Living Standards & Economic Growth A Primer

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New England Economic Adventure
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Living Standards & Economic Growth A Primer

The central purpose of the New England Economic Adventure is to build understanding of why we enjoy a higher standard of living today than did generations past. The simple answer to this question is rising labor productivity. Increases in labor productivity drive increases in living standards.

This primer looks at the rise in the U.S. standard of living over the past 200 years and at the factors that have made this possible — that is, at the gains we have experienced in labor productivity and how these have come about. Five topics are covered:

- what economists mean when they talk about living standards,
- how economists measure living standards,
- the historical record of increases in U.S. living standards,
- labor productivity and economic growth theory, and
- the factors that have contributed to U.S. economic growth over time.

Here you'll find the theoretical underpinnings of the New England Economic Adventure.

Key concepts in the text are in green type.

Living Standards

Standard of living refers to the economic well-being of people. It incorporates material comforts, ease of living, and opportunities for personal satisfaction. It is usually used in a relative context — we speak of the standard of living in country A relative to country B, for example, or standards of living today compared with standards of living 50 years ago.

For economists, a good measure of living standards would be the "value of all goods and services consumed per capita" (per capita = per person). Ideally, goods and services would be defined broadly and would include not only goods and services that are purchased (such as a loaf of Wonder Bread), but also goods and services produced at home (such as a loaf of home-baked bread). Goods and services provided by the government (such as public parks and fire protection) would be included, as would the value of leisure time. The ideal measure would also include the enjoyment of environmental amenities (such as clean air and water) and good health, and it would incorporate adjustments for demographic factors, such as the differing consumption needs of children and adults.

Such a comprehensive measure does not exist; so we turn to approximations. The most commonly used measure of standard of living is **national output per capita**, usually measured as **GDP** or **GNP** per capita.[1] By either measure, this has a number of weaknesses. It *does not* include the value of home production, nor does it capture the quality of the environment or public health. It *does* include something we do not consume — investments in equipment and factories; these are not consumption goods but instead have value for us because they increase our ability to produce more, and ultimately to consume more, in the future.

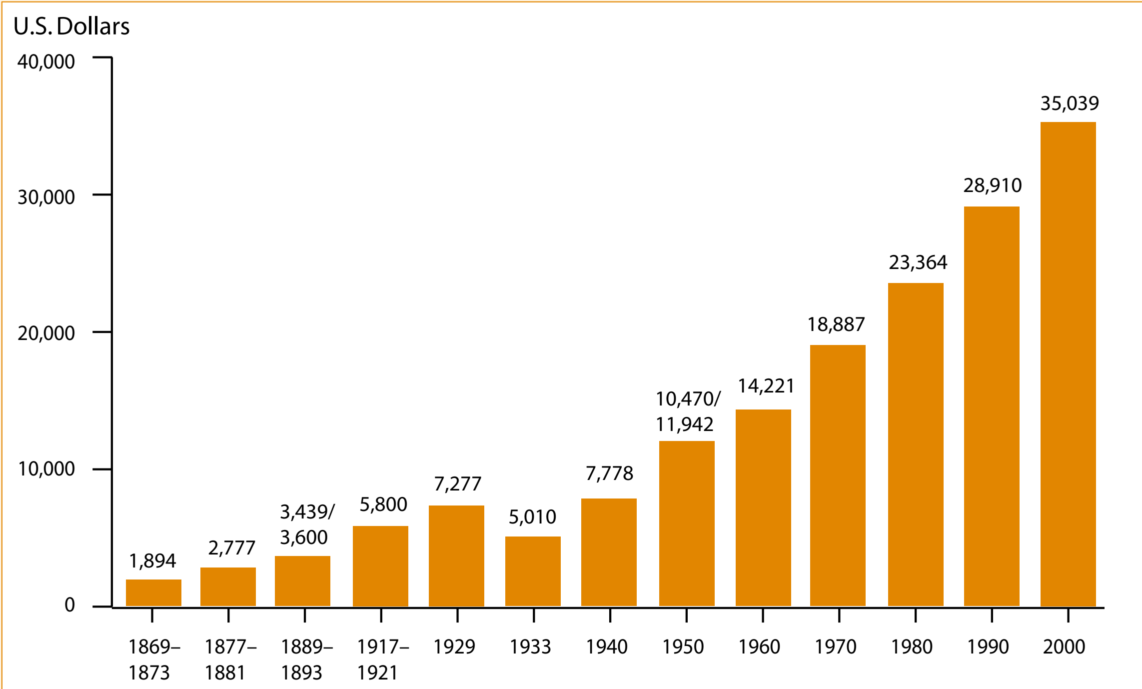
1 GDP stands for Gross Domestic Product, and GNP stands for Gross National Product

