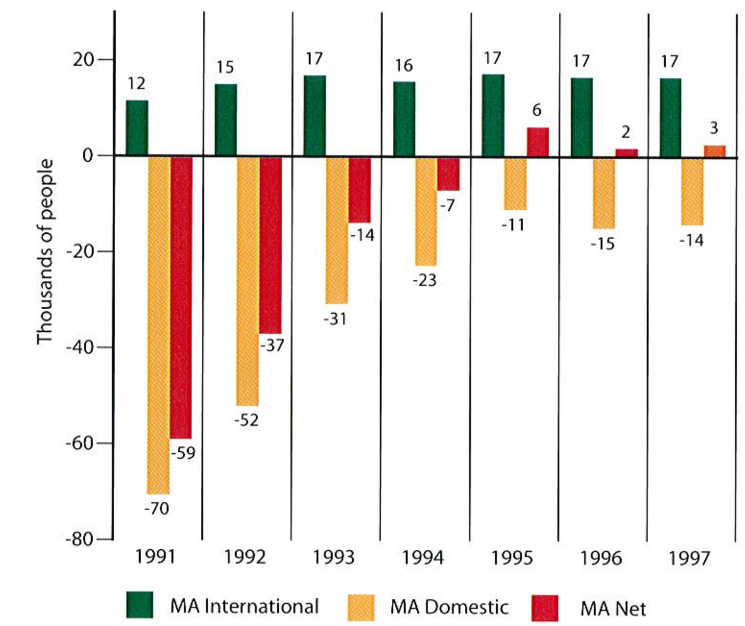
Immigration plays an important role in the growth of the Massachusetts population. Every year between 1991 and 1997, Massachusetts experienced domestic out-migration. In 1997, more people (13,900) moved from Massachusetts to other states than from other states to Massachusetts.

International immigration supplements the skilled workforce needed to drive everything from basic research at university and teaching hospitals to successful product development in businesses within the Massachusetts Innovation Economy. According to the 1990 U.S. Census, 28% of the immigrant workforce in the state had a bachelor's degree or higher, compared with 25% of native Massachusetts workers. Thirty-three percent of foreign immigrants to Massachusetts between 1990 and 1996 were employed in highly skilled occupations in 1996, compared to the national average of 25% and to averages of other Leading Technology States (LTS) such as Texas (24%) and California (19%).

WHAT DOES THIS TREND MEAN FOR MASSACHUSETTS?

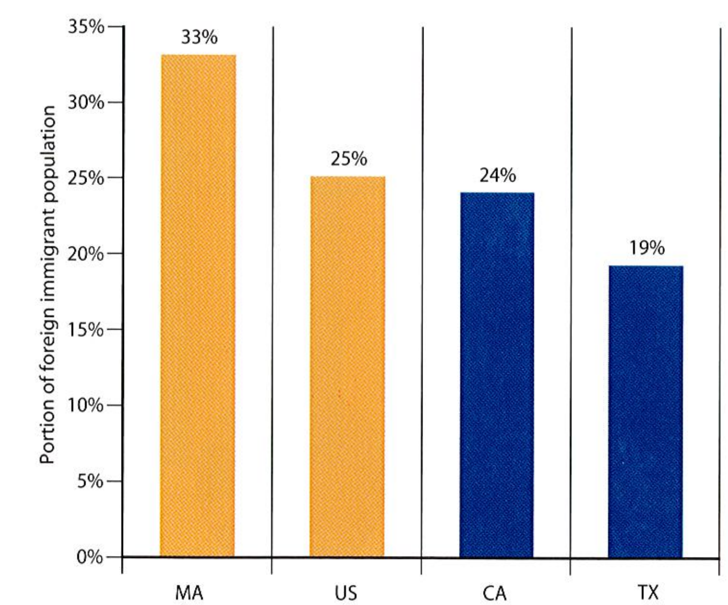
Immigration of skilled workers continues to be an important ingredient for the economic success of Massachusetts. Given the slow growth of the local workforce, Massachusetts has depended on workers from other states and countries to grow. Challenges to the state in this area are two-fold. They concern educating and retraining the local workforce for career advancement and encouraging continued in-migration of skilled workers. The state should monitor federal immigration policies that could affect the size and composition of the skilled workforce.

International and domestic migration, Massachusetts, 1991–1997



Source: Mass Insight, Regional Financial Associates, U.S. Census Bureau

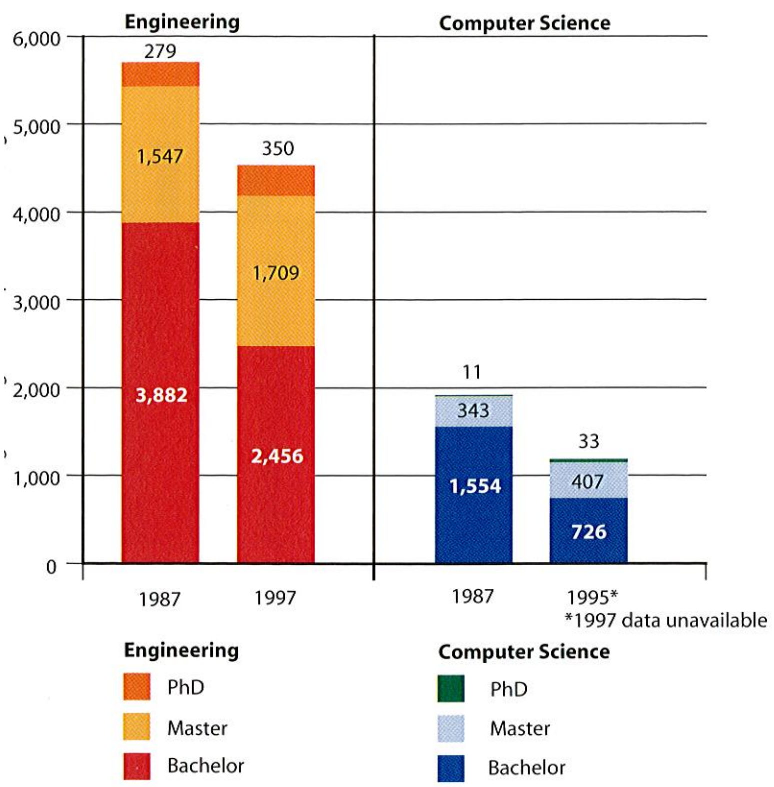
Portion of recent foreign immigrant population in highly skilled management, professional, and technical occupations, 1996



