

New England as the Twenty-First Century Approaches: No Time for Complacency

New England has undergone significant change in its employment and labor force over the past three decades. Employment in the region has shifted from manufacturing into services at a faster rate than it has in the U.S. economy. Within manufacturing the trend has been away from nondurable goods into high-value-added, high-tech industries. In this transition, both income and productivity have increased more rapidly in the region than in the nation.

A critical driver behind New England's prosperity is its high-technology infrastructure, which cultivates innovation, entrepreneurship, and the development of new technologies, processes, and products. New England captures a disproportionately large share of the nation's federal R&D funding, a pattern that has held true as federal funding has shifted from defense-related manufacturing toward services such as health care and biotechnology. The region attracts a relatively high percentage of the country's venture capital funds, and venture capital spending in New England is now at an all-time high. Also central to its high-technology infrastructure is the region's high concentration of colleges and universities, which contribute significantly to the well-educated, highly skilled work force as well as to research, innovation, and entrepreneurship in the area.

Recent trends in population, labor force, and college degrees awarded pose serious threats to New England's long-term prosperity. Growth in the region's high-tech sector has lagged the nation's in recent years. Slow labor force growth has contributed to low unemployment rates, but it has also limited the pool of available workers. The three southern New England states, in particular, have experienced net domestic out-migration and relatively slow growth in employment. The region has also lost market share in producing college graduates. Moreover, its college students are shifting away from the technical fields of study, including computer science, mathematics, and engineering, that bolster growth in high-tech industries.

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A well-educated, highly skilled work force has long been a competitive strength of New England, fostering growth and development of high-tech firms and attracting employers dependent on skilled workers to the area. Shortages of such workers can hinder the long-term economic development of the region.

This article provides an overview of the key trends in the labor force, employment, and college degrees awarded in New England since 1970. It addresses the region's high-technology infrastructure and the importance of research and development (R&D), venture capital, and colleges and universities to the New England economy. Opportunities and challenges facing the region as the twenty-first century approaches are discussed.

A critical driver behind New England's prosperity is its high-technology infrastructure, which cultivates innovation, entrepreneurship, and the development of new technologies, processes, and products.

I. The New England Economy in Transition

The New England economy has experienced slow growth in population, labor force, and employment relative to the nation in recent decades (Figure 1). Population in the region has grown at less than half the national rate since 1970. Moreover, from 1990 to 1998, the U.S. population expanded at a rate *five* times that of New England (1.0 percent on average per year versus 0.2 percent) (U.S. Bureau of the Census 1999b).¹

Labor Force

These population trends have a direct impact on the size of the New England labor force. After growing at an average annual rate of 1.8 percent in the 1970s

¹ This analysis uses the latest data available, and hence the dates will vary. In particular, detailed data (for example, 2-digit Standard Industrial Code (SIC) employment data) are available to 1997, whereas more aggregated data are often available through 1998.

and 1.4 percent in the 1980s, the New England labor force registered an average annual increase of zero percent from 1990 to 1998 (U.S. Bureau of Labor Statistics, at Federal Reserve Bank of Boston 1999). In contrast, the labor force nationwide expanded on average by 1.2 percent per year over the same period.

Labor force participation and migration patterns have also contributed to the relatively slow growth of the region's work force. Labor force participation in New England historically has been high compared to U.S. averages. This gap has narrowed in recent decades. In both the region and the country, the labor force participation of males has declined since 1970, while females have become more actively involved in the work force. However, in New England the labor force participation rate of males fell faster than in the United States overall, and for females, participation rose to a lesser extent than nationwide. In contrast to the nation, labor force participation in New England actually declined between 1990 and 1997. By 1997 it was still relatively high for females (62.1 percent in New England versus 59.3 percent in the nation), but the rate for males had fallen below the national rate (74.7 percent in New England compared to 74.9 percent in the United States). This, in part, reflects the aging of the area's population; four of the New England states (all except New Hampshire and Vermont) rank in the top 11 states in percent of the population older than 65.

Within the region, trends in labor force participation have varied considerably. The three southern New England states have experienced relatively slow growth in participation compared to the nation since 1970; the opposite is true for the three northern states. Greater participation by women in Vermont and Maine, in particular, triggered this outcome. In Vermont, for example, the female labor force participation rate rose over 18 percentage points (from 48.1 percent to 66.3 percent) between 1970 and 1996, while the rate for females nationally rose by 12 points (U.S. Bureau of Labor Statistics 1999b). In Maine, the female rate increased over 15 points (from 47.8 percent to 63.4 percent) during the same period.

Out-migration has diminished the size of the available work force in New England. More people have been moving out of New England than moving in from other states. The greatest exodus has been from southern New England. By 1997, Rhode Island, Connecticut, and Massachusetts had experienced net domestic out-migration amounting to 13.1 percent, 11.7 percent, and 7.3 percent, respectively, of their 1990 population. Maine had net domestic out-migra-

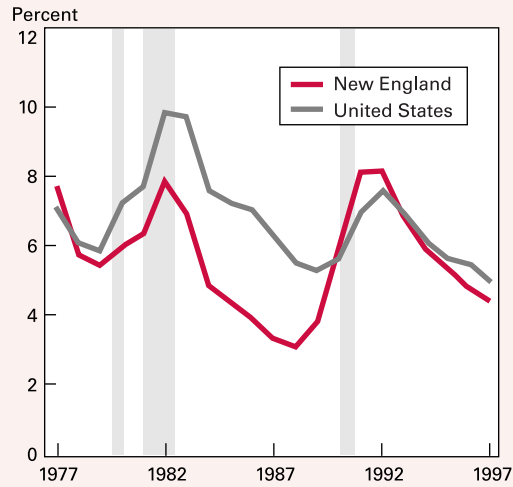
tion of 2.4 percent. In contrast, Vermont and New Hampshire experienced net domestic *in*-migration of 1.9 percent and 2.3 percent, respectively, during this period (U.S. Bureau of the Census 1999a).

