

## CHAPTER 5

# Knowledge, Markets, and Economic Progress

THE ECONOMY OF THE UNITED STATES has generated rising standards of living for most of its history. During this century, real output increased twelvefold, while population tripled, approximately quadrupling the goods and services available to the average American. Output per hour of work doubled in the first half of the century and has since doubled again. This enormous and sustained gain in productivity has led to rapid increases in living standards. Real per capita income rose at a 1.7 percent annual rate in the first half of the century and at a 2.0 percent annual rate in the postwar period.

Long-term economic progress is assessed not only by output and productivity, but also in terms of the means and choices that allow people to enjoy full, healthy, and satisfying lives. Gains in real per capita income improve well-being, as reflected in other indicators. The infant mortality rate in the United States declined from roughly 150 per thousand in 1900 to 11 per thousand in 1987. Life expectancy increased from 47 years in 1900 to 75 years for persons born in 1987. Retirement from work, a rare phenomenon a century ago and associated primarily with ill health, is now the norm, thanks to longer lifespans and higher incomes.

Steadily rising income and its broader benefits are not inevitable. In many societies throughout much of history, living standards rose only slowly and at times even declined. Indeed, the postwar period may be unique in terms of both the high overall rate of increase in real per capita income in the world and the widespread nature of the gains. In a world linked by trade, the benefits of economic progress are shared widely. Increased productivity and growth in one country enhance prospects for growth in other countries.

This chapter examines the factors that underlie increases in living standards over the long term and considers the role of government in supporting and sustaining the determinants of economic progress. Business cycle fluctuations aside, the output available for current consumption, or for investment to augment future consumption, is determined by (1) the quantity and quality of labor, capital, and natural resources; (2) the technology used in production processes; and

(3) the mechanisms that allocate inputs in production processes and distribute goods and services to final users. Government policies enhance the rise in living standards when they encourage increases in supplies of factors of production, support the advance and application of knowledge that increases productive efficiency, and improve allocative mechanisms.

In the United States, government policies have played an important positive role in supporting increased standards of living. Constitutional and common law traditions that protect individual rights and private property have provided the foundation for freedom and economic progress. Resulting improvements in well-being continue to attract those in search of better opportunities. Individual efforts to earn maximum returns in a competitive environment promote effective allocation of resources. Individuals have powerful incentives to increase supplies of productive resources, especially their own knowledge and skills (human capital), and to develop new products and technologies that promise economic rewards. In addition, government has supported public education, which has played a critical role in increasing the supply of human capital, and has financed basic research that contributes to economic advance but may generate little private reward. Recent actions in the United States to reduce high marginal tax rates and to remove burdensome regulations, both of which impair economic efficiency and diminish incentives for growth, have strengthened prospects for further improvements in living standards. These policies also have set an example for growth-oriented policies in other countries.

Expansion of the physical capital stock is a major contributor to economic progress and productivity. During the postwar years physical capital accounted for approximately one-third of output growth and 40 percent of growth in output per hour of work. Most measures of investment include only physical capital. It is estimated, however, that human capital accounts for three-quarters of the Nation's total stock of productive capital. Thus much investment is not identified as such in standard accounts of national income. Recognizing the importance of knowledge and effective resource allocation to economic progress, studies of the sources of growth have come to include contributions of human capital, technical innovations, and shifts in productive resources.

In the past in the United States, and still in some very poor countries, investments in human capital that led to better diets and improved health increased human capacity for physical labor. Today, the forms of human capital most important for progress are those that expand skill and knowledge. Investment in education, training, and work experience increases productivity and earnings. Individuals,

families, and businesses gain directly, and society at large benefits indirectly. The widely shared benefits of investment in human capital, and problems in borrowing to finance it, suggest that government should encourage such investment. The strong incentives of individuals and families to invest in the most useful forms of human capital also suggest the value of individual choice and market allocation mechanisms. Investments in human capital, and the government's role in promoting them, are the main issues discussed in the first major section of this chapter.

Advances in scientific and technical knowledge and their application to the development of new products, services, and technologies are widely recognized as important for economic progress. Without definition and enforcement of property rights that allow discoverers of valuable new knowledge to reap at least part of the benefits, incentives for these socially valuable activities would be inadequate. Governmental support also is needed for advances in knowledge in areas that are public by their nature, such as national security. As with investment in human capital, economic incentives are critical in allocating resources to research and development. These are the main issues discussed in the second major section of this chapter.

Finally, one of the key advantages of a competitive market system is its ability to respond quickly and appropriately to the rapidly changing conditions that accompany high rates of economic progress. Interventions that slow necessary adjustments in a dynamic economy are impediments to economic growth. Governmentally imposed barriers and distortions that diminish incentives for work, investment, and innovation, or that divert resources from their most productive uses, are further barriers to progress. In particular, growth often requires reallocations of labor. Policies intended to reduce adjustment costs and protect existing jobs often can reduce employment and stifle growth. The harmful effects of such policies and the benefits of a more flexible, market-oriented approach to economic adjustment are the main subject of the third major section of this chapter.

## HUMAN CAPITAL

The United States devoted roughly \$500 billion in 1987 to gross investment in formal education. Another \$100 billion was spent for worker training, not including informal efforts to improve skills and performance on the job. Investment in human capital is thus more than one-third larger than the approximately \$440 billion spent last year for gross private nonresidential investment in physical capital.

Human capital investment has contributed substantially to the productive capacity of the labor force and the growth of the U.S. economy. Recent studies indicate that, in the postwar period, increases in human capital have contributed 10 to 20 percent of real output growth and a similar percentage of the gains in output per hour of work.

Over the last 40 years, the education and skill of the U.S. labor force has improved continuously but unevenly. An index of human capital, primarily representing schooling and work experience, developed by the Bureau of Labor Statistics (BLS), grew at an average rate of about 0.25 percent per year over the postwar period. During the mid-1970s, as many new workers entered the labor force, the average human capital per worker stopped increasing. In contrast, during the 1980s this index has grown by almost 0.5 percent per year.

#### INVESTMENTS IN EDUCATION, TRAINING, AND WORK EXPERIENCE

Aggregate rates of human capital investment are affected by population growth and the age distribution of the population. In the United States, both the population and the labor force have grown steadily. Better health and increased longevity have increased potential years of working life. Demographic changes, such as the aging of the baby-boom generation, and labor market trends, such as increased employment of women outside the home and earlier retirement, also have affected patterns of schooling, training, and work experience.

##### *Education*

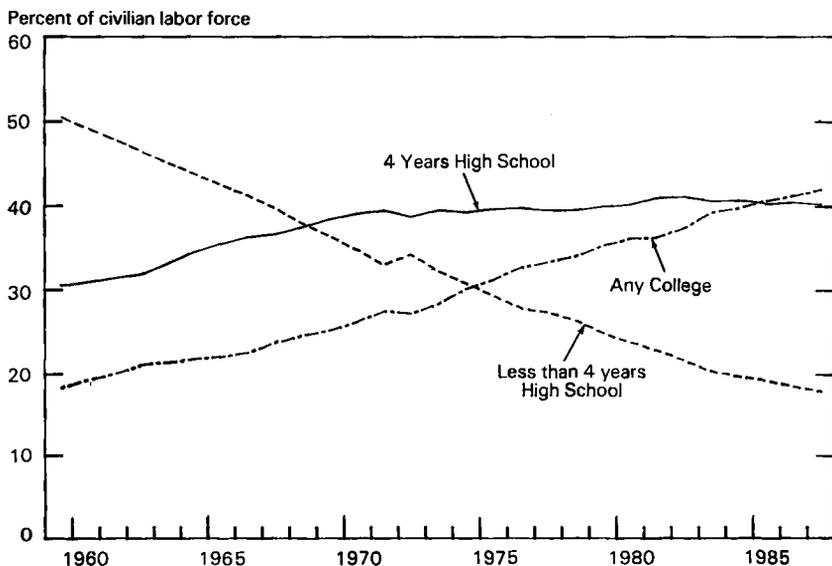
Direct annual expenditures for schooling, public and private, are currently about \$310 billion. About 60 percent, or \$185 billion, is spent on grade schools and high schools and the rest on post-secondary schooling, which includes vocational schools as well as colleges and universities. Expenditures for schooling have remained in the range of 6 to 7 percent of gross national product (GNP) for two decades, after having risen rapidly during the schooling of the baby-boom generation. The number of students has declined from a peak of almost 61 million in the mid-1970s to just under 58 million in the mid-1980s.

