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# 4 Knowledge-Based Economy

## Late 20<sup>th</sup> century

### Rapid Growth

When World War II ended in 1945, the U.S. economy slipped quickly back into peacetime operation. Productivity growth was rapid during the 1950s and 1960s, with technological advances fueling much of the growth. Productivity growth slowed around the early 1970s, but picked up again at the end of the 1990s. The effect of slower productivity growth on per capita income was offset by increased hours worked, as more and more women joined the workforce. The impact on living standards of increased female participation in the workforce may be overstated by the per capita income figures, however, as per capita income includes only market transactions and, thus, ignores the value of women's work in the home.

Many of the technological advances in the second half of the 20th century led to improvements in communications and the processing of information. In addition, many products and services introduced in the first half of the century came into common use in the second half as a result of improvements in their quality and reductions in their cost. Telephones, radios, refrigerators, and cars became ubiquitous. Air travel became commonplace rather than a novelty.



Women welders at the Landers, Frary and Clark plant in New Britain, Connecticut. Photograph by Gordon Parks. (Photo courtesy of Library of Congress, Prints & Photographs Division, FSA-OWI Collection, [reproduction number, e.g., LC-USF35-1326])

Improvements in health care both extended lives and improved the quality of life. Vaccines provided protection against many serious illnesses. New surgical techniques relieved the ravages of heart disease, as well as degenerating hips and knees. Unhealthy lifestyles, however, offset some of these advances.

Government was an important actor in the growth process in this period. Government-sponsored research and government support for education contributed to technological advances both directly and by creating a pool of scientific and engineering talent. The government also sought to encourage private

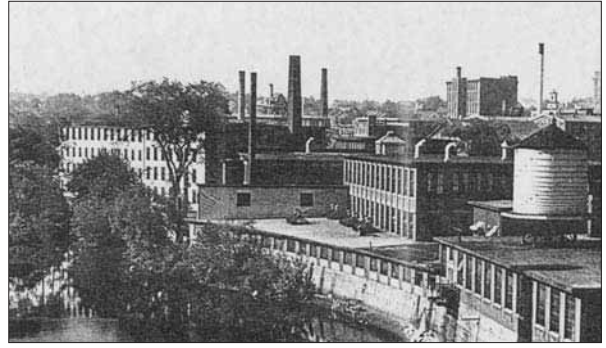


Denise LaRoche on Easter morning, 1962 in Lowell, Massachusetts. (Photograph by Roland LaRoche, courtesy of the LaRoche family)

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investment and research through tax policy. At the same time, some would argue that high tax rates and intrusive regulations discouraged entrepreneurial activity.

Wool mills in Woonsocket Rhode Island were still operating in 1947. Within ten years, they were out of business. (Photo courtesy of Photographic Archives, Ekstrom Library, University of Louisville)

International trade and investment had been disrupted by the Great Depression and World War II, but increased rapidly once the war was over. The growth in international commerce came in response both to improvements in transportation and communication and to government efforts led by the United States to lower barriers to commerce. U.S. consumers enjoyed a wider array of products at lower costs. U.S. manufacturers gained access to new markets, but found themselves facing intense competitive challenges. Exposure to management practices in other advanced countries helped the United States achieve productivity gains. In general, the U.S. comparative advantage in international trade tended to be twofold: on the one hand, in resource products, and, on the other hand, in sophisticated capital goods and services. With few resource products, New England focused on the latter.

## Out with the Old, In with the New<sup>1</sup>

The years following World War II were difficult for New England. Coming out of the war, New England's economy was still very much an outgrowth of the 19th century. Although many textile firms had closed or relocated, the textile industry was still a very large employer, as was the shoe industry. Machinery and metalworking were still prominent. The region was still more strongly oriented to manufacturing than was the country as a whole.

After World War II, textiles came under renewed competitive pressure from southern producers, and employment plummeted. Some communities heavily dependent on textile employment were thrown into severe local depressions. The shoe industry was also challenged, although a segment survived for several more decades in the region by shifting out of Massachusetts to the lower-wage northern states. In machinery and metalworking, in contrast, the continued need for skilled workers tied firms to the existing industry centers.

New industries emerged. Although the New England economy could not really be characterized as diversified, since textiles and shoes were so prominent, many different industries, especially manufacturing industries, were present in the region. Of particular importance in the immediate post-war years were electronics and aircraft engines. Subsequently, computers, instruments, and computer services provided an impetus to growth. Financial services and health care also contributed.



Store going out of business, Lowell, Massachusetts, 1941. Photograph by Jack Delano. (Photo courtesy of Library of Congress, Prints & Photographs Division, FSA-OWI Collection, [reproduction number, e.g., LC-USF34-042792-D])

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The industries driving growth in the region tended to be relatively sophisticated technically and relatively dependent upon professionals and technical workers. In other words, New England's comparative advantage lay in industries that had a high knowledge content.

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Although New England experienced some very difficult episodes in the postwar years, per capita income growth more than kept pace with that nationally. While total income continued rising, relatively slow population growth also helped sustain per capital income growth.

The mix of industries in New England began to more closely resemble the national mix. Employment in manufacturing in New England actually declined. To some degree, this decline reflected competitive pressures—New England firms in some industries simply could not produce as cost effectively as firms elsewhere. But, more important, productivity growth was faster in manufacturing than in services industries. Thus, even if manufacturing output and services output grew at the same rate, employment would grow more slowly in manufacturing. Nationally, manufacturing employment continued to increase, but the growth was slower than in services. Services growth was also faster because more affluent economies tend to demand more services relative to goods.

