

# Science and Technology Indicators: 1994

A Systematic Analysis of  
Science and Technology Activities in Japan

January 1995

Science and Technology Indicator Project Team  
National Institute of Science and Technology Policy (NISTEP)  
Science and Technology Agency, Japan

Translation from  
Japanese version

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# Preface

The National Institute of Science and Technology Policy developed indicators showing the state of science and technology in Japan and presented these in September 1991 as NISTEP Report No. 19, “Systematic Science and Technology Indicators”. These indicators systematically organized the scientific and technological activities of Japan and this report was the first to make the overall state of these activities quantitatively comprehensible. It has been more than three years since that report, and it was decided to release a 1994 report on scientific and technological indicators on the basis of research results since the prior report. This new report maintains the indicator structure of the previous report while adding new indicators and updating data on existing indicators. As a result, there have been some changes made to Chapter 2 (“Education and Human Resource Development for Science and Technology”), Chapter 7 (“Public Opinion on Science and Technology”), and Chapter 9 (“Regional R&D Activities”). The issue of composite indicators came up as a future consideration during the preparation of the earlier report, and an outline of a test of certain composite indicators has been given in Chapter 10.

Science and technology indicators cover a wide range of fields, and in compiling them, a project team was formed comprising research fellows from groups within our own institute as well as guest research fellows. This team discussed the overall structure and characteristics of the indicators and chose to delegate the explanation of individual indicators to specific team members. Our institute is grateful to Professor Fujio Niwa of Saitama University, presently affiliated with our institute and in charge of generating the indicators for the previous report, for his invaluable guidance in developing this report’s indicators.

We hope that, in the ever-changing world of science and technology, this report will be of some assistance in considering future directions for science and technology in Japan.

January 1995

Jiro Shibata

Research Director

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## **Explanatory Notes**

1. All descriptions, figures, tables, etc., except for diagrams whose source has been specifically mentioned, are the work of the National Institute of Science and Technology Policy.
2. Information sources for indicators listed below figures and tables in this report are defined as follows:

Sources: Original source for indicator data or original provider of data. In this report, figures and tables have been prepared on the basis of data from these sources; the expressions “prepared from” or “compiled from” will be used when considerable processing of data has been carried out.

Duplication: Figures duplicated from other publications.

3. Commentary on the text is marked by <sup>(1)</sup> within the text, and the commentary itself is given later in an appropriate spot.
4. References are given at the end of the chapter. References are marked by <sup>[1]</sup> within the text.
5. For yearly data, survey times and periods may differ by country or type of statistics. Distinctions between calendar and fiscal years are not necessarily made in the same manner as in the original source but rather expressed in a way appropriate for showing the characteristics of the data and for international comparisons.
6. Germany in this report, in the absence of any specific mention, refers to West Germany until 1990 and to the reunified Germany from 1991.

## **Introduction**

This report is a continuation of the report on science and technology indicators released in 1991 and has been compiled as a second edition of that report. In preparing this new report, the focus has been primarily on the following points:

- (1) Revision and improvement of the system of science and technology indicators (hereafter, “indicator system”)
- (2) Relationship between the indicator system and the structure of this report
- (3) Development of composite indicators

### **System of Science and Technology Indicators**

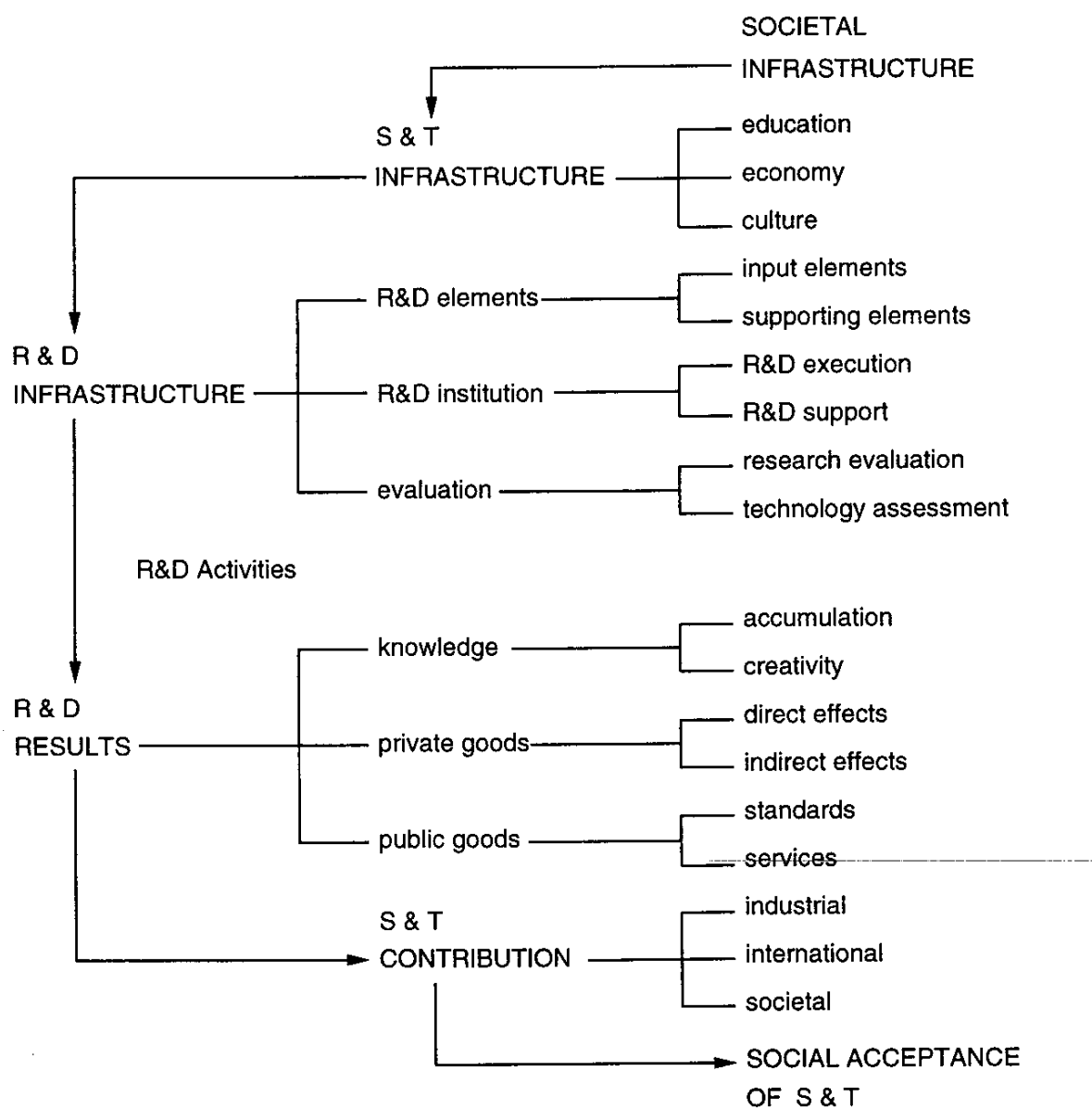
An indicator is a group of statistical values that together give an indication of an object’s state. GNP is a well-known indicator of economic activity. If a scalar quantity such as GNP can adequately represent the object’s state, it is considered an appropriate indicator. The state of science and technology in a particular country cannot be shown, however, in a single indicator. Because science and technology activities are complicated and their supporting infrastructure and scope of influence extensive, they must be viewed from a long-term perspective. Given such circumstances, science and technology’s many facets must be represented using a number of quantities. The S&T indicators developed in the U.S. or by OECD have been constructed based on such an idea.

When attempting to quantitatively illustrate science and technology activities through multiple indicators, one faces the problem of selecting the appropriate indicators. One must not only evaluate the suitability and representation of individual indicators but also consider their similarities, the scope of selected indicators overall, and the degree to which the goal of converting data into indicators has been achieved. Sufficient appraisal is also needed when multiple indicators are being collected. In addressing these needs, it is imperative to establish indicator development principles and to systematically develop these indicators. Our first aim was merely reporting on these indicators.

Systematization took the form of the system of science and technology indicators shown in Figure 0-1, called a cascade structure because of the resemblance of the flow of science and technology from the top down to water. The number of indicators set out in the previous report (1991) was 71. If indicators are systematically developed, each indicator’s significance can be clarified based on its relative position in the system, making it possible to judge the most suitable indicators. Combining indicators in accordance with this system allows one to construct composite indicators. This report will follow the system thus developed.



Figure 0-1 System of Science and Technology Indicators



1. Collection of appropriate individual indicators and an increased number of indicators:

In addition to those existing indicators for environmental contributions, new indicators have been added to show the contributions of science and technology to society through medical care, welfare, and regional science and technology activities, as well as the contributions of science and technology to the economy. Research by the National Institute of Science and Technology Policy has revealed considerable changes since the previous report, especially in regional science and technology activities. The results of international comparative surveys led by this institute on public opinion towards science and technology have been converted into indicators and an attempt made to illustrate the characteristics of Japanese public opinion.

2. Greater analysis:

Improved analysis of even the same statistics leads to more precise results. This report has included research conducted since the previous report on research and development (hereafter, “R&D”) expenditures, patents, technological trade, international transfer of human resources, and the activities of learned societies and other such organizations.

3. Scenarios:

The typical ‘reporting’ approach to indicators is to simply line up individual indicators and explain their meanings, but a lack of consistency makes this not wholly satisfactory. Bringing together a variety of scientific and technological activities into a single viewpoint also present problems, though, and thus no insistence was made for consistency for every single indicator. Adjustments were made for problems inferred from the indicators in human resources development for science and technology and other areas.

Improvements to a wide range of indicators and their interpretations and efforts to insure greater readability in the report itself have, hopefully, been successful in making this report significantly better than its predecessor.

## **Indicator System and Report Profile**

The indicator system is divided into the 6 broad categories shown in Figure 0-1.

1. Societal infrastructure

Societal infrastructure provides an indirect foundation for science and technology in a broad sense.

2. Scientific and technological infrastructure

This infrastructure indirectly supports R&D activities in a broad sense, and is made up of three sub-categories: education and human resource development, economic resources, and public organization activities.

3. R&D infrastructure

This infrastructure directly supports R&D activities, and comprises three sub-categories: (1) R&D elements such as R&D manpower and funds, (2) an institutional framework of research organizations, and (3) research evaluation of projects and other work.

#### 4. R&D achievements

These achievements are the direct results of R&D and comprises three sub-categories: the “knowledge” value of scientific papers, the “private property” value of patents, and the “public property” value of standards.

#### 5. Contributions of science and technology

These contributions are the indirect results of R&D and comprise three sub-categories: (1) contributions to the industrial economy, (2) contributions to the international community, and (3) contributions to society.

#### 6. Societal acceptance of science and technology

This category measures public opinion on science and technology and the indirect impact of R&D activities on society.

The structure of this report and the indicator system are related as follows:

#### Chapter 1 Overview of Science and Technology Activities in Japan

Summary of Chapters 2 through 9.

#### Chapter 2 Education and Human Resource Development for Science and Technology

Presentation of indicators related to the most important infrastructures for S&T activities, namely, primary and secondary education, higher education, and careers of those completing higher education. This chapter deals with indicators belonging to the educational infrastructure in “2. Science and Technology Infrastructure”.

#### Chapter 3 Social Support for Science and Technology

Analysis of the government’s R&D budget as an infrastructure element directly supporting science and technology as well as presentation of indicators related to learned societies and similar foundations that form part of societal support. This chapter deals with indicators belonging to the social and economic infrastructure in “2. Science and Technology Infrastructure”.

#### Chapter 4 R&D Activities in Industry, Academia and Government

Indicators for R&D human resources, R&D expenditures, and the number of R&D institutes are constructed and presented as direct inputs for science and technology. These are divided into inputs from the nation as a whole (including international comparisons), industry, academia, and the government. This chapter deals with indicators belonging to “3. R&D Infrastructure”.

#### Chapter 5 Achievements of R&D Activities

Indicators on citations for scientific papers and patents have been improved. Indicators related to science and technology awards and industrial standards have also been added, something not seen elsewhere internationally. This chapter deals with indicators belonging to “4. R&D Achievements”.

## Chapter 6 Social Contribution of Science and Technology

Indicators showing the indirect results of science and technology, factors not included in existing science and technology indicators. Indicators have been divided into three areas: economic growth, environmental protection, and medical care/welfare.

## Chapter 7 Public Opinion on Science and Technology

Indicators based on domestic opinion polls and international comparative surveys on science and technology that show the opinions of Japanese society towards science and technology. This chapter deals with indicators belonging to “6. Social Acceptance of Science and Technology”.

## Chapter 8 Internationalization of Research and Development

Indicators were constructed showing the internationalization of R&D through personnel and technology exchanges. In the indicator system, indicators of internationalization can be developed for all component indicators. These indicators comprise those indicators connected with internationalization from among the more important indicators belonging to “3. R&D Infrastructure” and “4. R&D Achievements”.

## Chapter 9 Regional Science and Technology Activities

Indicators were constructed in accordance with the indicator system for regional science and technology activities. In basically the same manner as for internationalization, all indicators in the indicator system can be applied to regional comparisons. These indicators can be broadly sub-divided into those for science and technology infrastructure, R&D activities, and the contributions of science and technology. This chapter deals primarily with indicators belonging to “3. R&D Infrastructure”, “4. R&D Achievements”, and “5. Contributions of science and technology”.

## Chapter 10 Composite Indicators

This chapter attempts to represent science and technology activities with only one or two indicators. The overall science and technology activities of a country can be quantified through composite indicators, allowing an understanding of chronological changes and international comparisons. An outline of these new tested indicators is given next.

## Development of Composite Indicators

There are three objectives in systematizing science and technology indicators:

### 1. Reporting

These indicators are designed to present a balanced and quantitative representation of the state of science and technology activities as a whole. They will enable quantitative assessment of the state and direction of change of a country's science and technology activities. These indicators are believed to be useful in identifying problems at an early stage, and thus become basic data in formulating science and technology policies and in understanding S&T activities.

## 2. Judging

This purpose is achieved by combining indicators using a number of indicators for specific purposes (such as for measuring the degree of internationalization). The value of such indicators will represent, for example, the degree of internationalization. Such indicators should comprehensively represent the level of science and technology activities or policy objectives.

## 3. Policy Evaluation

This requires an advanced knowledge of the relationships (e.g. causal) among indicators. Based on such knowledge, the implementation of specific policies can be understood quantitatively and indicators should enable evaluation of the policy's effects and progress.

These three objective types are listed from 1 to 3 in order of sophistication. The vast majority of existing science and technology indicators go no further than the first type, reporting. The 1991 report was the first attempt in Japan at systematic development of science and technology indicators, and given that reporting-type indicators are the most fundamental of these, such indicators were used in that report.

This report has explored the development of indicators of the second type, judging. As mentioned earlier, indicators such as R&D infrastructure and R&D achievements can be integrated by the category to which they belong within the indicator system. With the wealth of statistics available, the goal is to develop one or two composite indicators in order to place a particular country's science and technology activities in an international context.

A total of 13 statistical areas were targeted, including the number of R&D scientists and engineers, R&D expenditures, the number of scientific papers and patents and the number of citations each, and the amount of technology import and export. Five countries were examined—Japan, the U.S., Germany, France, and the U.K.—and the period covered was the nine-year period from 1981 to 1989. A principal component method was used for developing composite indicators, but as this method alone is inadequate, it was combined with factor analysis, another means of analyzing multiple variables. Other analysis methods were improved to permit analysis of the three-dimensional data for variables, countries, and years.

The results obtained clearly showed the two-dimensional structure of these 13 variables in terms of science vs. technology and input vs. output in science and technology activities. They also determined the place of each variable within that structure and consequently demonstrated the meaning of science and technology activities. This also had the unexpected result of clarifying the nature of several individual indicators. With respect to the original objective, the results showed among other things that the indicators were obtained that were deemed appropriate, that the level of science and technology activity in Japan (represented by a single indicator) was about half that of the U.S. and the level of the European countries half that of Japan, that this indicator had been gradually rising for Japan and the U.S. while remaining steady for the European countries, and that Germany has an excellent input-output ratio. In all of these cases, the results are certainly justifiable.

Thus, this test of new composite science and technology indicators was overall a success. There remain many problems, though, such as the comparative probability of the variables adopted, the degree of interpretation of variables within the structure, and the interpretation of national trends. Nevertheless, the development of several composite indicators for regional science and technology activities, internationalization, and human resources development, as evident in these results, has given new life to indicator development.

## **Outlook on Indicator Development**

Work on developing indicators has persisted since the previous report, permitting new science and technology indicators to be offered here, and this endeavor will continue. Science and technology indicators will be steadily improved and the best of these will be presented on occasion in reports. For the time being, however, the following issues must be addressed.

First is the improvement of indicators. Research to this point has most likely not omitted any major statistics, but there is always room for the collection of new statistics, and a new survey for the purposes of international comparison would be especially welcomed.

Next is the improvement of analysis. There is much need for varied and complex analysis in developing indicators, and complex analysis is vital in determining the suitability and interpretation of an indicator.

The system of science and technology indicators itself also merits study. This system must be revised periodically to reflect the rapid changes occurring in science and technology as well as in their relationship to society.

Further development of the composite indicators tested in this paper is also needed. It is important not only to increase the number of these composite indicators, but also to improve methodology and to ascertain the viability of composite indicators. Establishing suitable and reliable composite indicators will make it possible to achieve the second objective of indicators, judging-type indicator reports.

Working with indicators becomes much easier when relevant databases are available. A project is currently underway to convert indicator reports and the indicators used therein to database form. This will make the data easily accessible to many persons, including researchers at other institutes, via the Internet, not only helping them in their activities but also contributing to the development of indicators. The data for indicators developed in the 1991 report has been stored on computer disk in Lotus 1-2-3 format, an idea well received by those persons requesting this data.

The effectiveness of science and technology indicators is enhanced substantially in international comparisons, and common international definitions and measurement methods are needed in international comparisons. The OECD is the chief organization in this regard, and Japan has cooperated with the OECD in a variety of international comparative surveys related to technological forecasts, Full-time Equivalency (FTE) for R&D scientists and engineers, and technological innovation. This cooperation must be strengthened in future. For example, problems with the purchasing power parities used by OECD in international comparisons of R&D are often pointed out, but the organization has not yet attempted to develop more suitable parities. This institute, however, has already conducted tests in this area, and this could well be one topic for indicator research in an international cooperative framework. Indonesia, China, and Singapore among others have made progress recently in developing science and technology indicators, and Japan, as a leader in the development of indicators, should broaden its cooperation with these countries as well as with those which may develop indicators in the near future.

Introduction Fujio Niwa



# Chapter 1

## Outline of Science & Technology Indicators — Overview of Science & Technology Activities in Japan —

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# Chapter 1

## Outline of Science & Technology Indicators

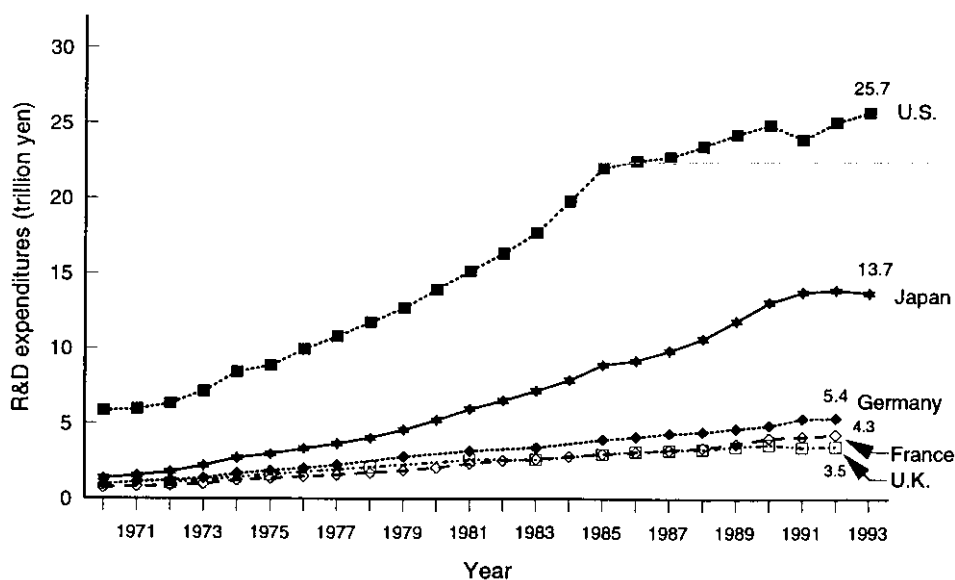
### — Overview of Science & Technology Activities in Japan —

Chapter 1 provides an overview of this report. Numerous indicators exist to help illustrate the status of science and technology in a particular country, but here a representative group of indicators has been selected to present an overview of science and technology activities in Japan. The figures shown in this chapter have been taken (reproduced) from later chapters.

#### 1.1 Overview of R&D Activities

- (1) Japan's R&D expenditures in FY1993 were 13.7091 trillion yen, a 1.4% drop from the previous year. This marked the first decline in R&D expenditures in 30 years, and is in great part attributable to the fact that private-sector R&D expenditures continued their decline, down 5.3% from the previous fiscal year.
- (2) Japan's R&D expenditures have increased eight-fold over the past 20 years, the highest rate of increase among the developed nations (including the U.S., Germany, France, and the U.K.) during the same period (Figure 1-1-1). In Figure 1-1-1, "R&D purchasing power parity" has been substituted for the standard "GDP purchasing power parity" to make the currency conversions needed for an international comparison of R&D expenditures.

**Figure 1-1-1 R&D Expenditures in Selected Countries**  
(R&D purchasing parity calculations)



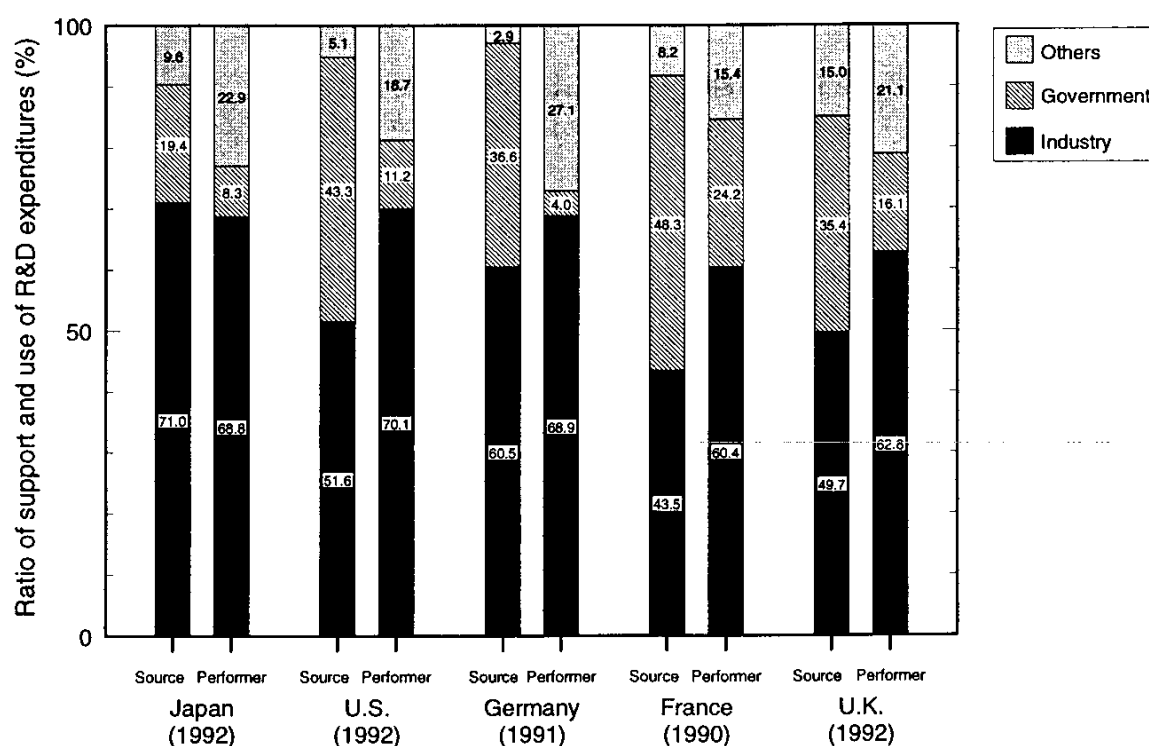
Note: R&D expenditures are surveyed each fiscal year in Japan, but calendar years are used here for the sake of international comparison.

Sources: Management & Coordination Agency (Japan), *Report on the Survey of Research and Development*, etc.; various data from foreign countries

See Figure 4-1-1

- (3) An international comparison of the ratio of R&D expenditures to gross national product (GNP) shows that Japan has led in this statistic since 1989. After reaching 3.00% in 1990 and 1991, however, its ratio dropped to 2.96% in 1992 and 2.90% in 1993.
- (4) Distinguishing between defense-related R&D expenditures and those for civilian purposes in individual countries, the small amount of defense-related R&D expenditures in Japan vis-a-vis the high proportion of such expenditures in the U.S. can be readily noted. The proportion of defense-related R&D expenditures in Germany, too, 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 provides a mere 20% of the total resources for R&D, substantially less than the governments of the U.S. and major European countries (Figure 1-1-2). Industry as a performer (user of resources) accounts for 70% of total R&D expenditures. Only a small part of Japanese R&D resources flows from government to industry, with industrial R&D expenditures borne almost entirely by industry. In the U.S., on the other hand, a large amount of R&D resources flows from government to industry.
- (6) Basic research has taken up 13 -14% of total R&D expenditures in Japan over the past decade, a level lower than that of many other major developed countries (Figure 1-1-3). The U.S. devotes the same proportion or more of its total R&D to basic research, while the share of basic research in Germany and France amounts to almost 20%.

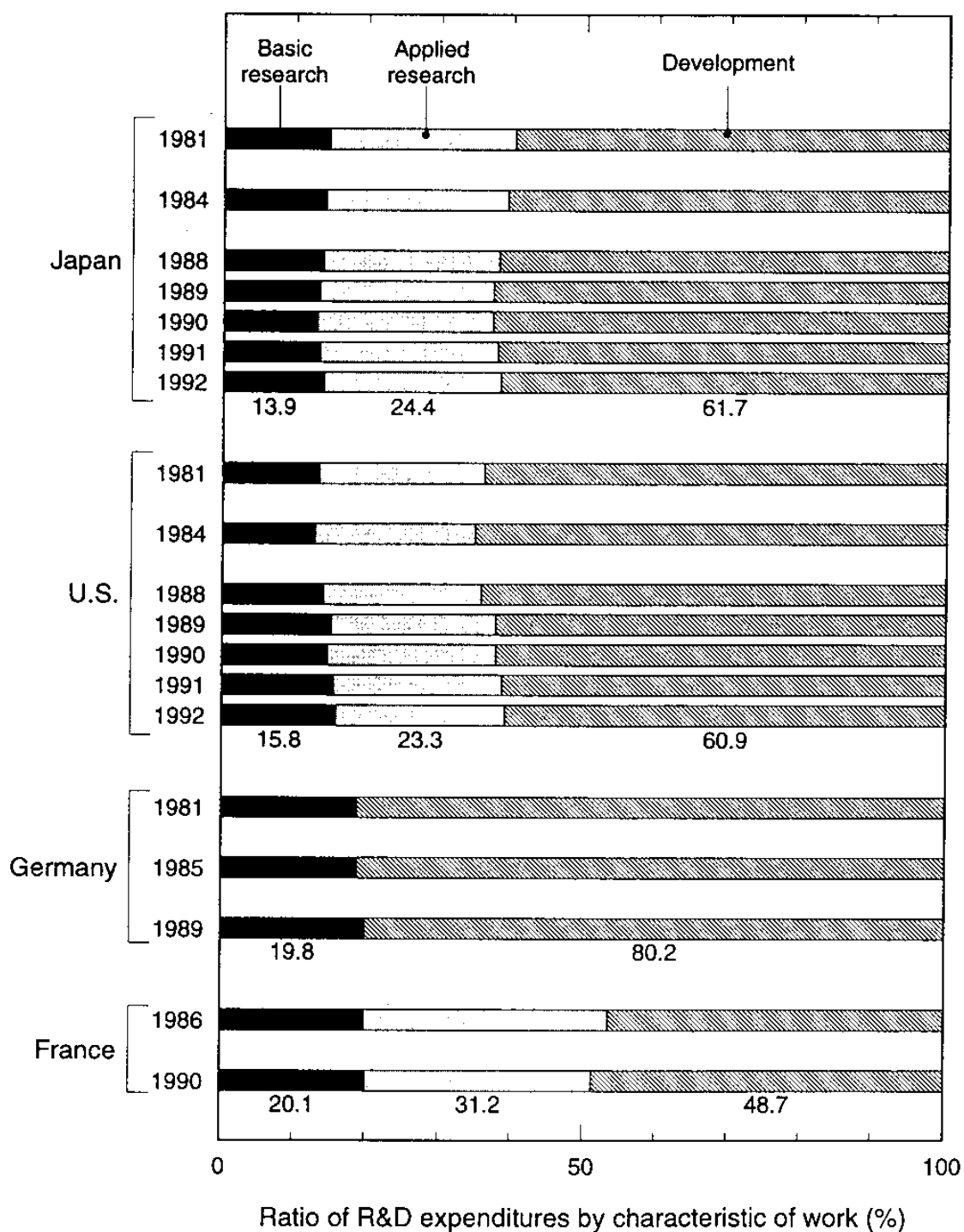
**Figure 1-1-2 R&D Expenditures Support by Sector in Selected Countries**



Sources: same as Figure 1-1-1

See Figure 4-1-6

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



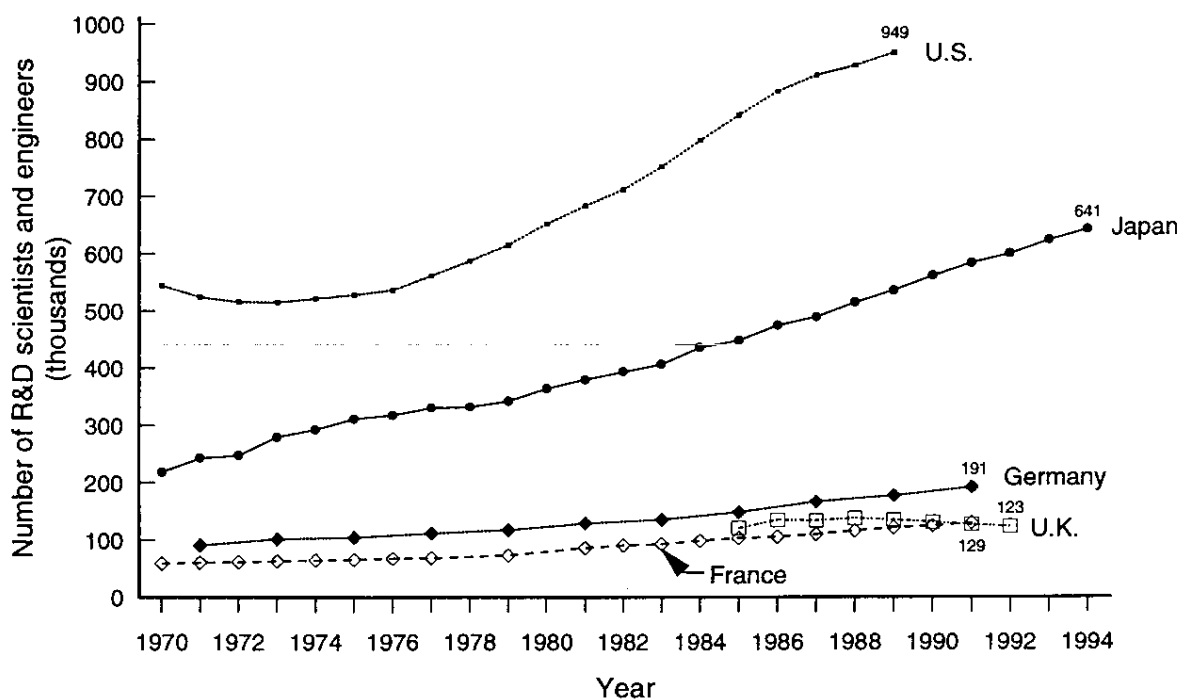
Note: No distinction is drawn in Germany between applied research and development. Data is not available for the U.K.

Sources: same as Figure 1-1-1

See Figure 4-1-9

- (7) In 1994 there were 642,000 R&D scientists and engineers in Japan; the number of R&D scientists and engineers has grown by approximately 300,000 over the past 20 years (Figure 1-1-4). In Japan and other developed countries, 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 the expanded employment of R&D scientists and engineers by industry.

**Figure 1-1-4 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.

Sources: same as Figure 1-1-1

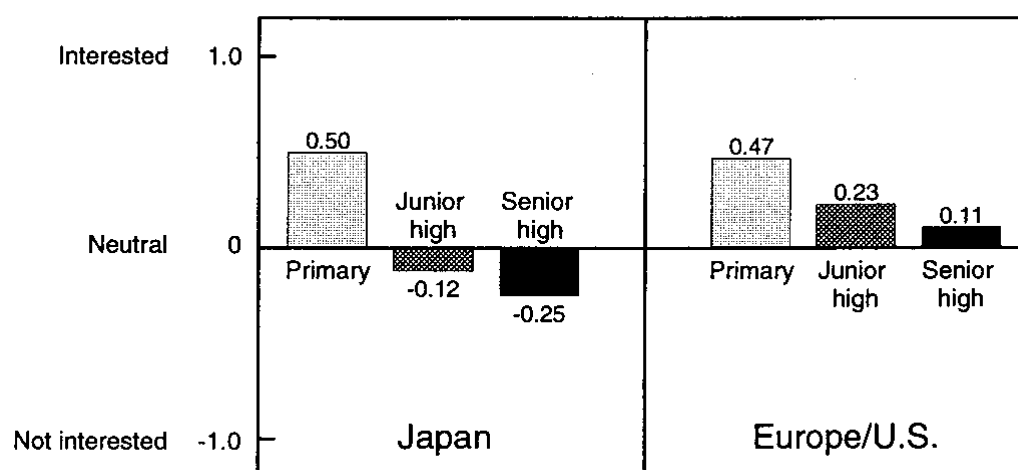
See Figure 4-1-11

## 1.2 Education and Human Resource Development for Science and Technology

### Environment for Basic Human Resource Development

- (1) An international comparison of science and mathematics education at the primary and secondary levels shows Japanese students ranking very high worldwide in these subjects. Japan's standing deteriorates somewhat, though, as students move up from primary and junior high school into senior high school.
- (2) There is a marked tendency in Japan for interest in science to decline as students progress from primary school to junior and senior high school (Figure 1-2-1).
- (3) The ratio of students to teachers in Japan is greater than that of Europe or the U.S., and Japanese students spend less time in the laboratory than their Western counterparts. Senior high school science teachers in Japan generally have had only a few years of higher education, and women still make up only a small proportion.

**Figure 1-2-1 Interest in Science (Primary School and Junior/Senior High School)**



Note: Interest in (enjoyment of) science and technology is greater as the value approaches +1 and decreases as the value approaches -1; 0 corresponds to a "neutral" attitude.

Sources: National Institute for Educational Research, *International Comparison of Science Education*, 1993; works by author

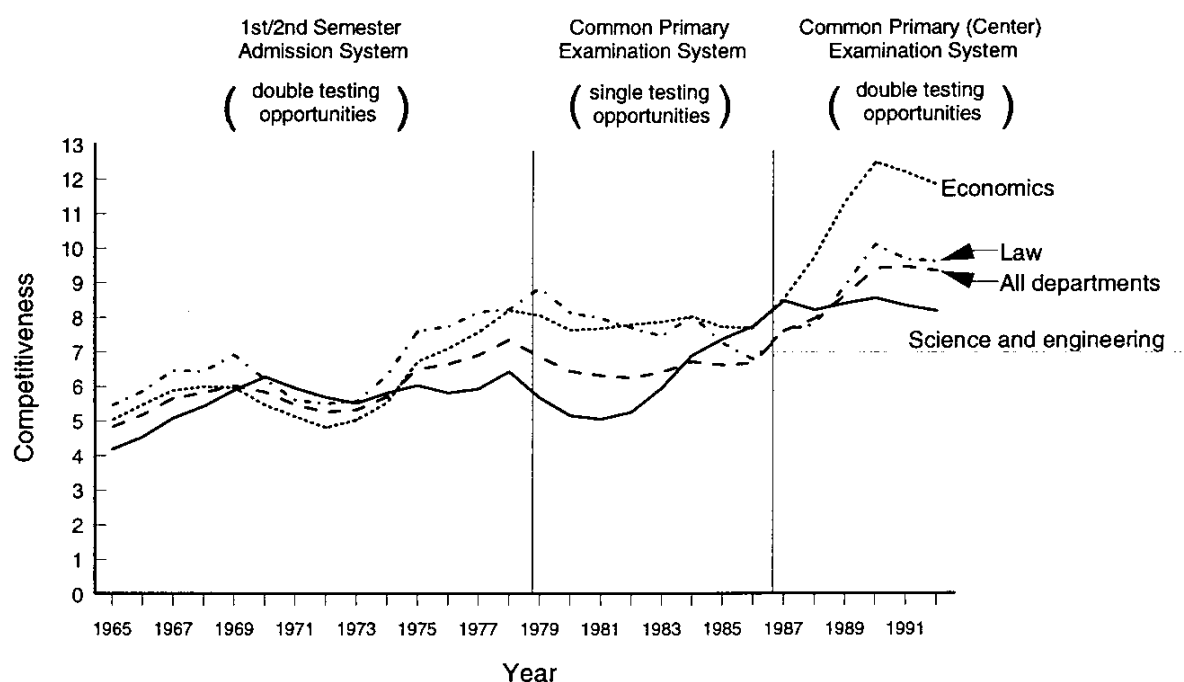
See Figure 2-1-1

### Senior High Schools

- (1) The proportion of junior high school students that go on to senior high school has reached saturation since hitting 92% in 1980. As more and more students seek entrance to universities, enrollment in general courses has risen, with a consequent decline in the proportion of students in industrial courses. Furthermore, an increasing number of students in commercial and industrial senior high schools are opting for information science courses.
- (2) The proportion of senior high school graduates employed by the manufacturing industry peaked in the mid-1980s and has fluctuated since, declining over the past two years. Employment in the service industry has seen a long-term rise, while that in financial and insurance industry has fallen off.

- (3) The number of applicants for the university departments of economics, law, and commerce (including those who apply to more than one department) has risen sharply, the number of applicants for the department of science and engineering has also grown, and consequently the overall number of prospective university students has increased. The economic slowdown among other factors has led to a decline in the number of students applying to more than one department, and this has had an impact on both the number of applicants for the department of science and engineering and the overall number of prospective students. Though there have been concerns voiced about a “alienated from science and engineering”, the proportion of applicants for the department of science and engineering has not dropped appreciably in the long term when compared with the average for all departments (Figure 1-2-2).

**Figure 1-2-2 Admission Competitiveness of Colleges and Universities by Department**



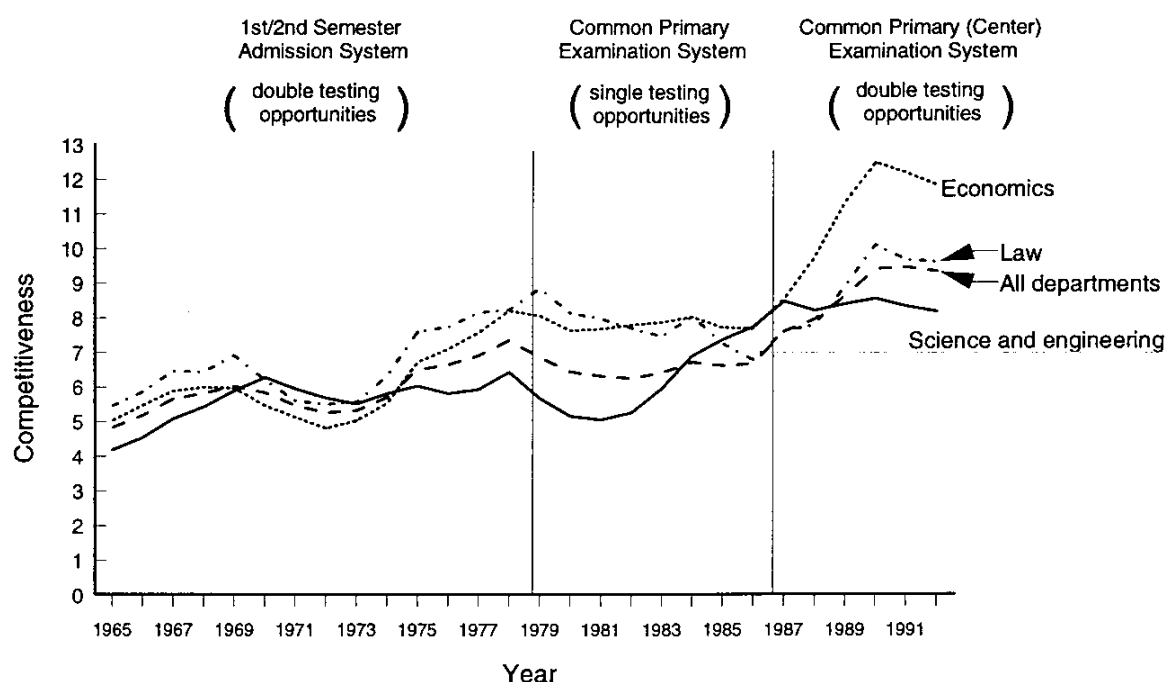
Source: Ministry of Education, *Report of Basic Survey on Schools*  
See Figure 2-2-6

### Universities, Junior Colleges, and Colleges of Technology

- (1) The number of students seeking entrance to the university department of science and engineering rose in the 1960s as a result of the “Income Doubling Plan”, plateaued afterwards, and since the mid-1980s has once again climbed; a greater proportion of women has accompanied this increase. Admission limits for information science departments have also been expanded.
- (2) Although manufacturing is still the largest single employer of science and engineering university graduates, this share has dropped in recent years. Employment in information and service industries saw a long-term rise from the mid-1970s, but this has tailed off in recent years (Figure 1-2-3). The financial and insurance industry employs only a small proportion of science and engineering graduates, and this has, despite a temporary boost in the late 1980s, continued to fall in the 1990s.

- (3) The past several years have seen a greater number of students in information science courses in junior colleges and colleges of technology. The ratio of employment in manufacturing of graduates of junior college engineering courses and colleges of technology has been static or declining, but there has been a substantial rise in the proportion of graduates finding work in information science and other service industries. While the absolute number of graduates joining the financial and insurance industry is still small, this number, too, is on the rise.

**Figure 1-2-3 Employment of Science and Engineering Graduates by Key Industrial Sector**



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

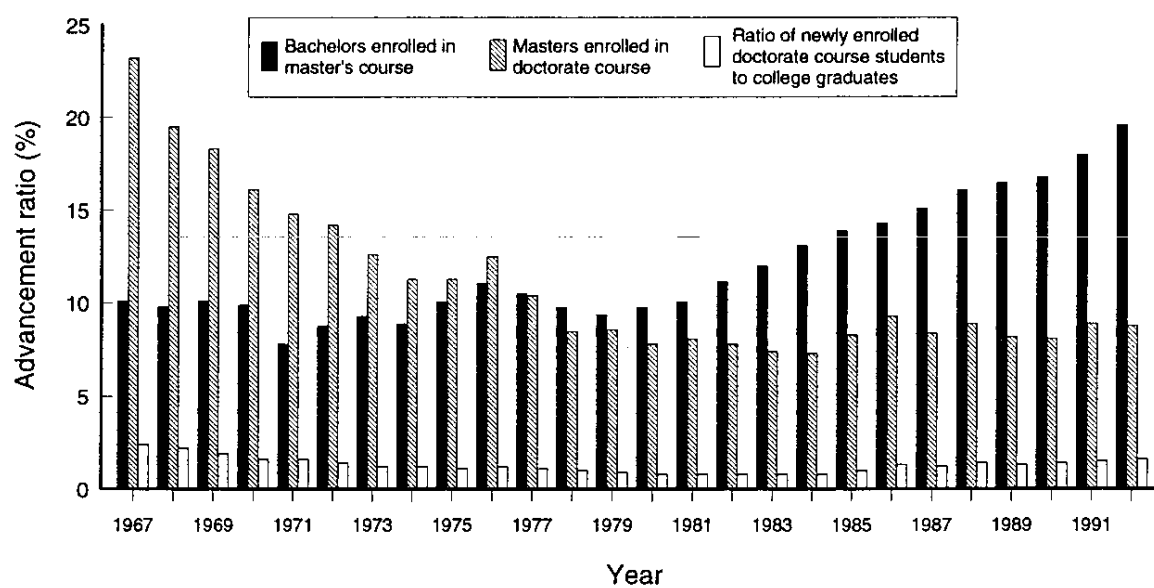
See Figure 2-4-5

### Graduate Schools: Master's and Doctorate Courses

- (1) Enrollment in master's courses in the department of science and engineering has been increasing (Figure 1-2-4). Enrollment in doctorate courses continually dropped from the beginning of the 1970s, but there have been recent signs of an increase. Nevertheless, more students per capita earn doctorates conferred in science and engineering in the U.S. than in Japan.
- (2) A consistent 70% of holders of master's degrees in science and engineering find employment in the manufacturing industry, and the employment ratio in information and service industries has continued to climb steadily. The finance and insurance industry attracts only a small proportion of such graduates, and, despite a rise in the mid-1980s, this share has grown even smaller in the 1990s.
- (3) Doctorate course graduates are of late increasingly finding employment in the manufacturing industry, with greater numbers also being employed in information and service industries, though the total in this area is still small.



**Figure 1-2-4 Advancement Rate into Engineering Graduate Schools**



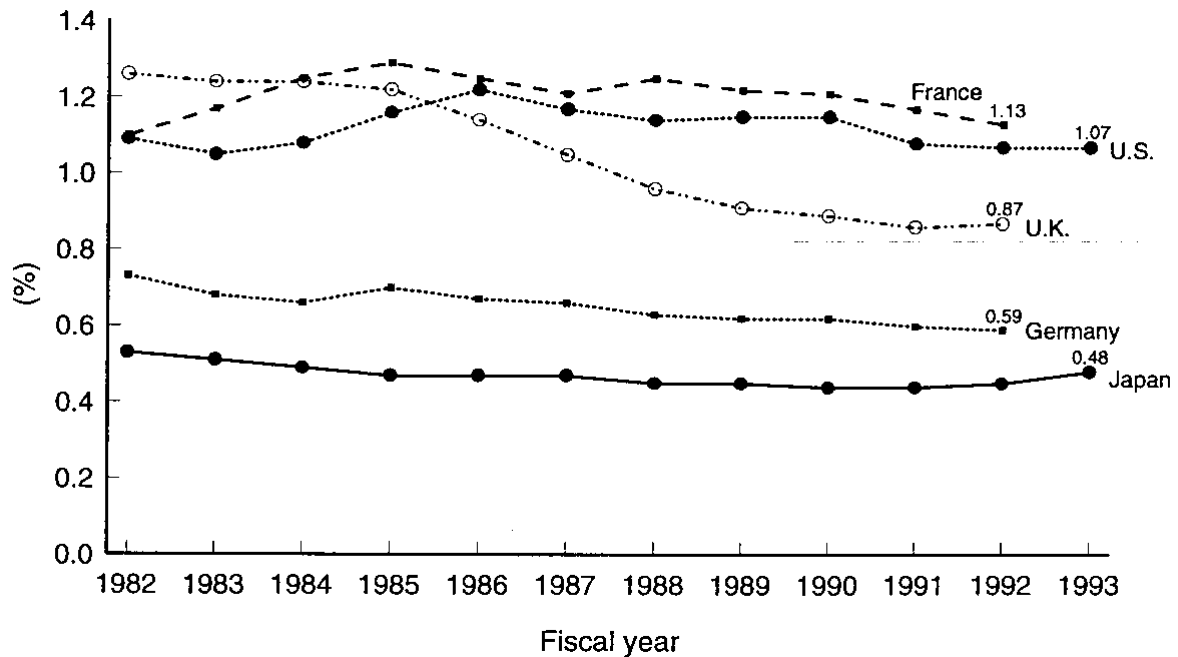
Source: Ministry of Education, *Report of Basic Survey on Schools*  
 See Figure 2-5-4 (see Figure 2-5-3 for graduate schools of science)

### 1.3 Social Support for Science and Technology

#### Governmental Support

- (1) The governmental science and technology budget in Japan was 2.3585 trillion yen in FY1994, representing about 3.2% of the General Account. The budget for science and technology has steadily grown in recent years, showing a much higher growth rate than general budget appropriations by the government.
- (2) The ratio of the governmental science and technology budget to GNP in Japan is about half the figure for the U.S., France, and the U.K. (Figure 1-3-1), quite small given the size of Japan's economy.
- (3) As regards the allocation of the science and technology budget among ministries and agencies, the Ministry of Education receives about half, the Science and Technology Agency about half of that, and the Ministry of International Trade and Industry only half of that, these three account for over 80% of the budget for science and technology. Nearly 80% of the science and technology budget earmarked for the Ministry of Education is funding for national universities.

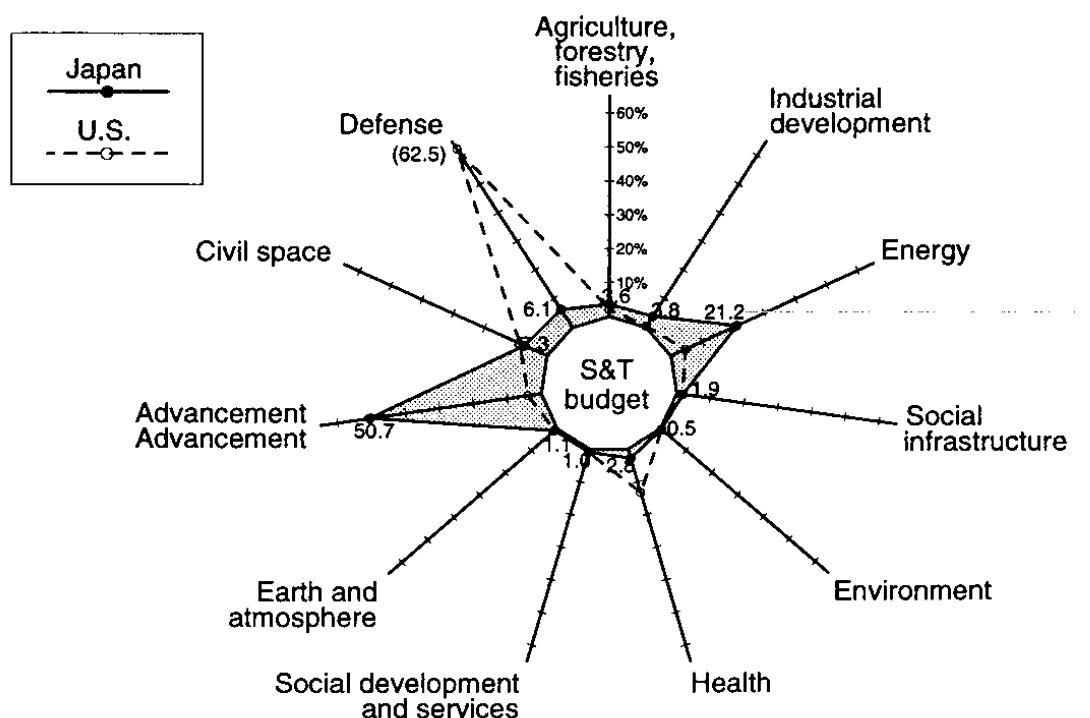
Figure 1-3-1 Ratio of S&T Budget to GNP in Selected Countries



Source: Science and Technology Agency, *Overview of Science and Technology*  
See Figure 3-1-7

- (4) Comparing the science and technology budgets of selected countries using the budget classifications for science and technology by socio-economic objective set out by the Organization for Economic Cooperation and Development (OECD), one sees that Japan is characterized by an extremely high share of its budget devoted to the “advancement of knowledge” (research funding for universities and subsidies for other uncategorized research), followed in percentage terms by “energy” (Figure 1-3-2). “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.

**Figure 1-3-2 Japanese S&T Budget by Socio-economic Objective**



Note: The S&T budgets used are FY1993 for Japan and FY1990 for the U.S.

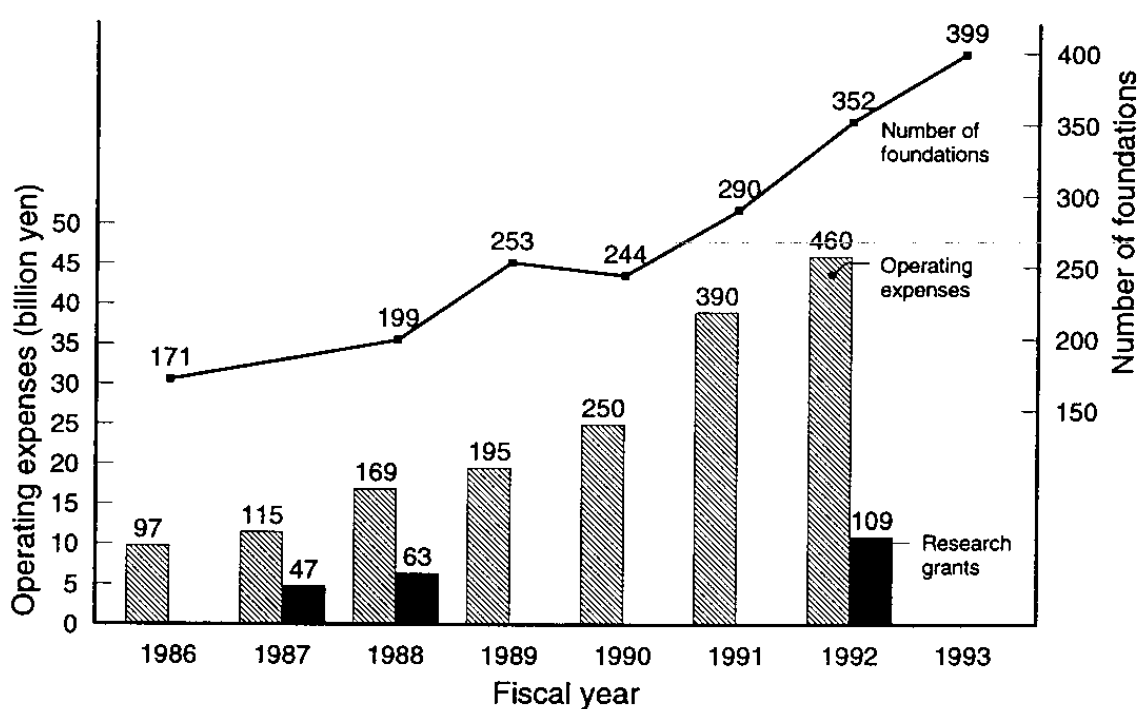
Source: Science and Technology Agency

See Figures 3-1-8 and 3-1-9

## Public Support

- (1) The total operating expenses of foundations that serve to complement government and other official support for science and technology and whose principal task is subsidizing research amounted in FY1993 to 46 billion yen, 10.9 billion yen of which was given out in research grants (Figure 1-3-3). Though this amount may seem small in comparison with the overall scale of R&D in Japan, it nonetheless plays an important part as a source for basic research funds.
- (2) The number of registered learned societies in 1992 was 1,331. Humanities-related and medical societies were the most numerous, together accounting for the majority of academic societies, followed by engineering, physical science, and agriculture. By an overwhelming margin medical societies had the largest number of individual members.

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



Note: Data is unavailable for certain years; only data for those years available has been used.

Source: Supportive Foundation Data Center

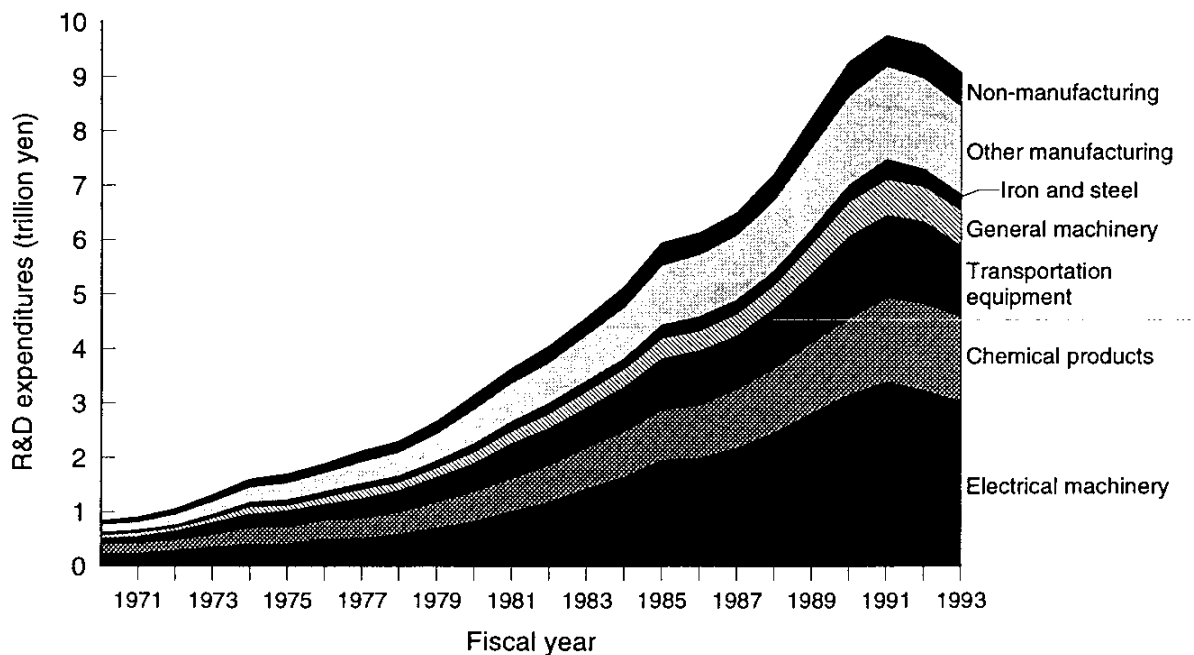
See Figure 3-2-1

## 1.4 R&D Activities in Industry, Academia and Government

### R&D in Industry

- (1) Industrial R&D expenditures in Japan had until recently been on the rise, but FY1992 saw a 1.9% drop from the previous year, the first such decrease since R&D statistics began being measured in 1953. A further fall of 5.3% occurred in FY1993, but this does not appear to be such a major decrease when one compares the 2.75% ratio of R&D expenditures to sales with the 2.83% ratio of FY1992.
- (2) Electrical machinery manufacturing has consistently claimed the largest ratio of R&D expenditures by industry as a whole, followed by chemical products manufacturing and transportation equipment manufacturing; these three industries alone account for about two-thirds (FY1993) of total industrial R&D expenditures (Figure 1-4-1).
- (3) When R&D expenditures are examined by product categories, communication and electronics equipment comes out on top, followed closely by motor vehicles and electrical machinery.
- (4) The number of R&D scientists and engineers in Japanese industry overall has increased over the past 20 years, and the electrical machinery manufacturing industry has witnessed an especially significant increase in the number of its R&D scientists and engineers.

Figure 1-4-1 R&D Expenditures in Japanese Industry

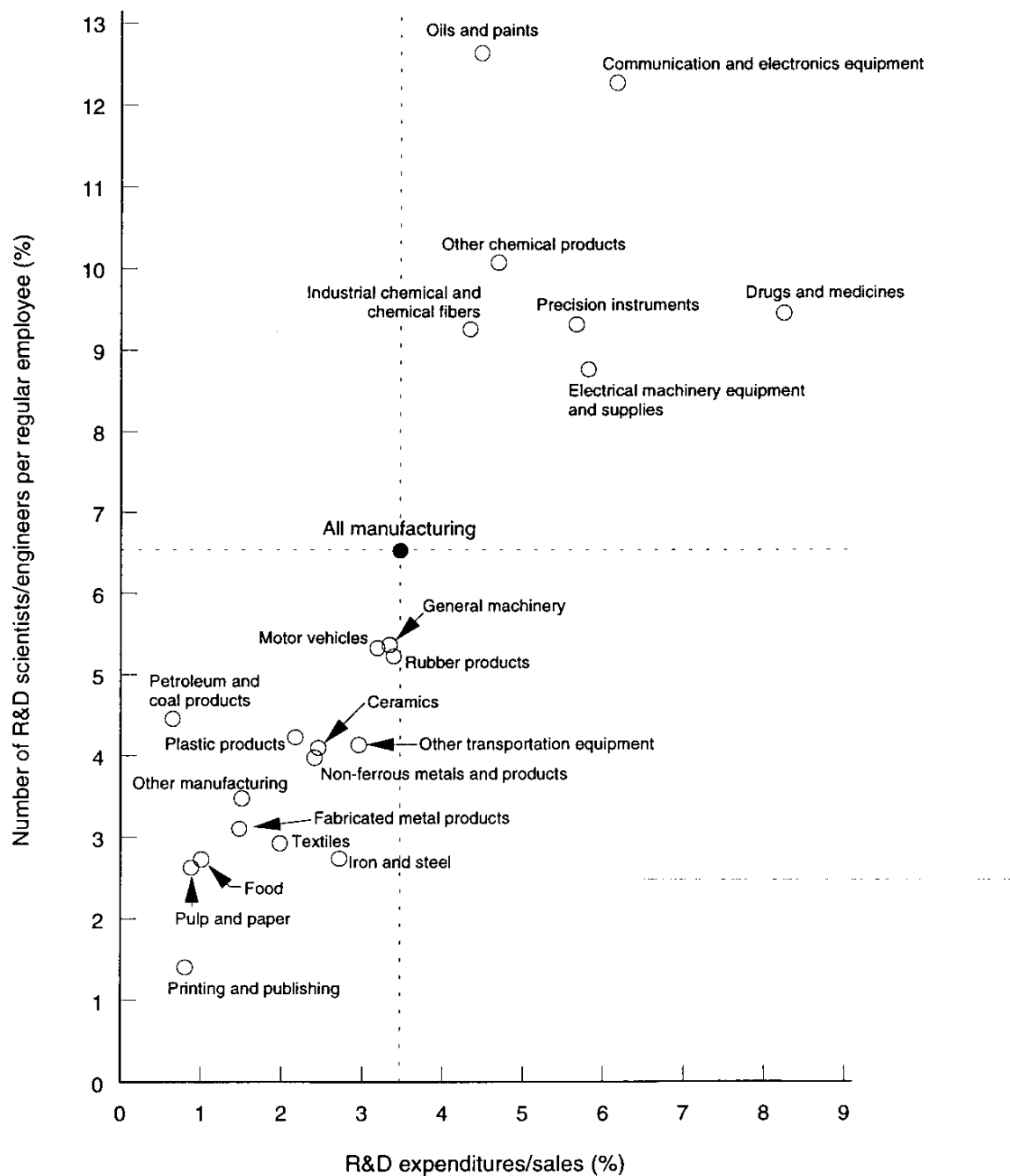


Source: Management & Coordination Agency, *Report on the Survey of Research and Development*  
See Figure 4-2-1

- (5) The ratio of R&D expenditures to sales and the number of R&D scientists and engineers per regular employee can serve as indicators of “R&D intensity” to show the levels of R&D expenditures and investment in human resources development. The intensity of R&D expenditures in manufacturing has continued to grow since the late 1980s, though the pitch has slowed somewhat, and there has also been a steady increase in the intensity of the number of R&D

scientists and engineers. The characteristics of individual industries can be identified by examining their R&D intensity (Figure 1-4-2).

**Figure 1-4-2 R&D Intensity by Industry (FY1993)**

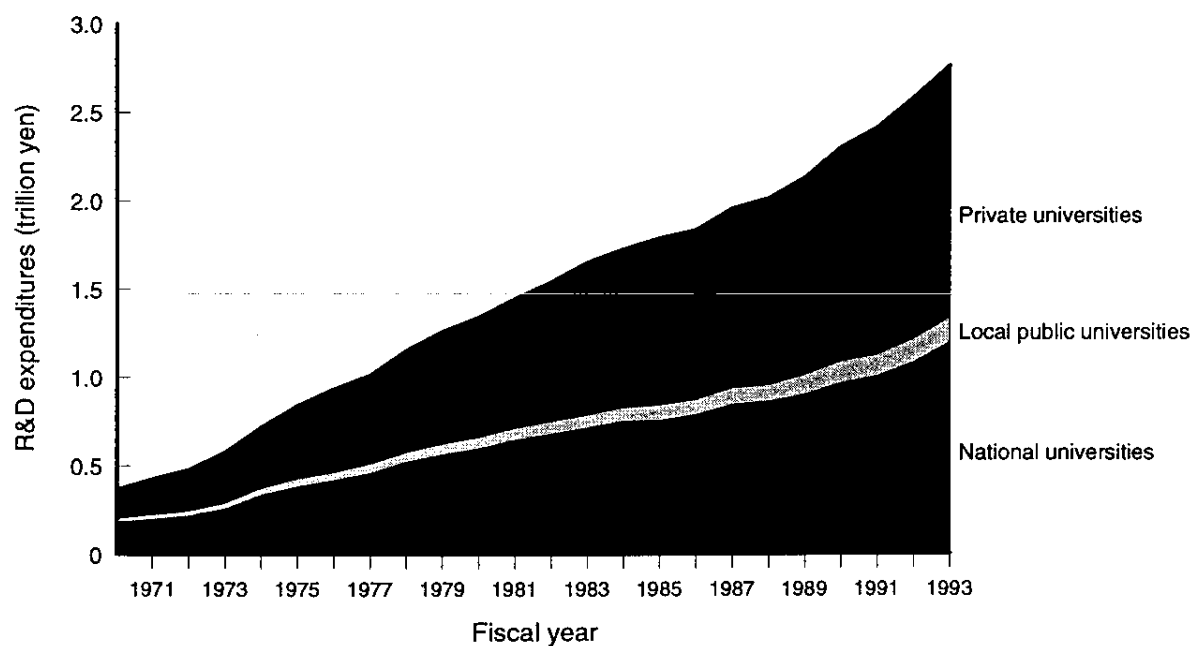


Source: Management & Coordination Agency, *Report on the Survey of Research and Development*  
See Figure 4-2-10

## R&D in Academia

- (1) R&D expenditures in private universities have recently surpassed those of national universities (Figure 1-4-3), and growth in R&D expenditures for private universities over the past two decades or so has been greater than that for national and local government universities. Physical science has seen the largest growth of any academic field.
- (2) The number of R&D scientists/engineers in universities has steadily climbed, with private universities slightly ahead of national universities. R&D scientists/engineers in the natural sciences outnumber those in the humanities/social sciences about two to one. Health is the largest academic field in terms of R&D scientists/engineers within the natural sciences.
- (3) R&D expenditures per scientist/engineer in universities are highest in private universities, their growth outpacing that of national and local government universities. Physical science and engineering have the highest R&D expenditures among the natural sciences, with those allocated for health being relatively small.

**Figure 1-4-3 R&D Expenditures in Japanese Universities**

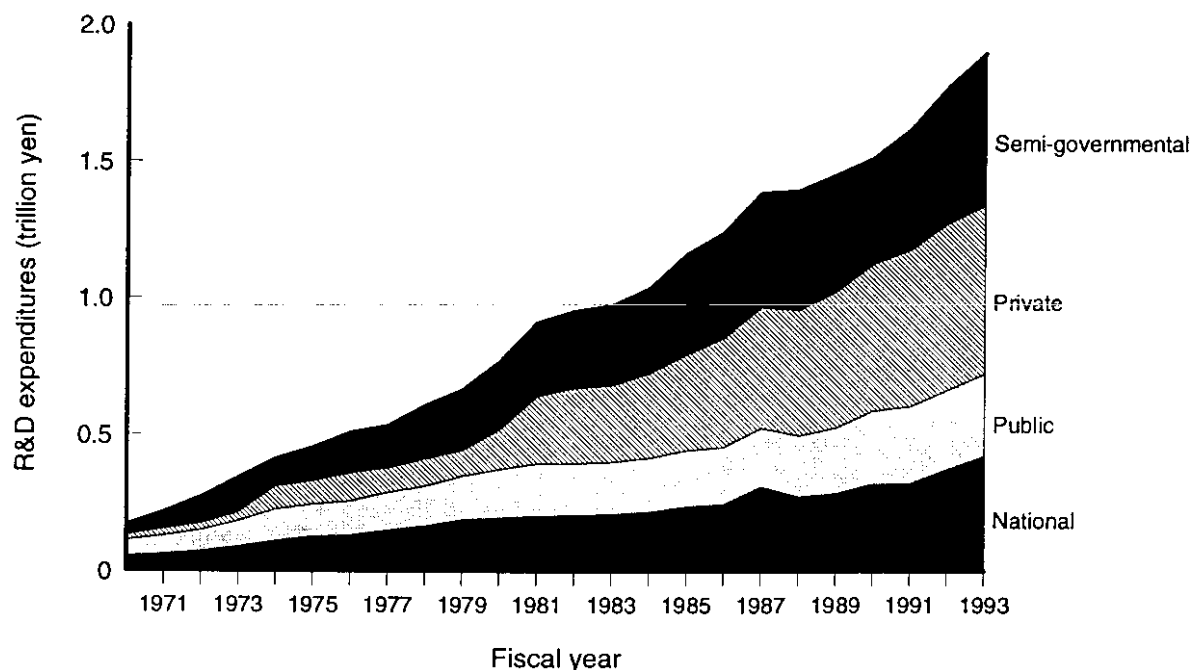


Source: Management & Coordination Agency, *Report on the Survey of Research and Development*  
See Figure 4-3-1

## R&D in R&D Organizations

- (1) Although R&D expenditures for national, semi-governmental, public, and private R&D institutes amounted to only 13.8% of total R&D expenditures in Japan for FY1993, these expenditures have risen over the past few years. R&D expenditures are greatest for private foundations (Figure 1-4-4). The growth of R&D expenditures for private foundations was substantial until the late 1980s, when the pace slackened. The past couple of years have seen significant growth in R&D expenditures for national R&D institutes.
- (2) The overall number of R&D scientists/engineers in R&D institutes has in recent years grown at a slower rate than that in industry or academia, especially the number in national R&D institutes. There has been substantial growth, however, in the number of R&D scientists/engineers in private R&D institutes.
- (3) R&D expenditures per R&D scientist/engineer are highest in semi-governmental R&D institutes, as these institutes are engaged in large-scale R&D projects.