Source: Mass Insight, Northeastern University, U.S. Census Bureau

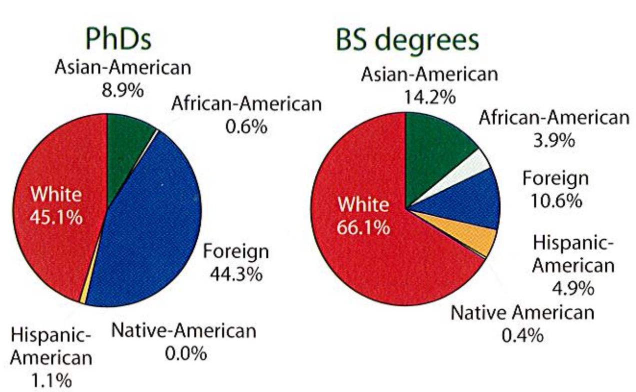
25. Engineering and Computer Science Degrees—Downward Trend in Engineering and Computer Science Degrees Outpaces that of Nation

Number of engineering and computer science degrees awarded by Massachusetts schools, by degree level, 1987 and 1995/97



Source: American Association of Engineering Societies, National Science Foundation

Distribution of engineering PhDs and BS degrees by major ethnic group, Massachusetts institutions, 1997



WHY IS IT SIGNIFICANT?

Regions that are well served by postsecondary 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 in Massachusetts is an important indicator of future workforce resources.

HOW DOES MASSACHUSETTS PERFORM?

The number of engineering degrees awarded in Massachusetts is declining and doing so more rapidly than national trends. At the undergraduate level, the number of degrees awarded by Massachusetts schools decreased 37% from 1987 to 1997 (from 3,882 to 2,456). Nationally, undergraduate engineering degrees decreased only 14% during the same period.

At the graduate level, the number of engineering degrees awarded by Massachusetts institutions from 1987 to 1996 rose 13% (from 1,826 to 2,059). However, this increase was significantly less than the national growth rate (32%) at the graduate level.

For computer science, the number of undergraduate degrees awarded also declined faster from 1987 to 1995 in Massachusetts (-52%) than in the nation (-38%). At the graduate level, computer science degrees awarded in Massachusetts increased 24%, compared with the nation's 29% increase during that period.

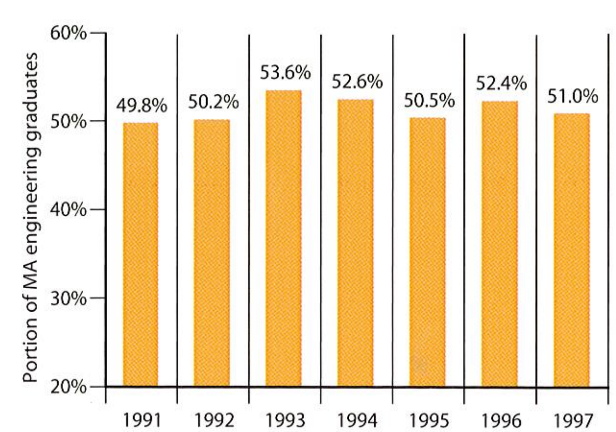
An MTC survey of Massachusetts engineering colleges and universities found that the portion of engineering graduates who stay in the state after graduation has remained relatively constant, at approximately 50%.

Foreign nationals earned 44% of the engineering PhDs and 11% of undergraduate engineering degrees in 1997. Women are underrepresented in all engineering degree levels, constituting only 20% of engineering graduates.

WHAT DOES THIS TREND MEAN FOR MASSACHUSETTS?

Historically, engineering and technical talent has played a critical role in the Massachusetts Innovation Economy. Declining numbers of engineering and computer science graduates can inhibit growth in technology-related sectors. Key questions that should be addressed include: Why is the number of engineering and computer science degrees awarded in Massachusetts lagging that of the nation? Do young people in the state have the science and math skill prerequisites for an engineering and computer science education and career? What factors are critical in retaining technical talent (domestic and foreign born) in Massachusetts?

Portion of Massachusetts engineering graduates still living in Massachusetts, by year of graduation, 1998



26. NAEP Scores—Eighth-Grade Math and Science Test Scores Vary across Race/Ethnicity

WHY IS IT SIGNIFICANT?

The future vitality of the Massachusetts Innovation Economy depends on the skills and knowledge of the state's increasingly diverse workforce. The academic performance of K-12 students is an indicator of the quality of that future workforce. Strong skills in math and science are the foundation for advanced education and experience and for lifelong learning.

HOW DOES MASSACHUSETTS PERFORM?

As reported in the 1997 *Index*, students in Massachusetts score among the top in the nation on the National Assessment of Educational Progress (NAEP) science and math tests given in the eighth grade. In math, Massachusetts students scored 278 compared to 271 for the nation in 1996, second among the Leading Technology States (LTS) behind Minnesota. In science, Massachusetts students scored 157 compared to 148 for the nation, third among the LTS behind Minnesota and Colorado.

However, these scores vary significantly across race and ethnicity. In Massachusetts, there is a large gap between the scores of White and non-White students. While Asian/Pacific Islander students consistently had average scores second to White students, Hispanic and African-American students scored on average significantly below these other groups. In addition to these lower test scores, the high school dropout rate for African-American and Hispanic students remains two to three times higher than for White students.

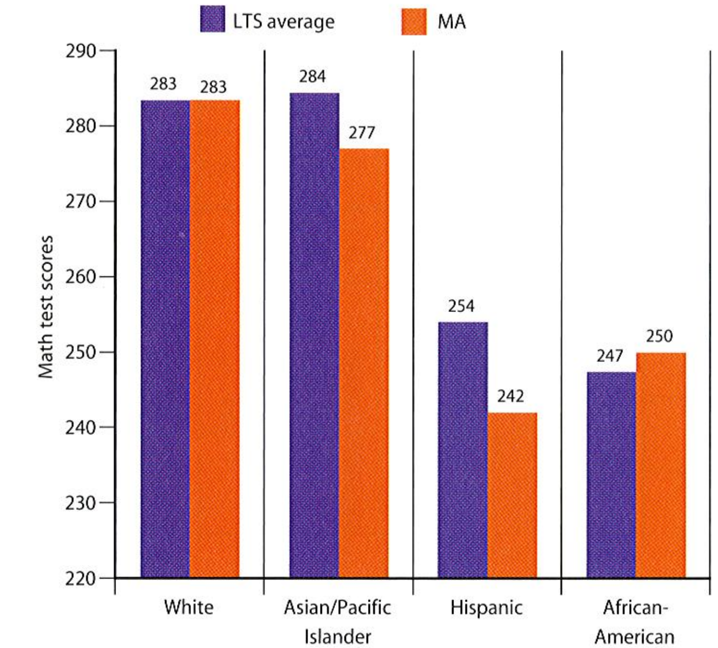
In Massachusetts, White students make up 79% of total enrollment, Hispanics 9%, African-Americans 8%, and Asian/Pacific Islanders 4%.

