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Science and Technology Indicators:1997

A Systematic Analysis of Science and Technology Activities in Japan

Summary

May 1997

Science and Technology Indicators Project Team

National Institute of Science and Technology Policy (NISTEP)

Science and Technology Agency, Japan

Translation from
Japanese version

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Preface

Science and technology has been going through rapid and dynamic progress in recent years, and its impact on the economy and society is ever increasing. This has given rise to the importance of the development of science and technology indicators as a tool for an accurate understanding of complex and diverse science and technology activities through systematic analysis based on objective and quantitative data.

This institute devised a set of systematic science and technology indicators in 1991, and has since been revising them approximately every three years. Along these lines, we have prepared a 1997 edition, which we are pleased to present for your perusal.

We hope that this report will be actively utilized by not only those involved in science and technology activities but also a broad spectrum of people from diverse backgrounds. We welcome any feedback, which would help us further refine our indicators.

Taking this opportunity, we would like to express our deep gratitude to all those who have given us their generous support and assistance in the course of our endeavor to prepare this report.

May 1997

Masayasu Miyabayashi
Director-General,
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Chapter 1

Outline of Science &Technology Indicators
- Overview of Science & Technology Activities in Japan -

Chapter 1

Outline of Science & Technology Indicators

— Overview of Science & Technology Activities in Japan —

Chapter 1 provides a summary of this report. This chapter shows an overview of science and technology activities in Japan using major indicators. The figures shown in this chapter have been taken (reproduced) from later chapters.

1.1 Education and Human Resources Development for Science and Technology

International Comparison of Mathematics and Science Education for Junior High School Students

(1) According to an international comparison of mathematics and science education for junior high school students, Japan's educational achievement is rated top level in the world.

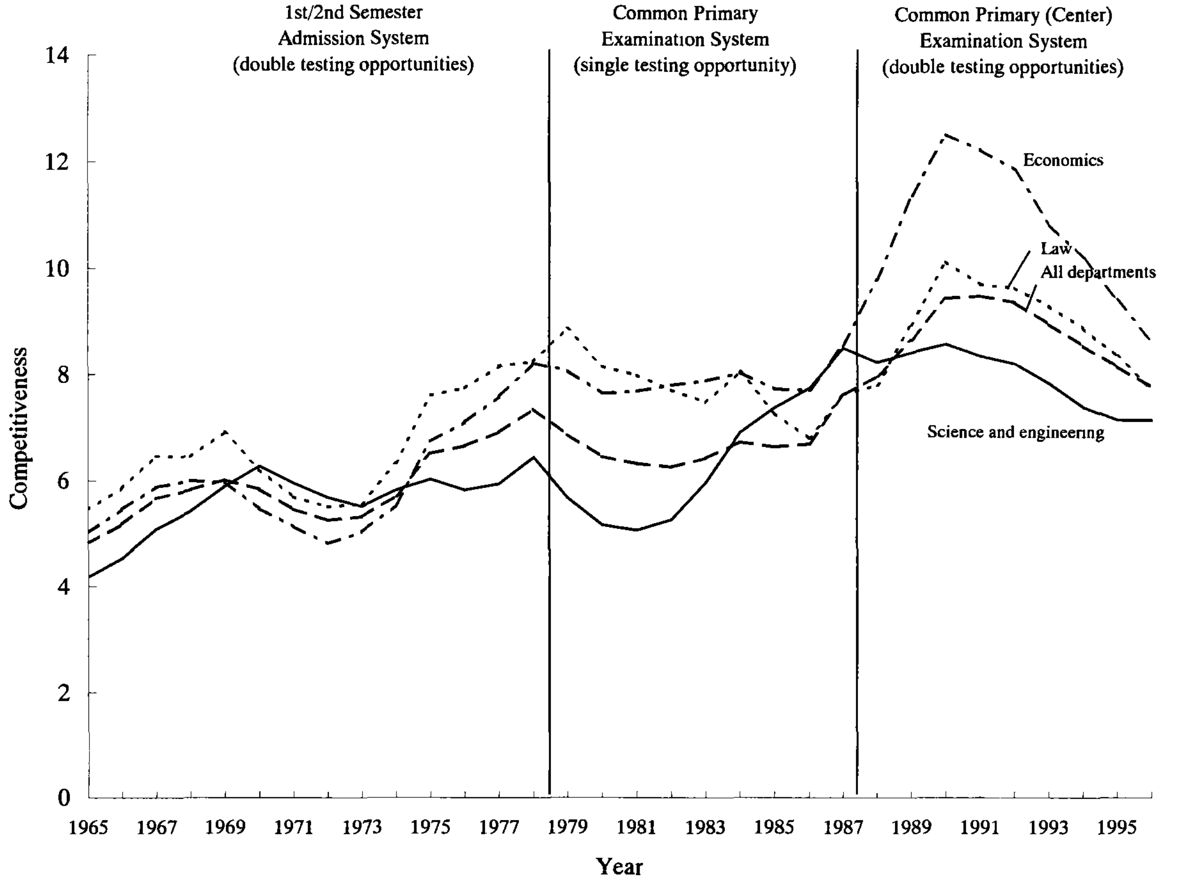
(2) However, the level of interest in these two subjects is found to be much lower than the international average.

Senior High Schools, Junior Colleges and Technical Colleges

(1) At senior high-school level, the share of students enrolled in technical courses peaked in 1970, and declined until 1990. However, this trend has recently leveled off.

(2) The total number of university applicants has been declining since 1993, with the share of applicants in science and engineering falling at a similar rate. On the other hand, the female share of applicants for science and engineering courses has been increasing at the same pace in other courses. In 1995, the admission competitiveness for science and engineering courses was the same as the previous year, despite the fact that the competitiveness in other courses continued to decline (Figure 1-1-1).

Figure 1-1-1 Admission Competitiveness of Colleges and Universities by Department



Source: Ministry of Education, Report of Basic Survey on Schools

(3) Regarding senior high school graduates entering the work force, the proportion of those finding a job in the manufacturing industry fluctuated after the mid-1980s, but has been steady for the past few years. Employment in the financial and insurance industry has been declining in the long term.

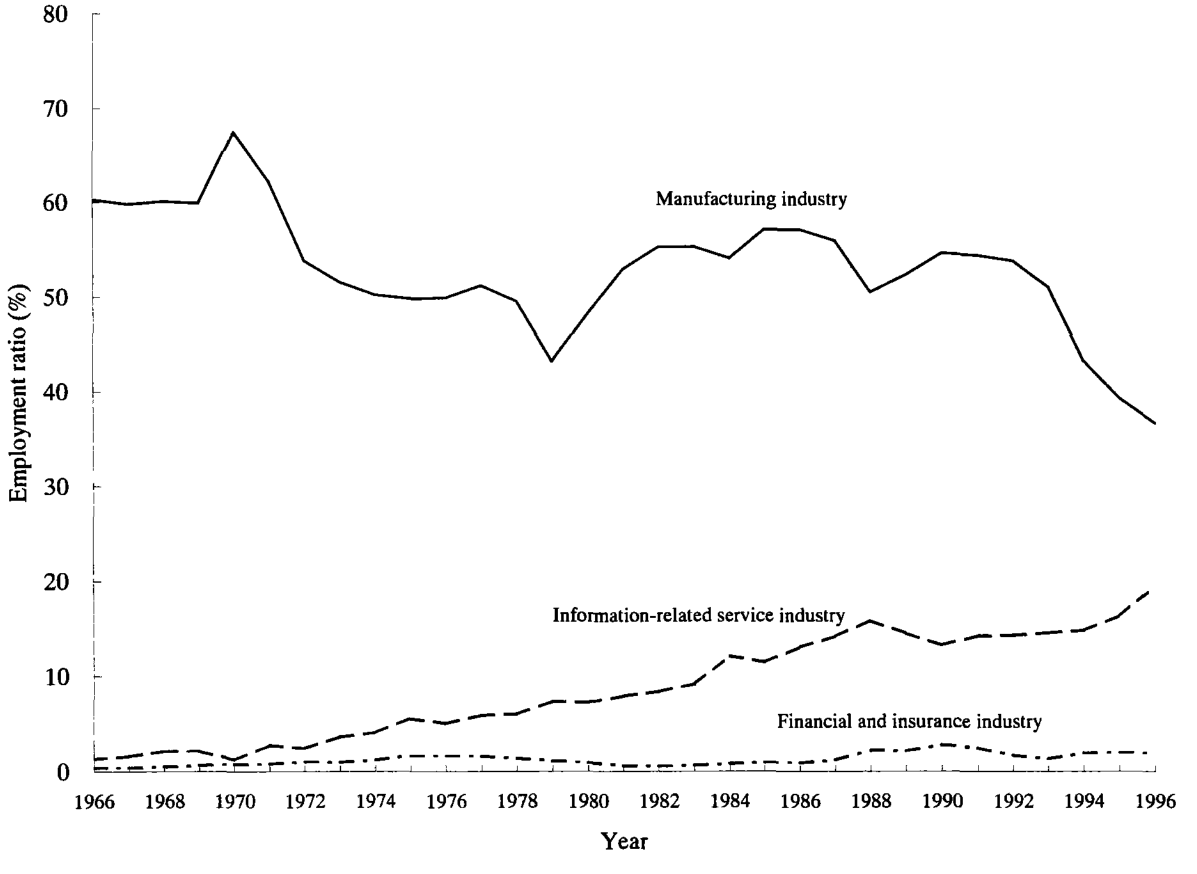
(4) While there has been in a slight long-term decline in the proportion of junior college (industry-related courses) and technical college graduates employed in the manufacturing industry, employment in the information and service industries has shown a long-term rise.

Universities (Undergraduate)

(1) Students enrolling in university science and engineering departments increased at a rate similar to the overall rate for all university entrants. Quotas for information-technology-related departments have increased dramatically.

(2) The proportion of graduates from science and engineering courses finding work in the manufacturing industry has been in decline in recent years. Employment in the information and service industries has risen on a long-term basis since the mid-1970s, but tailed off in recent years. The financial and insurance industry overall employs only a small proportion of science and engineering graduates, and the figure has remained static on a long-term basis (Figure 1-1-2).

Figure 1-1-2 Employment of Science and Engineering Graduates by Key Industrial Sector

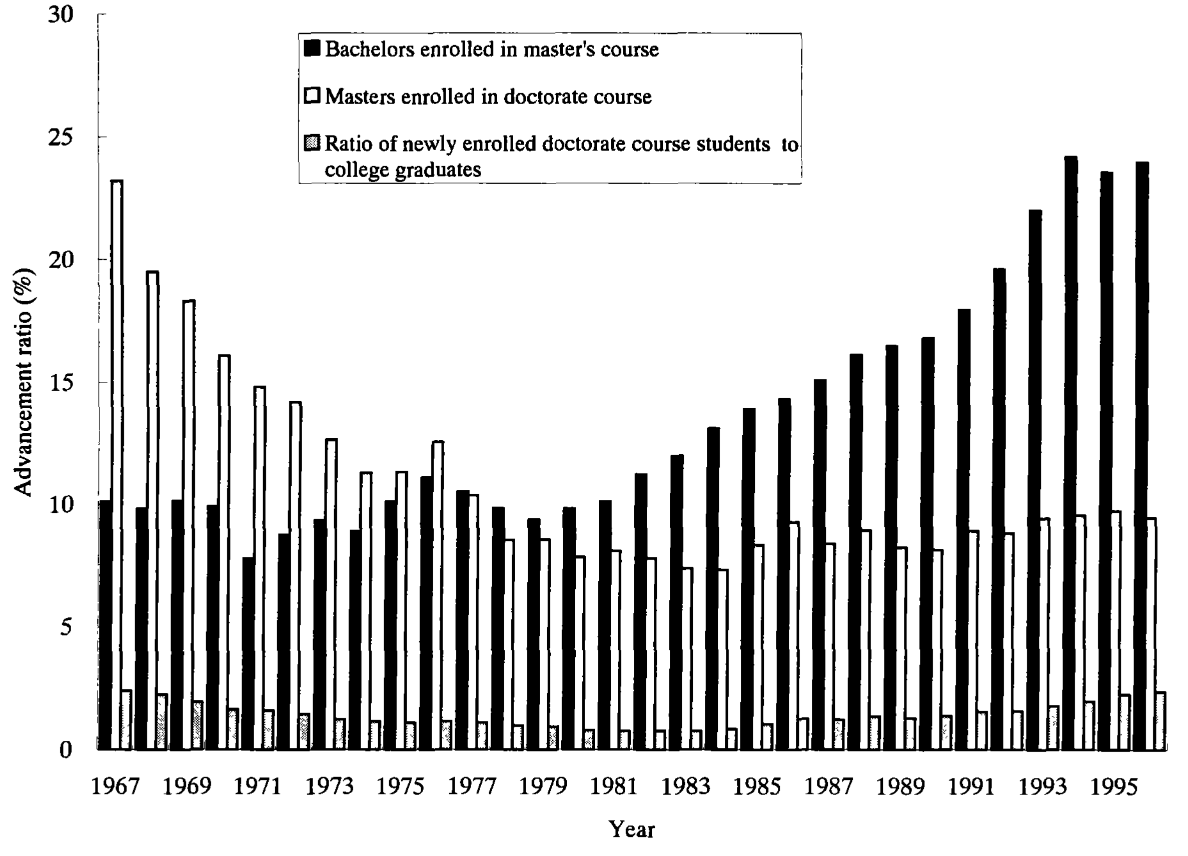


Sorce: Ministry of Edcation, Report of Basic Survay on Schools

Graduate Schools: Master's and Doctorate Courses

(1) Enrollment in master's courses as a whole has plateaued over the last few years, although, it has increased considerably on a long-term basis (Figure 1-1-3). Enrollment in doctorate courses in science and engineering departments has been steady overall since the 1980s. The number of persons with a Ph.D. in science and engineering per unit population in Japan is much lower than in the U.S.

Figure 1-1-3 Advancement Rate into Engineering Graduate Schools



Sorce: Ministry of Edcation, Report of Basic Survay on Schools

(2) The proportion of holders of master's degrees in science and engineering finding employment in the manufacturing industry has fallen dramatically over the last few years. In contrast, the employment ratio in information and service industries has continued to increase recently.

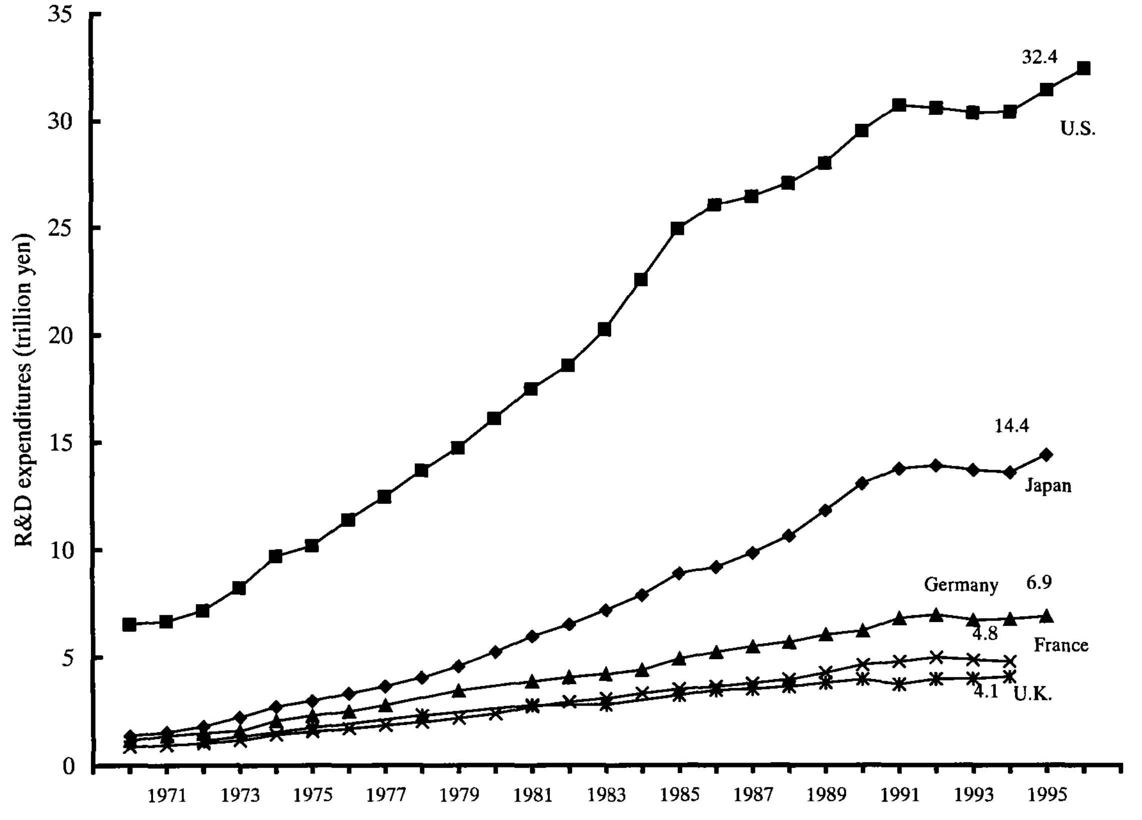
1.2 Research and Development Activities (R&D Expenditures and Number of R&D Personnel)

General Trends in Research and Development Activities

(1) Japan's R&D expenditures in FY 1995 stood at 14.4 trillion yen, up 5.8% from the previous fiscal year. This is in large part attributable to 4.5% rise in R&D expenditures in the private sector after consecutive yearly falls.