**Figure 1-4-4 R&D Expenditures in Japanese R&D Organizations**



Source: Management & Coordination Agency, *Report on the Survey of Research and Development*  
See Figure 4-4-1

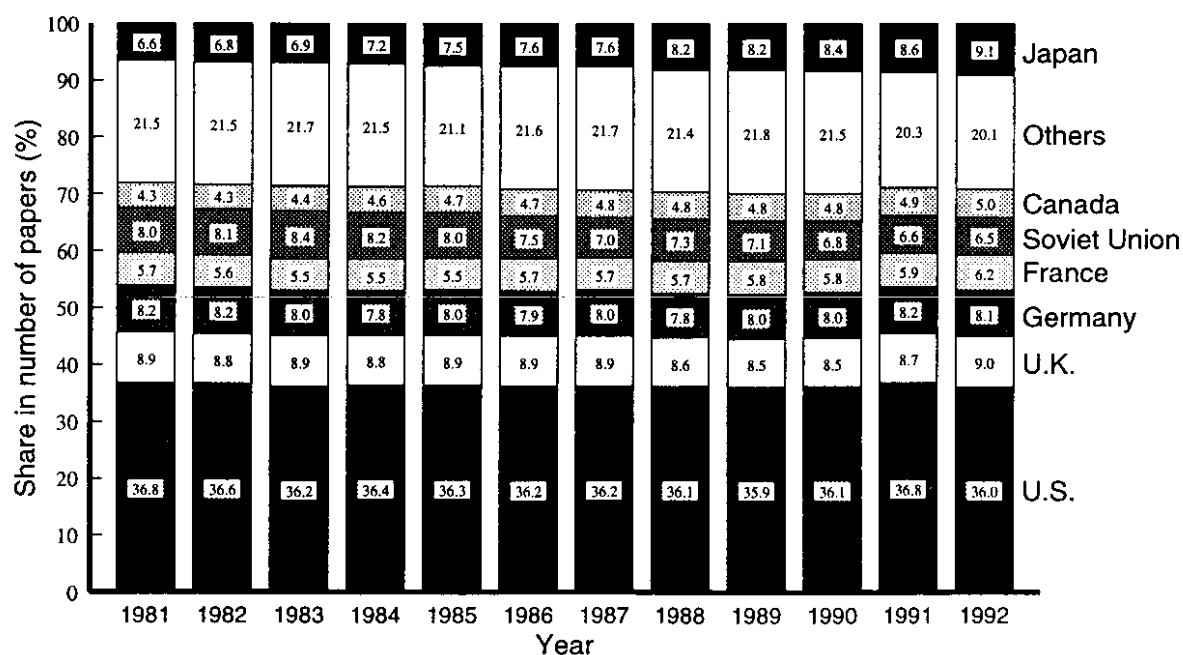


## 1.5 Achievements of R&D Activities

### Scientific Papers

- (1) The U.S. has consistently held the largest share by country of the number of scientific and engineering papers produced, Japan passing the U.K. in 1992 to take second place (Figure 1-5-1). The increase in Japan's share is one of the most notable worldwide.
- (2) The U.S. has the largest citing share of scientific papers and is thus very influential, with around half of the papers cited in the world being of U.S. origin. Although the absolute number of citations of Japanese papers is third, the number of citations per paper is still under the worldwide average.
- (3) Japan holds large shares in the number of scientific papers produced in the areas of pharmacology and material science, but only small shares in earth science and ecology/environmental science. Particularly conspicuous is the large disparity between Japan's small share in computer science and that of the U.S. being large.
- (4) Japan is above the world average in citation frequency of its scientific papers in material science, agriculture, and astrophysics; Japanese papers also have a high citation frequency in physics and chemistry (Figure 1-5-2). On the other hand, ecology/environmental science and computer science are among areas with a low citation frequency.

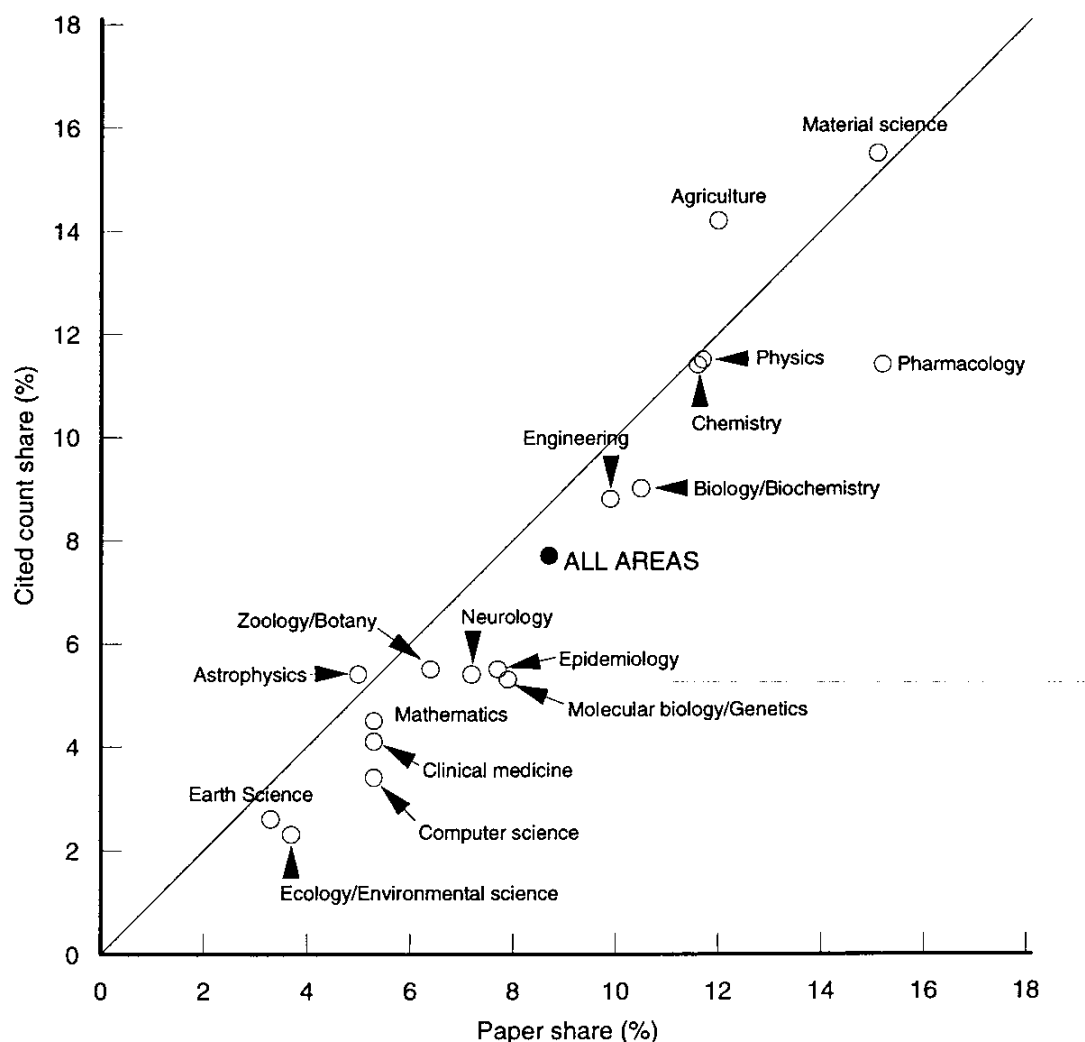
Figure 1-5-1 Country Share Trends in the Output of Scientific Papers



Source: Science Citation Index Database

See Figure 5-1-1

**Figure 1-5-2 Japanese Scientific Paper Citation Frequency by Academic Field (1990–92 average)**



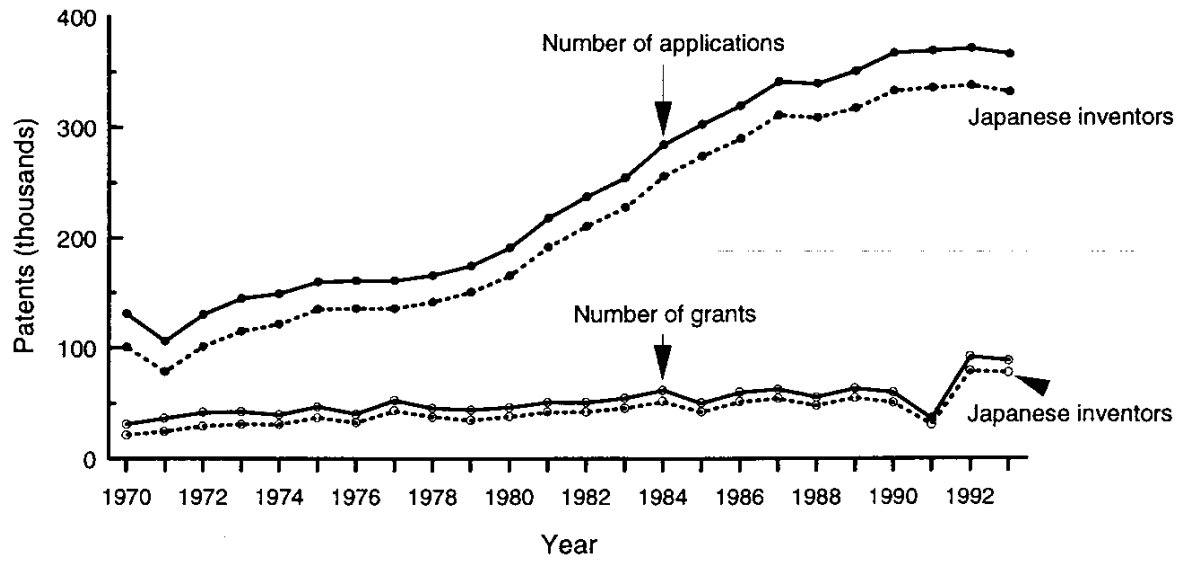
Source: Science Citation Index Database

See Figure 5-1-4

## Patenting

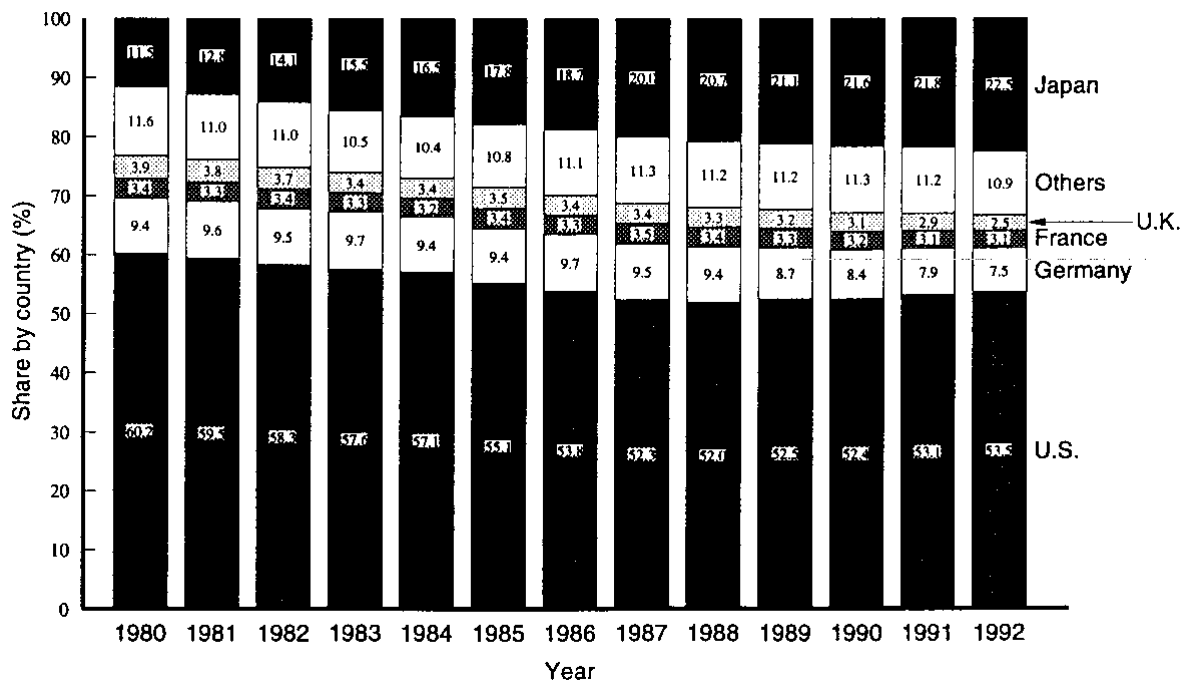
- (1) Although the number of patent applications has risen sharply from the 1980s, the number of patent grants has not seen the same rate of increase (Figure 1-5-3). This is likely due to the fierce competition in applications among Japanese corporations and the inability of patent screeners to cope with the rapid increase of applications.
- (2) Numbers of patent applications in 1991 were greatest in the areas of basic electrical components, telecommunications technology, and computation/counting.
- (3) Applications for Japanese inventions made abroad were most numerous in the U.S., followed by Germany and the U.K. (1992). The ratios of Japanese applications to the total number of applications in the U.S. and Germany have declined in recent years, but Italy and other European countries as well as South Korea have been receiving more and more Japanese applications.

Figure 1-5-3 Patenting Trends in Japan



Source: Patent Agency, *Patent Agency Annual Report*  
See Figure 5-2-1

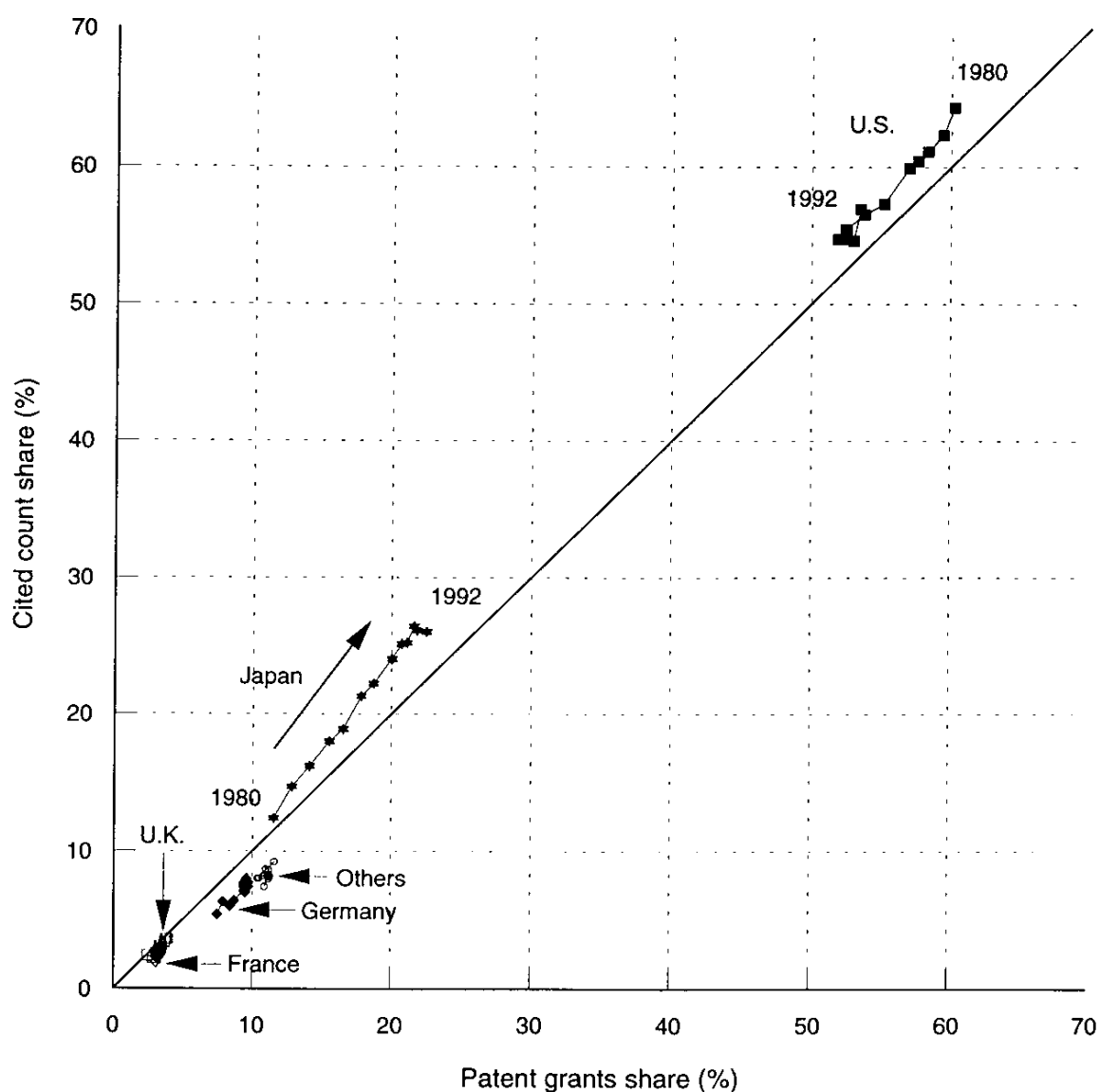
Figure 1-5-4 Patent Grant Share Trends by Country in the U.S. (1980–92)



Source: CHI Research Inc., *International Technology Indicators Database*  
See Figure 5-2-7

- (4) Japan has the largest share of patent grants in the U.S. of all countries other than the U.S. itself, and this share continues to rise (Figure 1-5-4). The U.S. itself received 54% of U.S. patent grants in 1992, while Japan received 23%.
- (5) The citation frequency of Japanese patents registered in the U.S. is extremely high and still rising (Figure 1-5-5).
- (6) Japan has edged past the U.S. to claim the top rank worldwide in domestic patents, but in external patents Japan is third behind the U.S. and Germany. The number of domestic patents in Japan has leveled off, while the number of external patents is increasing.

**Figure 1-5-5 Frequency of U.S.-Granted Patents Cited in Selected Countries**



Source: CHI Research Inc., *International Technology Indicators Database*

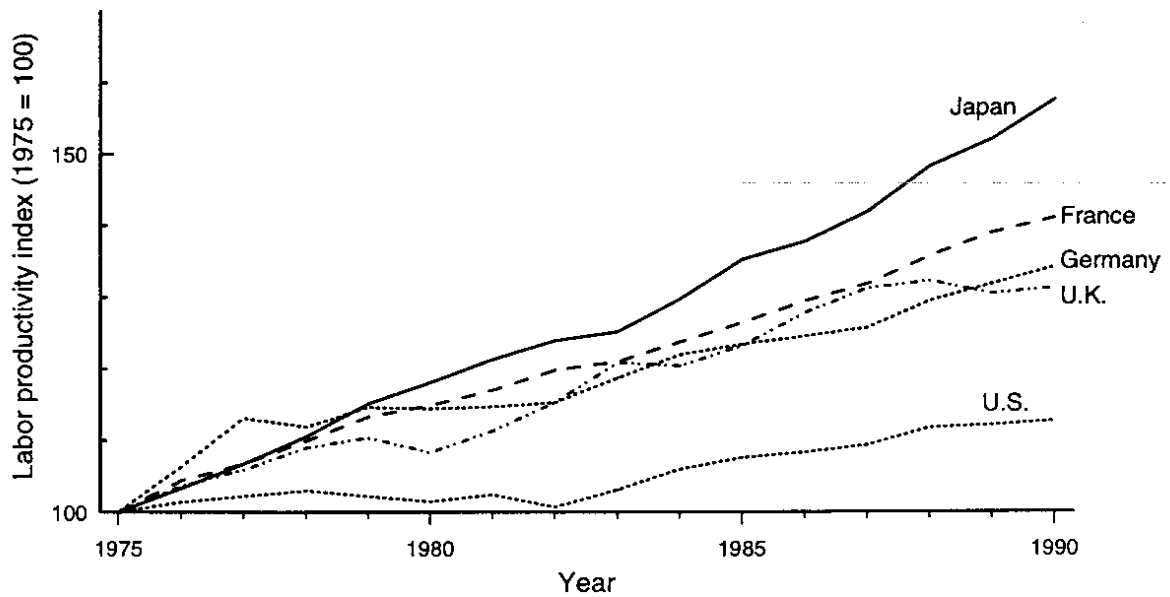
See Figure 5-2-8

## 1.6 Social Contribution of Science and Technology

### Contribution to Economic Growth

- (1) Japan has a lower added value labor productivity than the U.S., France, and Germany, but is advancing at a pace set to overcome these other countries (Figure 1-6-1).
- (2) Japan has since the 1960s had the highest total factor productivity among OECD nations and continues to see strong growth in this statistic.

**Figure 1-6-1 Labor Productivity Index of Added Value Index in Selected Countries**



Note: The data show the index of real GDP/labor force. Currency has been converted based on the purchasing power parity of 1985 prices.

Source: OECD, *National Accounts and Labor Force Statistics*

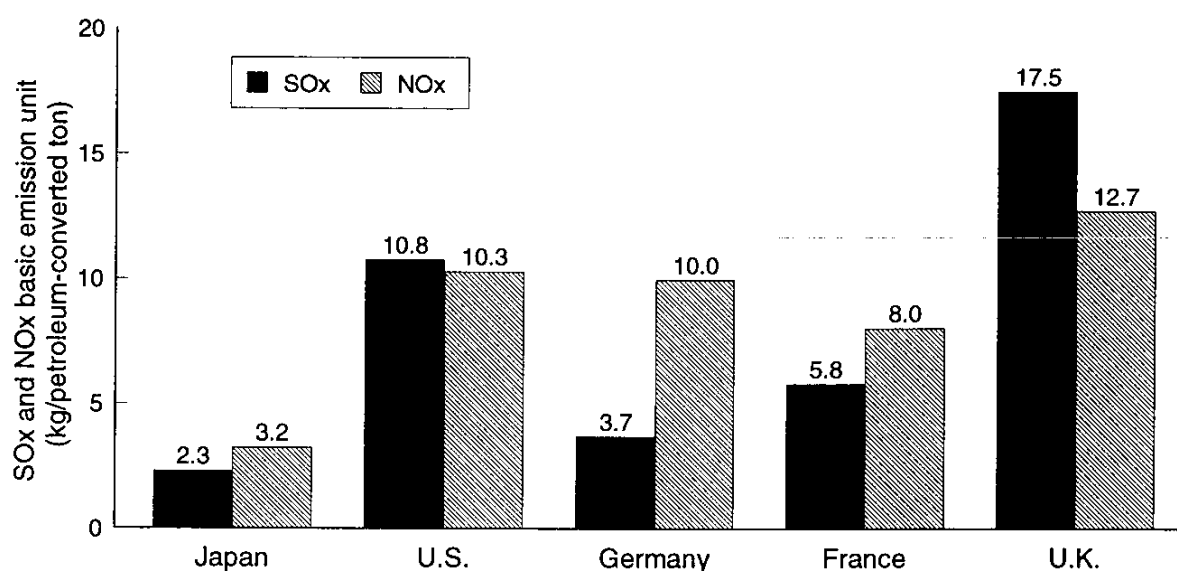
Japan Productivity Center, *International Comparison of Labor Productivity*, 1992.

See Figure 6-1-1

## Contribution to Preserving the Global Environment

- (1) Exhaust gas desulphurization and denitrification systems have led to great improvements in airborne sulphur oxide concentrations, and Japan's exhaust volume per unit of primary energy is the lowest in the world. Although exhaust volume of nitrogen oxides per unit of primary energy is the lowest in the world, an increased volume of motor vehicle traffic has kept the airborne concentration from declining (Figure 1-6-2).
- (2) The consumption of fossil fuels accounts for nearly 90% of carbon dioxide emissions. Emissions per unit of primary energy have gradually decreased in Japan, and, although still higher than those in France and Canada, emission levels are low by global standards (Figure 1-6-3).
- (3) 39% of Japan's industrial waste products arising from manufacturing were recycled in FY1991, while only 5% of general waste such as household garbage and office paper waste were recycled or reused during that same year.

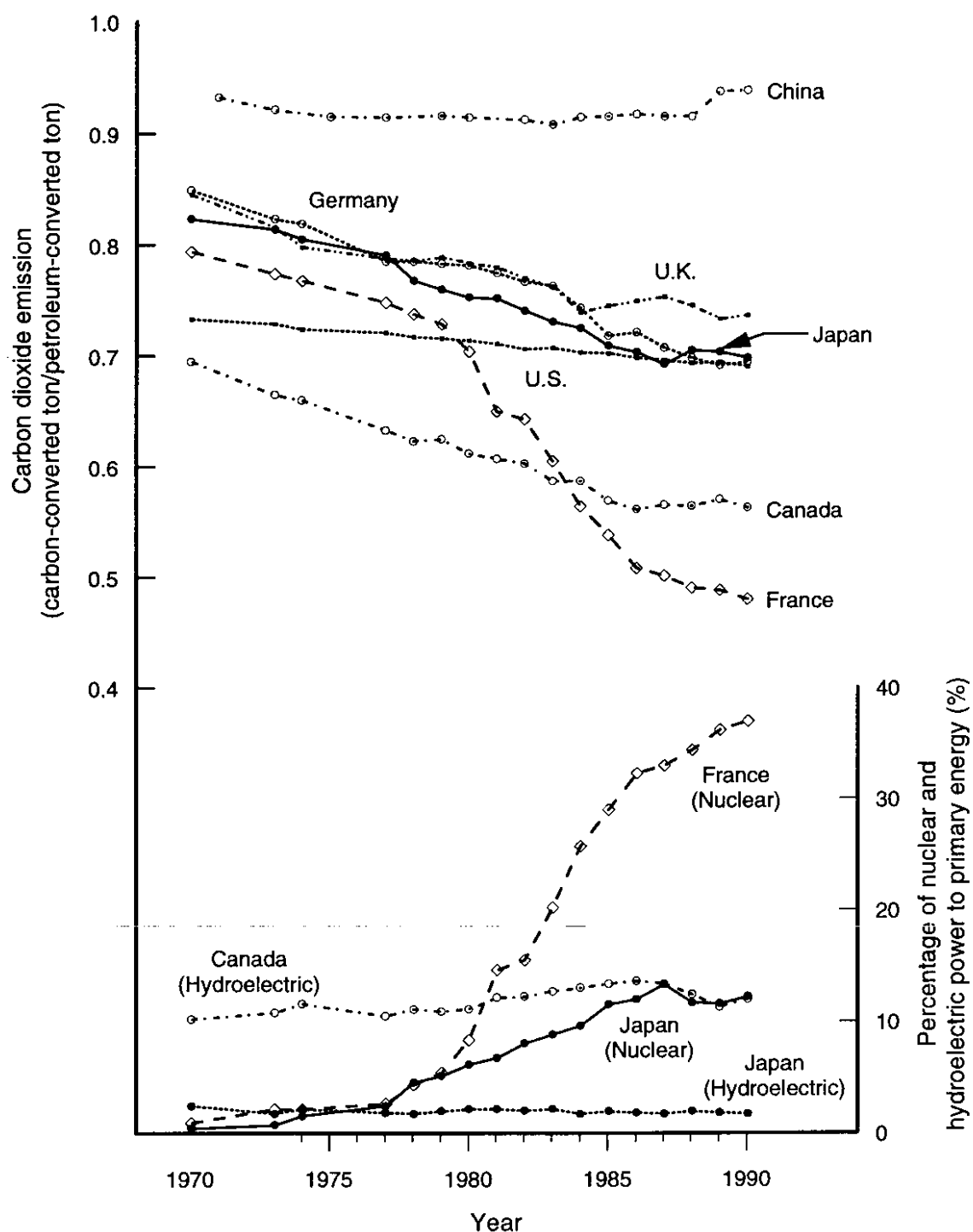
Figure 1-6-2 SO<sub>x</sub> and NO<sub>x</sub> Basic Emission Unit (emission per unit fuel consumption)



Source: OECD, *Environmental Data, Compendium 1991*

See Figure 6-2-8

Figure 1-6-3 CO<sub>2</sub> Emission per Primary Energy Unit and Percentage of Nuclear and Hydraulic Power to Primary Energy



Note: Because of the limitations of data, figures for China before 1988 are calculated by TPER ratio.

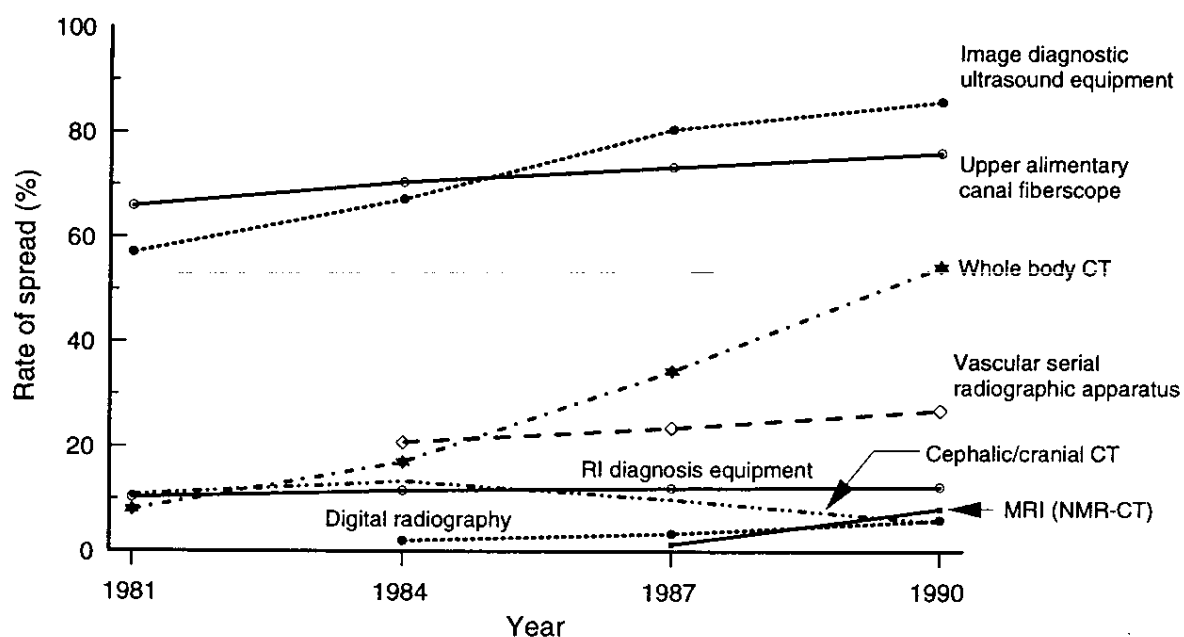
Source: OECD, *Energy Balances of OECD Countries* and *World Energy Statistics and Balances*

See Figure 6-2-11

## Improvement of Medical Care and Welfare

- (1) A few dozen new drugs are recently approved each year; in the 1980s more drugs were developed overseas than locally, but in 1991 and 1992 locally-developed drugs took the lead. Progress has been made recently in the development of drugs applying biotechnologies.
- (2) Among diagnostic devices, whole body CT has achieved a remarkable distribution rate, and there has also been wider distribution of magnetic resonance imaging equipment (MRI) and image diagnostic ultrasound equipment (Figure 1-6-4). Treatment devices have a lower distribution rate than diagnostic devices, but this rate is on the rise.
- (3) The examples of medical care technology recognized as highly advanced medical treatment system under the Health Insurance Law as well as the number of hospitals offering these treatments are increasing.

Figure 1-6-4 Spread of Major Medical Devices in General Hospitals



Note: In the data for upper alimentary canal fibscopes, the 1981, 1984, and 1987 figures are for gastric fibscopes. The 1981 figure for image diagnostic ultrasound equipment is for diagnostic ultrasound equipment.

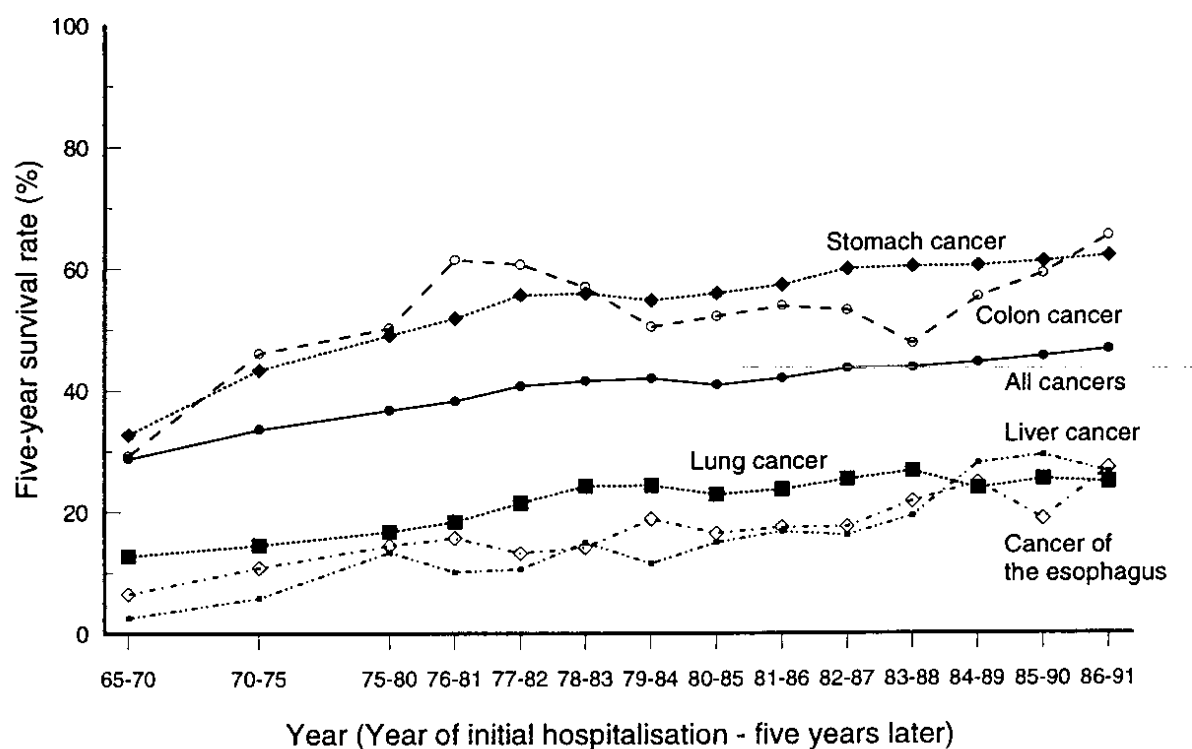
Source: Ministry of Health and Welfare, *Medical Facilities Survey*

See Figure 6-3-3

- (4) Of the three major adult diseases, the mortality rate of cerebral apoplexy has continued to decrease as those of heart disease and cancer have risen. Progress in high blood pressure prevention and emergency medical care has no doubt been an influential factor in the decreased death rate of cerebral apoplexy. The death rate per unit of population for cancer is increasing against a background of rising average life expectancy, but treatment is improving (Figure 1-6-5) due to progress in a combination of diagnostic technology, surgical technology, chemotherapy, and therapeutics.



**Figure 1-6-5 Trends in the Five-year Cancer Survived Rate  
(Patients hospitalized at the National Cancer Center for the first time)  
(Males)**



Source: Compiled from National Cancer Center data

See Figure 6-3-7

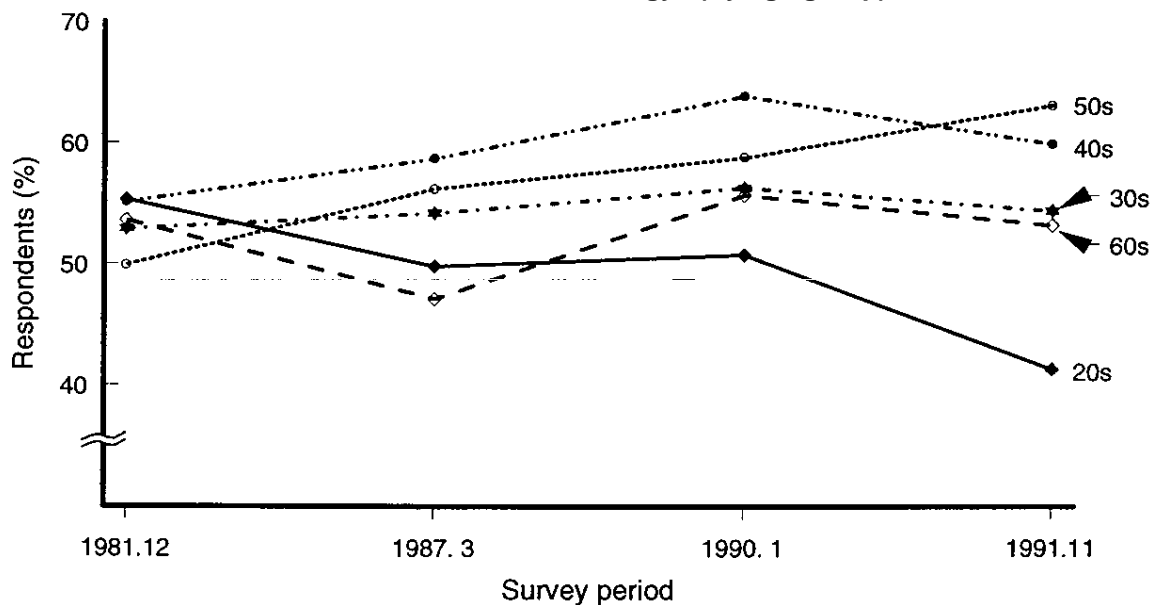
- (5) On viewing the production of welfare equipment, the manufacture of wheelchairs produced has grown almost continually since the beginning of the 1980s, and, although the manufacture of nursing beds grew substantially from 1982 to 1989, this number plateaued as a ceiling was reached in the number of hospitals and hospital beds.

## 1.7 Public Opinion on Science and Technology

### Japanese Opinions on Science and Technology

- (1) According to public opinion polls on science and technology, the average Japanese has a high estimation of Japan's S&T level.
- (2) A declining proportion of Japanese, especially those in their 20s, expressed an interest in news or topics about science and technology (Figure 1-7-1), giving a hint of the estrangement of young people from science and technology.

Figure 1-7-1 Percentage of Respondents Who “have and Interest in News or Topics about Science and Technology” (By age group)



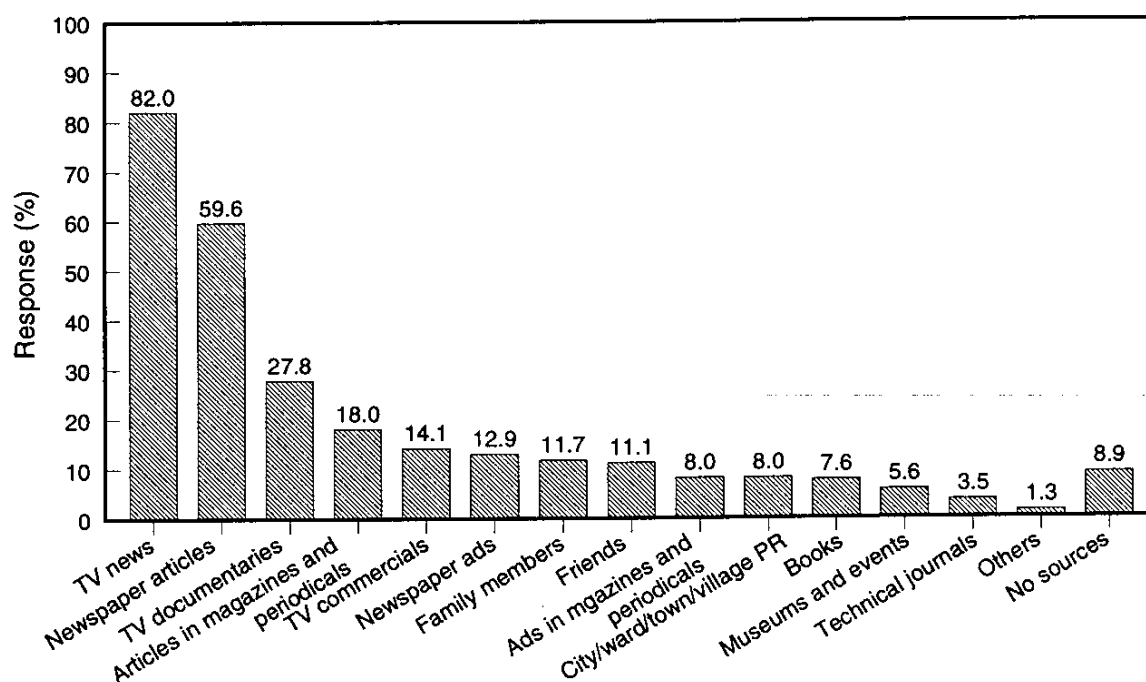
Source: National Institute of Science and Technology Policy, *Comparative Survey on Public Opinion Regarding Science and Technology in Japan, U.S. and Europe*, 1992

Prime Minister's Secretariat, *Public Opinion Poll on Science & Technology and Society*

See Figure 7-2-6

- (3) Interest in science and technology is high in matters closely related to daily living—“energy issues”, “environmental issues”, and “issues concerning new medical technology”—but low in areas such as “issues concerning new scientific discoveries” and “issues concerning space probes” that are not of such immediate concern.
- (4) Despite their recognition of the importance of science and technology in their daily lives, the majority of Japanese believe that they have insufficient access to information about science and technology and that inadequate information is available. Many people listed TV news and newspaper articles as their sources of science and technology information (Figure 1-7-2).
- (5) There was a wide disparity between men and women in interest in science and technology and in information sources. Overall, women expressed less interest in S&T news and topics than men; there was also a disparity in S&T knowledge between men and women.

**Figure 1-7-2 Source of Information about Science and Technology (Multiple response)**



Source: National Institute of Science and Technology Policy, *Comparative Survey on Public Opinion Regarding Science and Technology in Japan, U.S. and Europe*, 1992

Prime Minister's Secretariat, *Public Opinion Poll on Science & Technology and Society*

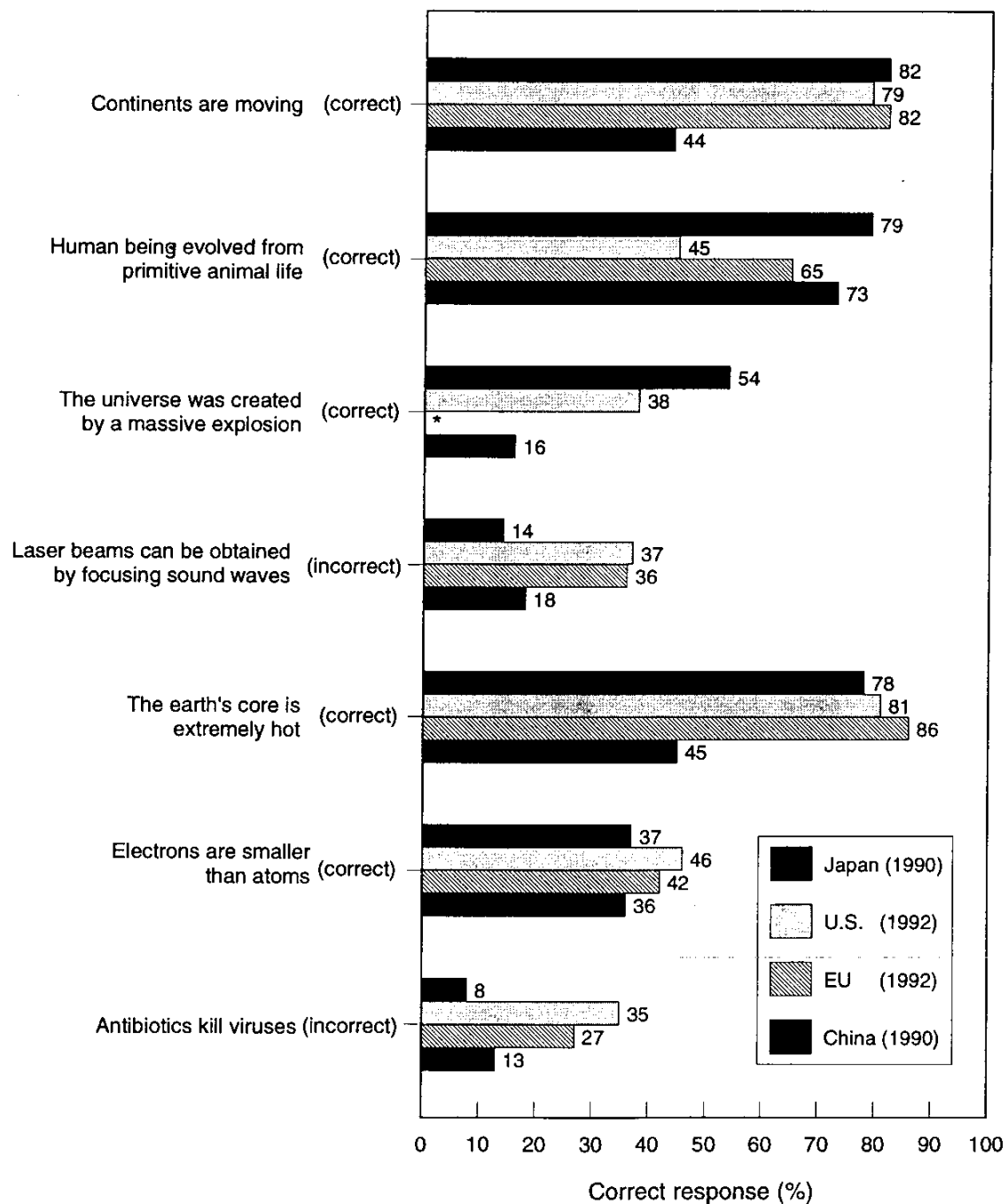
See Figure 7-2-8

- (6) There was low recognition of scientific and technological acronyms such as DNA. The highest levels of understanding by groups were demonstrated by males, young people, the highly educated, and people who enjoyed science in elementary and junior high school.
- (7) As to the benefits endowed by scientists or science/technology, while Japanese expressed a high degree of trust in scientists, their view on the impact of science and technology was not necessarily as favorable; much emphasis was placed on harmonization with society.

### **International Comparison of Public Opinion on S&T**

- (1) Survey results in Japan and the U.S. show that Americans have a greater interest in science and technology and are more actively receptive in this regard. The disparity between men and women in responses was smaller in the U.S.
- (2) In a comparison of surveys on understanding of science and technology in Japan, the U.S., the EU, and China, both Japan and the EU had high rates of correct responses. The impact of religious views on nature was apparent in the U.S., while in China there seemed to be delays in the dissemination of new scientific knowledge (Figure 1-7-3).

Figure 1-7-3 Level of Scientific Knowledge (International comparison)

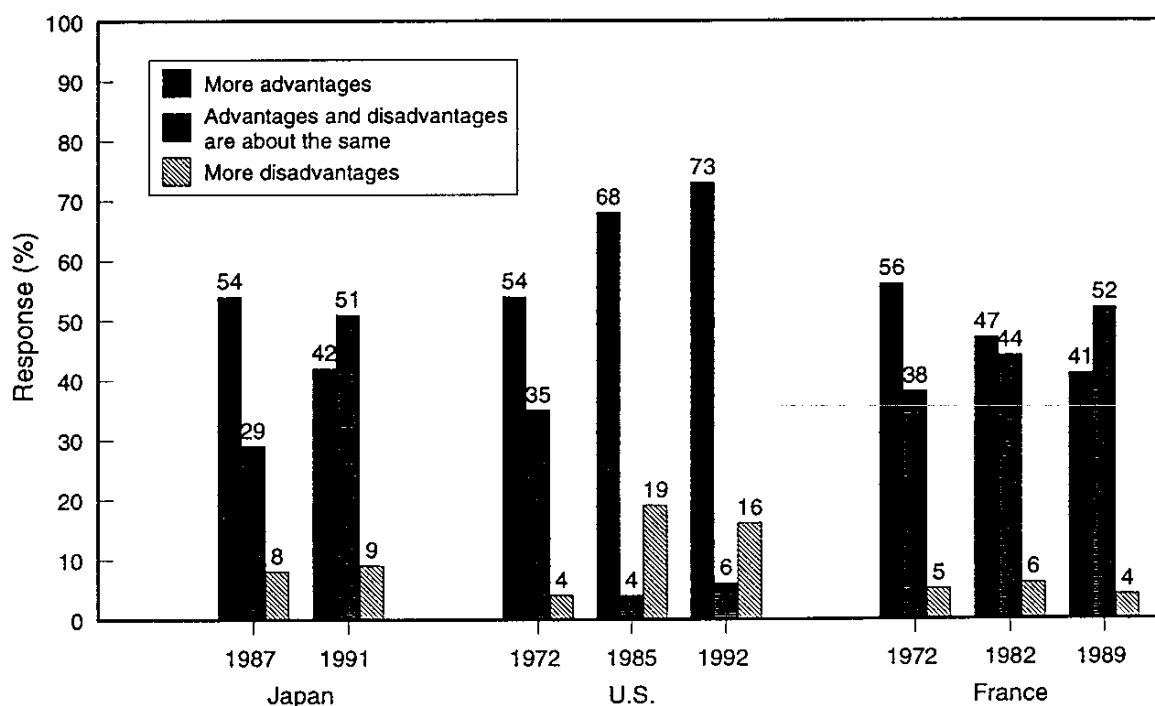


Source: Prime Minister's Office, *Public Opinion Poll on Science & Technology and Society*; data from other countries

See Figure 7-3-7

- (3) In polls on science and technology, there was a strong emphasis in the U.S. on the positive aspects of science and technology, while the assessment was not as positive in Japan and France. In these two countries, opinions have increasingly shifted away from the view of “more advantages” towards “advantages and disadvantages about the same”; in the U.S., Japan, and France negative opinions were few (Figure 1-7-4).

**Figure 1-7-4 Advantages and Disadvantages of Science and Technology  
(International comparison)**



Sources: Japan—National Institute of Science and Technology Policy, *Comparative Survey on Public Opinion Regarding Science and Technology in Japan, U.S. and Europe*, 1992  
 U.S.—J. D. Miller, *The Public Understanding of Science and Technology in the United States*, 1992, 1993  
 France—Daniel Boy, *Attitude of the French toward Science*, 1990

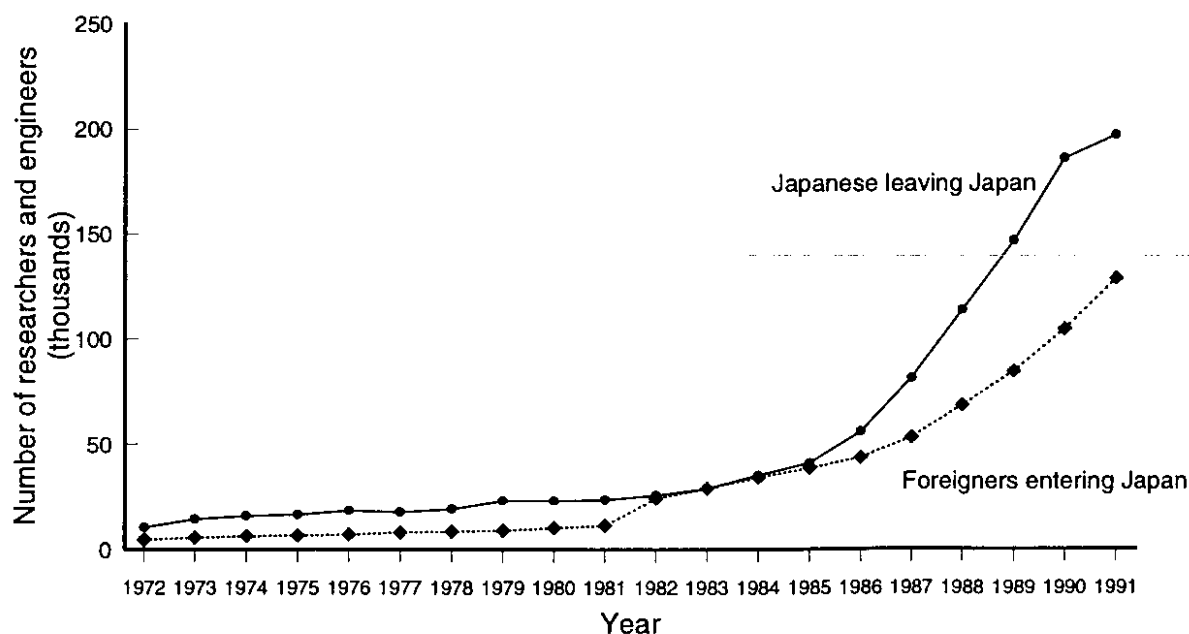
See Figure 7-3-10

## 1.8 Internationalization of R&D

### Interchange of Researchers and Engineers

- (1) A mere 200,000 Japanese researchers and engineers were dispatched overseas in 1991, accounting for 1.9% of the total number of Japanese going abroad. Only 130,000 foreign researchers and engineers were sent to Japan during the same year, 3.3% of the total number of foreigners admitted to the country. The numbers of researchers and engineers entering and leaving Japan has increased at a high rate from the latter half of the 1980s. While the number of foreign researchers and engineers entering Japan continues to rise rapidly, the growth of that of Japanese researchers and engineers leaving Japan slowed down in 1991 (Figure 1-8-1).
- (2) From 1986 to 1989 the number of Japanese going abroad for “study, training, or acquisition of technology” contributed greatly to the rapid increase in Japanese researchers and engineers leaving Japan; from 1990 a great number of the people going overseas went for “scientific research or investigation”. The most common destination, that of more than half of these researchers and engineers, was the U.S., but many also went to Europe.
- (3) The most common objective of foreign researchers and engineers entering Japan was “study”, followed by “training”; 90% of these researchers and engineers were from Asia. Only 10% of persons entering Japan came for “research”, “teaching”, or “technology”.
- (4) Major public institutions are increasingly accepting foreign researchers. In particular, the number of researchers on long-term stays in Japan has risen sharply since 1988. Most of these researchers come from West Europe, though their share is shrinking. Next in number are researchers from North America and Asia; since around 1990 a rising number of researchers have come from East Europe and the former Soviet Union.

**Figure 1-8-1 Trends in the Number of Researchers and Engineers Leaving and Entering Japan**



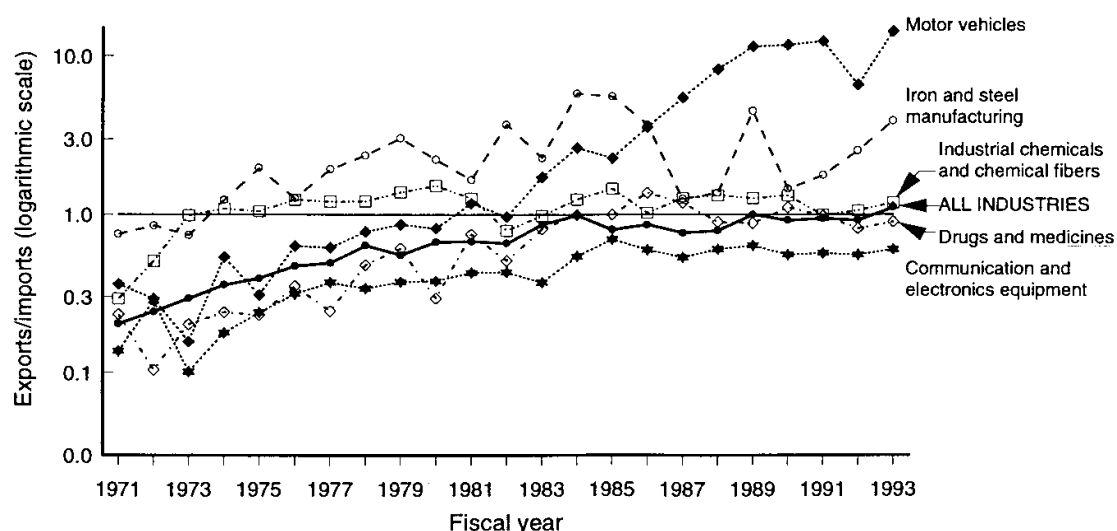
Source: Ministry of Justice, *Annual Report of Statistics on Legal Migrants*  
See Figure 8-1-1

- (5) The number of researchers and engineers dispatched by the Japan International Cooperation Agency to developing countries in scientific and cultural dispatches of experts has increased rectilinearly over the past decade, with more than two-thirds of these sent to Asia. There has also been a steady rise in the number of persons dispatched for scientific and cultural purposes by the Japan Overseas Cooperation Volunteers, the most common destinations being Central and South America. In both of these systems, scientific and cultural dispatches account for an increasing proportion of the total.

## Technology Trade

- (1) Technology trade reflects technological levels internationally, and according to statistics from the Management and Coordination Agency, Japan's technology exports for FY1993 came to 400.4 billion yen and technology imports 363.0 billion yen; this marked a turnabout from the excess of imports over exports that had continued since statistics were first kept in FY1971. This change was due to a very large decrease in new technology imports in FY1993 (about 45.0 billion yen, a drop of 52.5% from the previous year).
- (2) Because the growth rate of exports on the whole was higher than that of imports, the trade ratio (exports/imports) leveled off near 1 from the latter half of the 1980s. The large decrease in technology imports in FY1993 caused the trade ratio balance for the first time to reach 1.1 (Figure 1-8-2).
- (3) Looking at technology trade in major industries, there have been excess exports in motor vehicles in recent years, and total technology exports have been exceptionally large. A high level of technology exports has been maintained by the iron and steel manufacturing industry, exports exceeding imports for the past two decades. There have also been excess exports in the industrial chemicals and chemical fibers industry, an area in which the growth of both technology exports and imports has been low. A near balance has been achieved in the drugs and medicines industry. Both exports and imports are numerous in the communication and electronics equipment industry, but the balance of technology trade favors imports (Figure 1-8-2).

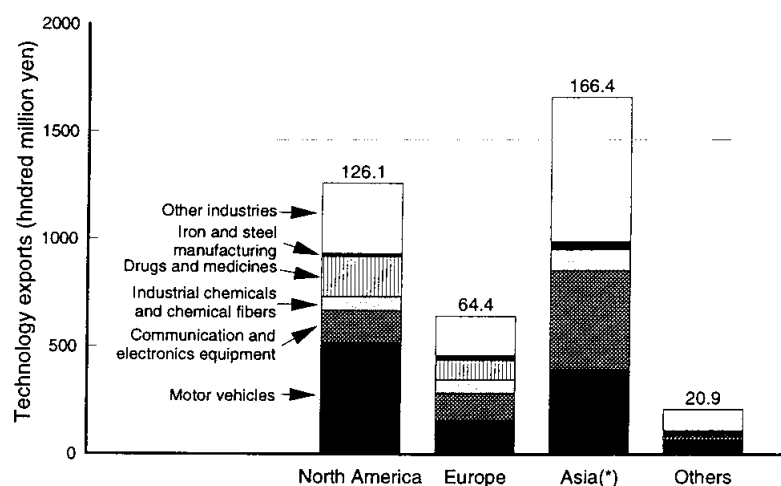
**Figure 1-8-2 Trends in Japan's Technology Trade Balance  
(All industries and major industries)**



Source: Management & Coordination Agency, *Report on the Survey of Research and Development*  
See Figure 8-2-3

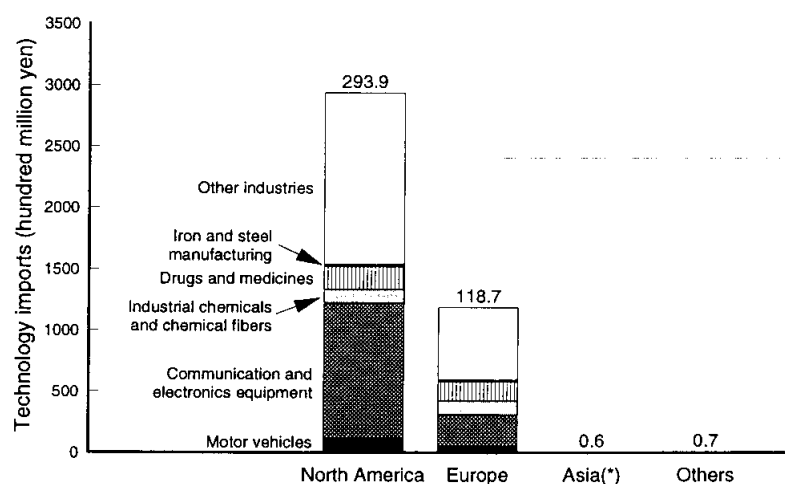
- (4) The majority of technology exports go to Asia (excluding West Asia), North America, and Europe, with that bound for Asia nearly equivalent to that bound for North America and Europe combined. North America is the principal destination of motor vehicles exports and Asia that of the communication and electronics equipment industry (Figure 1-8-3). More than 70% of technology imports come from North America, with most of the remainder originating in the developed European countries (Figure 1-8-4).

**Figure 1-8-3 Breakdown of Japan's Technology Exports by Region and Major Industry (FY1992)**



Source: Management & Coordination Agency, *Report on the Survey of Research and Development*  
See Figure 8-2-7

**Figure 1-8-4 Breakdown of Japan's Technology Imports by Region and Major Industry (FY1992)**



Source: Management & Coordination Agency, *Report on the Survey of Research and Development*  
See Figure 8-2-9



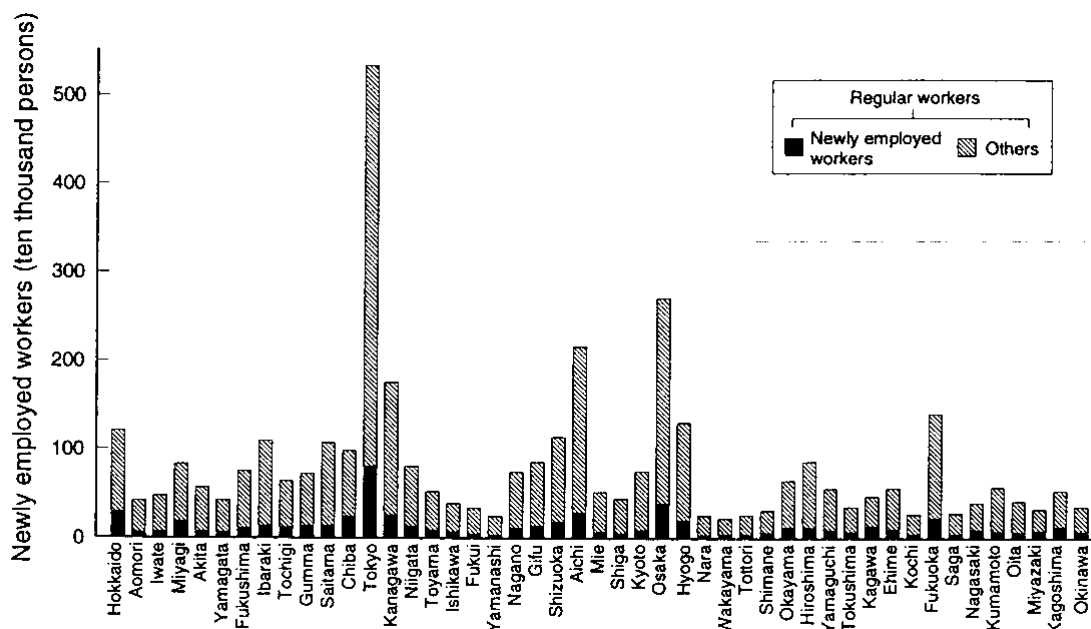
- (5) Statistics on Japan's technology trade are usually compiled using data from the Management and Coordination Agency and the Bank of Japan. However, differences in the scope of these surveys and in calculation methods between the two produce significantly different technology trade ratios: 0.91 by the Management and Coordination Agency and 0.45 by the Bank of Japan. Reviewing appropriate methodology and revising calculations accordingly to accurately assess Japan's technology trade, one arrives at a trade ratio of about 0.6. This figure seems a better approximation of the overall state of Japan's technological trade.
- (6) Statistics compiled by our research institute on the introduction of technology to Japan reveal that software technology corresponded to 50.3% of the total (FY1992), one likely factor pushing up technology imports.

## 1.9 Regional S&T Activities

### S&T Base

- (1) The population growth rate in Tokyo, Osaka, and their environs is quite high. Population concentration is such that the top five prefectures in total population constitute 34% of the nation's population (1990), and the top five prefectures in youth population make up 31% of the entire youth population of Japan (1990).
- (2) The higher the age group, the greater the tendency for regional concentration of primary, junior high, and senior high school students. In addition to this, there is much movement between prefectures of students who graduate from senior high school and go on to university; university students concentrate in certain areas such as Tokyo.
- (3) There is greater regional concentration of the population participating in economic activities than of the population in general. The top five prefectures in numbers of newly employed persons account for 52% of the total population nationwide (Figure 1-9-1).

**Figure 1-9-1 Number of Regular Workers and Newly Employed Workers by Prefecture (1992)**



Source: Ministry of Labor, *Report on the survey on Employment Trends*

See Figure 9-1-9

- (4) S&T-related expenditures by local governments was 614 billion yen in FY1992, 29% of total government S&T-related expenditures; local governments, hence, are a major source of S&T support within the public sector.

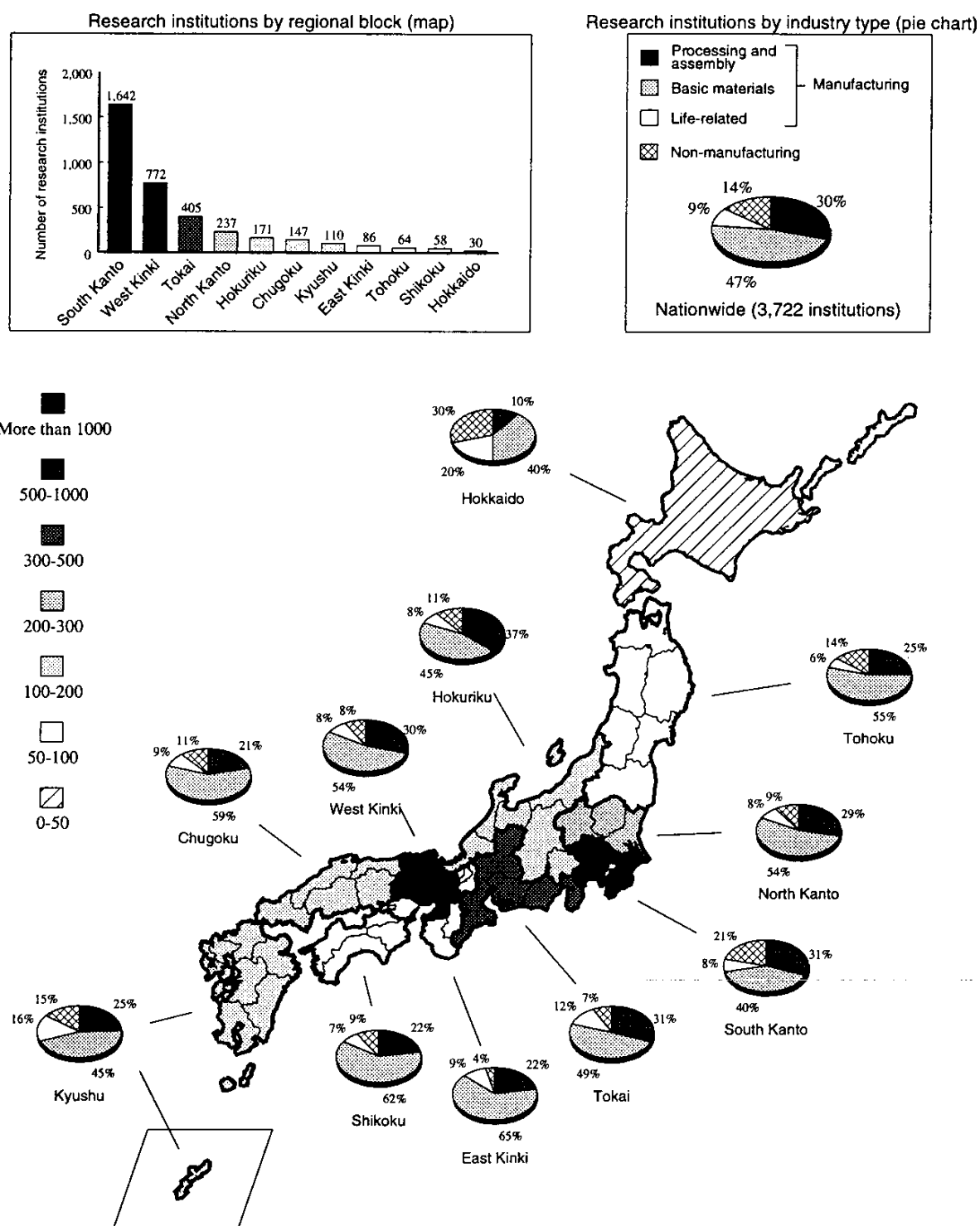
## **R&D Activities**

- (1) Twenty-two prefectures have at least one national experiment and research institution while twenty-five have none at all, indicating that no particular emphasis has been given on regional development thus far. In recent years, however, greater attention has been focused on various ripple effects in regional areas.
- (2) In FY1993 there were 656 public experiment and research institutions set up throughout the country by local governments, and, with at least seven organizations in each prefecture, there was little regional concentration or bias. Reorganization of and improvements to experiment and research institutions have been carried out recently by many local governments, marking a greater orientation towards research.
- (3) There is at least one national or local government university in every prefecture of the country, and there is little regional bias in view of the varying populations of the prefectures. The relative distribution of national and local government universities throughout the country contributes greatly to the regional distribution of R&D resources. Private universities, on the other hand, are concentrated in certain prefectures.
- (4) The top five prefectures in number of private R&D institutions boast 58% of the nationwide total, this showing considerable concentration in particular regions. Looking at the regional distribution of industry by type, there seem to be regional characteristics to R&D: non-manufacturing industries are prevalent in the South Kanto district (Tokyo and environs), the Western Kinki district is characterized by a somewhat high proportion of basic material industries, and life-related industries dominate in the Tokai region (Figure 1-9-2).

