Chapter 2 Toward Future Promotion of Science and Technology

1 Overview

According to the "2006 Report on the Survey of Research and Development", compiled by the Ministry of Internal Affairs and Communications' Statistics Bureau, R&D expenditures funded by the government in Japan totaled approximately 3,389.6 billion yen and those by the private sector in the country totaled approximately 14,397.4 billion yen in fiscal 2005. These figures mean that each Japanese citizen pays about 30,000 yen per year through the government for R&D expenditures while private companies, etc. together spend about four times as much on R&D.

This report also shows that the number of people engaged in research-related jobs totaled approximately 1.04 million, accounting for 0.8% of Japan's total population, and about 820,000 of them, or about 0.6% of the total population, were researchers.

2 Lessons to be learned from the past

(1) To surpass boundaries of industry, academia and government

The contributions of science to society represent a dynamic process that involves interaction between the two. In Section 2, Chapter 1, we showed that a variety of modern technologies have derived from quantum mechanics and high energy physics, both of which appeared to be fields of pure basic science and that the evolution of technology, for its part, has contributed to the advance of basic research. As shown in Section 3, Chapter 1, in many cases, benefits of science and technology are fed back to society over a long period of time and through a variety of processes, and they should therefore be judged from a long-term perspective.

It is becoming increasingly important for researchers engaged in the development of advanced technologies to broaden and deepen their understanding with regard to basic research. This, coupled with a rise in the number of researchers at private companies, increases the importance of education and research at universities and graduate schools. Therefore, mutual exchange between private companies and universities should be promoted in an effective manner.

(2) To surpass various fields

The essence of science lies in questioning and seeking to resolve unknowns, regardless of whether they concern basic research or practical applications. Knowledge and activity in various fields of science and technology are not developing independently of one another but they form a dynamic system as they interact with one another in a complex manner.

Communicating with other people in an open manner without being locked up in the area of specialty broadens the perspective of researchers and brings a fresh breeze of ideas, and it is particularly important to enable young researchers whose thinking is not constrained by conventional values to play an active role.

(3) To surpass organizational boundaries

Research organizations, particularly those engaged in basic research, need to ensure the freedom of research that enables researchers to fully exercise their capabilities. In order to enable talented researchers with a variety of backgrounds to inspire one another, it is important to facilitate exchange of information among various organizations, employ researchers in a fair manner, irrespective of whether they are alumni members or not, and from a global perspective and make efforts to increase the mobility of human resources.

(4) To surpass the boundaries of age and gender

Young researchers play a significant role in the advance of science and technology. As well, promoting the activity of female researchers, whose ratio remains conspicuously low in Japan will be very significant for the future development of science and technology in the country. In addition to promoting the implementation of systematic education and the independence of young researchers under the Support Program for Improving Graduate School Education, it is necessary to carry out measures such as adopting a competitive funding program that attaches importance to the novelty of research plans and utilizing young researchers in screening of research programs.

(5) To surpass national borders

Many researchers cross national borders so as to exchange opinions with foreign researchers, develop their own capabilities and find a place where they can tackle a challenging task. To attract such capable researchers, it is necessary to make intensive efforts to establish bases in Japan that will serve as a magnet for top-level researchers. In addition, as the scale of research programs expands, the need is growing for international cooperation in prompting science and technology.

(6) To surpass the boundary between scientists and ordinary people

The promotion of science and technology has now become a huge project into which national resources are poured. Therefore, it is necessary for scientists and ordinary people to discuss issues related to science and technology and society on an equal footing so as to ensure appropriate public understanding of the benefits of science and prevent science from going out of control unexpectedly.

In order to promote science and technology, with the support of the public, as something beneficial for the future of Japan, it is increasingly important to facilitate dialogue, in as plain language as possible, between scientists and ordinary people and form a national consensus.