GDP measures the market value of final goods and services produced within a country's borders during a given year. Example: A new car produced by a Japanese-owned company at a factory in Kentucky would be included in the U.S. GDP figures; a new car produced by an American-owned company at a factory in Brazil would not.

GNP measures the market value of final goods and services produced by U.S. residents anywhere in the world, and it includes the income earned on foreign investments made by U.S. citizens and American-owned companies. So, GNP figures would reflect the income earned on a new car produced at an American-owned factory in Brazil.

In 1991, the U.S. Bureau of Economic Analysis began using GDP to measure the size of the U.S. economy. From 1941 to 1991, it had used GNP. GDP is the more common term now, but GNP may be used when there is a need to go back historically.

The chart below shows U.S. GNP per capita from the mid 19th century to the present. (Two values are shown for time periods in which the measurement of GNP was changed.) The chart shows *real* GNP. When GNP or GDP is adjusted for price changes, it is called *real* GNP or *real* GDP. In the chart, all data have been adjusted to reflect prices as of the year 2000.[2]



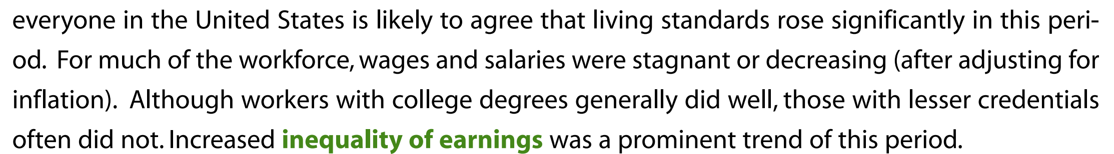
Source:
First three time periods: Kuznets in *Historical Statistics of the United States, 1960.*
Second value for 1889–1893 through first value for 1950: U.S. Department of Commerce in *Historical Statistics of the United States, 1960.*
Second value for 1950 through value for 2000: U.S. Bureau of Economic Analysis and U.S. Census Bureau.

Real GNP per capita increased nearly tenfold — 1000 percent — between 1870 and 1970, an amazing achievement. Growth was not smooth, however; for example, real GNP per capita dropped roughly 30 percent between 1929 and 1933 as the Great Depression set in.

Although the chart quantifies large gains in living standards over time, the quantification is broad-brush. The goods and services produced in the United States changed enormously over this period, making comparisons difficult. Today's television set is not yesterday's television set, and, going back further in time, there were no TV sets at all. The numbers also do not capture the tremendous improvement in well-being associated with increases in leisure or with improvements in public health and safety. (See *The Ledger*, Winter 2003, pages 4–8, for more on measuring standard of living. The URL is www.bos.frb.org/genpubs/ledger/ledger03/winter/index.htm.)

The figures also fail to tell us anything about the distribution of goods and services. Although the table shows that per capita real GNP increased about 85 percent between 1970 and 2000, not

2 Changes in real GDP or real GNP show what has actually happened to the quantities of goods and services, regardless of changes in the prices. For example, if a loaf of bread that sold for $1.00 a number of years ago is exactly the same as a loaf of bread that costs $2.00 in the year 2003, we want to value them exactly the same for real GDP/GNP purposes. So, if the two loaves of bread are exactly the same, and real GDP/GNP is being expressed in year 2003 prices, then the bread that sold for $1.00 in the earlier period is valued at $2.00 for real GDP/GNP purposes.



everyone in the United States is likely to agree that living standards rose significantly in this period. For much of the workforce, wages and salaries were stagnant or decreasing (after adjusting for inflation). Although workers with college degrees generally did well, those with lesser credentials often did not. Increased **inequality of earnings** was a prominent trend of this period.