## **Achievements and Contribution of S&T**

- (1) Industrial sales in the top five prefectures account for 40% of the national total, and while there is some degree of concentration in certain regions when compared to population, this concentration is less than that of R&D activities. Sales volume per small business is greatest in Shiga, Saitama, and Shizuoka prefectures, while sales are highest for large businesses in Aichi, Kanagawa, and Shiga prefectures. A comparison of sales in 1980 and in 1990 shows that the largest increase took place in Yamanashi prefecture, followed by Gumma, Shiga, and Yamagata prefectures (Figure 1-9-3).

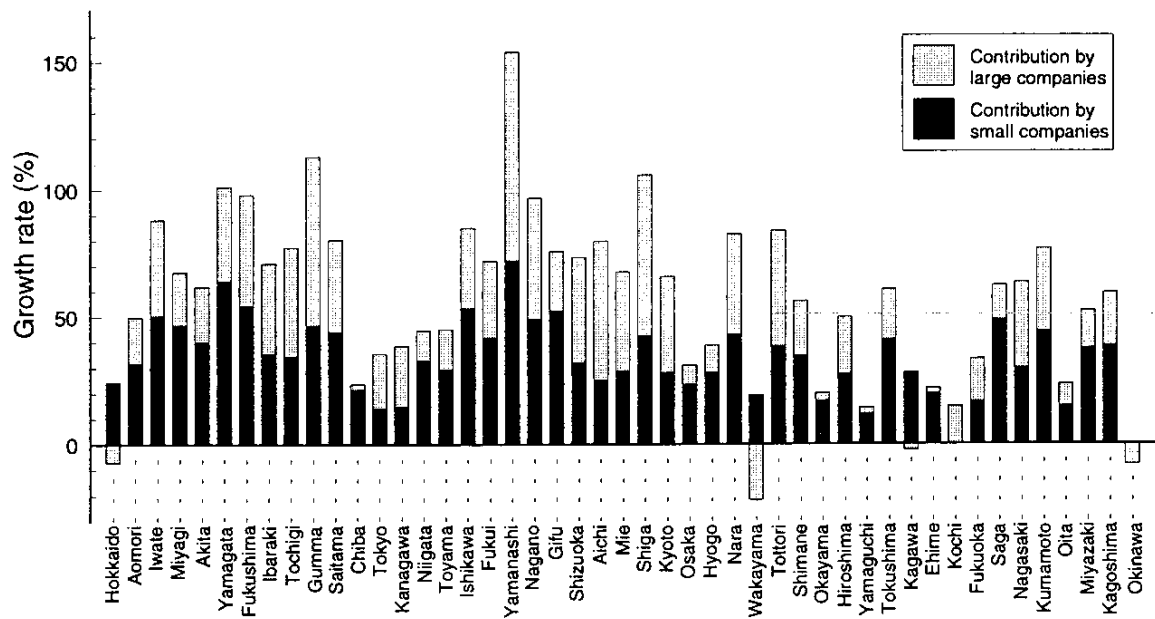
**Figure 1-9-2 Regional Distribution of Private Company Research Institutions by Industrial Category (1991)**



Source: Science and Technology Agency supervision, *Directory of National Experiment and Research Institutions 1991-1992*, Latis Co., Ltd., 1992

See Figure 9-2-12

Figure 1-9-3 Rate of Increase of Product Consignment Amount by Prefecture (1980–90)

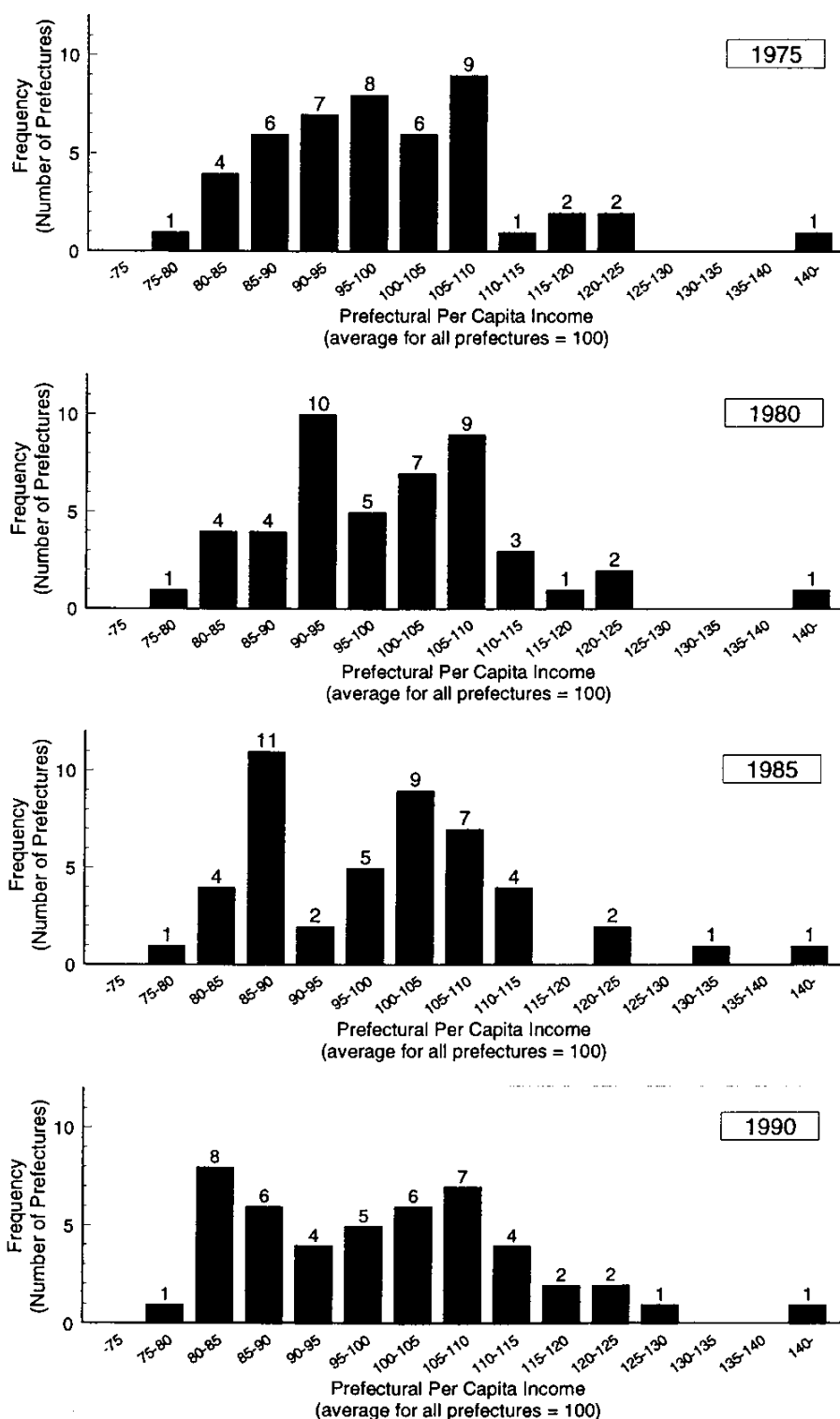


Source: Ministry of International Trade and Industry, *Statistical Tables on Japanese Manufacturing Industries*

See Figure 9-3-2

- (2) Among the applications for industrial rights, applications for patents are concentrated in Tokyo and certain other prefectures; there is little regional concentration in utility models, for which most applications appear to be made by small businesses.
- (3) Venture companies tend to concentrate in Tokyo and certain other prefectures. Companies holding an extremely high number of patents can be found in prefectures other than these, however, one sign of the vigor of regional activities by venture companies.
- (4) Due to the contributions of secondary industries, economic growth as measured by gross prefectural product and prefectural income levels can be seen in Shiga, Gumma, Yamanashi, Ibaraki, and Aichi prefectures; the contributions of tertiary industries have benefited Tokyo the most, and development paths do differ by region.
- (5) Looking at regional development in terms of local prefectural income levels, most prefectures are either affluent or non-affluent as determined by their per capita income, and many problems remain in regional development (Figure 1-9-4).

**Figure 1-9-4 Trends in the Distribution of Prefectural Per Capita Income Levels**

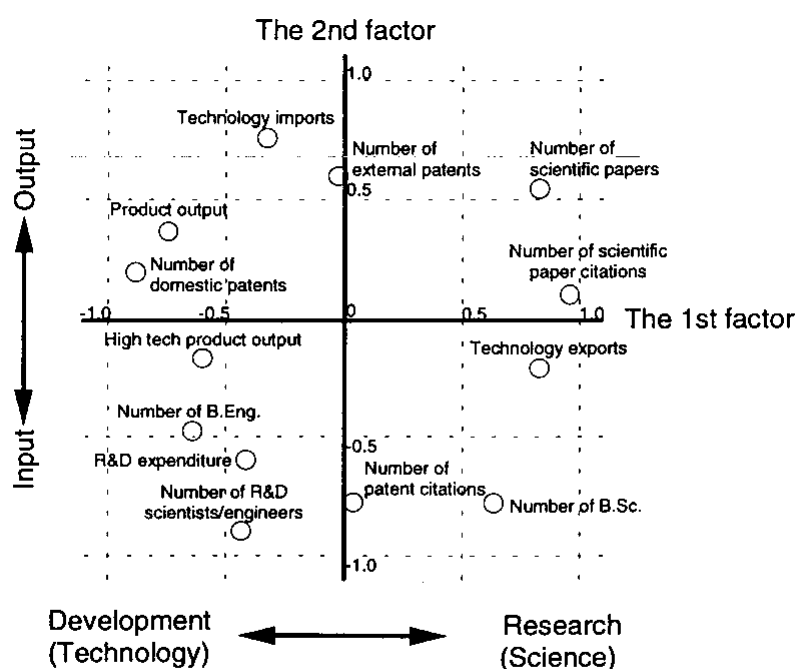


Source: Economic Planning Agency, *Annual Report on Prefectural Economics*  
See Figure 9-3-10

## 1.10 Composite Indicators International Comparison of Overall Strengths in S&T

- (1) Composite indicators are created by combining multiple indicators for S&T activities by one means or other into one or two indicators that represent the whole. Use of composite indicators allows one to grasp major trends in a given country's S&T activities and makes possible comprehensive international comparisons and time-series analysis.
- (2) 13 indicators for Japan and four other countries will be used here to illustrate Japan's S&T activities in relation to the rest of the world: input indicators such as "R&D expenditure", "number of R&D scientists/engineers", "number of Bachelor's of Science degrees conferred", "number of Bachelor's of Engineering degrees conferred", and "technology imports", and output indicators such as "number of scientific papers", "number of scientific paper citations", "number of domestic patents", "number of external patents", "number of patent citations", "product output", "high tech product output" and "technology exports". Multiple variable analysis methods—principal component analysis and factor analysis—were employed in combining these indicators.
- (3) Principal component analysis using the factor analysis method allows one to ascertain Factor 1 (horizontal axis), showing science—technology and basic research—applied research orientation, and Factor 2 (vertical axis), reflecting input—output balance (Figure 1-10-1). The plotted value (factor score) derived for each country in relation to these factors show Japan leaning towards technology, applied research, and input, while the U.S. is oriented towards science, basic research, and input. Germany's priorities appear to be technology, applied research, and output, and those of France and the U.K. science, basic research, and output (Figure 1-10-2).

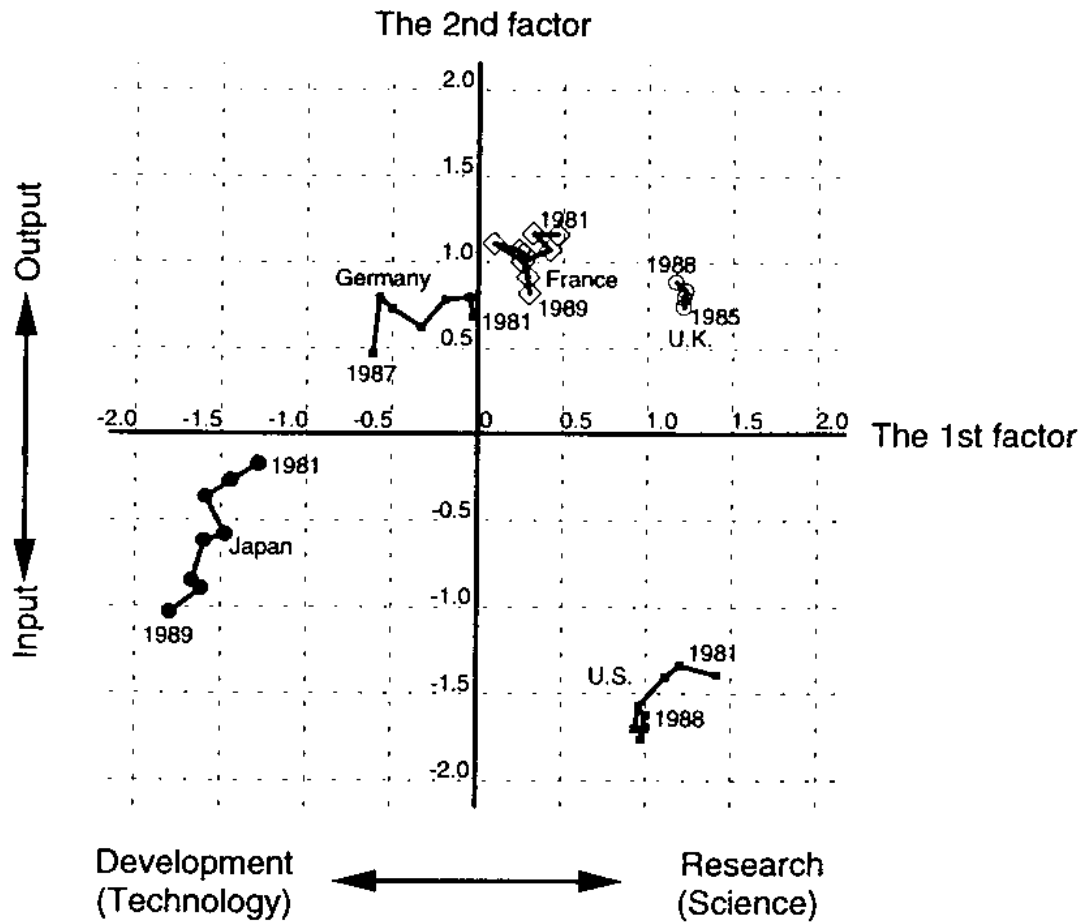
**Figure 1-10-1 Structure of S&T Activity Variables (Factor load)**



Note: The mutual relationship among variables (actual relationship) appears in the positioning of the variables in factor analysis, so they may be in a different position from the meaning indicated by the defining name of the variable.

See Figure 10-1

Figure 1-10-2 Trends in the S&T Factor Points for Each Country

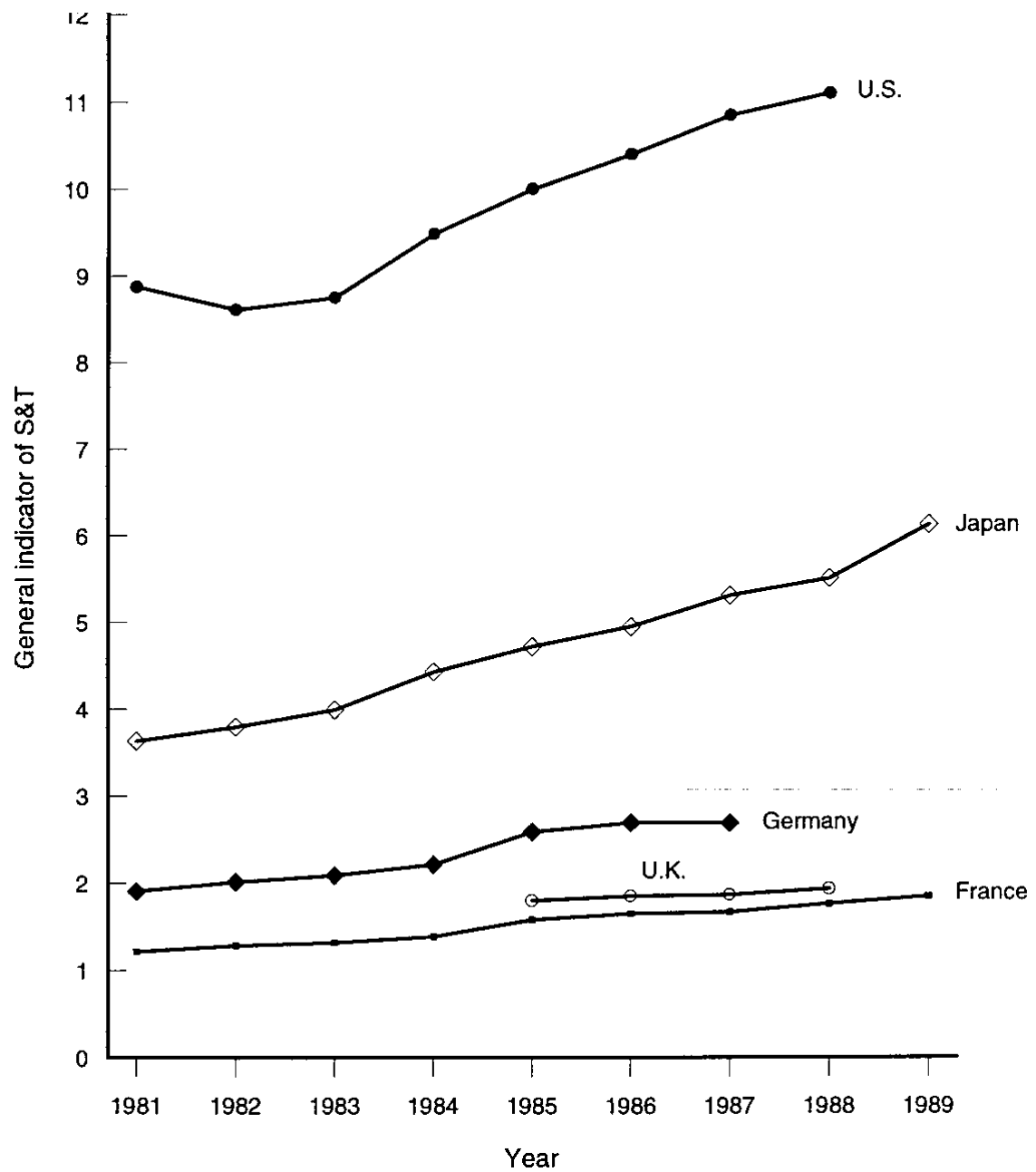


See Figure 10-2

- (4) The interrelationship between input and output in each country can be shown by computing a composite indicator for each country's S&T activities through principal component analysis. In Japan, both input and output are steadily rising. In the U.S., there was lowered output in the first half of the 1980s, but output has expanded substantially since then. In all three European countries, output is greater than input, indicating high efficiency.
- (5) The value of the composite indicator shows the overall capabilities of a country's S&T activities (GIST: General Indicator of Science and Technology). Japan's value is half that of the U.S., while those for Germany, France, and the U.K. were half that of Japan; this indicator of the total volume of S&T activities appears to reflect well the actual state in each country. Japan's value has continued to rise, as have those of the three European countries. Despite a declining trend apparent in the early 1980s, the U.S.' value has been climbing since then too (Figure 1-10-3).



Figure 1-10-3 Trends in General Indicator of S&T (GIST: General Indicator of Science and Technology) of Selected Countries



See Figure 10-6

## Chapter 2

### Education and Human Resource Development for Science and Technology

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## **Chapter 2**

### **Education and Human Resource Development for Science and Technology**

Human resource development is a critical foundation for scientific and technological activities. This chapter will focus on human resource development for science and technology in education, examining the present status of science education in primary, junior high, and senior high schools, enrollment in undergraduate and graduate science and engineering programs, and employment of higher education graduates.

#### **2.1 Environment for Basic Human Resource Development**

##### **2.1.1 Science education in primary and secondary schools**

The courses most closely connected with science and technology in primary and secondary education are arithmetic/mathematics and science. An international comparison of performance in arithmetic/mathematics and science shows that the scores of Japanese students were substantially above the international average as well as above the mean value of the countries studied in this comparison, and there are no particular problems apparent in this regard [1] [2]. However, the performance of Japanese students declined relatively as they moved from primary school into junior and senior high schools, and this indeed does present a problem.

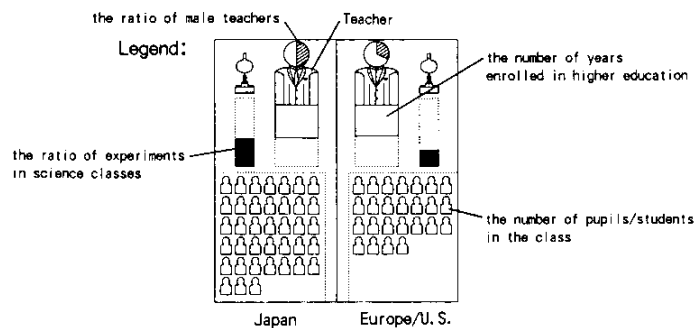
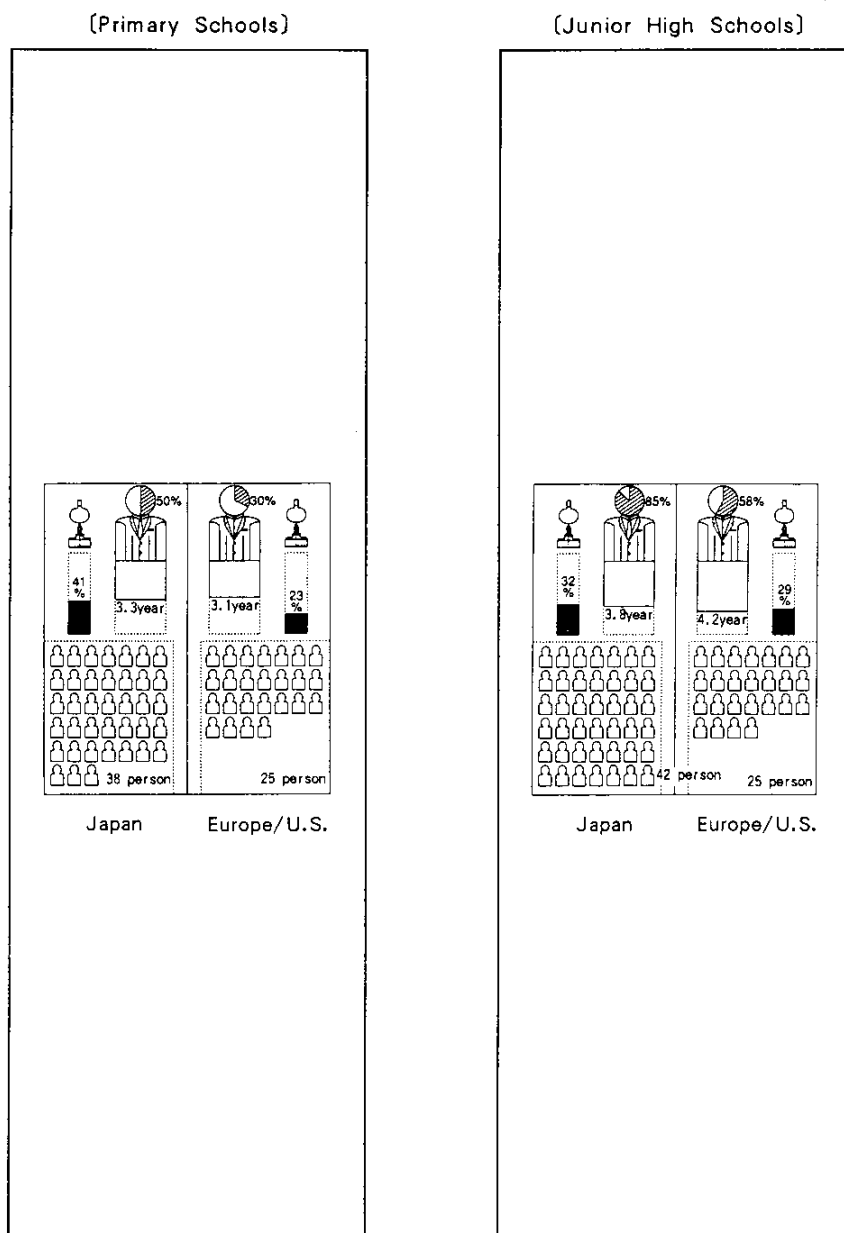
To better understand the environment of science education and students' interest in science, important background factors to this issue, a comparison was made between Japan and several Western countries (Figure 2-1-1).

Interest in (enjoyment of) science in all countries tends to drop off as students move up from primary school through junior and senior high school. In Japan's case, though, this decline is especially rapid, with the indicator becoming negative by junior high school and plummeting even further in senior high school.

In addition to the priorities of senior high school and university entrance examinations, differences in the educational environment help account for these circumstances. Figure 2-1-1 shows a comparison of the educational environments (primary through senior high school) of Japan and several Western countries (Australia, Finland, Sweden, Norway, the U.K., Poland, Hungary, Italy, Canada, and the U.S.); characteristic of Japan is a high number of students per teacher, a comparative lack of experimentation and observation, and a relatively short term of higher education for senior high school science teachers (see Table 2-1-1). With the number of students expected to decline in future, the number of first-graders will gradually slip downwards, but improvements to the educational environment, including reviews of student/teacher ratios and the skills of teachers, are still needed.

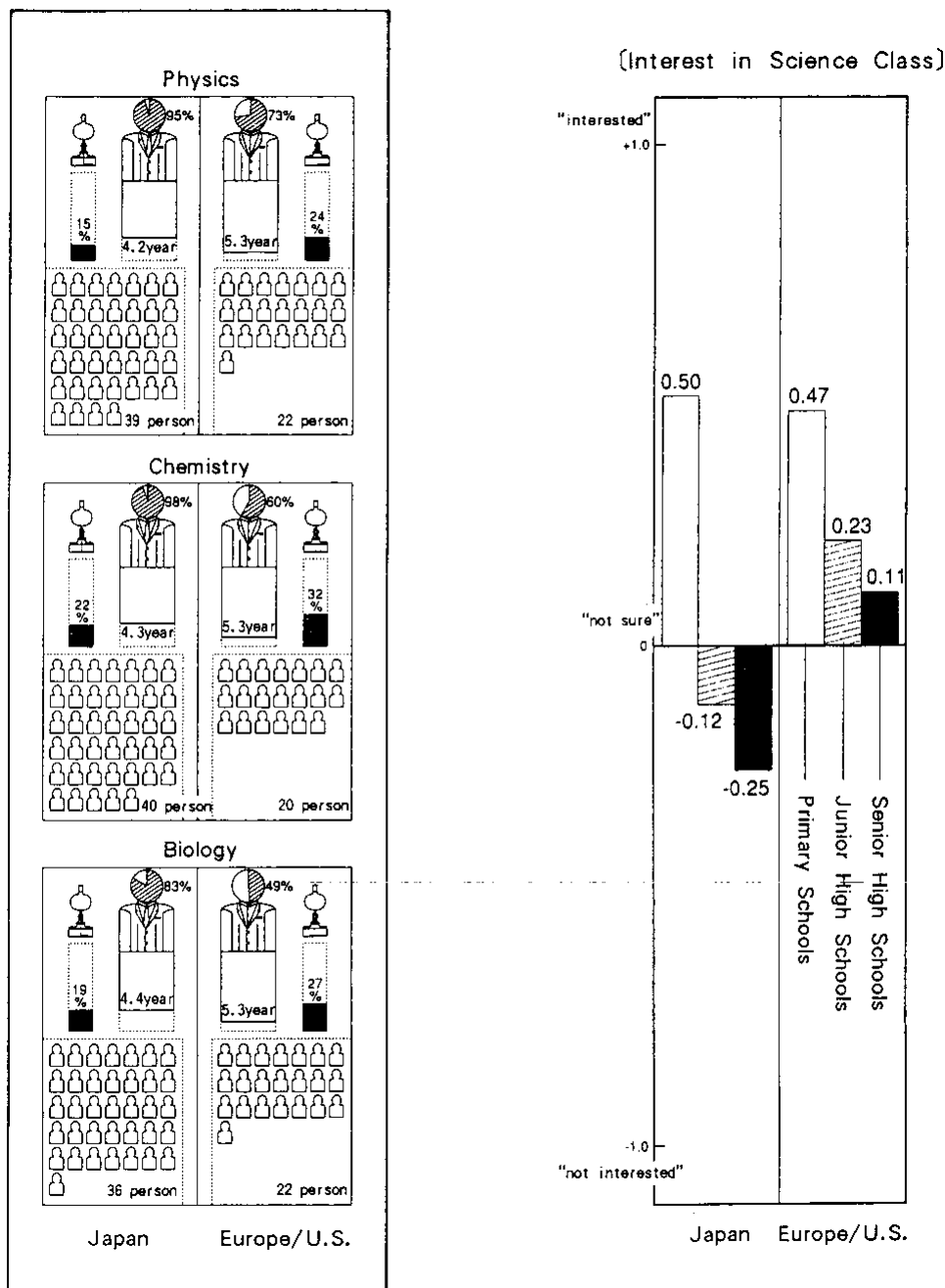
Japan also has a lower proportion of female senior high school science teachers than most Western countries. Given that students view teachers as role models, female students in Japan thus have fewer opportunities than in the West to consider becoming senior high school science teachers.

**Figure 2-1-1**  
**Interest in Science (Elementary, Junior High, Senior High Schools)**



**Figure 2-1-1**  
**Interest in Science (Elementary, Junior High, Senior High Schools)**

[Senior High Schools]



Note: Interest in (enjoyment of) science and technology is greater as the value approaches +1 and decreases as the value approaches -1; 0 corresponds to a "neutral" attitude.

Sources: National Institute of Educational Research, *International Comparison of Science Education*, 1993; works by author

See Table 2-1-1

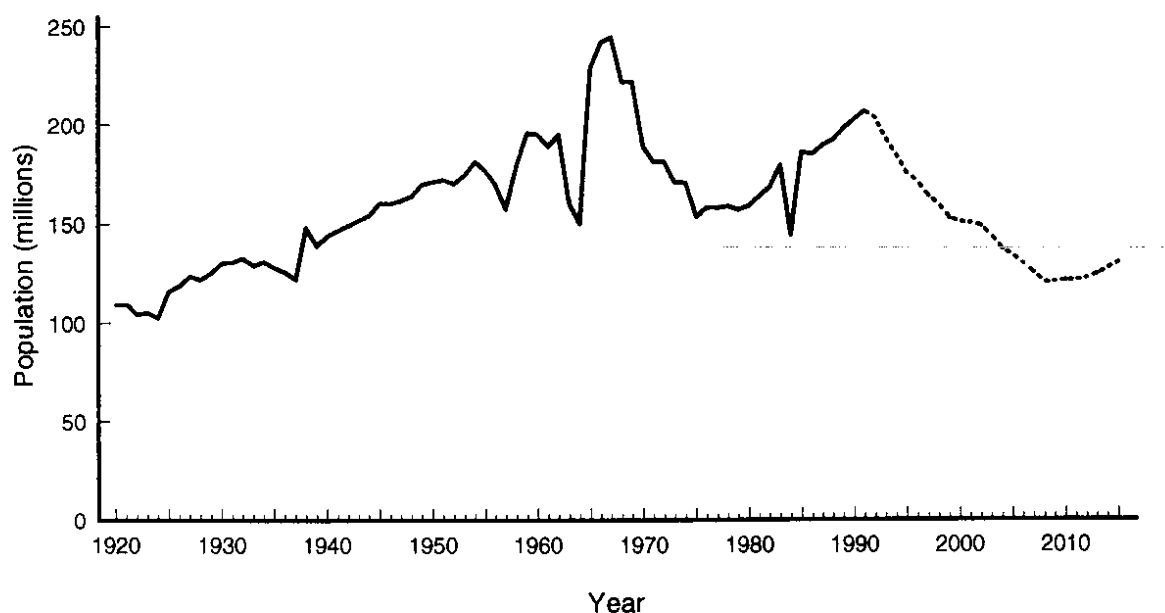
### 2.1.2 18-year-old population

At present, the youth population of Japan is shrinking at the same time that the elderly population is on the rise, marking the beginning of a historical transition period for the composition of Japan's population. Because the age of eighteen is that age at which most students graduate from senior high school and go on to university, the changes in the population at that age is an important indicator in considering future human resource development in science and technology.

Figure 2-1-2 shows the changes over time in the 18-year-old population and future estimates. A glance at this figure reveals that the 18-year-old population has since 1975 experienced long-term growth, reaching 20.68 million in 1991; this figure will likely drop in future, however, falling to an estimated 12.03 million by 2008 [3].

The proportion of 18-year-olds in the general population grew from 1.4% in 1975 to 1.7% in 1991, but this, too, has since dropped, and is predicted to decline to 0.9% by 2008.

**Figure 2-1-2 18-year-old Population**



Source: Ministry of Health and Welfare, Institute of Population Problems, *Population Projection for Japan: 1991–2090* (Estimates as of September 1992)

See Table 2-1-2

## 2.2 Senior High School

Overall enrollment in senior high school, enrollment in industrial and information science courses, and employment/university entrance rates of senior high school graduates will be used here as indicators showing the status of human resource development for science and technology in senior high schools.

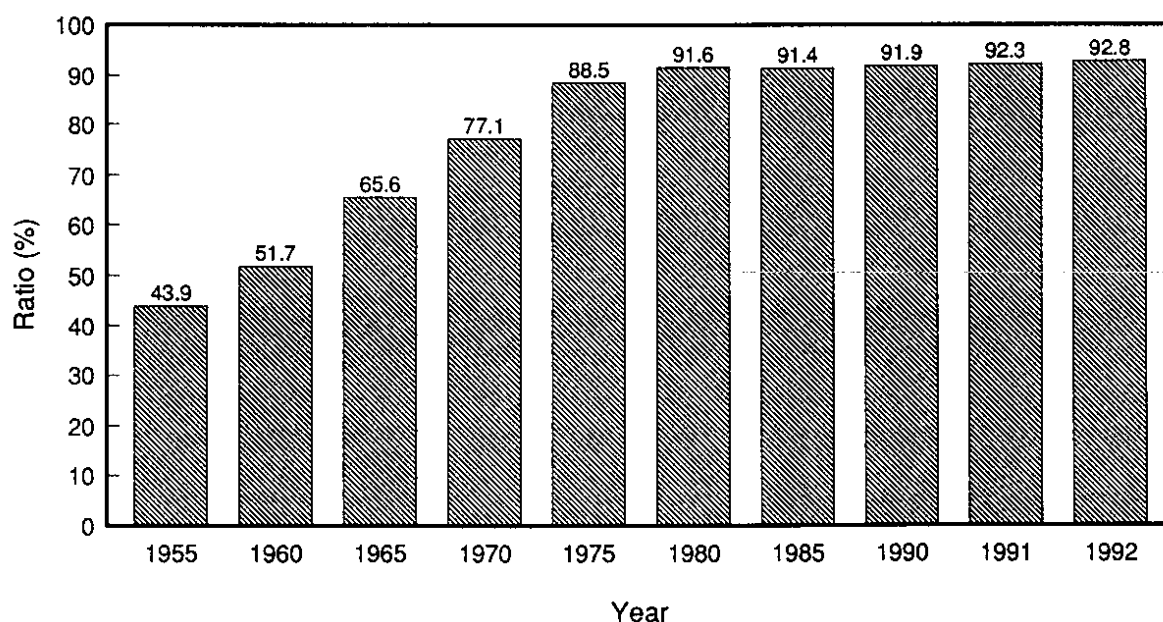
### 2.2.1 Overall enrollment in senior high school and enrollment in industrial and information science courses

#### (1) Overall enrollment and enrollment in industrial courses

Figure 2-2-1 shows the proportion of junior high school graduates going on to full-time senior high school programs. There were about 1.66 million junior high school graduates in 1955, 730,000 of whom enrolled in full-time senior high school programs, an advancement rate of 44%. The advancement rate rose annually thereafter, and in 1980 reached 92% or “full senior high school enrollment”. This rate soon hit a ceiling and leveled off. The number of junior high school graduates in 1992 was around 1.77 million, 1.65 million of whom went on to full-time senior high school programs, an advancement rate of 93%.

As the senior high school advancement rate and the 18-year-old population grew, so did overall enrollment in senior high school, but enrollment in industrial courses began declining from the latter half of the 1960s; the 1965 figure of about 620,000 students had fallen by 1992 to approximately 450,000 (see Table 2-2-2).

Figure 2-2-1 Students Advancing to Senior High School

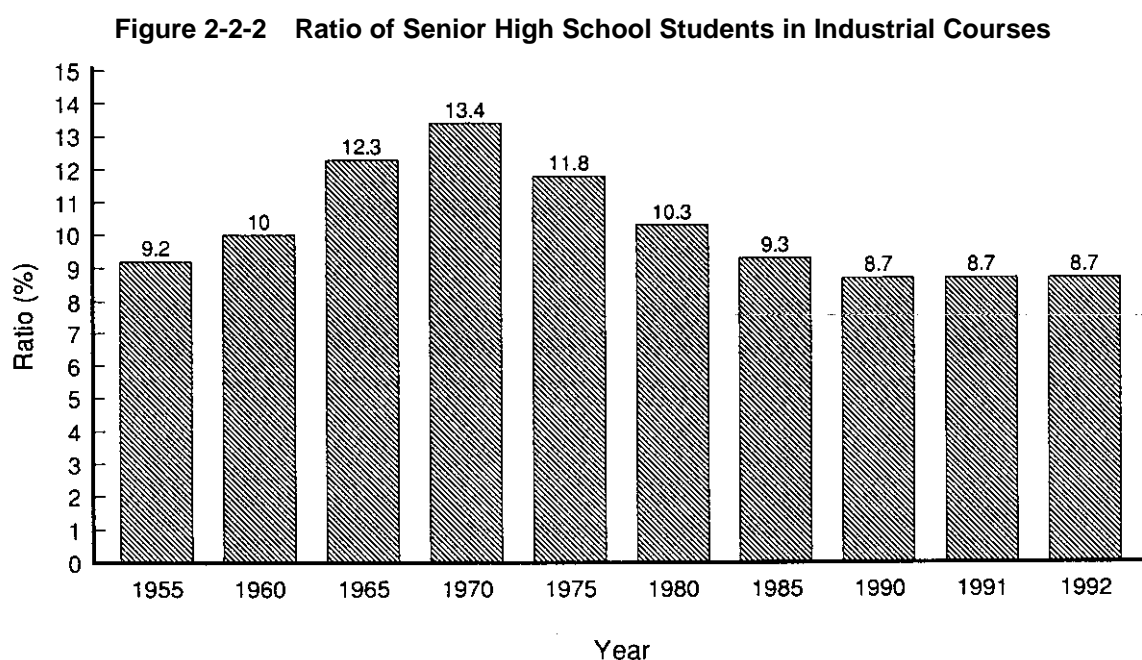


Sources: Ministry of Education, *Report of Basic Survey on Schools*  
See Table 2-2-1



Indexing 1955 as 100, overall enrollment rose to 203 by 1992, while enrollment in industrial courses was only 192. As a result, the ratio of enrollment in industrial courses to overall senior high school enrollment, 13% in 1970, dropped thereafter until leveling off from 1990, as shown in Figure 2-2-2.

The increase in enrollment in general courses can be attributed to a greater desire by students (and/or their parents) for admission to university and to the higher university admission limits set by the government since 1960.



Source: Ministry of Education, *Report of Basic Survey on Schools*  
See Table 2-2-2

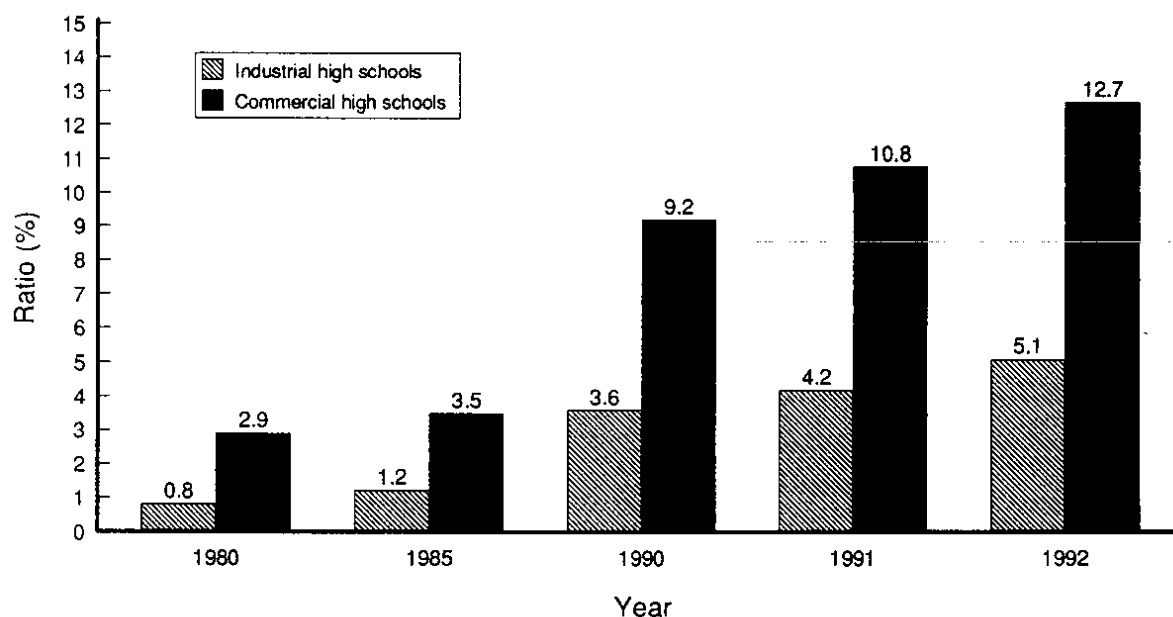
## (2) Enrollment in information science courses

Human resource development for information science in senior high school takes place primarily in industrial and commercial courses. Information technology courses are taught within the context of industrial courses, while information processing courses are assigned to commercial courses. Despite declining enrollment in industrial and commercial courses (from about 1.05 million in 1980 to 990,000 in 1992), enrollment in these information science courses has risen by 4.4 times (from about 21,000 in 1980 to around 91,000 in 1992).

Figure 2-2-3 shows the ratio of enrollment in information technology courses to total enrollment in industrial courses and the ratio of enrollment in information processing courses to total enrollment in commercial courses. The ratio of enrollment in information technology courses to total enrollment in industrial courses went from 0.8% in 1980 to 5.1% in 1992, and the ratio of enrollment in information processing courses to total enrollment in commercial courses climbed from 2.9% in 1980 to 13% in 1992.

This rise demonstrates that, in keeping with the development of an information society, human resource development in mainstay information science technologies has been pursued.

**Figure 2-2-3 Ratio of Senior High School Students in Information Science Courses**



Source: Ministry of Education, *Report of Basic Survey on Schools*  
See Table 2-2-3

## **2.2.2 Academic advancement/employment of senior high school graduates**

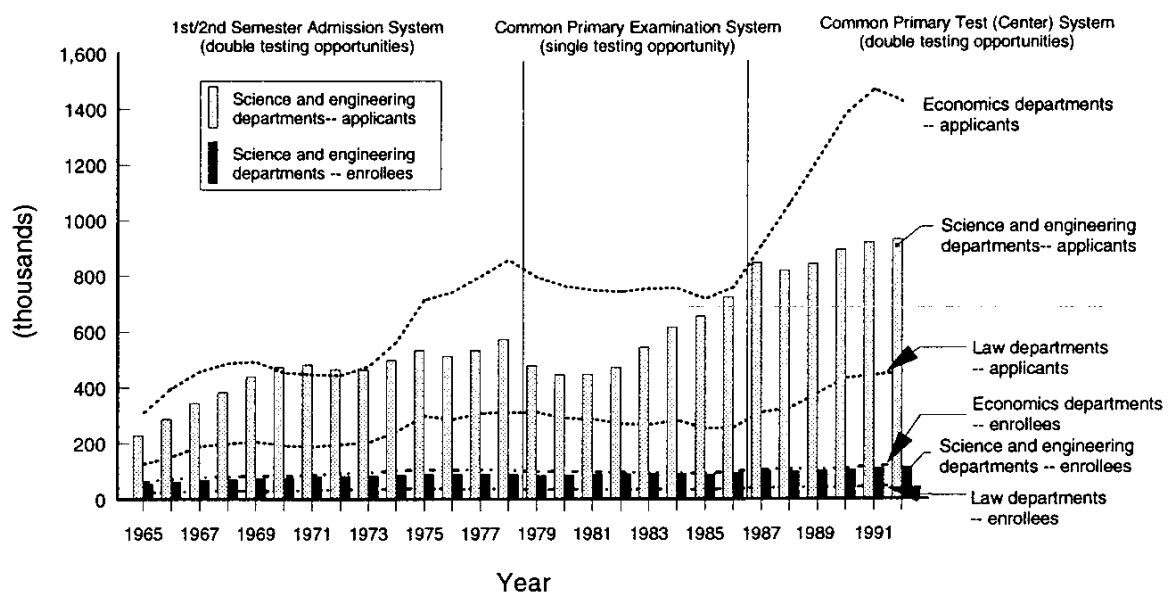
### **(1) Academic advancement**

This section will examine the academic advancement of senior high school graduates in terms of the total number of students applying for admission to key university departments and the proportion of female applicants among those seeking entrance to higher educational institutions.

The average applicant applies to two or more university departments. The number of applications made by one prospective student will be called here the composite number of applications; the sum of composite numbers of applications will be regarded as the total number of university applicants. University admission will be examined here in terms of the total number of university applicants.

Figure 2-2-4 illustrates the changes over time in the total number of university applicants by department. In interpreting this figure, one must bear in mind changes made to the entrance examination system for national universities. Until 1978, a “first/second semester system” was in place, allowing prospective students two chances each year to take the entrance examinations for national universities. The system was changed in 1979 to a “common primary examination system”, giving applicants only one opportunity to take the national university entrance examinations, but in 1987 the “double testing opportunity system” was resurrected. As a result of these revisions to the entrance examination system, the total number of university applicants was less between 1979 and 1986 than in other years. The changes in 1978 and 1987 led to sharp increases in the total number of applicants to national universities in those years, and the total numbers of applicants for both years must be considered aberrant values.

**Figure 2-2-4 Applicants to and Enrollees in Colleges and Universities by Department**



Source: Ministry of Education, *Report of Basic Survey on Schools*  
See Table 2-2-4

The total number of applicants to all departments was 1.2 million in 1965, growing by 4.2 times by 1992 to 5.06 million. The total number of applicants to the department of law over the same period rose by 3.6 times from 130,000 to 460,000. The total number of applicants to the departments of economics, management, and commerce (collectively referred to as “the department of economics”) increased by a significant 4.6 times during this timeframe, from 310,000 to 1.43 million.

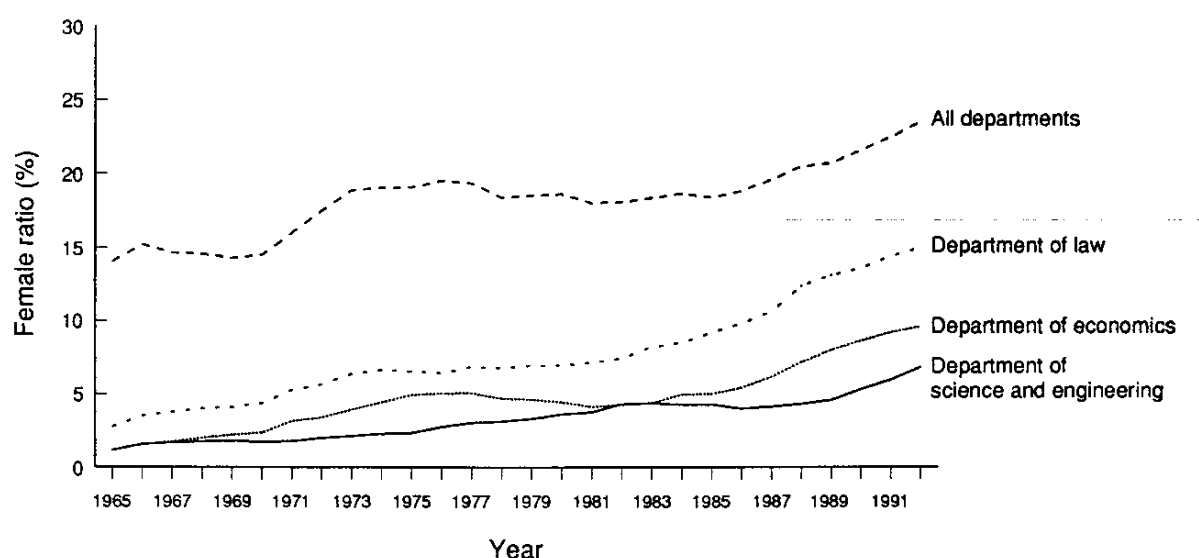
The total number of applicants to the departments of natural science, engineering, and science and engineering (collectively referred to as “the department of science and engineering”) was 230,000 in 1965, but grew by 4.1 times to 930,000 by 1992, nearly the same as the 4.2 times increase for all departments.

Figure 2-2-5 shows the changes over time in the ratio of female applicants to the total number of applicants to key departments.

This figure shows that the proportion of female applicants to all departments went from 14% in 1965 to 24% in 1992, that of female applicants to the department of law from 2.7% to 15%, and that of female applicants to the department of economics from 2.1% to 9.6%.

The ratio of female applicants to the department of science and engineering went from 1.2% in 1965 to 6.9% in 1992, expanding at a rate very similar to those of other departments.

**Figure 2-2-5 Female Applicants in Colleges and Universities by Department**



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

See Table 2-2-5

Figure 2-2-6 shows the changes over time in the ratio of the total number of university applicants to the number of students admitted (hereafter, “admission competitiveness rate”).

Looking at the period 1965–92 (but excluding the figures for 1978 and 1987, which as mentioned earlier should be treated as aberrant), one finds that in the five years from 1970 to 1974 and the four years from 1984 to 1988 (excluding 1987) the admission competitiveness rate for the department of science and engineering was higher than that for all departments (see table below). Only in two years, however, 1985 and 1986, was this difference 10% or greater.

	1970	1971	1972	1973	1974	1984	1985	1986	1988
Department of Science and Engineering (a)	6.3	5.9	5.7	5.5	5.8	6.9	7.4	7.7	8.2
All Departments (b)	5.8	5.5	5.3	5.3	5.7	6.7	6.6	6.7	8.0
(a)/(b) × 100	109	107	108	104	102	103	112	115	103

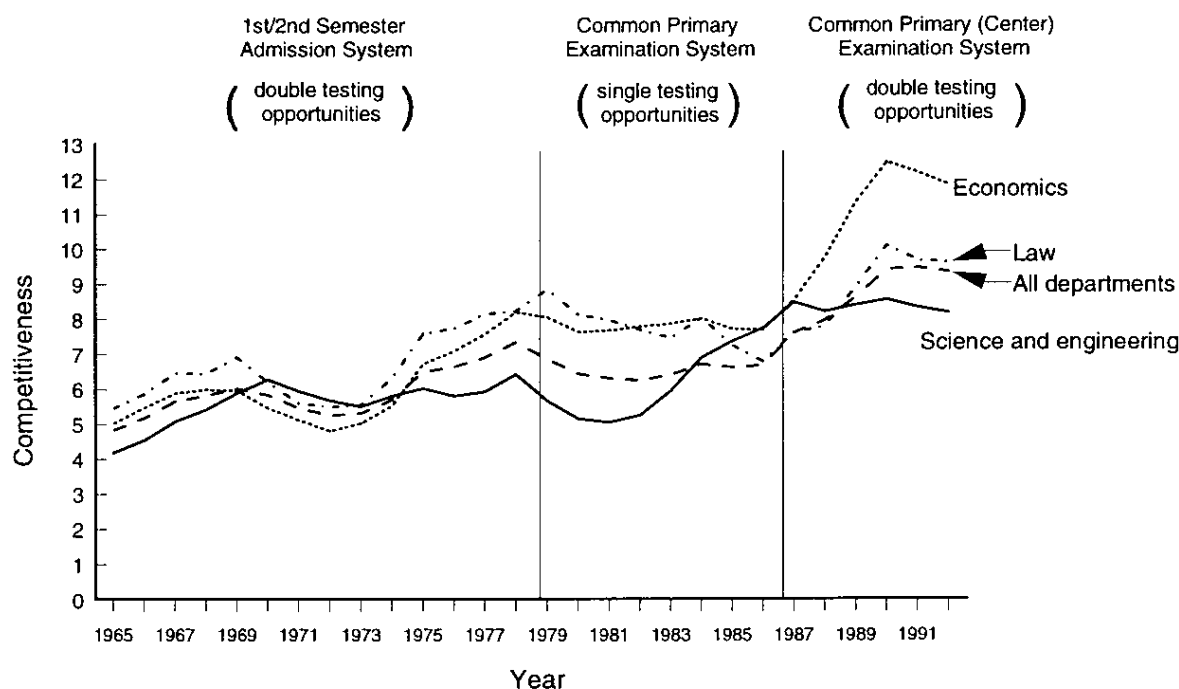
It is generally the case, therefore, that the admission competitiveness rate for the department of science and engineering is lower than that for all departments. Taking into account this conclusion as well as the fact that the composite number of applications for the departments of economics, management, and commerce was so high, it cannot necessarily be said that senior high school students are avoiding the department of science and engineering merely because the admission competitiveness rate for the department of science and engineering since 1988 has again fallen below that for all departments.

Furthermore, as seen in Figure 2-2-6, there has since 1991 been a decline in the total number of applicants throughout all departments, and consequently admission competitiveness rates are also on the decrease. This trend is indicative of a reduction in the number of composite applications to

private universities as a cost-saving measure prompted by the diminished financial support available from parents following the collapse of the “bubble economy”.

Possible future decreases in the number of senior high school graduates will change conventional thinking on entrance examinations, and scientific and technological developments will likely make new career alternatives available to senior high school students. Hence, applications by senior high school students to the department of science and engineering bear careful monitoring and approaches should be developed that appropriately address this trend.

**Figure 2-2-6 Admission Competitiveness of Colleges and Universities by Department**



Source: Ministry of Education, *Report of Basic Survey on Schools*  
See Table 2-2-6

## (2) Employment in key industries

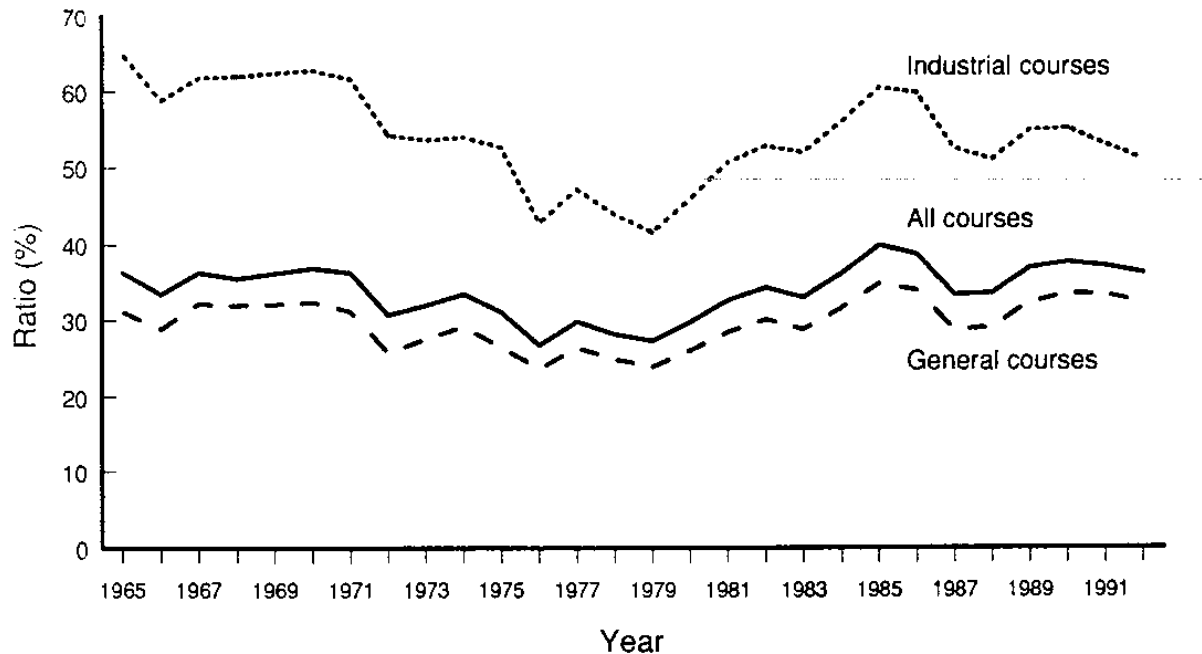
To study employment in key industries, the ratio of senior high school graduates in key industries to the total number of senior high school graduates finding employment will be utilized. These key industries are the manufacturing industry, financial and insurance industry, and service industry.

The total number of senior high school graduates from all courses in 1992 was 1.807 million, 592,000 of whom entered colleges and universities and 598,000 of whom joined the work force; each group accounts for about 33% of the total. General courses graduated 1.349 million students, 40% of whom went on to colleges and universities and 21% of whom found employment. 151,000 students graduated from industrial courses; 6% of them enrolled in colleges and universities while 78% took jobs.

Figure 2-2-7 shows the changes over time in the ratio of senior high school graduates in the manufacturing industry.

In 1965, this was 36% for all courses, 65% for industrial courses, and 31% for general courses, and in 1992 these were 36%, 51%, and 32% respectively.

**Figure 2-2-7 Employment of Senior High School Graduates in the Manufacturing Industry**



Source: Ministry of Education, *Report of Basic Survey on Schools*  
See Table 2-2-7

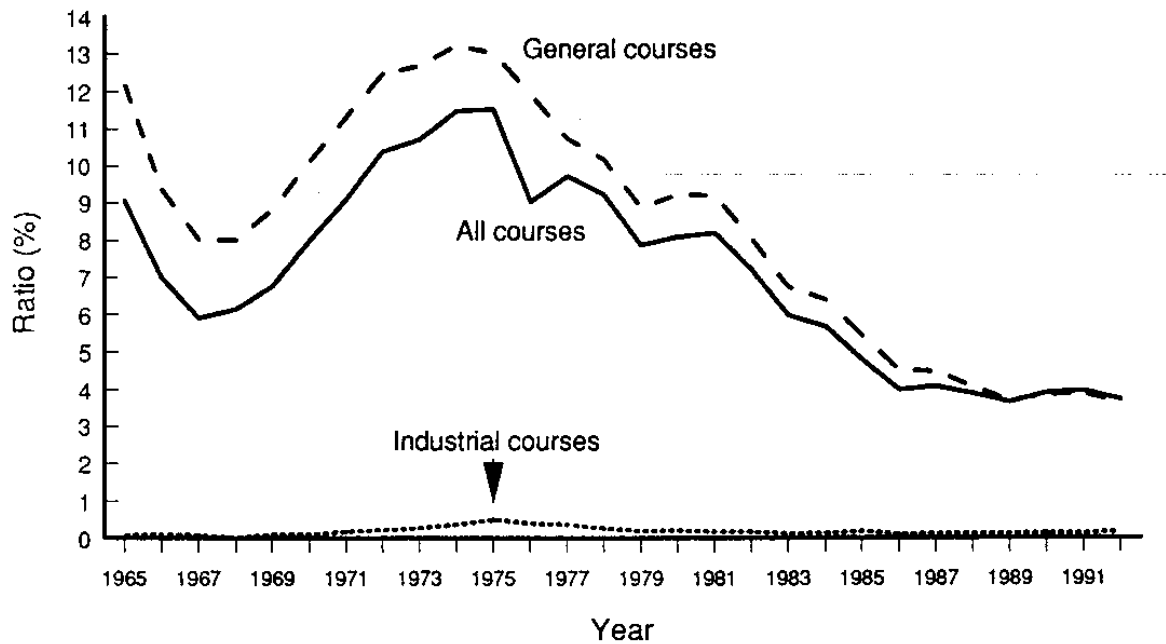
Figure 2-2-8 shows the changes over time in the ratio of graduates employed by financial and insurance industry.

In 1965, this was 9.0% for all courses, 0.1% for industrial courses, and 12% for general courses. Following a rapid drop, the ratios for all courses and for general courses rose, but after peaking in 1975 once again dropped; in 1992 these were 3.7% and 3.6% respectively. The ratio of graduates of industrial courses employed has dropped since its high in 1975 at 0.5%, and has leveled off recently, 1992's ratio being 0.2%.

The ratio of senior high school graduates employed by service industry is shown in Figure 2-2-9.

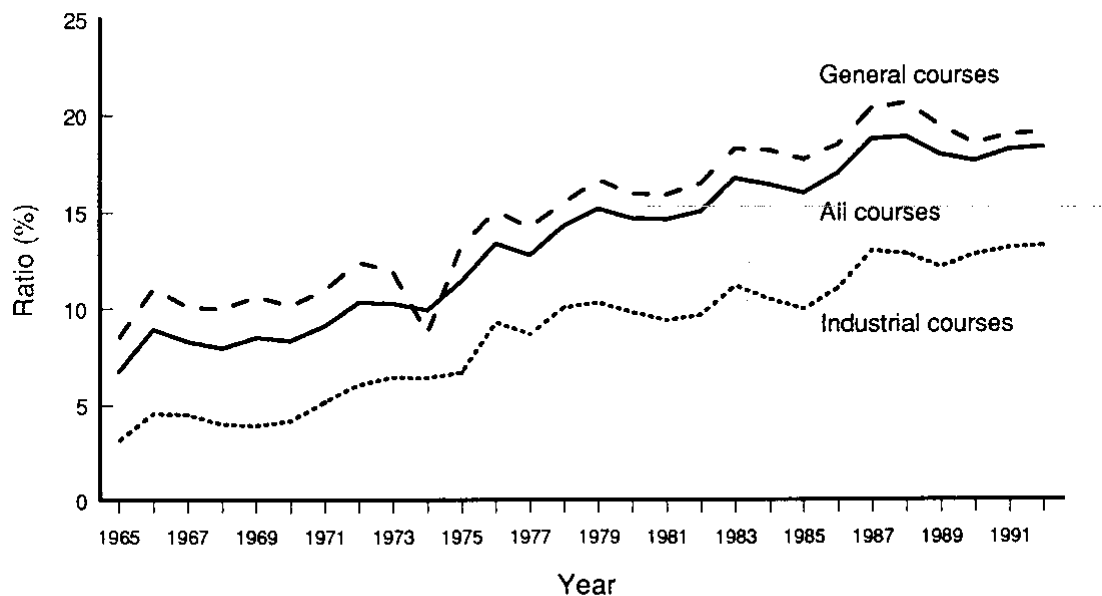
In 1965, this was 6.7% for all courses, 3.1% for industrial courses, and 8.4% for general courses. From that point, the ratios for all courses, industrial courses, and general courses all began to climb at about the same rate, in 1992 being 18%, 13%, and 19% respectively. The growth in the employment ratio for industrial courses has been driven by the progressively greater emphasis on service within industry, creating a competitive relationship between the manufacturing industry and service industry over the recruitment of senior high school graduates.

**Figure 2-2-8 Employment of Senior High School Graduates in Financial and Insurance Industry**



Source: Ministry of Education, *Report of Basic Survey on Schools*  
See Table 2-2-7

**Figure 2-2-9 Employment of Senior High School Graduates in Service Industry**



Source: Ministry of Education, *Report of Basic Survey on Schools*  
See Table 2-2-7

## 2.3 Junior Colleges and Colleges of Technologies

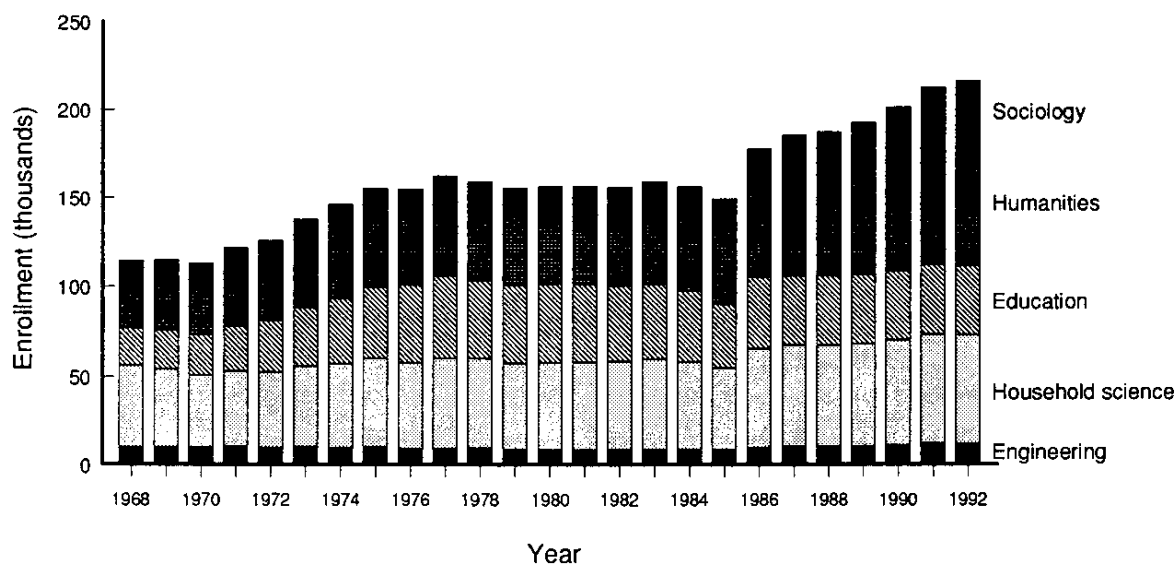
Enrollment in junior colleges and colleges of technology and employment/university entrance rates of graduates will be used here as indicators showing the status of human resource development for science and technology in junior colleges and colleges of technology.

### 2.3.1 Enrollment

Figure 2-3-1 shows the changes over time in enrollment in junior colleges. In junior colleges as a whole, enrollment doubled between 1968 and 1992 from 127,000 to 255,000. The number of students enrolling in technical programs at junior colleges has leveled off, growing only 20% between 1968 and 1992 from 10,000 to 12,000. Enrollment in humanities programs rose by 2.9 times from 24,000 in 1968 to 70,000 in 1992.

Admission limits for information science programs in junior colleges rose by 2.1 times in the decade 1975–85 from 385 to 815, while the five years between 1985 and 1990 saw a rapid rise of 6.9 times from 815 to 5,590 (see Section 2.4.1, Figure 2-4-4).

**Figure 2-3-1 Enrollment in Junior Colleges by Department**



Source: Ministry of Education, *Report of Basic Survey on Schools*  
See Table 2-3-1

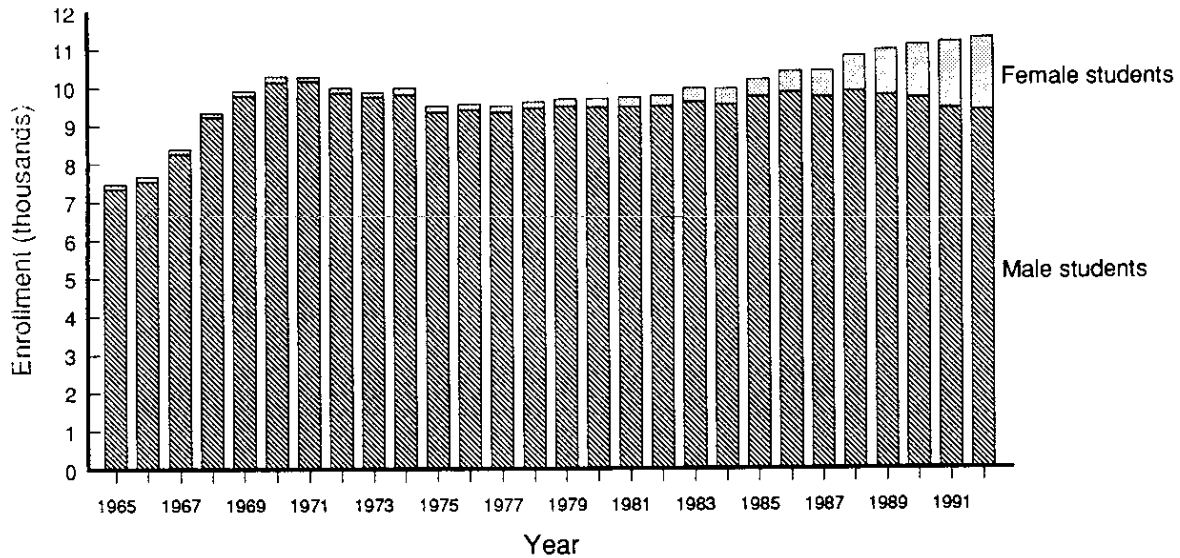
Figure 2-3-2 shows the changes over time in enrollment in colleges of technology.

After a significant increase in the latter half of the 1960s, enrollment in colleges of technology dropped for a short time, but since the latter half of the 1980s has again risen; enrollment in 1992 was about 11,000. The number of female students enrolling in colleges of technology has risen rapidly from the late 1980s, and in 1992 was 1,895 (16.8% of the total).