A large component of total investment in schooling at the higher levels, in addition to direct costs, is the forgone earnings of the students themselves. The time and effort devoted to study could otherwise be spent at work or leisure. The forgone earnings of students aged 16 and over are estimated to be about \$200 billion per year, most of which is accounted for by post-secondary students. The share of total social costs of education attributable to the postponed earnings of students has increased in recent years, because a larger

proportion of schooling is for post-secondary students with higher potential wages. In the early 1970s about 15 percent of the student population was enrolled in post-secondary schools, compared with 23 percent today.

Increases in years of schooling of the labor force are indicated in Chart 5-1. During the last 30 years the percent of the labor force not completing high school has fallen by more than half, while the percent having attended college has more than doubled. These trends have occurred primarily because retirees have had relatively little schooling. High school completion rates have been fairly stable for a decade at about 85 percent of persons 20 to 24 years old, and the proportion of persons 25 to 29 years old with 4 years or more of college has remained about 22 percent.

Chart 5-1  
Years of Schooling of the Labor Force



Note.—Data are for March and relate to highest years of schooling attained.  
Source: Department of Labor.

Data on hours of work by educational level and gender indicate that the amount of schooling has increased for both male and female workers, but more so for males. The BLS estimates that in 1948 two-thirds of the hours worked by men, and more than half the hours worked by women, were accounted for by those with fewer than 12 years of schooling. These proportions have declined to 17 percent for men and 13 percent for women. In 1948 only about 12 percent of

total work hours were accounted for by those with more than 12 years of schooling, compared with more than 40 percent now. Currently, about 25 percent of work hours of men and 18 percent of work hours of women are performed by those with 16 or more years of schooling.

Years of schooling and expenditures are inputs to the process of acquiring human capital; they do not measure learning. A variety of measures have documented the decline in the academic achievement of American students at every level during the 1960s and 1970s, with evidence of partial reversal of this trend in the 1980s. Some of the decline of Scholastic Aptitude Test (SAT) scores in the 1960s can be attributed to the increasing proportion of high school students taking the test. But in the 1970s the proportion taking the test declined while scores continued to fall; now the proportion of students taking the SAT is rising again, and scores are rising.

Concerns about student achievement are due not only to evidence of academic declines, but also to indications that achievement has been low relative to perceived requirements for success in today's economy. Although basic literacy rates have increased steadily during this century, a number of surveys document low reading comprehension and other academic deficiencies among U.S. students compared with students in other countries. Young Americans score particularly poorly in science and mathematics. Yet evidence indicates that mastery of these subjects is useful in many occupations, not only in science and engineering.

Not all of the benefits of education are reflected in increased productivity and earnings. Education may contribute to a person's well-being in other ways as well. For many people, learning is enjoyable. Formal education contributes to continued learning. Education also provides information and skills that encourage fuller appreciation and enjoyment of science, art, and culture, as well as effective participation in public affairs. Schooling contributes to more efficient household management, to better health and nutrition, and to the higher educational achievement and earnings of one's children.

The clearest relationship between education and economic success is indicated by earnings patterns. Workers with more schooling consistently earn more. In 1986, for example, the median income of persons with only an elementary school education was about \$9,000 per year, compared to high school graduates' median income of about \$20,000. Persons with 4 or more years of college had median incomes of about \$33,000.

As Table 5-1 indicates, after declining in the 1970s, the relative incomes of those with more education increased in the 1980s. During this decade, incomes of those with fewer than 4 years of high school

have declined compared to high school graduates, while the relative incomes of college-trained workers have risen. Thus the returns to investments in schooling have increased. Gains have been especially pronounced for younger workers, who will continue to benefit from more schooling for many years.

TABLE 5-1.—*Relation of Income and Education, Selected Years, 1969-86*

[Index, income of high school graduates = 1.00]

Years	Males			Females		
	1-3 years high school	1-3 years college	4 years college <sup>1</sup>	1-3 years high school	1-3 years college	4 years college <sup>1</sup>
1969-71.....	0.89	1.16	1.39	0.84	1.17	1.44
1974-76.....	.87	1.09	1.28	.82	1.14	1.33
1979-81.....	.83	1.08	1.26	.82	1.14	1.30
1984-86.....	.81	1.12	1.37	.78	1.16	1.39

<sup>1</sup> Excludes those with more than 4 years of college.

Note.—Data are 3-year averages of indexes of median annual income for year-round, full-time workers, aged 25 and over. Source: Department of Commerce, Bureau of the Census.

Changes in relative earnings are due to cyclical and demographic factors and to longer term economic changes. People with more schooling, for example, usually are more able to maintain employment and earnings during recessions. The relative earnings of college graduates declined during the 1970s as the highly schooled baby-boom generation entered the labor market, but they rose recently as this group gained experience in the 1980s. Over the longer term, increased demand for technical and managerial skills may be expected to raise the future relative earnings of workers with more education.

Earnings are higher for those with more years of schooling for reasons other than the productive value of education. Personal characteristics such as ability and effort, which contribute to success in both school and the workplace, account for some of the earnings differential. Higher earnings also are associated with factors such as parental income, gender, race, and geographic location. Research has confirmed, however, that schooling raises earnings even after accounting for the effects of these other measurable factors.

Estimated real private rates of return for investments in schooling in the United States have been 10 to 13 percent for secondary schooling and 8 to 10 percent for higher education during the 1970s and early 1980s. These estimates may be biased upward, because they cannot fully adjust for workers' ability and effort. Recent increases in relative earnings for more educated workers, however, suggest that estimates based on data from the mid-1980s would show even higher rates of return. Studies during the last 30 years consistently have shown that rates of return on investments in education

have been comparable to those available on alternative long-term investments.

A number of studies have shown that schooling increases earnings for managers and the self-employed, as well as for employees, and have suggested that the benefits of schooling are greater in more dynamic economic environments. More schooling for farmers, for example, increases the payoff from agricultural research, increases the rate of adoption of innovative technology, and reduces the lag between price changes and appropriate market responses. Returns to schooling are higher in industries with more technical progress and productivity growth.

Workers with more schooling not only have higher earnings but also safer, more comfortable working conditions and lower rates of unemployment. The unemployment rate for workers with fewer than 4 years of high school is double that for workers with 4 years of high school. Workers with a college education had unemployment rates of less than 4 percent throughout the last 15 years, and they experienced smaller cyclical swings in unemployment than those with less schooling. But increased schooling of the labor force has not resulted in lower overall unemployment rates; unemployment rates of all schooling groups have risen over the last 20 years (Chapter 2).

#### *Training and Experience*

The human capital that workers accumulate while employed includes formal training and learning-by-doing. Post-school training is pervasive in the United States. About 40 percent of workers report having taken training to improve their job skills. Workers with more years of schooling also acquire more training on the job.

While much on-the-job training is of general value, some has value only in a specific firm. The worker bears the cost of general training, usually in the form of lower wages, because its value will be fully reflected in wage growth, whether the worker stays at the current firm or goes to another. The cost of firm-specific human capital investment is borne jointly by the worker and the firm, and the benefits of future productivity improvements are shared. Thus firm-specific investments encourage both the worker and the firm to maintain the employment relationship. Conversely, when job tenure is expected to be long, both the worker and the firm have more incentive to invest jointly in training.

The investment in formal, employer-sponsored training has been estimated to be about \$60 billion per year and has been rising. About half this total reflects the wages and forgone output of employees receiving training. The \$60 billion does not include the value of reduced wages that workers accept for jobs that offer training, nor

does it include the informal, everyday activities of workers and firms to improve productivity.

In addition to schooling and training, the work experience of the labor force is an important source of productive human capital. Unpublished estimates by the BLS indicate an increase in the approximate years of work experience for private business workers from 17.4 years in 1950 to 18.1 years in 1964. Since 1964 average experience has fallen by more than 15 percent to 15.3 years in the mid-1980s. For men, average work experience has fallen by about 10 percent since peaking in the late 1950s, and it has held steady at about 17.6 years in the 1980s. The average work experience of women rose by about 15 percent between 1950 and 1965, to 13.2 years. In the late 1960s and the 1970s, many young women entered the labor force, and average experience fell back to about 11.6 years, where it has remained since about 1980.