In many cases, family incomes still rose, because more family members were engaged in work for pay. Women, in particular, were more likely to seek paid work than to perform unpaid work at home. The **labor force participation rate** of women aged 16 and older rose from 43 percent in 1970 to 60 percent in 2000. This increased labor force participation is an important factor in the rise in real GDP per capita from 1970 to 2000. It is consistent with the commonly held perception that families are having to work harder (or at least longer) in order to maintain their standard of living.

Despite these caveats, material living standards have clearly improved immensely. The increased quantity and quality of goods available to typical families over time is easily observed.

Produce More, Consume More

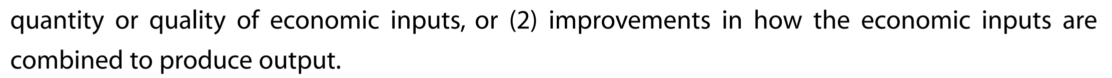
The improvement in living standards is the direct result of economic growth. Our per capita *consumption* of goods and services has increased because our per capita *production* (or *output*) of goods and services has increased. When we produce more, we can consume more.

The key to producing more per capita is higher **labor productivity**. Productivity is how much one worker can produce in one hour. For a given length of the workweek, the output of the economy is determined by the number of workers and by productivity. Increases in the number of workers will increase output but may not increase living standards. If the increase in workers is due to population growth, then the increased output is simply divided among more people, and no gain in output or consumption per capita occurs. An increase in the number of workers relative to population can boost measured output per capita, but this also may not increase living standards if it entails a loss in production at home or a sacrifice of leisure. In contrast, if the output of each worker increases, then the total value of goods and services produced will rise relative to the population. Real GNP or GDP per capita will rise. Labor productivity is, thus, the key factor in determining our standard of living.

Economic Growth Theory

To understand labor productivity and how it increases over time, it is necessary to have a rudimentary understanding of economic growth theory and accounting.

Goods and services are produced by people working with machines, equipment, structures, and the like. Economists refer to the people, regardless of the nature of their work, as **labor**; and they refer to the machines, equipment, and structures as **capital**. Together, labor and capital are called **economic inputs**. Natural resources — land, minerals, oil — are sometimes included with capital, but are also sometimes identified as a separate economic input. Improvements to land, such as buildings and highways, are considered capital. Economic growth, or the growth in the quantity and quality of the goods and services produced, occurs when there are (1) increases in the



quantity or quality of economic inputs, or (2) improvements in how the economic inputs are combined to produce output.

More machines and more worker-hours are examples of increases in the quantity of economic inputs; better machines and higher-skilled workers are examples of increases in the quality of the economic inputs. Sometimes there is no measurable increase in the quantity or quality of the inputs, but the way in which the inputs are combined is improved so that more goods and services are produced. Economists refer to this improvement as **technological change**.

While most people associate the term "technological change" with major new inventions and innovations, technological change in growth theory is a residual category. It is that part of growth that is not due to measurable changes in the quality and quantities of the inputs. It includes the effects of major changes in technology, such as the advent of electricity or the invention of the steam engine. But it also includes growth that comes from more mundane changes. Improved efficiency associated with learning-by-doing, gradual improvements in how machinery and workers are organized and utilized, and increased specialization made possible by the expansion of markets all fall into the "technological change" category.

A key measure in economic growth theory is the **ratio of capital to labor**, or **capital-labor ratio**. Labor productivity increases as the capital-labor ratio increases. As workers have more, and higher quality, equipment to use, they can produce more per hour of their time. For example, an auto mechanic can perform repairs faster if he has a full set of hand tools available than if he has to share tools with another mechanic. And he can work faster still if he has some power tools available (and faster yet if he has a diagnostic computer, a lift, etc.). When the capital-labor ratio increases, economists call this **capital deepening**.

Investing in capital does not always increase the capital-labor ratio (and labor productivity.) As the number of workers increases, new investment is needed just to equip each additional worker with the same capital as each worker had before. And some investment is needed to replace equipment and buildings as they wear out. Economists use the term **capital depreciation** to describe the wearing out of equipment and other capital.