Admission limits for information science programs at colleges of technology rose by 3.5 times in the decade 1975–85 from 80 to 280, and from 280 to 1,485 in the five years from 1985 to 1990, an increase of 5.3 times (See Section 2.4.1, Figure 2-4-4).



**Figure 2-3-2 Enrollment in Colleges of Technology**



Source: Ministry of Education, *Report of Basic Survey on Schools*  
See Table 2-3-2

### 2.3.2 Academic advancement/Employment

#### (1) Academic advancement

The number of graduates (advancement rate) of junior college technical programs going on to university was 543 (11%) in 1965 and at its highest in 1971 at 992 (12.5%); since then, however, the number has declined over the long term, falling to 697 in 1992 (7.0%).

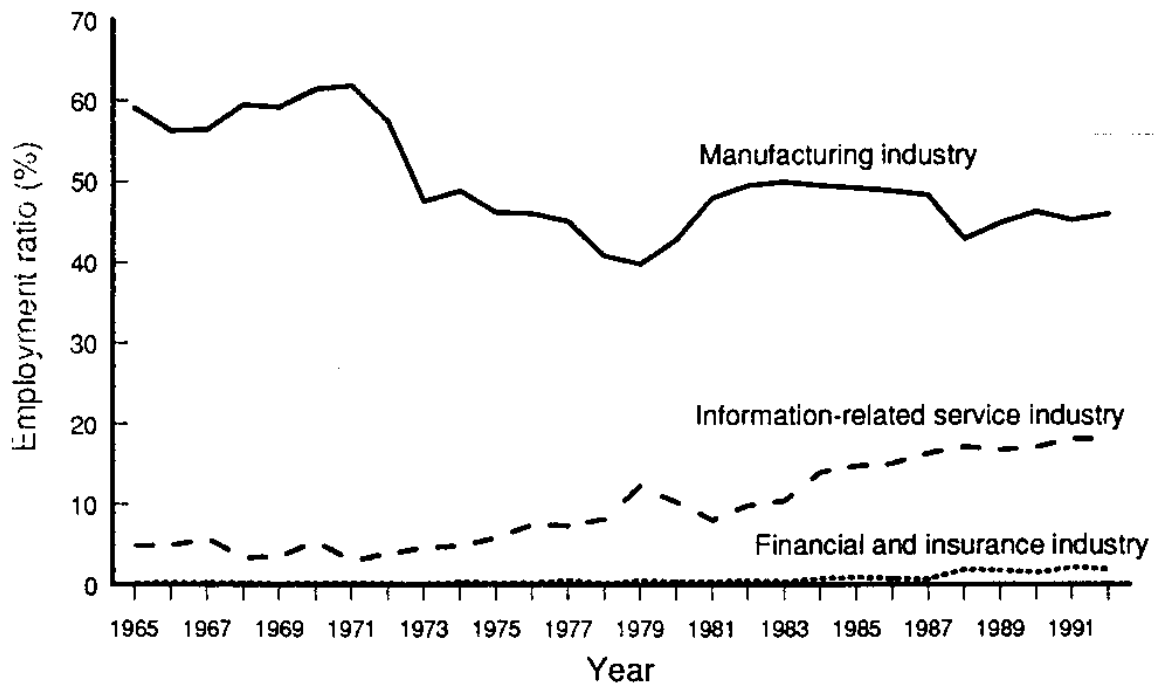
The number of technical college graduates (advancement rate) going on to university was 4 (1.4%) in 1965 and 133 (2.1%) in 1970; this number has since risen year by year, and was 1363 (15%) in 1992.

#### (2) Employment in key industries

This section will cover changes over time in the ratio of graduates of junior college technical programs and colleges of technology employed in key industries to the total number of such graduates finding employment after graduation. These key industries are the manufacturing industry, financial and insurance industry, and information-related service industry.

Figure 2-3-3 shows the changes over time in the employment ratios for key industries of graduates of junior college technical programs and colleges of technology.

**Figure 2-3-3 Employment of the Graduates of Junior Colleges (Industrial Department) and Colleges of Technology by Key Industrial Sector**



Source: Ministry of Education, *Report of Basic Survey on Schools*  
See Table 2-3-3

The employment ratio for the manufacturing industry peaked in 1971 but declined thereafter; at the beginning of the 1980s it rose again, and since has leveled off. In 1992 this ratio was 46%.

The employment ratio for financial and insurance industry, despite a rising trend in recent years, was a mere 2.0% in 1992.

The employment ratio for information-related service industry (excluding medical insurance businesses, legal services, as well as educational, religious, and non-profit organizations; hereafter referred to as “information-related and other service industries”) has risen since 1971 and was 18% in 1992.

## 2.4 University Departments

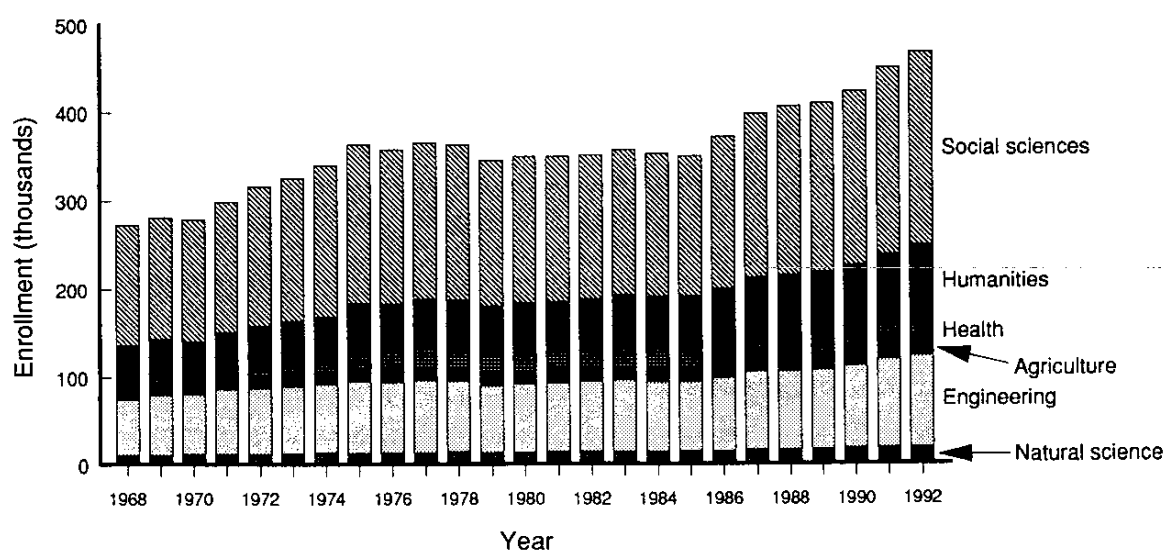
Enrollment in undergraduate university departments and the employment ratios in key industries for university graduates will be used here as indicators showing the status of human resource development for science and technology in undergraduate university departments.

### 2.4.1 Enrollment

The number of senior high school graduates peaked in 1992 at 1,807,175, and, at least for the immediate future, this number will likely drop steadily, presenting a critical situation for the recruitment of science and technology personnel.

The changes over time in enrollment in key university departments is shown in Figure 2-4-1. Within the time frame given in this figure, social sciences departments had the highest enrollment, followed by the department of engineering. Enrollment in social science departments in 1992 was 219,000 (40% of the total) and that in the department of engineering 104,000 (19% of the total); enrollment in the department of physical science was 18,000 (3.4% of the total) in 1992. Enrollment in the department of engineering rose by 1.6 times between 1968 and 1992, 1.8 times in the department of physical science. The increase over the same period for enrollment in all departments was 1.7 times, and hence the rate of increase in enrollment in the departments of engineering and physical science was almost the same as that for all departments. Enrollment expansion during this period was especially remarkable in the departments of health (3.3 times) and humanities departments (2.1 times).

Figure 2-4-1 Enrollment in Colleges and Universities by Department



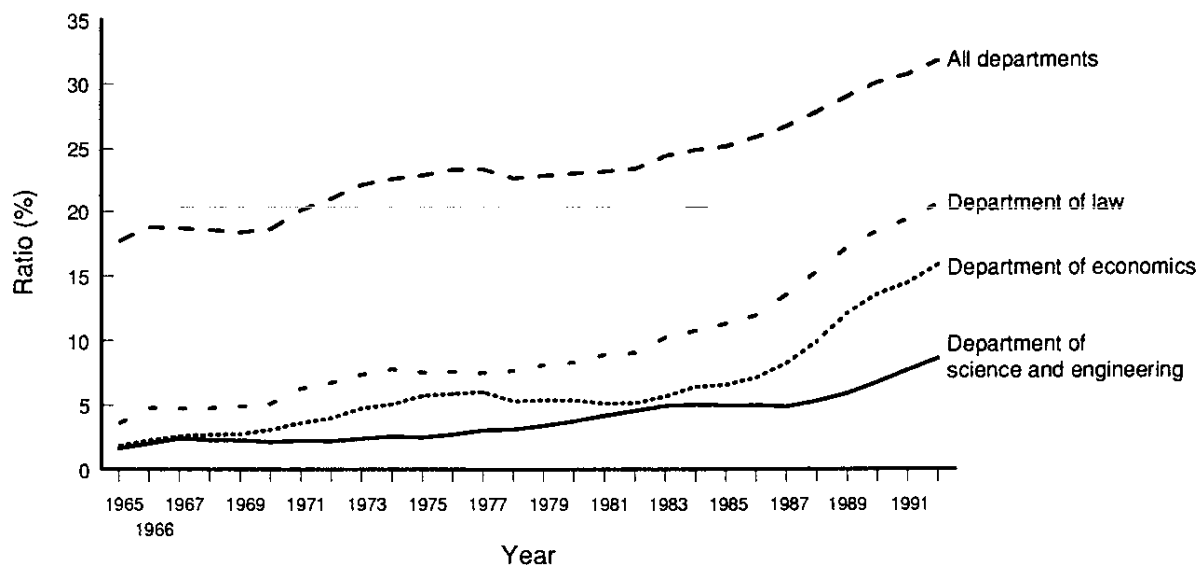
Source: Ministry of Education, *Report of Basic Survey on Schools*

See Table 2-4-1

Figure 2-4-2 shows the changes over time in the ratio of female students to the total number of enrollees in key departments.

Between 1965 and 1992, this ratio grew from 18% to 32% for all departments, from 3.6% to 21% for the department of law, from 1.9% to 16% for the departments of economics, management, and commerce (limited to departments bearing one of these designations), and from 1.6% to 8.7% for the departments of natural science, engineering, and science and engineering (limited to departments bearing one of these designations).

**Figure 2-4-2 Female Enrollment in Colleges and Universities by Department**



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

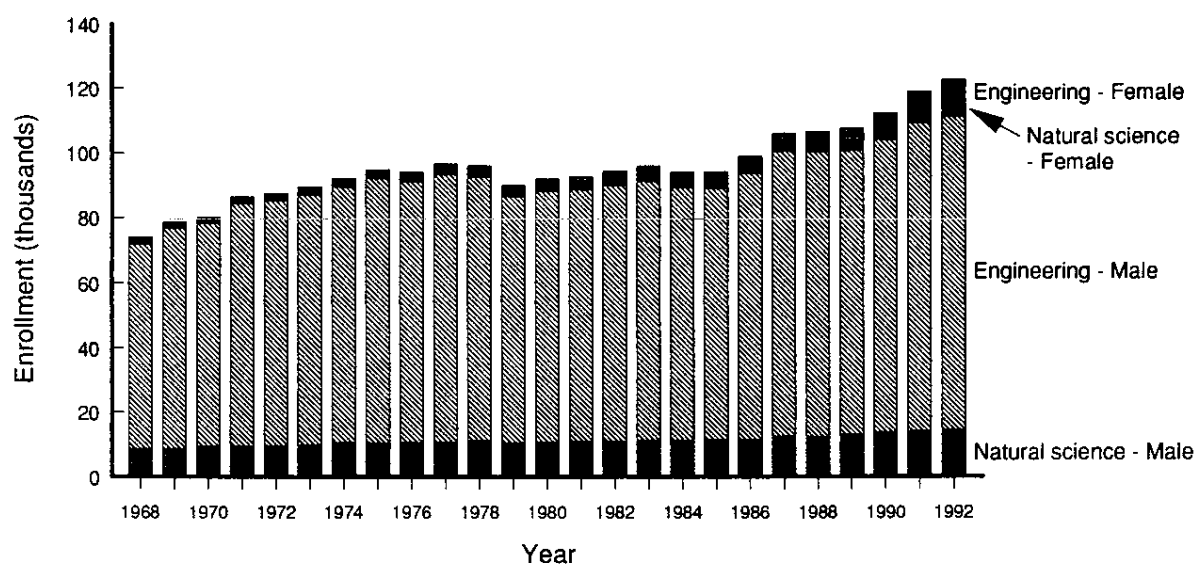
See Table 2-4-2

Figure 2-4-3 shows the changes over time in male and female enrollment in the departments of natural science and engineering.

In 1992 enrollment in the department of engineering was 104,316 and that for the department of natural science 18,313. Female enrollment in that same year was 7,195 in the department of engineering and 4,103 in the department of natural science, the ratio of female enrollment in each to total enrollment being 6.9% and 22% respectively. The proportion of female students in the department of engineering is still low but rising, as is the ratio of female students in the department of natural science, albeit at a slower rate.

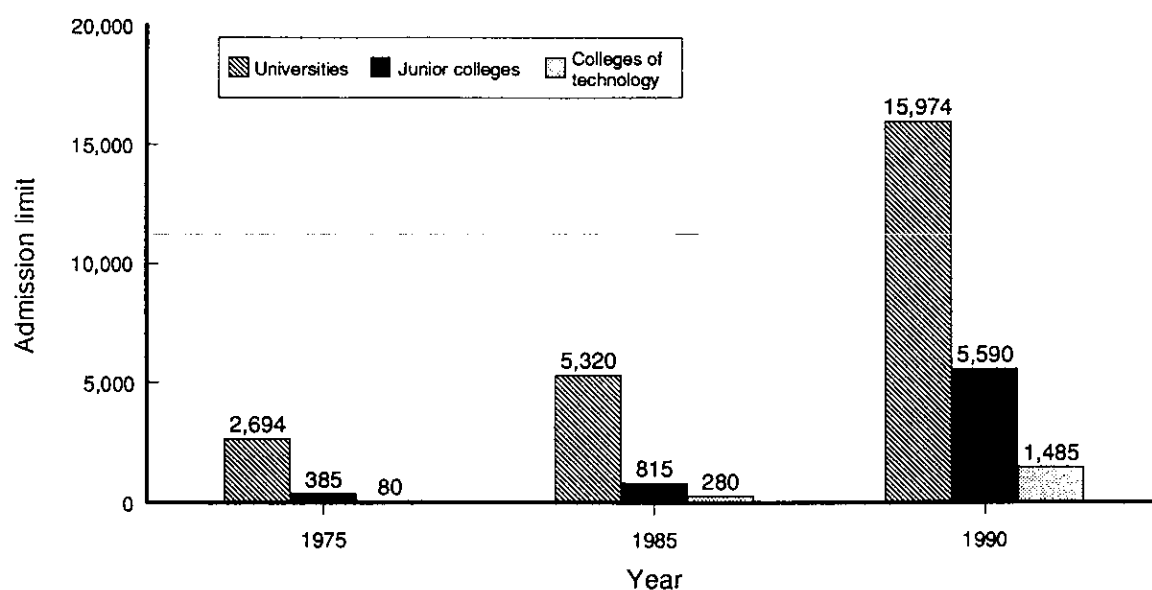
Using admission limits for information science programs as a means of illustrating the status of human resource development for information science in universities, one finds that in the ten years between 1975 and 1985 admission limits doubled from 2,694 to 5,320, and in the five years between 1985 and 1990 tripled from 5,320 to 15,974 (Figure 2-4-4). Such increases reflect the demands of modern society. Figure 2-4-4 shows admission limits for junior colleges and colleges of technology in addition to universities, and in all increases in admission limits for information science programs can be seen.

**Figure 2-4-3 Enrollment in the Departments of Natural Science and Engineering by Gender**



Source: Ministry of Education, *Report of Basic Survey on Schools*  
See Table 2-4-3

**Figure 2-4-4 Admission Limits for University and Other Information Science Programs**



Source: Ministry of Education, *Report of Basic Survey on Schools*  
See Table 2-4-4

## 2.4.2 Employment of science and engineering graduates

This section will cover employment in key industries of graduates of university science and engineering programs. Advancement to graduate school will be discussed in later sections (2.5 and 2.6).

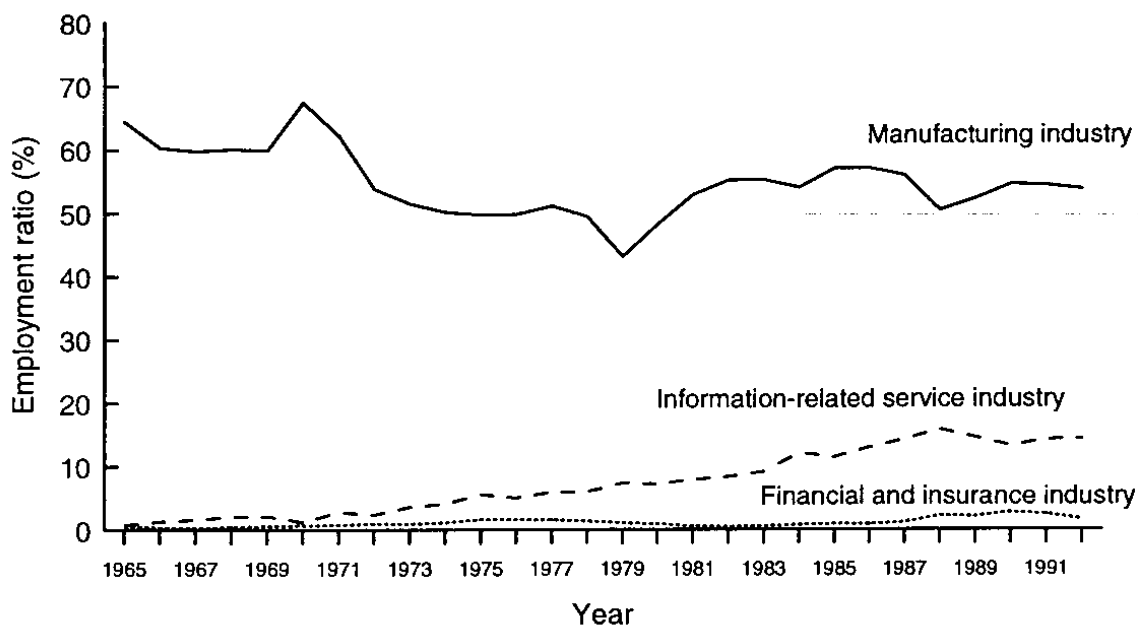
### (1) Employment in key industries

This sub-section will examine the employment of science and engineering graduates in the manufacturing industry, financial and insurance industry, and information-related service industry.

The number of graduates newly employed in the manufacturing industry in 1992 was 41,748, those in information-related service industry 11,085, and those in financial and insurance industry 1,293. The ratios of those graduates employed by key industries to the total number of graduates finding employment (77,596) are shown in Figure 2- 4-5.

The employment ratio for the manufacturing industry peaked in 1971 and fell off during the 1973 and 1979 Oil Crises; though recovering somewhat in the early 1980s, the ratio has since leveled off. The employment ratio for the manufacturing industry in 1992 was 54%. The employment ratio for information-related service industry continued on a long-term climb until about 1988; in 1992 it was 14%. Although the employment ratio for financial and insurance industry is low, it did rise between 1988 and 1990, and this phenomenon was especially noticeable in the top universities. The employment ratio for financial and insurance industry in 1992 was 1.7%.

**Figure 2-4-5 Employment of Science and Engineering Graduates by Key Industrial Sector**



Source: Ministry of Education, *Report of Basic Survey on Schools*  
See Table 2-4-5

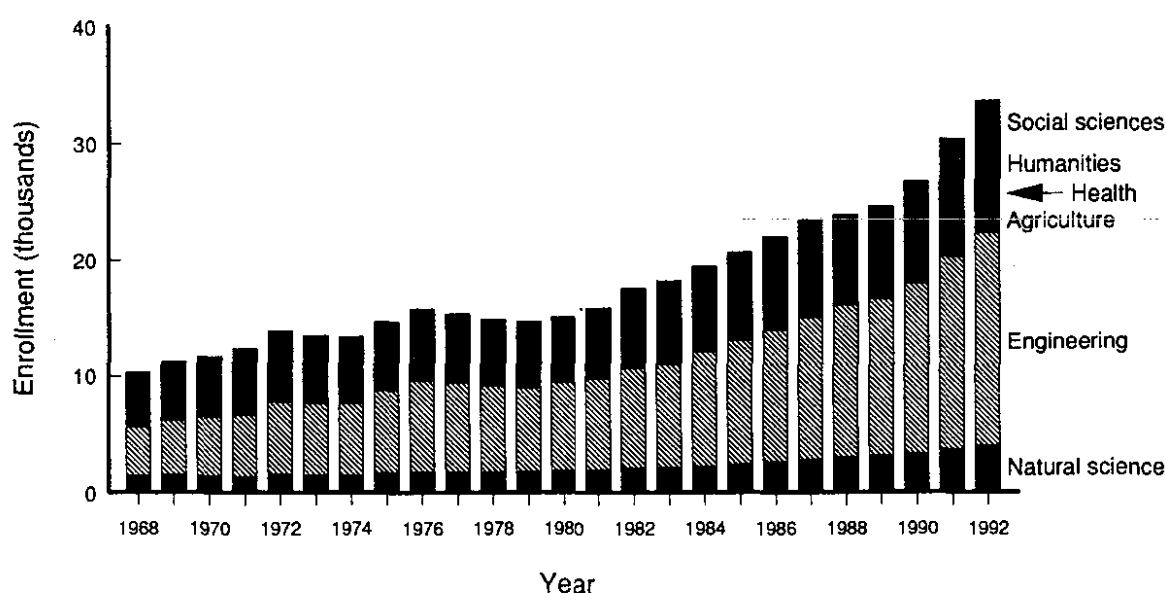
## 2.5 Master's Courses

Enrollment in master's courses and academic advancement/employment rates of master's degree holders will be used here as indicators showing the status of human resource development for science and technology in master's courses.

### 2.5.1 Enrollment

Enrollment in master's courses has risen remarkably since the beginning of the 1980s (Figure 2-5-1). The number of engineering majors has grown substantially, becoming an important factor in increased enrollment overall. Enrollment in engineering master's courses expanded by 4.4 times in the period 1968–92 shown in the figure, a rate higher than that of master's degrees overall (3.5 times); engineering claimed the largest share of master's degrees and was instrumental in boosting the total number of master's degrees conferred. Enrollment in natural science master's courses, on the other hand, grew by 2.8 times in this same period, a slower pace than that of master's degrees in general. In 1992 enrollment in master's courses overall was 38,709, for engineering courses 18,471, and for natural science courses 3,935.

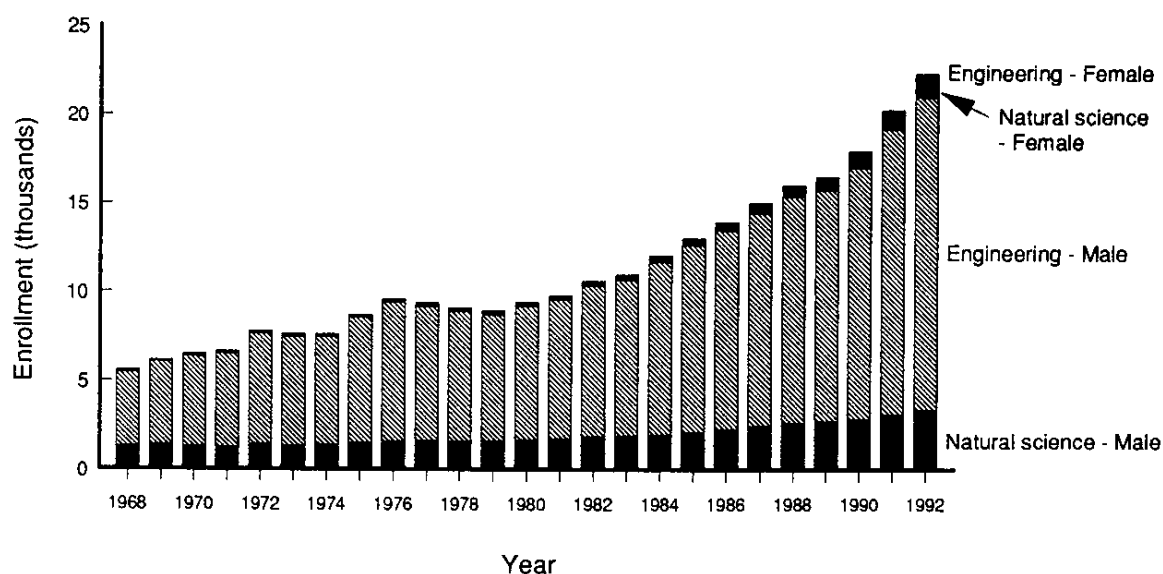
**Figure 2-5-1 Enrollment in Master's Courses in Key Department**



Source: Ministry of Education, *Report of Basic Survey on Schools*  
See Table 2-5-1

Figure 2-5-2 shows the number of students awarded master's degrees in natural science and engineering by gender. There has been an appreciable increase in the ratio of women to the total in both natural science and engineering from about the 1980s, and in 1992 the ratios were 14% (545 women) in natural science and 4.3% in engineering (794 women). A point to note is that the female ratio for master's courses is lower than that for natural science and engineering undergraduate degrees (see Section 2.4.1).

**Figure 2-5-2 Enrollment in Natural Science and Engineering Master's Courses by Gender**



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

See Table 2-5-2

Enrollment sufficiency rates (enrollment/admission limits) for master's courses are shown in the following table.

This table reveals sharp increases in recent years in sufficiency rates, with enrollment sufficiency rates for engineering somewhat higher than those for natural science.

**Enrollment Sufficiency Rates for Natural Science and Engineering Master's Courses**

Year	Natural science				Engineering			
	National	Other Public	Private	Total	National	Other Public	Private	Total
1980	0.70	0.66	0.61	0.68	0.87	0.71	0.65	0.81
1985	0.76	0.82	0.78	0.77	1.11	0.94	1.01	1.08
1990	1.04	1.04	0.97	1.02	1.43	1.39	1.14	1.33
1991	1.13	1.34	1.02	1.11	1.56	1.43	1.26	1.46
1992	1.21	1.29	1.05	1.17	1.61	1.55	1.22	1.47

Source: Data from the Ministry of Education



## 2.5.2 Academic advancement/Employment of science and engineering graduates

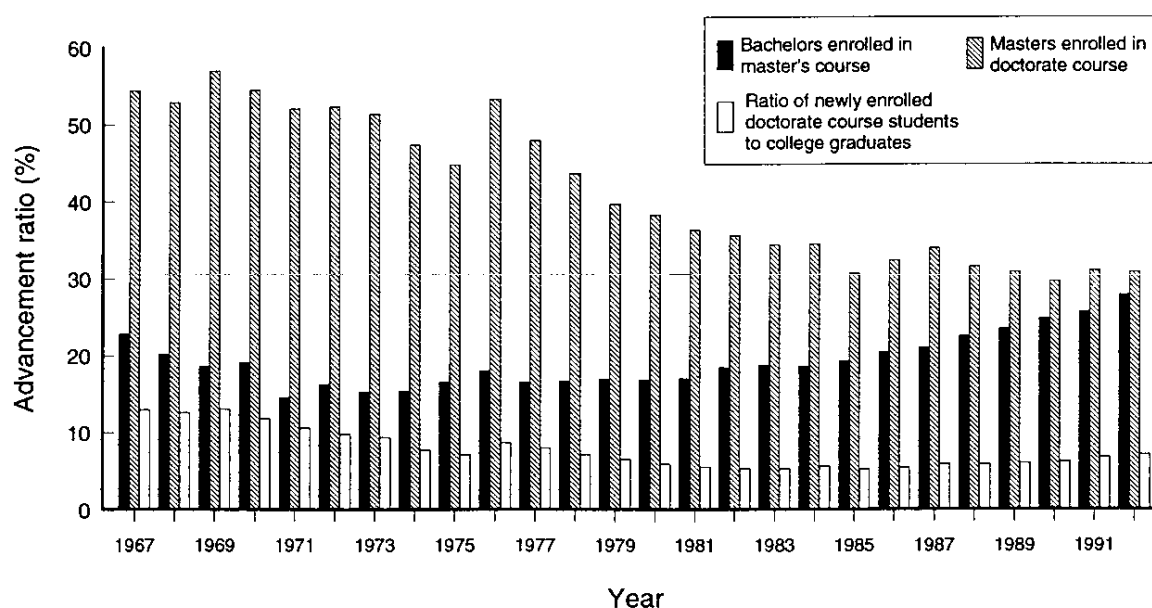
### (1) Academic advancement

The advancement rates to master's and doctorate courses in natural science and engineering are shown in Figures 2-5-3 and 2-5-4 respectively.

The advancement rate to master's courses in natural science remained steady throughout the 1970s, but grew annually in the 1980s to reach 28% in 1992. The advancement rate from master's courses to doctorate courses, however, has declined since the latter half of the 1970s, and was 31% in 1992. This drop in the advancement rate is partly attributable to increased enrollment in master's courses. The advancement rate to doctorate courses of all four-year college/university graduates dropped from 13% in 1967 to 5.2% in 1985, but has risen since, to 7.1% by 1992.

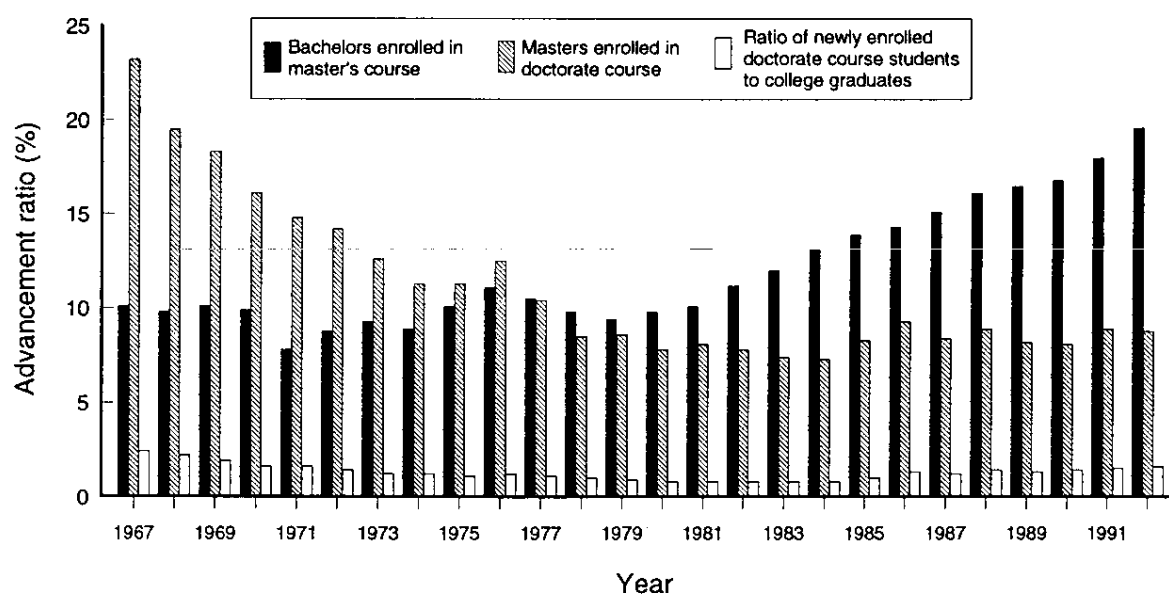
The advancement rate for master's courses in engineering, like those in natural science, remained steady throughout the 1970s but grew in the 1980s; the advancement rate in 1992 was 20%. The advancement rate from master's courses to doctorate courses declined substantially from the latter half of the 1960s to the first half of the 1970s, leveling off in the 7–9% range since the second half of the 1970s and at 8.8% in 1992. The advancement rate of four-year college/university graduates to doctorate courses in engineering has followed a pattern similar to that for natural science, declining from 2.4% in 1967 to 0.8% in the period 1980–84, and increasing thereafter to 1.6% in 1992.

Figure 2-5-3 Advancement Rate into Natural Science Graduate Schools



Source: Ministry of Education, *Report of Basic Survey on Schools*  
See Table 2-5-3

**Figure 2-5-4 Advancement Rate into Engineering Graduate Schools**



Source: Ministry of Education, *Report of Basic Survey on Schools*  
See Table 2-5-4

The low advancement rate to master's courses in both natural science and engineering in the 1970s was most likely due to the fact that Japan's manufacturing industry primarily recruited new personnel from among four-year college/university graduates and to the impact of the 1973 Oil Crisis. As manufacturing technology grew more sophisticated in the 1980s, greater emphasis was placed on basic research and recruitment of R&D personnel focused on master's degree holders; graduate education became more popular as parents were more capable financially of supporting their children's graduate studies, and in 1992, 3,950 natural science undergraduates (1 of every 3 natural science majors) and 17,139 engineering undergraduates (1 of every 5 engineering majors) enrolled in master's courses.

## (2) Employment in key industrial sector

This section will discuss the ratio of master's degree holders in natural science and engineering who have found employment in the manufacturing industry, financial and insurance industry, and information-related service industry.

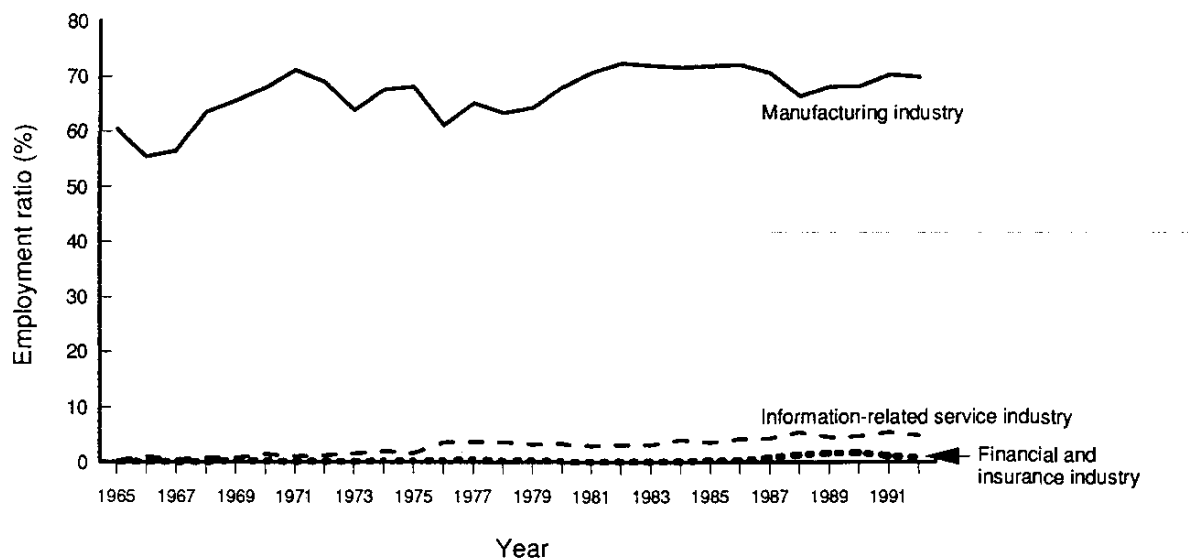
Despite short-term rises and falls, the ratio of such persons employed in the manufacturing industry to the total number finding employment has not changed greatly over the long run (Figure 2-5-5); in 1992 this ratio was 70%. With an increasing number of students enrolling in master's courses, however, the actual number of persons finding work is on the rise, the number of persons employed by the manufacturing industry in 1992 reaching 10,196.

The employment ratio for information-related service industry, although lower than that for the manufacturing industry, is rising, and in 1992 was 4.9% (709 persons).

The employment ratio for financial and insurance industry in 1992 was 0.8% (120 persons), a mere fraction of the total number of persons finding employment; with the introduction of a tertiary

online system, the number hired as computer experts boosted this ratio to 1.7% (230 persons) in 1990. This trend reversed thereafter, though, as was the case for four-year college/university graduates.

**Figure 2-5-5 Employment Ratio of Natural Science and Engineering Master's Graduates by Key Industrial Sector**



Source: Ministry of Education, *Report of Basic Survey on Schools*  
See Table 2-5-5

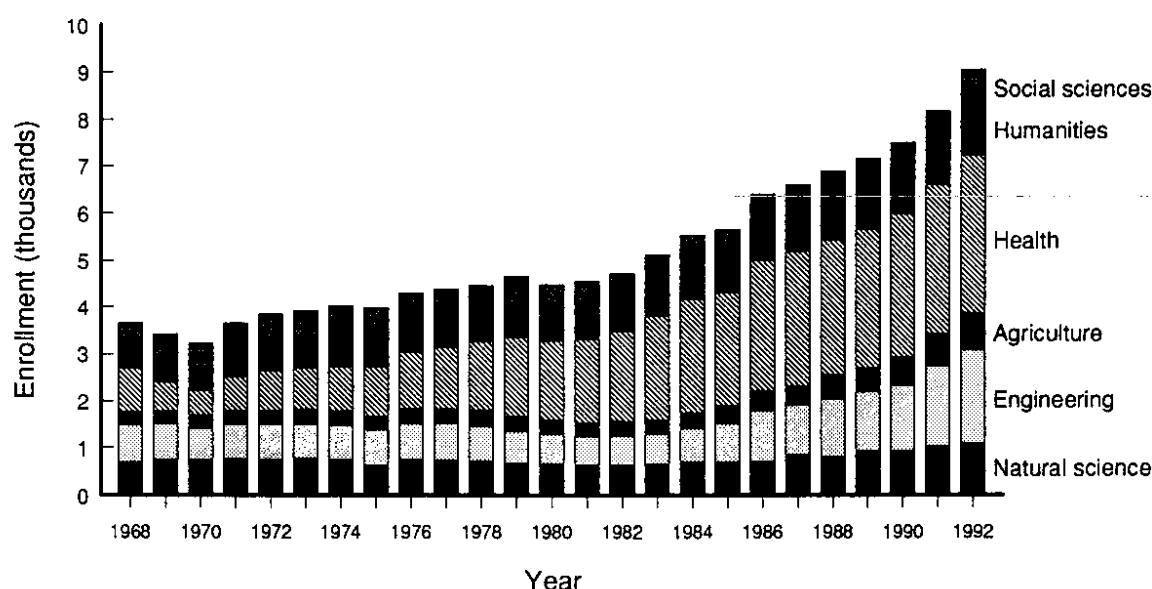
## 2.6 Doctorate Courses

Enrollment in doctorate courses, the number of doctorates conferred, and employment rates for doctorate course graduates will be used here as indicators showing the status of human resource development for science and technology in doctorate courses.

### 2.6.1 Enrollment

Enrollment in doctorate courses is shown in Figure 2-6-1. Enrollment was 3,773 in 1968 but by 1992 had grown by 2.5 times over these 24 years to 9,481. Enrollment in health courses was especially large, expanding by 3.6 times during this period to 3,395 (36% of all majors) in 1992. Next in enrollment was engineering, which in the period shown in the figure grew by 2.6 times to 2,010 in 1992. Natural science enrollment only increased by a multiple of 1.6 over the same period, and enrollment in 1992 was 1,076 (11% of all majors).

**Figure 2-6-1 Enrollment in Doctorate Courses in Key Departments**

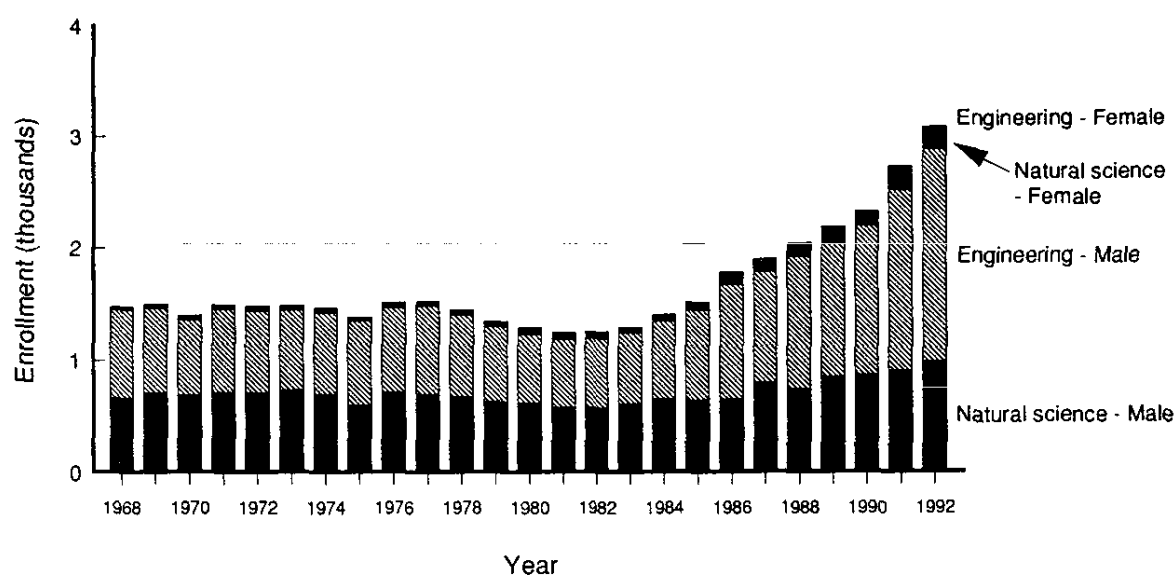


Source: Ministry of Education, *Report of Basic Survey on Schools*  
See Table 2-6-1

Figure 2-6-2 shows enrollment in natural science and engineering doctorate courses by gender.

In 1992 the ratio of female enrollment to the total was 8.6% (93 persons) in natural science and 5.4% (108 persons) in engineering. Although in natural science the ratio of female enrollment is lower than that for master's courses (see Section 2.5.1), the ratio is actually larger than that for master's courses in engineering, and the ratio of female enrollment in both natural science and engineering is larger each year.

**Figure 2-6-2 Enrollment in Natural Science and Engineering Doctorate Courses by Gender**



Source: Ministry of Education, *Report of Basic Survey on Schools*  
See Table 2-6-2

Enrollment sufficiency rates (enrollment/admission limits) for doctorate courses are shown in the following table.

Enrollment sufficiency rates for natural science overall have been rising, and admission limits have almost consistently been reached in national universities recently. Although the sufficiency rate at private universities is growing, it is still at just over 50%. The sufficiency rate for engineering is climbing, especially at national universities, but the increase has not been as high in private universities as in national universities, and is still around 30%; thus, the enrollment sufficiency rate for engineering is less than that for natural science, a trend especially marked at private universities.

**Enrollment Sufficiency Rates for Natural Science and Engineering Doctorate Courses**

Year	Natural science				Engineering			
	National	Other Public	Private	Total	National	Other Public	Private	Total
1980	0.76	0.92	0.34	0.68	0.33	0.14	0.19	0.28
1985	0.77	0.92	0.33	0.67	0.44	0.16	0.17	0.35
1990	0.90	0.73	0.45	0.79	0.65	0.26	0.25	0.52
1991	0.99	1.07	0.36	0.86	0.77	0.29	0.31	0.62
1992	0.99	0.95	0.53	0.89	0.84	0.32	0.29	0.67

Source: Data from the Ministry of Education

## 2.6.2 Employment of doctorate course graduates in natural science and engineering

This section will discuss the number of natural science and engineering doctorate course graduates who have not found work as well as those employed in key industrial sectors.

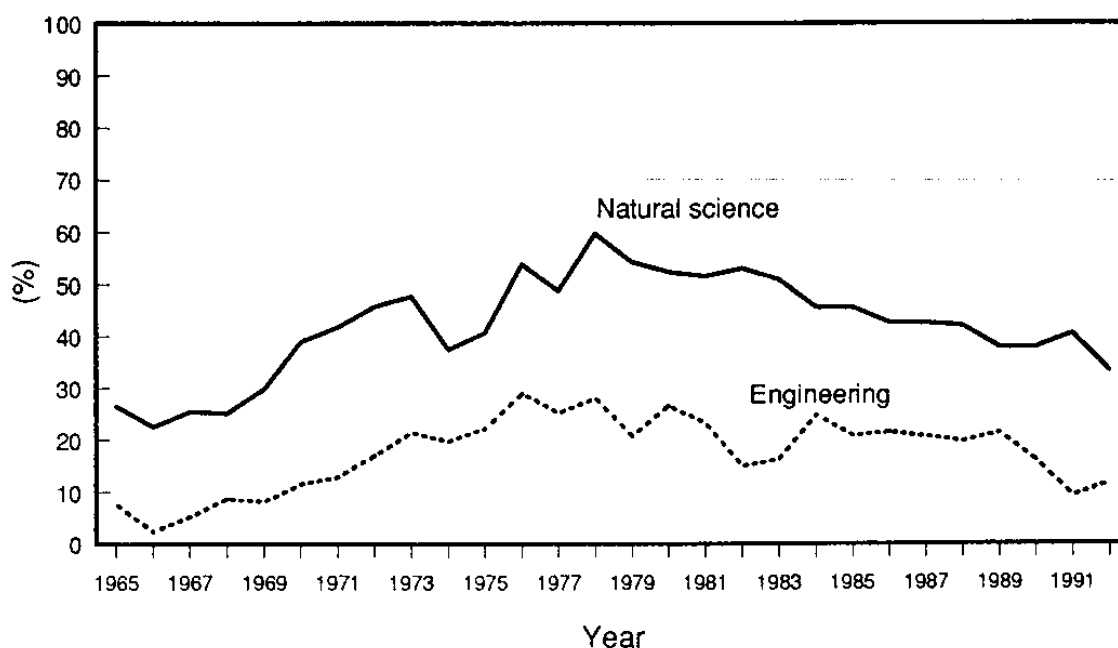
Because the “*Report of Basic Survey on Schools*” by the Ministry of Education is prepared in May, the number of unemployed doctorate course graduates in natural science and engineering listed therein does not adequately reflect cases of doctorate course graduates finding employment with universities and other institutions after the survey has been conducted; for the purposes of this section, however, it will be considered an illustration of annual employment.

The ratio of unemployed doctorate course graduates in natural science to the total was about 20% in the 1960s, but steadily grew until reaching 60% in 1978. This ratio has declined each year since the 1980s, however, and this can be taken as a favorable turn in the employment situation. Even so, in 1992 this ratio was 33% (243 persons), and a one-third unemployment rate symbolizes the difficulties remaining in finding employment.

The ratio of unemployed doctorate course graduates in engineering to the total, although still lower overall than that for natural science, is approaching the same level as natural science. The employment situation for doctorate course graduates in engineering has improved since the second half of the 1980s, the unemployment rate in 1992 at 12% (134 persons).

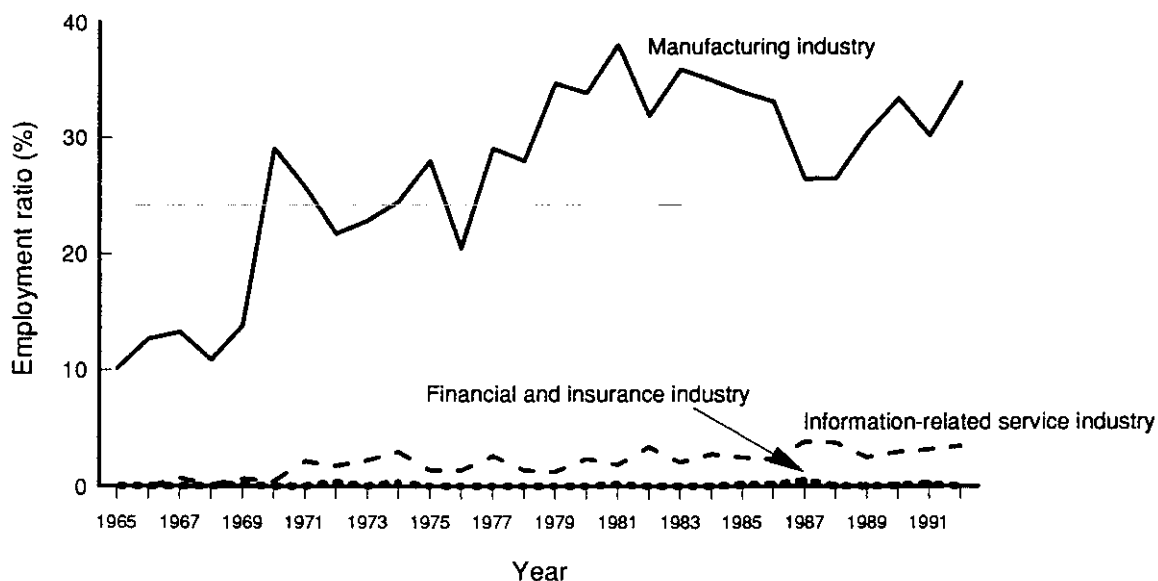
The ratios of doctorate course graduates in natural science or engineering and employed in the manufacturing industry, financial and insurance industry, and information-related service industry are shown in Figure 2-6-4.

Figure 2-6-3 Ratio of Unemployed Doctorate Course Graduates



Source: Ministry of Education, *Report of Basic Survey on Schools*  
See Table 2-6-3

**Figure 2-6-4 Employment of Science and Engineering Doctorate Course Graduates by Key Industrial Sector**



Source: Ministry of Education, *Report of Basic Survey on Schools*  
See Table 2-6-3

Despite major short-term fluctuations, the ratio of persons employed in manufacturing to the total of persons finding work has risen over the long term, and in 1992 this ratio was 35% (428 persons).

The ratio of persons employed in information-related service industry was a scant 3.4% (42 persons) in 1992, but this ratio has been rising moderately.

The number of persons employed in financial and insurance industry is at best 2–3 persons a year, and in some years, as in 1992, there are even less, perhaps none.

### 2.6.3 Number of doctorates conferred

The number of doctorates conferred can be considered one important indicator of the recognition of the abilities of personnel in the fields of science and technology. This section will discuss the number of doctorates conferred in key departments and draw a comparison of the number of science and engineering doctorates conferred per capita in Japan and the U.S.

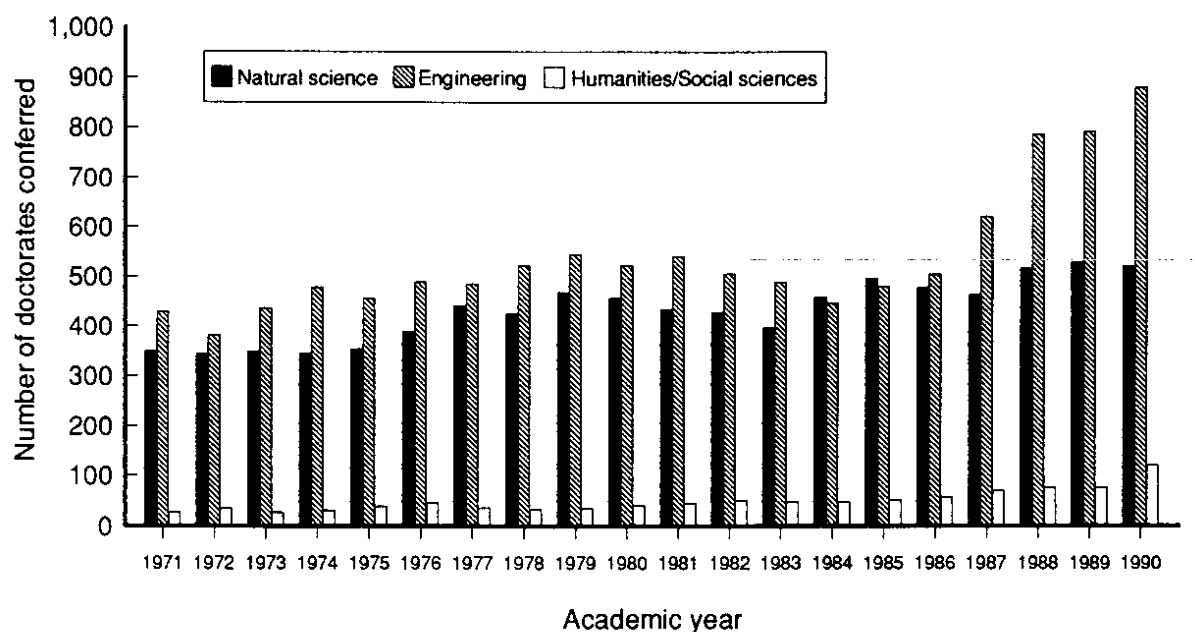
#### (1) Number of doctorates conferred by major

Figure 2-6-5 shows the number of persons awarded doctorate degrees in natural science, engineering, or humanities/social sciences after having completed the doctorate course (hereafter, “course doctorates”).

The number of course doctorates in natural science has generally risen in the period shown in the figure, with the exception of 1983, and in 1990 this number was 522. The number of engineering course doctorates has climbed rapidly since about 1987, reaching 882 in 1990. Far fewer course doctorates are conferred in humanities/social sciences than in natural science or engineering, and

only 120 such doctorates were awarded in 1990; nevertheless, the number of course doctorates in humanities/social sciences has been on the increase recently.

**Figure 2-6-5 Number of Doctorates (Course Doctorates) Conferred by Major**



Source: For humanities: Hiroshima University, Research Center for University Education, *Compilation of Higher Education Statistical Data*  
For science and engineering: National Institute of Science and Technology Policy, *Increasing the Number of High Quality Science and Engineering Taught-Course Doctorate in Japan*.  
However, for 1990, data from the Ministry of Education has been utilized.

See Table 2-6-4

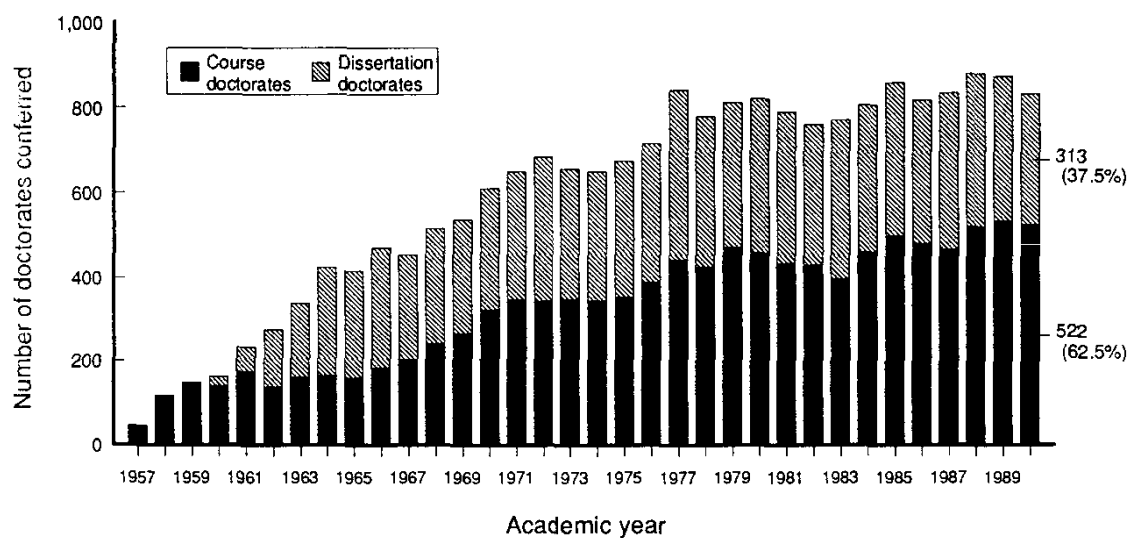
Figures 2-6-6 and 2-6-7 show the numbers of course doctorates and dissertation doctorates awarded.

The ratio of course doctorates to the total number of doctorates in natural science has exceeded that of dissertation doctorates almost every year; only in the mid-1960s were dissertation doctorates more common. In the past five years, the ratio of course doctorates has steadily risen, and was 63% in 1990.

In engineering, the number of dissertation doctorates was higher than that of course doctorates in almost all years in the period shown in the figure. Course doctorates were more numerous only in the period up to the beginning of the 1960s, i.e., before the dissertation doctorate system was fully implemented, and in the short period from the end of the 1960s to about 1970. In the past five years, though, as in natural science, the ratio of course doctorates in engineering has steadily risen, and was 45% in 1990.



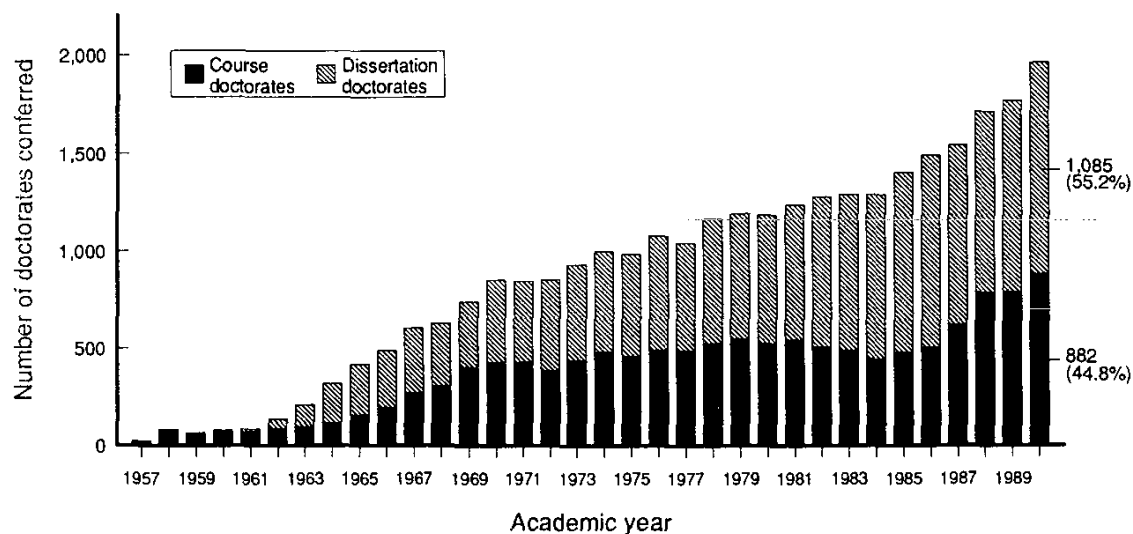
**Figure 2-6-6 Number of Natural Science Doctorates Conferred**



Source: National Institute of Science and Technology Policy, *Increasing the Number of High Quality Science and Engineering Taught-Course Doctorate in Japan*

See Table 2-6-5

**Figure 2-6-7 Number of Engineering Doctorates Conferred**



Source: National Institute of Science and Technology Policy, *Increasing the Number of High Quality Science and Engineering Taught-Course Doctorate in Japan*

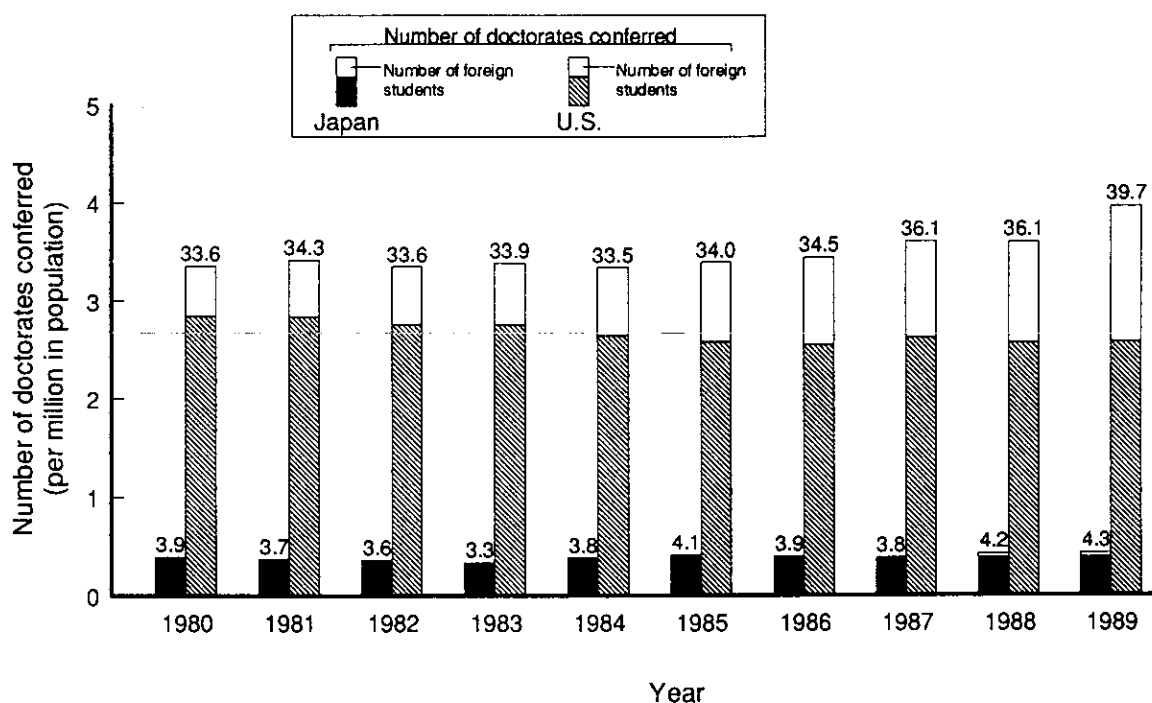
See Table 2-6-5

(2) Japan-U.S. comparison of natural science and engineering doctorates conferred

Figures 2-6-8 and 2-6-9 show comparisons of the numbers of natural science and engineering doctorates conferred yearly in Japan and the United States. In Japan's case, these numbers are limited to the number of course doctorates, and in both Japan and the U.S. the figures indicate doctorates conferred per million of population; computer science has been included under engineering.

The number of Japanese doctorates has been restricted to that of course doctorates for a variety of reasons: the average age of recipients of Japanese dissertation doctorates is about 10 years older than their American counterparts, the academic domain studied is very narrow, the contributions to graduate research of dissertation doctorate candidates are far less than those of course doctorate candidates, etc. Dissertation doctorates in Japan are thus of a clearly different character from those in the U.S. (for a comparison including dissertation theses, see Table 2-6-6).

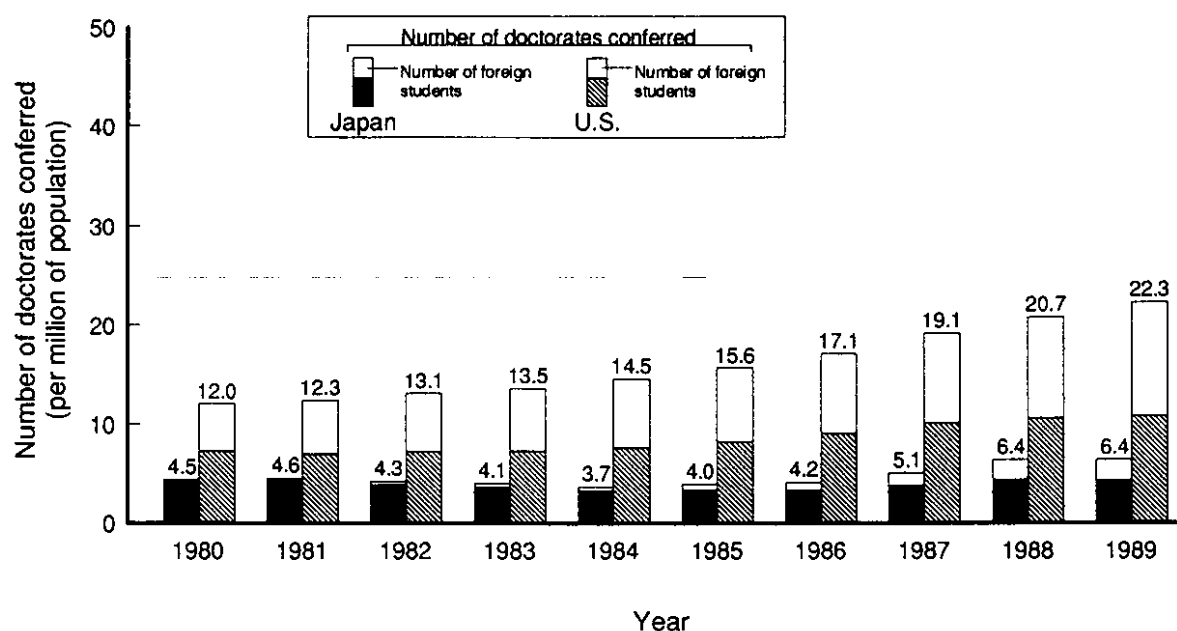
**Figure 2-6-8 Number of Natural Science Doctorates Conferred in Japan and the U.S.**



Source: National Institute of Science and Technology Policy, *Increasing the Number of High Quality Science and Engineering Taught-Course Doctorate in Japan*

See Table 2-6-6

**Figure 2-6-9 Number of Engineering Doctorates Conferred in Japan and the U.S.**



Source: National Institute of Science and Technology Policy, *Increasing the Number of High Quality Science and Engineering Taught-Course Doctorate in Japan*

See Table 2-6-6

Indexing the U.S. at 100, the number of natural science doctorates awarded in Japan, including those awarded to foreign students, was 12 in 1980 and 1985 and 11 in 1989. The same comparison for engineering produces figures of 37 for 1980, 25 for 1985, and 29 for 1989.

The number of natural science and engineering doctorates in Japan is extremely low in comparison with the U.S. Course doctorates are deemed adequate for basic research, and Japan must confront this fundamental issue if it truly wishes to make contributions to humanity through basic research.

The following table, using 1989 as an example and distinguishing between figures which do and do not include foreign students, shows a comparison of the number of doctorates per million of population in Japan and the U.S. The table reveals that the number of Japanese doctorates when foreign students are included is much lower than the American total, especially in natural science. Excluding foreign students, however, lessens the disparity with the U.S., especially in engineering, where the Japanese figure climbs above 40. Hence it is clear that foreign students account for a large number of engineering doctorates in the U.S.

### Number of Doctorates in Japan per Unit of Population (U.S.=100)

	Including foreign students	Excluding foreign students
Natural science	11	15
Engineering	29	41

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# Chapter 3

## Social Support for Science and Technology

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## Chapter 3

### Social Support for Science and Technology

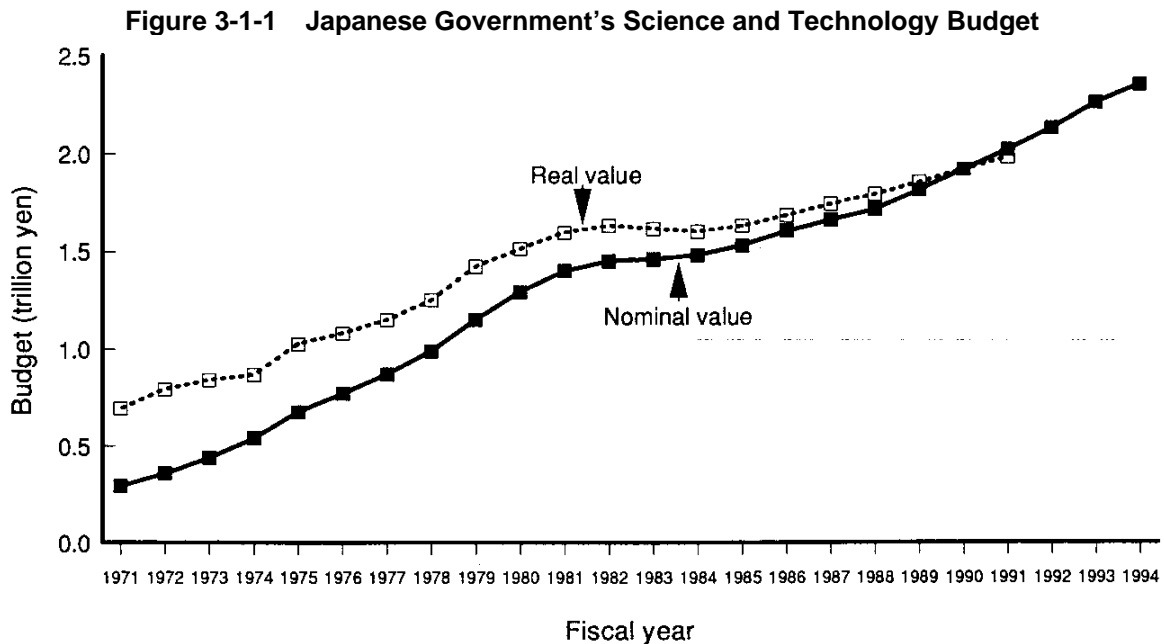
To better understand science and technology activities, one must focus attention not only on those organizations actually engaged in these activities but on those that support them as well. This chapter, therefore, discusses indicators of social support for science and technology. Social support will be divided into governmental support and support from other sectors of society, and these will be discussed in Sections 3.1 and 3.2 respectively.