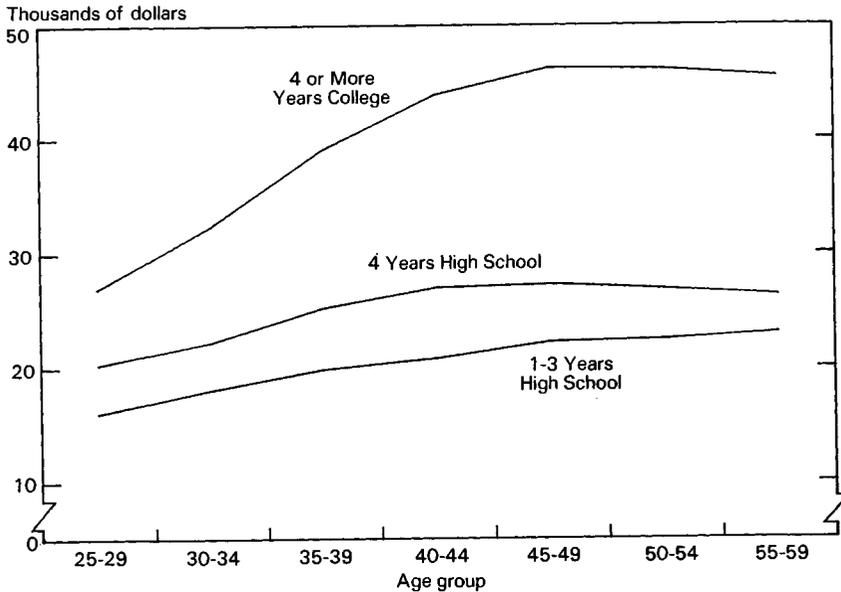
Four major demographic and labor market factors have contributed to these changes in work experience. First, more years in school have meant that workers enter the labor force at a later age. Second, with the labor market entry of the baby-boom generation during the 1970s, the age distribution of the labor force has shifted dramatically toward younger workers. Third, men are leaving the labor force at earlier ages than in the past. In 1948 about half the men 65 and over and 90 percent of those 55 to 64 were in the labor force. In the 1980s less than 20 percent of men 65 and over and about 70 percent of those 55 to 64 are labor force participants. Fourth, the share of women in the labor force has risen from less than 30 percent in 1948 to 45 percent today, and women generally have had less work experience than men.

Wages tend to rise with age through most of work life. Chart 5-2 shows that older workers have higher earnings and also that earnings rise faster and peak later for those with more schooling. This increase in wages over work life has become more pronounced during the 1980s. Younger workers are paid less, because they devote more time and effort to on-the-job learning. Their wages also rise as training and experience increase productivity. Some of the wage gains associated with experience are due to workers' finding employment that better matches their skills and interests. Younger workers change jobs frequently while they learn about the labor market, occupations, and particular jobs, and while employers learn about the capabilities of particular workers. Job or occupation change is part of a search process, and when a better job match is found, earnings and profits improve.

Work experience and training of the U.S. labor force will rise for the next two decades as a result of the large group of workers now

Chart 5-2

## Earnings by Age and Education



Note.—Data are mean annual earnings of male year-round full-time workers, average for 1984-85 in 1985 dollars.

Source: Department of Commerce.

gaining experience and the smaller group of young workers entering the labor market. These demographic factors should contribute to reduced unemployment and improved productivity growth.

#### RATIONALES FOR GOVERNMENT SUPPORT

Human capital investment contributes to the well-being of individuals and to the long-term performance of the economy. But economic returns alone do not imply that the government should regulate or subsidize investment. Government involvement in human capital formation is predicated on three premises. First, there are major social benefits to increased levels of education that are not fully realized in the returns to individuals. Second, government support of human capital investment widens economic opportunity. Third, there are particular difficulties in private financing of investment in schooling.

Social, political, and economic interaction is facilitated by a common language, basic skills, and shared knowledge. A broad base of educated individuals allows for a more efficient economy and a more viable democratic system. The effectiveness of the military,

moreover, is enhanced by a higher level of general knowledge and skills in the population, especially as national security relies increasingly on complex technology. These broad societal benefits of education provide one rationale for government funding and regulation of primary and secondary schooling.

Giving every child the opportunity for an education is considered necessary for a democratic society. Human capital contributes to individual earnings, and public support for schooling has been used to widen economic opportunities. Government support for human capital investment is also one way to help reduce dependence on other transfer programs. Most Federal funds devoted to education and public training programs are directed toward people with low incomes.

Private financing of human capital investment is relatively difficult, because most such investments are made by the young, and human capital itself cannot serve as collateral. For other investment opportunities, one can usually borrow funds by demonstrating profitability and pledging the investment itself as collateral, but for investments in schooling it is difficult for a lender to enforce repayment. Thus schooling generally is financed by the assets or income of parents or other family members. Parents commonly borrow to finance investments in their children's human capital. Adult students use their own resources, and if continued employment is assured, they may be able to obtain assistance from their employers. For individuals with insufficient access to private resources, there may be grounds for public support to help secure financing for education.

Public support for worker training generally is not provided, because training is funded jointly by the worker receiving lower wages and by the firm paying direct costs and allowing work time to be used for learning. Workers and firms realize the rewards from investments in job training through increased future wages and productivity.

#### POLICY ISSUES

Public policy affects all human capital investment, directly through government spending or indirectly through taxation and regulation. Education is the third largest object of government spending, after national defense and social security. State and local governments provide most of the public spending for education. The Federal Government pays about 6 percent of the approximately \$185 billion annual direct cost of primary and secondary education, and about 12 percent of the approximately \$125 billion in direct costs for higher education. Federal spending for training programs is about \$5 billion. The Federal Government also provides training for its own em-

ployees, spending close to \$20 billion each year for military training alone.

Government operation of schools is not a necessary consequence of government support of education. At the primary and secondary levels, State and local governments both fund and manage school systems. In post-secondary education almost all Federal support is provided to the student directly, allowing choice among public and private institutions. State government support of higher education also allows wider individual choice than at the lower levels.

#### *Primary and Secondary Education*

Poor achievement levels in primary and secondary schools have neither obvious causes nor simple remedies. Schools and teachers differ in their effectiveness, but there is no consensus on the underlying reasons. Low quality of teachers, low spending on teachers relative to school administration, curricula that fail to stress basic academic subjects, inadequate school discipline, poor early childhood preparation, and home environments that fail to encourage learning are among the suggested explanations.

Increased spending has not been effective in improving student performance. Public school expenditures per student rose steadily and most rapidly as student achievement was declining. In the early 1980s real spending per student was more than double that in 1960. Student-teacher ratios have fallen and the education and experience of teachers have increased, but none of these changes has been linked statistically with better student performance.

State and local school districts have introduced a number of reforms to promote quality. Some school systems have required students to meet minimum standards, and some have rewarded teachers for gains in student achievement. Many States have instituted state-wide testing for high school graduation, and some withhold funds or exercise other sanctions when local school districts have poor records of academic progress. Several States are using alternative certification to attract new teachers who are proficient in their subject but lack the required coursework in teacher education. Such flexible certification gives school systems wider latitude in hiring teachers and removes barriers that prevent skilled people from entering teaching.

A dominant role for State and local governments is consistent with principles of federalism. Traditionally, Federal spending for primary and secondary schooling has been quite limited and directed toward the disadvantaged. Close to \$4 billion per year is provided to State and local school districts to serve low-income students. Other major Federal programs support vocational, bilingual, and special education.

The Federal Government also supports research and the dissemination of information on student achievement in order to encourage choice and accountability in the Nation's schools. The ability of families to choose the schools their children attend is a critical factor in improving the quality of education. This Administration has proposed legislation and supported reforms that would encourage wider opportunities for parental choice and greater accountability in education assistance programs. More scope for choice would provide incentives for schools to improve. In school systems that are accountable for the quality of education, special programs and good reputations attract students. Schools that perform poorly face declining enrollments and reduced budgets. Magnet schools provide an alternative that incorporates parental choice, allowing parents and students to select among particular schools in a public school district.

One direct way for government to encourage schools to respond to demand for better education would be to provide financial support directly to families through vouchers. Families could use the vouchers at any school that meets basic standards. Voucher-type programs currently are used in Federal food and housing assistance programs, medicare, and in higher education. The GI Bill, which is an example of a successful Federal educational voucher program, has helped many veterans complete schooling, receive vocational training, and increase their earnings capacities. Competition among schools for students and support provides market incentives lacking in the current system of government-operated schools. Even partial voucher systems allowing choice among public schools would offer substantially increased competition and accountability, thereby promoting educational achievement.

#### *Post-Secondary Education*

Many U.S. institutions of higher education are operated by State and local governments. These institutions provide subsidies to local residents and others in the form of low tuition. Private operation and funding, however, play a much larger role than in primary and secondary schooling. Private schools account for close to one-third of total college and university expenditures, and proprietary schools are a major source of formal occupational education. State systems allow a large degree of student choice. Thus the higher education system in the United States, in contrast to primary and secondary education, has allowed students and their families some choice among institutions, thereby encouraging higher quality. One measure of the success of this approach is the large and growing number of students from other nations that choose to study in this country.