(2) Among major developed countries, R&D expenditures in the U.S. has increased for three consecutive years since 1994 based on OECD purchasing power parity, while it has been steady in Germany, France and the U.K. over the last few years (Figure 1-2-1).

Figure 1-2-1 R&D Expenditures in Selected Countries
(OECD purchasing power parity calculation basis)



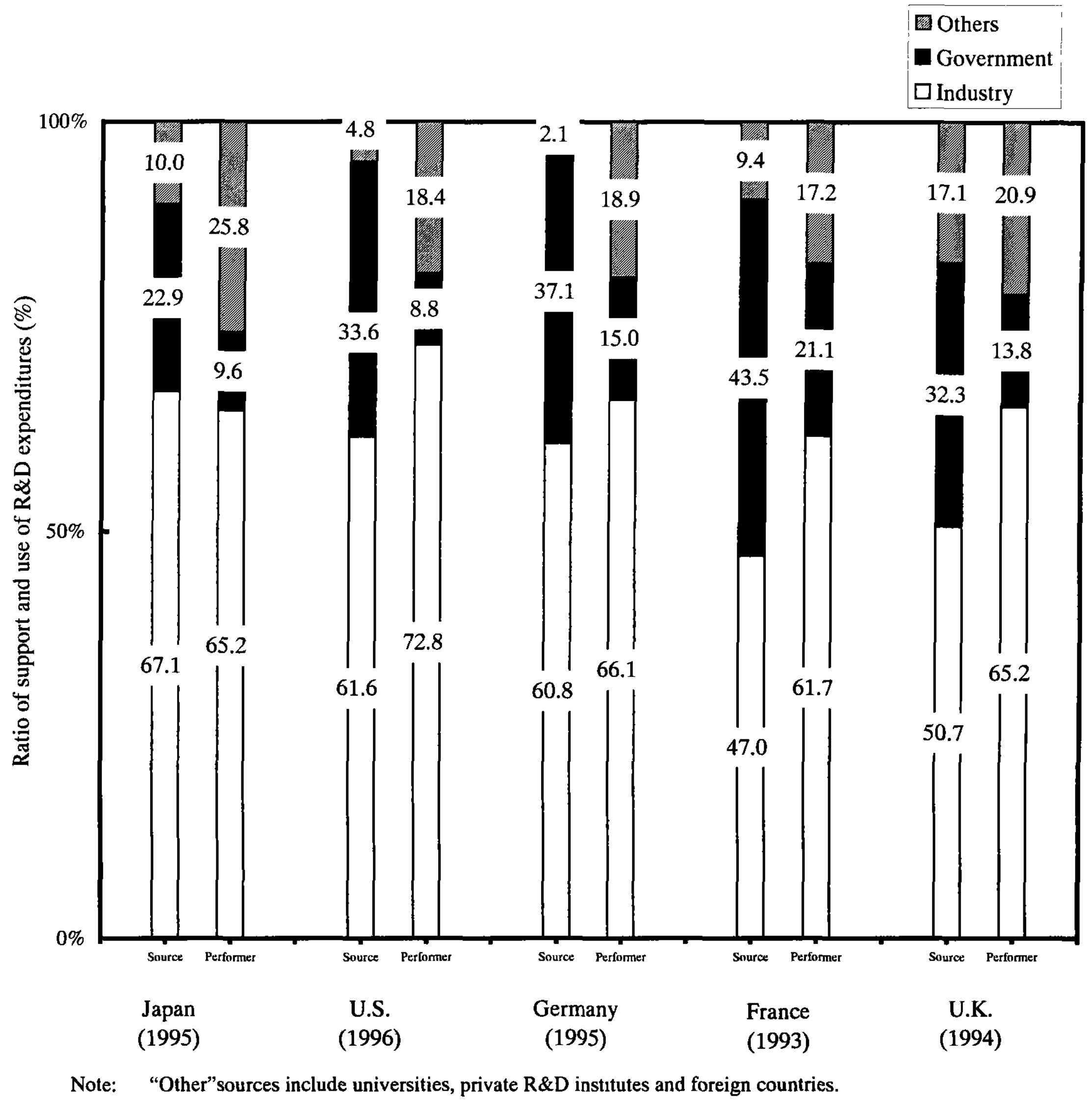
Source: Japan – Management & Coordination Agency, Report on the Survay on Science and Technology Reserch
U.S. – National Science Foundation, National Patterns of R&D Resources:1996
Germany – Bundesministerium fur Forschung und Technologie, Bundesbericht Forschung: 1996
France – OECD, Basic Science and Technology Statistics 1996
U.K. – Forward Look 96

(3) According to an international comparison of R&D expenditures in terms of its ratio to GNP (Gross National Product), Japan's R&D expenditures has been at the highest level since 1989, although it has eased somewhat after peaking at 2.96% in 1990. The ratio stood at 2.82% in 1994. On the other hand, R&D expenditures in the U.S. increased for two consecutive years, reaching highest level of 2.57% in 1995.

(4) Distinguishing between defense-related R&D expenditures and those for civilian purposes in individual countries, the small proportion of defense-related R&D expenditures in Japan vis-à-vis the high share of such expenditures in the U.S. can be readily noted. The proportion of defense-related R&D expenditures in Germany is lower than that of the U.K. or France.

(5) Comparing R&D expenditures by sector (industrial, academic, and government), one finds that the Japanese Government contributes about 20% of the total R&D expenditures, substantially less than the governments of the U.S. and major European countries (Figure 1-2-2). Slightly less than 70% of the total R&D expenditures is used by the industrial sector. In Japan, only a small part of R&D funds flow from government to industry. In the U.S., in contrast, there is a large R&D fund flow from government to industry.

Figure 1-2-2 R&D Expenditures by Source and Performer in Selected Countries

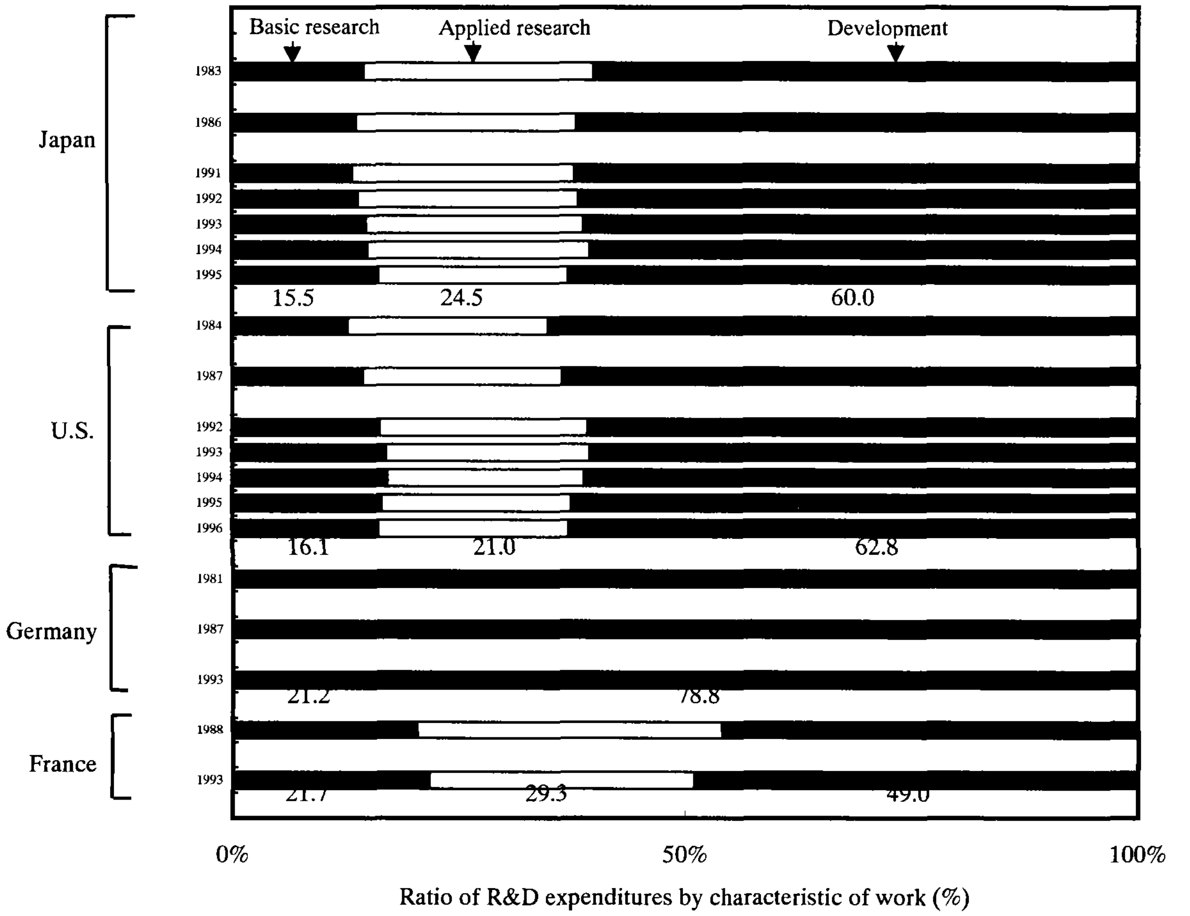


Note: "Other"sources include universities, private R&D institutes and foreign countries.
"Other" performaers include universities and private R&D institutes.
With Germany , the "Government" sector as the "performer" includes private R&D institutes.

Sources: Japan – Management & Coordination Agency, Report on the Survay on Science and Technology Research
U.S. – National Science Foundation, National Patterns of R&D Resources:1996
Germany – Bundesministerium fur Forschung und Technologie, Bundesbericht Forschung: 1996
France – OECD, Basic Science and Technology Statistics 1996
U.K. – Forward Look 96

(6) The basic research share of total R&D expenditures in Japan, though still smaller than that of other major developed countries, has been increasing since FY 1991, standing at 15.5% in FY 1995 (Figure 1-2-3). The U.S. devotes the same or slightly higher proportion of its total R&D funds to basic research, while the share of basic research in Germany and France is higher, at around 20%.

Figure 1-2-3 R&D Expenditures in Selected Countries by Characteristic of Work



Note: No distinction between applied research and development is drawn for Germany.

Sources: Japan – Management & Coordination Agency, Report on the Survay on Science and Technology Research

U.S. – National Science Foundation, National Patterns of R&D Resources:1996

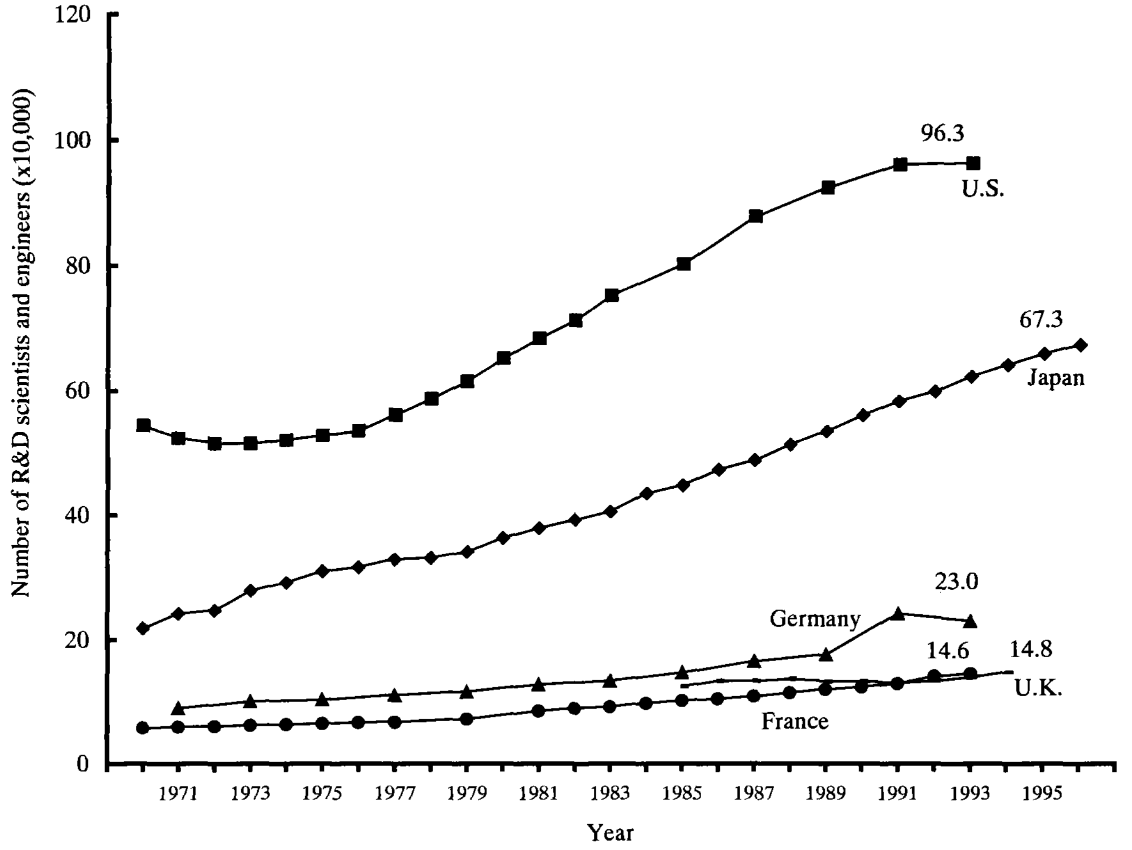
Germany – Bundesministerium fur Forschung und Technologie, Bundesbericht Forschung: 1996

France – OECD, Basic Science and Technology Statistics 1996

U.K. – Forward Look 96

(7) In 1996 there were 673,000 R&D scientists and engineers in Japan, and this represents about a 1.9 fold increase between 1980 and 1996 (Figure 1-2-4). In major developed countries including Japan, 60-80% of R&D scientists and engineers work in the industrial sector, and, in each of these countries, a major factor in the increase in R&D scientists and engineers over the past two decades has been a rise in the number of R&D scientists and engineers working in the industry.

Figure 1-2-4 Number of R&D Scientists and Engineers in Selected Countries



Note: The number of R&D scientists and engineers in Japan is not FTE-converted.
Figures for Germany cover West Germany only up to 1989 and represent unified Germany from 1991 onwards.