WHAT DOES THIS TREND MEAN FOR MASSACHUSETTS?

Massachusetts students perform well in science relative to their counterparts in the other LTS states. Yet, the state cannot become complacent in this regard if Massachusetts is to retain its competitive advantage in science and technology-based businesses of the future. As the Massachusetts Innovation Economy becomes increasingly integrated into global markets, the math and science skills of all Massachusetts students will need to be competitive with those students in other Innovation Economies worldwide.

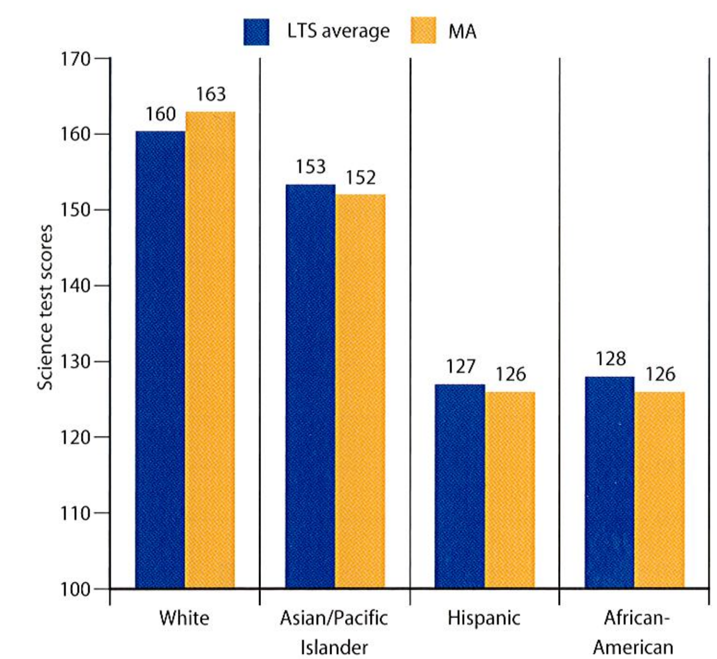
All Massachusetts students should have the opportunity to participate in the Innovation Economy. A strong science and math background can provide an excellent entry into this dynamic sector. The state should make sure that these educational programs are consistently strong across all populations. Students of all racial and ethnic backgrounds, who excel in science and math, should be encouraged and supported to continue on in these fields.

Mathematics test scores of eighth-grade students on the National Assessment of Education Progress, by ethnic group, 1996



Source: National Center for Education Statistics

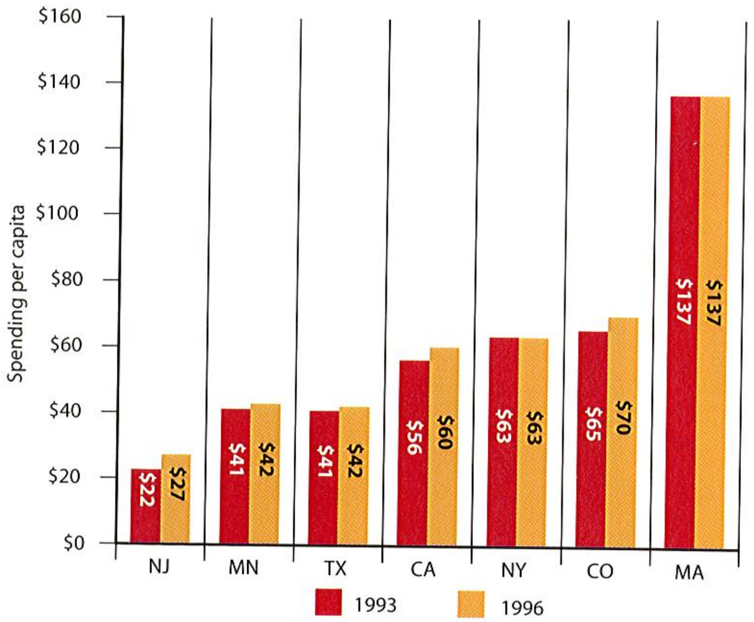
Science test scores of eighth-grade students on the National Assessment of Education Progress, by ethnic group, 1996



Source: National Center for Education Statistics

27. Federal R&D Spending—Per Capita Federal R&D Spending at Academic Institutions Continues to Be Highest of Leading Technology States

Federal R&D expenditures in academic institutions, per capita, Massachusetts and other LTS, 1993 and 1996 (1996 $ inflation adjusted)



Source: National Science Foundation

WHY IS IT SIGNIFICANT?

Research universities and other academic centers play a distinctive role in the Massachusetts economy, and federal R&D spending is a primary source of funding. R&D conducted by academic institutions also has a pronounced inducement effect in stimulating private-sector R&D.

HOW DOES MASSACHUSETTS PERFORM?

Massachusetts has the highest per capita federally funded R&D expenditures ($137 per person) of the Leading Technology States (LTS), with the next closest LTS, Colorado, at about half that amount ($70 per person). Total federal R&D spending in Massachusetts was $837.2 million in 1996.

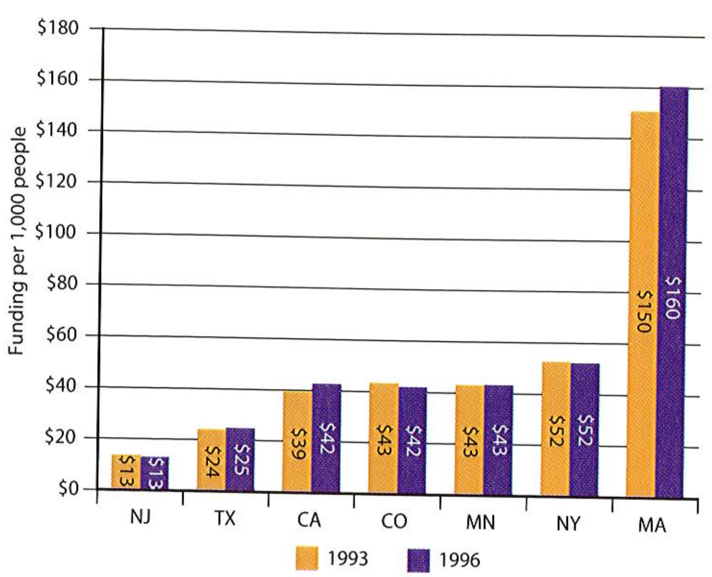
From 1989 to 1996, per capita federally funded R&D expenditures at Massachusetts academic institutions remained constant, when adjusted for inflation, while most of the other LTS experienced increases. Massachusetts continues to excel in acquiring federal R&D funds, with the Massachusetts share, relative to the other LTS, falling only from 32% to 31%.

WHAT DOES THIS TREND MEAN FOR MASSACHUSETTS?