Consistent with the policy emphasis on choice and accountability, the major Federal programs in post-secondary education provide aid

directly to students. In the last decade the number of student aid grants has increased by more than 65 percent. The largest Federal expenditure for support of post-secondary education is in the form of grants to low-income students. Close to \$4 billion in such grants was provided in 1987. The Guaranteed Student Loan Program makes funds available by providing government guarantees to banks and other private lending sources. More than \$9 billion annually is borrowed under this program. Students are responsible for repayment of principal and interest (after the period of schooling), but the Federal Government guarantees repayment if students fail to meet their obligations. These loans carry interest rates far below those that would be required without Federal backing. Other aid in the form of loans, work-study programs, and grants is provided to students through the educational institutions themselves.

Student loan defaults cost about \$1.5 billion in 1987. A large proportion of defaults are concentrated at relatively few schools. Student loan default rates exceed 50 percent at more than 500 schools, which make up about 7 percent of the post-secondary institutions that participate in loan programs. By more strongly encouraging the repayment of loans, the Federal Government can increase the amount available for investment in education. Sanctions now are applied to students, but incentives for schools to provide better monitoring and better education also should help encourage loan repayment.

#### *Worker Training*

Workers and firms invest in job training and retraining to obtain the future private returns that result from increased productivity. Many government policies influence investments in job training and experience. Direct government support of training programs is intended to raise the earnings capacity of the disadvantaged and to ease the adjustment of displaced workers to new jobs. During the last 25 years the Federal Government has spent more than \$115 billion on training and related programs, including classroom training, training on the job, and job search assistance, but there is no consensus that these training programs have significantly increased the earnings of participants. Past evaluations have been inconclusive, partly because of methodological problems. Evidence suggests that training for the disadvantaged has improved the earnings of adult women, but it has had little, and perhaps even adverse, effect on the earnings of youths and adult males. This Administration has encouraged recent efforts to develop more effective training programs with designs that facilitate better evaluation.

### *Education in Science and Engineering*

Private and social returns to education and training are affected not only by the years of schooling but also by the student's field of study. Undergraduate specialization in engineering, for example, generally leads to high earnings. Because they can command high starting salaries, engineers are less likely to postpone labor market entry and forgo current earnings in order to pursue post-baccalaureate education. As a result, most Americans with the requisite abilities and interest do not pursue masters or doctoral training. Post-baccalaureate study in the sciences and engineering, however, is vital for research and innovation. A major factor in maintaining the high level of research and development (R&D) activity in the United States is the attraction of U.S. graduate programs for students and scientists from abroad, about half of whom remain to pursue careers in this country. Foreign students comprise a growing proportion of full-time graduate students in science and engineering, having risen from 17 percent of the total in 1977 to 27 percent in 1986.

Most people who complete doctoral degrees in science and engineering pursue careers in research, for which much of the funding is provided by the Federal Government. This close link has encouraged Federal support for graduate studies and post-doctoral training in the sciences. The Federal Government provides fellowships and part-time employment for graduate students in federally funded research projects carried out under the supervision of faculty or other senior researchers. Some of the Federal support for post-baccalaureate training is similar to the joint funding of specific on-the-job training by firms and workers in the private sector. Since the Federal Government is a large consumer of R&D, it captures some of the benefits from training through a larger supply of scientists and engineers. Furthermore, R&D carried out in the private sector may have benefits that extend broadly through society.

### SCIENCE AND INNOVATION

Research and development leads to scientific discoveries and new technologies that enhance economic progress. In the United States private and public expenditures for formal R&D have reached more than \$120 billion per year. The contribution of this investment to the productivity of the economy and the quality of life is large and pervasive.

Research and development usually is divided into three categories: basic research, which investigates scientific questions with no readily foreseeable applications; applied research, which is intended for application; and development, which aims to produce particular prod-

ucts or processes. Formal investments in knowledge are described largely in these terms, but the distinctions are somewhat arbitrary. Solving problems of development can shed light on basic scientific problems, and some firms undertake basic research in hopes of eventual commercial applications. In addition, many informal R&D efforts are not measured as R&D.

Technological progress, which is at least partly a result of formal and informal R&D investments, has led to higher incomes, better working conditions, and a greater variety and abundance of products. Standard productivity measures, however, cannot capture many of the most visible improvements made possible by advances in science and technology. Much publicly supported R&D, for example, is devoted to public goods such as national defense and public health, the benefits of which are not measured as increased productivity. Even R&D that helps create better products and more efficient production processes provides benefits that are not easily measured, such as improvements in computers and calculators.

#### EXPENDITURES AND RETURNS

U.S. expenditures for R&D have increased considerably in real terms since World War II, as shown in Chart 5-3. Expenditures grew at about 9 percent per year from 1941 to 1967, when they abruptly leveled off. Since 1977, expenditures have been rising again with rapid growth of defense R&D, growth of privately sponsored industrial research, and restoration of government support for basic research. For the last 10 years, total real R&D expenditures have been growing at a rate of approximately 5 percent per year.

##### *Private Investment*

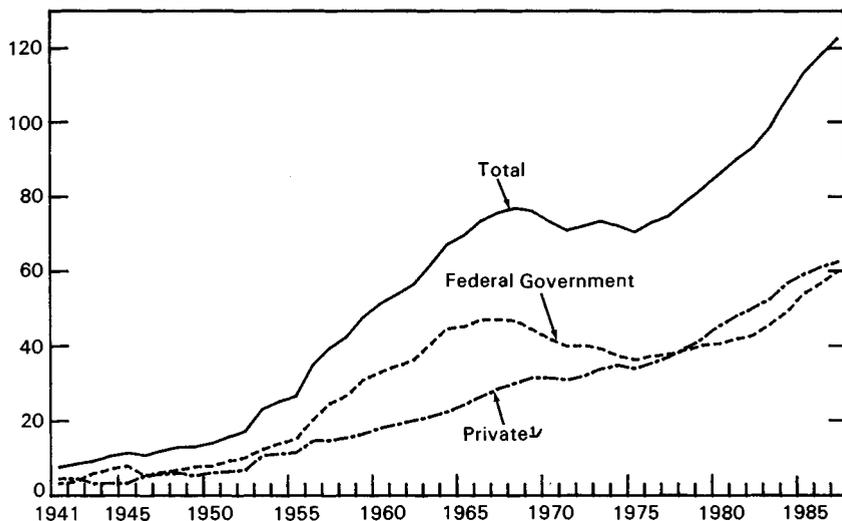
In 1987 approximately half of total national R&D expenditures were funded by private sources, up from about one-third in 1965. For the last 15 years private sources have provided more than two-thirds of U.S. expenditures on industrially performed R&D. About three-quarters of funding for nondefense R&D is provided by private sources, and about 20 percent of funding for basic research is private. The emergence of the private sector as a major provider of R&D funding is one of the most important developments in science and technology in the last two decades.

Private R&D has a strong relationship to economic growth. According to one study, from 1948 to 1985 private R&D investment accounted for an estimated 7 percent of growth in output per hour of work and about 13 percent of growth in productivity in the nonfarm business sector. Estimates of rates of return to private R&D vary considerably, but are consistently high. Privately funded basic research

Chart 5-3

## Research and Development Expenditures

Billions of 1987 dollars



∩ Private includes a small amount of State and local government funds.

Note.—GNP implicit price deflator used to deflate expenditures.

Sources: Department of Defense (1941-52) and National Science Foundation (1953-87).

has particularly strong effects on productivity growth, in part because its results raise the overall level of technology in an industry.

The gains to society from private R&D that are not captured by the firm performing it are significant. Knowledge produced by private R&D spreads first to technologically related firms and then throughout the economy. Patent studies reveal that firms whose technological neighbors invest relatively large amounts in R&D produce more patents per dollar of their own R&D and have higher rates of productivity growth than do firms in less research-intensive environments. Firms cannot simply adopt research, however; they generally must do a certain amount of research themselves to be able to take advantage of knowledge that other firms produce.

The extensive spillover benefits from private R&D are also apparent in the fact that firms often imitate the innovations of their rivals. One study found that 60 percent of patented inventions had been imitated within 4 years. The fast depreciation of patent values confirms that knowledge created by research and innovation spreads quickly and can be appropriated by other firms.