Sources: Japan – Management & Coordination Agency, Report on the Survay on Science and Technology Research
U.S. – National Science Foundation, National Patterns of R&D Resources:1996
Germany – Bundesministerium fur Forschung und Technologie, Bundesbericht Forschung: 1996
France – OECD, Basic Science and Technology Statistics 1996
U.K. – Forward Look 96

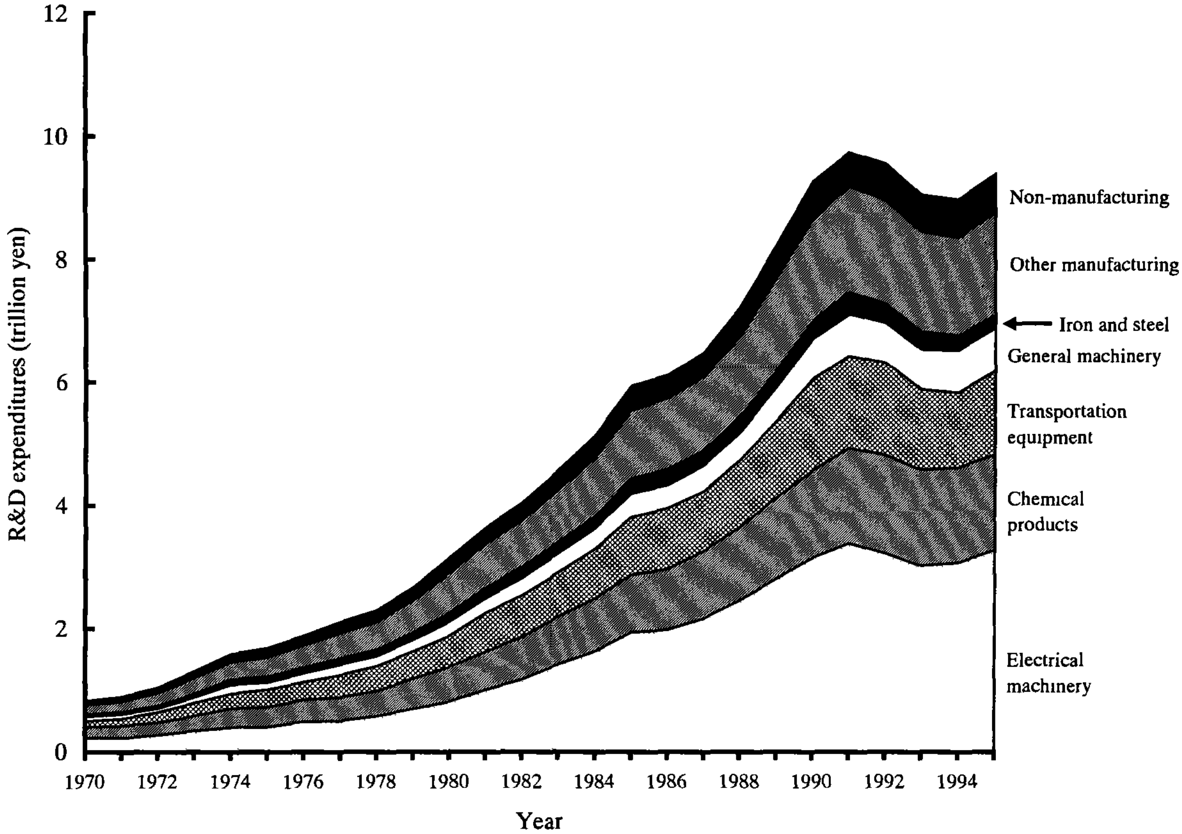
(8) The number of research support workers in Japan has been in decline for three consecutive years since 1994. The number of research support workers per R&D scientist or engineer in Japan is only 0.41 (1996), which compares with 1.07 in Germany (1993), 1.15 in France (1993) and 0.99 in the U.K. (1993). Thus, major European countries are much more generous in terms of the number of support workers than Japan. Statistical data on the number of research support workers in the U.S. is not available.

R&D in Industrial Sector

(1) After falling for three consecutive years from FY 1992, industrial R&D expenditures increased in FY 1995.

(2) By individual industry, electrical machinery manufacturing has consistently claimed the largest share of R&D expenditures, followed by chemical products manufacturing and transportation equipment manufacturing. These three industries alone account for 66% (FY 1995) of total industrial R&D expenditures (Figure 1-2-5).

Figure 1-2-5 R&D Expenditures in Japanese Industry



Source: Management & Coordination Agency, Report on the Survay of Research and Development

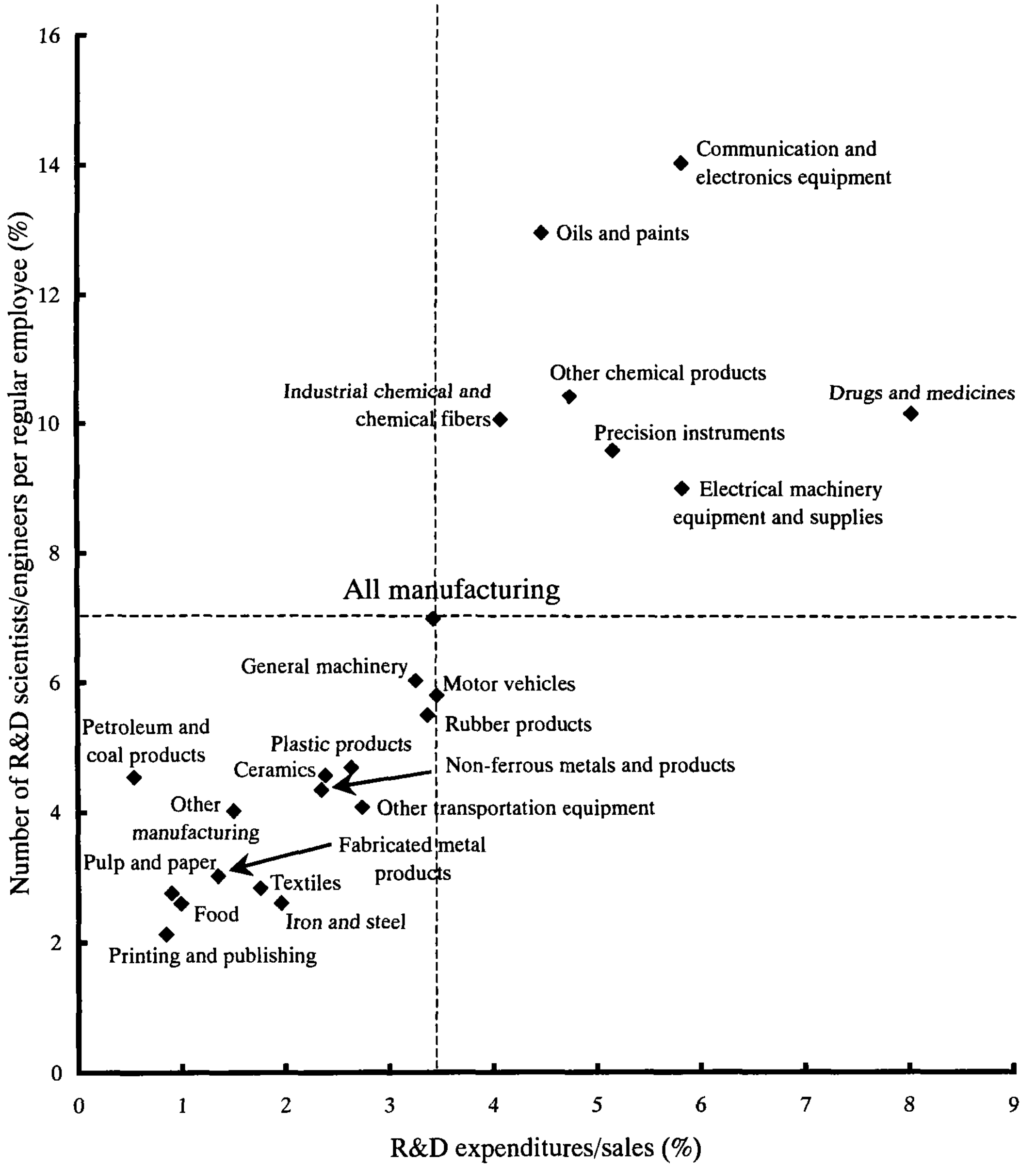
(3) When R&D expenditures are examined by product category, communication and electronics equipment comes out on top, followed by motor vehicles and electrical machinery, and drugs and medicines.

(4) The number of R&D scientists and engineers in Japanese industry as a whole has increased on a long-term basis, and the electrical machinery manufacturing industry has witnessed an especially significant increase in the number of its R&D scientists and

engineers.

(5) The ratio of R&D expenditures to sales and the number of R&D scientists and engineers per employee can serve as indicators of "R&D intensity", showing the levels of R&D expenditures and allocation of human resources to R&D. By individual manufacturing industry, the value of R&D intensity exceeded the manufacturing industry average in drugs and medicines manufacturing, communication and electronics equipment manufacturing, and precision instruments manufacturing, etc. (Figure 1-2-6).

Figure 1-2-6 R&D Intensity by Industry (1995)



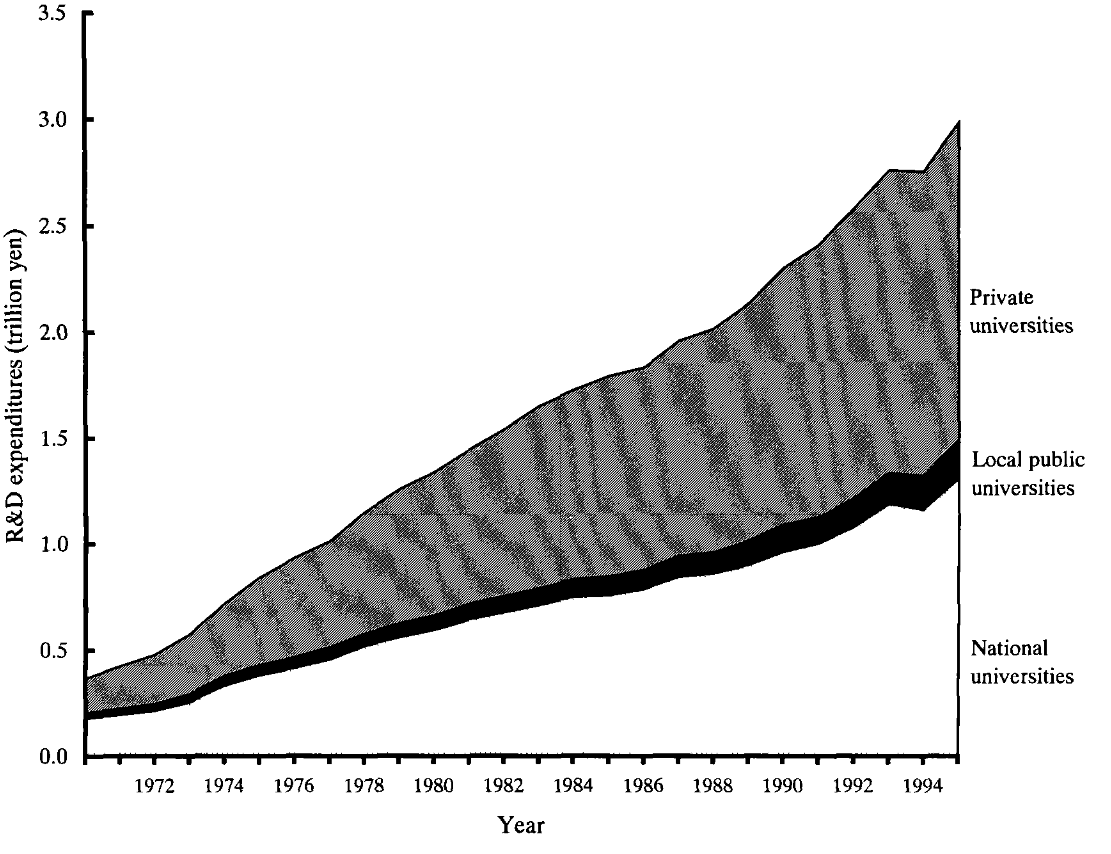
Note: The data is based on calendr years.

Source: Management & Coordination Agency, Report on the Survay of Research and Development

R&D at Universities

(1) While growth in R&D expenditures at private universities has long been higher than that at national universities, R&D expenditures at national universities rose sharply in FY 1995, contributing to the large increase in university R&D expenditures (Figure 1-2-7).

Figure 1-2-7 R&D Expenditures in Japanese Universities (by type of institution)



Source: Management & Coordination Agency, Report on the Survay of Research and Development

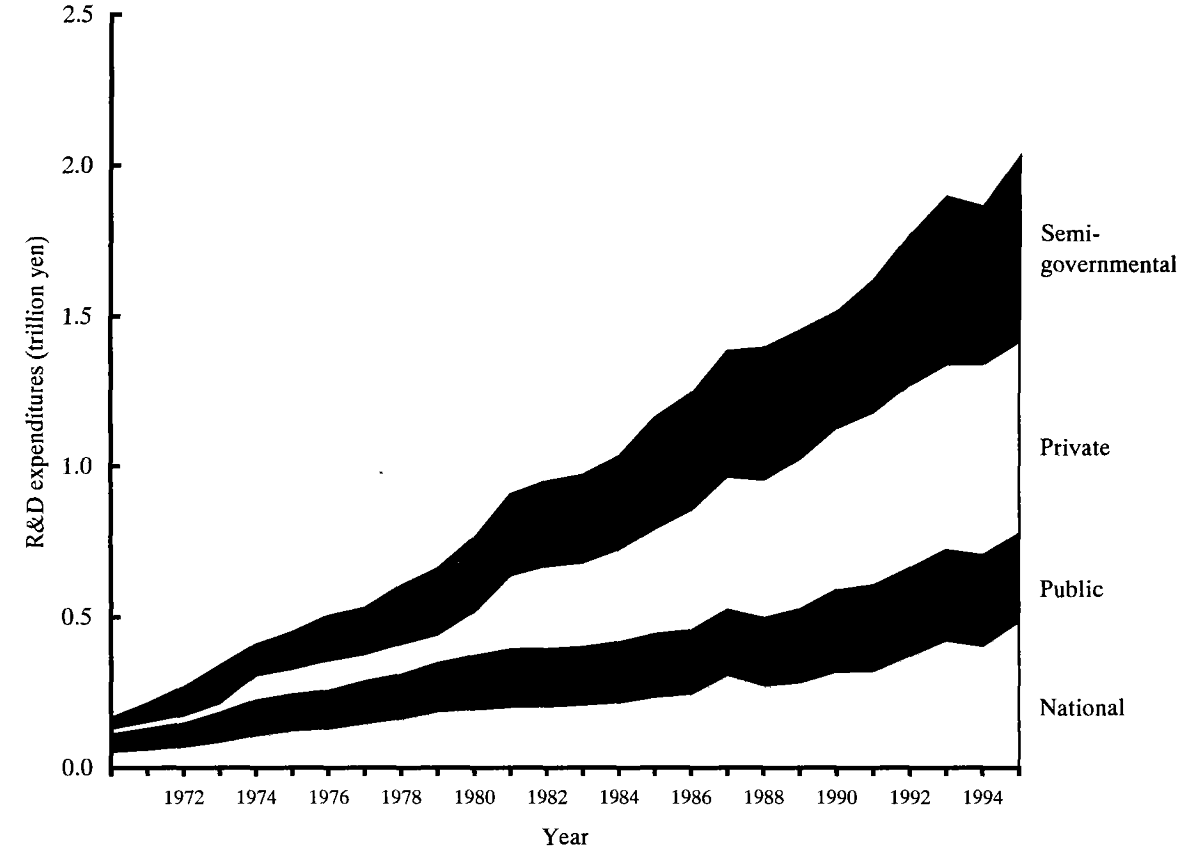
(2) The number of R&D scientists/engineers working at universities has steadily climbed. In 1996, national and private universities had a similar number of R&D scientists/engineers. R&D scientists/engineers in the natural sciences have outnumbered those in the humanities/social sciences by about two to one in recent years. Health is the largest academic field in terms of the number of R&D scientists/engineers within the natural sciences.

(3) University R&D expenditures per scientist/engineer are highest at private universities. Among the natural sciences, figures are particularly high in physical science and engineering.

R&D at R&D Institutions

(1) In FY 1995, R&D institutions (research institutions run by National Government, local governments, semi-governmental corporations, and non-profit private organizations) accounted for 13.7% of Japan's total R&D expenditures, and the figure has been rising over the past few years. Among R&D institutions, non-profit private organizations and semi-governmental corporations have the largest R&D expenditures (Figure 1-2-8).

Figure 1-2-8 R&D Expenditures in Japanese R&D Institutions



Source: Management & Coordination Agency, Report on the Survay of Research and Development

(2) In recent years, the growth rate in the number of R&D scientists/engineers at R&D institutions as a whole has been lower than that in industry or at universities, and this is especially so with national R&D institutions. Among R&D institutions, those in the private sector exhibit a particularly high growth in the number of R&D scientists/engineers.

(3) R&D expenditures per R&D scientist/engineer are highest at R&D institutions run by semi-governmental corporations, as these research institutions are engaged in large-scale

R&D projects.