### 3.1 Governmental Support

#### 3.1.1 Governmental science and technology budget

##### (1) Overall trends

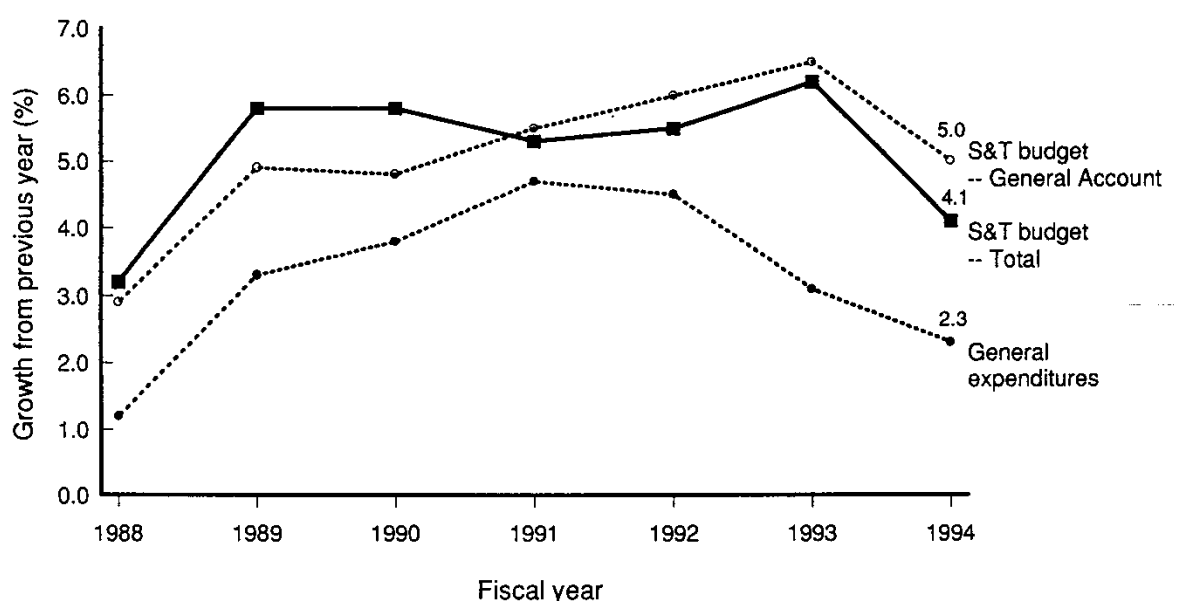
The Japanese government's (i.e., the central government's) science and technology budget is appropriated among 20 different ministries and government agencies, including the Science and Technology Agency and the Ministry of Education, and amounted to 2.3585 trillion yen in FY1994 (Figure 3-1-1). From 295.3 billion yen in FY1971, the science and technology budget grew by nearly 7 times over the next two decades to 2.226 trillion yen by FY1991. Taking into account rises in prices and using a GNP deflator (based on 1990 standards), the real increase over this period was only about three times.



Source: Science and Technology Agency  
See Table 3-1-1

Comparing the growth rate from the previous year in the FY1988–93 S&T budgets to the growth rate over the previous year in Japan's general expenditures (the expenditures remaining after excluding government bonds, distribution of local allocation tax, and provision for the Industrial Investment Special Account) (Figure 3-1-2), one finds that the growth rates of the total S&T budget and of the General Account portion of the S&T budget (see Figure 3-1-3) in all fiscal years were higher than the growth rate in general expenditures. Especially in FY1994, when insufficient tax revenues brought about by the economic recession forced the growth rate in general expenditures down, the growth rate of the total S&T budget was nevertheless 4.1%, nearly double the 2.3% growth in general expenditures and a clear indication of a steadily rising S&T budget.

**Figure 3-1-2 S&T Budget and General Expenditures Growth Rates**



Source: Science and Technology Agency

See Table 3-1-2

## (2) Composition of the S&T budget

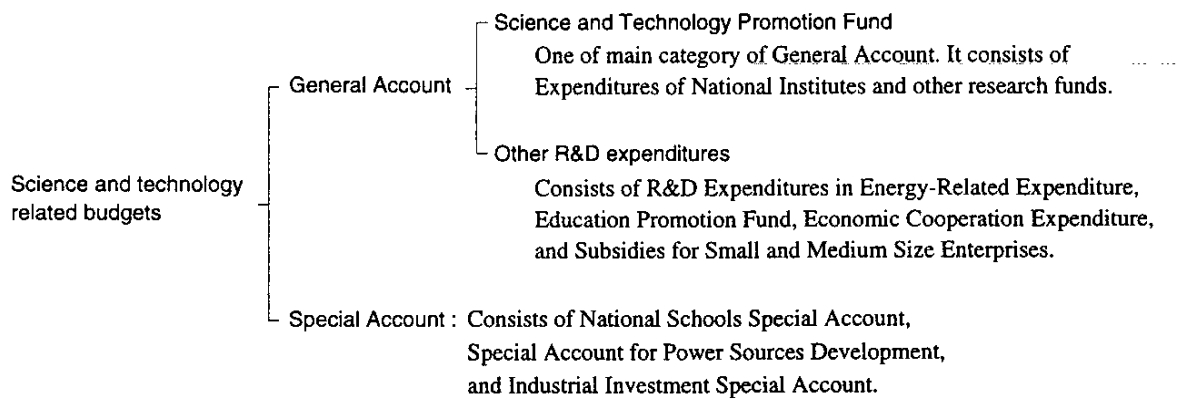
Figure 3-1-3 (A) shows the composition of the S&T budget, while Figure 3-1-3 (B) shows the share (FY1994) of each expenditure classification within the overall S&T budget.

The General Account and Special Accounts portions each make up nearly half of Japan's S&T budget; the Special Account expenditures for national schools (National Schools Special Account) came to 854.3 billion yen, accounting for nearly 70% of Special Accounts expenditures overall (FY1994).



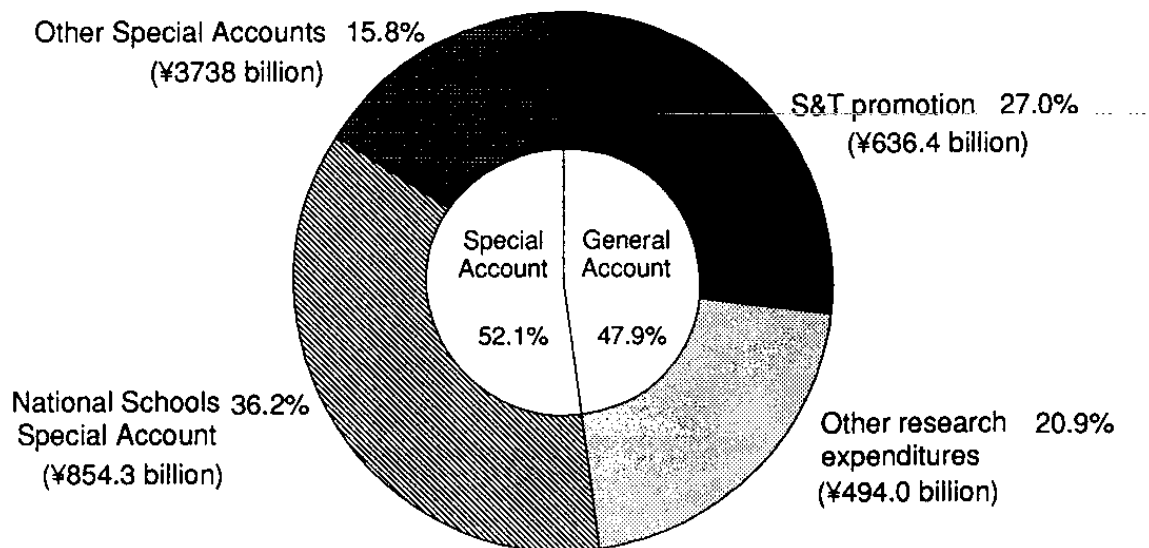
**Figure 3-1-3 S&T Budget**

**(A) Composition of S&T Budget**



Source: Science and Technology Agency

**(B) Share of S&T Budget (FY1994)**



Source: Science and Technology Agency  
See Table 3-1-3

### (3) Classifications within the S&T budget

The S&T budget is divided by content into the following four classifications:

#### 1) Grants, government investment, etc.

Includes adjusted expenditures for the promotion of science and technology, scientific research grants, investment and grants for semi-governmental corporations connected with research, grants to local governments, and grants to the private sector

#### 2) National university expenditures

Research-related expenditures for the natural sciences included in the National Schools Special Account

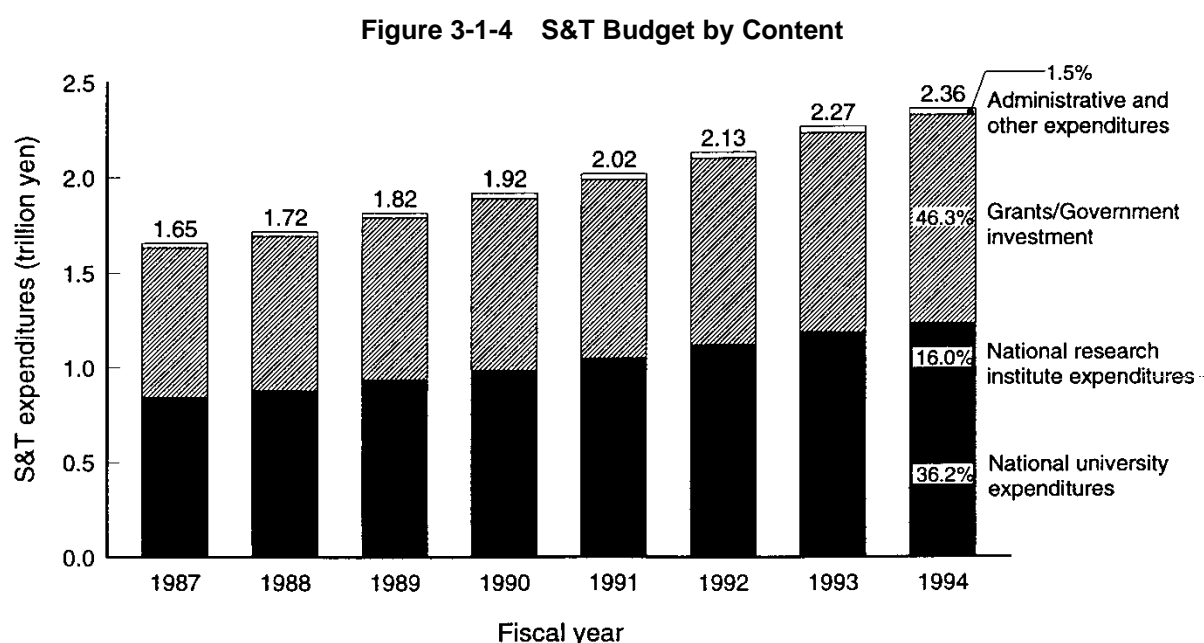
#### 3) National research institute expenditures

National research institute expenditures included in the General Account or Special Accounts

#### 4) Administrative and other expenditures

Expenses not included in 1) – 3), such as office expenditures for administrative organizations involved with science and technology, and the purchase of science and technology materials and publications for the National Diet Library.

As seen in Figure 3-1-4, grants and government investment totaled 1.919 trillion yen in FY1994, national university expenditures 854.3 billion yen, national research institute expenditures 377.2 billion yen, and administrative and other expenditures 35.0 billion yen. With the implementation of large scale projects in recent years and the grants and sponsorship offered to semi-governmental R&D institutes and to the private sector, grants and government investment account for the largest share of the total budget for science and technology, 46% in FY1994.



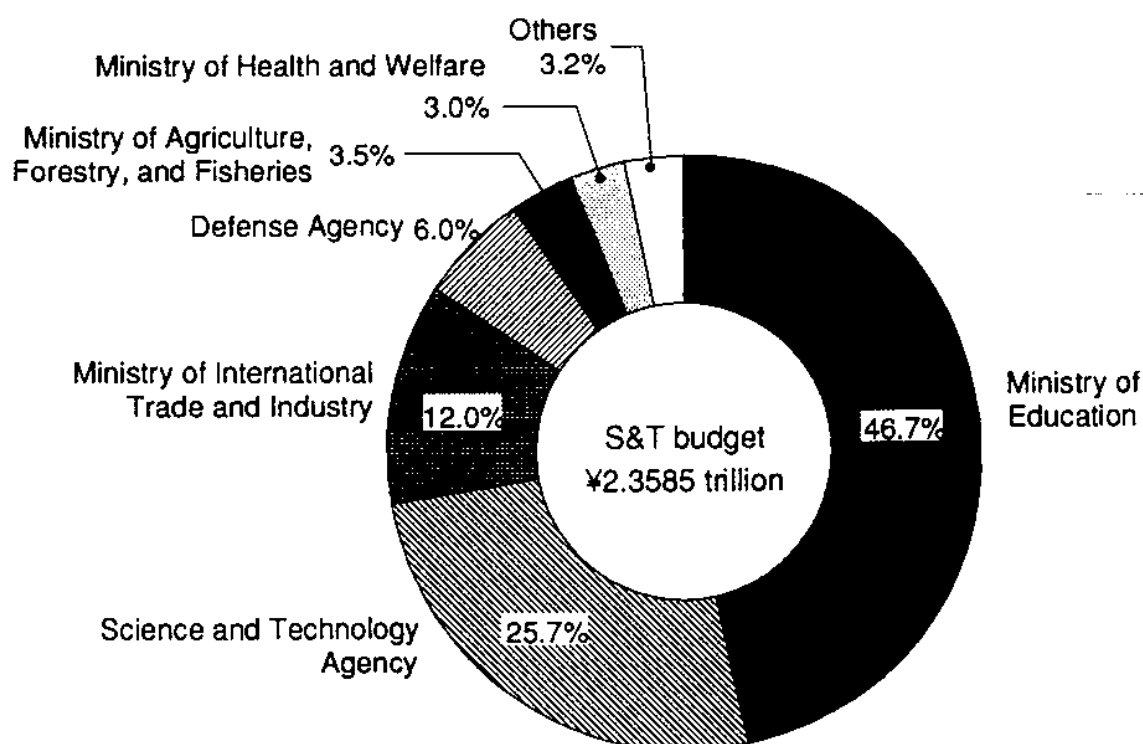
Source: Science and Technology Agency

See Table 3-1-4

(4) Budget for science and technology by government agency

The Ministry of Education claimed the largest share, 47%, of the budget for science and technology, followed by the Science and Technology Agency at 26% and the Ministry of International Trade and Industry at 12%; these three alone account for over 80% of the total budget for science and technology (Figure 3-1-5). There has been almost no change in the S&T budget shares of the various government agencies in the past several years.

**Figure 3-1-5 Share by Government Ministry/Agency of S&T Budget**



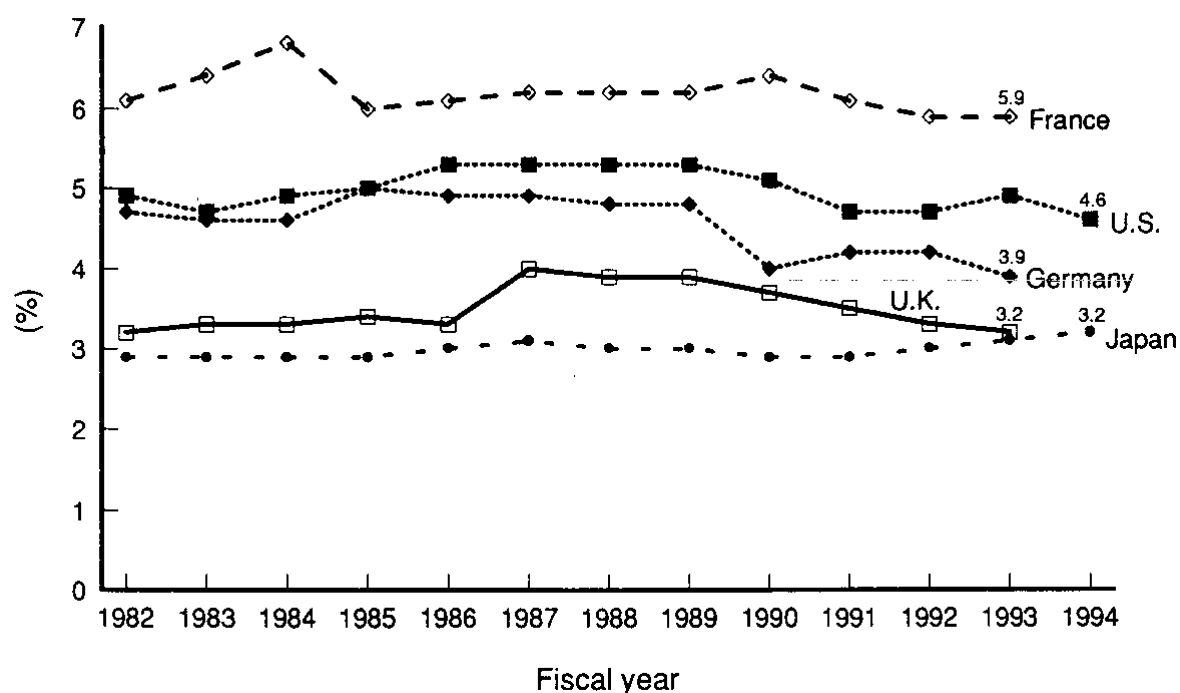
Source: Science and Technology Agency  
See Table 3-1-5

(5) International comparison of science & technology budgets

There has been, as mentioned above, a steady increase in Japan's science and technology budget, but the ratio of the science and technology budget (General Account portion) to the total General Account has held constant at around 3% over the past 25 years or so. Differences in financial systems among countries make direct comparisons impossible, but a glance at the ratio of the S&T budget to the total national budget in selected nations (Figure 3-1-6) shows that Japan ranks quite low among the selected countries. This ratio has, however, been on the rise since 1992.

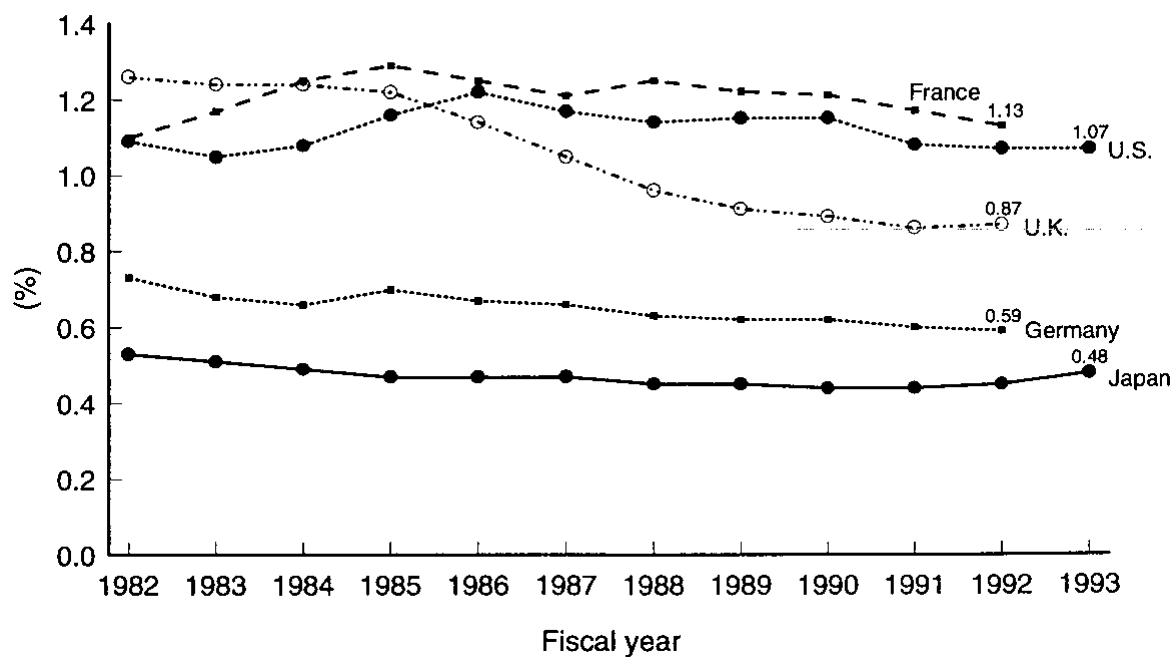
In a comparison of the ratio of the S&T budget to GNP in selected countries (Figure 3-1-7), Japan is only at about half the level of the U.S., France, and the U.K., extremely low in light of the size of its economy.

Figure 3-1-6 Share of S&T Budget in Government General Account in Selected Countries



Source: Science and Technology Agency, *Science and Technology Handbook*  
 Science and Technology Agency, *White Paper on Science and Technology*  
 See Table 3-1-6

Figure 3-1-7 Ratio of S&T Budget to GNP in Selected Countries



Source: Science and Technology Agency, *Science and Technology Handbook*  
 Science and Technology Agency, *White Paper on Science and Technology*  
 See Table 3-1-7

For the purpose of international comparisons, the Organization for Economic Cooperation and Development (OECD) classifies science and technology budgets into the items shown below:

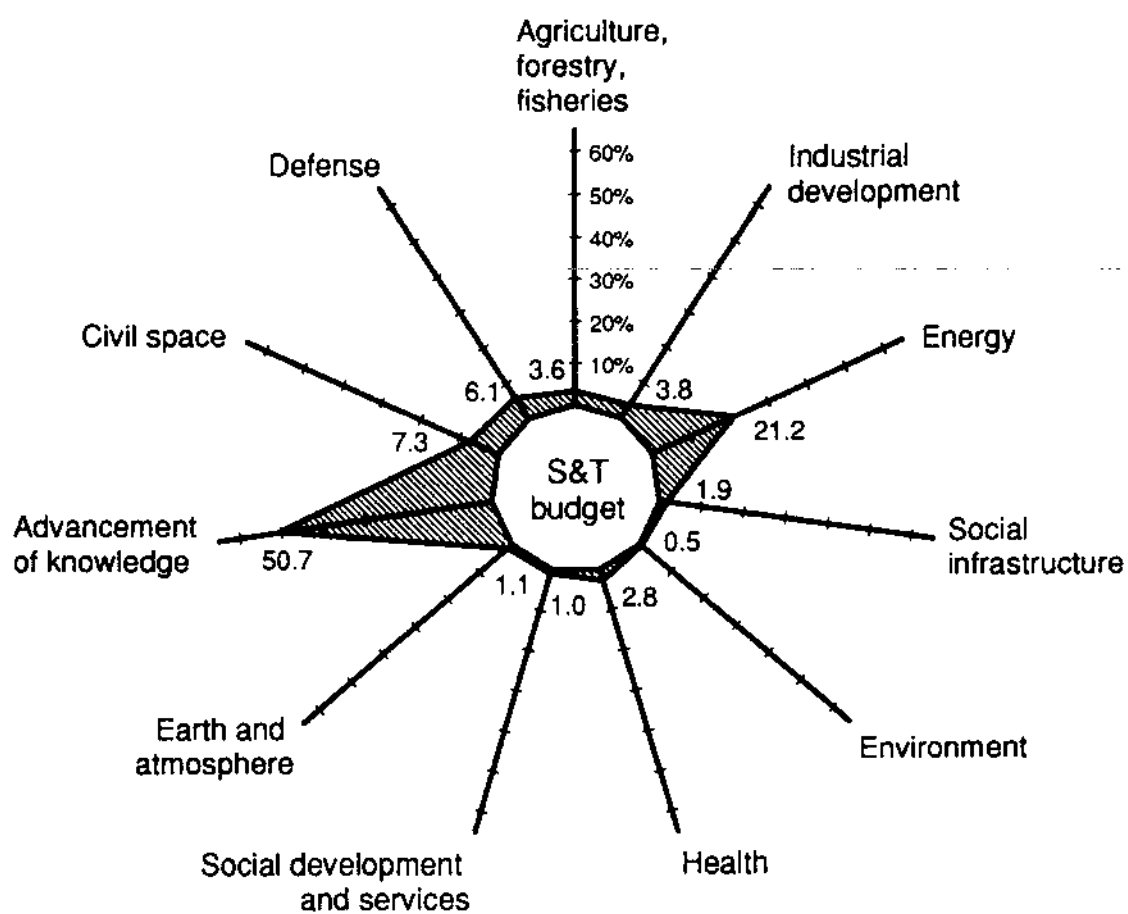
1. Development of agriculture, forestry, and fisheries
2. Industrial development
3. Energy
4. Social Infrastructure
5. Environment
6. Health
7. Social development and services
8. Earth and atmosphere
9. Advancement of knowledge (university and other research)
10. Civil space
11. Defense

Figure 3-1-8 shows the respective component ratios for items in Japan's science and technology budget when classified in accordance with this scheme. "General advancement of knowledge" (university research expenditures and grants for other unclassified research) is included in the budget for universities (950.9 billion yen in FY1993), which consequently accounts for over 50% of the total. It should also be noted that "energy" holds a high 21.2% share.

In an international comparison based on these classifications (Figures 3-1-9 (A)-(D)), the ratio of Japan's expenditures in the area of "defense" is relatively small, while that of "energy" is rather high. "Defense" (62.5%) claims a large share of the U.S. S&T budget, though, and it is clear, too, that the ratio of expenditures towards "health" (13.4%) are higher than in most other countries. In Germany as in Japan, the largest share of the S&T budget falls under "general advancement of knowledge" (45.6%); the share of "industrial development" (12.5%) is relatively high and those of "protection of the environment" and "social development and services" are also higher than in most other countries. In both France and the U.K., "defense" claims the largest single share, followed by "general advancement of knowledge". The share of "industrial development" in France is the largest of the five countries compared here.

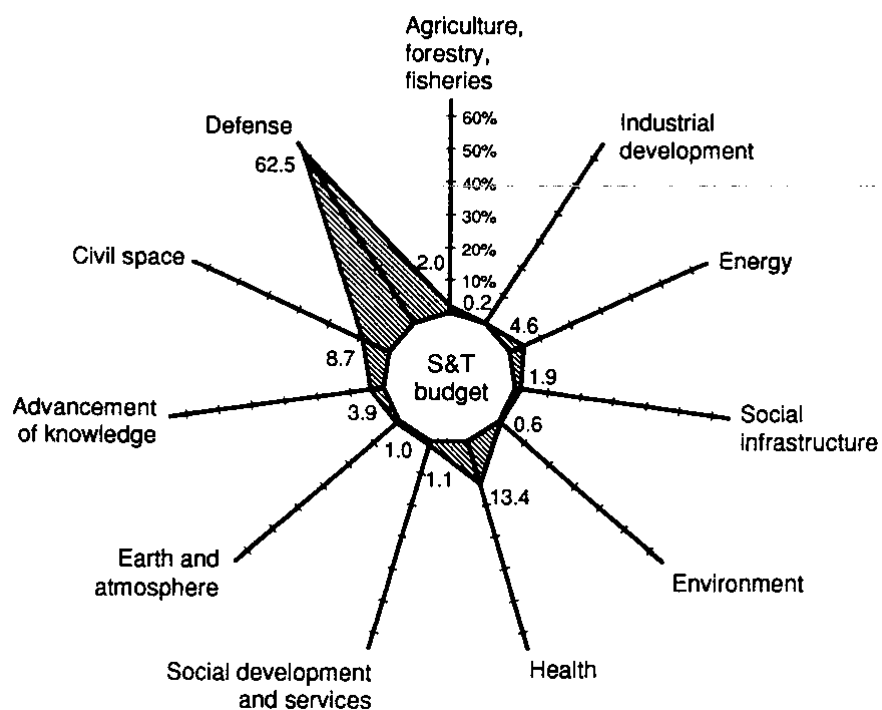
There is some disparity in the fiscal years listed for each country's data because this is an international comparison using the latest data available. It is doubtful that year to year there are very substantial changes in the shares of these classifications in individual countries, however, and hence this disparity should not present a major obstacle.

Figure 3-1-8 Japanese S&T Budget by Socio-economic Objective

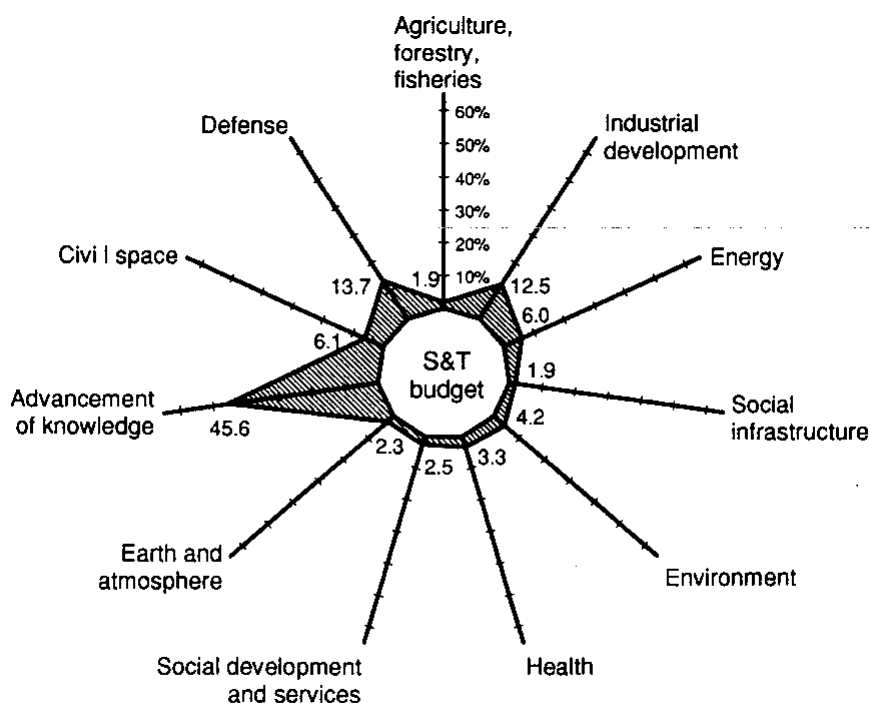


Source: Science and Technology Agency  
See Table 3-1-8

**Figure 3-1-9 S&T Budget by Socio-economic Objective**  
**(A) U.S. (FY1990)**



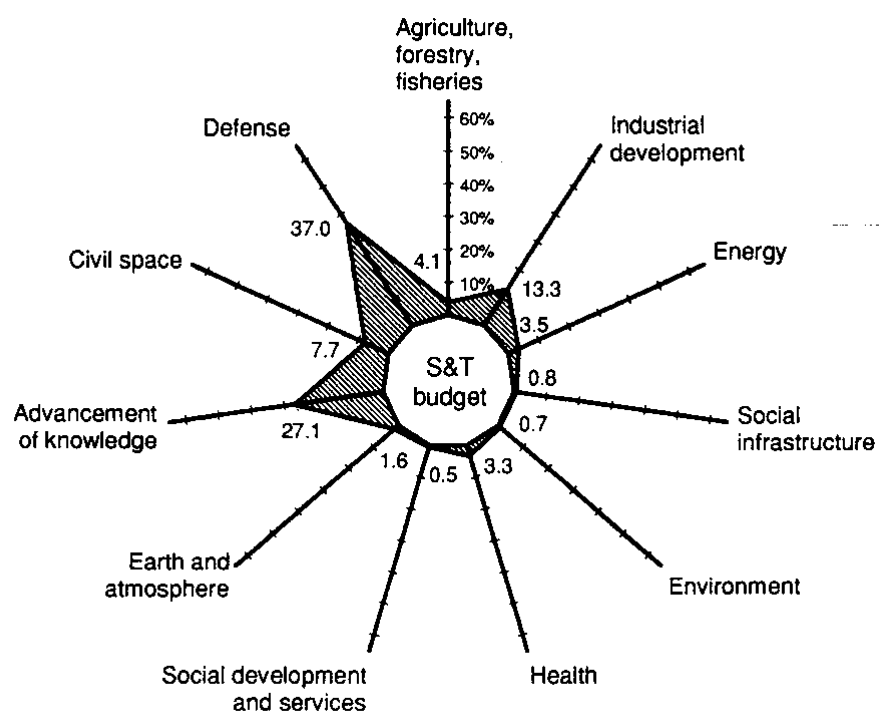
**(B) Germany (FY1990)**



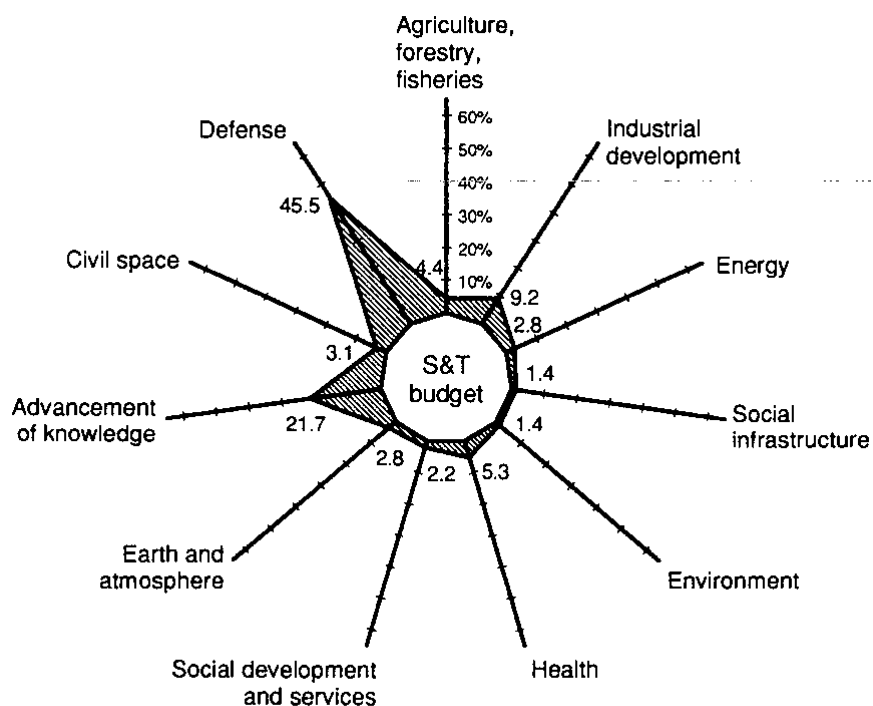
Source: OECD, *Main Science and Technology Indicators*, 1992/2, 1993  
 See Table 3-1-9

Figure 3-1-9 S&T Budget by Socio-economic Objective

(C) France (FY1989)



(D) U.K. (FY 1990)



Source: OECD, *Main Science and Technology Indicators*, 1992/2, 1993  
See Table 3-1-9



## 3.2 Public Support

Public support for science and technology can be broadly divided into direct financial support from various foundations and indirect support from learned societies and other academic communities, which provide a forum for research exchange among scientists and engineers. These types of support serve to complement official support for basic research in science and technology.

It has only been about 130 years since Japan first introduced a Western-style academic system and, compared with the West, there is still in Japan insufficient public support for and understanding of academic research. For Japan to contribute to the international community through science and technology, Japanese society must follow the example of government and provide adequate support for science and technology. In addition to this viewpoint, this section discusses indicators related to indirect support for science and technology and attempts to clarify certain aspects of the relationship between science and technology and society.

### 3.2.1 Foundations related to science and technology

Support for science and technology from various foundations serves a complementary function to official support for basic research in science and technology. The following non-profit bodies conduct activities related to science and technology:

- (1) Private higher education institutions (established as educational foundations)
- (2) Learned societies (established as aggregate corporations or corporate foundations as well as voluntary corporations)
- (3) Non-profit research institutes (mostly established as incorporated foundations)
- (4) Research support foundations (established mostly as incorporated foundations but sometimes in other forms)

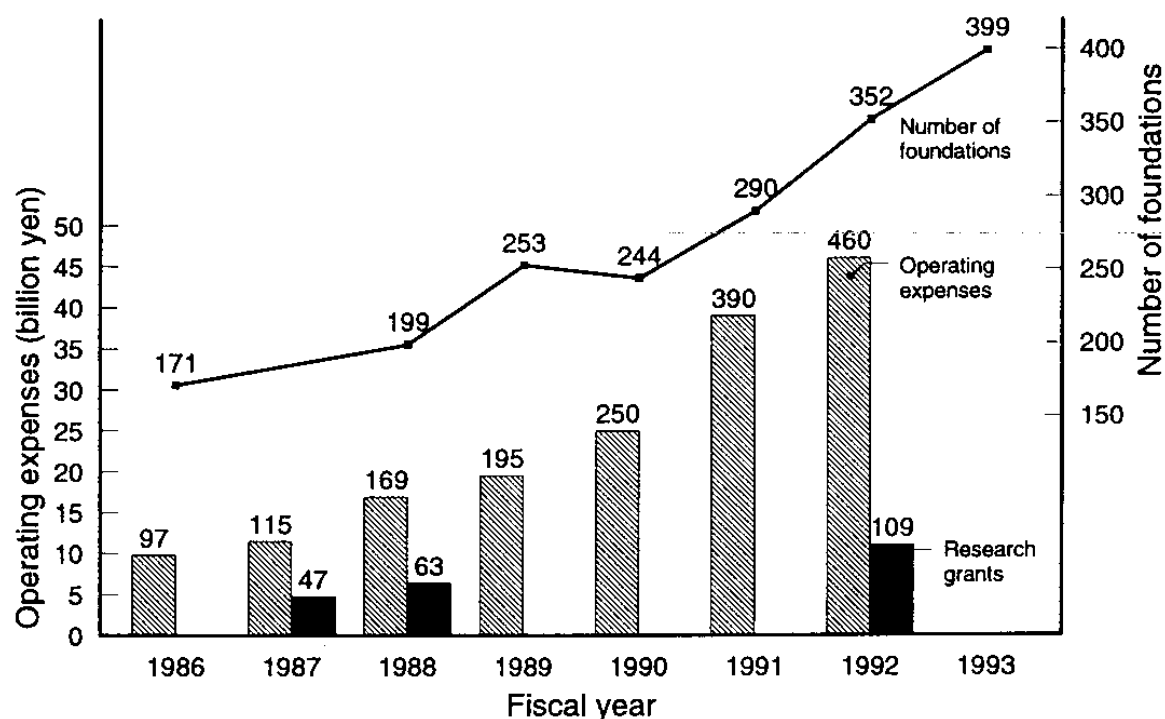
(1) corresponds to indicators related to university activities and (3) to indicators related to the activities of private research institutes. This section covers (4), research support foundations <sup>(1)</sup>.

The number of incorporated foundations in Japan principally engaged in supporting research has climbed sharply since 1991, and in FY1993 was 399 (Figure 3-2-1). This section analyzes the research support projects implemented by these foundations related to science and technology.

The total operating expenditures for FY1993 are not available at this time, but the total operating expenditures for FY1992 were 46.0 billion yen; of this 10.9047 billion yen was given out in research grants. Though the scale of these operating expenditures was small in comparison to the scientific research grants offered by the Ministry of Education (a total of 64.6 billion yen for FY1992), these foundations continue to play a very important role as a funding source for basic research.

These foundations provide research grants, conference grants, overseas dispatch grants, and scholarships. A breakdown by academic area of 384 of these research grant programs is shown in Figure 3-2-2. The numbers for science and engineering are about the same, and medical science is only slightly behind. This distribution is similar to that of general research supported by scientific research funding from the Ministry of Education.

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

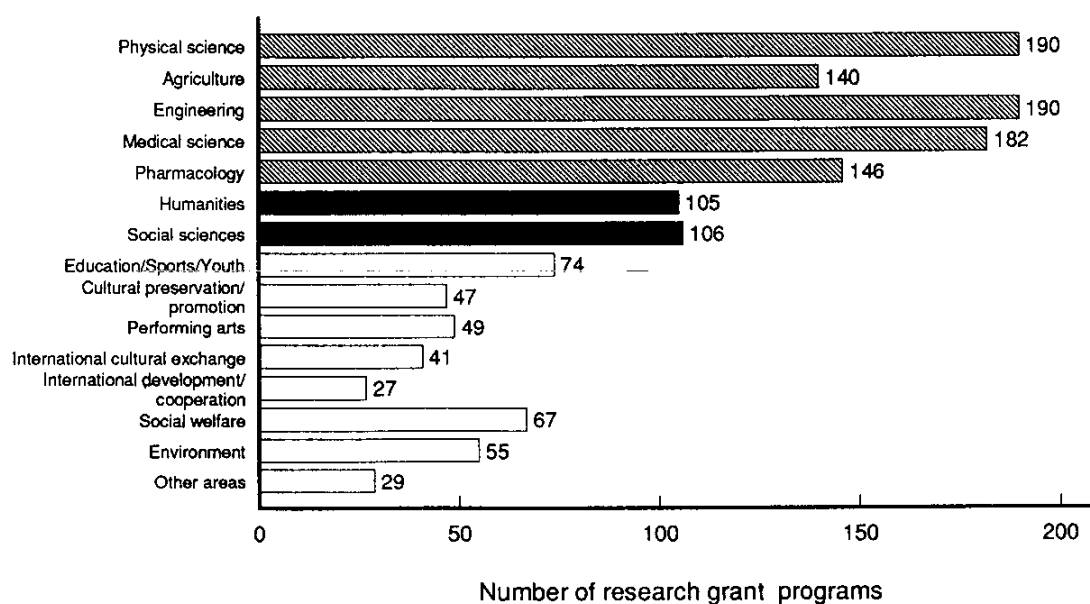


Note: Data for years not shown is either not available or not yet compiled.

Source: Supportive Foundations Data Center

See Table 3-2-1

**Figure 3-2-2 Number of Research Grant Programs by Research Area**



Source: Supportive Foundations Data Center

See Table 3-2-1

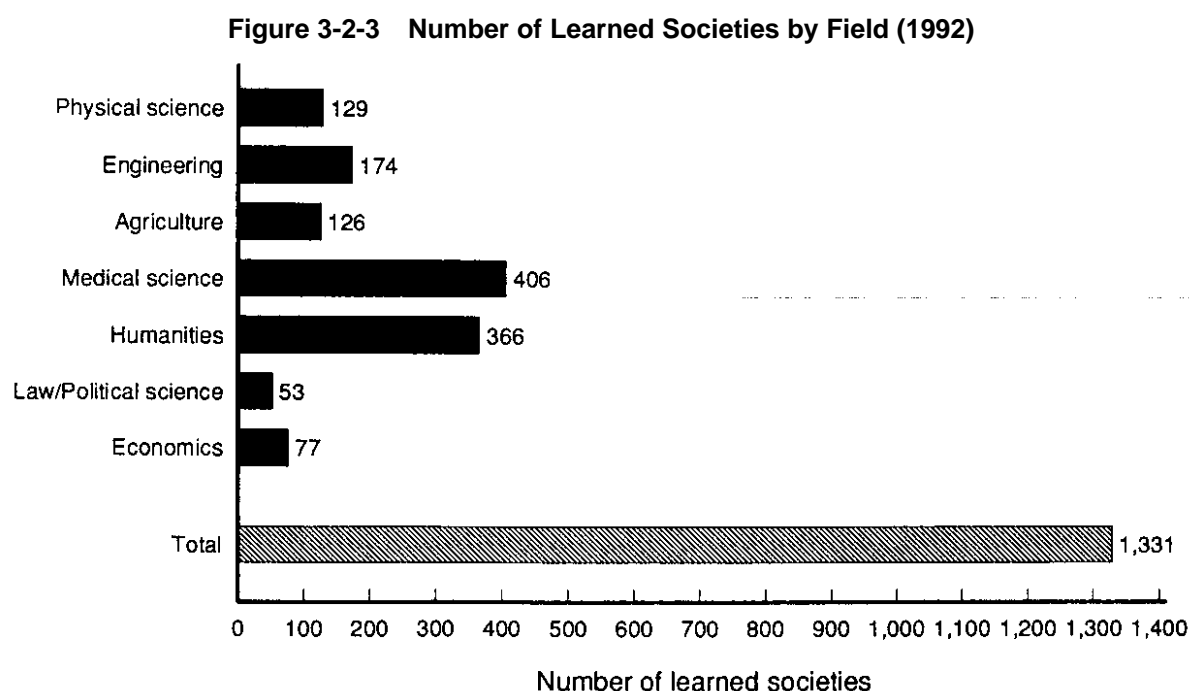
**[Note]**

(1) Data [1][2] used in this chapter to develop indicators was collected by the Supportive Foundations Data Center. As part of the recent promotion of science and technology at the regional level, an increasing number of incorporated foundations are being established through investment by local governments. Though some of these foundations provide research support for the regional promotion of science and technology, their numbers are not included in the data collected by the Supportive Foundations Data Center, and thus it is difficult to accurately assess the present status of research support foundations.

### 3.2.2 Learned societies

Learned societies provide a forum for exchange between researchers, and perform an important role in the promotion of research through contact between researchers and of exchanges of knowledge/information.

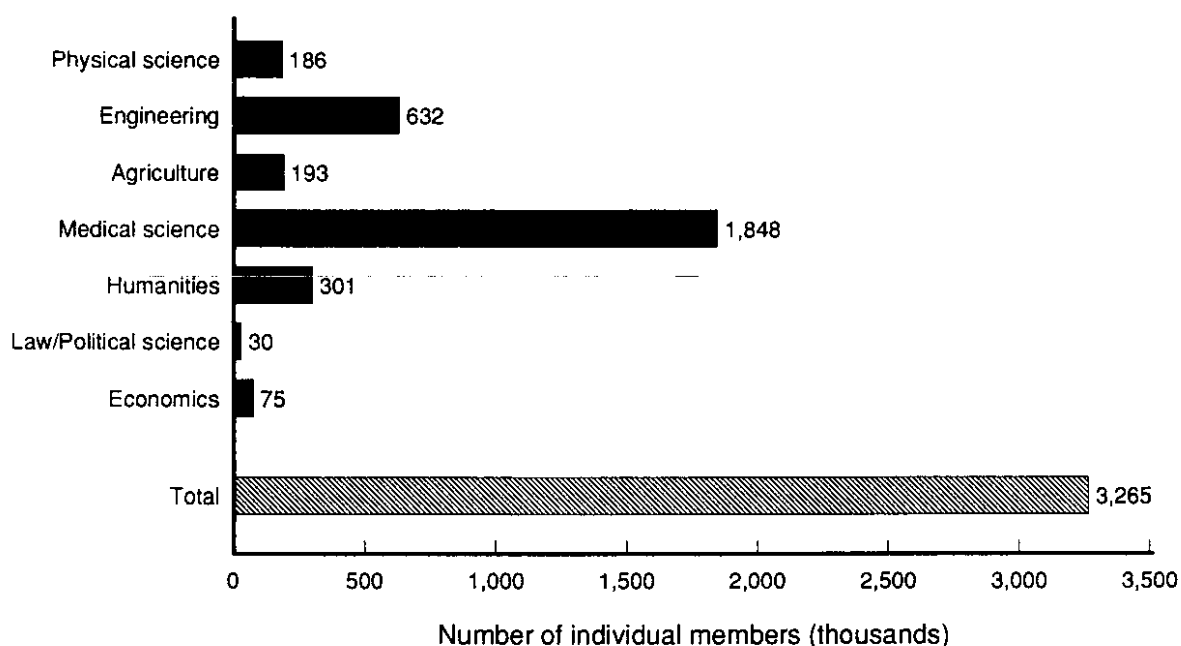
The number of registered learned societies in Japan was 1331 in 1992 <sup>(1)</sup>. The most popular fields in terms of number of registered learned societies were humanities and medical science, these two together accounting for the majority of learned societies in 1992 (Figure 3-2-3). These were followed in descending order by engineering, physical science, and agriculture. In 1992, a total of 3,086,000 individual members and about 90,000 organizational members comprised these learned societies. An overwhelmingly large number of individual members, 1.85 million, belonged to medical science societies, followed by engineering at 630,000, humanities at 300,000, and agriculture and physical science with approximately 190,000 each (Figure 3-2-4). Medical science societies also have the highest average number of individual members per society (approximately 4,600), with engineering in second place with about 3,600.



Source: Science Council of Japan, *Academic Research Bodies in Japan (1993)*

See Table 3-2-2

**Figure 3-2-4 Number of Individual Members in Learned Societies by Field (1992)**



Source: Science Council of Japan, *Academic Research Bodies in Japan* (1993)

See Table 3-2-3

Figures 3-2-5 (A) and (B) show the changes over time, in increments of five or ten years, in the number of learned societies established and a breakdown by academic field, allowing one a view of chronological trends in the establishment of learned societies. These figures reflect only those learned societies registered in the latest data, however, and does not include learned societies which no longer exist.

The oldest learned society in Japan was established in 1878, but despite the long history of such societies, the majority have been established since World War II. The period from just after the war until the mid-1950s was one of reconstruction for academia in Japan, and during that time, a sudden expansion of learned societies in major fields accompanied the promotion of new universities. From then until about 1970, the number of learned societies in individual fields centering on the humanities and medical science grew, and since 1970 new learned societies in almost all fields have continued to appear.

One remarkable trend recently has been the considerable number of learned societies devoted to medical science created since the mid-1970s. Other trends not reflected in the figure include the growth in learned societies in new fields and academic disciplines and the increasing number of chapters being set up within learned societies.

Figure 3-2-5 (A) Number of Learned Societies by Year of Establishment

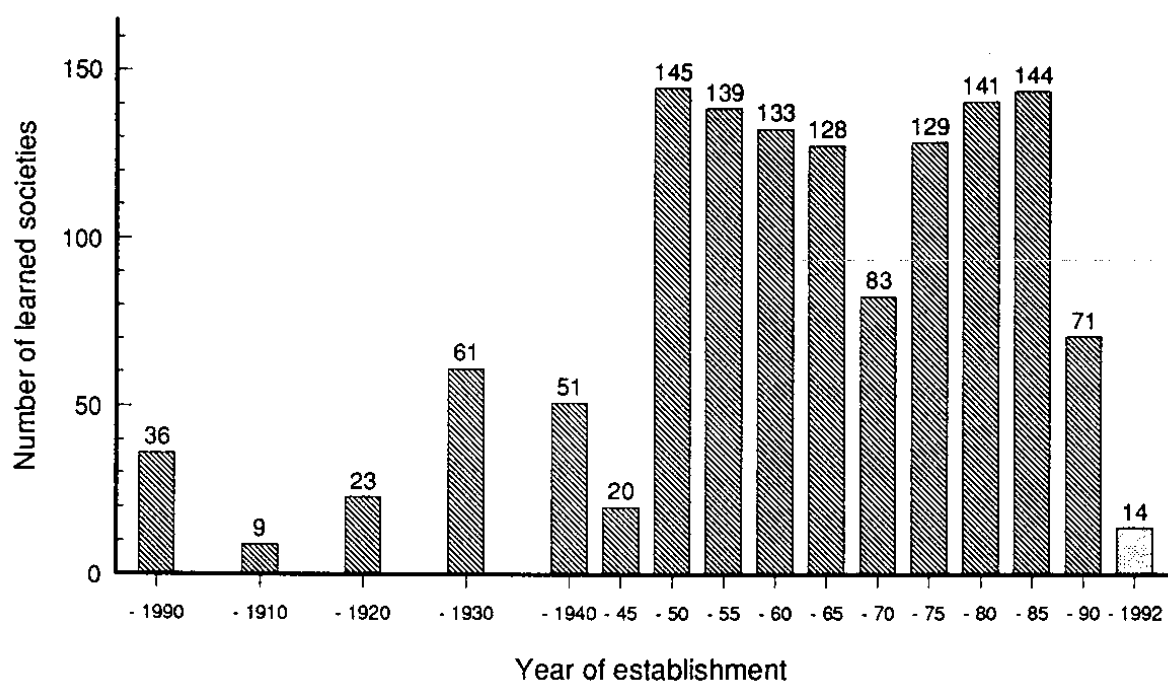
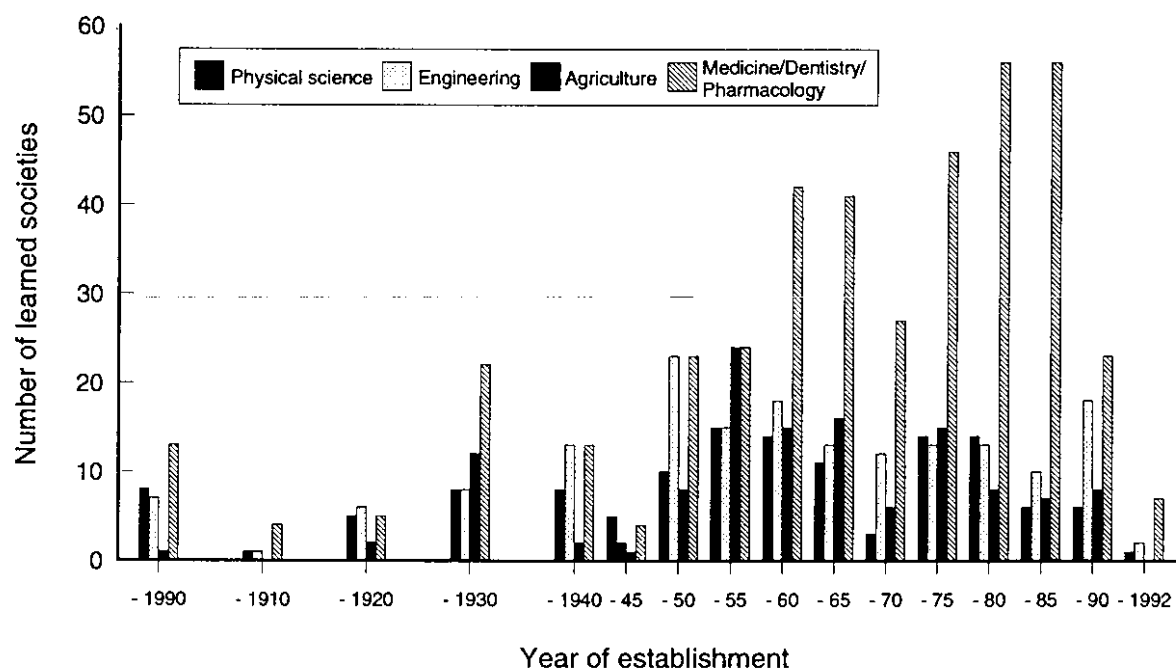


Figure 3-2-5 (B) Year of Establishment of Learned Societies by Field



Note: The number of learned societies established is shown in ten-year increments until 1940 and in five-year increments thereafter. The period “-1992”, however, represents only a two-year period.

Source: Science Council of Japan, *Academic Research Bodies in Japan* (1993)

See Table 3-2-5

## [Note]

- (1) In this section, “learned societies” are defined as those organizations which have been registered as academic research bodies with the Science Council of Japan, either on the occasion of the “Survey on Academic Research Organizations”, conducted every five years, or at the beginning of each quarter [3]. The Science Council’s general selection criteria are as follows: organizations that have as their primary objective the advancement and development of academic research, that are composed of at least a given number of individual members, that have their own rules, that hold meetings at least once a year, and that have continued to publish periodicals for a certain period. Those bodies with membership limited by locality or alma mater are not included in the survey. In addition to the learned societies covered in this section, there are many others such as those connected with colleges and universities (learned societies composed of persons affiliated with specific colleges and universities) and those established only recently.

### 3.2.3 Books, magazines, and libraries

This section will discuss the publication of books and magazines, especially those concerning science and technology, as well as the number and size of libraries as social foundations for science and technology. The number of materials related to science and technology within these publications and library collections reflects one aspect of the relationship between science and technology and society. Although indirect in nature, this information will be taken as an indicator of the base of social support for science and technology.

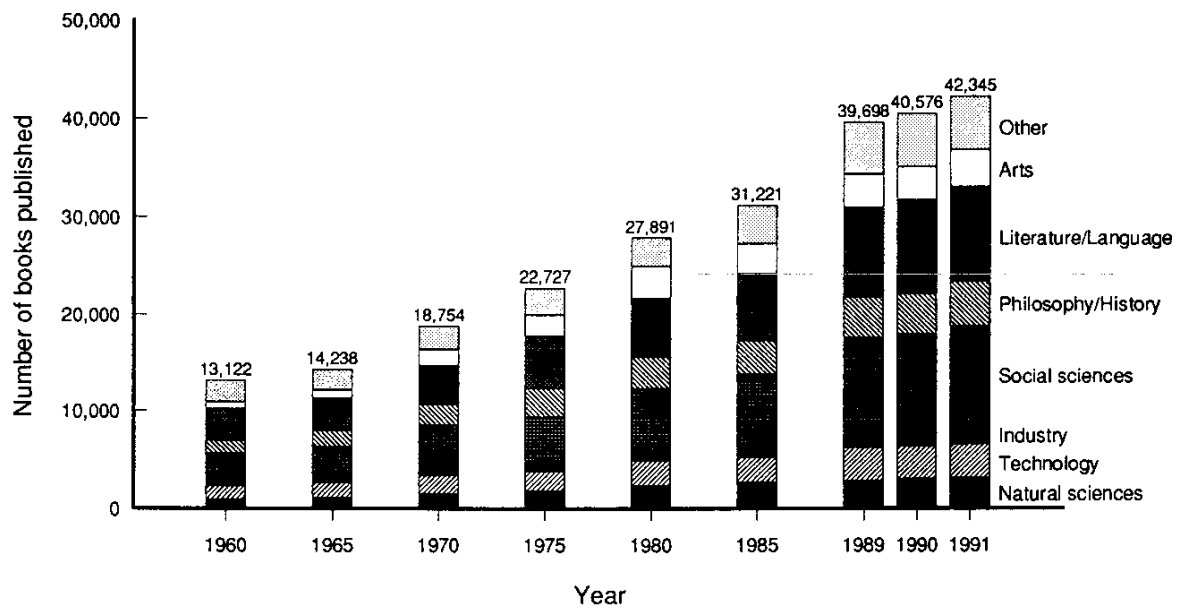
Figure 3-2-6 shows the number of new books published by field <sup>(1)</sup>. The number of new books published has increased each year, reaching 42,345 in 1991. 7% (3,036) of these were in “natural sciences” and 9% (3,601) in “technology”. In other areas related to science and technology, 4% were in “industry”, and 24% in “social science”. “Natural sciences” accounted for 7% of the total in 1960, and, though its share grew somewhat by 1980 to 8%, it has been dropping off since 1985. “Technology” laid claim to over 10% of new books until 1970, but this level fell in the following decade, and has stagnated since the mid-1980s. The share of “social sciences”, on the other hand, has grown.

The number of new books as discussed here refers to the number of individual works published, and no distinction is drawn between the actual numbers of books of each work printed. The lack of reliable statistics on the actual number of books printed makes it necessary to define the number of new books in this way.

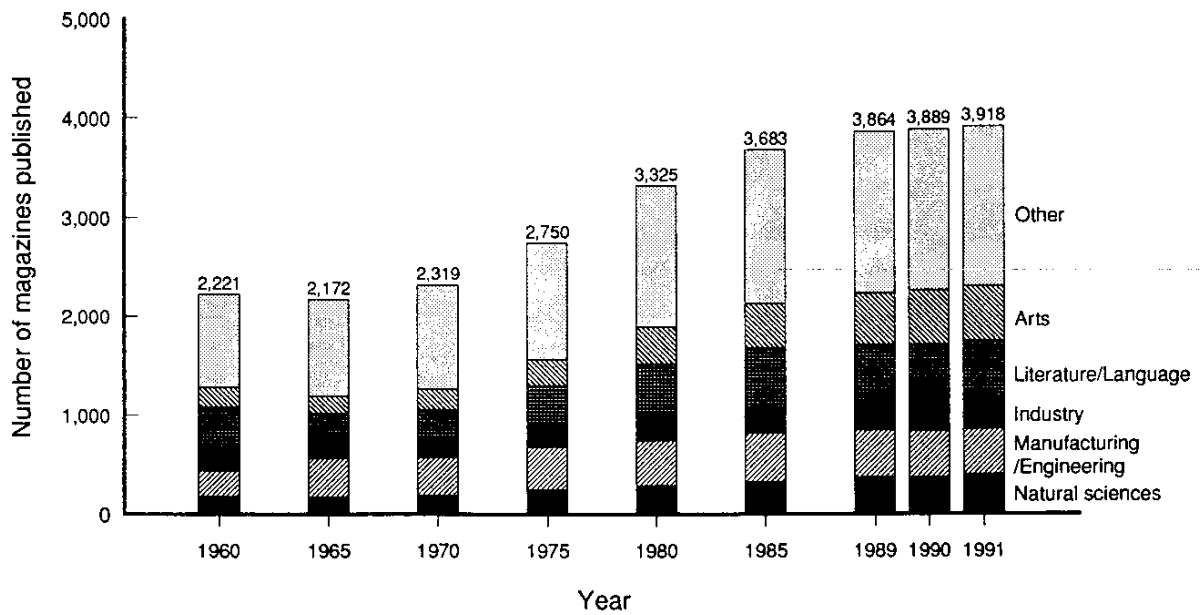
The number of magazines published <sup>(2)</sup> was 3,918 in 1991 (Figure 3-2-7). 10% (393) of these were in “natural sciences”, 12% (463) in “manufacturing/engineering”, and 8% (320) in “industry”. The share of “natural sciences” has been on the rise since the mid-1980s, while that of “manufacturing/engineering” has been declining from the 16–17% range it enjoyed from the late 1960s to the late 1970s.

Libraries (public libraries) <sup>(3)</sup> in 1990 housed a total of 161.69 million volumes (Figure 3-2-8). With 1,950 public libraries operating that year, the average number of books in these libraries’ collections was 83,000. 5% of these collections were materials related to “natural sciences” and 6% to “manufacturing/engineering”. “Industry” has a 3% share and “social sciences” an 11% one. There were no major changes in the shares of these fields during the period shown in the figure.

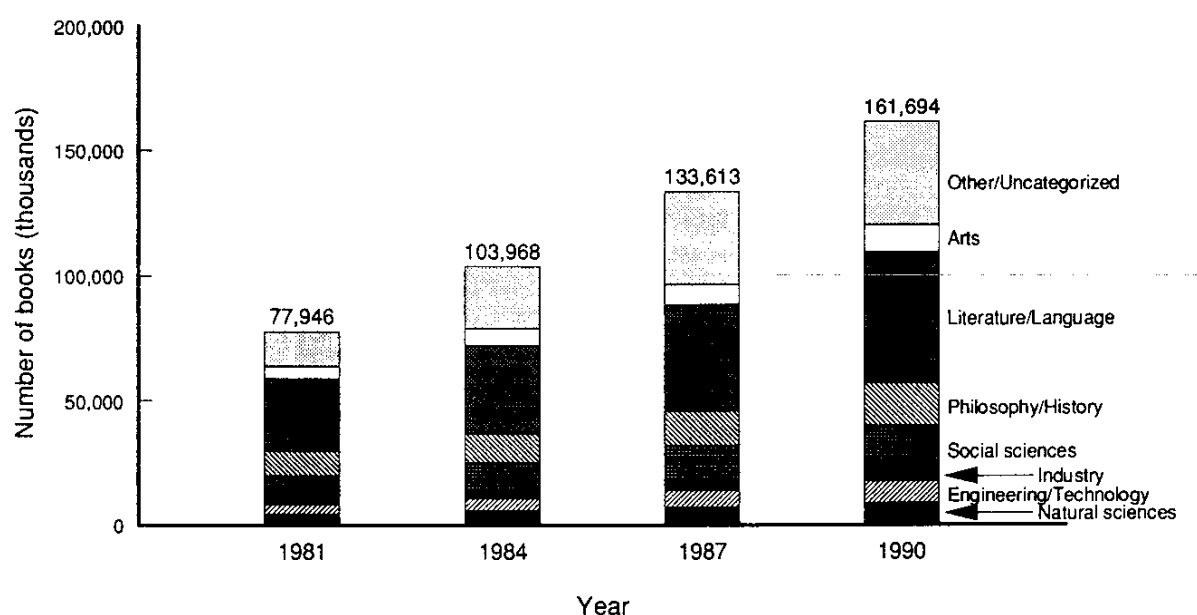
**Figure 3-2-6 Number of Books Published (By field)**



**Figure 3-2-7 Number of Magazines Published (By field)**



**Figure 3-2-8 Number of Books in Public Library Collections**



Source: Management & Coordination Agency, *Report on the Survey on Society and Education*  
See Table 3-2-8

#### [Notes]

- (1) The number of new books published according to the “*Publication Annual*”<sup>[4]</sup> released each year by the Shuppan News Company. To this total are added the results of a survey of major distributors focusing on trade books, specimen copies of which have been presented to the National Diet Library.
- (2) Same as Note (1). To this are added the numbers of academic and government publications, especially trade editions.
- (3) The number of books in public library collections according to the “*Survey on Society and Education*”<sup>[5]</sup> by the Ministry of Education.

### 3.2.4 Museums

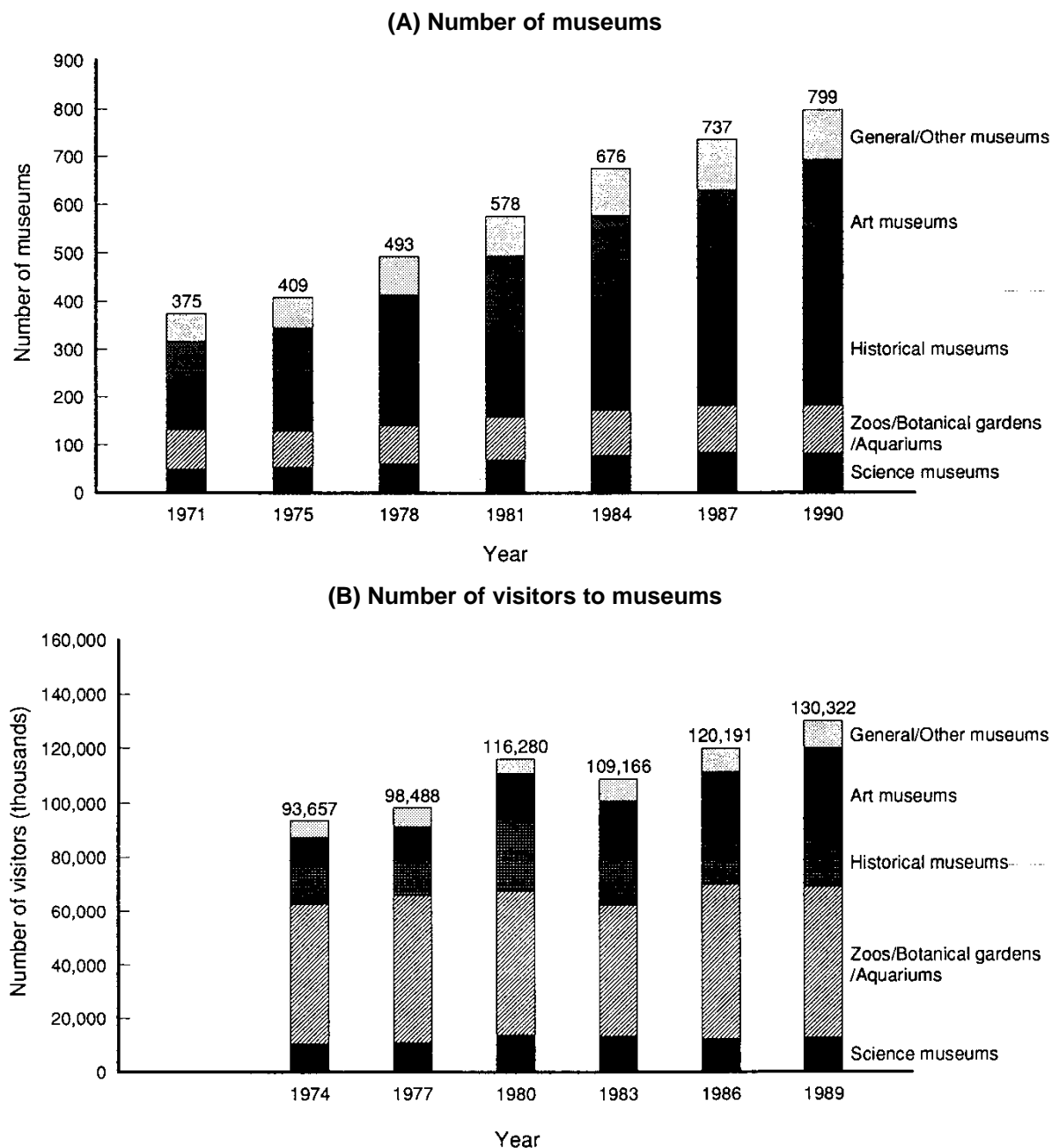
Science museums contribute to the broadening of scientific and technological knowledge within the general populace. The citizenry in societies that establish such facilities is usually highly receptive to scientific and technological knowledge and, in that sense, the establishment of these facilities improves the support base for science and technology. In attempting to develop an indicator to show this, the numbers of zoos, botanical gardens, aquariums, and other types of museums as well as the number of science museums have been included.

Figure 3-2-9 shows the number of museums by type and the number of visitors. In 1990 the total number of all types of museums was 799. Science museums (81) accounted for 10% of the total, and zoos, botanical gardens, and aquariums together (101) accounted for 13%. Although the numbers of science museums and zoos/botanical gardens/aquariums have grown very gradually, these increases are smaller than those for other types of museums, and their share of the total is decreasing. Art museums and historical museums, in contrast, account for larger and larger shares.



The total number of visitors (annually) to these facilities rose overall during the period shown in the figure. Zoos had the largest number of visitors; the number of visitors to science museums was greatest in 1980, and has declined slightly since then.

**Figure 3-2-9 Number of Museums / Number of Visitors to Museums**



Source: Management & Coordination Agency, *Report on the Survey on Society and Education*  
See Table 3-2-9

### 3.2.5 Corporate executives with academic backgrounds in science and engineering

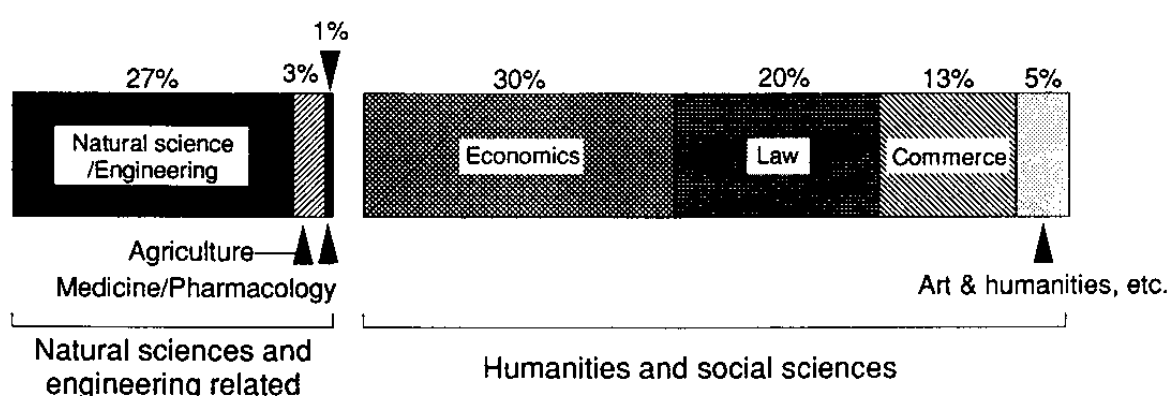
The number and ratio of corporate executives with academic backgrounds in science and engineering can be used as indicators to show the degree of social support for science and technology in companies. Persons defined as having academic backgrounds in science and engineering are those persons who have received higher education in natural sciences and engineering related; corporate executives are those persons involved in setting operational policy for companies. This indicator, therefore, shows the degree of emphasis placed on science and technology activities at the corporate management level, albeit in an indirect sense.