### *Federal Support*

Federal spending for R&D was about \$60 billion in 1987, almost half of the national total. In addition, a special tax credit is intended to encourage private investment in research. Defense R&D has increased from 51 percent of Federal R&D spending in 1977 to 69 percent today. From 1980 to 1987 Federal spending for basic research (defense and nondefense) increased by about 25 percent in real terms to \$9.7 billion. During the same period nondefense basic research grew from 28 to 46 percent of Federal nondefense R&D.

From the late 1940s to the mid-1960s, federally sponsored R&D advanced mainly defense and space technology. From 1967 to 1977 overall Federal funding for R&D slowed, but larger amounts were devoted to health and applied research, especially in the social and environmental sciences. Applied energy research and demonstration projects, heavily funded in the 1970s, have been curtailed in recent years as unproductive and inappropriate objects of Federal support. Recent concerns about international competitiveness, health, and national defense have prompted a surge in Federal support of basic and defense research.

Returns to federally sponsored research are sometimes dramatic and easy to see. Federal investment in satellite technology, for example, revolutionized the communications industry. Federal expenditures on defense and medical research help prevent war and improve health, but these results, by contrast, are more difficult to quantify. The results of basic research diffuse gradually into industries and lead to increased innovation. One study of commercial innovations in chemistry has found that university research, which was largely federally funded, accounted for a large proportion of footnotes in the scientific articles that announced the innovations.

The most direct measurement of returns to Federal R&D tries to discern its effect on productivity, taking R&D (along with labor and capital) to be an input, and production of goods and services to be the output. Such studies have not shown a strong relationship between industrial productivity and Federal R&D. One study has found a rate of return of only 1.5 percent to Federal R&D, compared to returns to private R&D of between 9.2 and 33.4 percent. These meager results have been questioned as a measure of the contribution to overall well-being, however, because most Federal R&D is directed toward public goods that do not generate significant private returns. In some areas, such as agriculture and health, returns to Federal R&D appear to be robust. If public expenditures stimulate private R&D, moreover, a portion of the high returns to private R&D could be attributable to complementary Federal research. Studies of wheth-

er Federal R&D increases private R&D have yielded conflicting results.

Case studies of Federal R&D also have attempted to measure returns to investment. Some have shown high returns to particular Federal R&D investments, but these results cannot be generalized. It is difficult to assign R&D inputs, especially in basic research, to the appropriate outputs. Furthermore, researchers tend to study successful R&D projects and may fail to account adequately for the costs of unsuccessful efforts.

#### *International Comparisons*

Because of intense competition in international markets, the level of U.S. investment in R&D has been questioned. The United States invests far more in R&D than any other country in the free world, spending more than two and one-half times as much as Japan, the next largest investor. The United States, Japan, West Germany, France, and the United Kingdom all devote about 2.5 percent of GNP to R&D. If defense R&D is excluded, Japan's and West Germany's outlays relative to GNP are higher than those of the United States by nearly 1 percentage point. The United States leads Japan and West Germany, however, in the ratio of nondefense R&D expenditures to manufacturing sales. The U.S.S.R. reportedly devotes the largest share of GNP to R&D. The productivity effects of this spending, much of which is probably military, appear mixed.

In part because of its large investments, the United States sells much more in R&D outputs, such as patent licenses, plans, and blueprints, than it buys. The balance of U.S. receipts minus payments for royalties and fees has grown 3.4 percent annually in real terms from 1961 until 1986, reaching almost \$1.7 billion in 1986. Relatively large amounts of technological knowledge enter the United States in the form of improved products, and large amounts diffuse out in the form of licensed technology. Another indication that scientific knowledge is an important U.S. export is the large role American universities play in training scientists and engineers from other countries.

The United States has led the worldwide advance in science and technology for many years, but the size of the U.S. lead has diminished. The number of patent applications made abroad by U.S. citizens, for example, fell by about half between 1969 and 1982, while Japanese external patent applications grew by almost 55 percent. The U.S. real trade balance in high-technology products, often used as an indicator of competitiveness, fell by \$41 billion (1987 dollars) between its peak in 1980 and 1986. This decline, however, coincided with a large increase in the value of the dollar and a decline in all other trade sectors.

The term "competitiveness" suggests to some that growth in one country disadvantages others. In fact, the United States gains from scientific and technological progress made by other countries. That penicillin was discovered in England and relativity in Switzerland does not diminish their contributions to U.S. health and scientific understanding. Advances in science and technology, which diffuse into and out of the United States and every other country, would be deterred by the closing of national borders to the transfer of knowledge.

The decrease in the the U.S. lead in science and technology has prompted some to call for increased government support for R&D. It is not clear, however, that U.S. firms invest too little in R&D or that their returns are not competitive. One recent study has suggested that applied R&D yields a higher return to Japanese firms, which in some industries may be better than U.S. firms in transforming externally produced technologies into marketable applications. Both the levels and overall returns to R&D investment in the United States, however, compare favorably to those in Japan. Another study of American and Japanese manufacturing firms found that Japanese firms spend about the same amounts on research relative to sales as U.S. firms, and they appear to gain similar returns.

#### ROLE OF GOVERNMENT

Because returns to investments in knowledge are difficult to measure, government research policy has no straightforward guide. Private firms must estimate the appropriate levels of R&D under conditions of greater uncertainty than is common for other kinds of investment. Private firms, however, unlike governments, both bear the costs and realize the gains from their investments in knowledge. The costs of government research, by contrast, are borne by taxpayers, while the benefits accrue to the public at large or to particular industries or firms. Private firms have incentives to invest the amount that produces the greatest net return, but governments do not face similar incentives or constraints. Thus governments usually can encourage R&D most efficiently by defining and enforcing property rights so that private researchers and their sponsors can undertake such activities profitably.

Providing incentives for R&D often involves extending the application of property rights in new ways. The definition of property rights in the use of satellites and their orbits, for example, has advanced telecommunications substantially. The definition of new property rights creates incentives for continued technological advancement that leads, in turn, to the more productive use of resources.

Defining property rights to research in a way that creates incentives for private firms to sponsor it is sometimes difficult or impossible. Purely basic research, for example, creates new knowledge that spreads into the world at large, improving life in unpredictable ways. Experience suggests that payoffs from basic research can be very high, even if they cannot be fully anticipated. The basic research that unraveled the molecular structure of DNA (deoxyribonucleic acid), for example, led to the birth of a new industry—genetic engineering. Individuals and firms that sponsor research can expect to capture only a fraction of the total yield it produces. One study estimates that the social returns of industrial innovations are about double the private returns. Firms tend to invest only where their gains are expected to cover costs. Thus, for basic research that produces unpatentable but potentially valuable new knowledge, an absence of public support would leave social benefits unexploited. The appropriate amount of basic research, the desirable level of public support, and the best allocation of resources among competing research opportunities are difficult to determine. Policymakers must estimate the prudent level of investment without exact quantitative evidence of rates of return, weighing the costs of diverting resources from productive private uses.

Firms sometimes may capture significant returns from research even without well-defined rights to innovations, if the research is applied to a product or service for which they represent a large share of the market. A very large computer firm, for example, may find it profitable to invest in relatively basic research on superconductivity, because it may hope to create highly profitable new products on the basis of resulting innovations.

If no single firm has a large enough share of the industry to fund research profitably, users of that research may form organizations to sponsor it. Private cooperative research efforts in the computer industry and voluntary organizations of farmers that fund research on plant disease are examples.

For potential innovations with many beneficiaries, however, the costs of organizing and operating a voluntary organization may be high, and access to the innovation by nonparticipants may be almost impossible to preclude. Compulsory funding through specific taxes or, if benefits are broad and indirect, through general funding is then sometimes used. Government funding of relatively basic, agricultural and health research often is justified in these terms.

Public goods that require large research inputs present a much clearer case for government support. Projects such as the superconducting super collider, if they are to be carried out at all, must be supported by government. National defense and protection from

contagious diseases depend on specialized research for which private individuals do not have adequate incentives. About 80 percent of federally funded R&D is devoted to defense or basic research.

#### INTELLECTUAL PROPERTY RIGHTS

Investment in knowledge, like other investment, depends on rights to future returns. Even in research that is publicly supported, the incentives created by property rights have powerful effects.

Patent, licensing, trademark, copyright, and trade secrets laws are critical in determining the share of the returns from commercially valuable ideas and inventions to which an inventor or investor is entitled. The dramatic advance of commercial biotechnology since 1980, for example, was aided by the U.S. Supreme Court decision that microorganisms produced by genetic engineering were patentable. Building on the long-established principle that specially bred lines of plants and animals belong to their breeders, genetically engineered higher organisms, such as improved goats and cattle, now are protected by property rights. Legislation such as the Plant Variety Protection Act of 1970 and subsequent regulatory changes have made property rights in agricultural innovations easier to establish. As a result, research previously supported by government can be undertaken profitably by private firms, which now fund more than 60 percent of agricultural research.