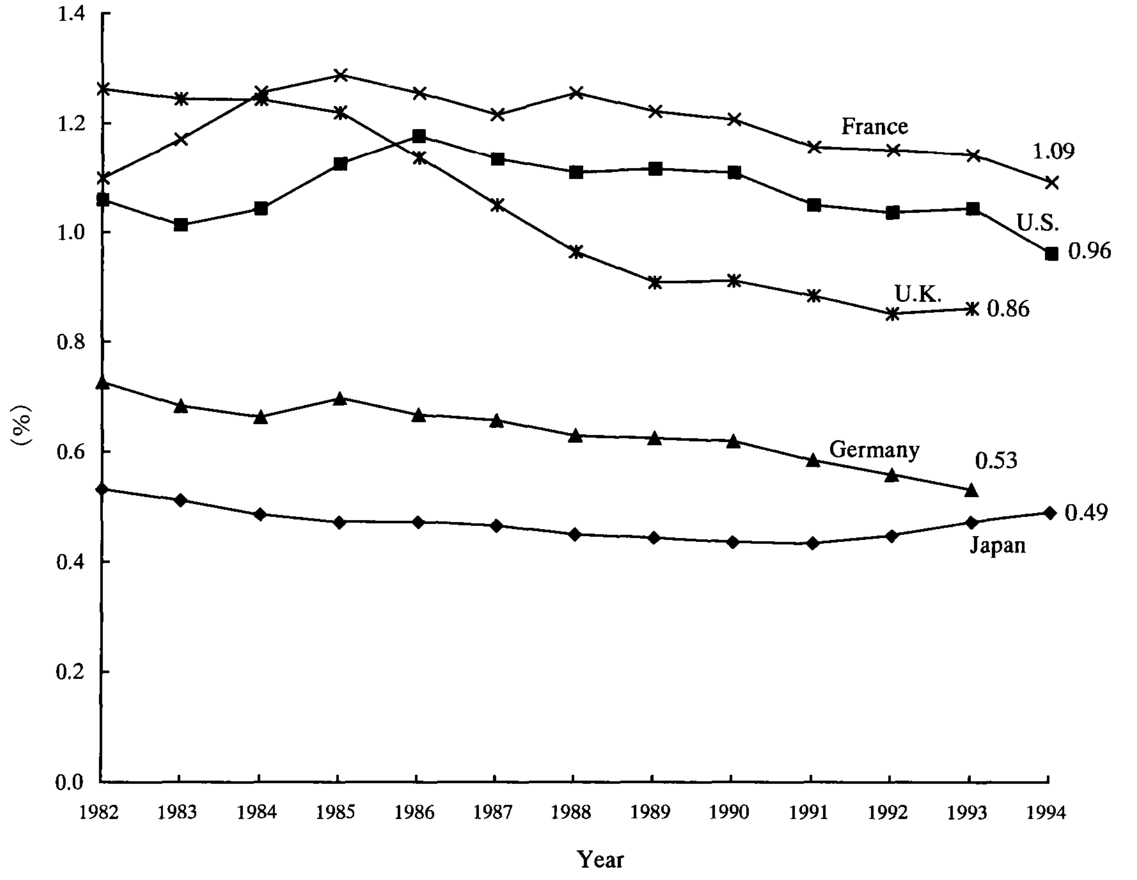
1.3 Science and Technology Support Infrastructure

Government Support through Science and Technology Budget

(1) Amounting to 2,672 billion yen in FY 1994, the Japanese Government's S&T budget has been steadily increasing in recent years. Compared to the overall budget, the S&T budget exhibits a large growth rate.

(2) Looking at major developed countries' government S&T budget in terms of its ratio to GNP, Japan's is only about half that of the U.S., France, and the U.K. — a level extremely low considering the size of its economy (Figure 1-3-1).

Figure 1-3-1 Ratio of Government S&T Budget to GNP in Selected Countries



Source: Science and Technology Agency

(3) The Ministry of Education claimed the largest share of the total S&T budget, about half

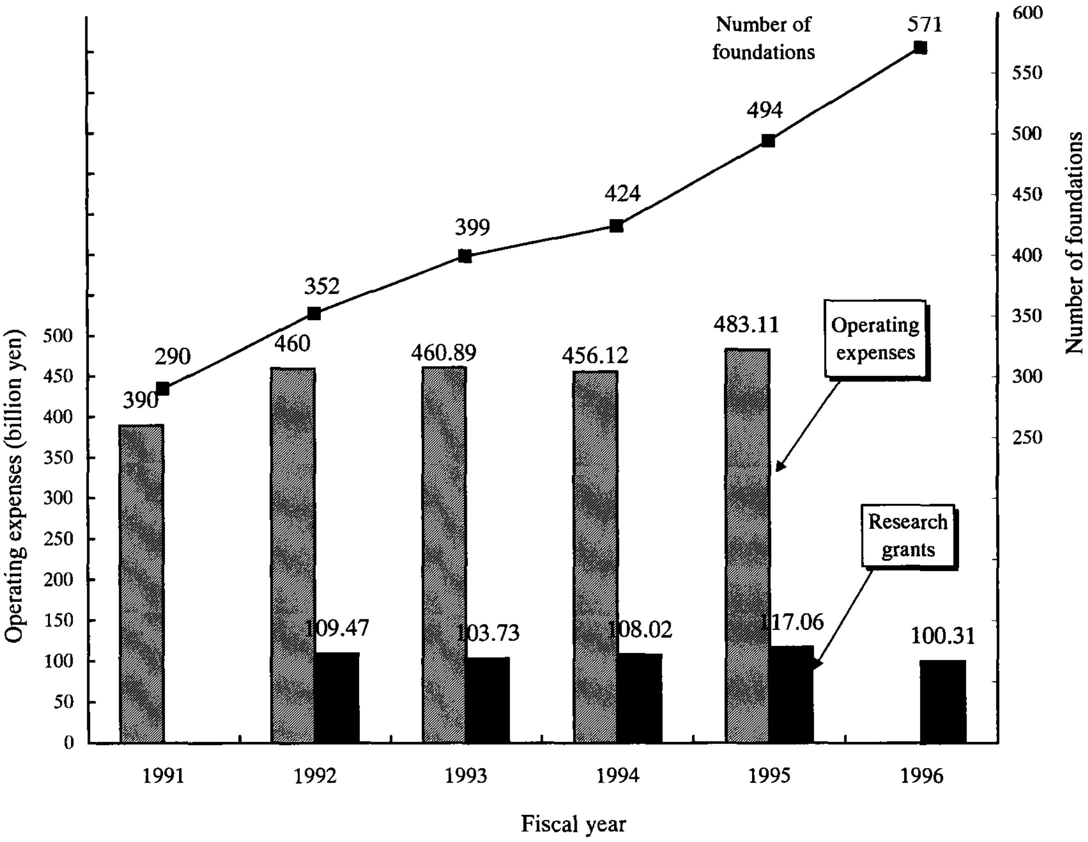
— followed by the Science and Technology Agency, with about a quarter, and the Ministry of International Trade and Industry, about one-eighth.

(4) In a comparison of major developed countries in terms of the nature of their government S&T budget based on the OECD socioeconomic objective classification, Japan is characterized as having an extremely high share of funds devoted to the "advancement of knowledge" (mainly university research funds), followed by "energy". "Defense" has the largest share in the U.S., France, and the U.K., while in Germany, as in Japan, "advancement of knowledge" is first.

Social Support Infrastructure

(1) Research funds provided by science and technology foundations in Japan play an important part as a source of financial assistance for researchers, although this service is relatively small-scale (Figure 1-3-2).

Figure 1-3-2 Number of Research Support Foundations and Scale of Activities



Note: Data for fiscal years not shown is either not available or not yet complied.

Source: Supportive Foundations Data Center

(2) In 1995, registered academic societies were most numerous in the medical and humanities areas in Japan, followed by engineering, physical science, and agriculture.

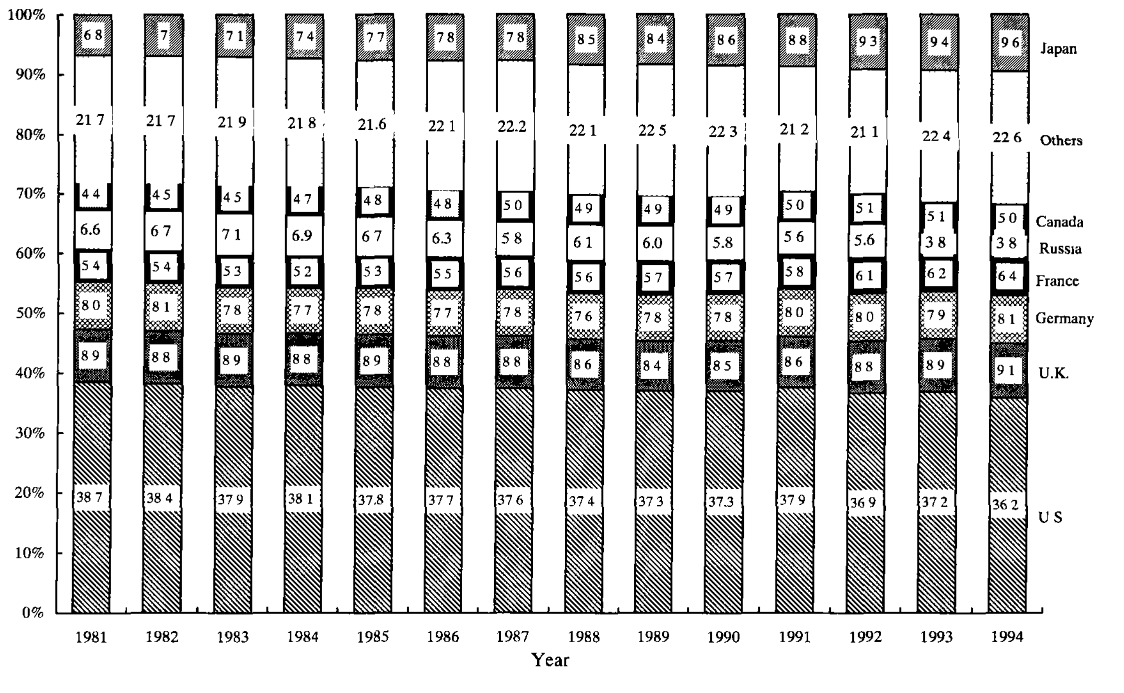
(3) The number of visitors to science museums peaked in 1980, and has since been somewhat on the decline.

1.4 Achievements of R&D Activities

Scientific Papers

(1) By country, the U.S. has consistently held the largest share of the number of scientific and engineering papers produced, and Japan took second place in 1992. The increase in Japan's share is quite notable worldwide (Figure 1-4-1).

Figure 1-4-1 Country Share Trends in the Production of Scientific Papers



Note: Up to 1992, figures under Russia apply to the Soviet Union.

Source: Institute for Scientific Information, National Science Indication on Diskette, 1981-1995

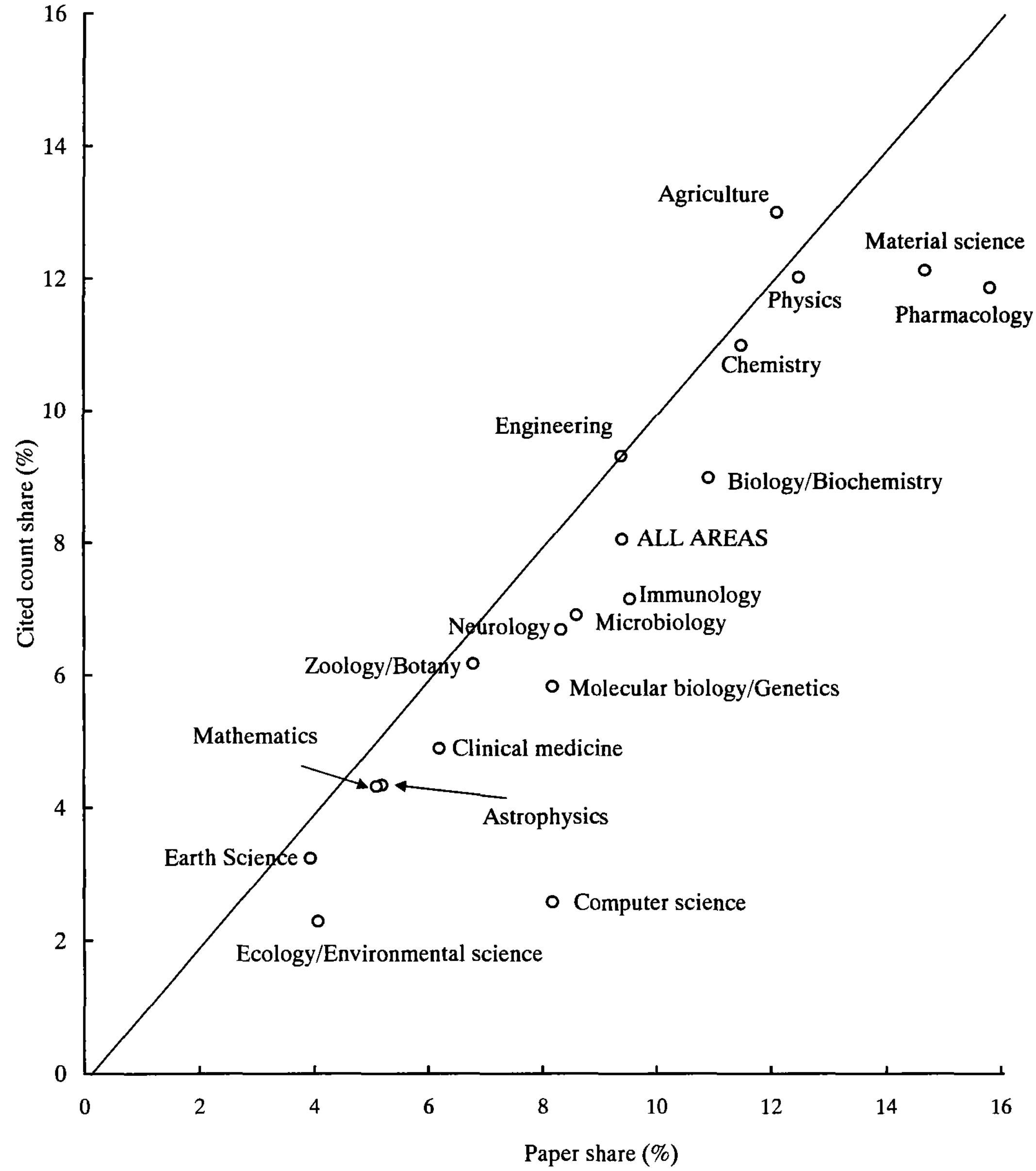
(2) The U.S. has the largest citing share of scientific papers with about half of the papers cited in the world. Although the number of citations of Japanese papers is fourth, the number of citations per paper is relatively low.

(3) Japan has a large share of scientific papers produced in the areas of pharmacology and

material science, but only a small share in earth science and ecology/environmental science. In computer science, Japan's share is minor compared to that of the U.S.

(4) Japanese scientific paper citation frequency is relatively high in agriculture, physics, engineering and chemistry, while it is relatively low in ecology/environmental science and computer science (Figure 1-4-2).

Figure 1-4-2 Japanese Scientific Paper Citation Frequency by Academic Field (1992–1994 average)

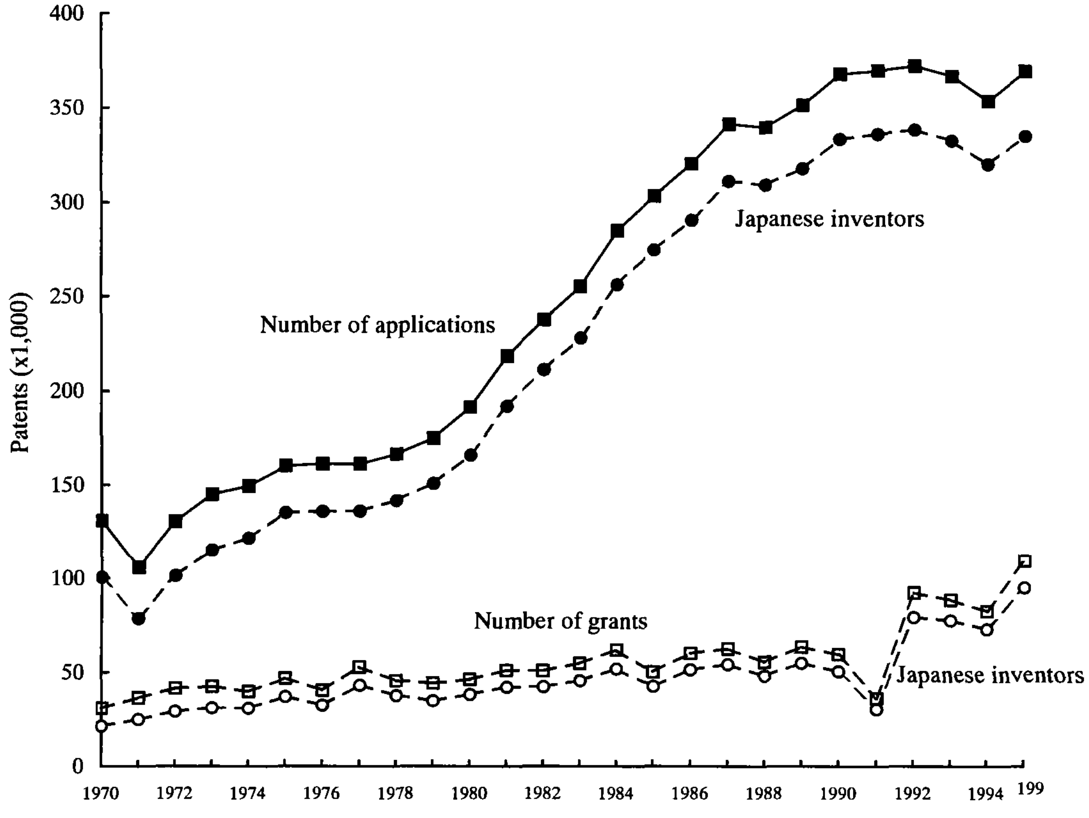


Source: Institute for Scientific Information, National Science Indication on Diskette, 1981-1995

Patents

(1) After falling in 1994, the number of patent applications and patent grants in Japan rose again in 1995 (Figure 1-4-3).