This indicator was calculated using data on the college/university majors of executives of listed companies from the “*Executive Quarterly Database*” published by the Toyo Keizai Inc.

As a basis for understanding the ratio of executives with academic backgrounds in science and engineering, Figure 3-2-10 shows the number of executives by university major. Executives whose college/university major is unknown or unclassifiable from the database have been excluded, and in light of the difficulty of distinguishing between the department of natural science and the department of engineering, the total numbers of graduates of the department of natural science and the department of science and engineering have been used. The most common major is economics, followed by law. There would appear to be the same number of engineering graduates as economic graduates, but, as mentioned earlier, there is no figure available for the department of engineering alone. On the basis of such data on the academic backgrounds by department of corporate executives, then, executives can be broadly divided by major into natural science and engineering related and arts; the ratio of graduates of natural science and engineering related departments to the total of all majors, hereafter referred to as the “ratio for Science and engineering”, has been calculated for a number of cases.

Figure 3-2-11 shows the ratio for science and engineering for corporate executives in a variety of cases. The ratio for science and engineering for all corporate executives of listed companies is 31%. In this figure, companies have been classified as either manufacturing and non-manufacturing, and these have been further divided into companies that more and those that have less than 10 billion yen in capital; the ratio for science and engineering for each of these groups is shown.

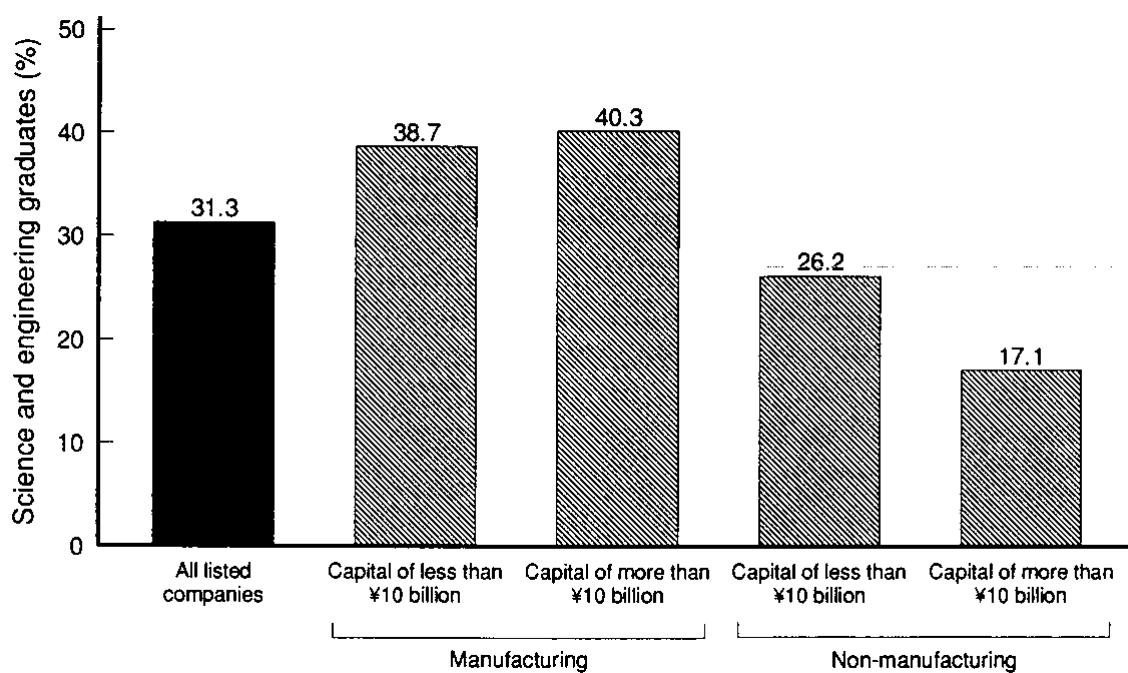
**Figure 3-2-10 Academic Backgrounds of Executives of Listed Companies (1993)**



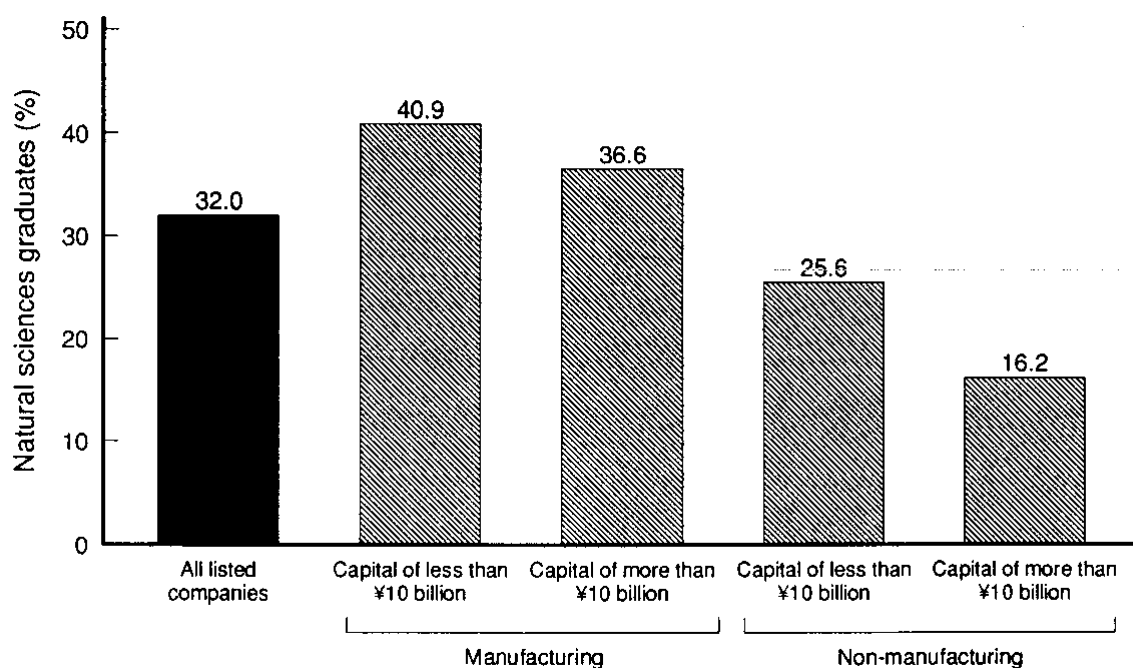
Source: Toyo Keizai Inc., *Executive Quarterly Database*  
See Table 3-2-10

**Figure 3-2-11 Share of Executives and Presidents of Listed Companies with Academic Backgrounds in science and engineering**

**(A) All executives**



**(B) Presidents**



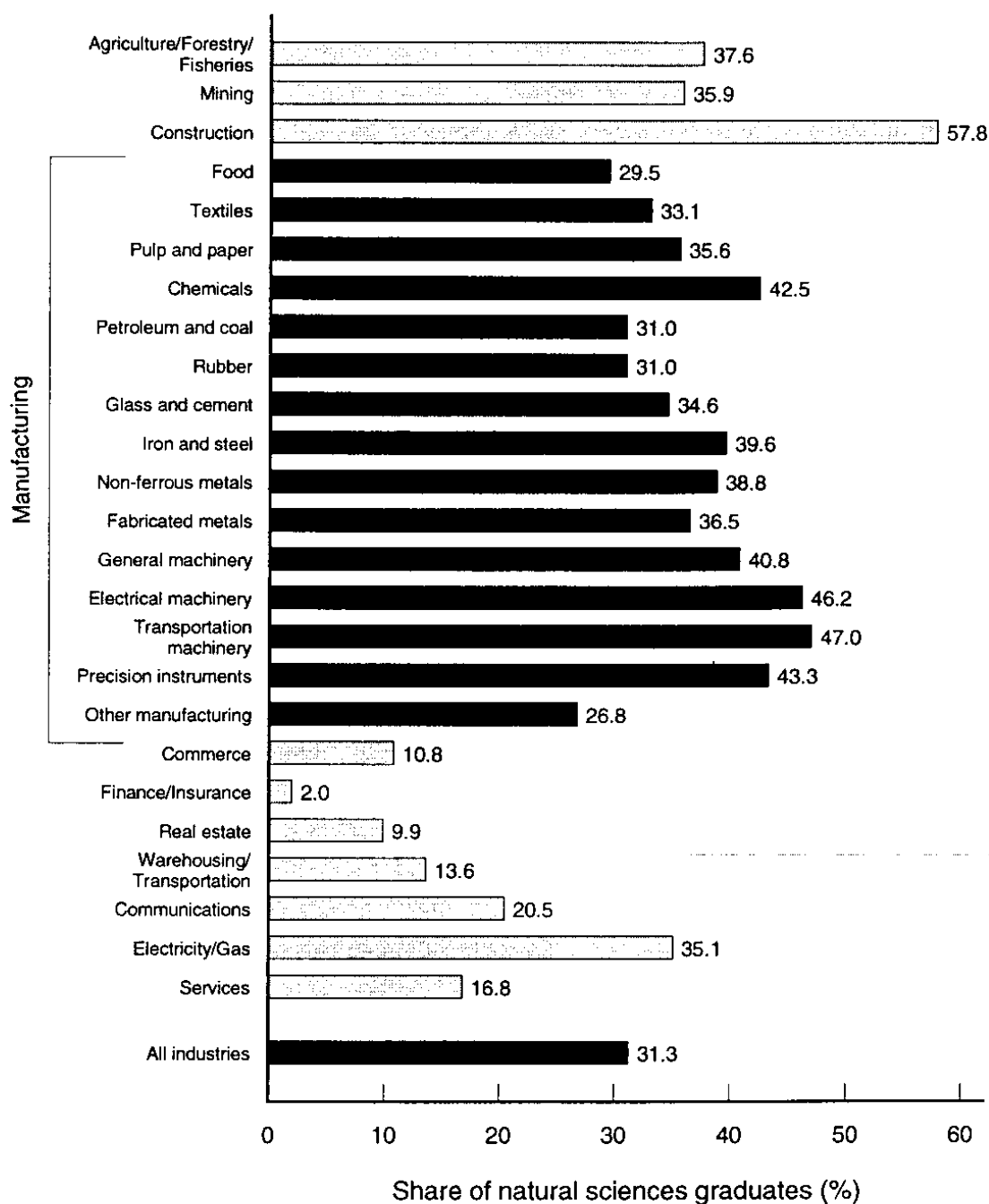
Source: Toyo Keizai Inc., *Executive Quarterly Database*  
See Table 3-2-10

In addition to a ratio for science and engineering for executives, a ratio for science and engineering for company presidents has also been given. From a comparison of these results, the following can be seen:

- (1) The ratio for science and engineering for executives and company presidents is higher in manufacturing than in non-manufacturing industries.
- (2) The ratio for science and engineering for executives in the manufacturing industry is higher in companies with more than 10 billion yen in capitalization than for those with less. For company presidents, conversely, the ratio for science and engineering is higher for companies with less than 10 billion yen in capitalization.
- (3) In non-manufacturing industries, the ratio for science and engineering is higher for companies with less than 10 billion yen for both corporate executives and company presidents.

The ratio for science and engineering for executives is highest in the construction industry, followed by the transportation equipment manufacturing industry, the electrical machinery manufacturing industry, the precision instruments manufacturing industry, the chemical products manufacturing industry, the general machinery manufacturing industry, and the mining industry (Figure 3-2-12). It is worthwhile noting that the ratio for science and engineering for the key manufacturing industries in Japan—the electrical machinery manufacturing, transportation equipment manufacturing, and chemical products manufacturing industries—are relatively high. There is increasing utilization of science and technology human resources by companies in these industries, indicating an emphasis placed on science and technology at the management level.

**Figure 3-2-12 Executives with Academic Backgrounds in Science and Engineering by Industry (1993)**



Source: Toyo Keizai Inc., *Executive Quarterly Database*

See Table 3-2-11

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# Chapter 4

## R&D Activities in Industry, Academia, and Government

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## **Chapter 4**

### **R&D Activities in Industry, Academia, and Government**

This chapter discusses indicators related to R&D expenditures and R&D scientists and engineers, both of which are essential elements of the R&D infrastructure. Needless to say, these are the principal indicators directly reflecting R&D activities. This chapter consists of four sections. Section 4.1 (“Overview of R&D Activities”) examines in chronological fashion the state of R&D in Japan and attempts to characterize Japan’s R&D through international comparison. Sections 4.2 through 4.4 analyze R&D activities by industry, academia, and government in terms of R&D expenditures and the number of R&D scientists and engineers.

#### **4.1 Overview of R&D Activities**

This section illustrates the present state of and general trends in R&D activities in Japan in terms of R&D expenditures and the number of R&D scientists and engineers. In doing so, time series analyses and international comparisons will be used to point out specific characteristics of Japan’s R&D activities. In making international comparisons of these indicators, however, there are problems that must be taken into consideration, and these will be addressed first.

#### **Problems in International Comparisons of R&D Activities**

##### **(1) Currency conversion rate problems**

One problem encountered when making international comparisons is that of determining appropriate methods for currency conversion for statistical data and indicators showing currency values/amounts for R&D and other expenditures. As countries usually report R&D expenditures in their own currencies, a set currency conversion standard, such as conversion to U.S. dollars, is needed for international comparisons. This gives rise to the question of what exchange rate to use. The Organization for Economic Cooperation and Development (OECD) uses purchasing power parity (PPP) for comparisons and it has urged individual countries to adopt this system. Purchasing power parities are calculated in terms of the amounts of different currencies necessary to purchase the same basket of goods, giving one a method of measuring the value of a currency by the goods that can be purchased.

The OECD and the developed countries use GDP purchasing power parities for calculating R&D expenditures. Because GDP purchasing power parities is calculated for the purpose of comparing GDPs, however, it is calculated on a basis different from purchasing power for goods and services used in R&D. For that reason, the National Institute of Science and Technology Policy has developed ‘R&D purchasing power parities’, purchasing power parities suited to the particular nature of R&D expenditures<sup>[2]</sup>. Calculating with R&D purchasing power parities allows one to make comparisons of R&D expenditures while taking into account the actual goods and services used in R&D. This section attempts an international comparison of R&D expenditures using R&D purchasing power parities. R&D purchasing power parities are not employed throughout this report, though, and their use has been restricted to comparisons of total R&D expenditures in selected countries; for international comparisons of other indicators, the commonly used GDP purchasing power parities developed by the OECD have been used to conform with standard international practice and to preserve a sense of continuity. Nevertheless, R&D purchasing power parity is an

indicator spanning international boundaries and it is hoped that international organizations such as the OECD will generate such indicators. This research institute for its part has urged the OECD to consider R&D purchasing power parities.

## (2) FTE conversion problems

International comparisons of R&D activities require values measured under identical conditions. However, Japan and Western countries do not measure the number of R&D scientists and engineers by the same means. While Japan measures the total number of scientists and engineers engaged in R&D, Western countries prefer not to use Japan's simple head-counting method but rather calculate their figures based on the time these scientists and engineers are actually engaged in R&D activities. The calculation method used by Western countries is known as the Full-Time Equivalent (hereafter, "FTE") method.

The idea behind FTE conversion is to distinguish between R&D and other activities and to measure the number of R&D scientists and engineers based on the time they are actually engaged in R&D activities. For example, it is normal practice for a university researcher to be engaged in teaching as well as in R&D activities. If this researcher spends 60% of his working time involved in R&D, then by FTE conversion he/she would be counted as 0.6 researchers. FTE conversion covers not only R&D scientists and engineers but R&D expenditures as well, as personnel costs for R&D scientists and engineers are included among R&D expenditures, and in FTE conversion, personnel costs for work other than R&D would be excluded.

Most Western countries have adopted FTE conversion in accordance with the recommendations set forth by the OECD in 1975. Japan stands alone as the only member of OECD not using FTE conversion and, in fact, the numbers of R&D scientists and engineers listed in studies by the Management & Coordination Agency, Japan's principal keeper of R&D statistics, are in fact not FTE-converted.

This being the case, a 1991 report on science and technology indicators <sup>[1]</sup> suggested that survey organizations in Japan conduct surveys using FTE conversion in addition to those done under the existing system, and, conversely, recommended to the OECD that, in addition to surveys using FTE conversion, it adopt a method of reporting the actual number of R&D scientists and engineers such as that presently used in Japan. The actual number of R&D scientists and engineers is needed for making comparisons with population statistics and other data and is useful for assessing R&D potential. In this same report, test calculations using a method similar to FTE conversion were made for existing statistical data for Japan. The results revealed the possibility that the number of R&D scientists and engineers and R&D expenditures in Japan is overestimated in comparison with Western countries.

Test calculations using FTE conversion have not been carried out in this report because accurate information is still lacking. For example, despite the fact that FTE conversion has not been formally adopted for statistical data in Japan, it has been pointed out that some reports contain figures similar to those derived from partial use of FTE conversion because of differences in response methods to statistical surveys <sup>[14]</sup>. In any case, many aspects remain unclear, and further study is needed. At present, there are studies underway by statistical survey organizations and researchers on science and technology indicators on the issue of FTE conversion.

#### 4.1.1 R&D expenditures

##### (1) Total R&D expenditures and R&D purchasing power parity

Figure 4-1-1(A) shows the yen conversions of total R&D expenses <sup>(1)</sup> in selected developed countries; R&D purchasing power parities were used in these conversions. During the time period shown in the figure, the U.S. held a dominant position, followed by Japan and Germany, with France and the U.K. at about the same level.

R&D expenditures in Japan for 1993 <sup>(2)</sup> totaled 13.7091 trillion yen, a 1.4% decline from the previous year. This was in great part due to the continued decline in R&D expenditures by private corporations (–5.3% from the previous year). Looking at the trends heretofore, R&D expenditures have grown by a factor of 8 over the past 20 years, with a long-term growth rate higher than that of other countries and an especially marked climb in the late 1980s.

R&D expenditures in selected major industrial countries have, for the sake of comparison, also been converted using GDP purchasing power parities in addition to R&D purchasing power parities (Figure 4-1-1(B)). Although there is little change in the rankings among countries when using either R&D or GDP purchasing power parities, there is some degree of difference in the amounts.

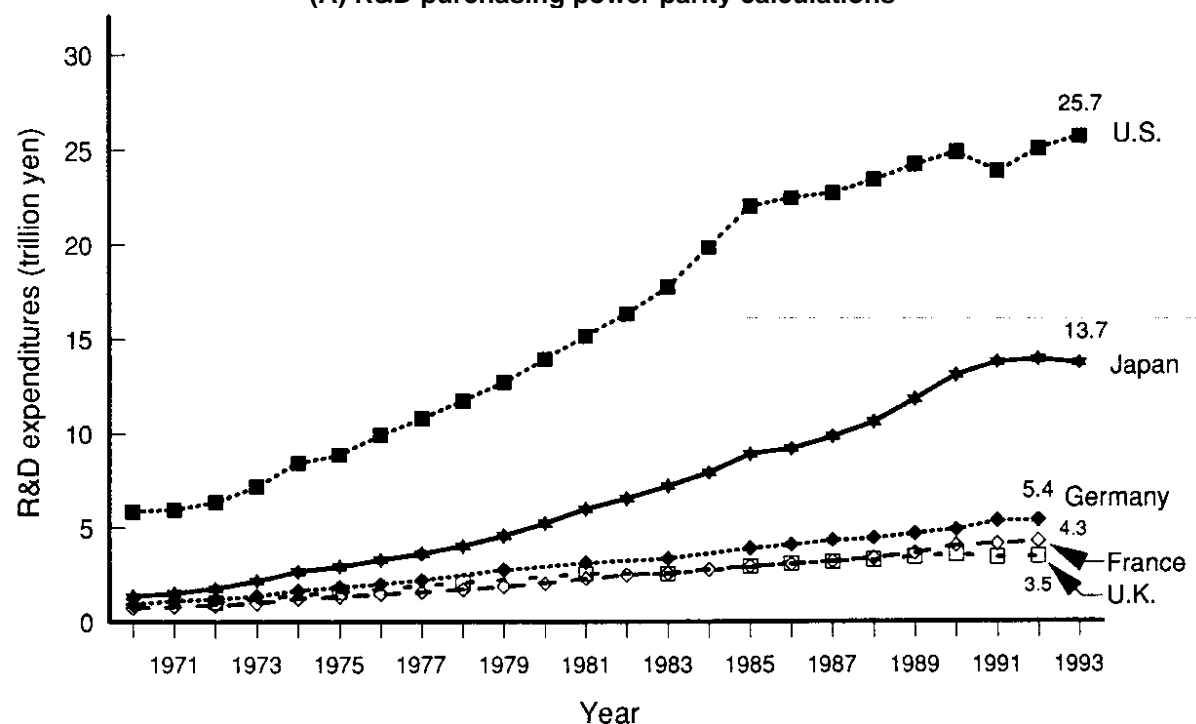
Converting the R&D expenditures of the U.S., Germany, France, and the U.K. by use of both R&D purchasing power parities and GDP purchasing power parities and comparing these results, one sees that the R&D PPP-converted figures were smaller for all four countries. For instance, the R&D PPP-converted value in 1992 in the U.S. was about 17% smaller than the GDP PPP-converted value. Japan ranked relatively higher among the major industrial nations in R&D expenditures when real investment amounts (corresponding to the use of R&D purchasing power parities) were measured than when GDP purchasing power parities were used.

#### [Notes]

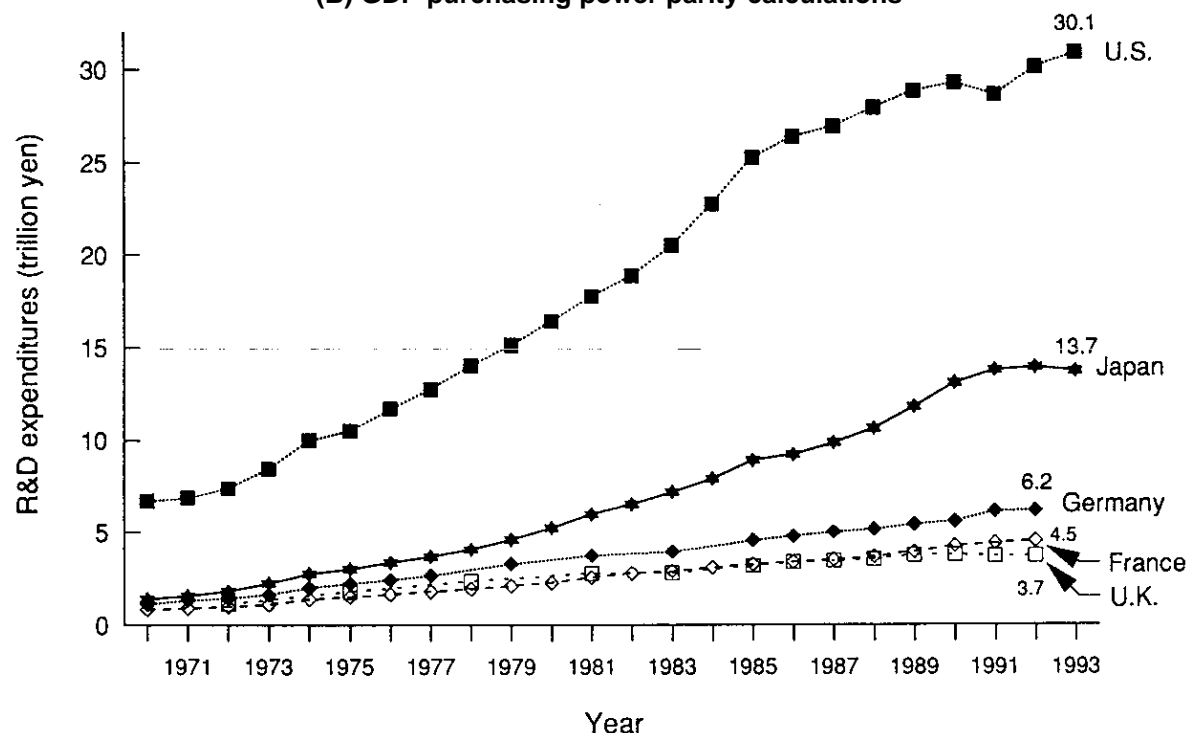
- (1) R&D expenditures shown in this section are the total nominal value of R&D expenditures in the natural sciences as well as in the humanities/social sciences. “Research expenditures” listed in the survey by the Management & Coordination Agency [5] of Japan are here given as “R&D expenditures”. For further details, see Note (1) in Section 4.1.3 (“R&D expenditures by characteristic of work”).
- (2) Survey periods differ by country; Japan reports R&D expenditure statistics on a fiscal year basis, while the U.S. uses the calendar year. Such differences have not been taken into account here because there is no accurate means of reconciling them and because they do not appear to present any major problems in studying trends.

Figure 4-1-1 R&D Expenditures in Selected Countries

(A) R&D purchasing power parity calculations



(B) GDP purchasing power parity calculations



Sources: Japan — Management & Coordination Agency, *Report on the Survey on Science and Technology Research*

U.S. — National Science Foundation, *National Patterns of R&D Resources: 1992*

Germany — Bundesministerium für Forschung und Technologie, *Bundesbericht Forschung: 1993*

France and the U.K. — Science and Technology Agency, *White Paper on Science and Technology*

See Table 4-1-1

R&D purchasing power parity in and of itself is a meaningful indicator for international comparisons of R&D. Figure 4-1-2 shows the R&D purchasing power parities, exchange rates, and GDP purchasing power parities for Japan, Germany, France, and the U.K. <sup>(1)</sup> The figure illustrates the exchange rates of the various national currencies against the U.S. dollar, with purchasing power increasing the lower the value on the vertical axis.

Though the exchange rates in each of these countries experiences major fluctuations, variations in R&D and GDP purchasing power parities have been more smooth. The long-term changes in the two purchasing power parities have in general matched the long-term changes in exchange rates.

Comparing R&D purchasing power parities with GDP purchasing power parities, one sees that the R&D purchasing power parities for the currencies of Japan, France, and the U.K. have been stronger than their purchasing power against the dollar for the entire period shown in the figure; the two are nearly even for Germany. Given the trend towards a weaker dollar and stronger currencies in these other countries from 1985 or 1986, the purchasing power of exchange rates in all of these countries grew higher than that of R&D purchasing power parity.

Examining the changes over time in the R&D purchasing power parities of the various national currencies, the purchasing power of the Japanese yen against the dollar grew from the latter half of the 1970s—in other words, the yen grew stronger—and the purchasing power of the German mark, too, rose. The purchasing power of the French franc continued to fall against the dollar until 1985, but has since rebounded somewhat. The purchasing power of the British pound has consistently grown weaker against the dollar.

#### [Notes]

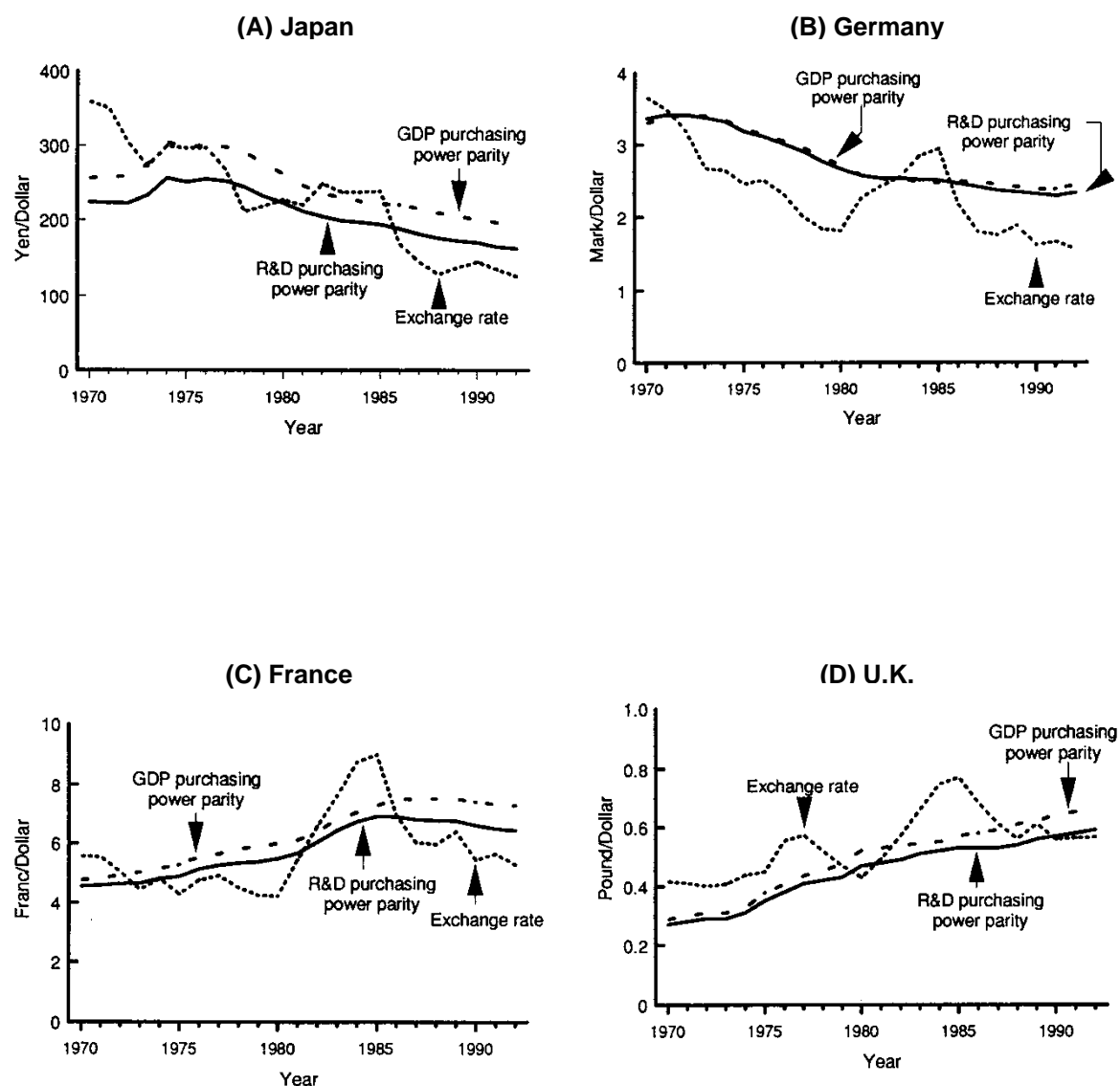
- (1) R&D purchasing power parities have been calculated using purchasing power parity data from OECD and ESCAP [2]. The OECD purchasing power parity values for items used in R&D have been weight-averaged using the share of each expenditure classification in national R&D expenditures.

The following approaches have been taken to matching the expenditure classifications for R&D expenditures with OECD purchasing power parity values:

- 1) Personnel expenditures correspond to the purchasing power parity for public service and education.
- 2) The purchase of tangible fixed assets corresponds to the purchasing power parity for equipment and facilities (machines, instruments, etc.). Land and building expenditures correspond to the purchasing power parity for fixed capital formation non-housing construction. The purchase of other fixed tangible assets corresponds to the purchasing power parity for fixed capital formation .
- 3) Miscellaneous expenditures correspond to the purchasing power parity for electrical power, communications, and printing and publishing.
- 4) Raw materials expenditures correspond to exchange rates and the purchasing power parity for machinery maintenance and repair.

1985 has been set as the index year; figures for other years have been estimated from the GDP deflator ratios of the individual countries.

**Figure 4-1-2 R&D Purchasing Power Parity, GDP Purchasing Power Parity, and Exchange Rates in Selected Countries**

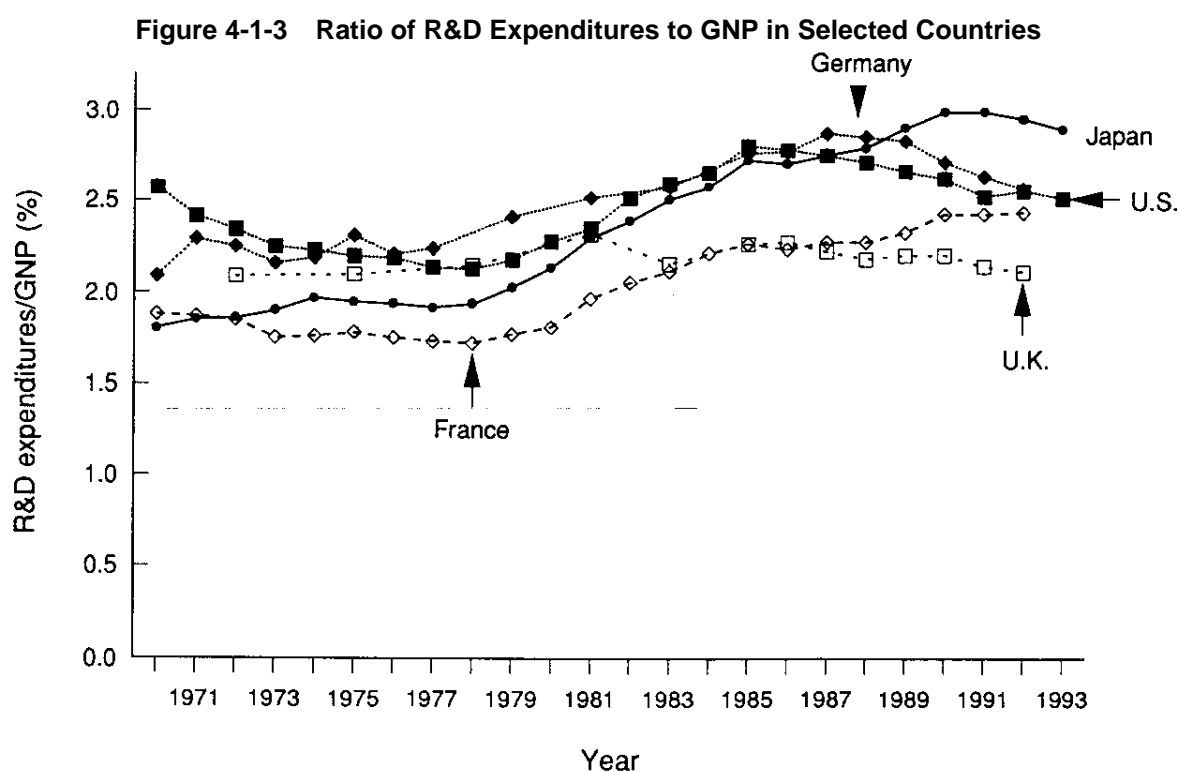


Source: Science and Technology Agency, National Institute of Science and Technology Policy, *Developing R&D Purchasing Power Parities* (NISTEP Report No. 31), 1994  
See Table 9-1-2

## (2) Ratio of R&D expenditures to GNP

The ratio of R&D expenditures to gross national product (GNP) (hereafter, “R&D expenditures/GNP ratio”) is often used in international comparisons of R&D expenditures. As this shows the size of R&D expenditures in relation to the economic scale of each country, use of this ratio allows an understanding of the degree of dedication to science and technology activities.

Figure 4-1-3 shows the changes over time in the R&D expenditures/GNP ratio and indicates that recently R&D expenditures have exceeded 2% of GNP in each country. The ratio in Japan has continued to grow almost steadily since the latter half of the 1970s and has been the highest in the world since 1989. After reaching 3.00% in 1990 and 1991, however, this ratio dropped to 2.96% in 1992 and to 2.90% in 1993. The ratio in the U.S. rose from the late 1970s but began dropping from 1985, falling by 1993 to 2.52%. Germany’s ratio was the highest in the world in 1987, but declined to 2.57% by 1992. The ratios in France and the U.K. were rather low in comparison with those of the top three countries. France’s ratio, however, has been rising since the late 1970s. The ratio for the U.K. peaked in 1981 at 2.32% and has since 1982 remained constant or fallen slightly.



Sources: R&D expenditures — same as Figure 4-1-1; GNP — OECD, *National Accounts*

See Table 4-1-3

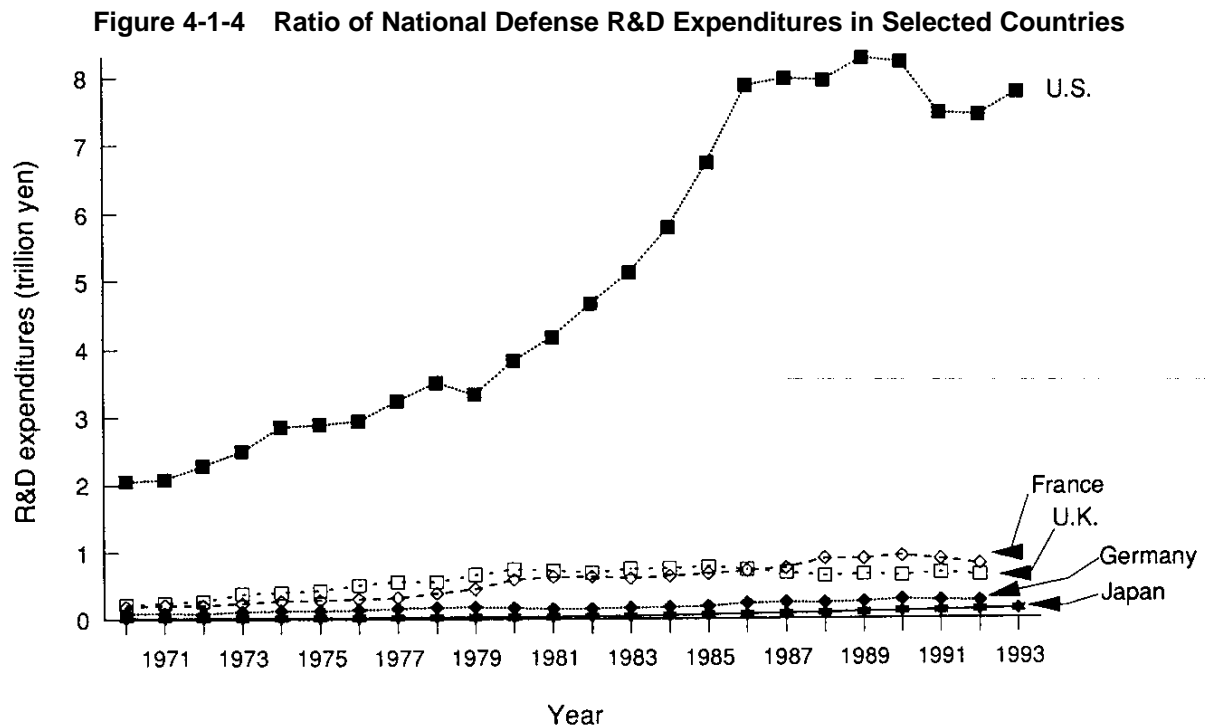
## (3) National defense and civilian R&D expenditures

The R&D expenditures of countries can be divided broadly into defense-related and civilian, and though differing systems in these countries make it difficult to compare these expenditures, this division is one means of illustrating R&D efforts in individual countries.

As can be seen in Figure 4-1-4, defense-related R&D expenditures in the U.S. are overwhelmingly large. Defense-related R&D expenditures in the U.S. account for 25% (1993) of the country’s en-

tire R&D expenditures, and this large proportion of defense-related R&D expenditures sets it apart from other countries. The ratio of Japan's defense-related R&D expenditures, on the other hand, was the smallest of all the countries shown in the figure, much lower than those of Germany, the U.K., and France.

The marked growth of defense-related R&D expenditures in the U.S. between 1979 and 1986 is distinctive. Growth leveled off after 1986, and expansion has been slight even in terms of dollars. Defense-related R&D expenditures even fell in 1992 due to the international situation and changes in U.S. policy.



Note: Defense-related R&D expenditures in Japan are those parts of the governmental science and technology budget allocated for the Defense Agency. Defense-related R&D expenditures for other countries are calculated in Japanese yen using GDP purchasing power parities.

Sources: For countries other than Japan, same as Figure 4-1-1.

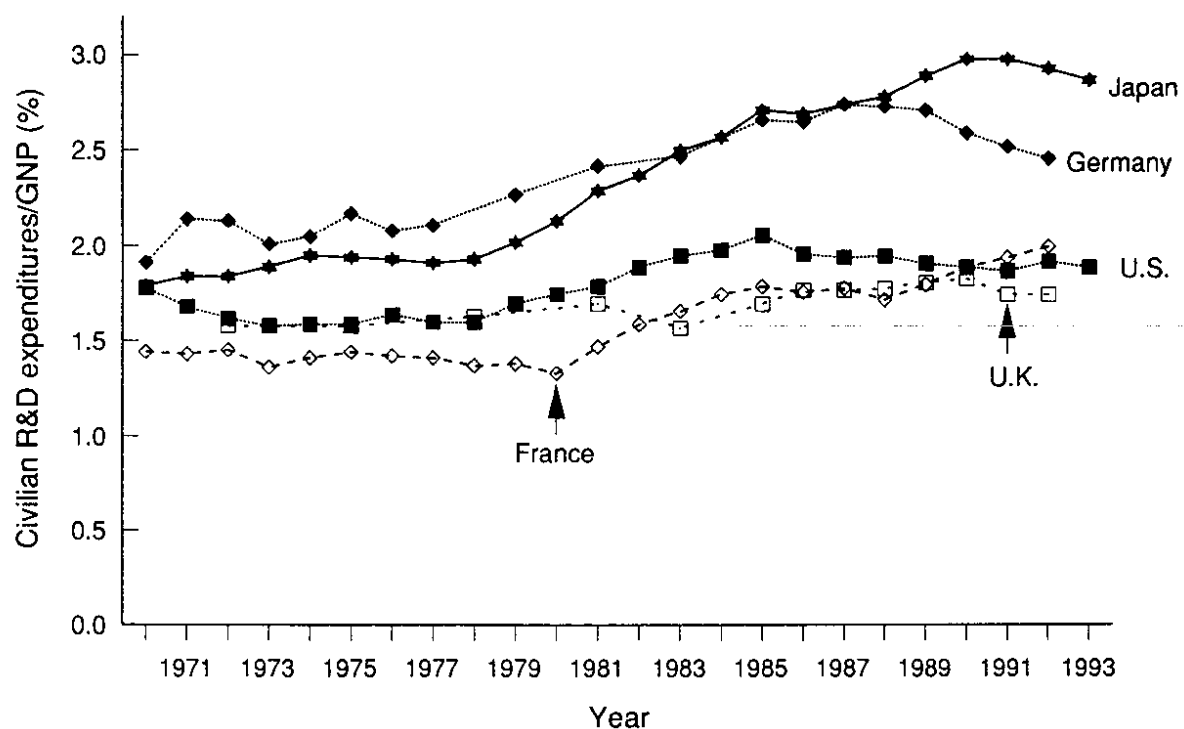
Japan's defense-related R&D expenditures are from the Science and Technology Agency.

See Table 4-1-4

Japan and Germany had the highest ratios of civilian R&D expenditures to GNP among the countries examined here (Figure 4-1-5). In both countries, the ratio of civilian R&D expenditures to GNP was not much different from the total R&D expenditures/GNP ratio (see above, Figure 4-1-3) because defense-related R&D expenditures were so low. The ratio in Japan was 2.87% in 1993, nearly the same as the total R&D expenditures/GNP ratio (2.90%) for that same year; the figure for Germany in 1992 was 2.46%. The U.S. ratio was low in comparison to overall R&D expenditure, only 1.89% in 1993. France's ratio was 2.00% in 1992, and that of the U.K. 1.75% in 1992.



**Figure 4-1-5 Ratio of Civilian R&D Expenditures to GNP in Selected Countries**



Note: same as Figure 4-1-4

Sources: same as Figure 4-1-4

See Table 4-1-5

#### 4.1.2 R&D expenditures in industry, academia, and government

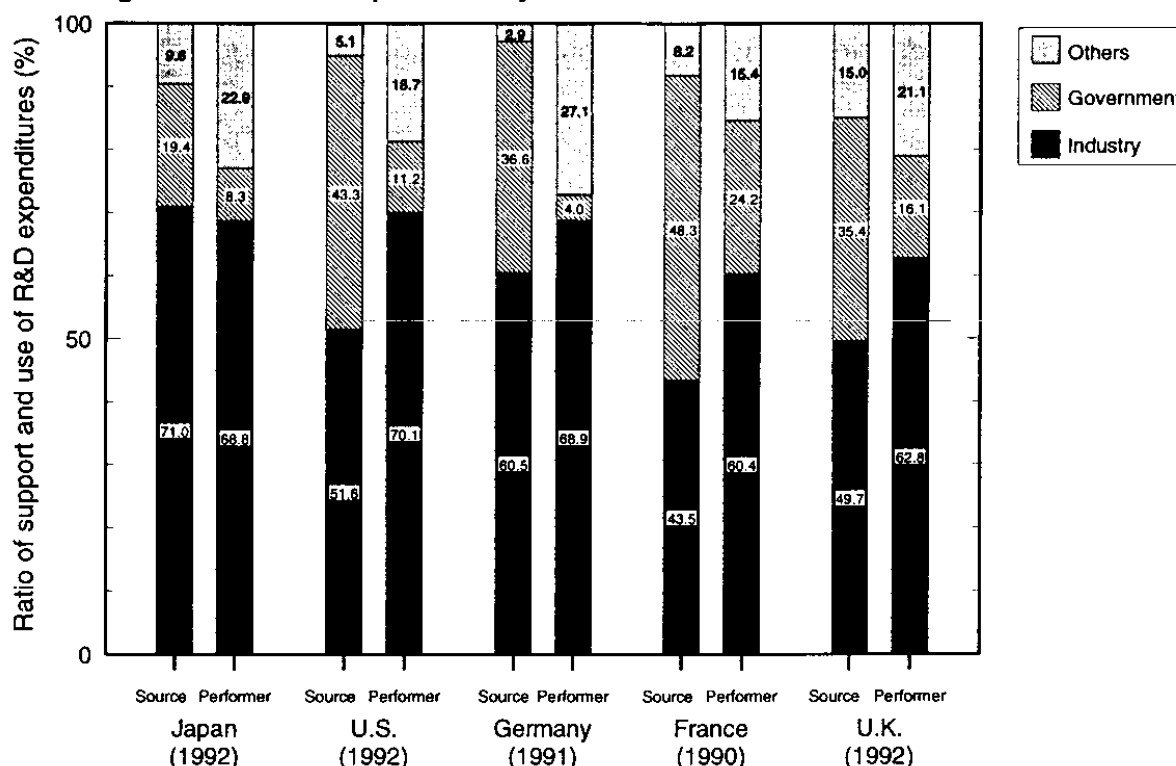
##### (1) R&D expenditures by source and performer

In analyzing R&D expenditures by sector (industry, academia, and government), it is necessary to study R&D expenditures in terms of source and performer. Figure 4-1-6 shows the sectorial share of R&D expenditures by source and performer in selected countries.

The shares of R&D expenditures borne by industry in Japan (around 70%) and Germany (around 60%) are considerably greater than those of other Western countries (40–50%). The government's burden is highest in France (just under 50%), followed by the U.S., Germany, and the U.K.; Japan's government (20%) has the lowest share, and this low rate is characteristic of Japan.

Industry is the largest performer of R&D in all major developed nations. French industry utilizes a relatively low share of R&D expenditures. The French government, on the other hand, is the largest performer of R&D among the governments examined here, followed by the governments of the U.K., the U.S., and Japan; the German government's share of R&D performance is the smallest.

Figure 4-1-6 R&D Expenditure by Source and Performer in Selected Countries



Notes: "Other" sources include universities, private R&D institutes, and foreign countries.

"Other" performers include universities and private R&D institutes.

Sources: same as Figure 4-1-1

See Table 4-1-6

## (2) R&D expenditures in Japan and the U.S. by performing sector

Figure 4-1-7 compares R&D expenditures by performing sector between Japan and the U.S. The sector categories are industry, academia, and government and private R&D institutes<sup>(1)</sup>. The "others" category in the previous figure is divided in this figure into universities and private R&D institutes.

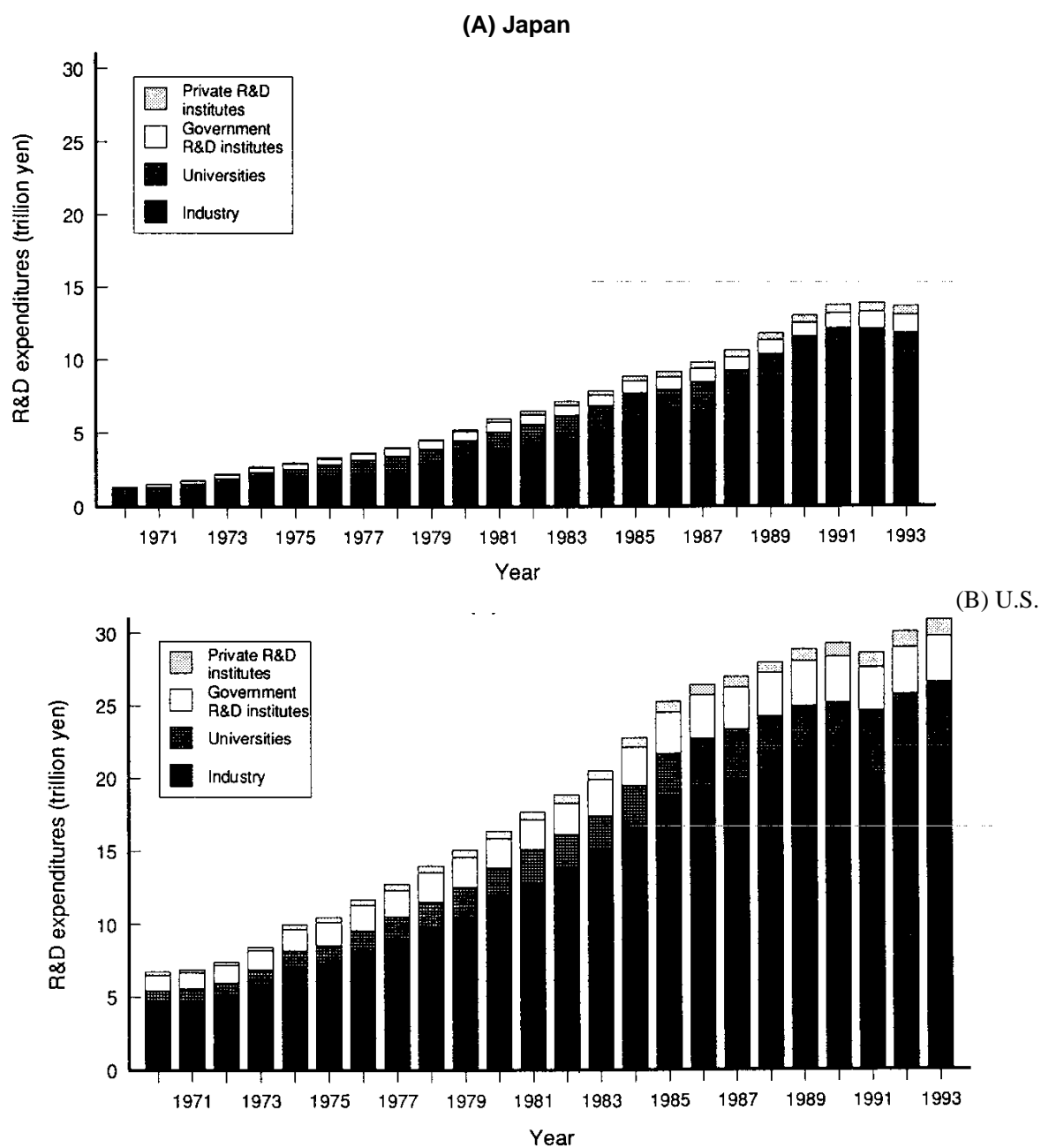
This figure shows that industry in both Japan and the U.S. is spending heavily on R&D and also shows that overall trends (increases and decreases) in R&D expenditures are greatly influenced by industry trends.

In Japan, the proportion of R&D expenditures used by industry has grown over 20 years from just under 60% in 1972 to just under 70% in 1992; the share of industry in 1992, however, was down from the previous year. Meanwhile, the share for universities has consistently declined, as has that for government research institutes. Offsetting this decrease has the rise in the proportion used by private research institutes. There has, thus, been a marked increase in the proportion of R&D expenditures utilized by the private sector, i.e., industry and private research institutes.

### [Note]

(1) Japanese government R&D institutes refer to national and public R&D organizations and special-status corporations whose main operation is R&D. U.S. government R&D institutes include those of the federal and state governments. U.S. federally funded or operated R&D institutes have been classified by the organizations to which they belong.

**Figure 4-1-7 R&D Expenditure by performing Sector in Japan and the U.S.**



Note: R&D expenditures for the U.S. have been converted to yen figures using GDP purchasing power parity.

Sources: Science and Technology Agency, *Report on the Survey of Research and Development*  
National Science Foundation, *National Patterns of R&D Resources: 1992*

See Table 4-1-7

The proportion of R&D expenditures utilized by U.S. industry has been slightly larger than that by Japanese industry, exceeding 70% in 1992. Over time it has more or less remained on the same level or has decreased slightly. The proportion of R&D expenditures utilized by American universities is about half that of their counterparts in Japan, but unlike in Japan, this proportion has remained at the same level or increased somewhat. The proportion used by government research institutes in the U.S. is gradually rising while the approximately 3% of R&D expenditures utilized by private research institutes is slowly decreasing.

## (2) Flow of R&D expenditures

Figures 4-1-8 (A) – (E) show a comparison of the flow of R&D expenditures from source to performer by sector in certain developed countries.

As mentioned above, both the source ratio and the performance ratio of industry in Japan is about 70% (1992), far beyond those of other sectors. Furthermore, as can be seen in the figure, the R&D expenditures utilized by industry have been almost wholly borne by industry itself. In other words, there is a major flow (9.4376 trillion yen) of R&D expenditures in Japan from industry to industry, with only an extremely small flow from other sectors to industry; R&D expenditures flow from the government to industry was 103.2 billion yen, a mere 0.7% of overall R&D expenditures in Japan. This ratio is extremely small in comparison with the ratios in major Western countries (to be discussed later). The flow from industry to other sectors is also small compared with total R&D expenditures in Japan. Within this context, however, the flow from industry to private R&D institutes (362.5 billion yen) is relatively large, and 60% of the funds used by private R&D institutes come from industry.

Below the industry to industry flow in Japan, in order of amounts, are the flows from government to academia (1.2766 trillion yen), from academia to academia (1.2317 trillion yen), and government to government R&D institutes (1.1416 trillion yen). Among these, only the government to academia flow spans different sectors. This flow, though, is only nominally an inter-sector flow because it includes self-capitalization for national and public universities <sup>(1)</sup>. It can therefore be said that there is overall little flow of R&D expenditures between differing sectors in Japan.

Moreover, the government-sourced R&D expenditures used by academia in Japan have from the 1980s been declining annually, while the ratio of that provided by industry has been on the rise; in other words, the industry to academia flow is increasing. The industry to private R&D institutes flow, too, has been swelling in recent years.

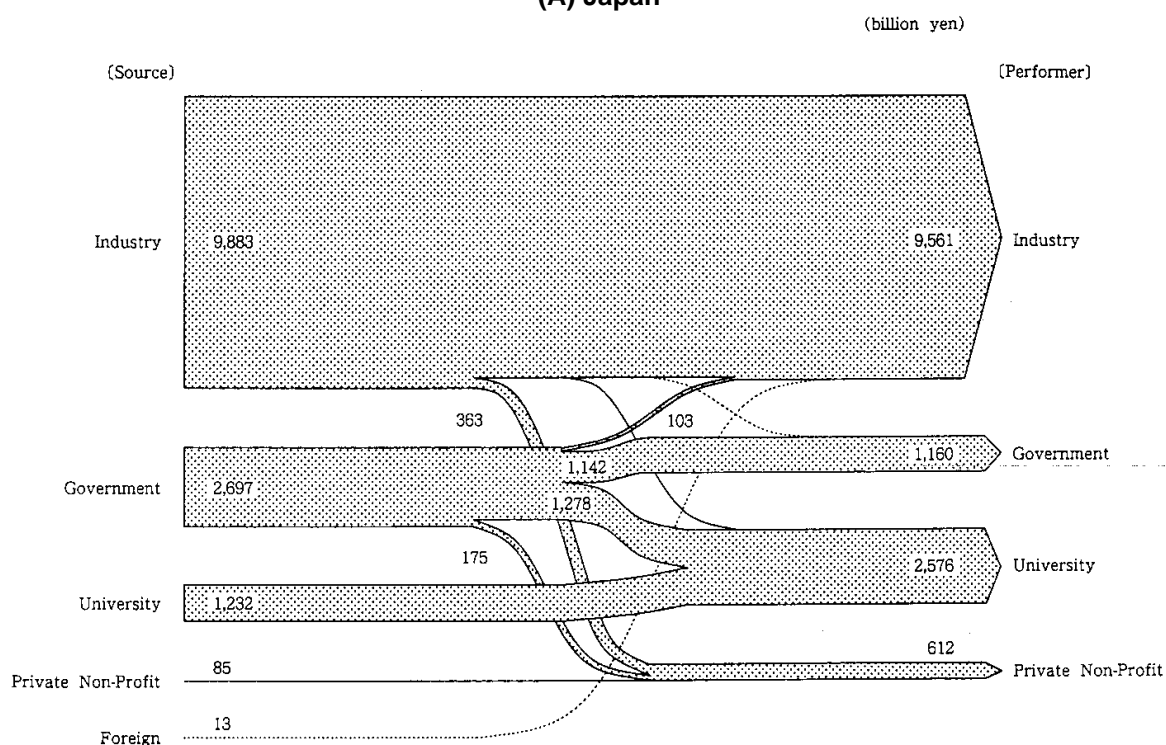
Though in other countries, as in Japan, the industry to industry flow of R&D expenditures is the largest, inter-sector flow is greater than in Japan. The figures here show that the flow originating from government branches out to other sectors, quite unlike the case in Japan. The government's role as a source of R&D expenditures is different in Japan and in these Western countries, and the contrast in the government to industry flow is readily apparent. In the U.S., in fact, nearly half of the R&D funding provided by government in 1992 was paid out to industry, amounting to 20% of total R&D expenditures in the U.S. Similarly, the ratio of the government to industry flow to total R&D expenditures was 7% in Germany, 12% in France, and 9% in the U.K., all higher than Japan's figure of 0.7% mentioned earlier.

### [Note]

- 1) The only universities included among sources in Japan are private universities; funding provided by national and public universities is calculated as government funding.

Summarizing the characteristics of each country, the share of government funding in the U.S. is high, with the government to industry flow especially prominent. In Germany, there is considerable diversity in the flow from government to other sectors. The proportion of R&D expenditures in Germany utilized by private R&D institutes is high in comparison with the other countries, and much of this comes from the government. In France, the government as both source and performer claims a larger share than in other countries, and especially large is the government to government R&D institutes flow. In the U.K., the foreign country to industry flow is considerable.

**Figure 4-1-8**  
**Flow of R&D Expenditure in selected Countries**  
**(A) Japan**

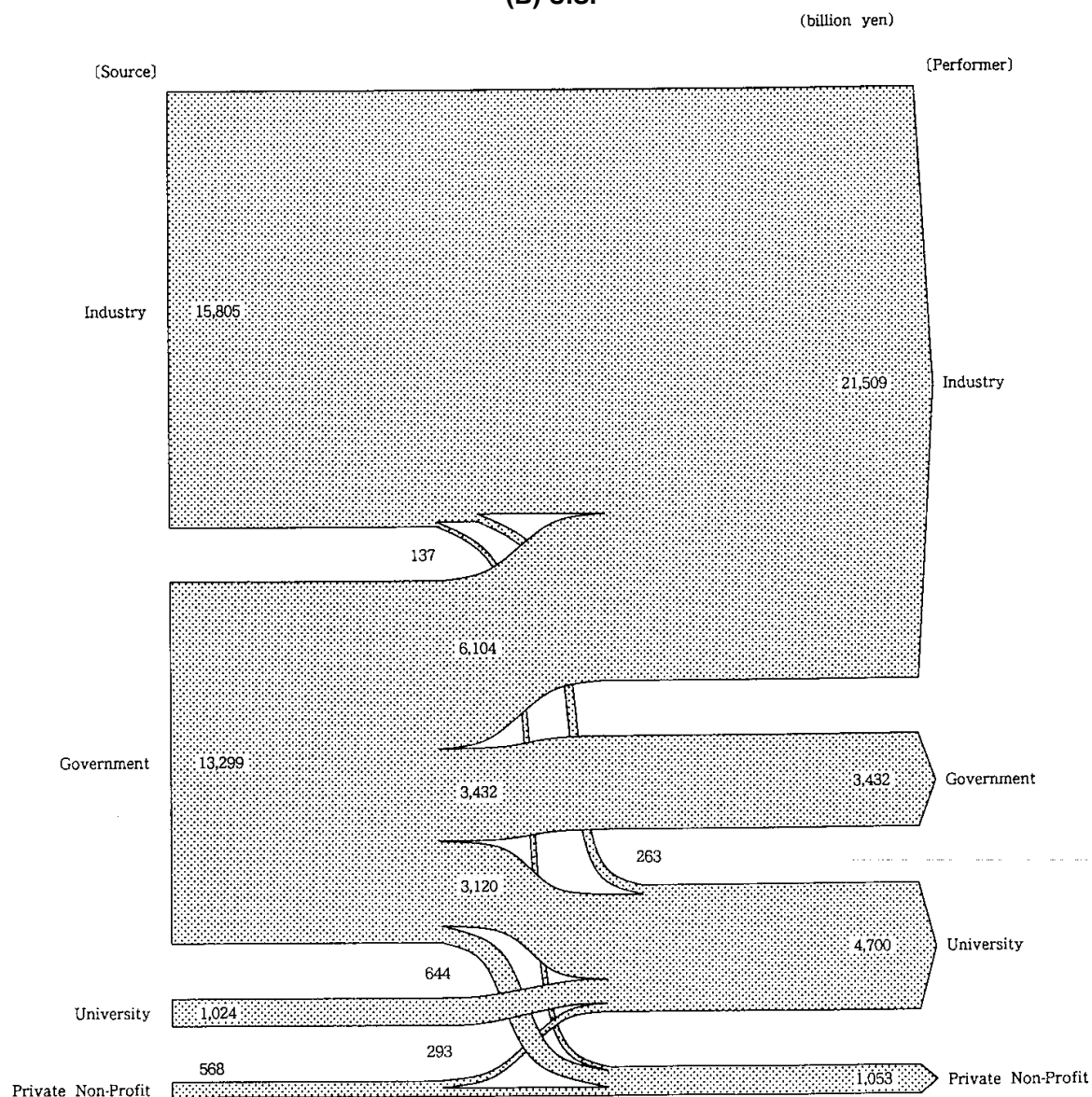


Note: Source "universities" are private universities.

Source: Management & Coordination Agency, *Report on the Survey on Science and Technology*

See Table 4-1-8

**Figure 4-1-8**  
**Flow of R&D Expenditure in selected Countries**  
**(B) U.S.**

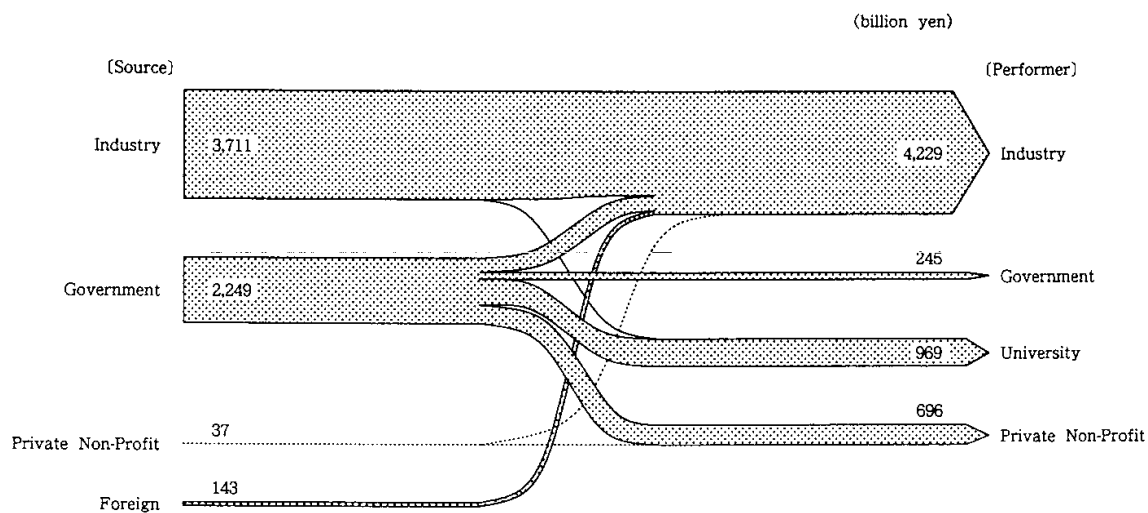


Note: R&D expenditures have been converted to yen figures using GDP purchasing power parities.

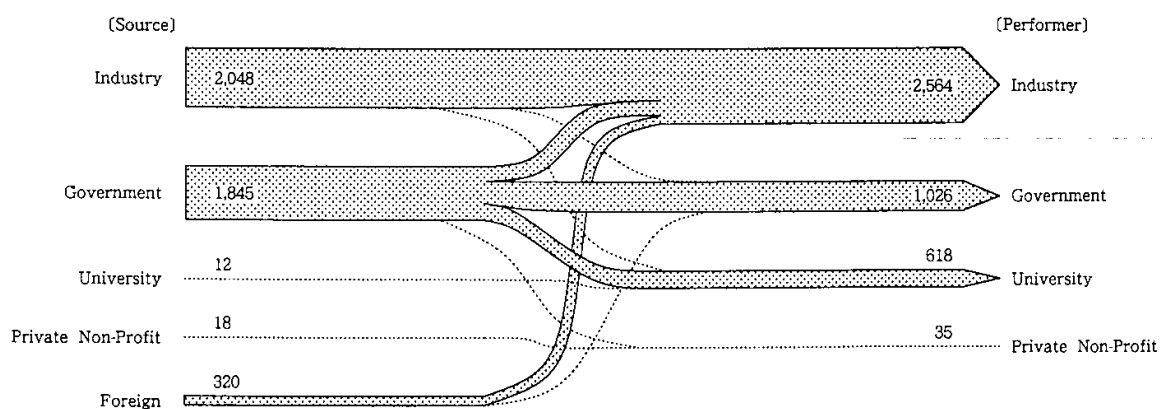
Source: National Science Foundation, *National Patterns of R&D Resources: 1992*

See Table 4-1-8

**Figure 4-1-8**  
**Flow of R&D Expenditure in selected Countries**  
**(C) Germany**



**(D) France**

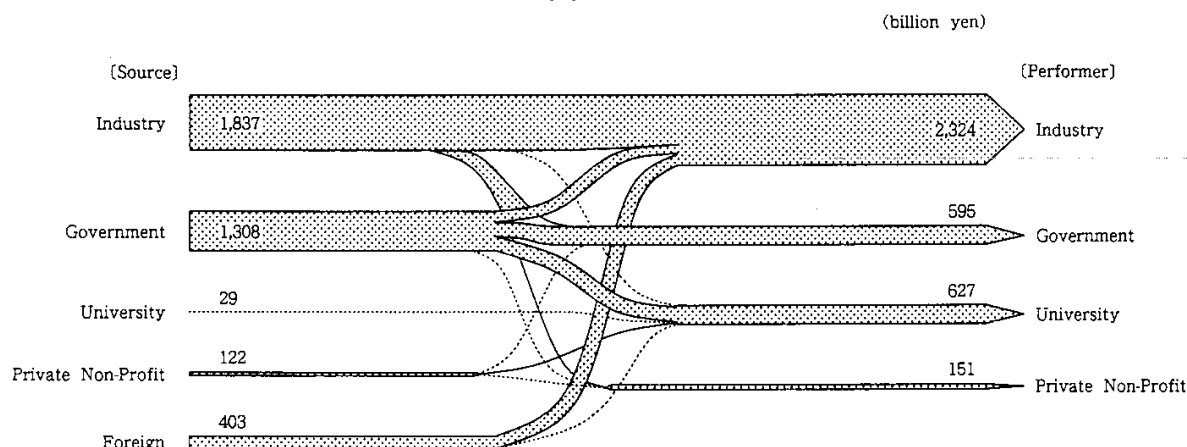


Note: R&D expenditures have been converted to yen figures using GDP purchasing power parities.

Source: Bundesministerium für Forschung und Technologie, *Bundesbericht Forschung: 1993*  
 Science and Technology Agency, *White Paper on Science and Technology*

See Table 4-1-8

**Figure 4-1-8**  
**Flow of R&D Expenditure in selected Countries**  
**(E) U.K.**



Note: R&D expenditures have been converted to yen figures using GDP purchasing power parities.

Source: Science and Technology Agency, *White Paper on Science and Technology*

See Table 4-1-8

### 4.1.3 R&D expenditures by characteristic of work

R&D expenditures can be divided by the characteristic of work into basic research, applied research, and development <sup>(1)</sup>. Among these, there is increasing interest in international comparisons on the ratio of basic research expenditures to total R&D expenditures.

Figure 4-1-9 shows the share by characteristic of work of basic research, applied research, and development of the R&D expenditures of certain major countries. Basic research expenditures in Japan accounted for 13–14% of total R&D expenditures in the period shown in the figure, the lowest share among the major developed nations. The share in the U.S. is somewhat higher than that in Japan, and the 20% shares of Germany and France are even higher than those in Japan and the U.S.