This Administration has supported many actions that protect intellectual property, including stronger international enforcement of property rights, facilitation of joint ventures, and improved procedures for regulatory review. For example, incentives for pharmaceutical innovations have been strengthened by reducing the time for regulatory approval and extending patent life to make up for most of the time lost during government review.

International enforcement of intellectual property rights is increasingly important as national economies become more closely linked by trade and investment. U.S. firms encounter myriad problems in protecting their intellectual property abroad. Some countries offer only limited protection to process patents. Others do not recognize patents on pharmaceuticals and chemicals or copyrights on computer software. Most newly industrialized countries lack rules sufficiently flexible to offer protection to new technologies such as biotechnology and satellite communications.

This Administration strongly supports protection of intellectual property rights through the General Agreement on Tariffs and Trade, and it is working to end piracy that erodes incentives to innovate (Chapter 4). U.S. inventors have been defended against the importation of goods made abroad with unlicensed technology by vig-

orous enforcement of existing trade law. The Administration also supports changes in the law to strengthen intellectual property provisions. The United States has proposed that the Organization for Economic Cooperation and Development (OECD) work to establish a framework in which nations cooperatively support basic scientific research and training and enforce intellectual property rights.

Intellectual property rights, broadly conceived, include not only the right to exclude others from the use of one's knowledge, but also the right to share knowledge for productive purposes. Private firms may want to conduct joint research in order to realize economies of scope and scale. In the past, fear of inappropriate application of antitrust laws has inhibited cooperative research among competing firms. By defining antitrust liability more clearly, the National Cooperative Research Act of 1984 opened the way to research joint ventures which may make research profitable in areas where property rights are difficult to define or enforce. In the computer industry, for example, cooperative research already has yielded important innovations and marketable products. Fear of antitrust liability sometimes has prevented firms from broad licensing of intellectual property. This Administration supports legislation that would promote the dissemination of new technology by preventing the award of multiple antitrust damages in cases where patent licensing has no anticompetitive effect.

Federally sponsored research can benefit from the incentives created by property rights. The Patent Law Amendments of 1980 provided a uniform system for assigning title to inventions made at universities that conduct government-sponsored research. Between 1980 and 1986 cooperative ventures increased, and the number of patents issued to American academic institutions grew by 70 percent. Before these reforms, patenting such inventions was uncertain, and cooperative research ventures between private firms and universities were difficult to establish because of the complex regulations that accompanied Federal funding. The Technology Transfer Act of 1986 also should allow government scientists to respond better to market demands by simplifying the process by which Federal laboratories' discoveries may be patented and developed. For example, a Federal laboratory and a private biotechnology firm jointly are exploring vaccines against poultry disease.

#### INCENTIVES IN GOVERNMENT RESEARCH

The Federal Government does not have the appropriate information and incentives to determine the most useful outputs of R&D, except when the government is the principal user. For example, in areas of defense research such as aviation, computers, and semicon-

ductors, the Federal Government was for many years not only the primary funder but also the primary user of the R&D product. Government thus had extensive knowledge of its needs and could guide research toward successful applications.

Federal support for R&D in health and agriculture often is mentioned as an example of government research that has produced large social benefits. Research in these fields illustrates the importance of close contact between the performers and users of R&D. The close association of most schools of agriculture and medicine with the decentralized farming and health care industries may allow scientists to have more contact with the ultimate users of R&D outputs when deciding how to allocate R&D resources than would be the case were research more centrally directed.

In contrast to research concerning public goods, the Federal Government's efforts to fund innovations in the private sector often have been unsuccessful. Government-sponsored energy research and research into building materials and low-cost housing design produced little that was ultimately marketable.

Support of synthetic fuels is perhaps the most notable example of inappropriate government-directed investment in recent years. Citing the dangers of dependence on imported oil, the previous Administration proposed spending \$88 billion to speed the development of synthetic fuels. The Energy Security Act of 1980 established price supports, direct subsidies, tax credits, and loan guarantees to encourage participation in the program.

After the synfuel program began, higher world energy prices induced greater supplies and conservation. In 1981, after deregulation, oil prices declined. However, the synfuel policy was based on the assumption that oil prices would reach \$40 to \$70 per barrel. Weak energy prices and political controversy helped convince the Congress to reduce the Synthetic Fuels Corporation's funding substantially in 1984. With the fall of world oil prices, much of the Federal Government's support of windmills and other quixotic energy projects came to an end. The history of these energy initiatives suggests that government should not try to impose new technologies on an industry which is unwilling to commit its own resources to them, and that political influence can make policies that are obvious economic failures difficult to abandon.

## MARKET FLEXIBILITY

Economic growth requires many adjustments, including the expansion of productive activities and the abandonment of those that prove unproductive. In a dynamic economy, markets for all productive fac-

tors—labor, capital, and natural resources—must accommodate shifting patterns of demand and changing technologies. As the economy grows, capital is assembled and used in new configurations, and industrial as well as occupational shifts take place in the labor force. The value of aggregate output is increased when factors of production shift to more highly valued uses in response to changes in demand and in costs of production. Many changes result from investments in human and other forms of capital and from new technology. The development of aircraft and computers, for example, has opened new opportunities for consumption, production, and employment.

Increased income per capita, as well as relative price changes, lead to shifts in demand patterns. Consumers with higher incomes demand a wider variety of products and more services relative to goods; they spend a smaller share of their income on the basic necessities of life. At the turn of the century, households spent more than 30 percent of disposable income on food, compared to about 15 percent today. Thus, choices available to consumers have increased as has discretionary spending for travel, recreation, and other services.

Changes in output, consumption, and technology are essential features of economic progress. Rigidities and distortions in markets can impede natural responses to economic change, reducing potential gains from investment and slowing productivity and income growth. Maintaining the flexibility of labor markets is particularly important for a healthy economy.

#### MARKET BARRIERS AND DISTORTIONS

Throughout the world there is increasing recognition that economic growth requires the reduction of structural barriers and distortions within domestic markets, as well as the reduction of protectionism in international trade. Constraints on capital and labor markets stand in the way of shifts in comparative advantage, barring allocation of resources to more productive uses. Taxation and regulation are major sources of market distortion, inhibiting activities that otherwise would expand or providing subsidies to activities that otherwise would be curtailed.

##### *Taxation*

In general, taxes are distortionary, because they interfere with the efficient allocation of productive resources and reduce incentives to work, save, and invest. These burdens can be limited by keeping marginal tax rates as low as possible and by imposing similar tax rates on similar products, resources, or activities.

The Tax Reform Act of 1986 moved the U.S. tax system substantially in the direction of lower and more equal marginal tax rates. As discussed in Chapter 2 of the 1987 *Report*, tax reform reduced the

marginal Federal tax rate on labor income from 25.8 percent to an average 21.7 percent, and it has significantly lessened differences in tax rates on the income from alternative forms of investment. The higher after-tax yield of labor income encourages work and investments in human capital, which in turn increase the productivity of labor. More equal taxation of investments also encourages a more productive distribution of capital, because investors' decisions will be made on the basis of expected economic returns rather than tax consequences.

It is estimated that over the long term tax reform will increase real net national product by approximately 2 percent and raise aggregate consumption by roughly 4 percent. The net improvement in economic welfare is equivalent to about \$50 billion per year.

Tax distortions, however, cannot be avoided entirely. Any practical system of taxation induces distortions, as discussed in Chapter 2 of the 1985 *Report*. Costs of resource misallocation have been estimated to range between 20 and 50 cents per additional tax dollar collected. The costs of private compliance with personal income taxes are estimated to add another 5 to 7 cents per dollar collected. Because government outlays must be financed by tax revenues—now or in the future—and because taxes have such sizable indirect costs, government spending should be undertaken only if the expected value of the activity is substantially higher than its outlay costs. Government services and transfer programs that fail to meet this test should be cut back.

### *Regulation*

Although often intended to correct externalities and other market imperfections, government regulation frequently causes distortions that reduce allocative efficiency and impede growth. The regulation of financial services, for example, has reduced the efficiency of capital markets. While in force, Federal interest rate ceilings on bank deposits lowered the returns available to small savers and constrained the amount of credit that depository institutions could provide to businesses and homeowners. Similarly, interstate banking laws restrict the flow of funds to productive investments and interfere with diversification of risks, thus reducing the gains that would be available to both savers and borrowers in nationwide capital markets.