Components of Recent Growth in Labor Productivity

Between 1970 and 2000, U.S. labor productivity grew at an average rate of just under 2 percent per year. For most of this period — that is, from 1973 to 1995 — increases in the capital-labor ratio — capital deepening — were responsible for about one-half of the growth in labor productivity. Between 1995 and 2000, the contribution of capital investment dropped to about one-third, and technological change assumed a greater role. Technological change accounted for over half of labor productivity growth between 1995 and 2000, up from just under 30 percent for 1973 through 1995.

Improvements in labor "quality" have consistently accounted for about one-sixth of the growth in labor productivity. Workers who are better trained and better educated tend to be more productive. In many cases, more advanced or more capital-intensive production techniques require more

educated or more highly trained workers to use them effectively. For example, earth moving at a construction site can be performed by workers with little education or training using hand shovels and wheelbarrows, or it can be performed by trained workers operating heavy construction equipment. Economists often speak of improvements in labor quality as investments in **human capital**. Increases in human capital typically require that people devote time to education and otherwise building their store of knowledge. This knowledge will enable them to be more productive in the future, but acquiring this knowledge requires postponing work that would permit higher consumption in the present.

Although improvements in labor quality have accounted for one-sixth of the increase in overall productivity over the past 30 years, from the personal perspective of an individual worker, education and training are much more important than this one-sixth suggests. Most people have little control over the current state of technology or pace of capital investment, but they are able to influence their own economic future through the education and training options they choose.

Two Centuries of U.S. Economic Growth

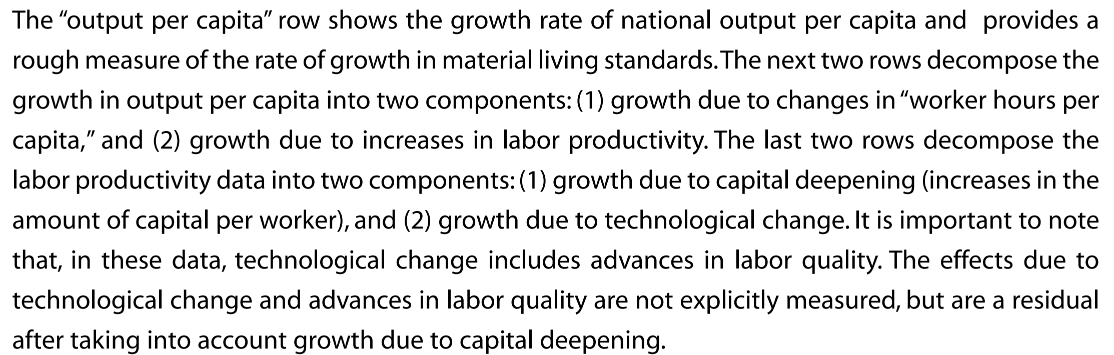
The table below provides estimates of productivity growth and its components for most of the nineteenth and twentieth centuries. Official productivity statistics are not available for most of the periods covered in the table, but these figures represent the best available estimates. They were adapted from work by two prominent researchers in this field, Moses Abramowitz and Paul A. David, working at the Stanford Institute for Economic Policy Research. One period, 1890 to 1927, is shown twice; the first set of numbers is based on nineteenth century sources, and the second is estimated using data comparable to data for the twentieth century periods.

Historical Sources of U.S Economic Growth

Average Annual Growth Rates

	Nineteenth Century			Twentieth Century		
	1800–1855	1855–1890	1890–1927	1890–1927	1926–1966	1966–1989
1 Output per Capita (Rough Measure of Growth in Living Standards)	0.87	1.47	1.74	1.94	1.73	1.84
2 Worker Hours per Capita	0.48	0.41	-0.26	-0.07	-0.78	0.60
3 Labor Productivity (Output per Worker Hour)	0.39	1.06	2.01	2.00	2.52	1.23
4 Contribution of More and Better Capital to Growth in Labor Productivity	0.19	0.69	0.62	0.51	0.43	0.57
5 Contribution of Technological Change to Growth in Labor Productivity (includes Investment in Human Capital)	0.20	0.37	1.39	1.49	2.09	0.66

Source: Adapted from Moses Abramowitz and Paul A. David, "Two Centuries of American Macroeconomic Growth: From Exploitation of Resource Abundance to Knowledge-Driven Development," Stanford Institute for Economic Policy Research, Discussion Paper No. 01–05, August 2001.