Federally funded research in Massachusetts remains relatively high. These funds are a critical factor in the Massachusetts Innovation Economy, and one that the state needs to continually assess and foster, especially as the economy shifts away from defense-related activities to knowledge-based services. These funds can help ensure relatively high levels of R&D in our academic institutions, which, in turn, foster patents and licenses, and new products, processes and services.

28. Health R&D Funding—Health R&D Funding Is the Highest of Leading Technology States in Absolute and Relative Terms

U.S. Department of Health and Human Services R&D expenditures, per capita, Massachusetts and other LTS, 1993 and 1996 (1996 $ inflation adjusted)



Source: National Science Foundation

WHY IS IT SIGNIFICANT?

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) expenditures for R&D occurs through the NIH.

HOW DOES MASSACHUSETTS PERFORM?

Massachusetts has the highest per capita federally funded health R&D expenditures of the Leading Technology States (LTS); the state's funding is more than three times greater than the closest LTS, New York. Funding for Massachusetts has consistently increased in inflation-adjusted terms and relative to the other LTS. Since 1993, HHS funding for Massachusetts increased 6.7% compared with 5.6% for the six LTS.

Historically, approximately 58% of all R&D funding awarded by HHS to teaching hospitals across the nation has been awarded to Massachusetts institutions.

WHAT DOES THIS TREND MEAN FOR MASSACHUSETTS?

Massachusetts sets itself apart as a leader in health-related R&D. This has strong favorable implications for the state's ability to maintain a competitive Healthcare Technology cluster. Health R&D funding has also played a key role in bolstering the Innovation Economy as the state's employment mix has shifted away from defense-related activities in recent years.

29. Corporate R&D per Employee—Biotechnology Firms Significantly Outpace other Industries in R&D per Employee

WHY IS IT SIGNIFICANT?

Corporate research and development (R&D) spending is an important indicator of how Massachusetts companies are investing in the future. Nationally, the private sector provides about $2 out of every $3 invested in R&D. R&D is essential for developing new products and services that help companies stay on the cutting edge, grow, and produce more jobs.

HOW DOES MASSACHUSETTS PERFORM?

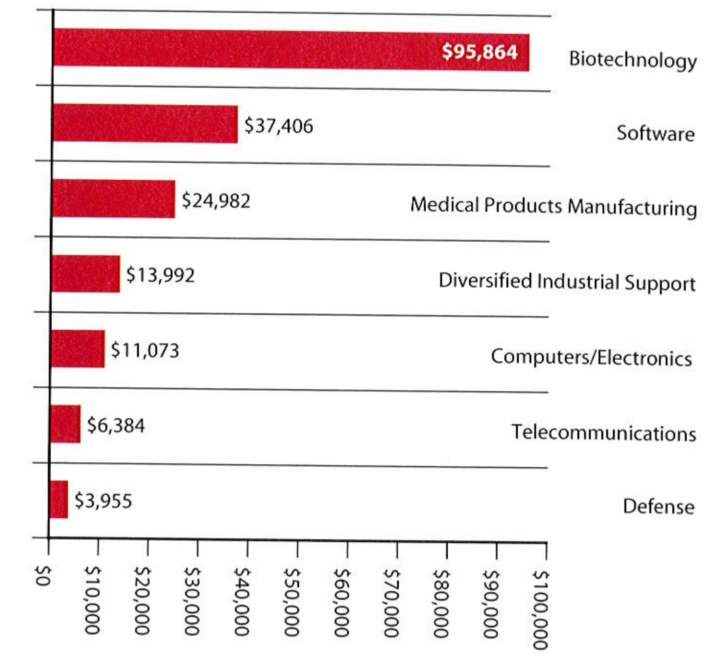
Several industry sectors important to the Massachusetts industry clusters posted significant levels of R&D per employee in 1997. By far, the biotechnology sector has the highest concentration of R&D per employee at $95,864. Software developers and medical equipment manufacturers also report significant levels of R&D investment per employee, at $37,406 and $24,982 respectively. Service sector industries such as software account for approximately one-fourth of all industrial R&D investment in the United States.

The defense sector, after years of federal government downsizing, is the least R&D-intensive of the industry clusters.

WHAT DOES THIS TREND MEAN FOR MASSACHUSETTS?

In the Innovation Economy, R&D fuels company growth and new technologies and goods and services. The fastest-growing sectors in Massachusetts are also the most R&D-intensive. Nationally, there has been a major upswing in the number of inter- and intra-sector industry research joint ventures. The state should place a premium on producing the people and environment for world-class corporate R&D.

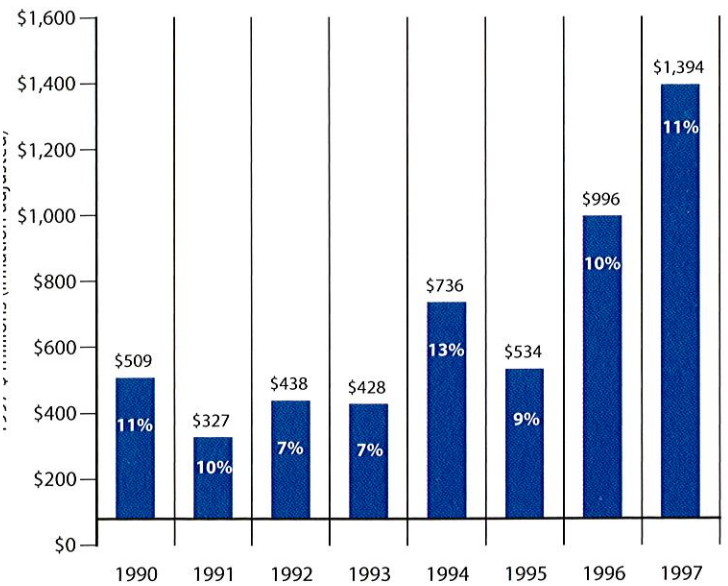
Corporate R&D expenditure per employee, publicly traded companies, Massachusetts, 1997



Source: Compustat, Global Researcher, Collaborative Economics

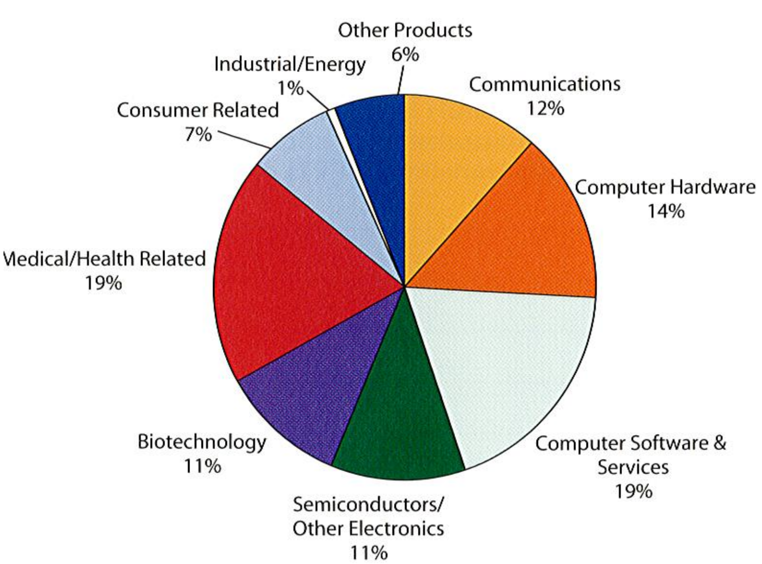
30. Venture Capital— Venture Capital Funding Grows in Absolute and Relative Terms