Individuals leaving New England include well-educated, relatively young workers. A recent report on the Massachusetts economy shows that between 1990 and 1997 over one-half of those who left Massachusetts were between the ages of 25 and 34, and about 40 percent had four or more years of college (MassINC 1998). The report attributes the out-migration to the relatively high cost of living in the state. Per capita and median family incomes in Massachusetts exceed national averages, but the high cost of living, driven in large part by housing expenses, results in below-average purchasing power for many workers, the MassINC report argues.

While the northern New England states were able to expand their work forces by relatively rapid growth in the labor force participation of women and by domestic *in*-migration, the southern states relied more on foreign immigrants. Indeed, without foreign *in*-migration, Massachusetts, Connecticut, and Rhode Island each would have experienced a decline in their

Figure 2

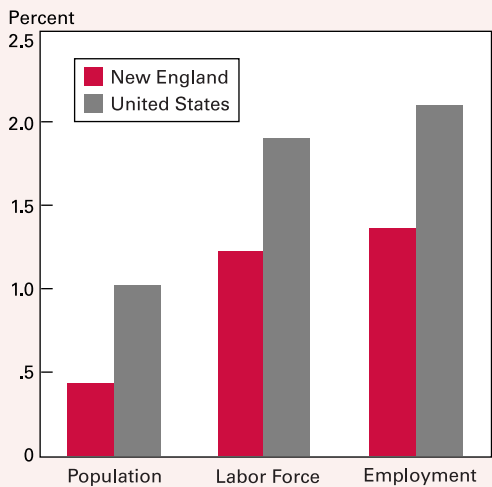
*Unemployment Rates,
New England and the United States*



Note: Shaded areas show recessions.
Source: U.S. Bureau of Labor Statistics.

Figure 1

*Average Annual Growth Rates,
New England and the United States,
1970 to 1998*



Source: Population, U.S. Bureau of the Census; labor force and employment, U.S. Bureau of Labor Statistics.

civilian labor force in recent years (Fogg and Sum 1998). Foreign immigrants have been an important source of skilled labor. For instance, one-third of foreign immigrants to Massachusetts between 1990 and 1996 were employed in highly skilled occupations in 1996, compared to 25 percent nationally (Massachusetts Technology Collaborative (MTC) 1998). According to the 1990 U.S. Census, a higher percentage of the immigrant work force in Massachusetts had a bachelor's degree or higher (28 percent) than did native Massachusetts residents (25 percent).

The relatively slow growth of the New England labor force has contributed to relatively low unemployment rates. Unemployment in New England has been below the national average throughout the past two decades, except for the recession in the early 1990s (Figure 2). In mid 1999 the unemployment rate was 3.2 percent, compared to 4.3 percent nationwide (U.S. Bureau of Labor Statistics 1999a).

Employment

Consistent with these population and labor force trends, employment in the New England economy grew relatively slowly in recent decades (Figure 1). From 1970 to 1998, average annual employment

Table 1
Relative Productivity of New England Manufacturing Industries in 1997

	Relative productivity of industry in N.E. to average productivity of all industries in N.E.	Relative productivity of industry in N.E. to industry in U.S.	Location Quotient 1997
Manufacturing, Total	1.25	.98	1.06
Durable goods	1.29	1.05	1.15
Instruments and related products	1.21	1.05	2.05
Miscellaneous manufacturing industries	1.15	1.25	1.97
Other transportation equipment	1.08	1.03	1.72
Electronic and other electric equipment	1.54	.94	1.46
Fabricated metal products	1.46	1.24	1.17
Industrial machinery and equipment	1.42	1.10	1.13
Primary metal industries	1.12	.84	.80
Lumber and wood products	.66	.81	.77
Stone, clay, and glass products	.93	.90	.65
Furniture and fixtures	.83	1.14	.55
Motor vehicles and equipment	2.22	1.43	.14
Nondurable goods	1.19	.89	.92
Leather and leather products	1.18	1.36	3.04
Paper and allied products	1.48	1.04	1.38
Printing and publishing	1.05	1.04	1.21
Rubber and misc. plastics products	1.01	1.08	1.07
Textile mill products	.69	.93	1.00
Chemicals and allied products	2.00	.73	.80
Apparel and other textile products	.57	.97	.59
Food and kindred products	1.26	1.02	.52
Petroleum and coal products	2.63	.57	.45
Tobacco products	3.75	.47	.18

Note: Highlighted rows indicate 2-digit SIC industries where the location quotient is greater than 1.00 (employment concentration is above the national average of 1.00).

Productivity is calculated as the value of industry gross product per worker.

Source: Based on data from the U.S. Bureau of Economic Analysis.

Manufacturing Employment

New England has experienced a steep drop in manufacturing employment, falling at a rate of 1.2 percent per year since 1970, compared to a 0.1 percent annual decline in the United States.² Manufacturing remains, however, an important part of the regional economy. In 1997, for example, 13.1 percent of the region's employment was in manufacturing compared to 12.4 percent in the nation. Productivity in the region, measured by output per worker, was 25 percent higher in manufacturing in 1997 than the average for all New England industries (Table 1).