The "output per capita" row shows the growth rate of national output per capita and provides a rough measure of the rate of growth in material living standards. The next two rows decompose the growth in output per capita into two components: (1) growth due to changes in "worker hours per capita," and (2) growth due to increases in labor productivity. The last two rows decompose the labor productivity data into two components: (1) growth due to capital deepening (increases in the amount of capital per worker), and (2) growth due to technological change. It is important to note that, in these data, technological change includes advances in labor quality. The effects due to technological change and advances in labor quality are not explicitly measured, but are a residual after taking into account growth due to capital deepening.

Labor inputs. For most of the nineteenth century, hours worked per person (Row 2) were increasing. Thus, the growth in output per capita (Row 1) may overstate the improvement in the quality of life since some of this growth came because people worked more hours and had less leisure time. However, beginning in the late nineteenth century, worker hours per capita decreased — some of the benefits of economic growth were taken in the form of increased leisure time. The abolishment of child labor and the emergence of the five-day/forty-hour work week during this period reduced the growth rate of national output from what it would otherwise have been, but contributed to the quality of life.

Hours worked per person began to climb again in the 1966 to 1989 period. As noted earlier, this is the time when the female labor force participation rate increased. Increases in the labor supply —more worker hours per capita — accounted for roughly one-third of the growth in national output between 1966 and 1989, with the other two-thirds due to productivity growth.

Productivity growth. As seen in Row 3, a marked pick-up occurred in the growth rate of labor productivity in the 1855 to 1890 period. Rows 4 and 5 show that this change is associated both with more capital per worker and with a greater rate of technological change. This period was a time of increasing industrialization, as improved transportation systems (railroads) and improved communications (telegraphs) allowed for expansion of markets; and improved manufacturing techniques (for example, development of steam power and the use of interchangeable parts) made production more efficient.

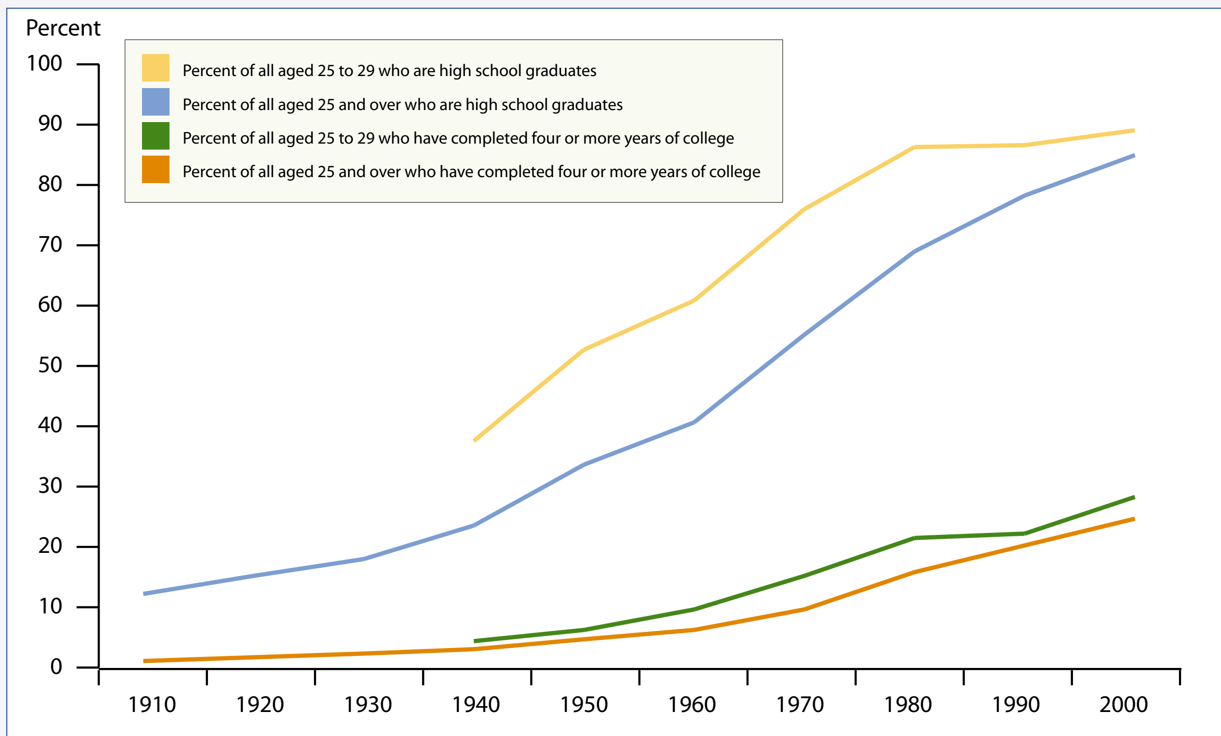
In the next time period, 1890 to 1927, further growth in labor productivity is associated with a substantially faster rate of growth in technological change. At first glance, it may seem puzzling that technological change should be so much more important in explaining productivity growth from 1890 to 1927 than in the earlier period. After all, the technological advances of the earlier period are arguably as economically important as those of the later period. Abramowitz and David have put forth a plausible explanation for this puzzle. They suggest that nineteenth century technological innovations tended to be of the labor-saving/capital-using variety, while twentieth century innovations were often capital-saving (or used **intangible capital**). In other words, nineteenth century technological improvements could be implemented only by substituting machinery for workers (using power looms rather than hand looms, for example). But twentieth century innovations were often such that intangible capital (skilled workers and knowledge gained from research and development) was used in place of tangible capital (equipment). Thus, nineteenth