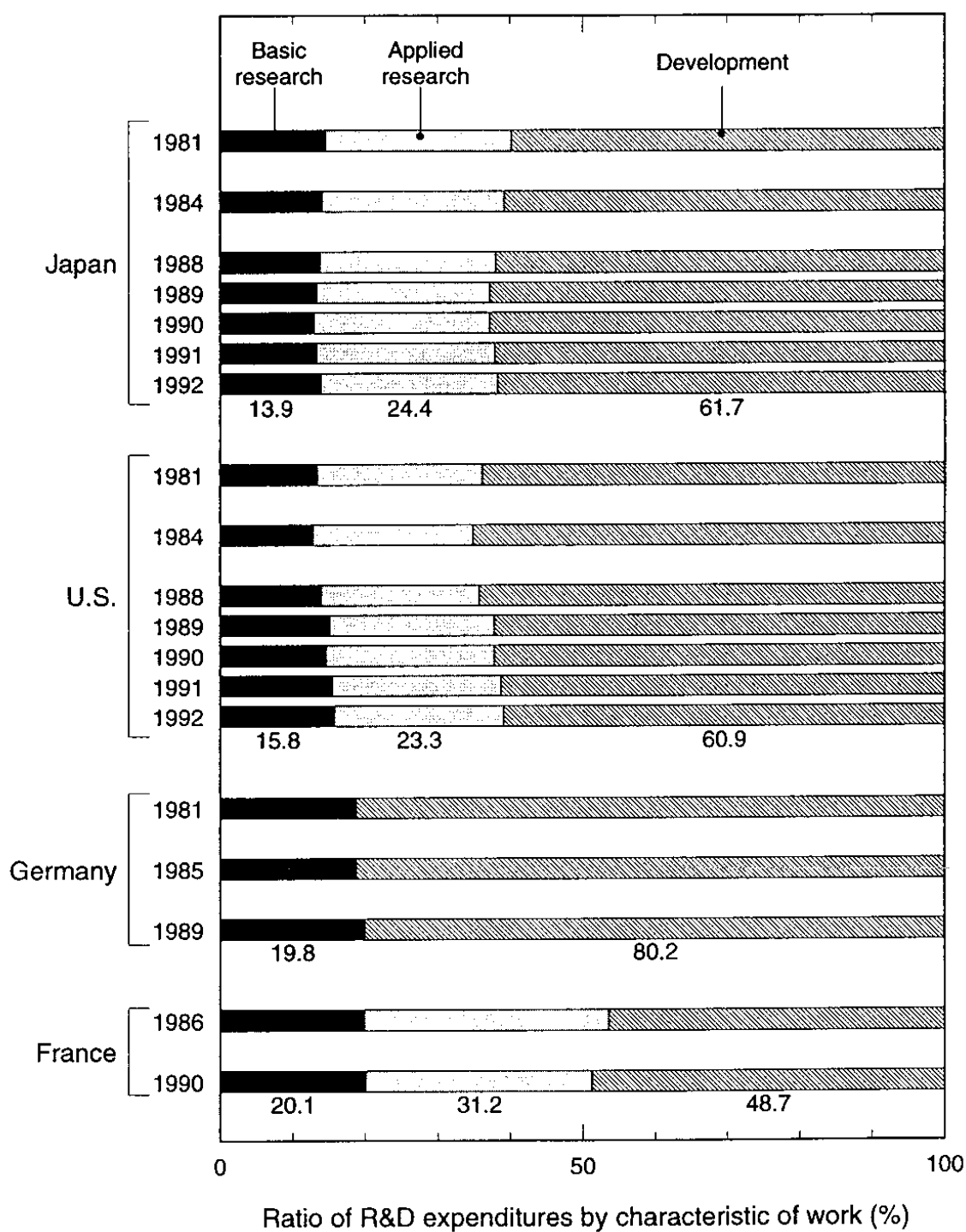
#### [Note]

(1) The survey of research and development conducted by the Management & Coordination Agency [5] defines R&D expenditures by the characteristic of work as internal expenditures by natural science divisions for work in the natural sciences which have been classified by characteristic of work into basic research, applied research, and development.

“Basic research” is defined as theoretical or experimental research conducted to develop hypotheses or theories or to acquire new knowledge on phenomena or observable facts without directly giving consideration to specific applications or uses. “Applied research” refers to research which aims to ascertain the possibility of practical application by establishing specific goals or that which explores new applications of methods which are already in practical application using knowledge discovered through basic research. “Development” consists of the utilization of the knowledge acquired from basic and applied research and actual experience and research designed for introduction of new materials, equipment, systems, or processes or their improvement. Hence the definition covers “research” in the broad sense by including development. When consideration is given to the definition’s content and to international comparisons, however, it is believed more appropriate to treat “developmental research” as “development”. Hence this paper uses the latter.



Figure 4-1-9 R&D Expenditures in Selected Countries by characteristic of Work



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

Sources: same as Figure 4-1-1

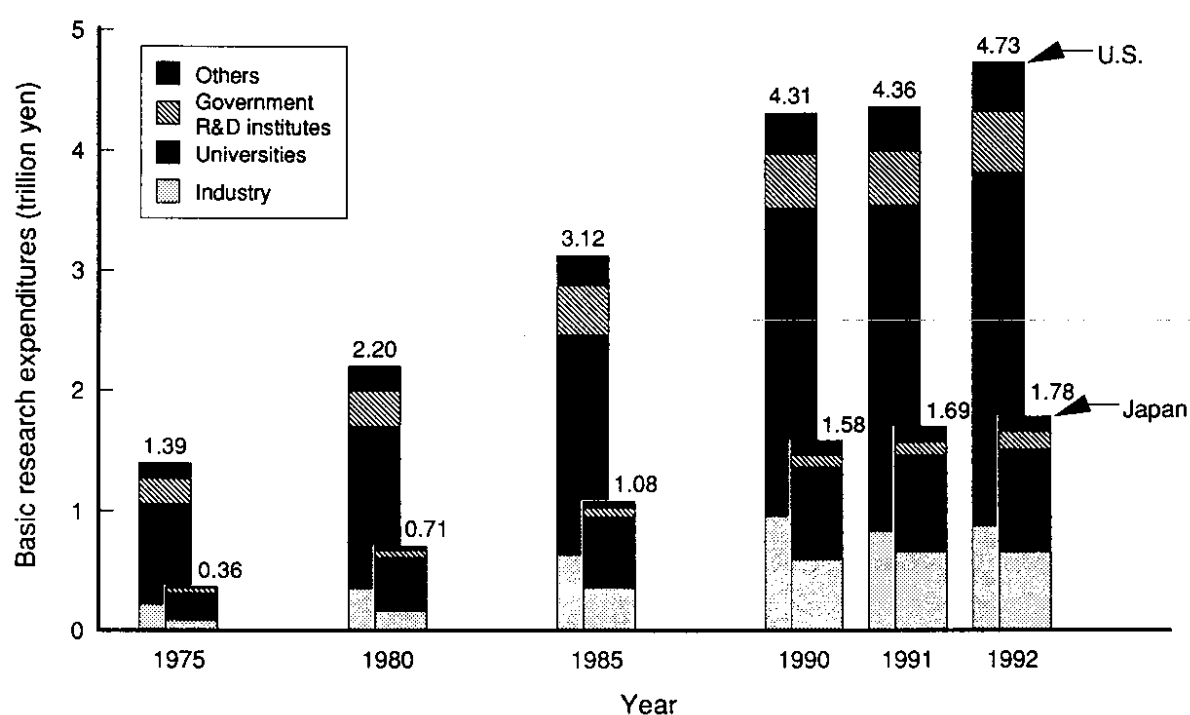
See Table 4-1-9

Despite some year-to-year fluctuations, the was throughout the 1980s on the decline. This can perhaps explain the increase in R&D expenditures in the industrial sector, which has the lowest ratio of basic research expenditures of all sectors. Bottoming out in 1990 (13.0%), the ratio of Japan's basic research expenditures to total R&D expenditures saw slight increases in 1991 and 1992, rising to 13.9% in the latter year. This upward turn came about because of the reduction of R&D expenditures by the industrial sector and because the rate of decrease in basic research expenditures that year was lower than those of applied research expenditures and development expenditures.

The share of basic research expenditures in the U.S. has begun to climb back, with some degree of fluctuation since 1985, after declining in the 1980s. In 1992 the ratio reached 15.8%, the highest level to that point. The share of basic research expenditures in Germany, like that in the U.S., began rising from the second half of the 1980s after falling over the first half of that decade. The share of basic research expenditures in France dropped slightly during the latter half of the 1980s.

Figure 4-1-10 shows the total amounts of basic research expenditures in Japan and the U.S. as well as a sectorial breakdown into industry, academia, and government. Direct comparisons are difficult because the basic research expenditures in both countries are reported in their respective currencies, but here a comparison will be attempted by converting figures for U.S. basic research expenditures into yen using purchasing power parities.

**Figure 4-1-10 Basic Research Expenditures in Japan and the U.S. by Sector**



Note: U.S. basic research expenditures have been converted to yen using GDP purchasing power parity.

Sources: Management & Coordination Agency, *Report on the Survey of Research and Development*  
National Science Foundation, *National Patterns of R&D Resources: 1992*

See Table 4-1-10

The total amount of basic research expenditures in 1992 was 1.7831 trillion yen in Japan and 4.7297 trillion yen in the U.S., the U.S. figure about 2.7 times that of the Japanese one. Basic research expenditures in industry alone in 1992 were 873.0 billion yen in the U.S. and 656.0 billion yen in Japan, a difference of only 1.3 times. This illustrates the fact that Japanese industry uses a relatively large share of basic research expenditures. Basic research expenditures for academia in that same year was 2.9294 trillion yen in the U.S., 3.5 times the 846.5 billion yen figure for Japan; basic research expenditures for government R&D institutes was 523.8 billion yen in the U.S., 3.4 times the 155.1 billion yen figure for Japan. One may conclude, therefore, that basic research expenditures in Japan for academia and government R&D institutes are relatively small.

#### 4.1.4 Number of R&D scientists and engineers

##### (1) Total number of R&D scientists and engineers

Figure 4-1-11 shows the changes over time in the number of R&D scientists and engineers <sup>(1)</sup> in certain major countries. Throughout the period shown in the figure, the number of R&D scientists and engineers in the U.S. has greatly surpassed those in the other countries. Japan has the next highest number of R&D scientists and engineers, 598,000 as of 1992.

The number of R&D scientists and engineers in Japan has grown by about 350,000 (an increase of 2.4 times) in the 20-year period between 1972 and 1992. The number of R&D scientists and engineers in industry alone has grown by about 230,000, accounting for a great part of the increase in the total number of Japanese R&D scientists and engineers. Next after industry was academia, which saw its ranks swell by about 110,000 R&D scientists and engineers, due in great part to the increase in universities, academic departments, and programs. On the other hand, the overall number of R&D scientists and engineers at national and publicly-funded R&D institutes has not changed much due to downsizing.

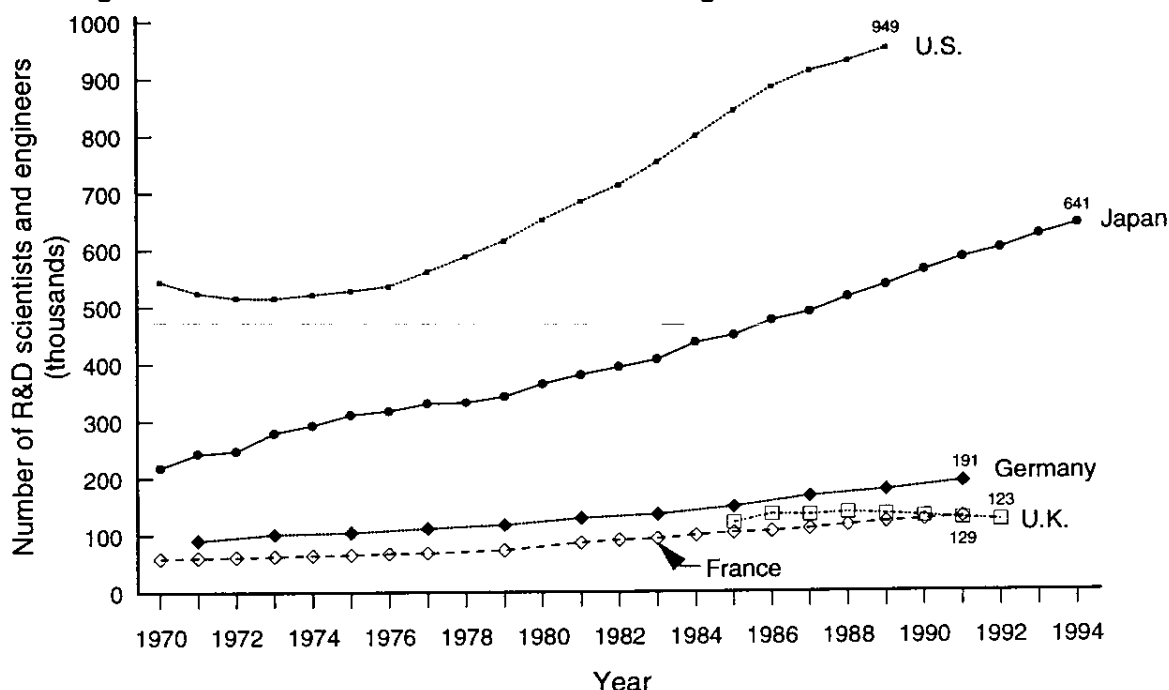
#### [Note]

- (1) The Japanese term *kenkyusha* is defined as follows. The term *kenkyu honmusha* as used by the Statistics Bureau of the Management & Coordination Agency is here translated as “R&D scientists and engineers”. At the Statistics Bureau of the Management & Coordination Agency, *kenkyusha* is defined as “a person who has completed a university (excluding junior colleges) program (or who possesses the equivalent specialist knowledge), who has two or more years experience in research and who is involved in research on a specific topic”; *kenkyusha* are subdivided into *kenkyu honmusha* (persons principally engaged in research within an organization) and *kenkyu kenmusha* (persons whose principal work is with another organization).

For U.S. and OECD science and technology indicators, the phrase “R&D scientists and engineers” is used in almost the exact same sense as *kenkyusha*. The usual translation of *kenkyusha* is “researchers”, but the preference here is for “R&D scientists and engineers”. The term “researchers” refers only to those people who conduct research, and because those persons involved in development are not normally included in this, we use the term “R&D scientists and engineers” to describe persons engaged in research and development.

Furthermore, the term *kenkyu* as used by the Statistics Bureau of the Management & Coordination Agency includes not only basic and applied research but also development (i.e., R&D), and the term “R&D scientists and engineers” here is used to include not only those engaged in research but those involved in development as well.

**Figure 4-1-11 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.

The 1991 figure for Germany is an estimate.

Sources: same as Figure 4-1-1

See Table 4-1-11

The number of R&D scientists and engineers in the U.S. has increased significantly since the latter half of the 1970s. In Germany and France, there has been a consistent straight-line increase, while in the U.K., the number of R&D scientists and engineers dropped in both 1989 and 1990. For countries other than the U.K., the increase in R&D scientists and engineers in the industrial sector, which accounts for 60–80% of the total, has been a principal factor in the overall increase in R&D scientists and engineers. In France, the number of R&D scientists and engineers in government R&D institutes has grown about the same degree as the industrial sector.

## (2) Number of R&D scientists and engineers per unit of work force/population

In making international comparisons of R&D scientists and engineers, it is important to compare not only absolute numbers but also the numbers in relation to the size of the work force and of the population. This is for the same reasons that the ratio to GNP was used in international comparisons of R&D expenditures. In the case of R&D scientists and engineers, the number of R&D scientists and engineers per 1,000 workers (hereafter, “number of R&D scientists and engineers per work force”) and the number of R&D scientists and engineers per 1,000 of the general population (hereafter, “number of R&D scientists and engineers per population”) will be used.

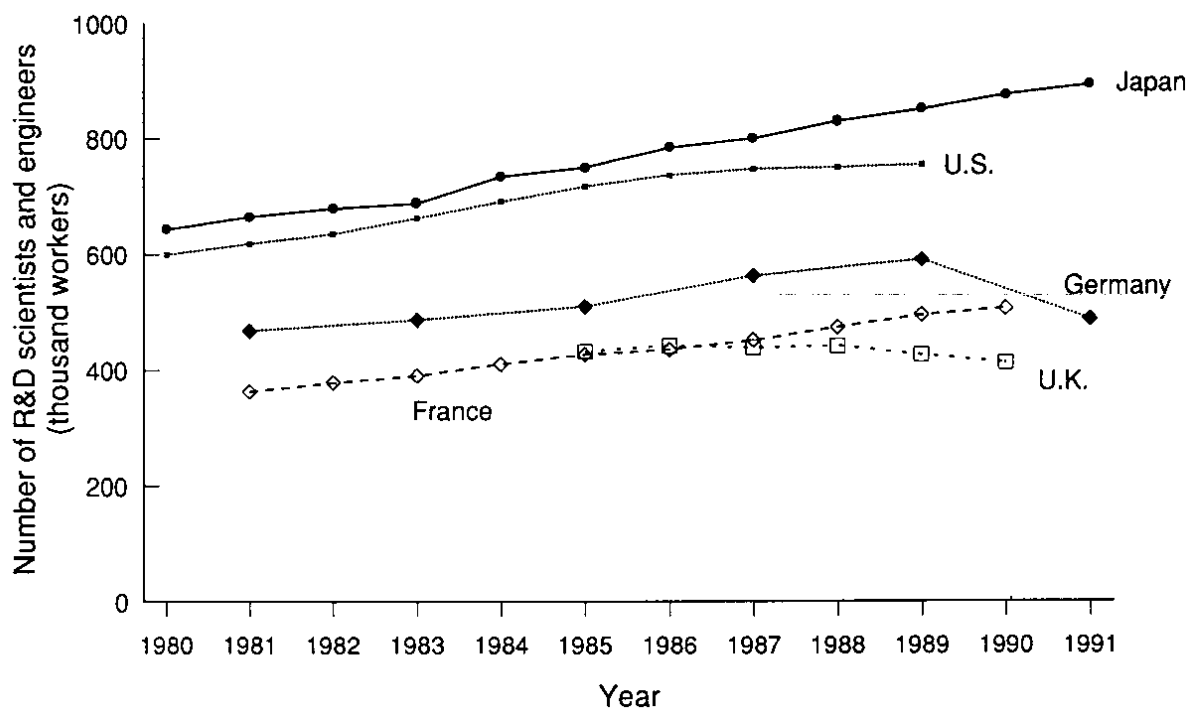
Figures 4-1-12 and 4-1-13 show the number of R&D scientists and engineers per work force and per population. In both instances, Japan has quite high levels in comparison with the other major countries. However, the numbers of R&D scientists and engineers in Japan are not an FTE-adjusted figures, and it is possible that these numbers are overestimated in relation to the other

countries. Even with FTE-adjusted figures, though, the numbers of R&D scientists and engineers per work force and per population in Japan would probably be somewhat below those numbers in the U.S. but above the same numbers in Germany, France, and the U.K. <sup>(1)</sup> Furthermore, the numbers of R&D scientists and engineers per work force and per population in Japan have clearly grown relative to the other major countries since the latter half of the 1980s.

**[Note]**

- (1) Making test calculations of the number of R&D scientists and engineers in Japan using a method similar to FTE conversion and calculating the numbers of R&D scientists and engineers per work force and per population accordingly, this institute found that the numbers, although somewhat below those of the U.S., would still be above those of Germany, France, and the U.K. (test calculations by the National Institute of Science and Technology Policy<sup>[1]</sup>)

**Figure 4-1-12 Number of R&D Scientists and Engineers per Unit of Work Force in Selected Countries**



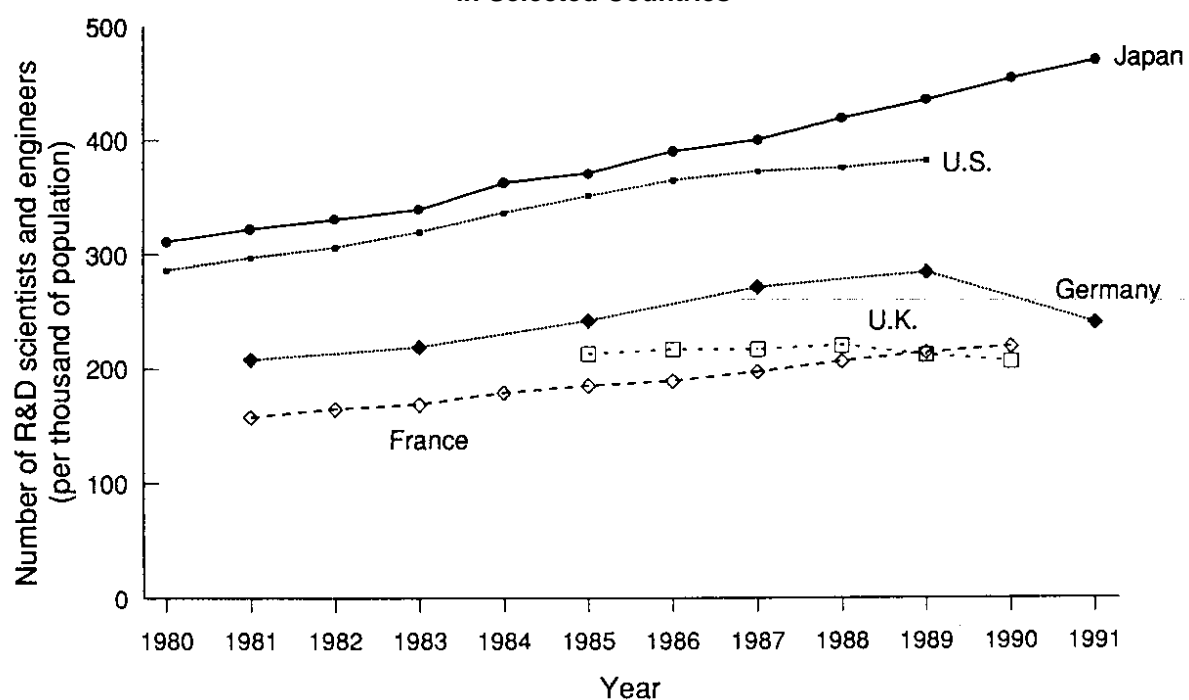
Note: same as Figure 4-1-11

Sources: Number of R&D scientists and engineers: same as Figure 4-1-1

Work force: OECD, *Main Science and Technology Indicators*

See Table 4-1-12

**Figure 4-1-13 Number of R&D Scientists and Engineers per Unit of Population in Selected Countries**



Note: same as Figure 4-1-11

Sources: same as Figure 4-1-1

See Table 4-1-13

## 4.2 R&D in Industry

A large share of R&D activities in Japan is carried out by industry. In fact, as has already been pointed out, nearly 70% of R&D expenditures in Japan have been utilized by industry in the past few years. Industry also accounts for just under 60% of the total number of R&D scientists and engineers.

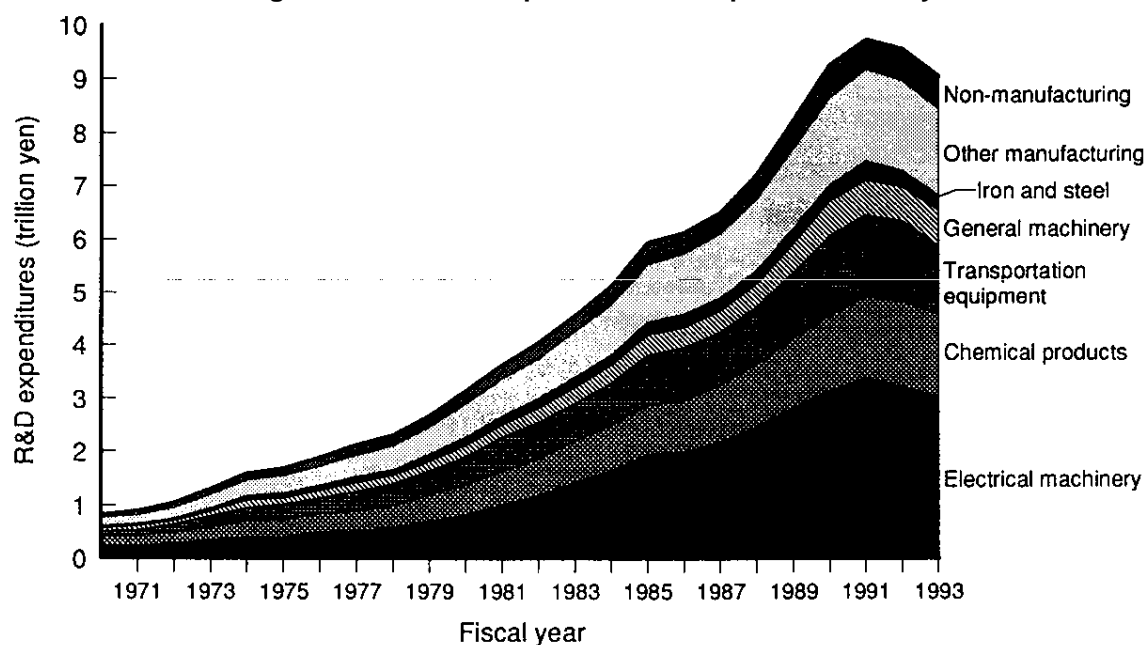
### 4.2.1 R&D expenditures in industry

#### (1) R&D expenditures by the industrial sector and by key industries

Figure 4-2-1 shows R&D expenditures in Japanese industry. In FY1993, R&D expenditures <sup>(1)</sup> in Japanese industry totaled 9.536 trillion yen. There was a steady increase in industrial R&D expenditures from the second half of the 1970s, and though this temporarily eased off in FY1985, the rise continued until FY1990. However, the growth once again slowed down in FY1991 and turned negative in FY1992, dropping further in FY1993. This being the first decreasing trend in R&D expenditures in the industrial sector in Japan since the keeping of statistics on R&D expenditures began, this section will focus on this phenomenon in examining R&D in industry. It must be noted, however, as will be discussed later (Section 4.2.3), that the ratio of R&D expenditures to sales has not dropped that substantially.

The electrical machinery manufacturing industry has consistently had the largest share of R&D expenditures among key industries, followed by the chemical products manufacturing and transportation equipment manufacturing industries. These top three industries accounted for 64.9% (FY1993) of all industrial R&D expenditures utilized. Moreover the share of these three industries of total R&D expenditures in Japan reached 42.9% in FY1993, evidence that a large portion of Japanese R&D is performed by the electronics, motor vehicles, and chemical industries.

Figure 4-2-1 R&D Expenditures in Japanese Industry



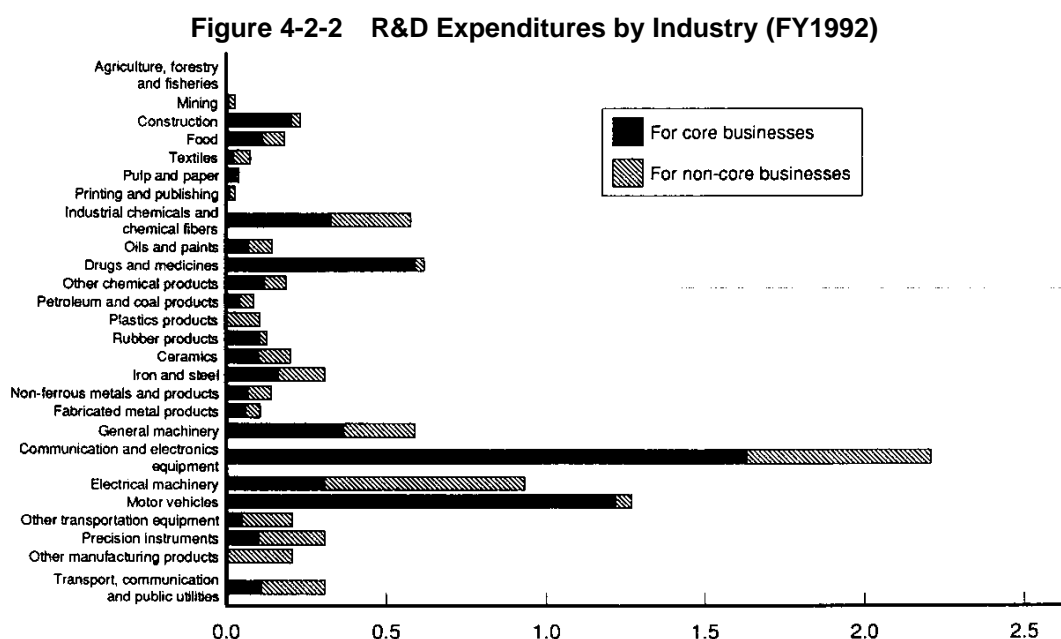
Source: Management & Coordination Agency, *Report on the Survey of Research and Development*  
See Table 4-2-1

The ratio to industry as a whole of the R&D expenditures of the electrical machinery manufacturing industry generally rose from FY1980 until FY1991, but both R&D expenditures and this ratio declined in FY1992 and FY1993. On the other hand, the chemical products manufacturing industry saw a long-term decline in the ratio of its R&D expenditures to those of the industrial sector until FY1990, but this ratio climbed in FY1991 and FY1992. The transportation equipment manufacturing industry has had a declining ratio since FY1991.

**[Note]**

- (1) Intramural R&D expenditures refer to funds spent by companies, R&D organizations or universities for personnel expenditures, raw material expenditures, for purchase of tangible fixed assets (or their depreciation) and other expenditures<sup>[5]</sup>. They include corporate funds internally used as R&D expenditures and externally sourced funds used as R&D expenditures but do not include R&D expenditures paid outside for such things as commissioned (or joint) research.
- (2) R&D expenditures in core and non-core businesses

Figure 4-2-2 shows a breakdown of R&D expenditures by industry and R&D expenditures for core and non-core businesses in FY1992. Core businesses are, for example, iron and steel, in the iron and steel manufacturing industry, while non-core businesses are other product areas. In recent years, the iron and steel manufacturing industry has been active in R&D in electronics, a non-core business, and the diversification of R&D is shown by R&D expenditures in non-core business (hereafter, “non-core business R&D expenditures”).



Source: Management & Coordination Agency, *Report on the Survey of Research and Development*  
See Table 4-2-2



The Japanese electrical machinery manufacturing industry (as a single category), the industry with the largest R&D expenditures in the country, can be sub-divided into the “electrical equipment and supplies” industry and the “communication and electronics equipment” industry. In these two industries, non-core business R&D expenditures are especially high: 628.0 billion yen for the electrical equipment and supplies industry and 577.0 billion yen for the communication and electronics equipment industry. A closer look reveals, however, that a great deal of these non-core business R&D expenditures derive from mutual entry between the two industries. Of the 628.0 billion yen of non-core business R&D expenditures for the electrical equipment and supplies, 443.8 billion yen was invested in the area of communication and electronics equipment, while conversely, 509.1 billion yen of the 577.0 billion yen of non-core business R&D expenditures in the communication and electronics equipment industry was invested in the area of electrical equipment and supplies. Outside this mutual penetration within the electrical machinery manufacturing industry, relatively large investments totaling 101.1 billion yen in the area of motor vehicles and 43.2 billion yen in the area of general machinery manufacturing were made by the electrical equipment and supplies industry as well as investments totaling 25.8 billion yen in the area of precision instruments manufacturing by the communication and electronics equipment industry.

The chemical products manufacturing industry (as a single category) can be sub-divided into four product areas, namely, the industrial chemicals and chemical fibers industry, the oils and paints industry, the drugs and medicines industry, and the other chemical products manufacturing industry. The share of non-core business R&D expenditures in the drugs and medicines industry is small, as most of its R&D expenditures are directed towards its core business. Of the non-core business R&D expenditures of the other three industries, a great portion is used in mutual penetration within the chemical products manufacturing industry. Investment in areas other than chemical products manufacturing industry product areas is still relatively large: for example, 30.5 billion yen by the industrial chemicals and chemical fibers industry in the area of communication and electronics equipment, and 29.7 billion yen in the area of general machinery manufacturing by the other chemical products manufacturing industry.

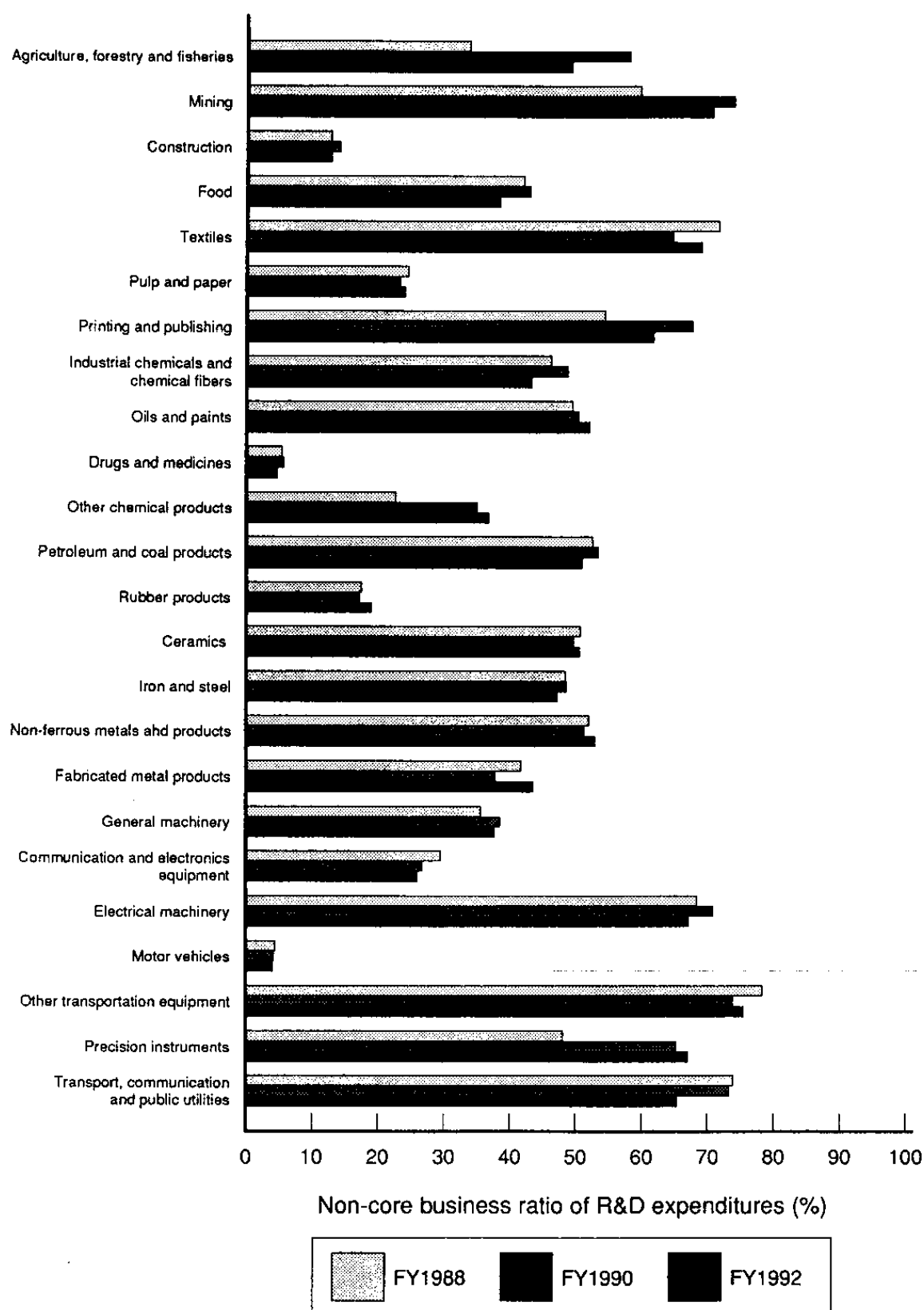
Most of the R&D expenditures of the motor vehicles industry, which belongs to the transportation equipment manufacturing industry (as a single category), go towards its core business; non-core business R&D expenditures are small.

### (3) Non-core business R&D expenditure ratio

Although the absolute amount of non-core business R&D expenditures is important, the ratio of these R&D expenditures to total R&D expenditures is perhaps more useful as an indicator showing the diversification of the various industries. In other words, the ratio of non-core business R&D expenditures to total R&D expenditures in a given industry (“non-core business ratio of R&D expenditures”) shows the degree of diversification in R&D.

Figure 4-2-3 shows the changes over time in the non-core business ratio of R&D expenditures by industry. Changes in non-core business R&D expenditures for FY1988, FY1990, and FY1992 have been shown in the figure to determine whether R&D expenditures in non-core businesses dropped as a result of the decline in overall R&D expenditures in the industrial sector in FY1992. Among the industries whose non-core business ratio dropped was the communication and electronics equipment. As has already been mentioned, this industry, in addition to being the largest performer of R&D in Japanese industry, played a major role in the FY1992 reduction of industrial R&D expenditures. This suggests that the industry was forced by the economic slowdown to cut R&D expenditures for areas outside its core business.

**Figure 4-2-3 Non-core Business Ratio of R&D Expenditures by Industry**



Source: Management & Coordination Agency, *Report on the Survey of Research and Development*  
See Table 4-2-3

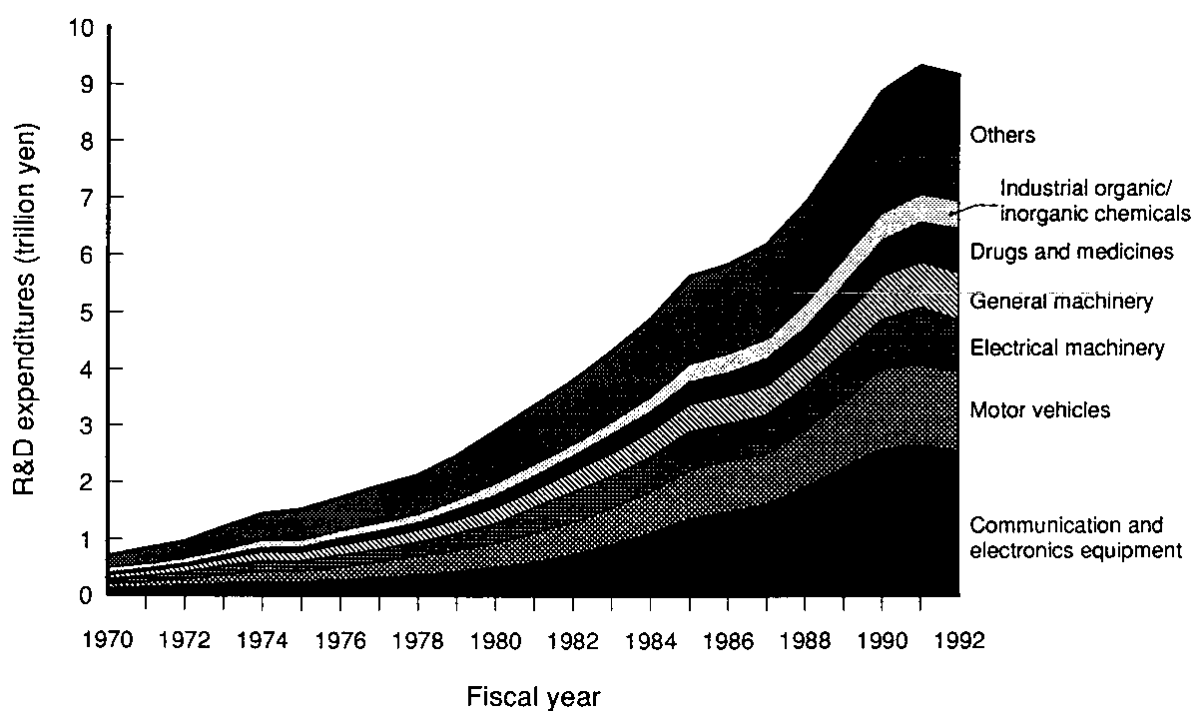
The precision instruments manufacturing industry, on the other hand, was among the industries whose non-core business ratio rose. This industry increased its R&D expenditures in the area of electrical machinery manufacturing, drawing precision instrument technology ever closer to electronics.

#### (4) R&D expenditures by product area

Here the areas in which R&D is being conducted by Japanese industry will be analyzed by dividing R&D expenditures by product area. For example, in the case of motor vehicle companies conducting R&D in the area of electronic equipment, those R&D expenditures would not be classified as R&D expenditures for the motor vehicles industry but rather as R&D expenditures in the electronic equipment area. In other words, R&D is classified not by the industry conducting it but the area in which the R&D is conducted.

Figure 4-2-4 shows the changes over time in industrial R&D expenditures by major product area. The area of communication and electronics equipment has consistently had the largest R&D expenditures of any area. It is followed by motor vehicles and electrical machinery manufacturing. R&D expenditures are also large in the areas of general machinery manufacturing, drugs and medicines, industrial organic and inorganic chemicals, chemical fertilizers, and chemical fibers.

**Figure 4-2-4 R&D Expenditures by Key Product Area**

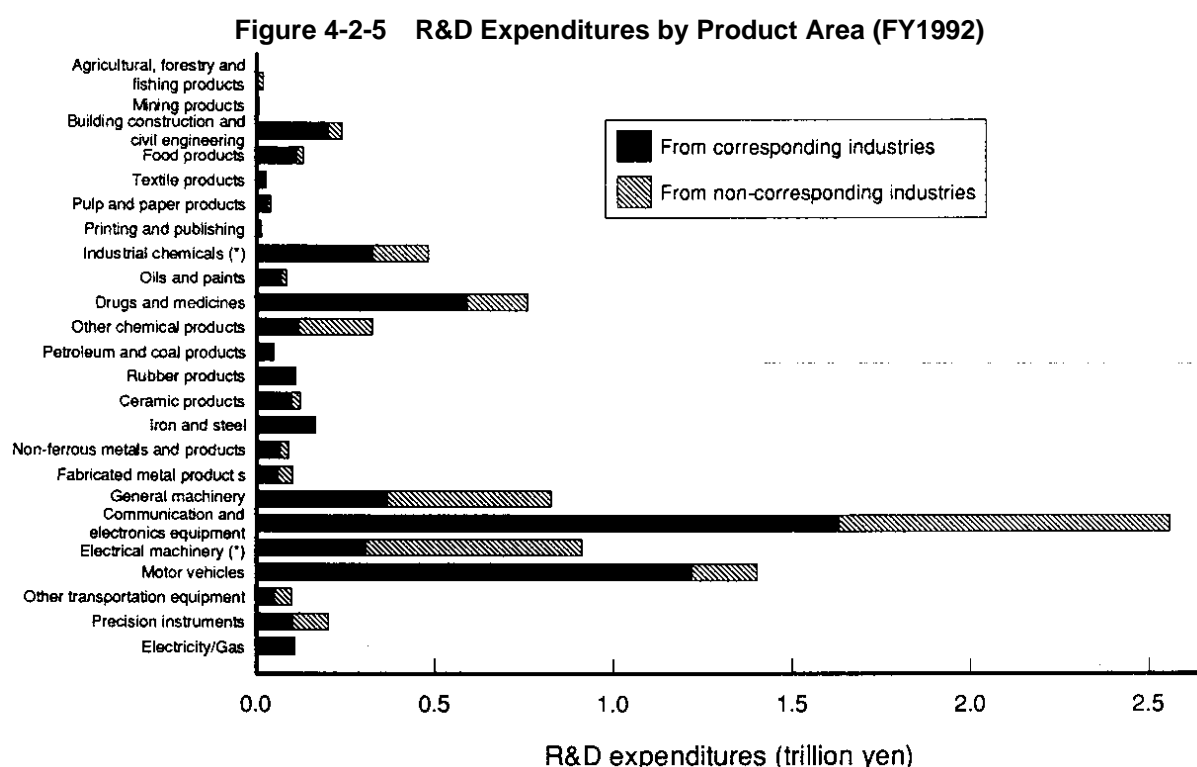


Source: Management & Coordination Agency, *Report on the Survey of Research and Development*  
See Table 4-2-4

The growth in R&D expenditures has since FY1980 been greatest in the area of communication and electronics equipment, and its share of the R&D expenditures of all areas is also rapidly increasing; this share did, however, drop in FY1992. The share of R&D expenditures in the area of motor vehicles to those of all areas has leveled off since the latter half of the 1970s. R&D expenditures fell in FY1992 in the area of electrical equipment and supplies. The decrease in R&D expenditures in the industrial sector as a whole in this year was greatly influenced by the decreases in the electrical machinery industry (comprising “communication and electronics equipment” and “electrical equipment and supplies”).

#### (5) Penetration by other industries

Figure 4-2-5 shows R&D expenditures by product area, distinguishing between R&D expenditures by businesses for which the product area is the core business and those by entrants coming from other industries. Product areas in which the R&D expenditures from outside industries (hereafter, “penetration value”) is large may be regarded as areas deemed promising by outside companies.



Source: Management & Coordination Agency, *Report on the Survey of Research and Development*  
See Table 4-2-5

The penetration value is largest in communication and electronics equipment; as much as 40% of the R&D expenditures in this area are from penetration by outside industries. Penetration by the electrical equipment and supplies industry (which, like the communication and electronics equipment industry, for whom this area is the core business, belongs to the electrical machinery manufacturing industry) is highest, with companies from the transport, communications, public utilities, general machinery manufacturing, precision instruments manufacturing, iron and steel

manufacturing, ceramics, and chemical products manufacturing industries also conducting R&D in the area of communication and electronics equipment. Thus, as mentioned earlier, the fact that R&D expenditures in the area of communication and electronics equipment are so much higher than other areas is not due only to investment by the communication and electronics equipment industry, for whom this area is a core business, but also due to the contributions of other industries.

The next highest penetration value is in the area of electrical equipment and supplies. The greater part of this, though, is from the technologically-related communication and electronics equipment industry.

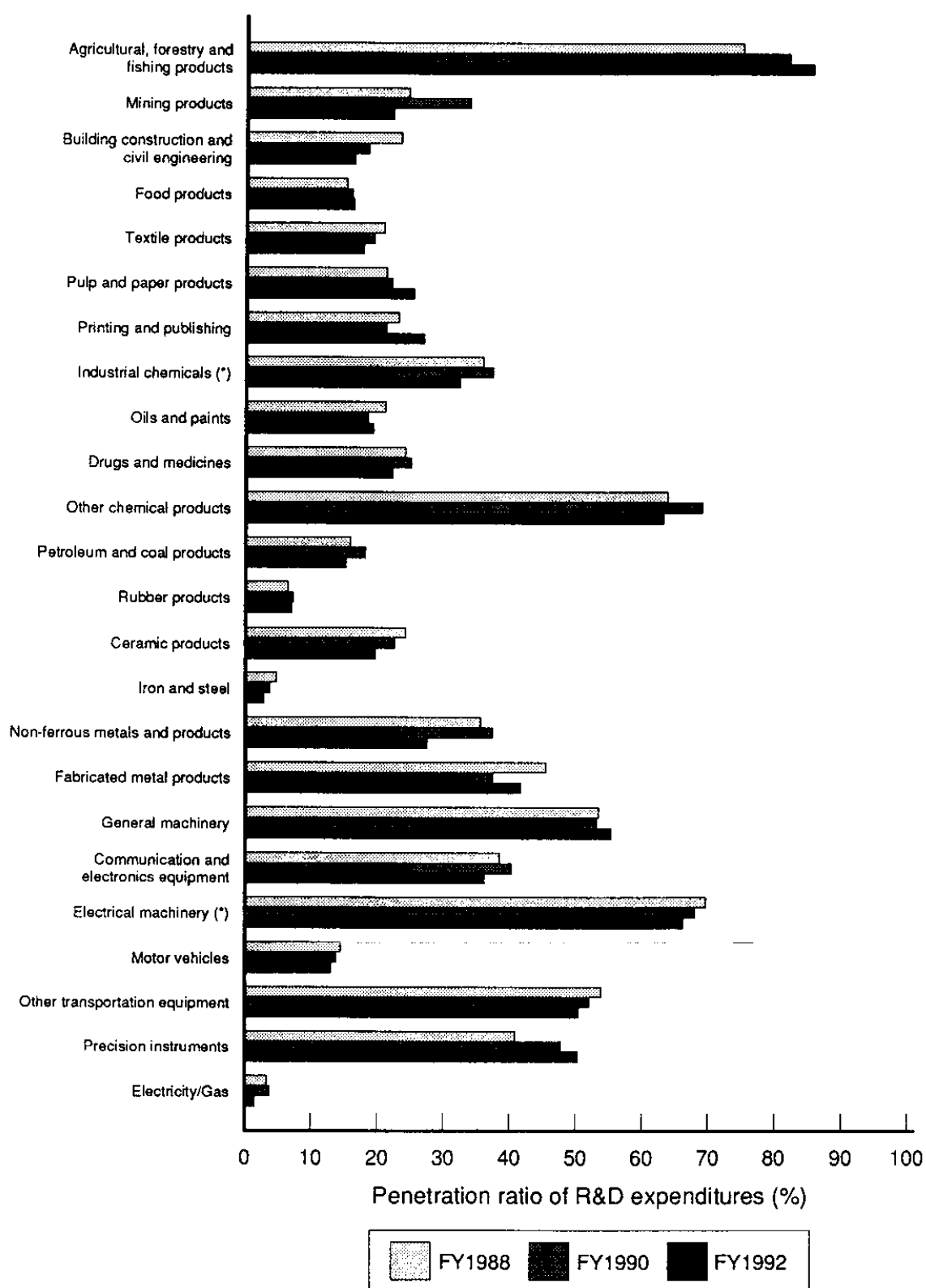
Other areas in which the penetration value is high are general machinery manufacturing, other chemical products manufacturing, and motor vehicles.

#### (6) Penetration ratio for R&D expenditures

The ratio of the penetration value of R&D expenditures in each product area by other industries is defined here as the penetration ratio, and Figure 4-2-6 shows the recent trends in this ratio.

The penetration ratio in the area of communication and electronics equipment dropped during the period shown in the figure. Precision instruments manufacturing was one area, however, in which the penetration ratio rose. Earlier, in Figure 4-2-3, it was pointed out that the non-core business ratio in the precision instruments manufacturing industry was on the rise. In other words, companies for which precision instruments manufacturing is the core business are increasing their R&D expenditures in electrical machinery manufacturing and other areas, while the penetration in precision instruments manufacturing by other industries is increasing.

Figure 4-2-6 Penetration Ratio by Product Area



Source: Management & Coordination Agency, *Report on the Survey of Research and Development*  
See Table 4-2-6

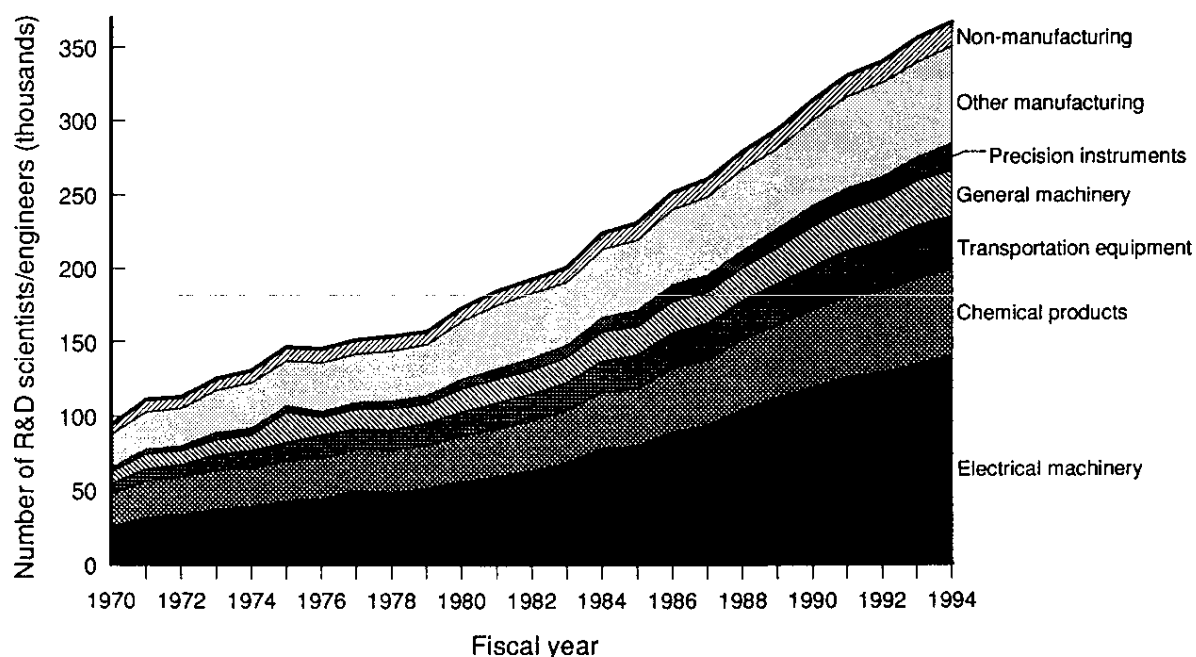
#### 4.2.2 Number of R&D scientists and engineers in industry

##### (1) Number of R&D scientists and engineers in the industrial sector and by industry

Figure 4-2-7 shows the changes over time in the number of R&D scientists and engineers in Japanese industry by key industrial sector. The number of R&D scientists and engineers has expanded greatly in the electrical machinery manufacturing industry, while the number in other industries has not increased as much. Thus, it is the electrical machinery manufacturing industry that has been responsible for the dramatic increases in the number of R&D scientists and engineers in the Japanese manufacturing industry. As mentioned earlier, a similar trend can be seen for R&D expenditures, and this shows a characteristic focus of R&D on electronics in Japan.

Neither the ratio to the total nor the growth in the number of R&D scientists and engineers employed in the transportation equipment manufacturing industry (including the motor vehicles industry, one of Japan's more important industries) is very large. The number of R&D scientists and engineers in the chemical products manufacturing industry, although second only to the electrical machinery manufacturing industry, has not grown much and its ratio to the total number of industrial R&D scientists and engineers has declined somewhat over the past 20 years. Nevertheless, the ratio for the drugs and medicines industry, a sub-category of the chemical products manufacturing industry, has slowly risen. The precision instruments manufacturing industry is yet another industry in which this ratio has increased over the past 20 years. In both cases, though, the growth is no more than a fraction of that in the communication and electronics equipment industry.

**Figure 4-2-7 Number of R&D Scientists/Engineers in Japanese Industry (By industry)**

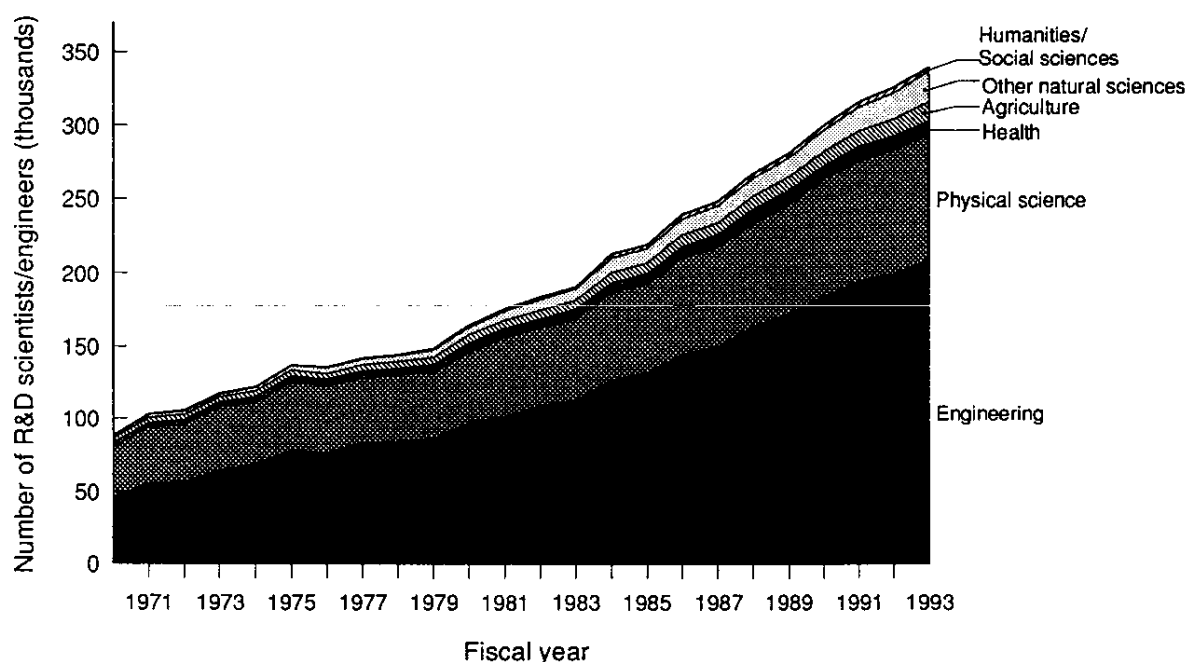


Source: Management & Coordination Agency, *Report on the Survey of Research and Development*  
See Table 4-2-7

## (2) Number of R&D scientists and engineers by specialization

Engineering is the most common specialization of R&D scientists and engineers, followed by physical science (Figure 4-2-8). R&D scientists and engineers whose specialization is in agriculture or health account for about 3% each of the total number, while those whose specialization is in humanities or the social sciences make up only 1%. Consequently, an overwhelmingly large number of R&D scientists and engineers have specializations in either engineering or physical science. Most of the specializations of R&D scientists and engineers in manufacturing are determined by the specializations offered by universities and graduate schools, and it appears inevitable from the large ratio of engineering students to physical science students in Japan that the number of R&D scientists and engineers with specializations in engineering will grow even larger.

**Figure 4-2-8 Number of R&D Scientists/Engineers in Japanese Industry (By specialization)**



Source: Management & Coordination Agency, *Report on the Survey of Research and Development*  
See Table 4-2-8

### 4.2.3 R&D intensity in industry

R&D intensity is an indicator showing to what degree companies and businesses devote efforts to R&D activities. The ratio of R&D expenditures to sales and the ratio of R&D scientists and engineers to the total number of employees will be used here as indicators of R&D intensity.

#### (1) Trends in R&D intensity

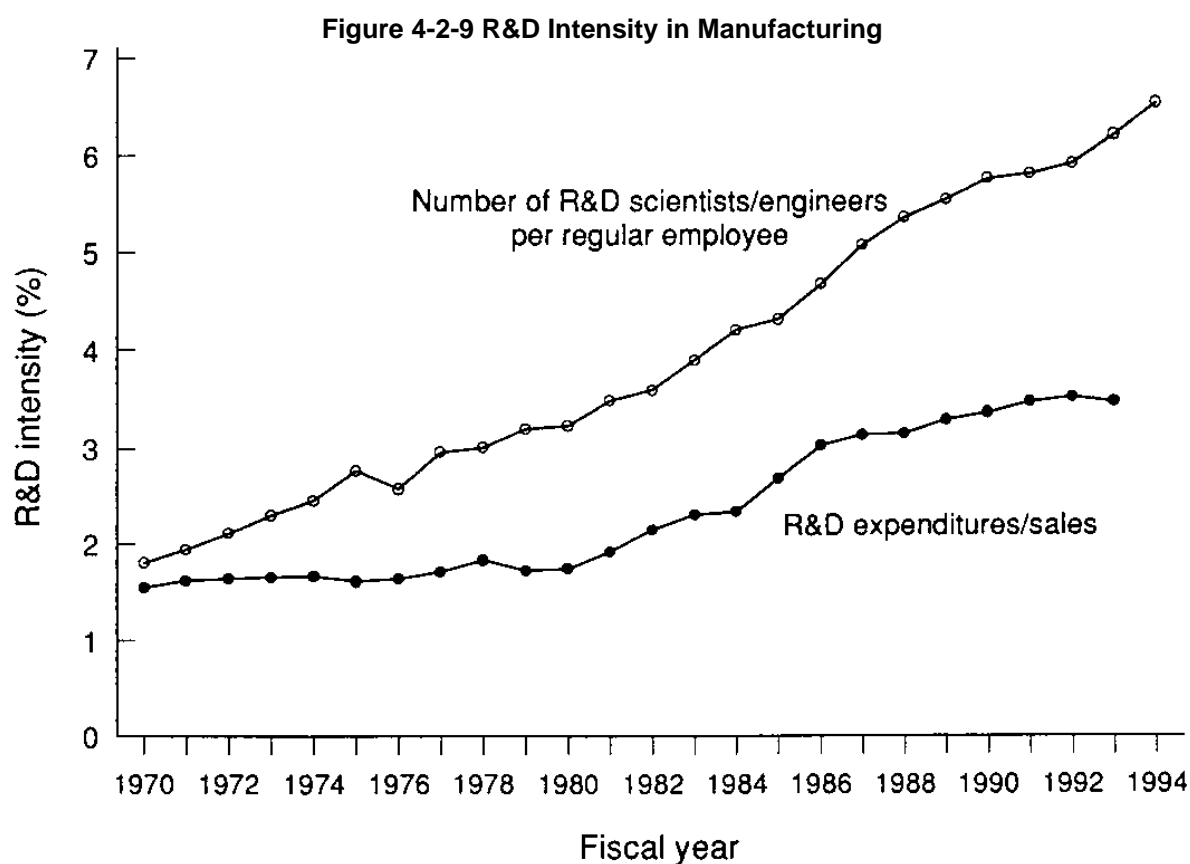
The ratio of R&D expenditures to sales for industry as a whole in FY1993 was 2.76%, and that of manufacturing alone 3.47%; the R&D intensity of the manufacturing industry in terms of R&D expenditures is 1.26 times that of the industry as a whole (comparing the R&D intensity of both). The ratio of R&D scientists and engineers to the total number of employees for industry overall was 5.42% and that of manufacturing 6.54%. The R&D intensity of manufacturing in terms of



personnel is 1.25 times that of industry as a whole, and this is the about the same as when viewed from the perspective of R&D expenditures.

Figure 4-2-9 shows the change over time in these intensities for the manufacturing industry. The R&D intensity of R&D expenditures remained fairly constant throughout the 1970s, but grew substantially during the 1980s. Though the growth tapered off somewhat in the second half of the 1980s, growth continued up to FY1992. In FY1993 intensity dropped. On the other hand, R&D intensity of the number of R&D scientists and engineers, with the exception of a drop in FY1976, has risen steadily.

R&D expenditure as a percentage of sales, in addition to being a meaningful indicator of R&D intensity, is important for understanding the changes in R&D expenditures. As mentioned earlier (Section 4.2.1 (1)), FY1992 marked the start of negative growth in R&D expenditures in the manufacturing industry, but R&D expenditure as a percentage of sales was, as seen here, actually up over the previous year. Consequently, the reduction in R&D expenditures in the manufacturing industry in FY1992 suggests a reduction in sales, which occurred not only in the manufacturing industry, but also in industry as a whole. In FY1993 R&D expenditures in the manufacturing industry (and in industry as a whole) decreased substantially and R&D expenditure as a percentage of sales also dropped, but it must be remembered that the drop in the latter was not that large.



Source: Management & Coordination Agency, *Report on the Survey of Research and Development*  
See Tables 4-2-9 and 4-2-10

## (2) Intensity by industrial category

Figure 4-2-10 shows R&D intensity by industrial category. The horizontal axis shows R&D intensity for R&D expenditures while the vertical axis shows R&D intensity for the number of R&D scientists and engineer; these figures are plotted for each industrial category in FY1993.

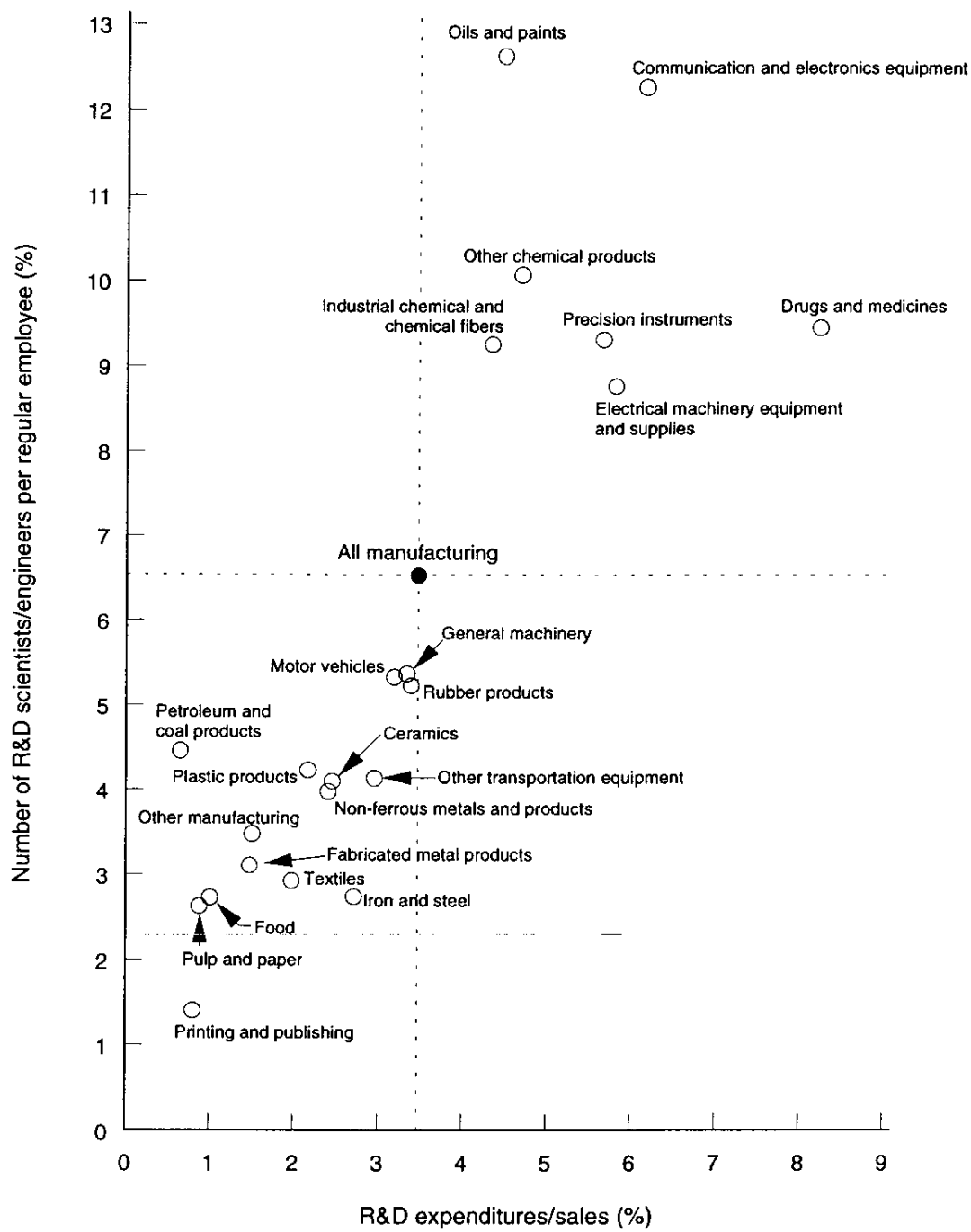
The highest intensity in R&D expenditures was the 8.2% of the drugs and medicines industry. In the case of the drugs and medicines industry, large amounts of investment are required in the safety inspection process, the principle emphasis in the development of products, and this is indeed the situation depicted. Next in R&D expenditure intensity are the communication and electronics equipment industry (6.2%), the electrical equipment and supplies industry (5.8%), and the precision instruments manufacturing industry (5.7%). One can see that R&D expenditure intensity is highest in those high-tech industries where software development accounts for a large share. Next in line in intensity is the other chemical products manufacturing industry, the oils and paints industry, and the industrial chemicals and chemical fibers industry. The intensity in the motor vehicles industry is somewhat higher than the manufacturing industry average.

The intensity in the number of R&D scientists and engineers is high in the oils and paints industry (12.7%), the communication and electronics equipment industry (12.3%), the other chemical products manufacturing industry (10.1%), the drugs and medicines industry (9.5%), and the industrial chemicals and chemical fibers industry (9.3%), the rankings here being quite different from those for R&D expenditure intensity. Many of the industries in which the intensity in the number of R&D scientists and engineers is high are industries related to chemicals.

Intensity in R&D expenditures and intensity in R&D scientists and engineers, except for the top rankings described above, generally have a proportional relationship. In other words, industries with a high ratio of R&D expenditures to sales also tend to have a high ratio of R&D scientists and engineers to total employees.

Looking at R&D intensity by capitalization, in general the larger the capitalization, the higher the intensity of both R&D expenditures and R&D scientists and engineers. However, the R&D intensity of companies in the low end of the capitalization scale (5 million – 10 million yen) is higher than the figure for companies in the next higher capitalization range (10 million – 100 million yen).

Figure 4-2-10 R&D Intensity by Industry (FY1993)



Source: Management & Coordination Agency, *Report on the Survey of Research and Development*  
See Tables 4-2-9 and 4-2-10

### 4.3 R&D in Academia

Universities play an extremely important role in basic and creative fields and in long-term R&D. They also play an important role in human resources development for R&D scientists and engineers for the nation. Cooperation in R&D between universities and industry in applied research and development has been actively pursued of late at the request of industry.

#### 4.3.1 R&D expenditures in academia

R&D expenditures at universities <sup>(1)</sup> can be divided into ordinary/standard expenditures, R&D expenditures paid depending on the content and necessity of research, and specific project-oriented expenditures. Expenditures for developing research facilities and equipment also have a large share of the total.

Ordinary/standard R&D expenditures aim at developing the foundations for R&D scientists and engineers to freely conduct research. At national universities it includes personnel and instructor expenditures and their research and travel expenditures. In the case of private universities, the national government subsidizes the personnel and other educational and research activity expenditures in general.