(7) To surpass the boundary of conventional thinking

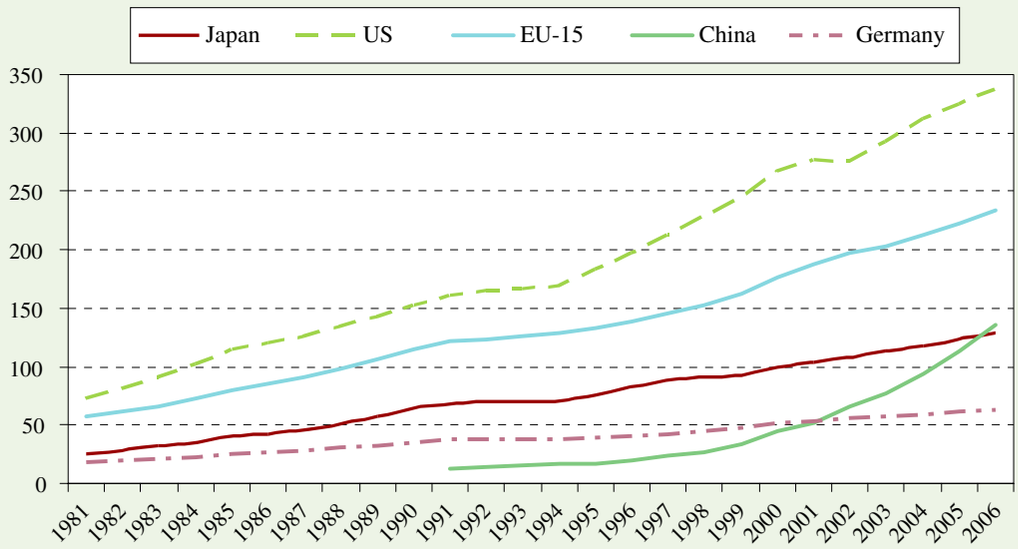
Ideas such as the Copernican theory and the theory of evolution were initially regarded as heretical but eventually came to be accepted as conventional ideas, after being verified through a variety of observation activities conducted over a long period of time. Future creative scientists willing to tackle the unresolved and unknown are sure to find the way to a solution by furthering their reasoning beyond the boundary of conventional thinking and by exercising their sound skepticism to the full.

3 How science and technology should be promoted in the future

(1) Investment in science and technology

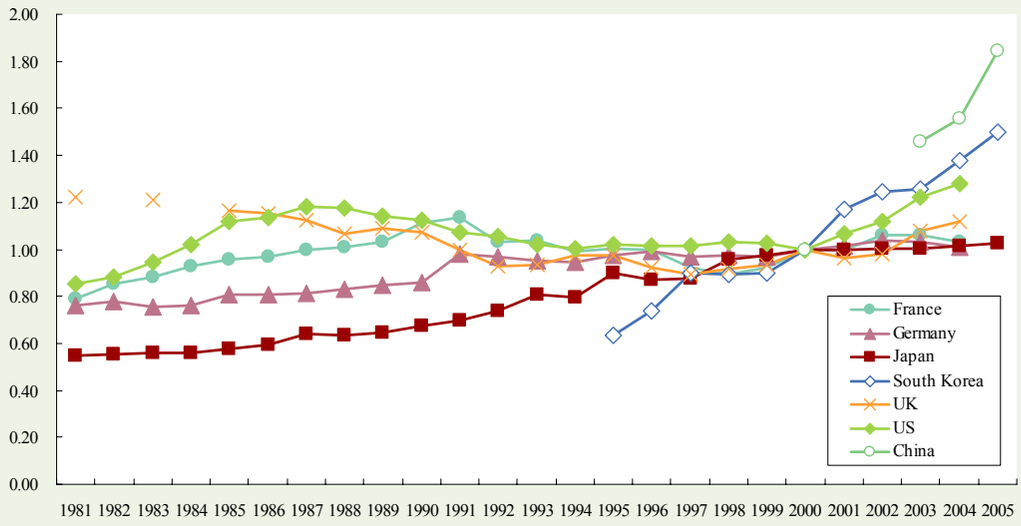
Major countries around the world are increasing their R&D expenditures as forward-looking investments. China's expenditures have shown a particularly sharp increase, and according to an estimate by the OECD, they exceeded Japan's expenditures in 2006 on a purchasing power parity basis (Figure 18). Although Japan made efforts in the past to raise government-funded R&D expenditures, such expenditures have remained almost flat in recent years, in contrast to the rapid increases in the expenditures of countries such as China and South Korea (Figure 19). Compared with the situations in other countries, the government's share of expenditures on R&D and basic research in Japan is relatively small, and public financing for higher education accounts for only 0.5% of GDP, a level about half of the figures for the United States, France and Germany and about two-thirds of the figure for the United Kingdom (Figure 20). In order to keep attractive the career path for people willing to make contributions to society by acquiring advanced knowledge in science and technology fields at graduate schools, it is necessary to make strenuous efforts to cultivate an environment that enables the implementation of sufficient education and research, reduce the financial burden on students enrolled in master's degree and doctoral programs and reform the contents and method of education so as to allow students to acquire knowledge and capabilities useful for real-life society.