Venture capital investment received by companies and as a percent of total U.S. venture investments, Massachusetts, 1990–1997



Source: Venture Economics

Distribution of venture capital investments, Massachusetts, 1997



Note: Portions may not sum to 100% due to rounding
Source: Venture Economics

WHY IS IT SIGNIFICANT?

Venture capital is one of the three main sources of funding used to grow new companies. (Other sources include personal savings and investment by family, friends, and individual investors.) The amount of venture capital invested and the types of industries supported are predictors of future job and revenue growth.

HOW DOES MASSACHUSETTS PERFORM?

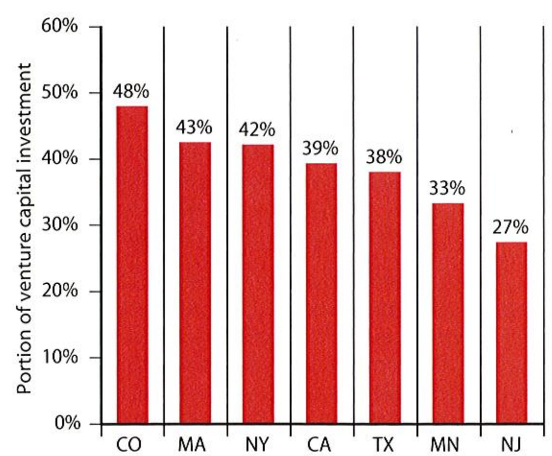
The amount of venture capital received by Massachusetts companies reached approximately $1.4 billion in 1997—a jump of 40%, in inflation-adjusted terms, from the amount in 1996, and 161% higher than that in 1995. The sectors that received the most venture capital funding in 1997 were Medical/Health Related and Computer Software and Services, each with a 19% share. Massachusetts has increased its share of venture capital dollars invested in the U.S. from 9% to 11% since 1995.

The portion of Massachusetts venture capital funding invested in emerging growth companies (those firms in early and start-up stages as opposed to more established firms) has varied over the past three years; it has remained, however, consistently higher than the Leading Technology State (LTS) average. In 1997, 43% of venture capital investments in Massachusetts was in emerging growth firms, compared to a 39% average in the other LTS. Currently, Massachusetts ranks second behind Colorado and just ahead of New York in the share of venture capital investment in early stage companies.

WHAT DOES THIS TREND MEAN FOR MASSACHUSETTS?

Venture financing fuels growth-oriented companies and the Innovation Economy. The strong increase in venture capital invested in Massachusetts and the moderate increase relative to that of other LTS states indicates confidence in Massachusetts entrepreneurs and start-up companies.

Portion of venture capital investment in the early and start-up stages of companies, Massachusetts and other LTS, 1995–1997



Source: PricewaterhouseCoopers Money Tree Survey

31. Internet Connectivity— Internet Connectivity Quadruples

WHY IS IT SIGNIFICANT?

An Internet host reflects any computer system physically connected to the Internet, either full- or part-time, directly, or by dial-up. A high number of Internet hosts relative to the population indicates adoption of Internet-based communications and use of the information infrastructure.

Internet host counts have been used to compare broad trends and regions, although they are not a good way to determine the number of users. Some Internet host numbers are unused, being kept in reserve for future growth; others support multiple individual users; and still others connect vending machines and other equipment to the Internet. Because such practices are applied consistently across the country, however, they can be used for interstate comparisons.

HOW DOES MASSACHUSETTS PERFORM?

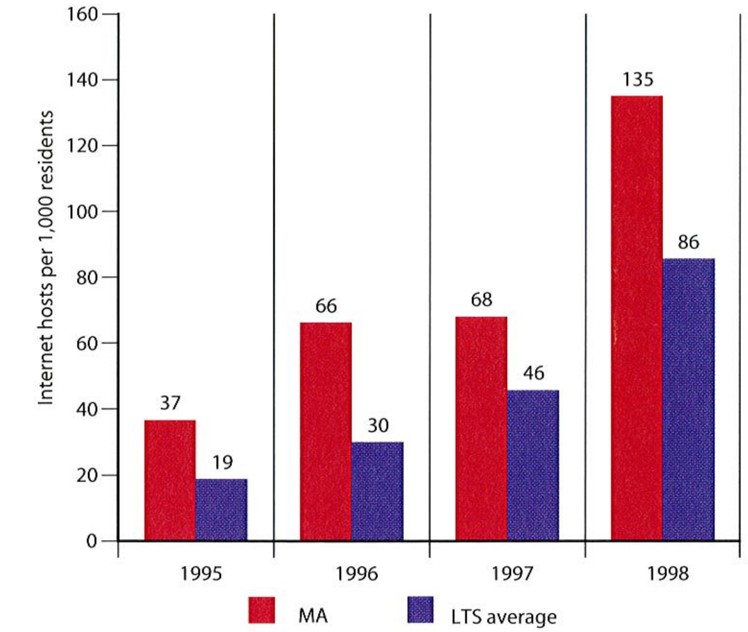
From January 1995 to January 1998, the number of Internet hosts in Massachusetts jumped from 221,204 to more than 826,253, an increase of almost 370%.

Massachusetts ranks second in the number of Internet hosts per capita among the Leading Technology States (LTS), after Minnesota. As of January 1998, Massachusetts had 135 Internet hosts per 1,000 residents. This number compares with the LTS average of 86 hosts per capita.

WHAT DOES THIS TREND MEAN FOR MASSACHUSETTS?

With such a high concentration of Internet hosts, Massachusetts has a strong foundation for developing a robust information infrastructure to support its Innovation Economy. Massachusetts should foster an environment that facilitates the integration of Internet technologies throughout the state, given their vital role in doing business and being competitive in the information age. State policy should seek to foster infrastructure consistency across the state, ensuring that currently under-served regions such as Berkshire County and Cape Cod can leverage Innovation Economy opportunities.

Number of Internet hosts per 1,000 population, Massachusetts and other LTS average, 1995-1998



Source: Matrix Information and Directory Services, Inc.

