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insult of Carter's 1979 budget, which proposed a net reduction in formula funding. USDA officials are reluctant to do anything that might cause further offense, for they seem to think the states might withdraw from the federation. Nevertheless, Bertrand does plan to have the department look more critically at the way states conduct research. He has created an evaluation and impact office, directed by J. Michael Brazzel, an economist, whose sole task will be to study the impact of USDA programs and suggest ways to improve the management of research. Brazzel hopes to hire 10 to 12 professional analysts, but at the moment he has no staff. It is not yet clear how much clout the department will give his office.

Although the agricultural experiment stations do conduct internal reviews of individual projects, Prager says, they are generally not the kind that would "pass muster" at the National Institutes of Health or the National Science Foundation. "They are still pretty much carried out by the people at the stations. It is highly unusual, if not unheard of, to bring in an outsider. The reviews are usually done by the same people who get the grants." The 5-year program reviews have similar problems. As a rule, the chief research official chooses the time of the review, the subject, and the reviewers. The USDA's role has been to offer advice when requested and occasionally to send its own employees to sit on panels. No effort is made to see that their advice is followed.

Some universities and experiment stations have an excellent record in soliciting and using outside criticism, Prager says, but many do not: "they are very mixed in quality." There is no equivalent of a national accrediting body for the agricultural schools, and thus no universal procedure for setting standards.

As a group, the state research institutions have shown little enthusiasm for outside reviews until now, so it is no surprise that the federal government should offer to become an active critic on their behalf. Undoubtedly some state officials will see this as an example of Washington's inclination to meddle in others' affairs. But given the spotty record of self-criticism in the past, this kind of meddling could be very helpful.

—ELIOT MARSHALL

Productivity Problems Trouble Economy

Everybody talks about the lag in the growth of productivity, but nobody seems to know enough to do much about it

A lag in the growth of productivity has been diagnosed as the new American disease. In the past 10 years the average yearly rate of increase of productivity in the United States was half that of the previous two decades, and in the past year or so the rate has been virtually zero. Flagging productivity has become the most popular shorthand explanation of why the United States is increasingly vulnerable to inflationary pressures at home and to foreign competition in world markets.

Concern about sagging productivity was a major stimulus to the recent Domestic Policy Review of Industrial Innovation (*Science,* 27 July). And politicians and policy makers are giving the problem priority status in hearings and studies. Prospects for a simple solution, however, are not very promising. Economists studying the problem see it as a complex phenomenon with multiple causes. And if blame is to be allotted, the culprits are likely to be found in an economic hall of mirrors where, once again, the enemy is us.

During a period of inflation, the pressure for wage increases is strong and other costs of production go up. Without a rise in productivity, business can meet higher costs only by cutting profits or raising prices. All of this exacerbates inflation and puts heavy pressure on the dollar.

Although economists who study innovation and its relation to productivity are cautious about categorical explanations, it is possible to point to several contributing factors.

America's relatively high productivity rate in the years after World War II owed much to the movement of agricultural workers to other sectors of the economy, especially service industries. Agricultural workers are now such a small part of the work force that this trend can no longer be a significant source of gain in productivity. Also, the relatively high education level of the U.S. work force is no longer viewed as advantageous over other countries. And the labor force has become increasingly inexperienced because of an influx of women, young people, and part-timers, who are thought to be less productive than older male workers.

Some economists assign major blame for the slump in productivity to a shift to a "service" economy. The service sector includes wholesale and retail trade, finance, insurance, real estate, the professions, business, repair services, and general government. The percentage of the labor force in the service sector rose from about 50 percent to 60 percent between 1950 and 1970. In general, productivity has risen more slowly in this sector than in industry, which includes manufacturing, mining, construction, communications, public utilities, and certain government-financed enterprises.

Victor R. Fuchs, of Stanford University and the National Bureau of Economic Research, is one of a number of economists who, nevertheless, discount the notion that the slowdown in productivity is largely attributable to growth in the service sector. In a contribution to a recent book on economic growth,* Fuchs referred to analyses of sectoral differentials to make his point. In particular, he emphasized the decline in productivity in the economy as a whole and the importance of the growth of the work force. In seeking to explain the decline in annual productivity growth from an average of about 3 percent in the 1960's to 1.5 or 1 percent in the 1970's, he suggested that the growth of the service industry accounts for about 0.1 percent of the decline and the influx of women into the labor force for a similar portion.

*V. R. Fuchs, in *Economic Growth or Stagnation: the Future of the U. S. Economy*, J. Backman, Ed. (Bobbs-Merrill, Indianapolis, Ind., in press).

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Fuchs cautions that analysis of sectoral differentials is tricky because methods of measuring "real output" in service industries leave much to be desired. For example, he thinks that the growth of productivity in government, banks, and some other services is understated, but that growth of productivity in retailing may be overestimated. According to Fuchs, "there probably are large downward biases in many indexes of industry output, especially when the goods produced are complex and undergoing rapid technological change (for example, computers).