Figure 1-4-3 Patenting Trends in Japan



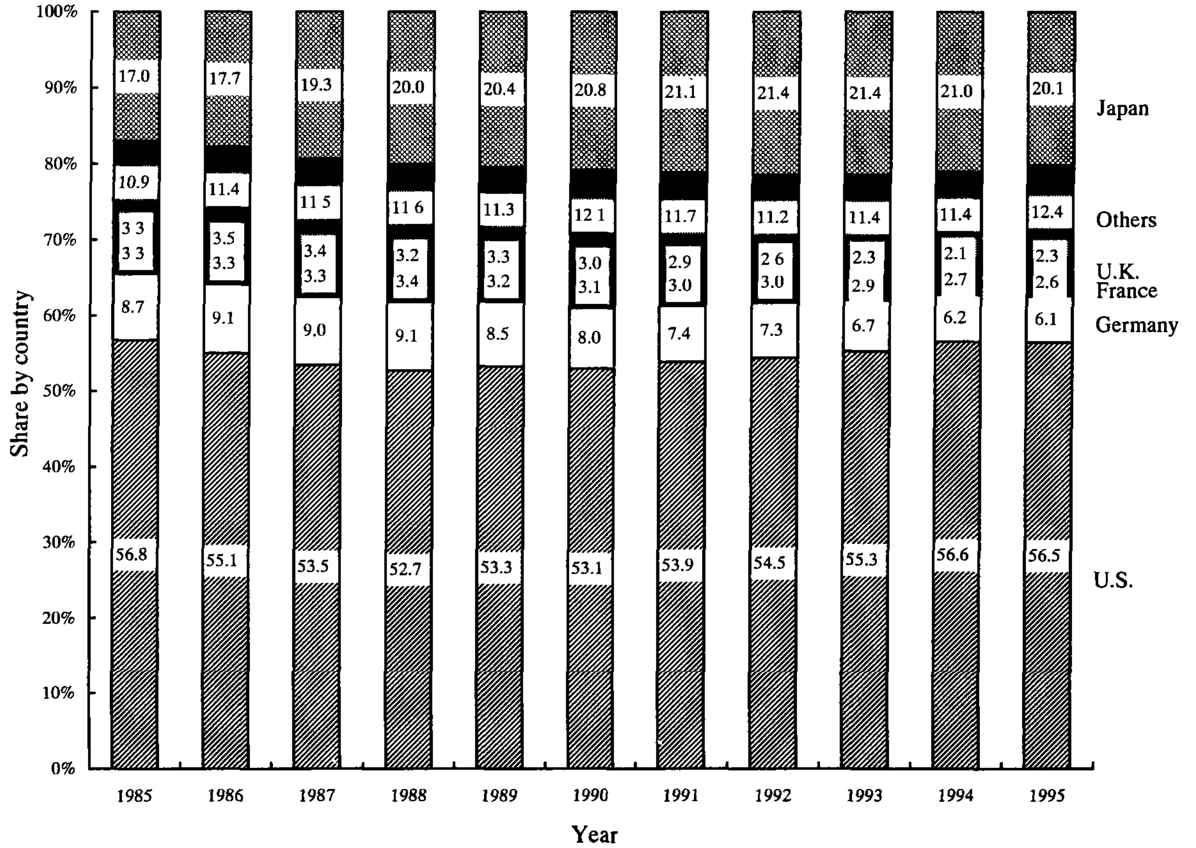
Source: Patent Office, Patent Office Annual Report

(2) The number of patent applications in Japan has been high in the areas of basic electrical components, telecommunications technology, and computation/counting for two consecutive years.

(3) In 1993, Japanese patent applications to foreign countries were most in the U.S., followed by Germany and the U.K. The ratio of Japanese patent applications in the U.S. and Germany to the total Japanese foreign patent applications has been declining in recent years, while Italy and other European countries as well as South Korea have been receiving an increasing number of Japanese applications.

(4) The Japanese constitute the largest group of foreigners holding registered U.S. patents. In 1995, with share of 20% (Figure 1-4-4).

Figure 1-4-4 Patent Grant Share Trends by Country in the U.S. (1985–1995)



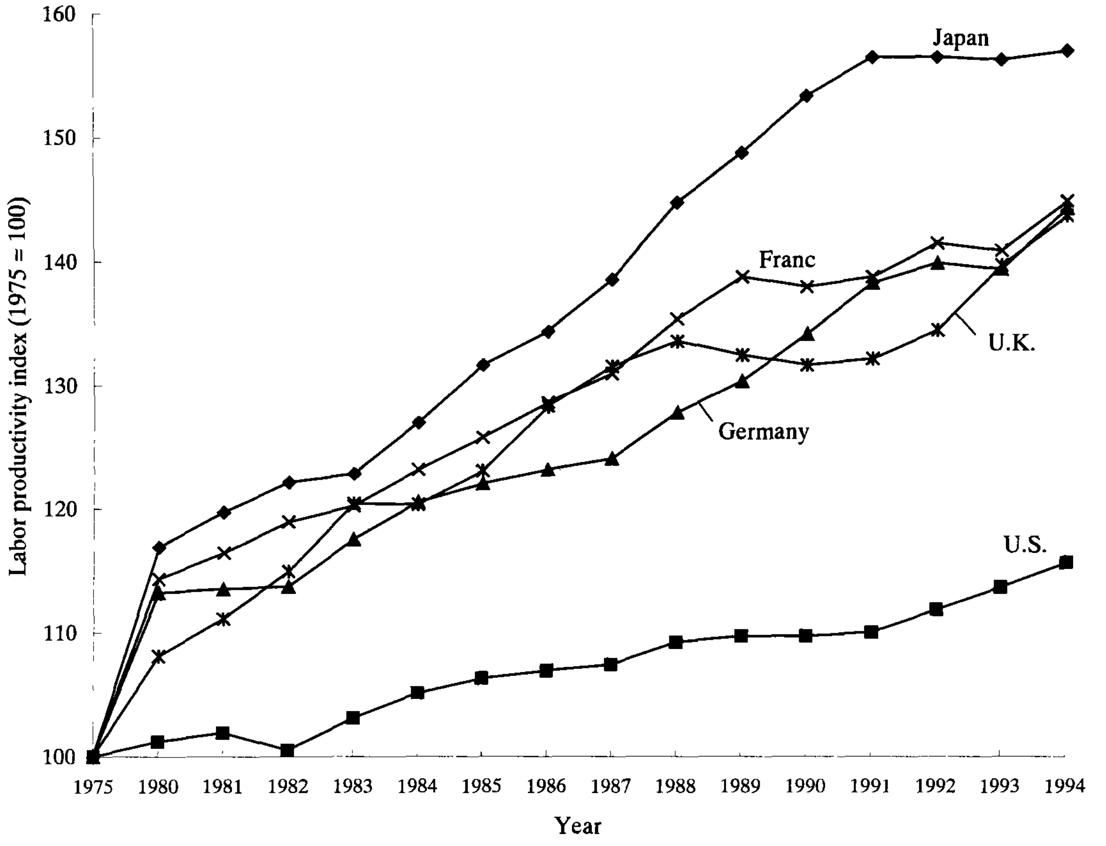
Source: U.S. Department of Commerce, Setting The Course For Our Future – A Patent and Trademark Office Review -

1.5 Economic and Social Contribution of Science and Technology

Contribution to Economic Growth

(1) Japan's added-value labor productivity increased at a pace far greater than that of other major developed countries until 1991, but has not increased since 1992 due to recession (Figure 1-5-1).

Figure 1-5-1 Labor productivity Index of Added Value Trends in Selected Countries



Note: The data shows the index of real GDP/ employed persons. Currencies have been converted based on the purchasing power parity of 1990 prices.

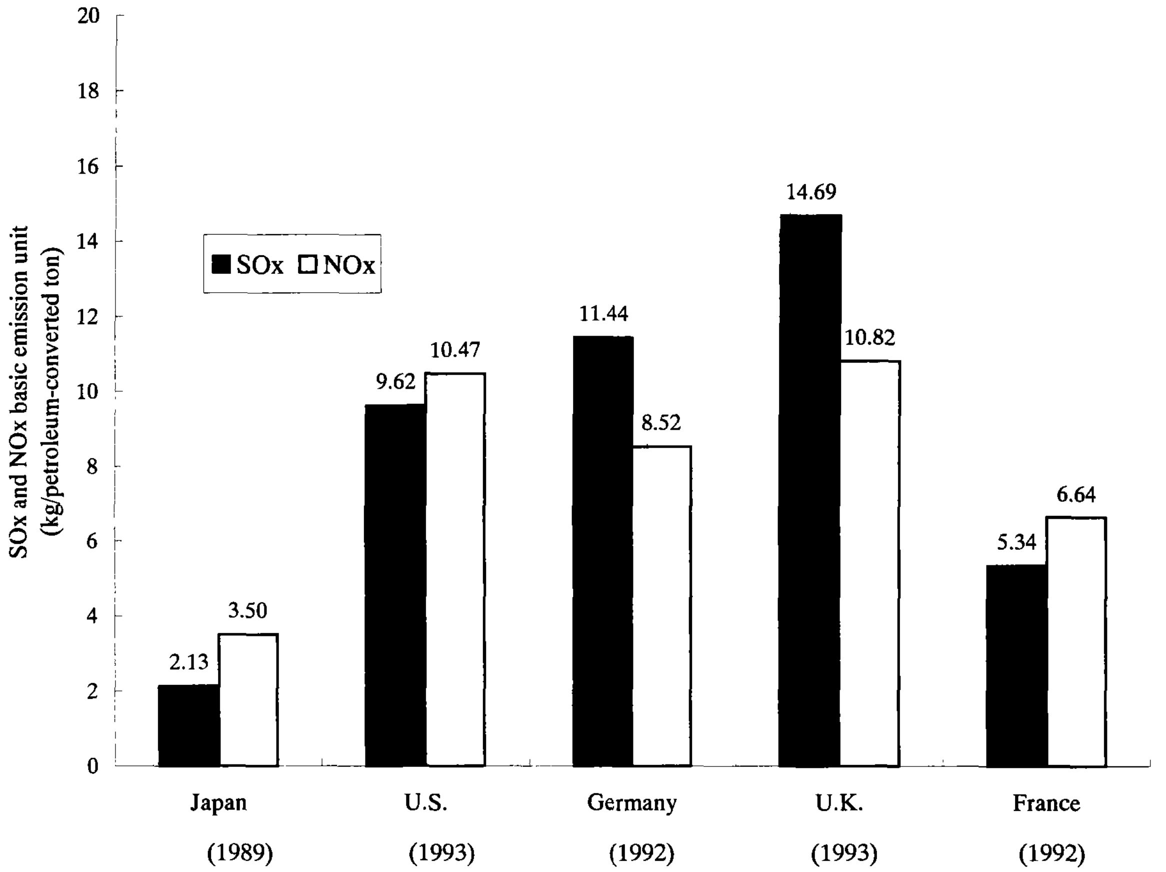
Source: Japan Productivity Center for Socio-Economic Development, International Comparison of Labor Productivity, (1996)

(2) Regarding the total factor productivity, Japan and Germany recorded an annual average growth rate of 1.4% between 1985 and 1990, followed by France at 1.3%, while the figure for the U.S. was 0.01%.

Contribution to Global Environmental Preservation

(1) Measures such as the introduction of exhaust gas desulphurization and denitration systems have made Japan's SOx and NOx emissions per unit primary energy consumption the lowest in the world (Figure 1-5-2).

Figure 1-5-2 SOx and NOx Basic Emission Unit (emission per unit fuel consumption)



Source: OECD, Environmaental Data, Compedium 1995

(2) Although CO_2 emissions per unit primary energy consumption in Japan have fallen slightly, they are still higher than those of France and Canada.

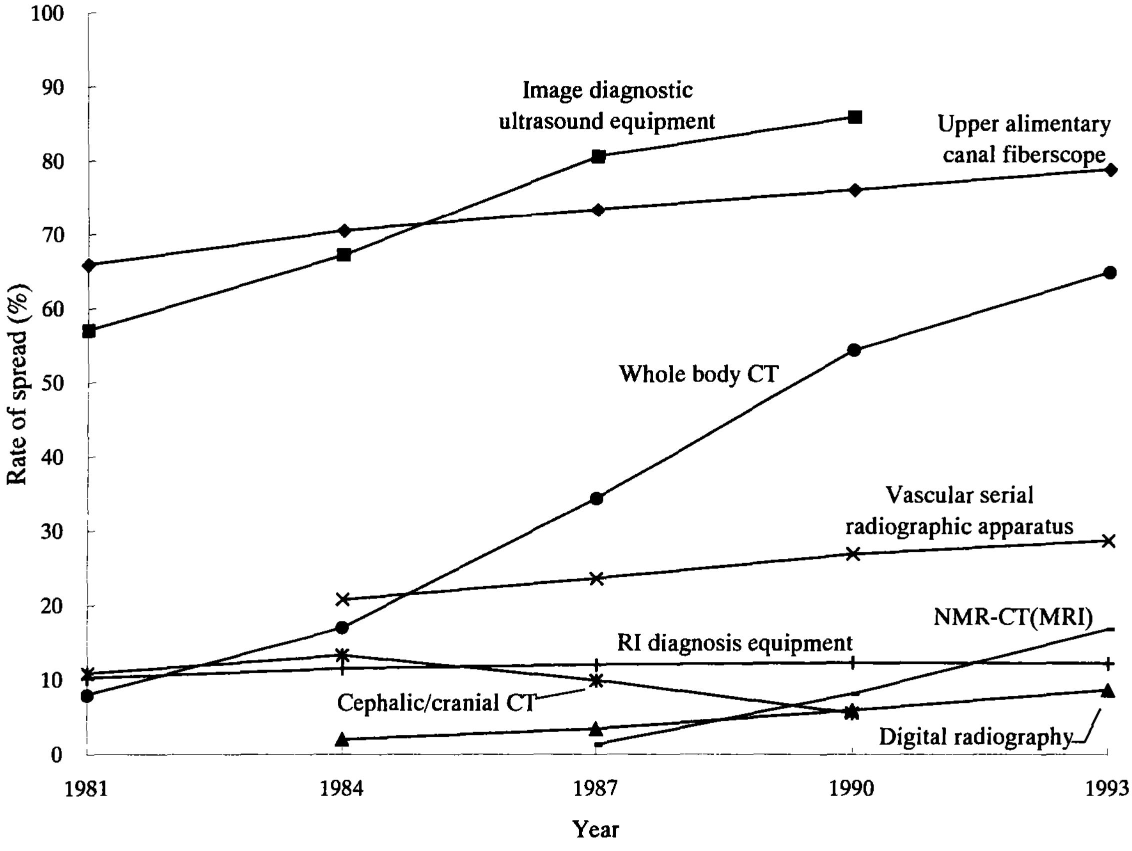
(3) According to FY 1993 data, 39% of industrial wastes generated by the Japanese manufacturing industry are recycled. Japan's waste paper recycling rate is the highest in the world.

Improvement of Medical Care

(1) Regarding the development of drugs, the approval of new products such as circulatory-organ drugs, vitamin supplements and metabolic disease drugs has been increasing in recent years. Most recently, progress has been made in the development of biotechnology-applied drugs.

(2) The use of diagnostic imaging ultrasonic equipment and whole-body CT scanners has been steadily increasing, with remarkable growth rate of MRI (Magnetic Resonance Imaging) equipment (Figure 1-5-3). Although the use of therapeutic devices is not as widespread as diagnostic devices, it has nevertheless been steadily increasing.