century innovations tend to be reflected in Row 4 of the table, "greater capital per worker hour," because an increase in tangible capital per worker was needed in order to implement them, while twentieth century innovations are more likely to be reflected in Row 5.

Intangible capital. In the twentieth century, intangible capital became much more important than was previously the case. The chart below shows the substantial increases in educational attainment that occurred during this period.

High School and College Completion Rates of U.S. Population

Aged 25 and Over and Aged 25 to 29



Source: U.S. Census Bureau in *Digest of Education Statistics 2001*.

The expansion of public secondary education in the first half of the twentieth century did much to augment the growth rate of intangible capital. Growing university enrollments and increased resources devoted to research and development also contributed to the growth of intangible capital. The growing importance of intangible capital (especially human capital) relative to tangible (physical) capital is one of the major trends affecting economic growth in the twentieth century. Because of data limitations, the effects of human capital accumulation are incorporated into the technological change row of the table, and we cannot break out the contribution of the growth in human capital.

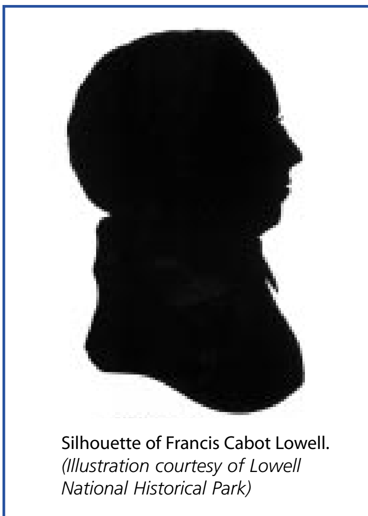
As the "Sources of Growth" table shows, productivity growth slowed in the 1966 to 1989 period. This drop in growth is associated with a decrease in the growth rate of technological change rather than a decrease in the rate of growth of tangible capital per worker hour. The reason for

the slower growth of technological change remains largely a mystery. Some of the falloff can be traced to a stabilization of educational attainment, but most of the slowing is due to other, still unknown, factors.

Invest-in-Growth Games

The three Invest-in-Growth games played in the New England Economic Adventure all involve a combination of capital accumulation and technological change. They also show the human element. Advances in productivity come about through the efforts of individuals to find better ways of doing things. In particular, entrepreneurs are often motivated by economic incentives. They see an opportunity to gain a competitive edge over rivals by developing a new product or devising ways to lower production costs. Other motivations, such as intellectual curiosity, also lead to innovations.