Benchmarking Massachusetts Performance

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

New in this year's selection are the states of Colorado and Minnesota. These states replace last year's inclusion of Florida and Illinois. This selection reflects a desire to have the LTS include those states with a similar set of key industry clusters to that of Massachusetts. See Appendix B for definitions of the nine key industry clusters.

The LTS are selected on the basis of the number of innovative clusters in each state 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. The specific steps are as follows:

- We focused first on the nation's widely acknowledged 13 leading technology states. They are: Arizona, California, Colorado, Florida, Illinois, Michigan, Minnesota, North Carolina, New Jersey, New York, Pennsylvania, Texas, and Washington. We then focused on how these technology states' strengths compare to Massachusetts and its nine key industry clusters.
- We summed the number of clusters within each state with a concentration above 1.10 (i.e., a cluster's share of the state's jobs is at least 1.1 times the national average) and ranked them accordingly. For example, Minnesota's computer/electronics, healthcare technology, and financial services clusters are 1.82, 1.39, and 1.13, respectively. This state thus had three clusters with employment concentrations at least 1.1 times above the national average.
- Selection of the LTS using this methodology results in the inclusion of two new states: Minnesota and Colorado. Two states, New York and Pennsylvania, tied for the sixth-place ranking. We selected New York state because of its overall strength across the five innovation industries compared to Pennsylvania.
- On several indicators in the document, Massachusetts is compared to an LTS average. This average is always the mean of each state's reported data. It is not the mean of all LTS data aggregated together.

Throughout the document, dollar values are in current dollars unless noted as inflation-adjusted values.

Except for wages, which are adjusted using the Consumer Price Index (CPI) for all urban consumers (all items, U.S. city average), inflation-adjusted indicators use the calendar-year-based Gross Domestic Product (GDP) implicit price deflator (1992 base equal to 1.000) published by the Office of Management and Budget. The GDP price deflator is the most appropriate adjustment for various kinds of R&D activity. The National Science Foundation refers to its own use of the deflator as follows:

In keeping with U.S. Government and international standards, R&D trend data usually are deflated to 1992 constant dollars using the Gross Domestic Product (GDP) implicit price deflator. Since GDP deflators are calculated on an economy-wide rather than R&D-specific basis, their use more accurately reflects an "opportunity cost" criterion, rather than a measure of cost changes in doing research.

State	Employment Concentration					State	1997 Selection	1998 Selection	No. of clusters above 1.1
	Software	Computer/ Electronics	Healthcare Technology	Innovation Services	Financial Services				
AZ	0.87	1.96	0.59	0.97	0.79	AZ			1
CA	**1.32**	**2.15**	**1.50**	**1.21**	**0.93**	**CA**	**X**	**X**	**4**
CO	**1.84**	**1.90**	**1.22**	**1.39**	**0.99**	**CO**		**X**	**4**
FL	0.93	0.75	0.96	0.91	0.96	FL	X		0
IL	0.89	0.94	1.02	1.01	1.23	IL	X		1
MA	**1.51**	**2.14**	**1.97**	**1.63**	**1.67**	**MA**			
MI	0.73	0.24	0.78	1.06	0.74	MI			0
MN	**0.90**	**1.82**	**1.39**	**0.65**	**1.13**	**MN**		**X**	**3**
NC	0.67	0.66	0.99	0.59	0.58	NC			0
NJ	**1.61**	**0.64**	**2.25**	**1.13**	**1.39**	**NJ**	**X**	**X**	**4**
NY	**0.99**	**0.76**	**1.12**	**1.02**	**1.85**	**NY**	**X**	**X**	**2**
PA	0.80	0.65	1.07	1.24	1.10	PA			2
TX	**1.12**	**1.28**	**0.71**	**1.11**	**0.85**	**TX**	**X**	**X**	**3**
WA	1.04	0.89	0.76	1.09	0.83	WA			0

III. Notes on Data Sources for Individual Indicators

Results Indicators

1. Industry Clusters
Regional Financial Associates (RFA) tracks industry employment at the state level using a methodology based upon individual corporations filings with State Employment Securities Agencies (SESA) and the Bureau of Labor Statistics (BLS). Data from RFA were analyzed in comparison to information from the Massachusetts Division of Employment and Training (DET) to arrive at the number of jobs in Massachusetts cluster industries. Both sets of data do not cover self-employment or employment of military personnel. Definitions for each industry cluster are in Appendix B.

2. Employment Diversification
This indicator was developed from RFA state-level data of unemployment insurance filings (UI) between 1992 and 1997. Employment concentration is measured as the amount of employment in a cluster as a portion of total state employment, compared with the same clusters employment nationally as a portion of total U.S. employment. For each cluster, the level of national employment is indexed at 1.0. Therefore, Postsecondary Education employment, at 3.0, is three times more concentrated in Massachusetts than at the national level. The annual average growth rate is the rate of change in industry cluster employment over the five periods from 1992 to 1997. The size of each circle on the chart reflects the relative size of employment in Massachusetts. The largest circle, Financial Services, employed 128,000 people in 1997.

3. Average Pay
Data are from RFA and DET and are derived from payroll data reported as part of unemployment insurance filings. The average pay estimate for each cluster is the mean payroll per employee in 1997 current dollars.

4. Pay per Worker
Annual figures in this indicator differ from those reported in last year's *Index*. This year's data are derived from a dataset developed by RFA. Last year's information was based on data from the Bureau of Labor Statistics (BLS). Updated BLS data were not available at the time of the 1998 *Index* publication. While the RFA data are based on information from the BLS, differences occur due to methodological reasons. In addition, data for this indicator have been adjusted for inflation into 1997 dollars as opposed to 1996 dollars.

5. Earnings Distribution
Earnings data for working families are derived from the March Supplement of the Census Bureau's Current Population Survey. Working families are defined as those families that reported any earned income above $0.

6. Skills Needs
Data are derived from a special MTC workforce needs survey conducted in June 1998 in conjunction with the Massachusetts Biotechnology Council, Massachusetts High Technology Council, Massachusetts Medical Device Industry Council, and the Massachusetts Software Council.

Surveys were sent to 570 Massachusetts companies, of which 129 (23%) provided responses about their skills needs. Companies were asked to provide information about their current numbers of payroll employees, vacant positions, and contract/temporary employees, all by occupational categories. In addition, Massachusetts corporations were asked to provide information on their recent hiring activities for both payroll and contract positions. In total, the 129 survey respondents reported 1,646 full-time payroll position vacancies.

7. Business Climate
Data are from the Massachusetts High Technology Council's annual business climate survey, 1987-1998.

8. Manufacturing Exports
The Office of Trade and Economic Analysis in the U.S. Department of Commerce tracks the dollar value of exported manufactured goods from all U.S. states through the Exporter Location Series. Percentages reported in this indicator are for the change in dollar value after adjusting for inflation, using the GDP implicit price deflator.