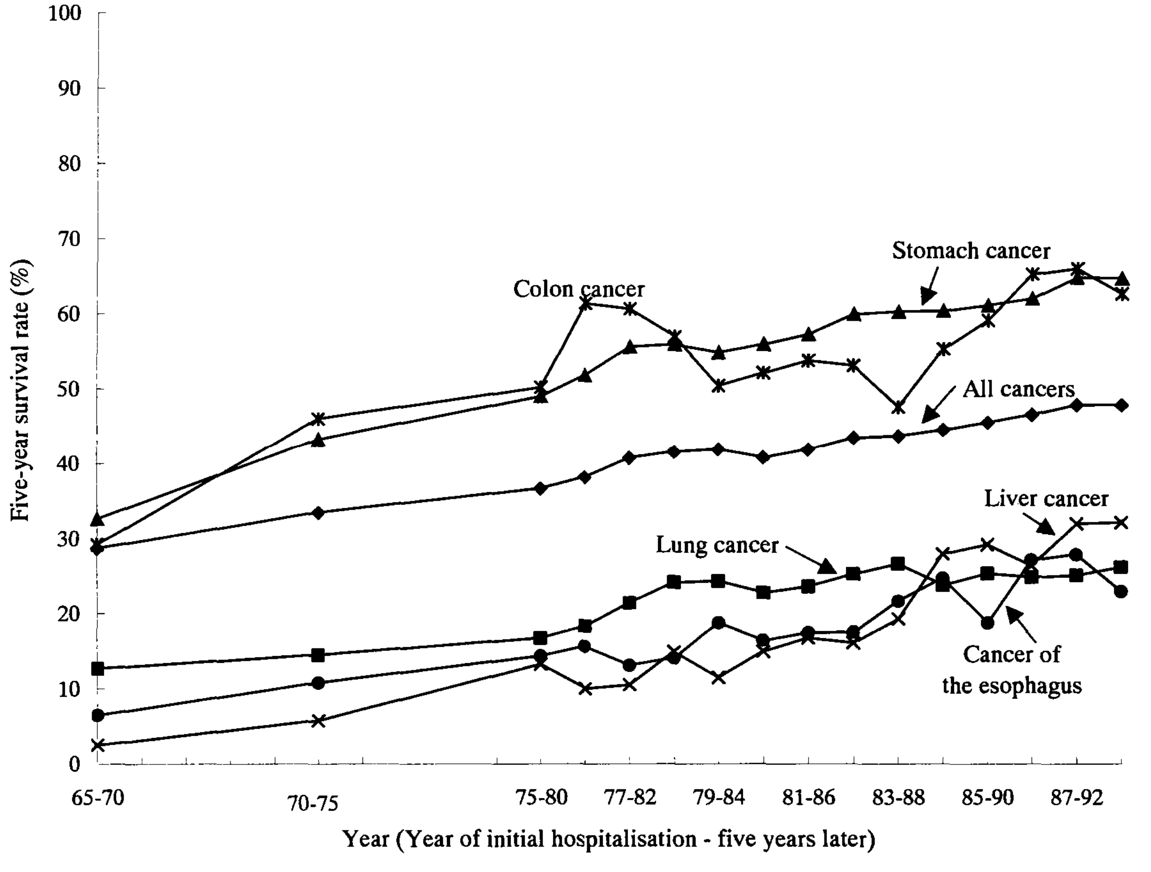
Figure 1-5-3 Spread of Major Medical Devices in General Hospitals (Diagnostic devices)



Note: In the data for upper alimentary canal fiberscope, the 1981,1984, and 1987 figures are for gastric fiberscopes. The 1981 value for diagnostic ultrasound imaging equipment is that for diagnostic ultrasound equipment.

(3) Of the three major adult diseases, the mortality rate of cerebral apoplexy has continued to fall, while that of cancer has risen. Progress in high blood pressure prevention and an improvement in the emergency medical care service appears to have had a major impact on reducing death rate of cerebral apoplexy. The five-year survival rate for cancer has steadily been improving (Figure 6-4-5).

Figure 1-5-4 Trends in the Five-year Cancer Survival Rate at the National Cancer Center (Males)



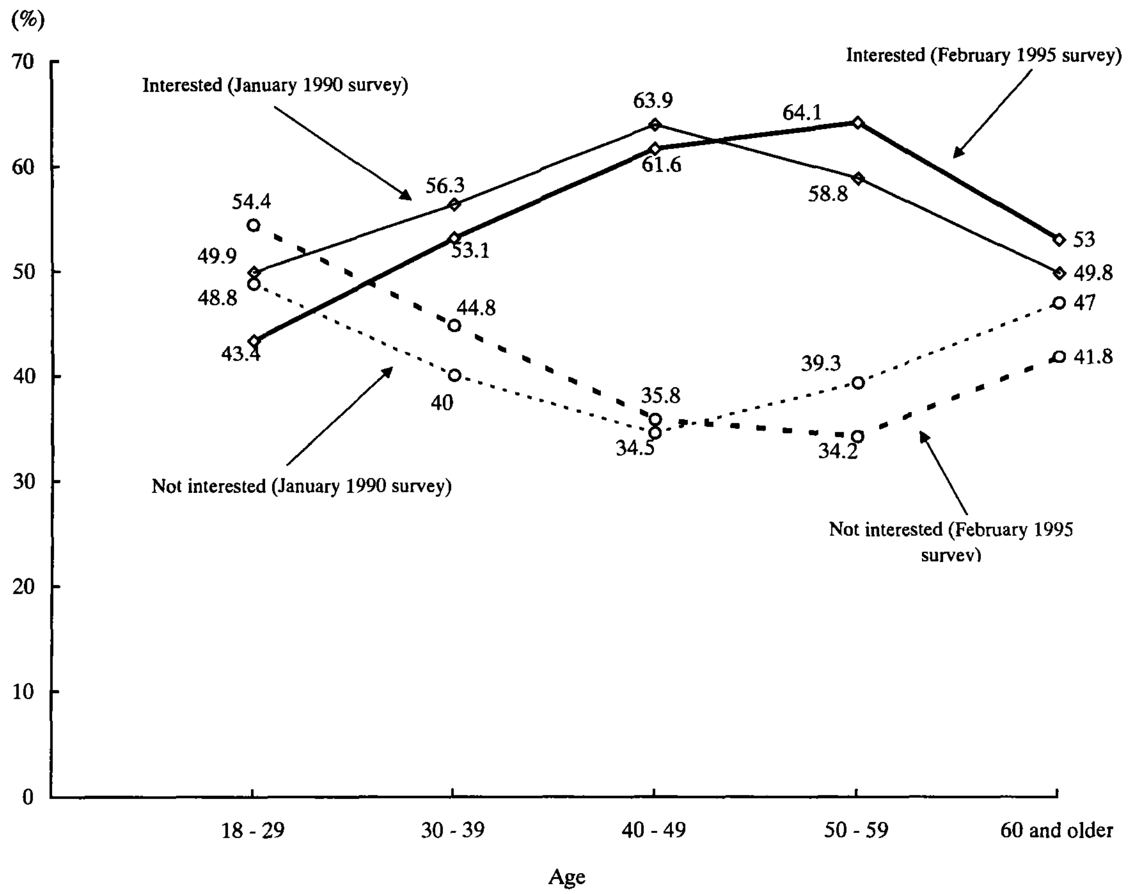
Source: National Cancer Center, Cancer Statistics

1.6 Public Awareness of Science and Technology

Opinion Survey on Science and Technology and Society

(1) The proportion of respondents 'interested in science and technology' is high among men, and that of those 'not interested in science and technology' is high among women. In particular, the proportion of those 'not interested in science and technology' increased significantly in the 18–29 year age group from 1990 to 1995 (Figure 1-6-1).

Figure 1-6-1 Interest in Science and Technology (by age group)

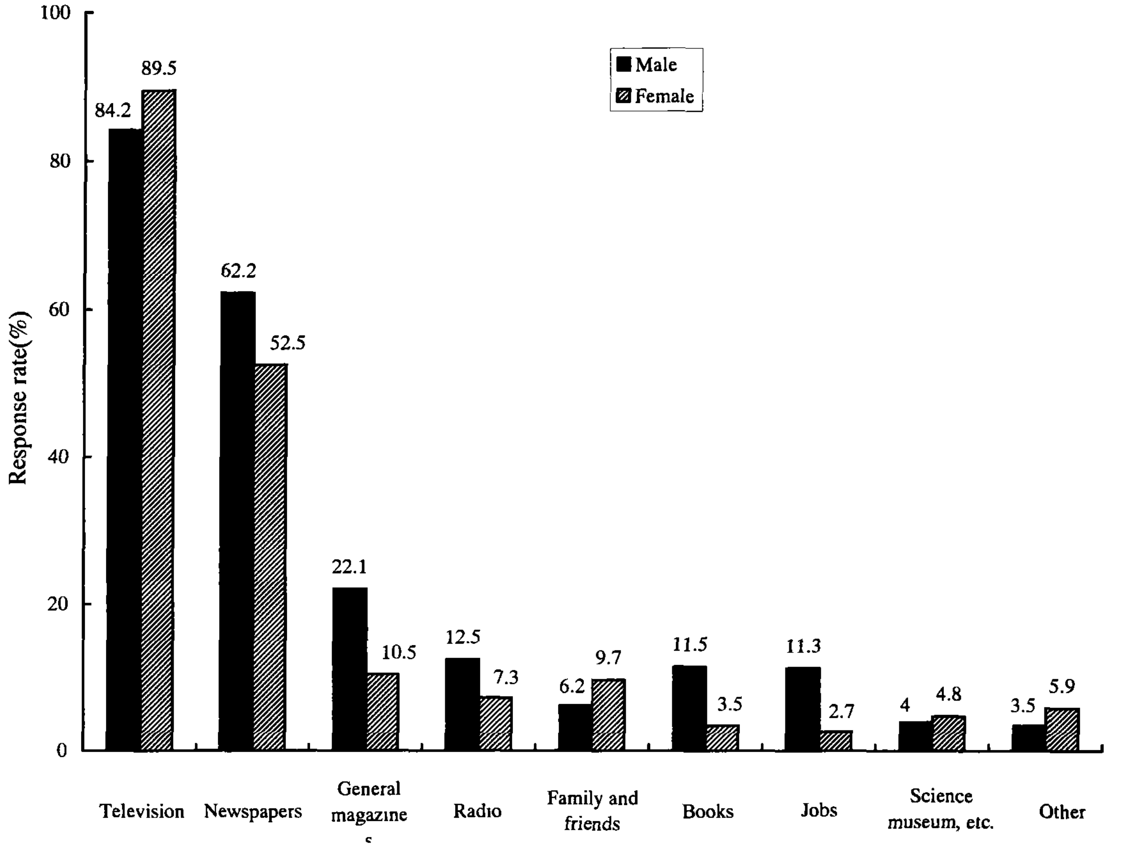


Source: Prime Minister's Office, Public Opinion Poll on Science & Technology and Society

(2) A considerable proportion of Japanese think that the young people's indifference toward science and technology is a problem.

(3) Television was cited by the greatest number of respondents as the main source of science and technology information, followed by newspapers and magazines (Figure 1-6-2).

Figure 1-6-2 Source of Information about Science and Technology (February 1995 survey)



Source: Prime Minister's Office, Public Opinion Poll on Science & Technology and Society

(4) Compared to 1990, the proportion of respondents 'finding benefits in the progress of science and technology' fell sharply in the 18–29 year age group in 1995.

(5) As reasons for the uneasiness one feels about the progress of science and technology, many respondents cited the danger of abuse and misuse and the growing trend of fragmentation and over-specialization.

Opinion Survey on Science and Technology for Improving Quality of Life

(1) A large proportion of people hold high expectations for the future progress of science and technology for improving quality of life.

(2) Of the selected 20 topics, 'earthquake prediction', 'cancer prevention drugs' and 'AIDS cure' rate high among the general public.

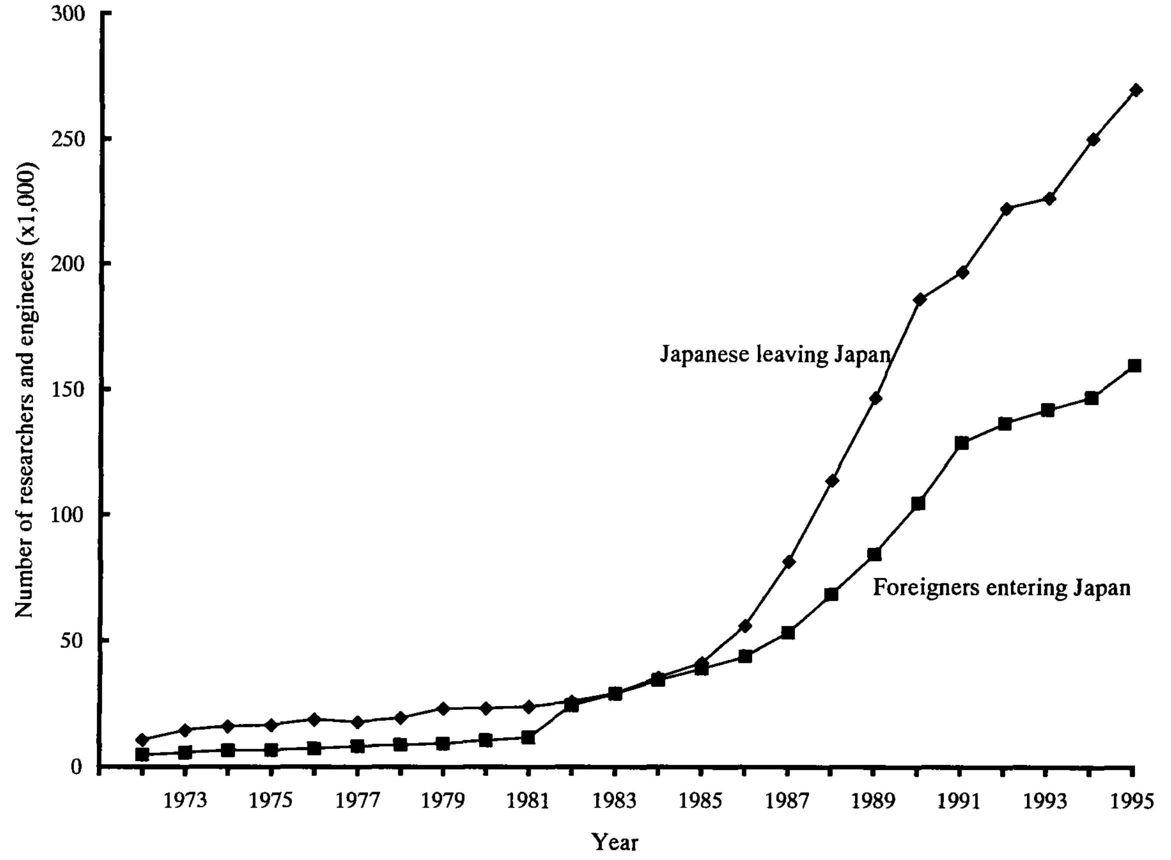
(3) Regarding problems involved in obtaining information in this field, many respondents cited 'difficulties in locating information' and 'difficulties in gaining access'.

1.7 Internationalization of R&D

Interchange of Researchers and Engineers

(1) The ratio of the number of foreign researchers and engineers entering Japan to that of Japanese researchers and engineers leaving Japan stood at 1.7 in 1995 — rising from 1.5 in 1991. Namely, the gap between the two is widening (Figure 1-7-1).

Figure 1-7-1 Trends in the Number of Researchers and Engineers Leaving and Entering Japan



Source: Ministry of Justice, Annual Report of Statistics on Legal Migrants

(2) Since 1986, the number of Japanese researchers and engineers leaving Japan has increased dramatically. The most common destination is the U.S., accounting for slightly

less than 50%, and many also went to Europe and Asia.

(3) The most common objective of foreign researchers and engineers entering Japan was "study", followed by "training", and 90% of these researchers and engineers were from Asia. Only about 10% came for "research", "teaching" or "technology".

(4) The acceptance of foreign researchers by the Science and Technology Agency, the Japan Society for the Promotion of Science has been gradually increasingly over the past eight years. Asia tops the list of origins of foreign researchers with share of 50%, followed by Western Europe, North America, Eastern Europe and the former Soviet Union.

(5) The number of researchers and engineers, who was sent over to developing countries by the Japan International Cooperation Agency in 'scientific and cultural' areas, has been falling since 1993, by reason of the completion of Japan-ASEAN science and technology cooperation projects. In contrast, there has been a marked rise in the number of persons dispatched for scientific and cultural purposes under the Japan Overseas Cooperation Volunteers program, the most common destinations being Central and South America.