Textiles. The first game, focusing on the development of large-scale textile manufacturing in New England, takes place in the first time period shown in the table, 1800 to 1855. Here we see clearly the role of economic incentives. In the early years of the nineteenth century, tensions with England, arising out the Napoleonic Wars, led Congress to place an embargo on foreign trade. The embargo severely limited the activities of New England merchants and ship-owners. At the same time, it produced shortages of textiles and other manufactured goods previously imported from Europe, thereby creating an incentive to develop a local manufacturing capability. In this environment, Francis Cabot Lowell was able to persuade a number of fellow Boston merchants to invest in textile manufacturing on a large scale.



Silhouette of Francis Cabot Lowell. *(Illustration courtesy of Lowell National Historical Park)*

The textile mills incorporated a new technology — the power loom — that had been developed in England. Lowell was able to memorize this technology when he viewed it in England and arrange to have it reproduced from memory when he returned to this country. The looms and other new textile machinery made workers in factories much more productive than workers spinning and weaving cloth at home. The investment required was substantial, however. New mills and machinery had to be built from scratch. Waterpower had to be harnessed on a large scale.

Increased capital per worker (Row 4) is the primary growth mechanism at work in the establishment of New England's textile mills. But technological change (Row 5) was also important. Combining spinning and weaving in one facility was more efficient than the earlier approach whereby mills spun yarn that was then woven at home. Developing river systems to produce waterpower on a large scale meant that additional mills could be added to the site without creating new power sources. As the mill complex expanded, production costs per unit of output declined. Through the financial innovation of joint stock companies, the large sums of money needed to undertake these investments could be raised from multiple investors.

Bicycles. The second Invest-in-Growth game, featuring the manufacture and sale of bicycles by Colonel Albert A. Pope, takes place in the 1890s. The role of technological change (Row 5) is especially important in this time period. Manufacturers were becoming adept at using machines

to produce parts that were so uniform that they were interchangeable. The advantages of interchangeability had been recognized long before it was technically possible to achieve interchangeability. Years of improvements in machinery and in metallurgy were required before parts could be made with the requisite precision. These production techniques laid the foundation for low-cost mass production in the twentieth century.

Reproduction of Pope Manufacturing poster from the collection of Zip and Carol Zamarchi.

The role of intangible capital (Row 5 again) was also important in this time period. Machinists skilled in new manufacturing techniques transferred ideas from one industry to another. There were transfers from other industries, such as weapons and sewing machines, to the bicycle industry, and the bicycle industry itself laid the foundation for the motor vehicle industry. The motor vehicle industry drew upon both the production processes and the products developed for bicycles, such as pneumatic tires.

Product innovations also played a key role in the bicycle industry. The safety bicycle, with two wheels of equal size, was much more popular than the high wheeler. Women, as well as men, rode safety bicycles.

Computers. The third Invest-in-Growth game takes place in 1965 and looks at the development of the minicomputer by Digital Equipment Corporation (DEC). Technological progress (Row 5) and more and better capital (Row 4) were important at this time. Technological progress in the computer industry itself led to more powerful machines that were also smaller and less costly. As the cost of computers declined, more users could afford them and more workers were equipped with computers — more and better capital per worker. Moreover, as computers spread throughout the economy, users came up with new ways to take advantage of their capabilities. Investments in education helped create a body of engineers, scientists, and other users with the ability to develop new applications. Ken Olsen, founder of DEC, seems to have been strongly motivated by a desire to see computers used broadly, and he was confident that smart people would figure out how to use a good product.

Ken Olsen, circa 1965.
(Photo courtesy of Ken H. Olsen)

* * *

The games illustrate the increasing generality of capital. The power loom and other textile machinery of Lowell's time were built for the specific purpose of producing textiles. In Pope's era, the technology and equipment of the machine tool industry came increasingly to be adapted for producing a wide variety of products — the best example perhaps being Pope's use of a sewing machine factory for bicycle production. Coming a century after Pope's time, DEC's computers are an example of very general capital goods; DEC minicomputers were used for a wide variety of purposes and in many different industries.

The increased generality of capital and the growing importance of intangible capital continue to this day as important trends. In recent years, information technology has increasingly dominated business investment. Computer hardware tends to be general purpose, with software written for specific purposes. And as hardware prices have declined, the role of intangible capital in the deployment of information technology has become increasingly important.

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