Although the New England economy became more similar to the national economy in broad terms, key differences remained. The industries driving growth in the region tended to be relatively sophisticated technically and relatively dependent upon professionals and technical workers. In other words, New England's comparative advantage lay in industries that had high knowledge content.

### Role of Defense Spending

World War II and the Cold War played an important role in the development of New England's industrial mix. Connecticut's existing orientation to metalworking was reinforced by defense expenditures. Pratt and Whitney, now part of United Technologies, became the primary supplier of aircraft engines in World War II.<sup>2</sup> The manufacture of aircraft engines and parts remained an important Connecticut industry through the rest of the century, supported by continued, albeit erratic, military demand and the growth of civilian aviation. Submarines were manufactured in New London, Connecticut.

Massachusetts, too, became an important defense contractor. Here the emphasis was more on military research, especially at MIT, and electronics. Raytheon, which previously manufactured radio vacuum tubes, became a major supplier of radar equipment in World War II and subsequently moved into missiles. Additionally, various research projects with their origins in World War II and subsequent conflicts gave rise to a host of applications in electronics, instruments, and computers. The best known of the companies that got its start in this way was Digital Equipment Corporation.



Aircraft workers at the Naval Air Base in Corpus Christi, Texas, World War II. (Photo courtesy of Library of Congress, Prints & Photographs Division, 325115 Collection, [reproduction number, e.g., USE6-D-006777])

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## Digital Equipment Corporation (DEC)

Digital Equipment Corporation (DEC) had its origins in a World War II flight simulator project under the direction of Jay Forrester at MIT.<sup>3</sup> Although the project was not completed, a central computer system was devised that could analyze and react to incoming data instantaneously. This became the foundation for an air defense system that could intercept incoming fighters.

Ken Olsen worked on the flight simulator project with Forrester, but eventually became impatient with the slowness with which computers were being put to use. To see the new technology used more broadly, he founded his own firm. Olsen's early customers were scientists and other knowledgeable people who could develop their own applications.

Olsen's vision of small, relatively inexpensive and versatile mini-computers was very successful for a time. The model was followed not only by DEC but also by other New England manufacturers, and it dominated the regional computer industry. These computers were used for a host of different purposes, from analyzing weather patterns to designing razor blades to automating the printing of newspapers.

As one moves from the textile mills of the 1800s to mass production of bicycles and other complex products at the turn of the 20th century and on to computers in the second half of the 20th century, one can see an evolution toward more general-purpose capital goods. In a textile mill, machines produce a single relatively straightforward product. In Pope's bicycle plant, the product is much more complex, and the machines can be adapted to produce quite different products, such as sewing machines. In the computer era, the computer/machines are still more versatile. Particularly in the DEC model, they represent raw brain power that can be applied to whatever task the user can devise. Over time, machines in use in New England came to be used to produce an increasing array of products, and in the computer era, even to produce services as well as goods.

## Higher Education

Defense research conducted in support of World War II and in the subsequent Cold War years created a pool of scientists, engineers, and technicians in the Boston area that supported the growth of technically oriented industries, both civilian and defense. Increased college attendance reinforced this development.



Teenager listening to the radio, 1964.  
(Photo courtesy of Roland LaRochelle)

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The GI Bill enacted in 1944 encouraged many veterans to attend college and generally heightened public attention to education. State institutions of higher learning were expanded. College enrollments jumped with the baby boom generation. Boomers were much more likely to attend college than prior cohorts, and their numbers were large. New England institutions captured a disproportionate share of the postwar increase in enrollments. The region's elite institutions targeted smart, young people from all over the country, even as federal financial support made attendance more feasible. Many of these students stayed in the region after graduation, giving New England a supply of highly educated, often technically trained, workers. This labor force facilitated the growth of the computer industry and other activities requiring relatively large numbers of professional and technical workers.



Massachusetts Institute of Technology computers. (Photo courtesy of the Boston Public Library, Print Department)

## Comparative Advantage in Brains

In the 1950s and 1960s, defense-oriented industries played a key role in sustaining the New England economy. The 1970s saw the computer industry emerge as a significant factor, especially in Massachusetts. Certain services industries also contributed to the region's growth, serving national and even international markets. These included financial services, such as insurance and mutual funds, and the software industry. Higher education also became an industry of some consequence in its own right.

The lines between industries became progressively fuzzier. By the 1990s, for example, the telecommunications industry included manufacturing, software, and communications segments.

Most of the industries of this period had two distinctive features: They were dynamic—always changing—and they depended relatively heavily on highly educated workers. As previously noted, New England's comparative advantage lay in activities with a large knowledge content.

In some ways, New England's situation at the turn of the 21st century resembled its situation in the colonial era. The region no longer had a dominant industry in which it was more productive than competitors elsewhere, as the textile industry had been through much of the 19th century and as staple crops had been for the southern colonies many years earlier. Rather, the region's prosperity depended on the ingenuity and skills of its people and especially on their ability to see new opportunities in a rapidly changing world. Moreover, New Englanders of the early 21st century resemble the Puritans of 350 years ago in being relatively well educated and entrepreneurial, in valuing and exploiting their local connections, and in being willing to use government to advantage but ready to reject burdensome regulation.

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A family enjoys an outing to Wyman's beach in Westford Massachusetts, 1961. (Photo courtesy of Roland LaRochelle)

## Endnotes

<sup>1</sup>Lynn Elaine Browne and Steven Sass, "The Transition from a Mill-based to a Knowledge-based Economy: New England 1940-2000," in *Engines of Enterprise*.

<sup>2</sup> Browne and Sass in *Engines of Enterprise*, p. 209.

<sup>3</sup> Browne and Sass in *Engines of Enterprise*, p. 211.