9. Services Exports
Because no consistent annual services exports data are available at the state level, services exports are projected from the exported services revenue data by state in the 1992 Economic Census for Service Industries. In this indicator, the projection to 1997 levels assumes that software exports grew at a rate similar to the growth rate of the gross state product in each state in the Business Services sector (SIC=73) during the 1992-1997 period. In a similar fashion, the growth of Innovation Services exports is based upon the growth of the state product in each state for the Engineering, Accounting, Research, Management, and Related Services sector (SIC=87).

10. Mutual Fund Exports
These data are obtained from the Investment Company Institute's biannual survey of financial services companies nationwide.

Innovation Process Indicators

11. Patents per Capita
Patents per capita data for Massachusetts and other LTS are provided by the U.S. Patent and Trademark Office. Patent distribution and patent citation of scientific literature data are from CHI Research.

The expected rate of patent citations is based upon the level of research and patents occurring within a state. Because Massachusetts has significantly more academic R&D and patent activity occurring within the state, the absolute number of patent references to scientific literature from within the state will be higher than in other states. The expected rate of patent references controls for this fact. Every state has an expected rate of patent references to in-state scientific publications equal to one. Patents from some states, such as New Jersey and Texas, rely on the R&D occurring within their own states at considerably higher than expected rates. Other states, such as California and Maryland, reference out-of-state-based research more often than is expected.

12. Invention and Patent Applications
Indicator data are from the Association of University Technology Managers' (AUTM) annual licensing survey of universities, hospitals, and research institutions and an additional survey conducted by MTC. The 1997 AUTM survey had an overall response rate of 58%. The MTC survey returned information from those specific Massachusetts institutions that did not participate in the AUTM survey.

For this analysis, the Massachusetts universities that provided information for either of the surveys included the Massachusetts Institute of Technology, Harvard University, Boston University, Tufts University, Brandeis University, University of Massachusetts-Amherst, University of Massachusetts Medical Center, and Northeastern University. Massachusetts hospitals/research institutions included are Massachusetts General Hospital, Children's Hospital Boston, Brigham and Women's Hospital, Woods Hole Oceanographic Institute, Dana-Farber Cancer Institute, New England Medical Center, and New England Deaconess Hospital.

13. Technology Licenses and Royalties
Data on licensing agreements involving Massachusetts institutions are also from AUTM and the MTC survey. These data are from the same institutions providing patent and invention disclosure information in indicator number 12.

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

FDA approval of investigational device exemptions (IDEs) allows for clinical trials to begin on particularly high-risk medical devices. Medical device companies are also required to secure premarket approvals (PMAs) before intricate medical devices are allowed market entry. 510(k) approvals are required of less sophisticated instruments or small product modifications and improvements.

15. New Business Incorporations
Data are provided by the Massachusetts Secretary of the Commonwealth's office. Of the 17,485 new business incorporations in 1997, 12,520 were Massachusetts-based for-profit business, 1,421 were out-of-state businesses, and 605 were nonprofit enterprises.

16. SBIR Awards
Data are provided by the Small Business Administration (SBA). 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.

17. Initial Public Offerings
Data on the total number, value, and distribution of IPOs by industry cluster are provided by Hale & Dorr, LLP, from a special data run of its tracking of IPOs throughout New England.

18. Mergers and Acquisitions
The numbers of "information technology" mergers and acquisitions by state are provided by Broadview International LLC. Broadview's tracking of information technology mergers and acquisitions includes five industry sectors: software, hardware, telecommunications, supporting services, and media.

19. NASDAQ Firms' Market Value
Provided by the National Association of Securities Dealers, Inc., this dataset contains the market capitalization/value of all publicly traded firms listed on the NASDAQ Exchange on March 31st of each year from 1993 to 1998. Market capitalization for an individual company is the product of the number of shares outstanding times the share price on a given day.

20. Gazelle Companies
The number of gazelle companies is derived from a special data run conducted by Standard & Poor's Compustat of publicly traded companies headquartered in Massachusetts. This dataset tracks all publicly traded companies filing 10K and 10Q reports with the Securities and Exchange Commission (SEC) from between 1986 and 1996. This dataset has been updated for 1997 using information from corporate 10K filings as reported by Compustat, Global Researcher, and the SEC.

21. Average Establishment Size
Establishment data are provided by RFA and are based upon corporations' filings of unemployment insurance (UI) information to the DET. Establishments are classified as the individual business enterprises that report UI information to the DET.

It is possible for a single firm to have multiple business locations within the state and to be considered a single establishment if UI information is filed for all locations from a single corporate headquarters address. Likewise, it is possible for a single firm to have multiple establishments if those establishments report UI information individually. Especially within the cluster industries, business establishments tend to reflect a single firm reporting UI information for all locations.

22. Corporate Headquarters
Data are provided by American Business Information.

23. Value-Added per Employee
This indicator reflects annual value-added per employee in each industry cluster. Value-added per employee is the total value-added by companies divided by these companies' total number of employees. Total value-added per company is derived by subtracting the total cost of inputs, other than direct labor costs, from the stated value of the final goods produced. Employment and value-added data for this indicator are based upon information from Regional Financial Associates.

Last year's *Index* did not include service clusters such as Software and Communications, Innovation, Financial, and Postsecondary Education Services.

Resource Indicators

24. Migration
Total foreign and domestic immigration data are provided by RFA. Data on immigrant occupations are provided by Mass Insight and based upon analysis of Census Bureau information by Northeastern University.

25. Engineering and Computer Science Degrees
Data on total number of engineering degrees and degrees by ethnicity are provided by the American Association of Engineering Societies (AAES). The AAES tracks the number of engineering degrees awarded from accredited institutions throughout the United States each year. Data on the total number of computer science degrees are provided by the National Science Foundation.

Information on the number of engineering degrees retained in Massachusetts is compiled by MTC in partnership with the major engineering degree-granting institutions in Massachusetts. Data for this indicator are based upon information provided by Worcester Polytechnic Institute, Massachusetts Institute of Technology, University of Massachusetts-Lowell, Boston University, Northeastern University, University of Massachusetts-Amherst, and Merrimack College. Seventy-seven percent of all Massachusetts engineering graduates in 1997 came from these seven institutions.

26. NAEP Scores
Science and mathematics assessment test scores are from the National Assessment of Educational Progress (NAEP), 1996, U.S. Department of Education, Office of Educational Research and Improvement, National Center for Education Statistics. The LTS average does not include scores for the state of New Jersey, because it did not participate in the 1996 NAEP.