Within manufacturing there has been a significant shift from nondurable to durable goods, especially to high-value-added and high technology products. Productivity in durable goods industries in the region is 29 percent higher than the all-industry average in the region and 5 percent higher than U.S. average productivity in durable goods.³ In 1997 durable goods manufacturing industries in the region employed approximately 80 percent more workers

growth in New England was 1.3 percent, compared to 2.0 percent for the United States.

Within the region, employment trends varied considerably. The three northern New England states have had the most growth. Employment expanded at an average annual rate of 2.9 percent in New Hampshire, 2.4 percent in Vermont, and 1.9 percent in Maine from 1970 to 1998, compared to the national average of 2.0 percent. In contrast, the three southern New England states grew at rates well below the national average. Massachusetts, which accounts for almost half (48 percent) of the region's employment, grew on average by only 1.2 percent per year from 1970 to 1998. Connecticut and Rhode Island grew even more slowly, at annual average rates of 1.1 percent and 1.0 percent, respectively.

² Data at the 2-digit SIC level are extracted from the U.S. Bureau of Economic Analysis, Regional Economic Information System (REIS). The breakdown of employment beyond the major 1-digit SIC level is from the U.S. Bureau of Labor Statistics, available at the Federal Reserve Bank of Boston Web Site at www.bos.frb.org/economic/neel/neeidata.htm. This data set is updated through 1997. Data on employment by major industry are updated to 1998 but are not available at the 2-digit SIC level or below.

³ Measurement problems make it difficult to compare productivity across states or regions.

than the nondurable goods manufacturing sector. Within durable goods, the region has a relatively high concentration of employment compared to the nation in the instrumentation, electronics, and industrial machinery industries. In recent years, however, New England has experienced a decline in its share of national employment in each of these three industries.

In the nondurable goods sector, New England has gone from above-average to below-average concentration in employment, relative to the nation. Most of the pronounced declines in the region have been in "traditional" manufacturing industries such as apparel and textiles, paper and allied products, and leather products. Productivity in New England's nondurable goods sector is 11 percent below the national figure. There is, however, considerable variation in productivity in industries in this sector (Table 1).

Nonmanufacturing Employment

Since 1970 nonmanufacturing employment in the region has grown, but at a pace below the national average (2.1 percent average annual growth for the region versus 2.7 percent for the United States). Services is the largest and fastest-growing sector in the New England economy. By 1998 over 33 percent of the region's jobs were in services, compared to 30 percent in the nation. The major services employers in New England in 1997 included health care (with 757,000 workers and over 9 percent of total employment); business services (581,000 workers and 6.9 percent of employment); engineering and management (313,000 workers and 3.9 percent of employment); and education (nearly 300,000 workers and 3.5 percent of employment).

The regional concentration of employment in 1997 was 29 percent above that of the country in health care, and 3 percent above in business services. Computer and data processing (including software) and suppliers of personal services accounted for the largest number of jobs in business services. Regional concentration of employment in engineering and management services was 25 percent above the national figure, while educational services in New England had twice the concentration of employment in the United States. Each of the New England states has a greater proportion of its employment in education than the national average.

The region's concentration of jobs in the finance, insurance, and real estate (FIRE) sector has grown to levels comparable to the nation (8.0 percent compared to 7.5 percent nationwide in 1997). The region shifted

from below-average to above-average employment share in the early 1980s, driven in large part by rapid employment growth at securities and commodities brokers, holding companies, and investment offices. Insurance agencies and brokerages in the region also have been growing relatively fast.

The retail and wholesale trade sector of the New England economy accounted for over 23 percent of the work force in 1998, approximately the same share as in the nation. The construction industry accounts for 5 percent of employment in the region; it plays a slightly smaller role in the New England economy than it does nationally, and it has grown at a slower pace since 1970. Over the past year, however, construction employment, fueled by strong housing and commercial markets and large infrastructure projects, grew faster than employment in any other sector in the region. The transportation and public utilities sector, with 4.0 percent of New England employment, also accounts for a smaller share than nationally; it has experienced growth below national averages in recent decades.

Recent trends in population, labor force, and college degrees awarded could undermine the region's competitive advantage and pose serious threats to New England's long-term prosperity.

High-Technology Employment

Several of the fastest-growing segments of the New England economy are in "high-technology" industries. In the absence of a standard U.S. Census classification, several definitions of high-technology industries have emerged. One of the more comprehensive and widely recognized definitions, which includes services as well as manufacturing, is that of the American Electronics Association (AEA). The AEA definition encompasses the following industries: computers and office equipment, consumer electronics, communication equipment, electronic components, semiconductors, industrial electronics, photonics, defense electronics, electromedical equipment, communication services, and software and computer-related services (AEA 1999).