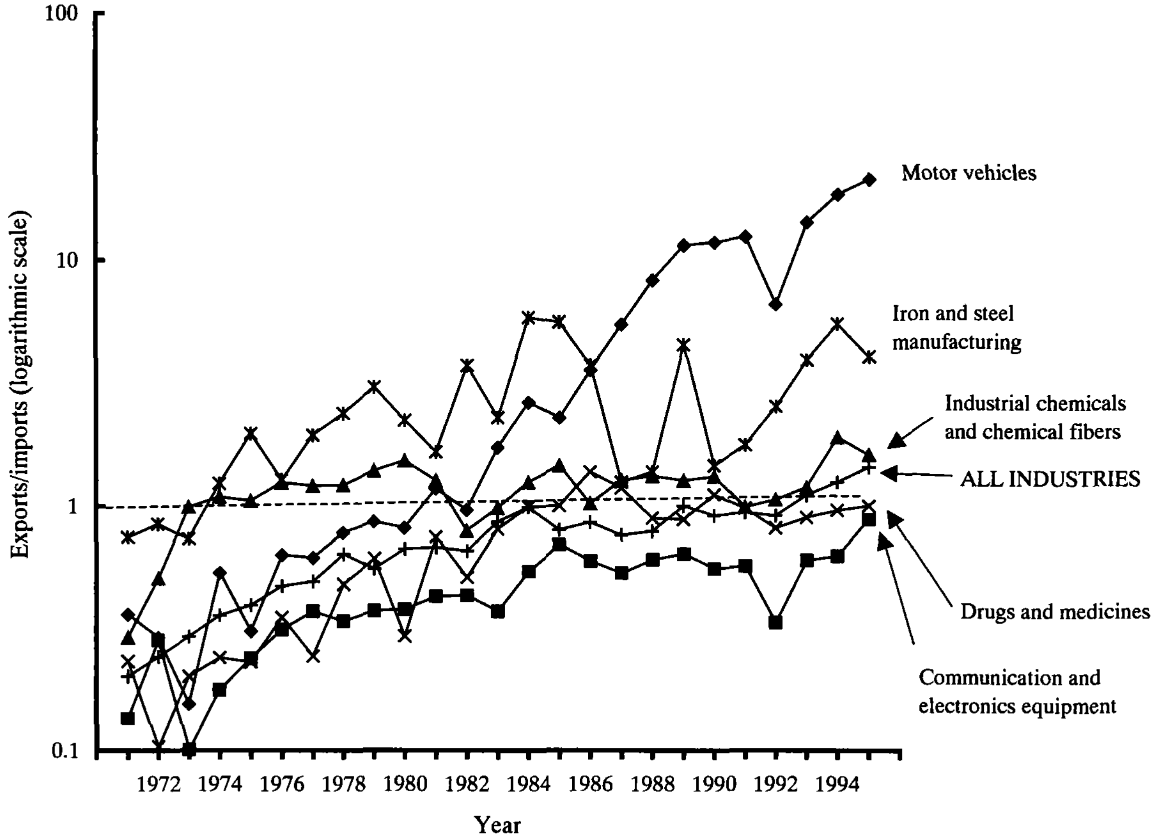
Technology Trade

(1) According to Management and Coordination Agency statistics, Japan's technology exports and imports for FY 1995 amounted to 562 billion yen and 392 billion yen, respectively, and this represents a surplus of 170 billion yen.

(2) The trade ratio (exports/imports) exceeded 1 for the first time in FY 1993, and has been increasing since (Figure 1-7-2).

(3) Looking at technology trade in major industries, exports exceeded imports in the motor vehicles industry, iron and steel manufacturing industry, industrial chemicals and chemical fibers industry, in FY 1995, while imports exceeded exports in the communication and electronics equipment industry. The drugs and medicines industry kept near balance between exports and imports (Figure 1-7-2).

Figure 1-7-2 Trends in Japan's Technology Trade Balance (All industries and major industries)



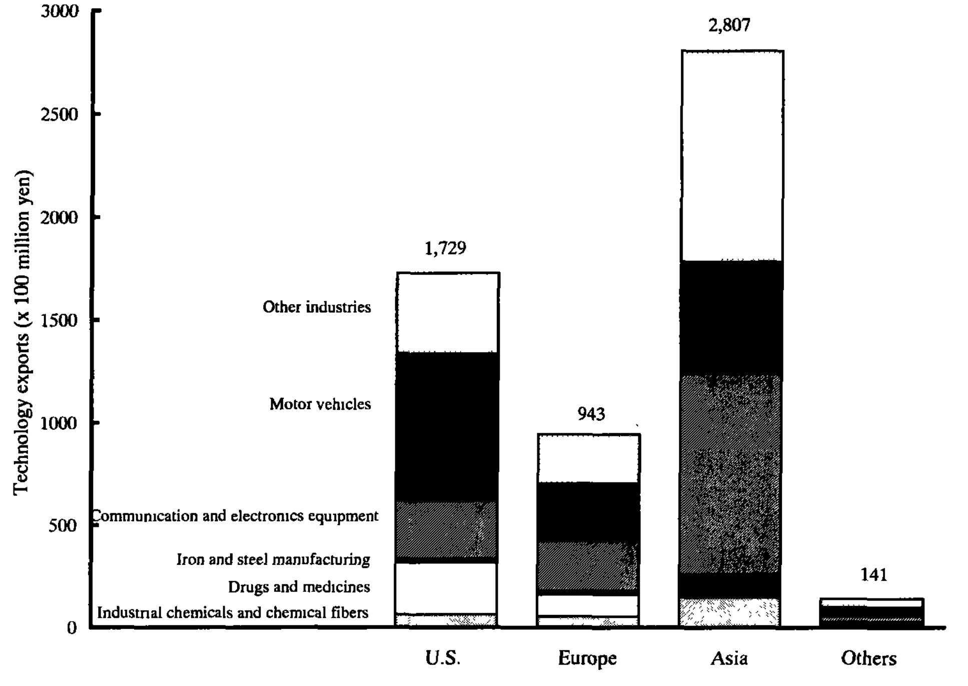
Source: Management and Coordination Agency, Report on Survay of Research & Development

(4) By region, Asia (excluding West Asia) tops the list of technology export destinations, accounting for 50% of the total, followed by North America and Europe (Figure 1-7-3). On the other hand, more than 70% of technology imports come from North America, with most of the remainder originating in Europe (Figure 1-7-4).

(5) Official statistics on Japan's technology trade are available from two sources: the Management and Coordination Agency and the Bank of Japan. However, to determine the state of Japan's technology trade more accurately, statistical data was revised by NISTEP after devising an appropriate calculation method. The results show that Japan's trade ratio was more or less 1 in FY 1995.

(6) Software takes up a large share of technology introduced to Japan, and this share has been increasing every year.

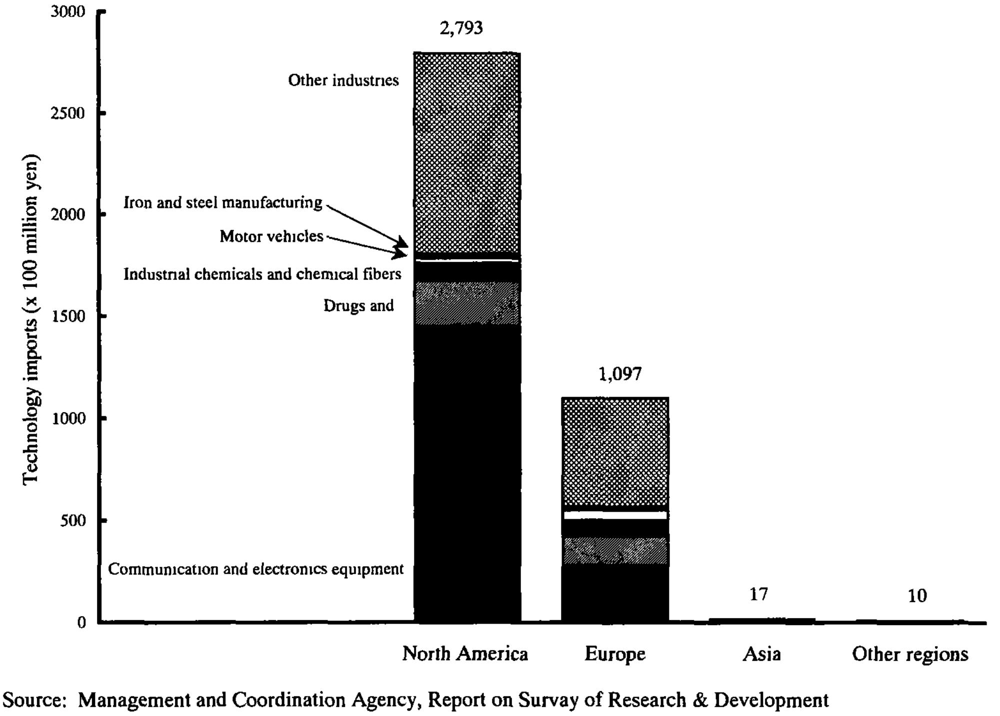
Figure 1-7-3 Breakdown of Japan's Technology Exports by Region and Major Industry (FY1995)



Note: "Asia" does not include West Asia.

Source: *Management and Coordination Agency, Report on Survay of Research & Development*

Figure 1-7-4 Breakdown of Japan's Technology Imports by Region and Major Industry (FY1995)



Source: Management and Coordination Agency, Report on Survay of Research & Development

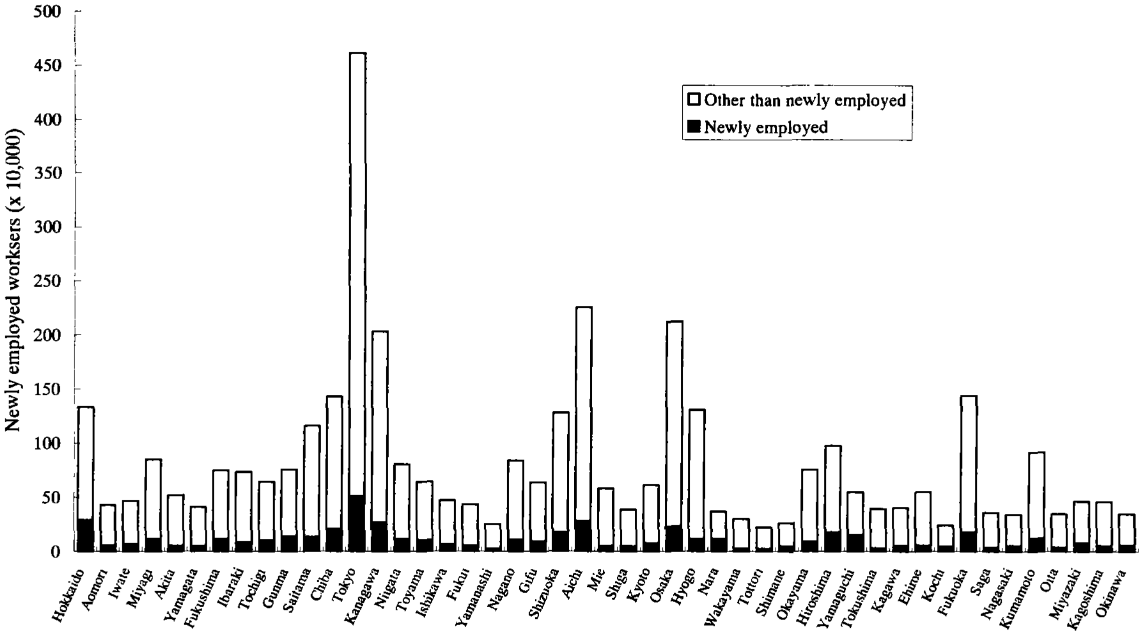
1.8 Regional S&T Activities

S&T Base

(1) The regional concentration of elementary school, junior high school and senior high school students per unit population is low, while university students tend to concentrate in certain prefectures such as Tokyo. Many high school graduates move from one prefecture to another when they go on to university.

(2) In 1995, there were 38.4 million full-time workers nationwide, and the number of workers recruited during the year accounted for 13% of all full-time workers. The top five prefectures accounted for 30% of the total number of newly employed workers nationwide (Figure 1-8-1).

Figure 1-8-1 Number of Regular Workers and Newly Employed Workers by Prefecture (1995)



Source: Ministry of Labor, Report on the Survay on Employment Trends

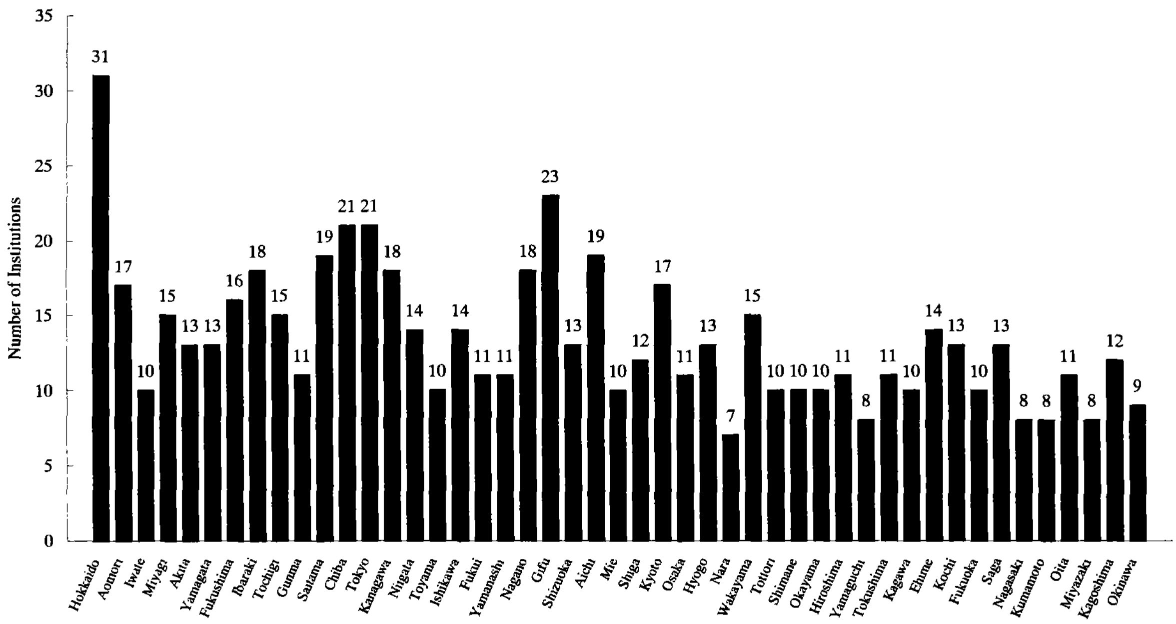
(3) Hokkaido Prefecture accounts for the greatest number of science museums, zoos, botanical gardens, and zoological & botanical gardens, followed by Tokyo, Kanagawa and Shizuoka prefectures.

R&D Activities

(1) In FY 1995, there were 91 national research institutions throughout Japan, employing a total of 10,551 researchers. Of the nation's prefectures, 19 had at least one national research institution and 28 did not have any. In recent years, greater attention has been focused on various regional effects of national research institutions.

(2) In FY 1995, there were 632 public research institutions, which are run by local governments, throughout Japan. The regional concentration or disparity are relatively low (Figure 1-8-2).

Figure 1-8-2 Number of Local Government Research Institutions by Prefecture (FY1995)



Source: Ministry of Labor, Report on the Survey on Employment Trends

(3) There is at least one national or local government university in every prefecture and the regional disparity is relatively small, when factors such as population are taken into account. Private universities, on the other hand, are concentrated in certain prefectures.

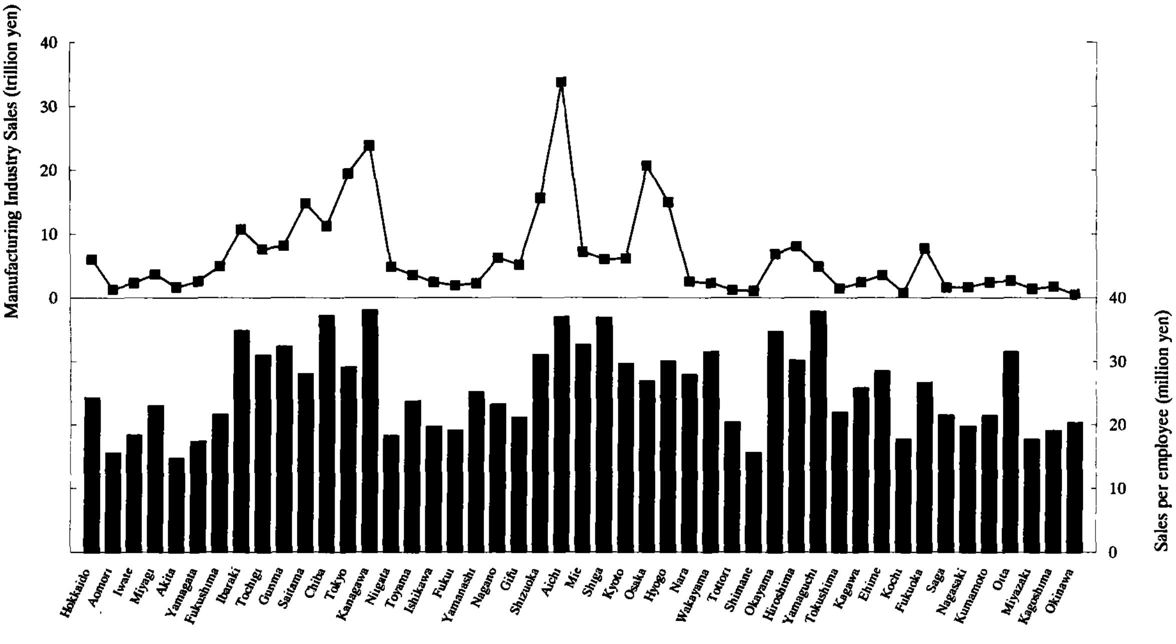
(4) In FY 1995, there were 4,056 relevant private R&D institutions throughout Japan. With the top five prefectures boasting 53.6% of the nationwide total, there is a considerable concentration in particular regions.