27. Federal R&D Spending
Data are provided by the National Science Foundation for all academic institutions. This information includes its university-associated federally funded research and development centers.

28. Health R&D Funding
Data are provided by the National Science Foundation. Data are for all R&D expenditures by the U.S. Department of Health and Human Services. More than 95% of these expenditures occur through the National Institutes of Health.

29. Corporate R&D per Employee
Data are derived from publicly traded corporations' annual 10K report filings with the SEC, using the Global Researcher database. Industry R&D per employee was calculated for all companies that reported any R&D expenditures. In 1997, 233 of 503 corporations reported R&D expenditures.

Due to changes in industry sector definitions in Massachusetts, R&D per employee expenditures are not available for earlier years. However, nationally, industry R&D has played an increasingly important role over the last decade as the primary supplier of R&D dollars, increasing from just over half in 1987 to today's level of two-thirds of all R&D dollars. Some of the most significant growth has occurred in the biotechnology sector.

30. Venture Capital
Data for total venture capital investments in Massachusetts and venture capital investments by industry activity are provided by Venture Economics. Industry category designations are determined by Venture Economics. Data for investment by stage of company development are provided by PricewaterhouseCoopers, LLP. Company stages are divided into start-up, early, expansion, late, public, turnaround, and not categorized.

31. Internet Connectivity
The number of Internet host computers is from Matrix Information and Directory Services (MIDS), Austin, Texas. Data are derived from estimates of Internet protocol addresses from Network Wizard's annual Domain Survey.

I. Defining Key Industry Clusters in Massachusetts

The analysis of key industry clusters within Massachusetts begins with a disaggregation of all Massachusetts state industry activity to the four-digit Standard Industrial Classification (SIC) code level. (SIC codes are set by the Executive Office of the President, Office of Management and Budget. These codes were last revised in 1987.) Employment, payroll, and the number of establishments for all four-digit industries are examined. The following measures are used to analyze industry data:

- Employment concentration relative to that of the nation
- Payroll per employee relative to the state average
- Employment as a share of total state employment
- Average annual growth rate, and absolute change, of employment
- Absolute number of establishments

Clusters are crafted from those interrelated SIC codes that were identified as individually significant according to the above set of criteria.

Computers & Communications Hardware

3571	Electronic computers
3572	Computer storage devices
3661	Telephone and telegraph apparatus
3663	Radio & TV communications equipment
3669	Communications equipment, nec
3577	Computer peripheral equipment, nec
3672	Printed circuit boards
3674	Semiconductors and related devices
3675	Electronic capacitors
3679	Electronic components, nec
3695	Magnetic and optical recording media
3699	Electrical equipment & supplies, nec
3823	Process control instruments
3825	Instruments to measure electricity

Defense

3483	Ammunition, except for small arms, nec
3484	Small arms
3489	Ordnance and accessories, nec
3671	Electron tubes
3724	Aircraft engines and engine parts
3761	Guided missiles and space vehicles
3769	Space vehicle equipment, nec
3812	Search and navigation equipment
3827	Optical instruments and lenses
3829	Measuring & controlling devices, nec

Diversified Industrial Support

2821	Plastics materials and resins
2992	Lubricating oils and greases
3061	Mechanical rubber goods
3069	Fabricated rubber products, nec
3081	Unsupported plastics film & sheet
3082	Unsupported plastics profile shapes
3087	Custom compound purchased resins
3291	Abrasive products
3355	Aluminum rolling and drawing, nec
3357	Nonferrous wiredrawing & insulating
3369	Nonferrous foundries, nec
3398	Metal heat treating
3399	Primary metal products, nec
3463	Nonferrous forgings
3469	Metal stampings, nec
3471	Plating and polishing
3479	Metal coating and allied services
3491	Industrial valves
3511	Turbines and turbine generator sets
3545	Machine tool accessories
3547	Rolling mill machinery
3559	Special industry machinery, nec
3561	Pumps and pumping equipment
3568	Power transmission equipment, nec
3569	General industrial machinery, nec
3599	Industrial machinery, nec
3625	Relays and industrial controls
3629	Electrical industrial apparatus, nec
3999	Manufacturing industries, nec

Financial Services

6036	Savings institutions, not Federally chartered
6111	Federal and Federally-sponsored credit
6159	Misc. business credit institutions
6211	Security brokers, dealers, and flotation companies
6282	Investment advice
6289	Services allied with the exchange of securities
6311	Life insurance
6324	Hospital and medical service plans
6331	Fire, marine, and casualty insurance
6411	Insurance agents, brokers, and services
7323	Credit reporting services

Healthcare Technology

2833	Medicinals and botanicals
2834	Pharmaceutical preparations
2835	Diagnostic substances
2836	Biological products exc. diagnostic
3821	Laboratory apparatus and furniture
3826	Analytical instruments
3841	Surgical and medical instruments
3844	X-ray apparatus and tubes
3845	Electromedical equipment
3851	Ophthalmic goods
8071	Medical laboratories

Innovation Services

8711	Engineering services
8731	Commercial physical research
8732	Commercial nonphysical research
8734	Testing laboratories
8741	Management services
8742	Management consulting services
8733	Noncommercial research organizations

Postsecondary Education

8221	Colleges, universities and professional schools
8222	Junior colleges and technical institutes
8299	Schools and educational services, nec

Software & Communications Services

7371	Computer programming services
4812	Radiotelephone communications
4813	Telephone communications, exc. radio
4822	Telegraph and other message communications
4841	Cable and other pay television services
4899	Communications services, nec
7372	Prepackaged software
7373	Computer integrated systems design
7374	Data processing and preparation
7375	Information retrieval services
7377	Computer rental & leasing
7378	Computer maintenance & repair
7379	Computer related services, nec

Textiles & Apparel

2221	Broadwoven fabric mills, manmade
2231	Broadwoven fabric mills, wool
2257	Weft knit fabric mills
2261	Finishing plants, cotton
2262	Finishing plants, manmade
2269	Finishing plants, nec
2284	Thread mills
2295	Coated fabrics, not rubberized
2297	Nonwoven fabrics
2298	Cordage and twine
2299	Textile goods, nec
2329	Men's and boys' clothing, nec
2337	Women's and misses' suits and coats
2342	Bras, girdles, and allied garments
2385	Waterproof outerwear
2386	Leather and sheep-lined clothing
2391	Curtains and draperies
3021	Rubber and plastics footwear
3111	Leather tanning and finishing
3131	Boot and shoe cut stock and findings
3149	Footwear, except rubber, nec
3171	Women's handbags and purses
3172	Personal leather goods, nec
3911	Jewelry, precious metal
3915	Jewelers' materials & lapidary work
3961	Costume jewelry
5136	Men's and boys' clothing
5137	Women's and children's clothing
5139	Footwear

nec - not elsewhere classified

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