Table 2

Employment and Employment Distribution in High Technology Industries, United States and New England, 1997

	US	NE	CT	MA	ME	NH	RI	VT
Total Number of High Tech Workers	4,566,056	355,205	71,507	205,091	10,511	39,660	13,999	14,437
Percent of High Tech Workers	4.5	6.4	5.1	7.7	2.3	8.2	3.7	6.3
Distribution of High Tech Employment Across Industries								
Manufacturing, Total	43.4	55.0	46.2	53.5	49.7	73.5	52.9	77.9
Computers and Office Equipment	8.1	10.9	8.5	12.8	.0	14.8	1.9	.0
Consumer Electronics	1.8	.9	1.5	.9	1.8	.2	.0	.0
Communications Equipment	6.1	7.0	7.1	7.3	4.5	9.9	.2	.0
Electronic Components and Accessories	8.1	9.9	9.4	7.9	19.3	20.8	10.0	2.5
Semiconductors	6.0	7.3	.7	5.7	21.9	3.8	10.6	66.7
Defense Electronics	3.5	4.2	2.6	2.9	.0	14.6	8.4	.1
Industrial Electronics	6.1	9.8	10.7	9.9	2.2	8.0	21.2	6.1
Electromedical Equipment	1.2	1.3	.8	1.8	.0	.3	.5	.7
Photonics	2.4	3.8	4.9	4.4	.0	1.2	.0	1.8
Services, Total	56.6	45.0	53.8	46.5	50.3	26.5	47.1	22.1
Communications	25.8	14.6	23.1	11.8	32.1	8.7	16.4	13.7
Software	15.5	16.5	10.7	21.0	6.6	11.0	14.6	3.9
Data Processing	7.8	5.1	7.6	5.4	5.6	2.0	.2	.6
Rental, Maintenance, and Other Computer	7.6	8.7	12.5	8.2	5.9	4.7	15.9	3.9

Note: Numbers may not add to totals because of rounding.

Source: Based on data from the American Electronics Association, *Cyberstates* 3.0.

Using the AEA classification, 6.4 percent of the region's 1997 employment (approximately 462,000 jobs) was in high-technology industries—over 40 percent above the national average of 4.5 percent (Table 2). Moreover, in the AEA's ranking of individual states by the percentage of total private sector employment in high-technology industries, three New England states rank in the top five: New Hampshire (first, with 8.2 percent); Massachusetts (third, with 7.7 percent); and Vermont (fifth, with 6.3 percent).⁴ The largest employers in the New England high-technology sector include software services, communication services, computer equipment, electronic components, and defense electronics. Compared to the nation, the region has a relatively high concentration of its high-tech jobs in manufacturing, rather than services.

High-tech industries in the region have contributed to high per capita income and impressive growth in gross state product (GSP) per worker. These industries pay above-average wages. For example, the average wage in high-technology industries nationally in 1997 was 77 percent higher than the average U.S.

⁴ Connecticut ranks 14th (with 5.1 percent of employment in high-technology industries) in the AEA rankings, Rhode Island 23rd (3.7 percent), and Maine 37th (2.3 percent).

private sector wage (AEA 1999).⁵ New England has competitive strength in high-technology industries, but the region's share of these jobs is on the decline. Annual growth in high-tech industries in New England since 1992 has been only 0.7 percent, compared to 3.0 percent nationally (AEA 1999).

While growth in population and employment has lagged national trends, gross state product (GSP) and per capita income have increased faster in New England than in the nation. All six New England states rank among the top 15 in change in GSP per capita over the last two decades; New Hampshire, Connecticut, and Massachusetts rank first, second, and third. This trend continues. The latest U.S. Bureau of Economic Analysis data on the percent change in GSP from 1996 to 1997 show regional average growth at 4.8 percent, compared to the national average of 4.3 percent.

As of 1998, three New England states are among

⁵ In the New England states with the highest concentration of high-technology employment, the average wage in high-technology industries compared to the average private sector wage was as follows: \$46,971 versus \$27,648 in New Hampshire; \$56,067 versus \$33,764 in Massachusetts; and \$46,767 versus \$24,040 in Vermont (BLS data; AEA 1999).

the top 10 in per capita income: Connecticut ranks first; Massachusetts, third; and New Hampshire, seventh. Rhode Island ranks 15th, Vermont, 30th, and Maine 36th. The state rankings for median family income are similar. In addition, each of the New England states ranks among the top 10 in percent change in median family income over this period. Coupled with its relatively high average incomes, New England has relatively low poverty rates compared to the nation. All six states in the region rank in the bottom one-third of all states in this measure.

Higher productivity and per capita income in New England are in part products of both the region's concentration of employment in high-technology industries and its productivity advantages in particular industries. Historically the region's mix of industries has included a disproportionate share of those with relatively high productivity. For example, within manufacturing, all of the industries where New England has employment concentrations above the national average (as indicated by a location quotient greater than one) have output per worker that is above the average for all industries in New England (Table 1). Except for electronics, the productivity of these industries in the region is also higher than the productivity in the industry nationwide.

II. High-Technology Infrastructure

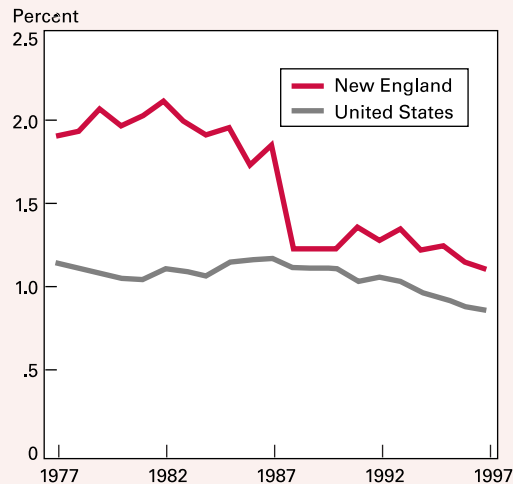
A multifaceted "high-technology infrastructure" has contributed to the success historically of high technology and innovation-based industries in New England. Funding by venture capitalists and from the federal government fuels the region's strong R&D base and entrepreneurial talent. In addition, New England's colleges and universities provide a supply of highly educated and skilled labor, world-class research, and "seed" ideas and entrepreneurs for innovation and technology-based start-up firms.