During the past 50 years, regulation of agriculture has posed significant obstacles to economic efficiency and adjustment. Agricultural regulation has restricted imports, subsidized production, raised prices, and kept land idle. Federal outlays and consumer costs of farm commodity programs are estimated to have been about \$22 billion in 1987. Furthermore, the regulation of agriculture has slowed the movement of labor and capital to other industries. It has wasted

resources by distorting investment within agriculture and by diverting investment from more profitable activities.

Rent controls, remaining controls on trucking, natural gas regulation, automobile fuel economy standards (discussed in Chapter 5 of the 1986 *Report*), import barriers such as voluntary agreements to restrict imports of automobiles, and some rules designed to control environmental risks (discussed in Chapter 6 of the 1987 *Report*) are all examples of regulations that reduce market flexibility. Price controls distort resource allocation. Regulation often reduces incentives for investment by insulating firms from competition, by creating hidden subsidies and uncertainty about future changes in rules, and by requiring adherence to rigid standards that preclude innovation and the introduction of lower cost methods of production. Safety and health regulations that require the installation of particular equipment, for example, may stifle incentives for developing better ways of improving workplace safety.

In recent years the United States has made substantial progress in deregulating oil prices as well as major industries such as airlines (Chapter 6), buses, and railroads. Deregulation of transportation industries has been associated with a resurgence of productivity growth (Chapter 2); one study has estimated savings for the economy of roughly \$50 billion per year. Procedures also have been established for review of Federal regulations on a systematic basis to ensure that new regulations are worth their costs.

#### LABOR MARKET FLEXIBILITY

Flexibility in labor markets is particularly significant for allocative efficiency and growth, because labor is the dominant input to production. In the United States, labor has contributed about 70 percent to output for well over a hundred years. Compensation of employees now accounts for almost 75 percent of national income, up from about 55 percent at the turn of the century.

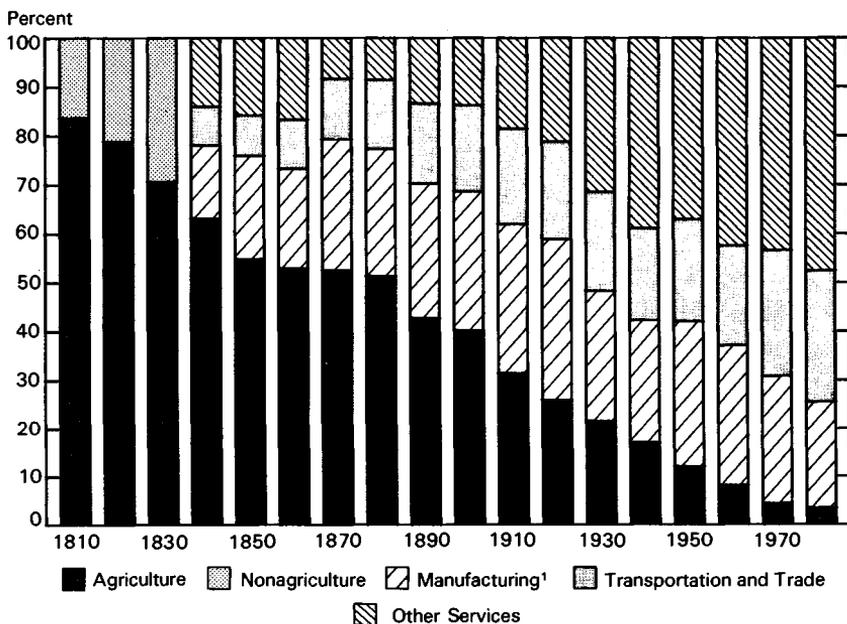
In addition to improving the allocation of productive resources, flexible labor markets expand employment opportunities and further contribute to growth by encouraging investment. Adaptable labor markets increase returns to investment, particularly in knowledge, by rewarding the acquisition of skills that are in demand and the adoption of cost-saving innovations in production.

As discussed in Chapter 2, U.S. labor markets have been remarkably successful in generating new jobs for a growing labor force and in accommodating structural change. Primarily as a result of strong growth in productivity, the share of the U.S. labor force devoted to agriculture fell from more than 80 percent in 1810 to about 3 percent today, as shown in Chart 5-4. The share of the labor force in

manufacturing rose earlier in this century, but has declined in recent decades, also reflecting strong productivity growth. Shares in finance, government, and other services have increased. Employment has shifted toward jobs that are safer and less physically arduous, and that demand more human capital. Work fatality rates in service industries, for example, are less than one-sixth of those in agriculture. Employment in manual and farm occupations, which accounted for about three-fourths of U.S. jobs in 1900, fell to less than 40 percent in 1970, and the decline has continued.

Chart 5-4

Labor Force Shares by Industry



¹Also includes fisheries, mining, and construction.

Sources: Department of Commerce and Department of Labor.

Contrary to popular notions, increased unemployment in the post-war years in the United States has not been associated with unusually rapid changes in industrial structure. Measures of the structure of employment by industry in the United States do not indicate greater turbulence or increasingly rapid shifts in employment, across either major or more narrowly defined industrial sectors. The level of unemployment accounted for by workers' changing industry has been steady since 1970.

Flexible labor markets facilitate change, but they do not preclude job attachment or long careers in a single firm. Long-term employment is common among American workers. About half stay with a single employer for 8 or more years, and almost 30 percent do so for at least 20 years.

Most changes in employment patterns take place as a result of employment growth and voluntary job change. Workers, particularly the young, change jobs as they find opportunities that better suit their skills and preferences. Evidence shows that the changing employment patterns of workers under 25 years of age account for much of the sectoral reallocation of jobs. In manufacturing, voluntary quit rates have ranged from about 15 to 25 percent of the work force in recent years, and layoffs typically have accounted for less than half of all job separations.

However, job losses that occur in mid-career as a result of declining employment in particular industries or firms can pose serious problems for workers and their families, leading to unemployment, reduced earnings, and other hardships. The BLS estimates that, between 1981 and 1985, 5.1 million workers lost jobs they had held for more than 3 years, due to slack work, job abolition, or a plant or business closing. On average, a little more than one-half million of these workers lost jobs each year because their plants closed or their employers went out of business. Most of the affected workers experienced some unemployment, and some had lengthy unemployment spells. Other research based on these data, however, has found that the duration of joblessness over the year for displaced workers was similar to that of average workers who had spells of unemployment.

Evidence suggests that earnings losses do not persist over the long term. Losses for workers whose jobs were abolished vary considerably, reflecting losses in specific human capital and sometimes higher wages associated with unionization. On average, wages upon reemployment have been about 90 percent of prior wages. Losses typically have been higher in smaller and weaker labor markets. Workers with more job tenure experienced larger losses, as did those with less education. More educated workers had less unemployment. Workers with more schooling have better access to labor market information, a greater capacity to identify new opportunities, and more skills of general value. In addition, forgone earnings during unemployment are higher for workers with more human capital. Evidence shows that schooling eases the transition for those leaving agricultural as well as industrial jobs.

Employment growth and a general absence of impediments to mobility have facilitated the voluntary reallocation of labor to expanding sectors. When jobs have been lost involuntarily, problems for individ-

uals typically have been temporary and usually mitigated by their general knowledge and skills and by the availability of alternative employment.

#### POLICIES FOR LABOR ADJUSTMENT

The flexibility of the U.S. labor market, and the relative ease with which workers can move between geographic areas and avail themselves of better job opportunities, have contributed substantially to economic growth. Government can improve labor adjustment by reducing existing market interventions and avoiding the imposition of new ones.

A number of labor market regulations, such as the minimum wage, many occupational safety and health rules, and occupational licensing, impair flexibility and adjustment. Many studies have shown that the minimum wage is a barrier to work and job-training opportunities for inexperienced and unskilled workers. Erosion in the real value of the minimum wage has contributed to substantial recent employment growth and reduced unemployment among black teenagers, both of which are documented in Chapter 2. Further lowering of the minimum wage would increase employment and accumulation of human capital among young people, thereby raising future wages as well as economic output.

Providing unemployment insurance and training may produce net economic gains by broadening public support for the removal of trade barriers and other market distortions. But programs intended to ease the transitions of workers to new jobs can slow economic change by creating work disincentives and other sources of inefficiency. Improving current policies that directly address adjustment—unemployment insurance, pension rules, and retraining—would increase market flexibility and enhance prospects for growth. Establishing protection for existing jobs, such as requiring advance notice of layoffs, would introduce new market rigidities.