"I also do not believe that these biases can explain the slowing down of productivity growth in recent years. This slowing down seems to be a real phenomenon, the explanation of which should rather be sought in the slowing down of growth of capital per worker and in a variety of other social and economic changes."

Two such changes are the recent rise in energy costs and the increase in government regulation. Industry in the United States has long been the world's most energy-intensive, and the soaring cost of fuel has taken a toll. Government regulation, particularly in the areas of health, safety, and the environment are claiming a greater proportion of the gross national product and, according to some industry commentators, have caused a diversion of research and development (R & D) efforts away from the kind that result in new products and processes.

Comparisons with competitors such as Japan and West Germany have inevitably directed attention to productivity trends in other economic and social systems. Currently, the industrial nation most successful in maintaining growth in productivity has been Japan, whose annual average increases exceed 6 percent. Japan, a country of densely populated islands with meagre natural resources, has consistently stressed exports in its economic policy. Government, industry, and labor have developed a collaborative relationship that has earned the sobriquet "Japan, Inc." Government has acted as a facilitator, encouraging growth through such means as tax policies and R & D subsidies, and has pursued foreign economic policies aimed at ensuring that Japanese products remain competitive in world markets. Japanese workers, at least until recently, could count on lifetime employment by a firm and have seen their interests as identical with those of the companies which employed them.

The United States, by contrast, has developed its economy by stressing competition in a national market, with the government acting as a referee and reinforcer of competition. As a result, relationships among government, industry, and labor are dominated by adversary attitudes. Government policies, especially as embodied in antitrust and patent laws, were designed to foment competition in a huge domestic market; they often put U.S. companies at a disadvantage in international markets.

Changing attitudes among workers also appear to be contributing to the lag in productivity. Depending on point of view, the change consists of an erosion of the American work ethic or a gain of more humane working conditions. Federal social legislation including Social Security, unemployment insurance, Medicaid, and Medicare and welfare programs have done much to insulate workers from the economic rigors of earlier days. And success by unions in negotiating job security, pension plans, and other fringe benefits has also bolstered workers' "rights." Beyond that, a new devotion to leisure and relaxation and a questioning of authority by all parts of society seem to reflect a stronger assertion of individual prerogatives, but have not led to higher productivity.

It is doubtful that the United States would want to emulate Japan or West Germany in the cause of higher productivity—if indeed it were possible to do so. Some observers speculate that the transformation of the U.S. economy is proceeding in the direction taken by the British rather than the Japanese. Anglo-Saxon attitudes may produce a less pressured, less competitive way of life, but Americans do not seem ready to accept the lower standard of living that this entails.

Government and industry would appear to have limited power to alter currents of social change, but there are some levers which can be worked. Capital investment and technological change are probably the most readily traceable influences on productivity growth and both have been diminishing. Many of the recommendations put forward during the domestic policy review on innovation were designed to encourage investment. And the slump in growth of technological innovation has stimulated new interest in the place of R & D in the innovation process.

In the past, a belief that spending on R & D led to innovation was widely, rather uncritically held in the United States and used as blanket justification for government support of R & D. That view came to be considered as oversimplified both outside and inside government, and spending on R & D by government declined. Similarly, economists who study the relationship between R & D and growth in productivity have refined their understanding of it in recent years. For example, Edwin Mansfield of the University of Pennsylvania, who is among the best known of economists who have researched the economics of the innovation process and productivity, has studied the rate of change in productivity in relation to the amount of basic research performed. Mansfield found that the marginal rate of return on investment in R & D is substantial; but that an important distinction must be made between the social rate of return, which accrues to the industry or economy as a whole, and the private rate of return, which is a return to the company that conducts the research (*Science*, 17 September 1976).

The private rate of return is highly unpredictable, and this deters individual firms from investing in R & D.

More recently, Mansfield has found that an industry's investment in basic research is significantly related to its own productivity. He notes that expenditures on basic research by industry declined by about a quarter between 1967 and 1977.

In an address at an Edison Centennial symposium in May, Mansfield drew six cautious conclusions based on 20 years of economic studies:

(i) Research and development seems to have had a very significant effect on the rate of productivity growth in the industries and time periods that have been studied. (ii) The marginal social rate of return from investments in new technology seems to be relatively high, which suggests that there may be some underinvestment in such projects. (iii) Holding constant the amount spent on both applied R & D and basic research, an industry's rate of productivity change seems to be directly and significantly related to the extent to which its R & D is long-term. (iv) During the past decade, firms have tended to cut back the proportion of their R & D going for relatively basic and risky projects. (v) The slowdown in the rate of growth of U.S. productivity that began during the 1960's and early 1970's is continuing into the late 1970's. (vi) In formulating public policy, the Federal government should pay much more attention than in the past to the effects of its policies on the rate of technological change in the civilian economy.

R & D, of course, is only one of the pieces in the puzzle of productivity. There is a temptation to see productivity as an index of social change. But while it is impossible to control—perhaps even to understand—all the variables governing the rate of productivity growth, it does appear that R & D is one area in which something can be done.

—JOHN WALSH