Research and Development (R&D)

New England traditionally has been a major center for R&D and has attracted a relatively large share of federal funds supporting R&D, particularly in defense-related areas. On a per employee basis, the region received over 35 percent more dollars in Department of Defense procurement contract awards than the national average in 1970; by 1992 this lead had increased to over 78 percent. Defense-related R&D funds bolstered the initial development of the

Figure 3

Federal Obligations for R&D as a Percent of Gross State Product, New England and the United States



Source: Federal R&D dollars, National Science Foundation; gross state product, U.S. Bureau of Economic Analysis.

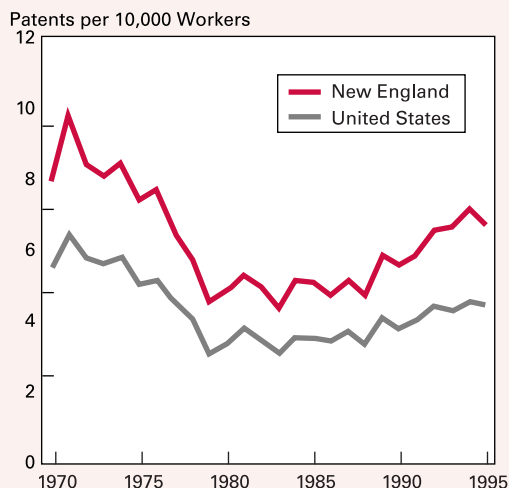
Cambridge/Route 128 high-tech corridor, which became a leader in electronics, instrumentation, communications, and software (Saxenian 1994). The region's share of Defense Department funding has declined in recent years. By 1996, for example, the regional percentage of procurement contract dollars had fallen to 55 percent above the U.S. average (U.S. Department of Defense Annual).

As federal R&D support declined for defense-related fields, the region experienced a drop in total federal R&D dollars as a percentage of GSP from approximately 2 percent in the late 1970s to about 1 percent in 1997. As Figure 3 shows, the gap between the region and the nation expanded modestly in the 1990s as additional funds went to support research in health care. Massachusetts, in particular, has benefited from federal support of R&D in the health field. The regional differential remains well below that which the region enjoyed throughout most of the 1980s, however.

In terms of *total* R&D, which includes corporate expenditures, the region continues to be strong. Total R&D in New England equaled 4.0 percent of GSP in 1995, compared to 2.8 percent nationally (National Science Foundation 1999a).

Figure 4

*Patents Granted per 10,000 Workers,
New England and the United States*



Source: Patents, U.S. Patent and Trademark Office; employment, U.S. Bureau of Economic Analysis.

The region's strength in R&D contributes to its strong performance in patents per worker: 6.57 patents per 10,000 workers in New England in 1996, compared to 4.34 per 10,000 workers in the entire country (U.S. Patent and Trademark Office, Annual). Four New England states (Connecticut, Massachusetts, New Hampshire, and Vermont) ranked in the top 10 states for patents per worker in 1996. Rhode Island was not far behind in 12th place, while Maine ranked 43rd. While patents per worker in New England and in the United States rose from the mid 1980s to the mid 1990s, these figures remain below the levels experienced regionally and nationally in the early 1970s (Figure 4).

Patent activity often triggers innovations that generate new technologies, processes, and products. An important linkage has been identified between patents and overall economic growth (Amable 1993; Fagerburg 1994; Verspagen 1991). Patent citation data show, for instance, that companies benefit from close proximity to universities and scientific research (Jaffe, Trajtenberg, and Henderson 1993). Moreover, these authors suggest that the geographic concentration of knowledge is increasing in the U.S. economy, noting that the probability is growing that a citation of a

patent is from the same Metropolitan Statistical Area from which the patent was filed.

Venture Capital

Venture capital is another key component of the region's high-technology infrastructure. New England receives a relatively high percentage of the venture capital dollars in the United States, that is, dollars invested by U.S. venture capital firms in U.S. companies. Venture capital funding is at record high levels in New England, and the region cracked the \$2 billion mark for venture capital monies for the first time in 1998.⁶ New England consistently ranks second to Silicon Valley in attracting venture capital. (Silicon Valley attracted over \$4.5 billion in venture funds in 1998.) In recent years, however, venture capital funds have been growing faster in New England than in Silicon Valley or in the rest of the country. From 1995 to 1998, for example, venture capital funds in New England grew by 248 percent (in real, inflation-adjusted terms)—a rate significantly higher than that in Silicon Valley (177 percent) and double that of the nation (123 percent). During this period, New England's share of venture capital in the United States rose from 9.2 to 14.2 percent, and the average size of a deal in the region doubled, from \$2.5 million to \$5 million.