(5) In FY 1994, there were 70 science and technology parks set up in Japan. This compares with 118 in the US (1991), 34 in the U.K. (1991), 120 in Germany (1991) and 52 in China (1992).

S&T and Regional Economic Activities

(1) Regarding the manufacturing industry sales, the top five prefectures account for 38.6% of the national total. While there is some degree of disparity compared to other factors such as population, this is not as large as that of R&D activities. The value of manufacturing industry sales per employee is greatest in Kanagawa Prefecture, followed by Yamaguchi, Chiba, Aichi and Shiga prefectures (Figure 1-8-3).

Figure 1-8-3 Manufacturing Industry Sales by Prefecture (1994)



Note: For Hyogo Prefecture, 1993 data is used.

Source: Ministry of International Trade and Industry, Statistical Tables on Japanese Manufacturing Industries

(2) Patent applications are concentrated in Tokyo and certain other prefectures. However, the regional concentration is small for utility models, for which many applications are believed to come from small and medium-size businesses.

(3) Venture businesses tend to concentrate in certain prefectures such as Tokyo. However, the fact that companies holding a very large number of patents can be found in other prefectures gives us development venture business activities in region.

(4) In terms of regional economic growth, prefectures are classified into two groups: those in which the contributions of manufacturing industries are large — e.g. Shiga, Ibaraki, Fukushima, Gunma and Saitama; and those in which the contributions of service industries are large — e.g. Tokyo. Thus, types of economic development do differ from region to

region.

(5) Looking at regional development in terms of per-capita prefectural income, the polarization of prefectures into rich and poor has emerged as a trend in recent years, and this illustrates the fact that many problems still remain in regional development.

1.9 Integrated Indicators

(1) Integrated indicators are created by somehow combining a large number of indicators relating to S&T activities into one or two indicators that represent the whole. Use of integrated indicators allows one to grasp overall trends in a country's S&T activities and makes comprehensive international comparisons and time-series analysis possible. With a view to application to Japan's S&T activities to illustrate their standing, integrated indicators were developed based on principal component analysis and factor analysis — both multivariate analysis methods — using 12 indicators involving five countries including Japan.

(3) A structural analysis using the factor analysis method yielded Factor 1 (horizontal axis), representing 'science vs. technology' orientation, and Factor 2 (vertical axis), representing 'input vs. output' orientation (Figure 1-9-1). Plots obtained based on values arrived at using these factors for the above countries (factor scores) show that Japan leans towards 'technology' (i.e. applied research) and 'input', while the U.S. is oriented towards 'science' (i.e. basic research) and 'input' (Figure 1-9-2). The three European countries are all 'output-oriented'. In terms of 'science vs. technology' orientation, the U.K. is most science-oriented, while Germany is somewhat technology-oriented. France falls midway between the two. The patterns of change in the factor scores allocated to Japan and the U.S. since 1992 exhibit some deviations from their respective earlier trends.

Figure 1-9-1 Structure of S&T Activity Variables (factor loadings)

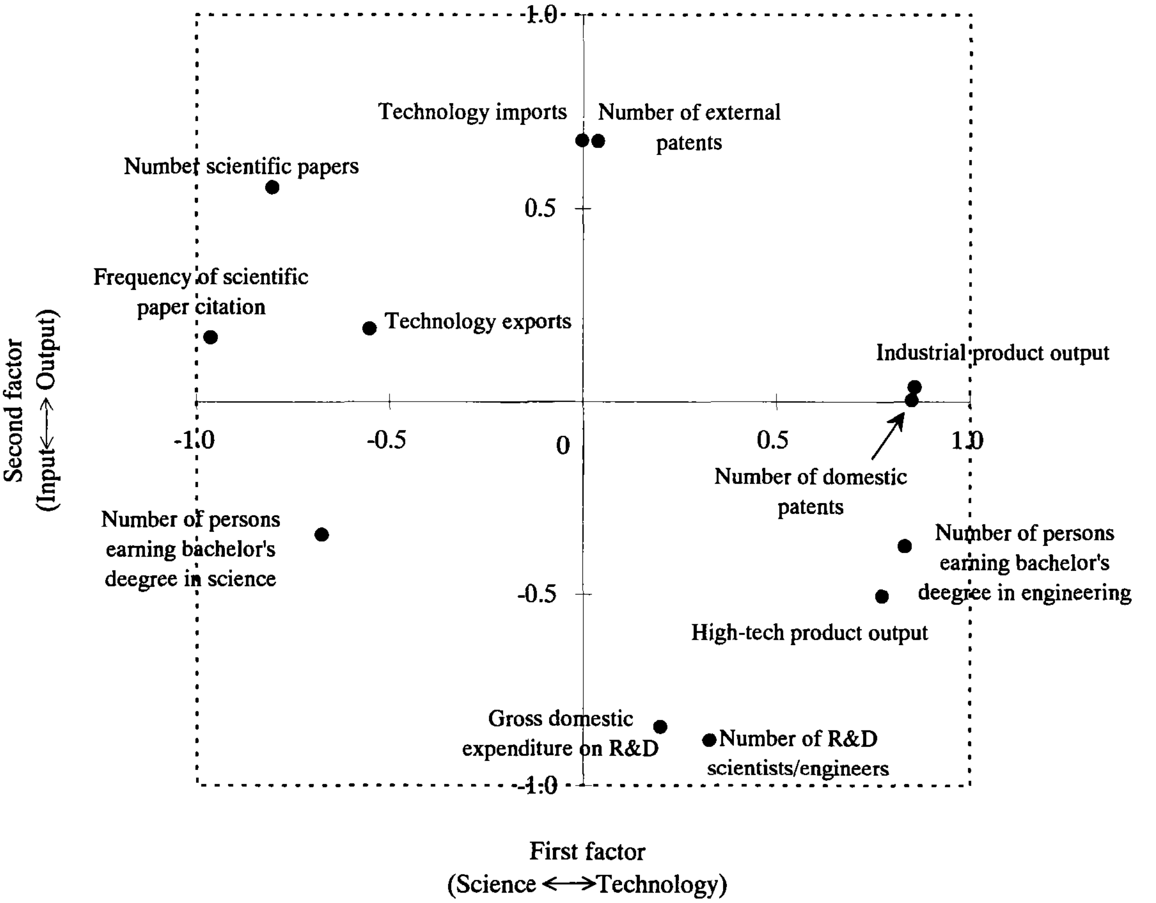
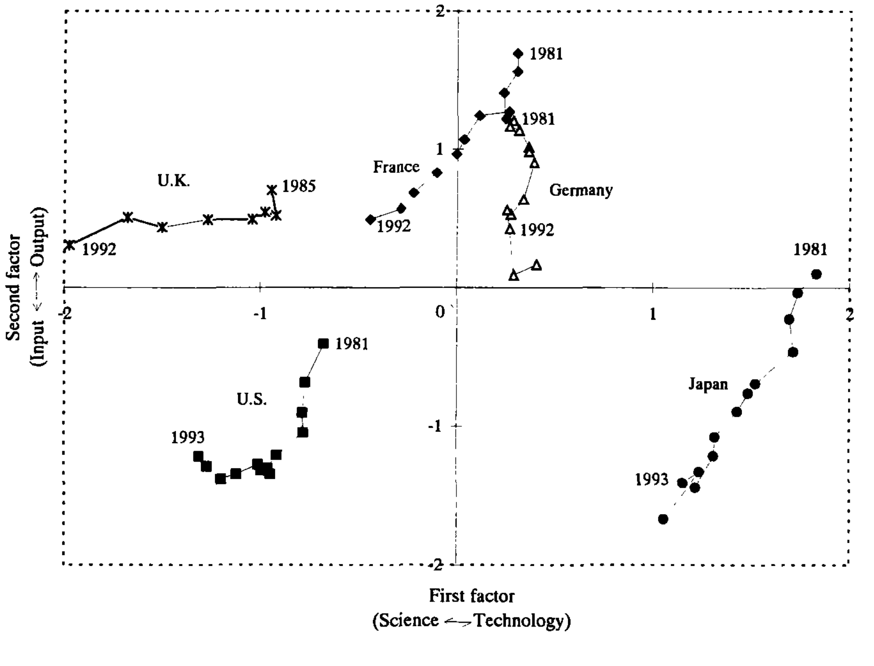
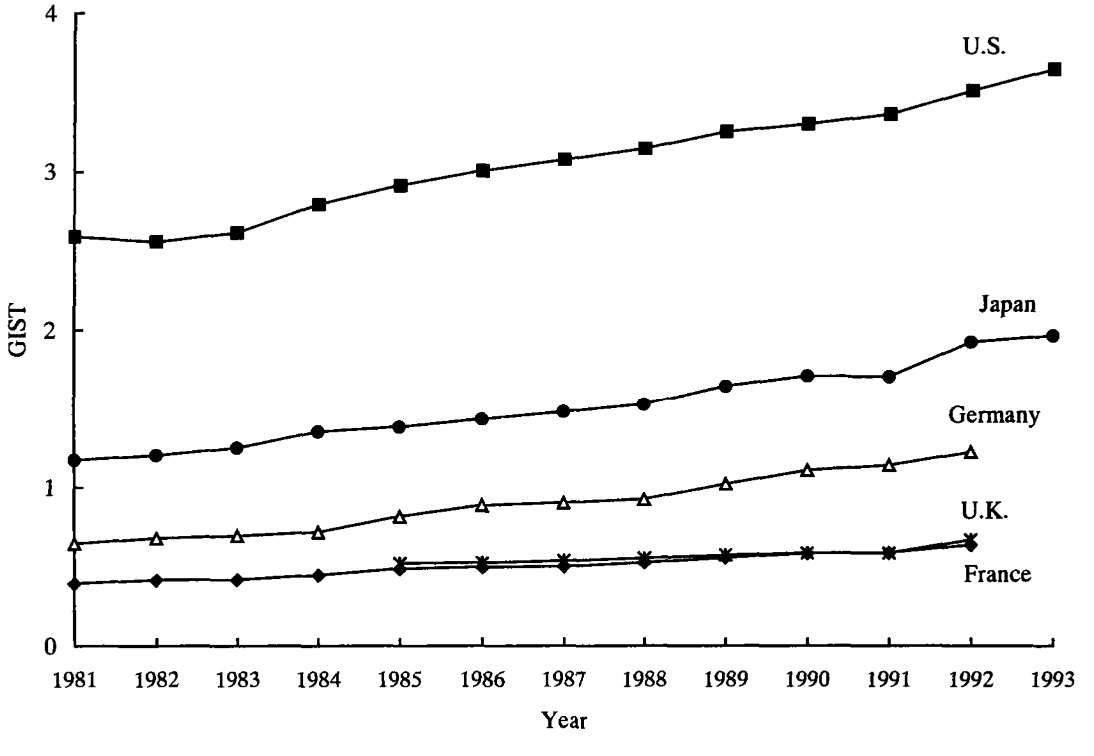


Figure 1-9-2 S&T Factor Scores for Each Country



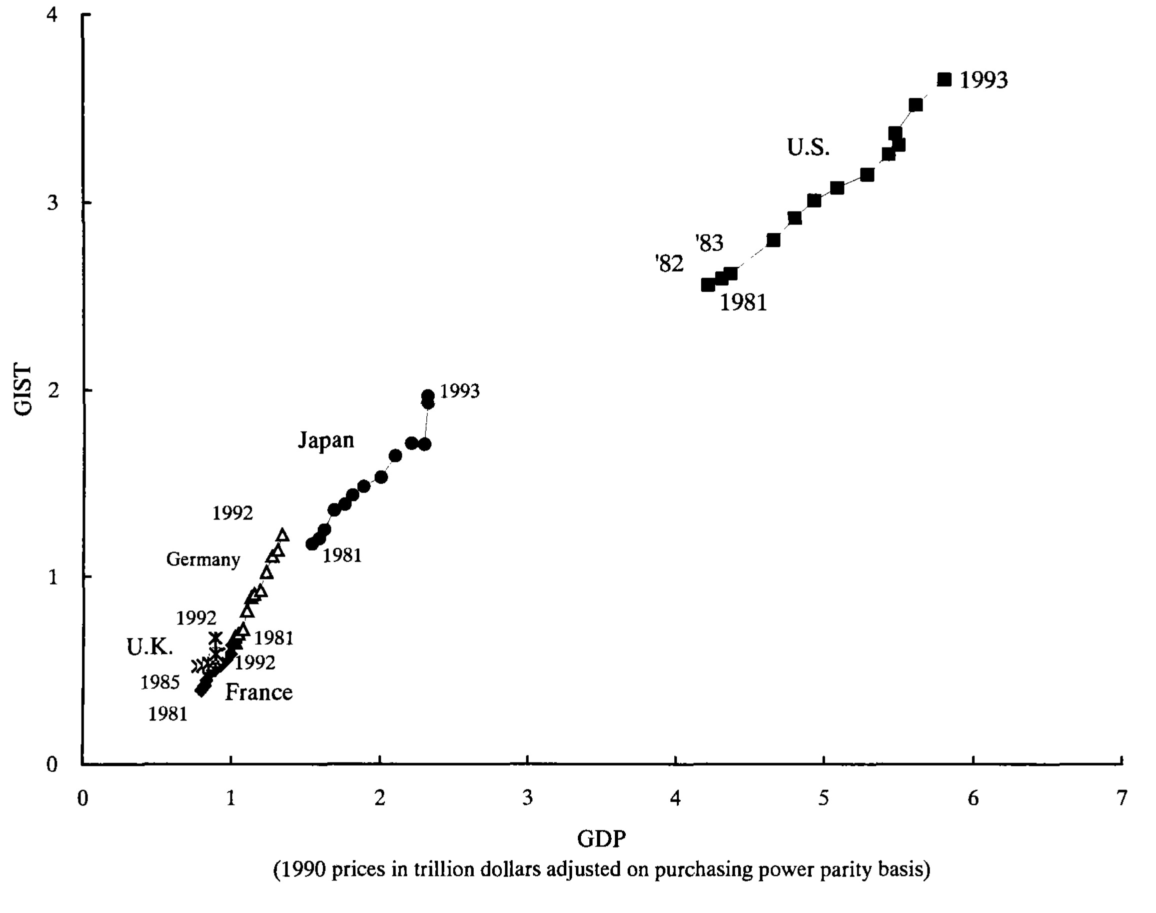
(3) The U.S. is on top in terms of the value of the integrated indicator, which shows the overall capability of a country's S&T activities (GIST: General Indicator of Science and Technology). Japan trails the U.S. with a value half that of the U.S., followed by Germany. France and the U.K., which are at about the same levels, are further behind (Figure 1-9-3). This indicator, designed to measure the overall level of S&T activities of each country, appears to, by and large, reflect the reality. The value of the indicator has been rising on a long-term basis for all countries.

Figure 1-9-3 Trends in General Indicators of S&T (GIST) of Selected Countries



(4) For all countries, GIST vs. GDP plots form straight lines generally, illustrating that there is a correlation between the two quantities, and that the economic capacity and overall S&T capability have been growing hand in hand (Figure 1-9-4). An observation of plots for individual countries reveals some aspects of the characteristics of their development. These include: the U.S. has a low growth in its overall S&T capability relative to its GDP growth; Germany and France have relatively high growth in S&T capability; and Japan falls midway between the two.

Figure 1-9-4 Relationship between General Indicators of S&T (GIST) and GDP



(5) Applying the integrated indicator method, a structural analysis of S&T activities in Japanese industry was undertaken. A factor analysis focusing on the position of S&T activities in companies' business operations shed light on relative corporate orientations towards R&D, and the character of each industry emerged. Industries with intensive R&D activities include 'communication and electronics equipment', 'electrical machinery', 'general machinery', 'drugs and medicines', and 'industrial chemicals and chemical fibers', while those achieving growth without particularly intensive R&D activities include

'transportation, communication and public utility', 'motor vehicles manufacturing' and 'construction'.

(6) The structure of R&D activities in Japanese industry was analyzed in terms of product development, thereby elucidating the trends in its content. Through factor analysis, the following four technology areas were identified as common features in R&D across 25 industries: 'electronics', 'machinery and process technology', 'new materials' and 'biotechnology'. These are all cutting-edgy technologies that have been the driving force of Japan's technological advancement. As well as identifying major technological areas, these factors have made quantitative assessment of the activity trend of each industry possible.