#### *Reducing the Inefficiencies of Unemployment Insurance*

The Federal-State unemployment insurance program, established more than 50 years ago, provides partial wage replacement for experienced workers who lose their jobs because of temporary layoffs or job terminations. With few restrictions, States establish the amount as well as the duration of compensation and the structure of payroll taxes. Weekly benefits replace about 35 percent of prior wages on average; in most States compensation may be received up to 26 weeks. Total benefits were about \$14 billion in 1987. Benefit outlays are greater in years of higher unemployment; for example, they were \$23.8 billion in 1982, about 70 percent higher in nominal dollars than in 1987.

Compensation is intended to reduce earnings losses that result from changing market conditions and thus to cushion labor adjustment. By replacing a portion of wages during unemployment, benefits support the search for a new job. At the same time, benefits tend to prolong unemployment by reducing its costs for workers and allowing them to search longer, but they do not appear to increase subsequent wages. Recent Federal reforms and State actions to tighten eligibility and job search requirements have reduced work disincentives substantially. Additional policy options to enhance reemployment incentives and the effectiveness of job search efforts are being explored.

Further improvements can be realized in the program's financing. Risk rating, or experience rating, is fundamental to private insurance, because, when higher premiums are charged to insure against greater risk, insured parties have an incentive to reduce risk. Since the unemployment insurance system is only partially experience rated, it provides incentives that increase unemployment. When a firm can lay off workers temporarily and spread much of the cost to other firms that also pay taxes into the program, it is more likely to generate layoffs. Strengthening experience rating would reduce unemployment by making individual firms bear more of the cost, thereby encouraging them to explore alternatives to temporary layoffs, such as rescheduling work or modifying inventories.

Financial transfers that are generated by the tax structure of the unemployment insurance system subsidize declining firms and those in seasonal or cyclical industries at the expense of growing or stable firms. Studies have found that agricultural and construction firms are heavily subsidized by firms engaged in trade and in finance, insurance, and real estate. States have made a number of changes during the 1980s to improve experience rating, partly in response to Federal law. The Department of Labor, in an effort to increase information and accountability, recently has required more complete State reporting of experience rating.

#### *Improving Pension Rules*

Pension termination insurance, which has been a Federal responsibility since 1974, has been funded by a flat premium per worker. As a result, firms that fund their pension plans inadequately have been subsidized at the expense of firms that maintain sound funding. These indirect subsidies to poorly funded plans have reduced incentives for adequate funding and benefited failing firms at the expense of healthier firms. This Administration strongly supported recently enacted legislation that establishes partial risk rating of pension premiums and improved pension funding rules. This legislation will reduce the automatic financial transfers generated by the system. An

additional step would allow pensions to be insured privately, provided basic standards are met. Private pension insurance would have major advantages. Premiums would be based on risk, thus preserving incentives for adequate pension funding as well as eliminating remaining automatic subsidies, and insurance would likely be provided at an even lower cost for well-funded plans.

Government regulation of pensions can distort resource allocation through the effect on job tenure and training as well as through cross subsidies among firms. Rules such as those requiring early vesting may increase worker mobility, but at the same time such rules diminish employer incentives to provide training. Employer investments in job training are based on expectations of future returns from increased worker productivity. To the extent that employment contracts are precluded from offering pension inducements for longer worker tenure with the firm, the amount of training is likely to be reduced, along with future productivity. Among other features of privately negotiated employment contracts, pension provisions reflect the benefits and costs of job attachment to workers and firms. Government mandates with regard to pensions and other employment benefits can prevent employers from offering the most desirable pay packages to workers and can slow investment in human capital.

### *Retraining*

Government-supported retraining may facilitate reemployment following job loss. Job training and retraining, however, are primarily a private responsibility. Since private firms know best what skills they require, they can tailor training to their needs. In its role as employer, the Federal Government provides substantial amounts of training for military and other Federal occupations. As discussed earlier, however, the wider effectiveness of government-run training programs in raising earnings over the long term has not been established.

The Administration's proposed Worker Readjustment Assistance Program (WRAP) would replace Trade Adjustment Assistance (TAA) and other existing retraining programs. In addition to training, TAA provides compensation which, in combination with unemployment insurance, can be received for as many as 78 weeks. Evidence shows that TAA has failed to facilitate adjustment and has prolonged unemployment. WRAP would offer training to all experienced workers who have lost their jobs, in recognition that adjustment costs are unrelated to the cause of job loss, whether changing trade patterns or other factors. At the options of States, vouchers for purchasing training in the market could be offered along with traditional retraining services and job search assistance.

### *Costs of Job Protection*

Government actions to insulate industries and jobs from international competition, or to protect existing jobs by requiring employers to provide advance notification of layoffs and plant closings, would reduce market flexibility and diminish overall employment opportunities. Proponents argue that advance notice of layoffs would ease worker adjustment. Mandated notice, however, as called for in proposed trade legislation, would constrain the responses of firms to changing market conditions and reduce employment. Because required notice means that employers would incur greater liabilities in the event of business contractions, hiring during expansions would be curtailed. Higher costs and increased risks also would discourage new business formation. In contrast, when job security provisions are chosen in the marketplace, they can be weighed against other forms of compensation according to workers' preferences and employers' costs.

Employers frequently provide their workers with advance notice. Recent government surveys have found that advance notice of the specific date of an impending layoff was given in about one-half to two-thirds of the cases surveyed, and general notice in one-third to three-fourths of the cases. On average, general notice was given 46 days in advance. Notice was not the result of collective bargaining alone; the likelihood of receiving notice was about equal in union and nonunion establishments.

Although labor market performance is affected by numerous forces, including macroeconomic and tax policies, an important reason for high unemployment and lack of job growth in Europe has been labor market rigidities. Many European governments severely restrict an employer's ability to dismiss workers, and they require substantial severance pay and notice prior to layoff. Unemployment benefits are higher and last longer than in the United States, commonly replacing at least 70 percent of prior wages for a year or more, and more of the unemployed qualify for benefits. Financing, moreover, is not experience rated. Employment in Western Europe has been flat since 1970; during the same period, employment in the United States has increased by more than 40 percent. Unemployment rates in Western Europe have approximately tripled since the early 1970s, and they are now higher than in the United States, thus reversing earlier patterns. The incidence of long spells of unemployment is substantially higher in Western Europe than in the United States, as is unemployment among youth.

European governments have realized that the inflexibility of their labor markets due to job security mandates, along with a variety of other labor market interventions, have impaired growth in employ-

ment and spawned high unemployment rates, particularly among youth. During the 1980s, European countries have begun to reverse previous policies of increasing job protection, unemployment compensation, and other measures that impose constraints on labor markets and distort incentives. A number of countries have reduced the costs of employment termination by relaxing job protections and increasing the ability of employers to effect dismissals. Government-mandated severance pay in Western Europe has been reduced from the levels of the late 1970s. In a majority of OECD countries, unemployment benefits, which had risen during the 1970s, have been reduced. Stricter eligibility conditions have been applied and work incentives strengthened. In a number of countries, minimum wages have been held constant in nominal terms and reduced in real terms. Several countries have reduced minimum wages for youth.

Policies such as those in Western Europe that had attempted to reduce adjustment costs by preserving existing jobs at the expense of new jobs have been recognized as shortsighted, benefiting some workers by shifting high costs to others. In addition to the steps that individual countries have taken to reverse such policies, the OECD and the Venice Economic Summit formally recognized the need for removing labor market barriers and increasing flexibility. At its May 1987 Ministerial meeting, the OECD concluded that improved functioning of labor markets is essential for sustained economic growth.

## CONCLUSION

Investments in human capital and in science and technology have made substantial contributions to productivity and economic progress. In the future such investments may assume even greater importance. Market incentives provide the primary mechanism for the accumulation and allocation of investments in knowledge and skill as well as in physical capital. Government support for education and research can improve prospects for long-term economic growth, but it should be linked closely to private incentives. Public support of most education and training and of research should be limited to investments for which individuals and firms do not have adequate incentives and for which benefits exceed costs, including costs that arise from tax distortions. Many government interventions, including those that are designed to spur increases in knowledge, generate costs and inefficiencies that in the end retard growth.

Economic progress requires change, and to realize the gains from investments in human capital and in research and development it is vital that markets remain flexible and responsive. To resist change and to introduce protection that slows change will stifle investment

and diminish opportunities for future growth. Policies that reduce market barriers and strengthen the incentives of individuals and businesses to invest and to innovate are the surest ways to improve economic performance. Government can encourage further advances in knowledge and economic progress by maintaining flexible markets and a stable framework in which property rights are protected and initiatives are rewarded.