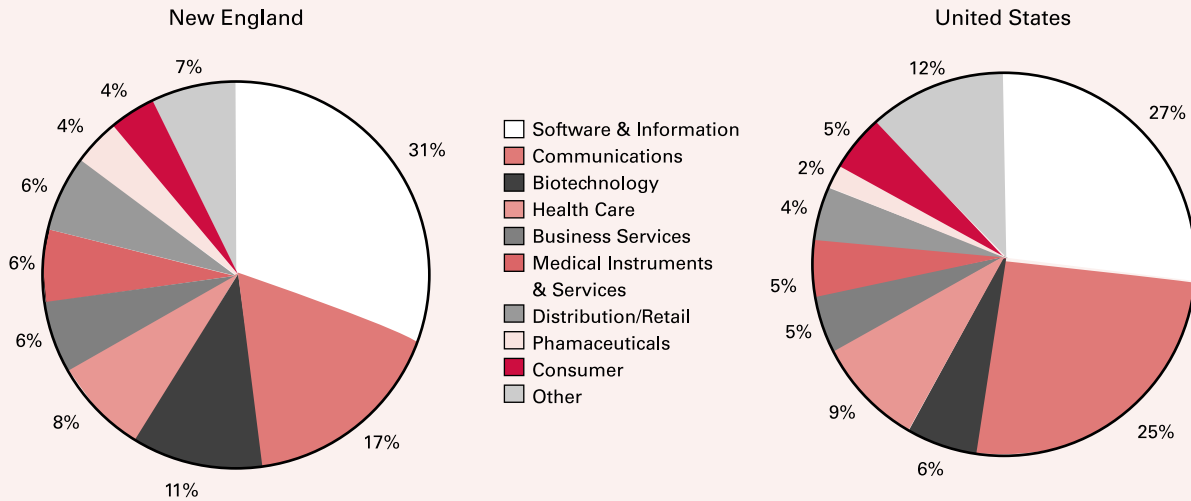
Massachusetts consistently accounts for the bulk of venture capital investments in the region. In 1998, for example, Massachusetts attracted 80.7 percent of the venture capital funds in New England, followed by Connecticut at 11.7 percent and New Hampshire at 6.5 percent. Rhode Island, Maine, and Vermont each received less than 1 percent of the region's venture capital that year.

Venture capital funds in New England are now allocated across a diverse set of industries, whereas in the 1980s these funds were concentrated in defense-related and computer industries. From 1995 to 1998 software and information, communications, biotechnology, and health care received the bulk of venture capital funds in New England (Figure 5). All four of these industries have enjoyed considerable increases in venture funds since 1995, with the software and information and the communications fields (including Internet-related activities) experiencing the greatest gains.

⁶ All of the data on venture capital were provided by Price-waterhouseCoopers Global Technology Industry Group (1999).

Figure 5

Venture Capital Investments, 1995 to 1998



Source: PricewaterhouseCoopers Global Technology Industry Group (1999).

Colleges and Universities

New England’s colleges and universities are the third key component of the region’s high-technology infrastructure. New England is home to approximately 280 colleges and universities, which enrolled almost 800,000 students in 1996 (Harney 1997). New England has long been a leading exporter of college graduates. With 5 percent of the nation’s population, the region awarded 6.7 percent of the college degrees conferred in 1996 in the United States.⁷

Over the past two decades, New England has been losing market share in the number of degrees awarded. At the associate level, degrees awarded in New England fell from 7.2 percent of the national total in 1977 to 4.8 percent in 1997; at the bachelor’s degree level, from 7.7 percent to 6.7 percent; and at the doctoral level, from 8.5 percent to 7.6 percent. Only at the master’s degree level did the regional share rise between 1977 and 1997, from 8.0 to 9.0 percent.

The largest drop in college degrees awarded in New England occurred in the 1990s, reflecting the relatively steep decline in the region’s traditional

college-age population. The bulk (approximately 75 percent) of the students who attend college in the region are New England natives (Harney 1997). Students from other parts of the country account for about 20 percent. Five percent of New England students are from outside the United States.

From 1990 to 1997, the number of college degrees awarded at all levels in New England grew by less than 1 percent, while nationwide the growth was 14.5 percent. The region was particularly hard hit at the four-year college level, where bachelor’s degrees awarded *declined* 7.0 percent during this period; in contrast, bachelor’s degrees awarded nationwide rose by 7.2 percent.

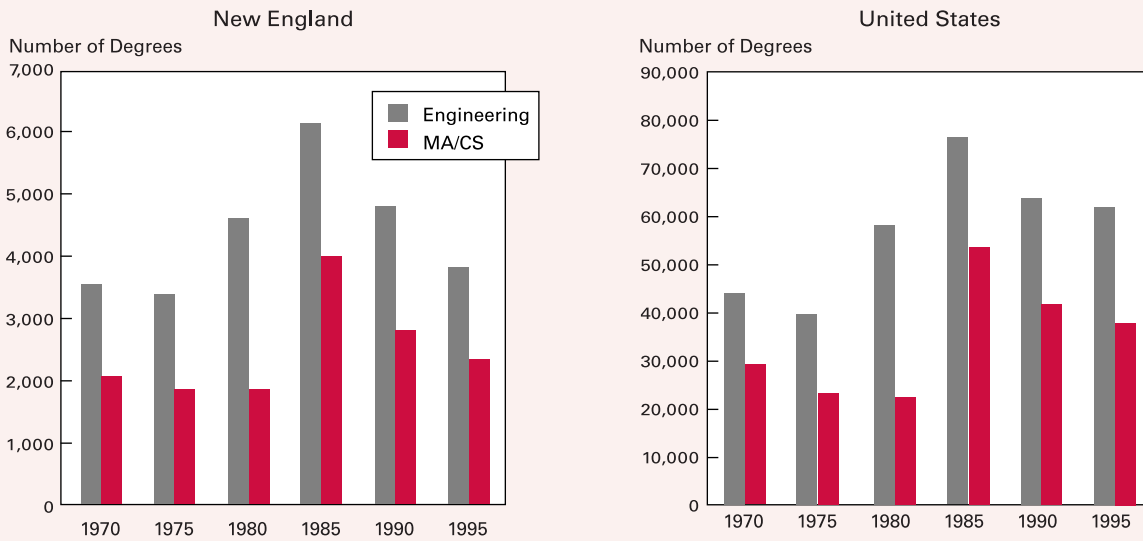
At the graduate level, regional population declines have less impact on enrollments, as these programs draw from more national and international markets than do undergraduate programs. Graduate degrees awarded in the region, however, have still lagged national trends since 1990. Master’s degrees awarded in New England rose by 20.2 percent from 1990 to 1997, compared to 23.5 percent nationally. New England universities awarded 7.0 percent more Ph.D.s in 1997 than in 1990, versus a 15.3 percent increase nationally.