Figure 18 Total domestic expenditures on R&D (unit: US$1 billion, purchasing power parity basis)



Note: Figures for 2005 and 2006 are estimates calculated based on the assumption that the growth rate of R&D expenditures in these years was the same as the average growth in 2000 to 2004.
Source: "Main Science and Technology Indicators, 2006-I" by OECD

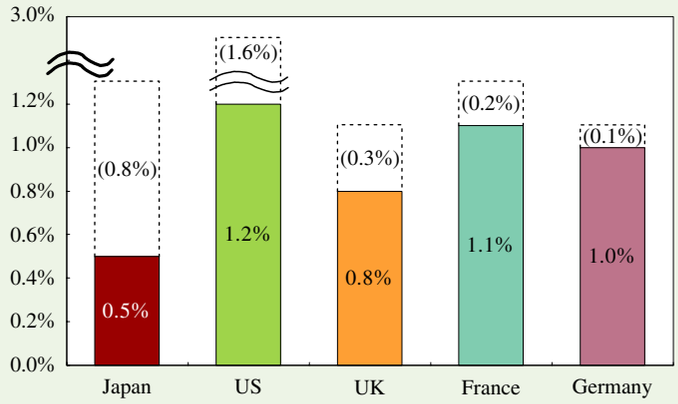
Figure 19 Trends in government-funded real R&D expenditures in major countries with figures for FY2000 taken as the base of 1



Note:
1. Real R&D expenditures are calculated with the use of the Implicit GDP Price Indices of "Main Science and Technology Indicators by the OECD (2000=1.00).
2. Figures for 2000, the earliest year when data for all of the seven countries covered became available, are taken as the base of 1.

Source: "Report on the Survey of Research and Development" by the Statistics Bureau of the Ministry of Internal Affairs and Communications

Figure 20 Public financing for higher education as a percentage of GDP



Note: Figures in parentheses represent private-sector expenditures as a percentage of GDP.
Source: "Education at a Glance" (2006 Edition) by OECD

(2) Selection and concentration

The Third Science and Technology Basic Plan calls for promoting strategic priority setting for government-funded R&D expenditures through selection and concentration and selects items targeted for intensive investments during the period of the plan as "strategic prioritized S&T." Moreover, projects for which "concentrated investments" are required are characterized as "Key Technologies of National Importance." Such technologies include: the "next-generation supercomputer," the "X-ray Free Electron Laser project," the "space transport system," the "earth observation and marine prospecting system," and the "fast breeder reactor (FRB) cycle technology."

Meanwhile, in order to enable individual researchers to develop original and challenging ideas, it is important to expand competitive funding while maintaining a certain level of basic expenditures.

(3) Promoting science and technology in ways to obtain public support

The advance of science and technology has benefited mankind by bringing about long life and material welfare. Given the expected increase in affluence due to a rise in the living standards of more countries and the expected expansion of the global population, however, the level of technology as it is would be insufficient to prevent us and our offspring from being confronted with environmental constraints in the future. Under such circumstances, we face the critical decision of which sorts of science and technology we should seek to develop further: the future for us and our offspring depends on this decision. In making this decision, it is important to obtain the understanding of the taxpayers regarding the sorts of science and technology to be selected for promotion and the way of advancing them. To this end, researchers and people involved in the promotion of science and technology should make constant efforts to provide comprehensive explanations concerning their activities and advance science and technology in the right direction with the participation of ordinary people.

Column 9: "Cherishing Creativity of Individuals" (Dr. Leo Esaki)