A smaller supply of new college graduates in

⁷ Data in this section are from the Integrated Post-Secondary Education Data Set (IPEDS), 1977–1997 completions data.

Figure 6

Bachelor's Degrees Awarded in Engineering and Mathematics/Computer Science



Source: New England Board of Higher Education.

New England reduces the pool of talent from which businesses can recruit. Moreover, degrees granted in several fields critically linked to high-tech industries have experienced greater than average declines in the region.

Engineering and Math/Computer Science Degrees

New England's share of engineering and math/computer science degrees awarded in the United States has also fallen over the past two decades. The region's percent of U.S. engineering degrees conferred fell from 8.7 percent in 1975 to 6.2 percent in 1995 at the bachelor's level, from 9.1 to 7.5 percent at the master's level, and from 12.9 to 8.2 percent at the doctoral level. For math/computer science degrees, the region's share fell over this 20-year period from 8.4 to 6.1 percent at the bachelor's degree level, from 6.9 to 6.5 percent at the master's level, and from 9.8 to 7.5 percent at the Ph.D. level.⁸

⁸ Data provided by the New England Board of Higher Education from analysis of National Science Foundation WebCASPAR Database System.

The supply of new graduates in engineering and math/computer science at the bachelor's degree level exhibited a boom-bust pattern both regionally and nationally between 1975 and 1995 (Figure 6). New England, however, has experienced significantly larger declines since 1985 than the rest of the country. From 1985 to 1995, baccalaureate engineering degrees awarded fell by 37.4 percent in the region, nearly double the decline in the nation. A similar story emerges for bachelor's degrees in the math/computer science category.

These patterns in engineering and math/computer science degrees awarded reflect not only regional population declines but also a nationwide shift in the interests of students away from these technical fields of study. The change in student interests is especially pronounced at the bachelor's degree level. For example, 8.0 percent of the bachelor's degrees awarded in New England in 1985 went to engineering; by 1995 this figure had dropped to 4.8 percent. At the master's and doctoral levels 7.1 percent of graduates in New England were in engineering in 1995, versus 8.1 percent in 1985. For math/computer science, only 2.9 percent of the four-year college degrees awarded

were in this field in 1995, down from 5.2 percent a decade earlier. The share of graduate degrees awarded in New England in math/computer science remained relatively constant at approximately 3 percent from 1985 to 1995.

III. Skill Shortages

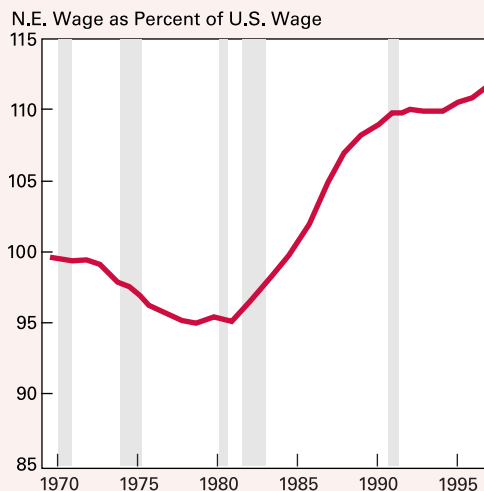
In the 1980s, the relatively slow growth in the New England labor force and relatively low unemployment rates occurred during a period of significant growth in the number of college graduates. Most firms were able to meet their needs for professional, technical, and managerial personnel. With the 1988–92 recession, surpluses of workers and college graduates emerged, rather than shortages. Liberal arts and other nontechnical graduates were especially hard hit by the recession. Engineering and computer science graduates also experienced declines in demand as the region suffered disproportionately large cuts in defense spending (Kodrzycki 1995). Retrenchment that started in the mid 1980s had a continuing impact on many of the region's large minicomputer firms, including Wang, Data General, Prime Computer, Hewlett-Packard, Bull HN, and Digital. The subsequent shift of students away from these technical fields in the 1990s reflects a lagged response to these labor market trends. As the region rebounded from the recession, firms found not only fewer new college graduates, but also smaller proportions of these graduates in the engineering and math/computer science fields.

Evidence of a skills gap is increasing. Demand for highly skilled and well-educated workers has been rising, as the fastest-growing segments of the New England economy have high proportions of professional, technical, and managerial occupations. In addition, integration of new technologies and production processes has led to greater use of college graduates across a range of industries, including those that traditionally have employed significant numbers of blue-collar workers. In Massachusetts, for example, over one-third of all workers in manufacturing were professional, technical, and managerial workers in 1996, compared to only one-quarter in 1983 (Harrington and Fogg 1997).

By the late 1990s, shortages were increasingly being reported in high-technology fields (Harrington and Fogg 1997; MassINC 1998). A survey conducted in May 1998 by the Massachusetts Technology Collaborative found technology-intensive employers unable to fill many of their positions for highly skilled work-

Figure 7

Relative Average Wages, New England and the United States



Note: Shaded areas show recessions.
Source: U.S. Bureau of Economic Analysis.

ers (MTC 1998). Scientists and engineers had the highest vacancy rates, at 11 and 9 percent, respectively. In addition, over 5 percent of the technician positions in these firms were vacant. More than half the vacancies in the software industry were for engineering professionals.

Interviews conducted in 1998 with Massachusetts employers across a range of high-tech areas suggest that skill shortages are constraining growth in many fields, including Internet development, networking technology, management information systems, and software engineering (Mass Insight 1998). Focus groups and surveys of businesses in New Hampshire in 1998 further suggested that labor and skill shortages are deterring business expansions and relocations to the area (Gittell 1999).

Wage rates in New England have increased relative to the United States since 1980 (Figure 7), rising from 4.6 percent below the national average in 1980 to 11.9 percent above the national figure in 1997 (U.S. Bureau of Economic Analysis 1999). Wage increases can reflect a variety of factors in addition to tightness in the labor market, as suggested by the fact that relative wages continued to rise in New England

during the 1988–92 recession period. In particular, the region's relatively high levels of educational attainment compared to the nation's, increasing returns to education nationally over the past two decades, and New England's relatively high productivity account for some of the growing differential in relative wages (Massachusetts Taxpayers Foundation 1999). In 1995, after several years of stability at 10 percent above the national average, the region's relative wages again began to rise. Some of this increase reflects the tight labor markets in the region, especially for highly skilled workers.

IV. Opportunities and Challenges

The New England economy faces many opportunities and challenges as it moves into the twenty-first century. High technology infrastructure and human resources are central to the outcomes and to the long-term development of the region.

New England has outpaced the nation in realigning its employment away from manufacturing to a services-based economy over the past three decades. Federal R&D funding facilitated this transition by shifting from support of defense-related manufacturing to high-value-added nonmanufacturing areas such as health care and biotechnology. Venture capital, too, has fueled innovation and change in the region. In addition, New England's colleges and universities bolster the well-educated, highly skilled pool of workers and research, entrepreneurship, and new ideas in the region.

For decades this dynamic infrastructure has provided the backbone for New England's competitive advantage in innovation and high technology. The region has a relatively high concentration of high-technology employment compared to the nation. Even though fewer than 7 percent of the region's workers are employed in high-technology industries, this sector has been a critical component and major stimulus of the New England economy. The high-technology industries generate demands for supplier firms and for providers of an extensive array of personal services for relatively well-paid, high-tech workers. Moreover, many industries outside the high-technology definition, such as mutual funds and health care, have benefited from the R&D, venture capital, and skilled work force that the high-tech firms attract.

However, some significant challenges lie ahead. While venture capital is now at an all-time high in the region, federal R&D funding in New England has

fallen as a percent of GSP, and other regions are starting to claim an increasing share. Job growth in New England has lagged that of the nation in recent years; employment in the region's high-technology industries, in particular, grew well below the U.S. rate from 1992 to 1997.

Recent trends in New England's population, labor force, and college degrees awarded could undermine the region's competitive advantage. Within the region, two different patterns have emerged. The three northern New England states, which have experienced relatively high growth, have benefited from in-migration from other states and from a significant increase in the participation of women in the work force. Labor force participation rates of women in northern New England are now well above the national average, however, and are unlikely to increase much further.

The region needs to bolster the viability of its high-technology infrastructure, in order to secure New England's position as a leader in high technology, innovation, and change in the twenty-first century.

The three southern states have experienced employment growth well below that of the nation. These states have become increasingly dependent on foreign in-migration to fill positions. Foreign immigrants have provided a critical source of skilled workers, particularly important at a time when southern New England has experienced significant domestic out-migration that includes many well-educated individuals. Recent changes in immigration laws have increased quotas, thereby allowing expansion of the region's immigrant work force. The region is vulnerable, however, to possible future changes in these laws, which are federal, and which could further restrict the numbers of immigrants allowed into the country. Moreover, the region needs to better understand the reasons behind the exodus of well-educated workers, especially in times of worker and skill shortages. If, as has been suggested by the recent MassINC report, skilled workers are leaving for geographic areas with lower living

costs, employers have to consider increasing real wages or otherwise improving living and working conditions in order to attract and keep workers in New England.⁹

The declining number and share of college degrees awarded in the region in recent years has further shaped and limited the supply of workers from which New England employers can draw. Demographic trends should result in larger numbers of college degrees being awarded in New England in the next few years, and enrollments are on the rise. The shift in student interest away from engineering and other technical areas critical to the high-technology sector, however, suggests that the increases in graduates will

⁹ The high living costs are most problematic in the Greater Boston metropolitan area. In some cities in the region, including Hartford and Providence, prices are close to the national averages.

be at least partially offset by smaller shares of students studying in these fields. Increases in relative pay in engineering and related fields have historically reversed such student enrollment declines. These market adjustments, however, often occur with a lag of four to six years, and hence will not provide a solution in the short term to skill shortages being felt by employers.

The next few years are critical to New England. If the region is unable to maintain its strength and competitive advantage in innovation and high technology, other regions may make significant inroads that will be harder to overcome when New England rebounds. The region needs to bolster the viability of its high-technology infrastructure, in order to secure New England's position as a leader in high technology, innovation, and change in the twenty-first century.

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