Special R&D expenditures include miscellaneous expenditures. Among these are expenditures based on the Ministry of Education's scientific research grants designed to markedly develop superior academic research and to contribute toward the promotion of learning in Japan. They are granted for research voluntarily planned by university R&D scientists and engineers or research groups deemed especially important in view of the academic trends in Japan and expected to produce noteworthy research results.

Looking at the changes over time in internal R&D expenditures in universities by type of institution <sup>(2)</sup>, there were many instances during the period shown in the figure when growth in R&D expenditures was greater for private universities than for national universities. This was likely due to the tightening of the nation's finances during the recession triggered by the first Oil Crisis. Growth in R&D expenditures for national universities did surpass that in private universities in FY1992 and FY1993.

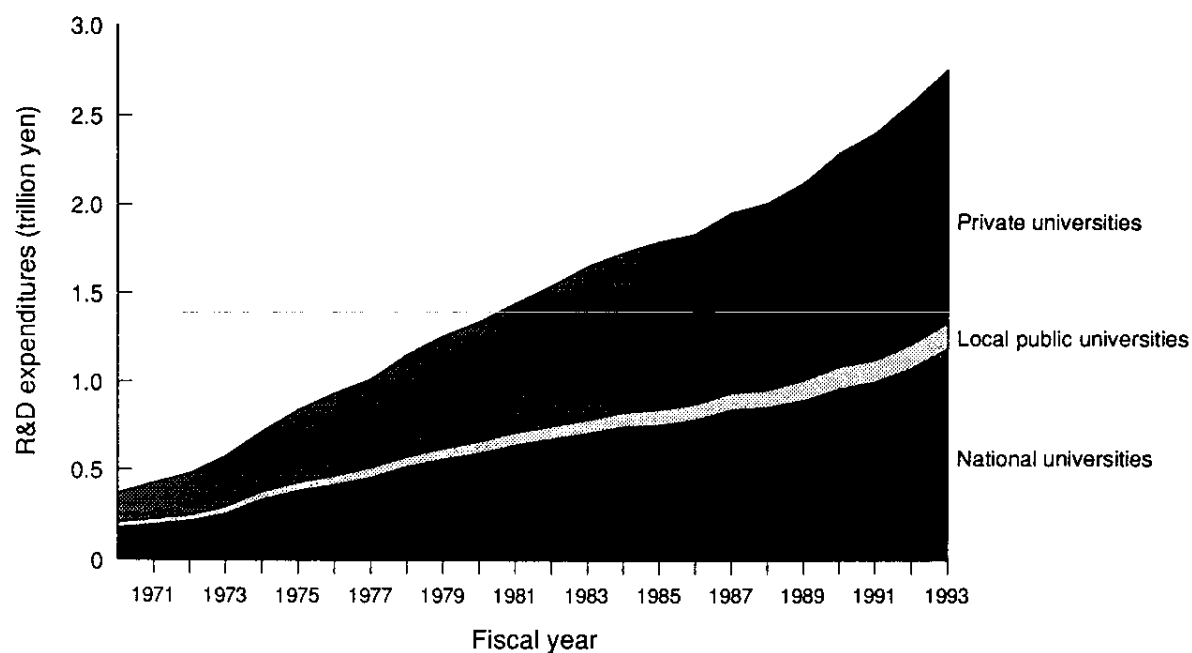
Figure 4-3-1(B) shows R&D expenditures for universities by academic field. Conspicuous has been the lack of significant growth in agriculture. There was considerable growth, however, in R&D expenditures for the physical sciences.

#### [Notes]

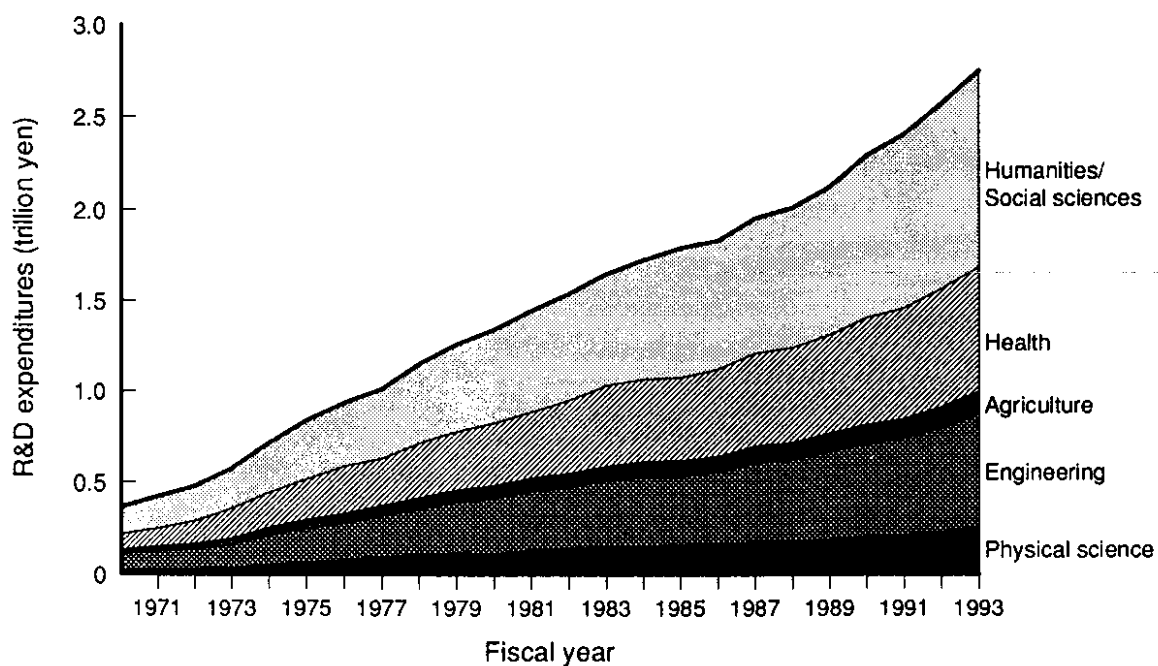
- (1) Universities as defined in the "Report on the Survey of Research and Development" by the Management & Coordination Agency include colleges, junior colleges, colleges of technology, university laboratories, inter-university research institutes, and others.
- (2) Internal R&D expenditures at universities are R&D expenditures used within universities, and include expenditures for personnel, raw materials, and for purchase of tangible fixed assets.

**Figure 4-3-1 R&D Expenditures in Japanese Universities**

**(A) by type of institution**



**(B) by academic field**



Source: Management & Coordination Agency, *Report on the Survey of Research and Development*  
See Table 4-2-7

### **4.3.2 Number of university R&D scientists and engineers**

In FY1994 university R&D scientists and engineers numbered 229,000. This includes those enrolled in doctorate courses and medical staff in addition to instructors. The majority of R&D scientists and engineers were instructors, accounting for 69.0%; enrollees in doctorate courses made up 17.4% and medical staff 13.6%.

Figure 4-3-3 shows the number of university R&D scientists and engineers by type of institution. The overall number of university R&D scientists and engineers has grown at a firm rate. The ratio by organization in 1994 was 47.2% for private universities, 46.4% for national universities, and 6.4% for public universities. There has been no major change to these ratios during the period shown in the figure.

The number of R&D scientists and engineers in the natural sciences has grown to approximately double that of those in the humanities/social sciences (Figure 4-3-2(B)), although in 1961 it was in fact humanities/social sciences that had more. The very next year the two changed places, though, and since then the ratio of R&D scientists and engineers in the natural sciences has gradually climbed.

The natural sciences comprise physical science, engineering, agriculture, and health. Most numerous among were university were those in health, followed by those in engineering. The rate of increase for engineering has not been as high as that for health, though. In addition to this high ratio of health-related R&D scientists and engineers, the recent high growth rate in the number of university R&D scientists and engineers sets academia apart from industry. Although the ratio of physical science R&D scientists and engineers to the total is still small, this ratio is growing even faster than that for health.

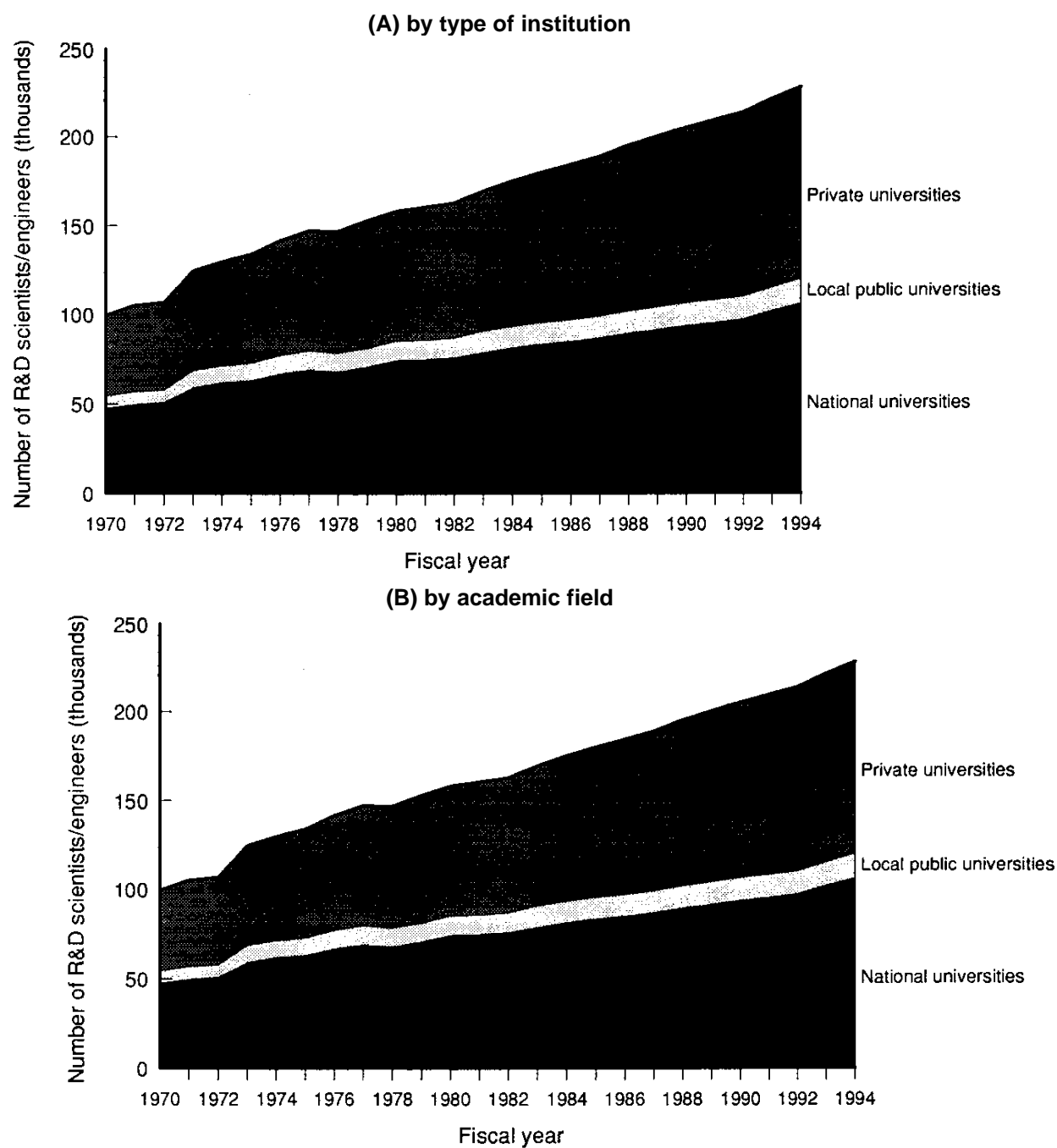
### **4.3.3 R&D expenditures per university R&D scientist/engineer**

By type of institution, private universities have since FY1971 had the largest internal R&D expenditures per university R&D scientist/engineer (Figure 4-3-3(A)). There have been many years in which the growth in this ratio has been higher than that of national or public universities. However, the growth for national universities in FY1993 surpassed that of private and public universities. Before the 1970s it was generally the national universities that were highest, but since a reversal in 1971 private universities have consistently been higher.

By specialization, health had the largest internal R&D expenditures per university R&D scientist/engineer, but the growth in this rate has been conspicuously small (Figure 4-3-3(B)). In the natural sciences, physical science and engineering have recently enjoyed the largest rates.

In national universities persons enrolled in doctorate courses make up a large share of university R&D scientists and engineers, while the largest share in public universities consists of medical staff. In private universities instructors make up the largest share, while persons enrolled in doctorate courses account for only a small share. The composition of R&D scientists and engineers must be considered when comparing R&D expenditures per R&D scientist/engineer.

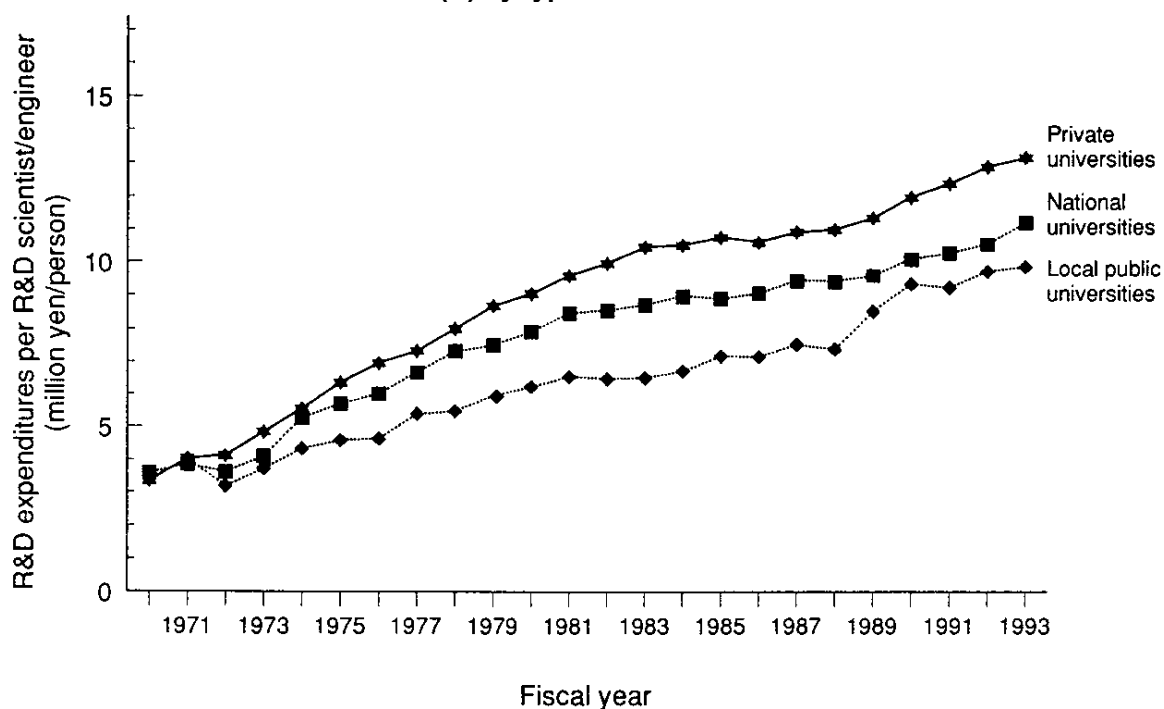
**Figure 4-3-2 Number of R&D Scientists/Engineers in Japanese Universities**



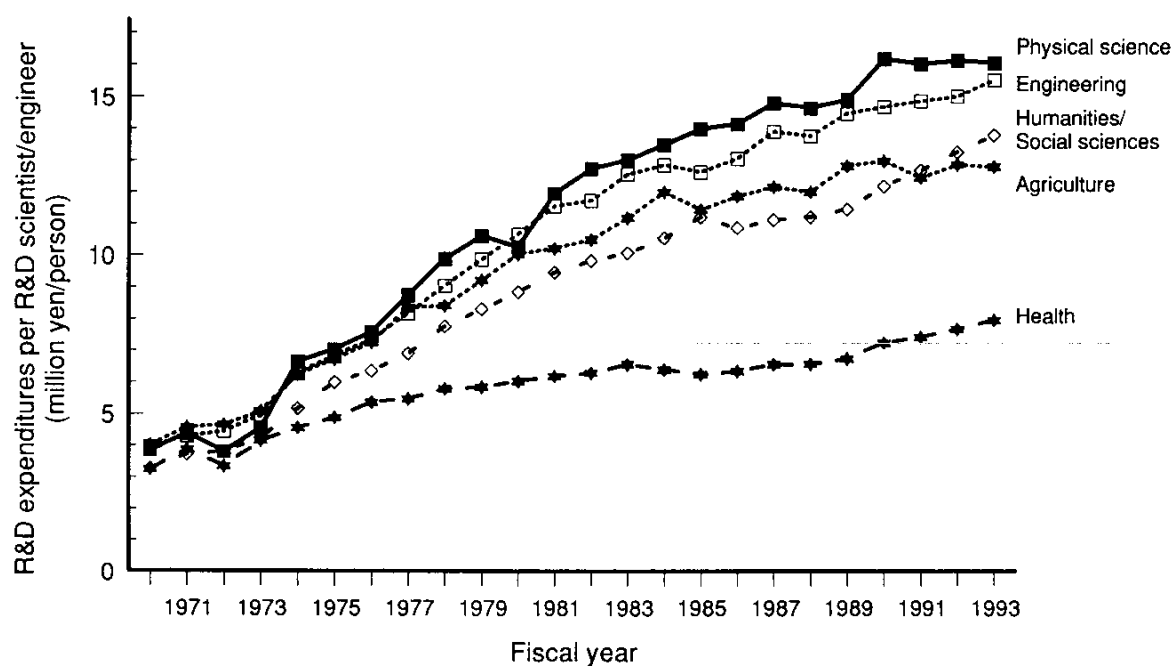
Source: Management & Coordination Agency, Report on the Survey of Research and Development  
See Table 4-3-2

Figure 4-3-3 R&D Expenditures per R&D Scientist/Engineer in Japanese Universities

(A) by type of institution



(B) by academic field



Source: Management & Coordination Agency, *Report on the Survey of Research and Development*  
See Table 4-3-3



## 4.4 R&D in R&D Organizations

Here R&D organizations refer to the following:

- (1) national R&D institutes;
- (2) semi-governmental corporations whose principal activity is R&D (hereafter, “semi-governmental R&D institutes”);
- (3) public R&D institutes established by local governmental authorities; and
- (4) private R&D institutes, primarily foundations.

Organizations belonging to (1) are often called “national R&D institutes”, while organizations belonging to (3) are often called “public R&D institutes”; in keeping with statistical categories [5], this paper will use these terms.

Unlike universities and industry, these R&D institutes all specialize in R&D but they are quite different in nature. National R&D institutes belong to government ministries/agencies and promote R&D in areas of strong social or administrative need. Semi-governmental R&D institutes are mainly financed or subsidized by the government or privately funded, and along with national R&D institutes they play major roles in the national R&D structure. Because semi-governmental R&D institutes can recruit talent widely from the government and the private sector, because they can be operated flexibly as organizations, and because they can introduce private funding, they are instrumental in efficiently promoting goal-oriented R&D. They play major roles today as R&D grows in scale and complexity. Public R&D institutes contribute to the promotion of regional areas by conducting R&D as local circumstances dictate. Private R&D institutes are foundations and other non-corporate private organizations, and their number is still small. These institutes made contributions of a kind different from other R&D organizations and they should develop even further in future. National and semi-governmental R&D institutes are usually treated as governmental R&D organizations.

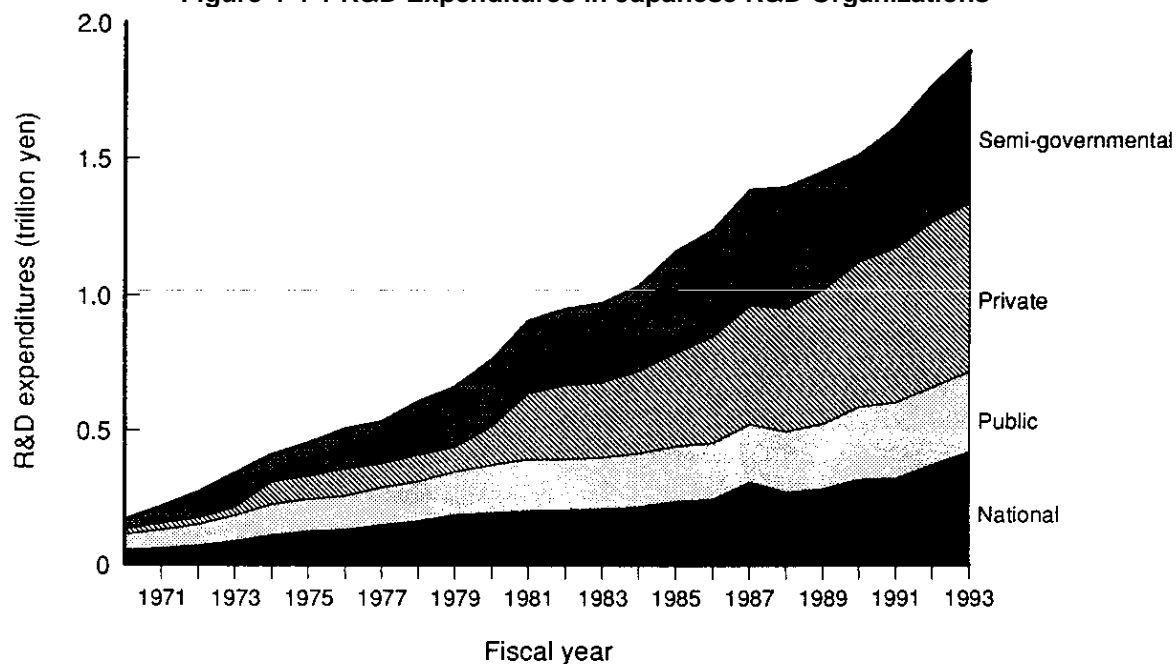
### 4.4.1 R&D expenditures by R&D organizations

R&D expenditures by Japanese R&D organizations reached 1.8968 trillion yen in FY1993, 13.8% of all R&D expenditures in Japan. The ratio in recent years has been declining slightly.

Figure 4-4-1 shows R&D expenditures by type of research organization. Private and semi-governmental R&D institutes have high R&D expenditures, while those of public R&D institutes have been relatively small.

The R&D expenditures of private R&D institutes experienced significant growth from the late 1960s to the early 1970s. They also saw major growth in the first half of the 1980s. From the latter half of the 1980s, however, this growth tapered off. R&D expenditures of national R&D institutes grew slowly for a long time, but in FY1991 and FY1992 they saw major growth.

**Figure 4-4-1 R&D Expenditures in Japanese R&D Organizations**



Source: Management & Coordination Agency, *Report on the Survey of Research and Development*  
See Table 4-4-1

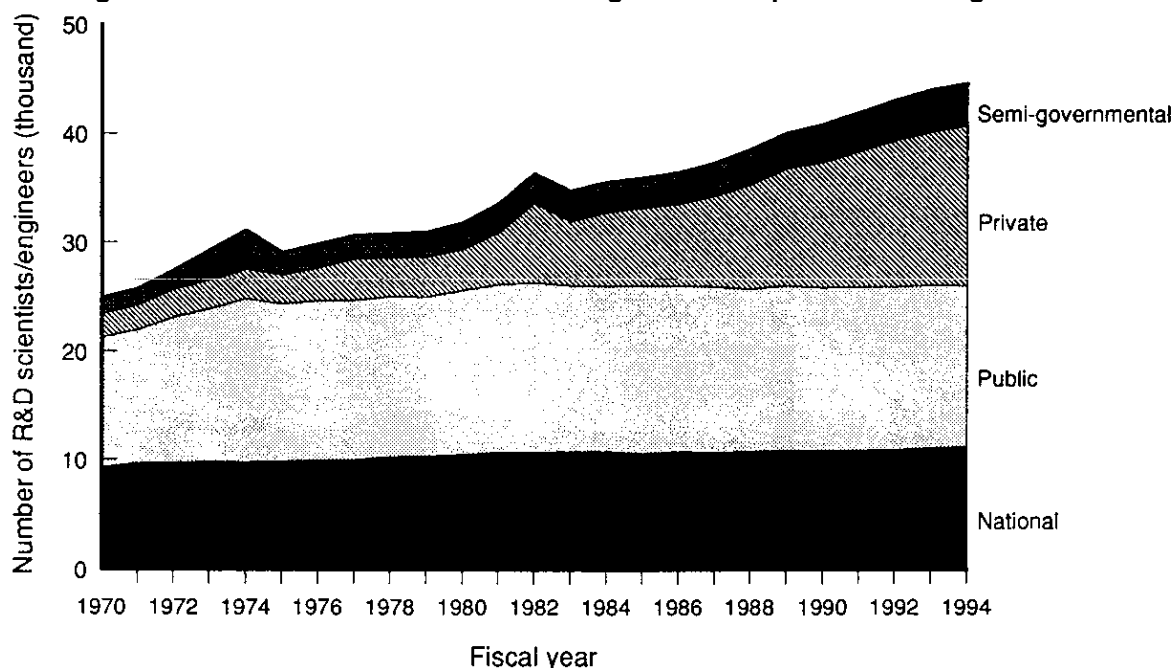
#### **4.4.2 Number of R&D scientists and engineers at R&D organizations**

In FY1994 R&D scientists and engineers working in Japan numbered about 45,000. This was 7.1% of the total number of R&D scientists and engineers in Japan that year. Examining recent trends shows that growth in this number has been lower than that of both corporations and universities. In particular, the number of R&D scientists and engineers at R&D organizations has dropped as fiscal constraints have forced down the total number of positions.

Figure 4-4-2 shows the number of R&D scientists and engineers at R&D organizations. A quick glance reveals that the number of R&D scientists and engineers at national R&D institutes has not grown. The number at public R&D institutes has also remained virtually the same since the 1970s, as has the number of R&D scientists and engineers at semi-governmental R&D institutes. In contrast, the number at private R&D institutes has been increasing, and this increase was especially marked in the 1980s.

As can be seen in Figure 4-4-2, the ratio of the number of R&D scientists and engineers in private R&D institutes to the total has been increasing, while the ratios for other types of institutes has been decreasing. The increase in the overall number of R&D scientists and engineers at R&D organizations has been almost entirely due to the increase in the number of R&D scientists and engineers at private R&D institutes. Conversely, the ratio for governmental R&D institutes has been decreasing. In FY1994, public R&D institutes employed 33% of those R&D scientists and engineers working in R&D organizations, private R&D institutes 33.0%, national R&D institutes 25.1%, and semi-governmental R&D institutes 8.6%.

**Figure 4-4-2 Number of R&D Scientists/Engineers in Japanese R&D Organization**



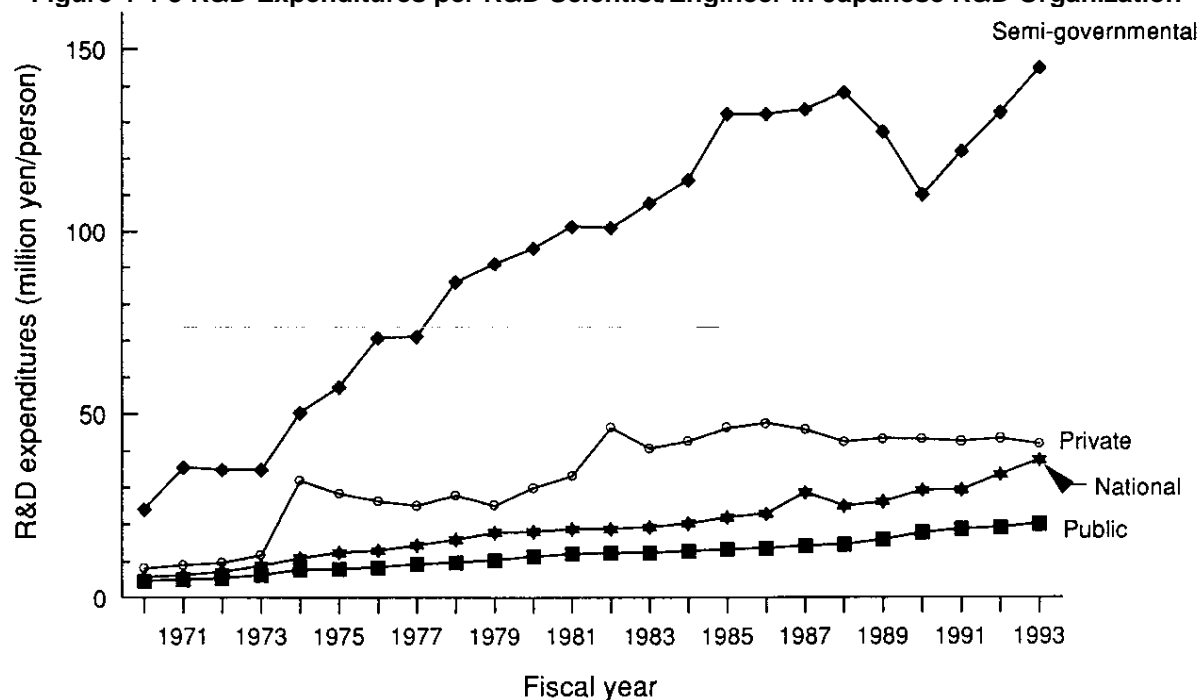
Source: Management & Coordination Agency, "Report on the Survey of Research and Development"  
See Table 4-4-2

#### **4.4.3 R&D expenditures per R&D scientist/engineer at R&D organizations**

Figure 4-4-3 shows the internal R&D expenditures per at R&D organizations. Semi-governmental R&D institutes had the largest R&D expenditures per R&D scientist/engineer throughout the period shown in the figure, and this rate grew remarkably from FY1974 to FY1985. In 1993 the largest R&D expenditures per R&D scientist/engineer was at semi-governmental R&D institutes, 145.01 million yen. Next in terms of R&D expenditures per R&D scientist/engineer were private R&D institutes. The average amount for private R&D institutes was small in comparison to that of semi-governmental R&D institutes, and in FY1993 this amount was 41.96 million yen, about one-third that of semi-governmental R&D institutes. R&D expenditures per R&D scientist/engineer were even smaller in national and public R&D institutes, and in 1993 these were 37.66 million yen and 20.19 million yen respectively.

Organizations with a high level of R&D expenditures per R&D scientist/engineer appear to be engaged in R&D that requires large amounts of R&D expenditures for facilities and equipment, and this figure thus closely reflects the nature of R&D activities. In particular, it shows that large-scale R&D is being conducted at semi-governmental R&D institutes.

Figure 4-4-3 R&D Expenditures per R&D Scientist/Engineer in Japanese R&D Organization



Source: Management & Coordination Agency, *Report on the Survey of Research and Development*  
See Table 4-4-3

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# Chapter 5

## Achievements of R&D Activities

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## **Chapter 5**

### **Achievements of R&D Activities**

This chapter discusses indicators that show the achievements of R&D activities. The system for scientific and technological indicators which served as the guideline in structuring this report views the indirect impact of R&D as “contributions of science and technology” and indicators of more direct achievements such as scientific papers and patents as “R&D achievements”. In accordance with this, indicators connected with scientific papers and patents as well as the numbers of standards and awards for scientific and technological merit will in this chapter be used to demonstrate “R&D achievements”.

#### **5.1 Scientific Papers**

There can be said to be two main objectives of R&D. One is to explore cause and effect relationships and laws related to natural and social phenomena and the other is develop technologies for the application of these phenomena and laws by human society. The former often appears in the form of scientific papers, while the experience and knowledge generated through the latter also sometimes appear in the form of scientific papers. By thus being published in the form of papers, R&D achievements become the common intellectual property of mankind. Indicators related to scientific papers therefore point out the level of R&D achievements and their contribution to scientific and technological knowledge.

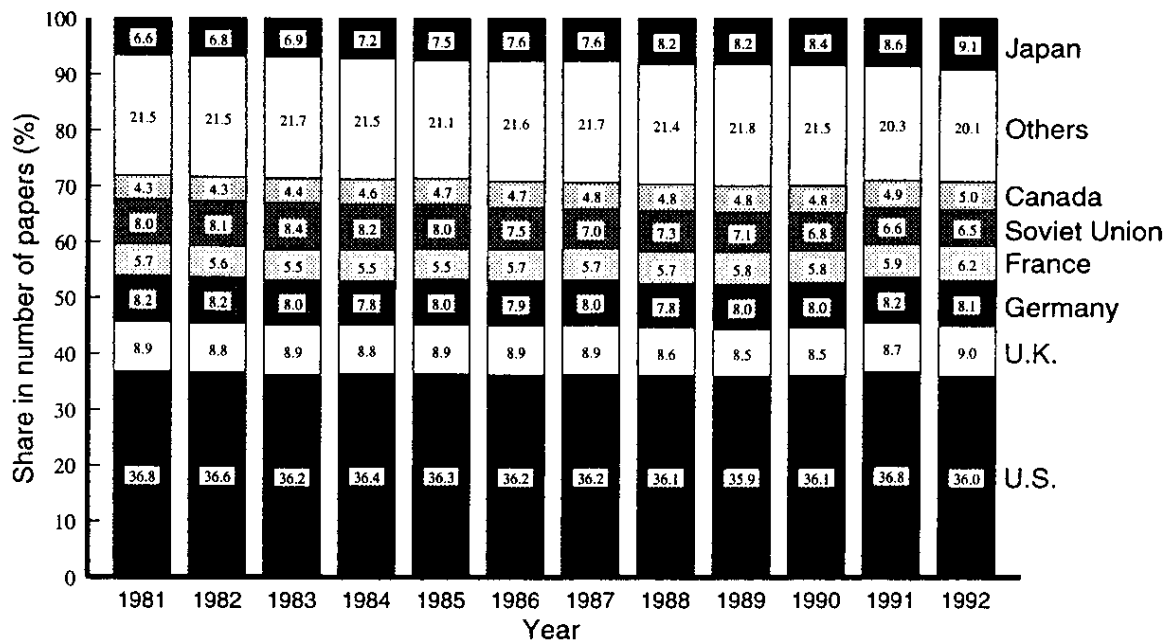
In generating indicators related to scientific papers, it is difficult to model calculations directly on the enormous number of scientific and technical journals that exist, and hence a Database of the literature is used. Internationally, the Science Citation Index Database [1],[2] (hereafter, “SCI Database”) is often used. Some of the reasons the SCI Database is considered suitable are that it covers all areas of science and technology, it makes available data on papers cited, and it bases its selection of journals on the citation frequency of scientific papers. Compared to other databases specializing in specific areas, on the other hand, the SCI Database has only a small number of papers in each area and it contains mainly English-language papers. Nevertheless, this chapter calculates indicators for scientific and technological papers in accordance with SCI.

##### **5.1.1 Number of papers**

The most basic indicator for scientific papers is simply their total number. The total number of papers analyzed in this chapter as drawn from the SCI was 564,829 in 1992. As the SCI does not cover all of the papers published around the world, though, this figure should not be taken as the “composite worldwide total” of papers. Instead it should be seen as indicating the scale of the subject of analysis before going into more detailed consideration below.

Examination of the world share of scientific papers and not merely of the absolute number of papers gives a quantitative view of the level of Japan’s R&D achievements and their degree of contribution to the world. Figure 5-1-1 shows the share by country of scientific paper output. During the period shown in the figure, the U.S. consistently had an overwhelming share of over 30% of worldwide output. This share decreased until 1989, but since 1990 has leveled off. While Japan’s share was fifth in the world in 1981, it passed the Soviet Union in 1986, Germany in 1988, and the U.K. in 1992 to rank second behind the U.S.

Figure 5-1-1 Country Share Trends in the Output of Scientific Papers



Source: *Science Citation Index Database*  
See Table 5-1-1

Because the SCI Database used here for calculation purposes contains such a high proportion of English-language papers, it would appear in light of the above that the actual number of papers produced in Japan (when many of those papers produced only in Japanese are included) has been underestimated. This indicator nonetheless shows that Japan's share has been increasing and that the number of scientific papers in Japan, even when underestimated, ranks second in the world.

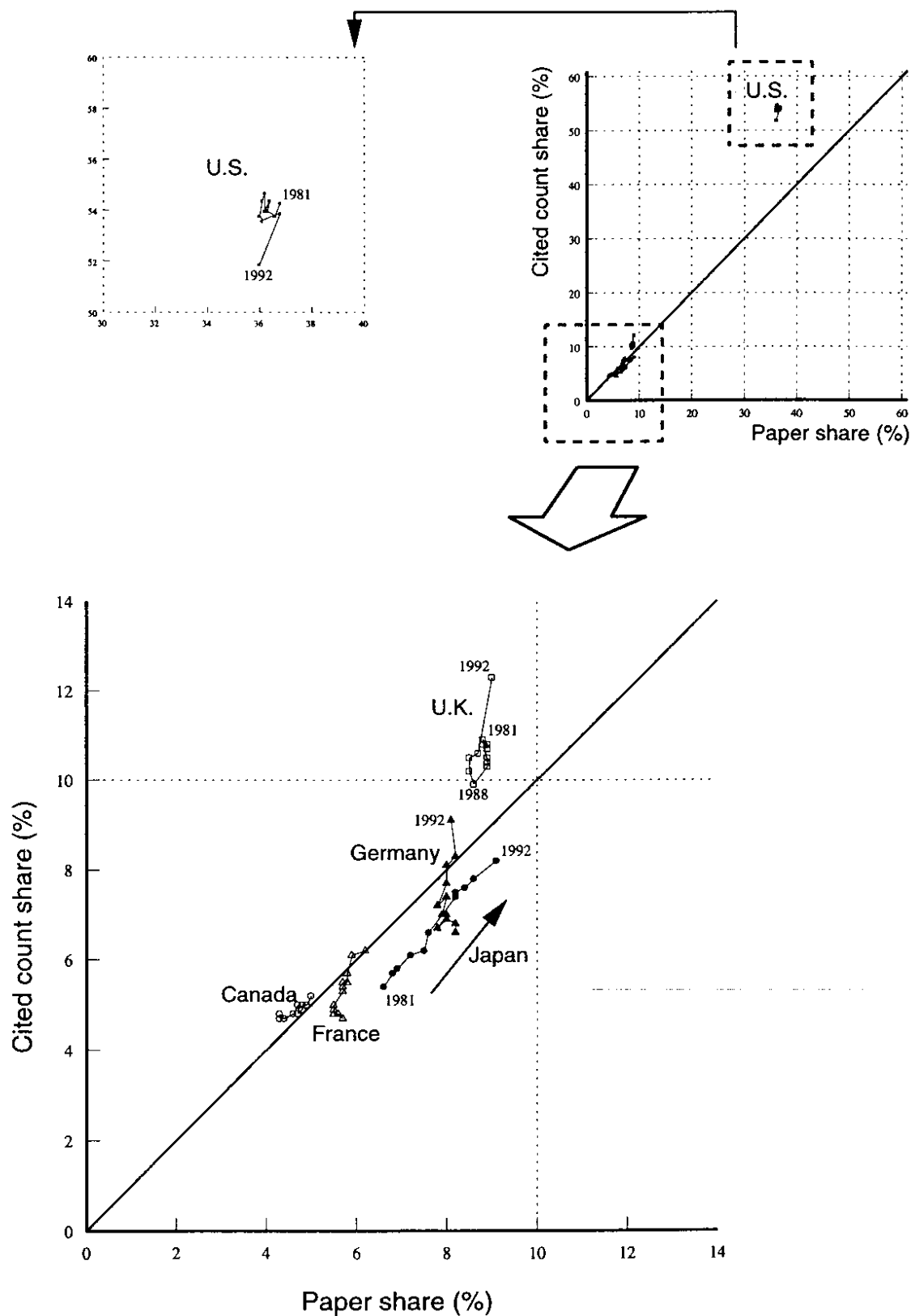
### 5.1.2 Scientific paper citations

The total number of papers produced alone is inadequate as an indicator of R&D achievements and a qualitative examination is also required. Here the number of scientific paper citations has been adopted as such an indicator. The number of scientific paper citations is the number of times a paper is cited in other scientific papers. Scientific papers are not necessarily cited because of their outstanding quality, however, so the number of paper citations does not directly reflect high evaluations of the quality of papers. Rather, the number of paper citations shows the degree of impact a given paper has on the scientific community. Along this line of thinking, the impact of the scientific papers of individual countries will be shown in this section through the number of paper citations on a national level; quality, too, which cannot be understood simply through the absolute number of papers produced, will also be shown. The number of paper citations is not simply used alone, but in combination with the number of scientific papers. This is because the more papers a country produces the more likely it is that these papers will be cited, and it would not be justifiable to judge impact and quality merely on paper citation frequency. For this reason, the number of paper citations and the number of papers produced will be combined here into one indicator, "paper citation frequency".

Figure 5-1-2 shows paper citation frequency for selected countries. This figure shows the relationship of two values, the paper share on the horizontal axis and the cited count share on the vertical.



Figure 5-1-2 Scientific Paper Citation Frequency by Country



Source: Science Citation Index Database  
See Table 5-1-2

The straight line (slope = 1) in the figure shows equality between the paper share and the cited count share; points along this line have a cited count share equal to the world average, in other words, the number of paper citations matches the number of scientific papers produced. For points above this line, the cited count share is higher than the paper share, meaning that the impact of these papers is higher than the world average.

The U.S. has the largest paper share, and its cited count share is higher than its paper share; almost half of the papers cited throughout the world are of U.S. origin. Thus one can see the enormous impact of U.S. papers. Next after the U.S. in cited count share is the U.K. The U.K. also has a cited count share higher than its paper share, and thus the impact of its papers appears high. The U.K. cited count share declined until 1988, but has turned upward from 1989. Japan's cited count share in 1992 ranked third in the world. Throughout the period shown in the figure, however, its plot was lower than the slope 1 line, and thus its cited count share was relatively smaller than its paper share, indicating that the impact of its papers were below the world average. Japan's cited count share has continued to increase, though. Although the paper shares of France and Germany have increased almost not at all, their cited count share has risen. The papers of both countries thus appear to be scoring more impact per paper.

The fact that Japan's cited count share is below the world average is, as was mentioned in the previous section, partly due to the impact of the bias towards English-language publications in the SCI Database. However, this indicator reflects the fact that English-language publications constitute the mainstream in science and technology output, and in this sense, it does show the actual influence of Japanese scientific papers.

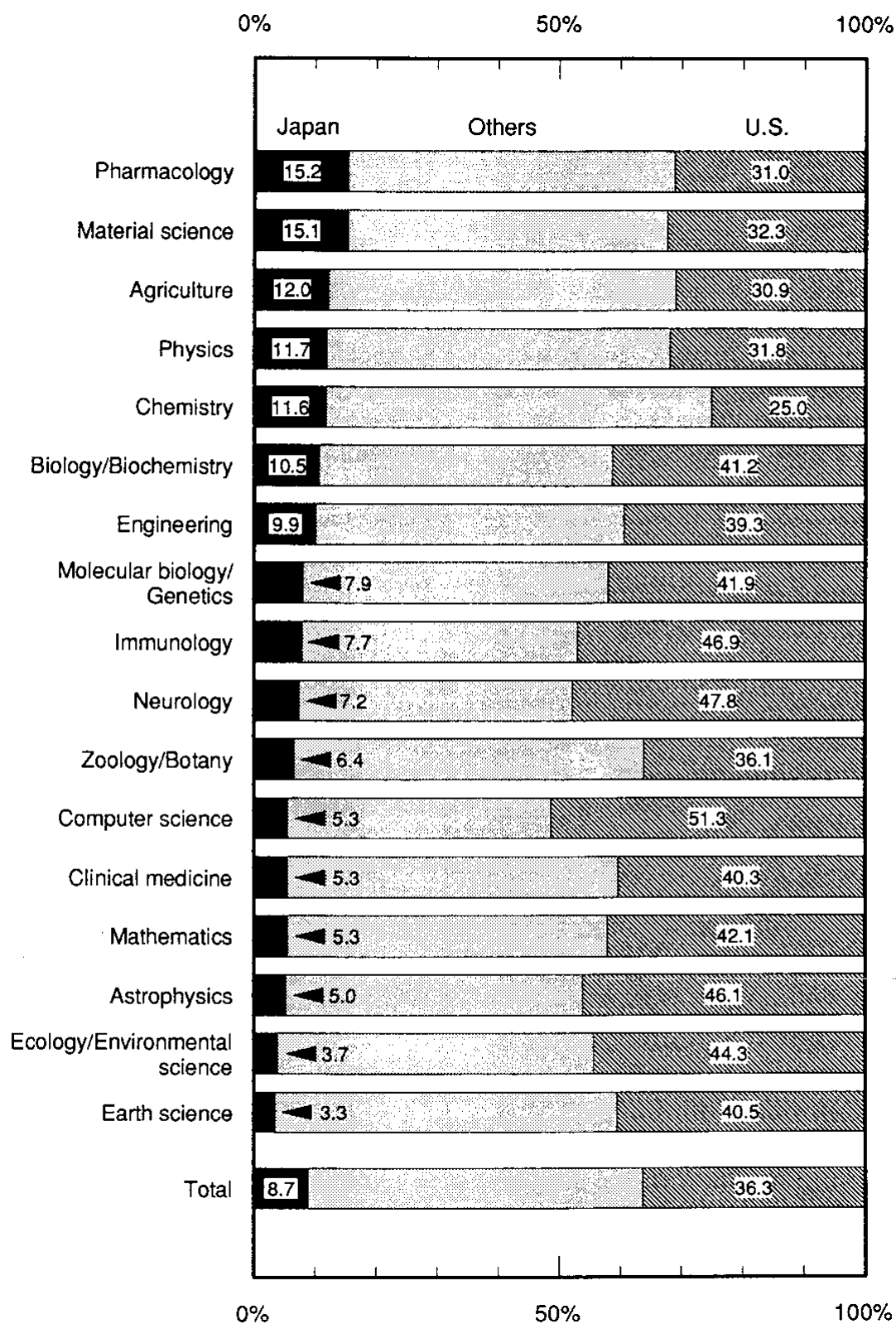
### **5.1.3 Number of scientific papers by area of research**

The share of Japanese scientific papers published in each area of research has studied as a means of learning the status of Japanese scientific papers by area, and in doing so, the categories given in the SCI Database were used. 17 areas of research are listed in the SCI Database based on the types of scientific and technical journals being published. Figure 5-1-3 shows the share of scientific papers in Japan and the U.S. in these 17 areas of research, listed in order of Japan's share. While Japan has relatively large shares in pharmacology and material science, it has extremely low shares in earth science and ecology/environmental science. Particularly conspicuous is Japan's small share in computer science in comparison with the U.S. The U.S. also has large shares in areas connected with medical and biological sciences such as neurology and immunology. Overall, the areas in which Japan and the U.S. have large shares differ considerably.

### **5.1.4 Citation frequency by area of research**

In studying citation frequency by area of research, it is possible to learn in which areas of science and technology Japan has produced outstanding achievements. Figure 5-1-4, as did Figure 5-1-2, plots paper share on the horizontal axis and cited count share on the vertical, and shows the Japanese citation frequency (1992) for each of the 17 areas as well as for all areas as a whole. Only three areas had plots above the slope 1 line and were consequently above the world's average in citation frequency: material science, agriculture, and astrophysics. In these it can be said that high quality achievements have been made. Although below the slope 1 line, physics and chemistry also had relatively high citation frequencies. On the other hand, ecology/environmental science and computer science were among the areas with low citation frequency. While the largest paper share belonged to pharmacology, its cited count share was relatively low.

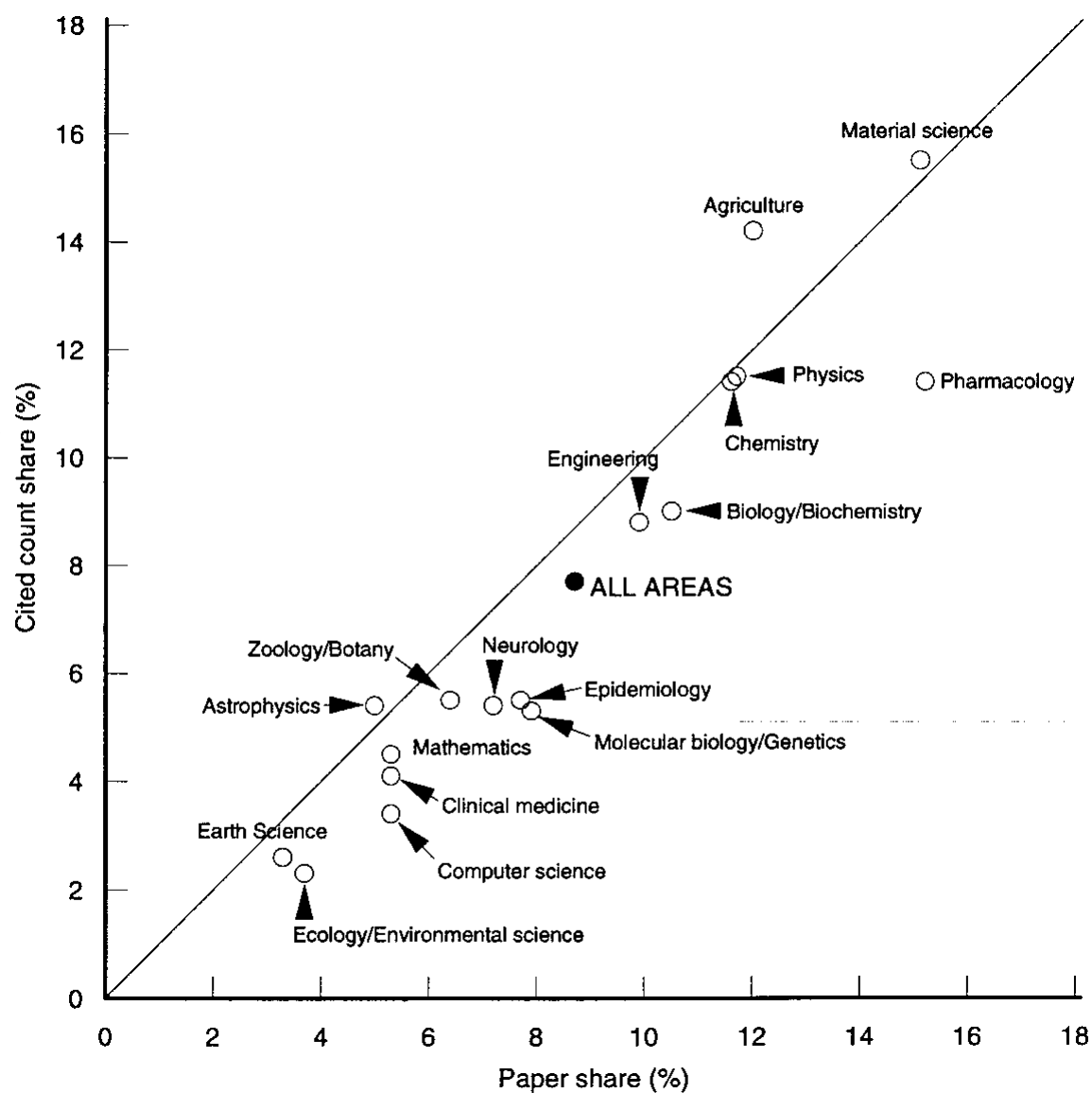
Figure 5-1-3 Paper Share by Academic Field in Japan and the U.S.



Source: Science Citation Index Database

See Table 5-1-3

**Figure 5-1-4 Japanese Scientific Paper Citation Frequency by Academic Field  
(1990–92 average)**



Source: *Science Citation Index Database*  
See Table 5-1-4

## 5.2 Patenting

This chapter will use data related to patenting for indicators of R&D achievements. In addition to protecting the natural rights of the inventor, another basic objective of the current patenting system is contributing to industrial development through the encouragement of invention and the spread of technology. It has become quite common in recent years for more time and money to be spent on follow-up technological development than on the inventions themselves, and the patenting system has grown in importance as a means of guaranteeing possible returns on investment. For that reason, data on patenting provides indicators essential to understanding modern science and technology as they develop in conjunction with industry.

Patenting data provides high quality information on technical knowledge as manifested in inventions and on technological inventions, but there are several points that should be remembered when using such data as indicators. First, technical knowledge, also termed “know-how”, does not always take the form of patents and inventions are even sometimes kept secret by inventors; hence, patenting data does not necessarily cover all inventions and technical knowledge. Second, the value of holding a patent differs greatly by industry and technological field, and the weight of patenting data differs accordingly. Third, international comparisons are difficult because patent systems differ greatly across countries. Fourth, problems of continuity arise in time-series data, even in an individual country’s patent system, due to the impact of changes in the system and in the fees charged applicants. The above points must be borne in mind when interpreting patenting data, and it is important to recognize the limitations of such data.

### 5.2.1 Patent applications and grants in Japan

This section will use the number of patent applications and grants in Japan as an indicator for patenting. The number of patents in those countries that accept and screen patent applications is often used as the most basic of patenting statistics. Such a figure also includes patent applications made by foreign inventors, though, and in principle is not an appropriate indicator for measuring the degree of R&D achievements in a country because it is not the same as the number of patents by nationality of inventor. In particular, an international comparison of such figures, for anything more than patent administration purposes, would not be of much significance. For that reason, this institute has endeavored to develop an indicator using the numbers of patent applications and grants in Japan that can reflect as closely as possible the R&D achievements of Japan by distinguishing between figures for Japanese nationals and for foreign nationals. Indicators for comparing the degree of R&D achievements in individual countries will be discussed in Section 5.2.4.

#### (1) Patent applications and grants: Trends

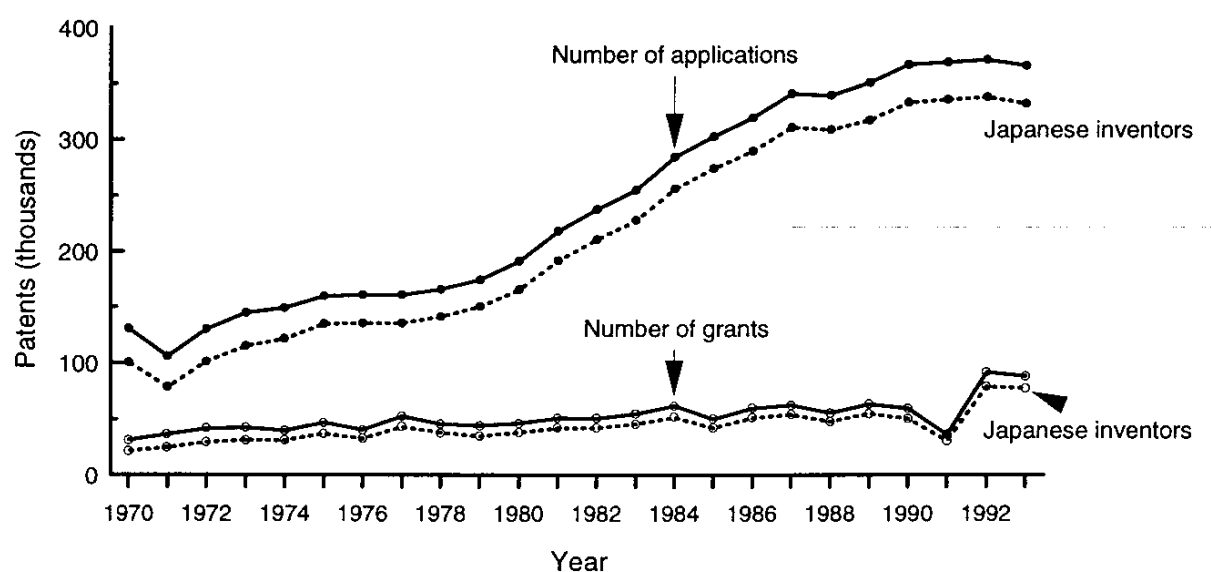
Figure 5-2-1 shows the number of patent applications and grants in Japan. The number of applications grew especially sharply in the 1980s. Most of these applications were submitted by Japanese nationals. Behind this increase in applications in the 1980s was the intensification of R&D in Japanese industry as seen in the increase in R&D expenditures from the latter half of the 1970s. From the late 1980s, however, growth in the number of applications tapered off due to diminished applications by companies.

The number of patent grants (the number actually registered as patents) is small in comparison with the number of applications, and this number has not increased as fast as the number of applications. Still, there has been a slight increase over the long term. Temporary fluctuations in the number of patent grants have been due to changes in the patenting system, and the substantial

decrease in 1991 can be attributed to the transition to a new patenting system known as the “paperless system” (1).

The fact that the number of patent grants is far below that of patent applications is due to several reasons. Many applications were made for the express purpose of invalidating identical applications by others (known as strategic applications or defensive applications (2)); there were times when insufficient preliminary investigation by applicants led to the repetitive applications for similar patents; and some applications were not accepted because the inventions were obsolete. Such reasons are apparently behind the fact that the number of patents actually granted in recent years has been no more than about half the number of inventions for which applications are submitted. Yet another reason is that the patent screening system has not been able to cope with the rapid increase in applications.

**Figure 5-2-1 Patenting Trends in Japan**



Source: Patent Agency, *Patent Agency Annual Report*  
See Table 5-2-1

## (2) Patenting trends by technological area

Figures 5-2-2 (A) and (B) show the number of patent applications and grants by technological area. These technological areas correspond to the International Patent Classifications (IPC). The highest shares in the number of applications in 1991 were held by physics and electricity. Even higher than the areas of physics and electricity in terms of shares in the number of patent grants, however, were chemicals/metallurgy/textiles, and processing/control/transportation. The number of patent grants in the areas of physics and electricity is quite low in relation to the number of applications; there are many strategic applications submitted in these areas as well as much overlapping between applications.

(3) Number of patent applications by patent classification

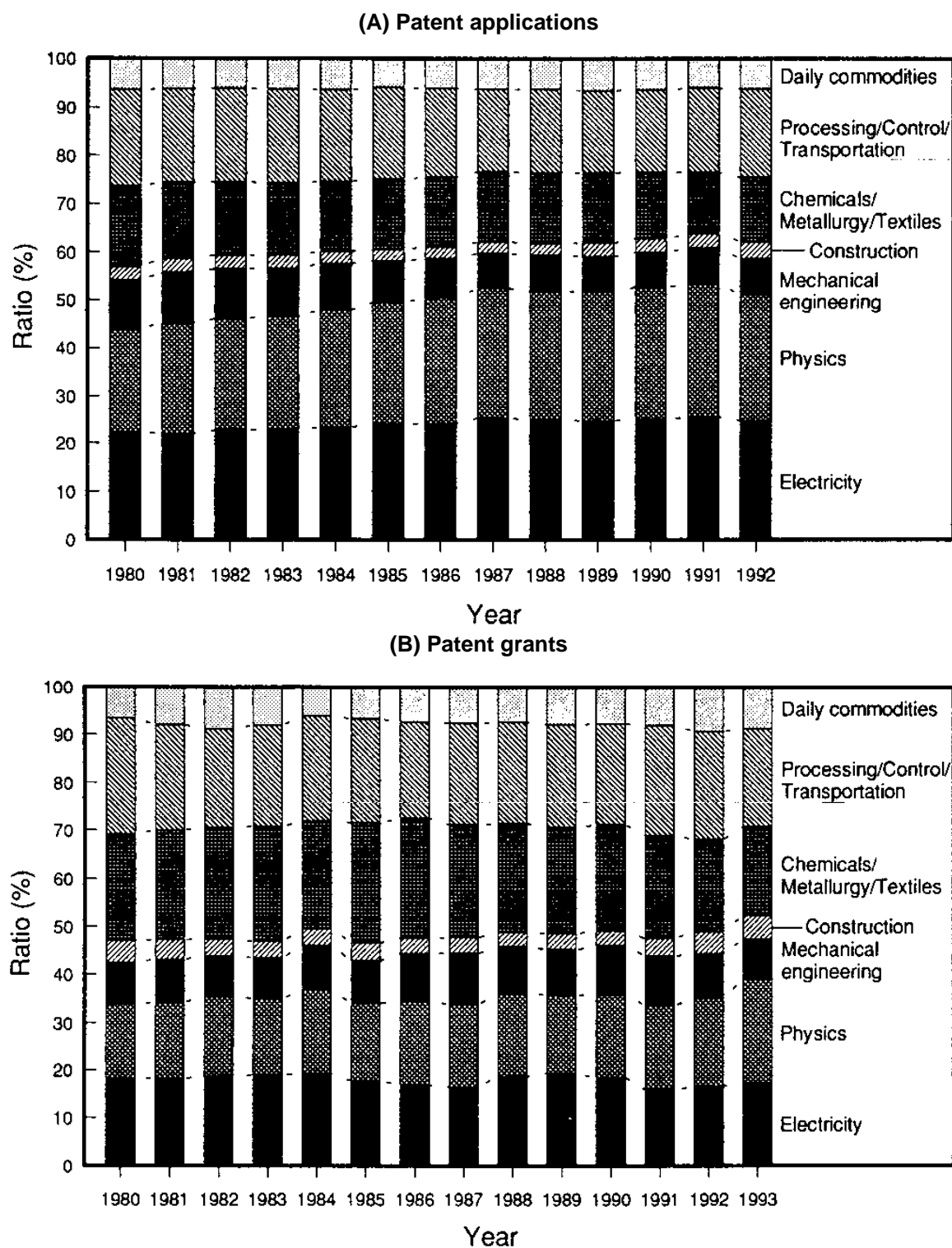
In addition to the aforementioned technological area statistics, Japanese patenting statistics also report the number of applications in more detail using 118 patent classifications. These patent classifications, too, are in accordance with the IPC. The top 20 classifications in terms of numbers of patent applications in 1991 are shown in Figure 5-2-3. The top three areas, both overall and for Japanese inventors, were basic electrical components, telecommunications technology, and computation/counting. The largest single share of applications by foreign inventors was in organic chemistry, followed by basic electrical components and medicine/veterinary medicine.

This figure shows only the number of applications; the number of patent grants has been omitted. Calculation of the number of patent grants by patent classification for U.S. patents obtained by Japanese inventors will be discussed later (Section 5.2.3). Data of this type covers a more carefully selected range of patents, given the importance of applications for U.S. patents by Japanese inventors and the high costs associated with domestic applications in Japan.

**[Notes]**

- (1) In order to cope with the rapid increase in the number of patent applications in Japan, the Patent Agency has been pushing ahead since 1984 with the implementation of a paperless system. This system, by using computers instead of normal paper documentation for the submission, receipt, and screening of applications as well as for the provision of information on industrial property rights, attempts to streamline processing by shorting screening time for industrial property rights applications. Electronic applications for utility models and the electronification of the general registration of industrial property rights commenced in December 1992.
- (2) Strategic and defensive applications is the general term used for applications submitted to block the patent rights of other parties or to prevent the submission of claims by other parties. There are several types of such applications, with those submitted to invalidate the applications of other parties often withdrawn before actual screening; this is a pathological phenomenon in the patent system and one reason for screening delays.

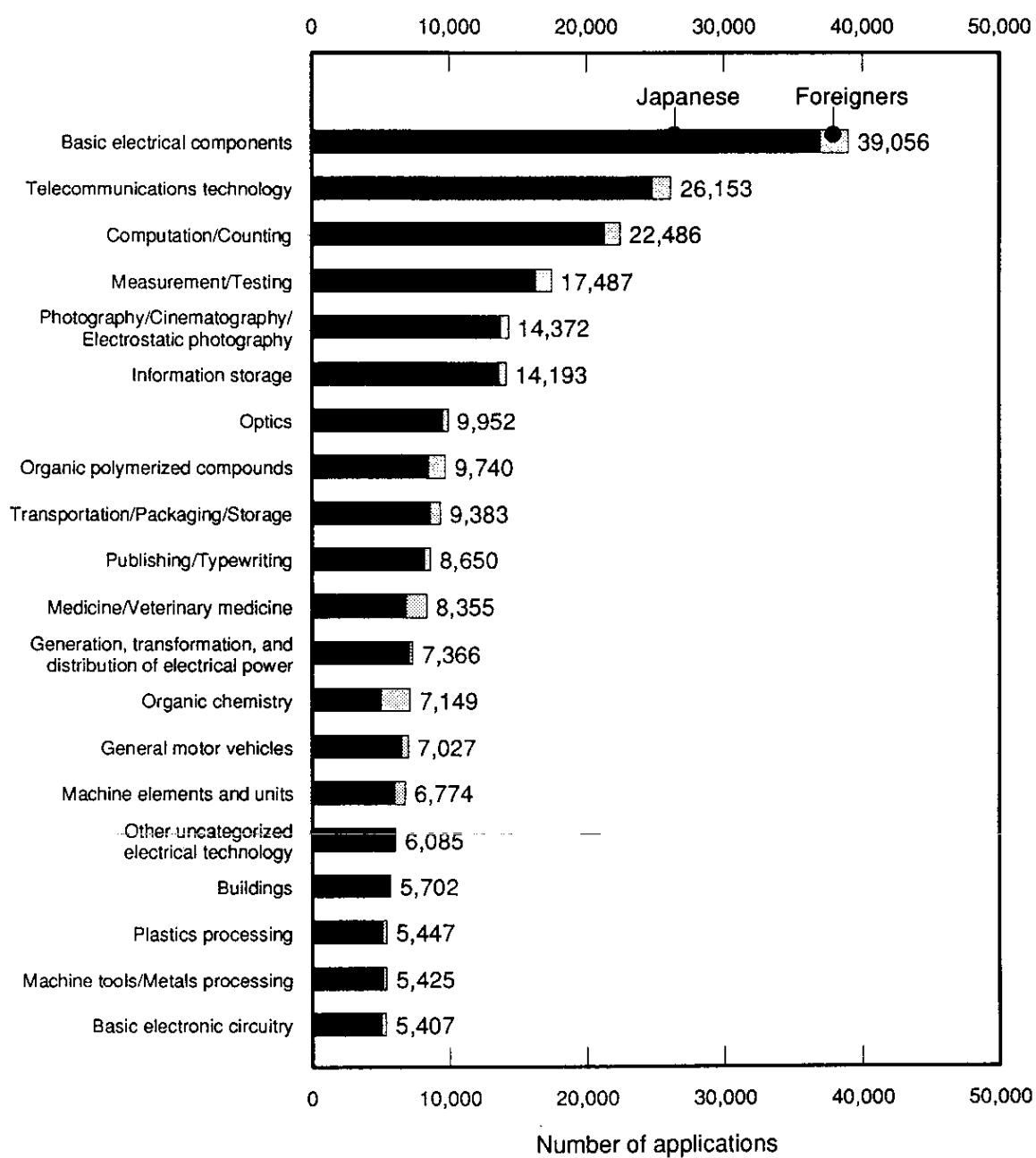
Figure 5-2-2 Patenting Trends in Japan by Technological Area



Source: Patent Agency, *Patent Agency Annual Report*  
See Table 5-2-2



**Figure 5-2-3 Patent Applications in Japan by Classification (Top 20 classifications, 1992)**



Source: Patent Agency, *Patent Agency Annual Report*  
See Table 5-2-3

#### (4) Patents to foreign inventors

The number of patent applications by and grants to foreign inventors has no direct connection with the achievements of Japanese R&D, but it is important as a leading indicator of new competition in the Japanese domestic market. In 1992 the U.S. accounted for nearly half of the number of foreign applications in 1992 by nationality of inventor, followed by Germany, France, and the U.K. (Figure 5-2-4). Immediately below these countries are numerous other European countries, South Korea at seventh place being the one exception. By region, the Americas and Europe account for the vast majority, followed by Asia, although the total for Asia as a whole does not amount to one-tenth that of the U.S. nor does it even equal that of the U.K. South Korea accounts for more than 70% of Asia's total, followed by Taiwan at a mere one-fifth of South Korea's figure. While the shares of the number of patent grants for the U.S. and Europe are similar to their shares in the number of applications, for other countries, especially South Korea, the share of grants is extremely small in comparison with the share in applications.

### 5.2.2 Japanese external patents

#### (1) Number of external patent applications and grants

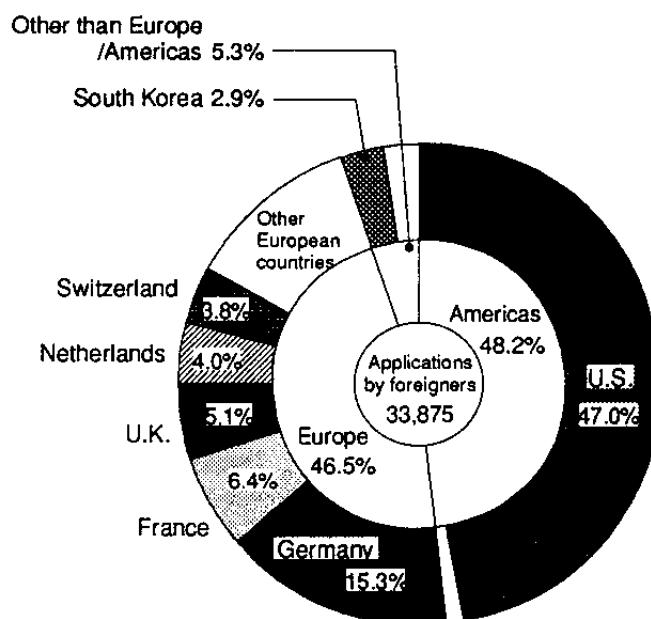
Figure 5-2-5 shows the number of Japanese external patent applications (applications for foreign patents by Japanese inventors) by country. In 1991 applications for U.S. patents were most numerous, followed by applications for German and British patents. The share of applications submitted for U.S. and German patents of the total number of external patent applications had by 1991 clearly dropped in comparison with 1981. Italy, the Netherlands, Sweden, and Switzerland, however, were among the countries whose shares increased, the majority of these being European countries. Applications for South Korean patents have also grown remarkably in recent years.

The situation is similar for the number of external patent grants (patents registered in foreign countries); both the U.S. and Germany have high shares. As the shares claimed by applications in both countries is decreasing, though, their shares in patent grants should also decrease in the near future.

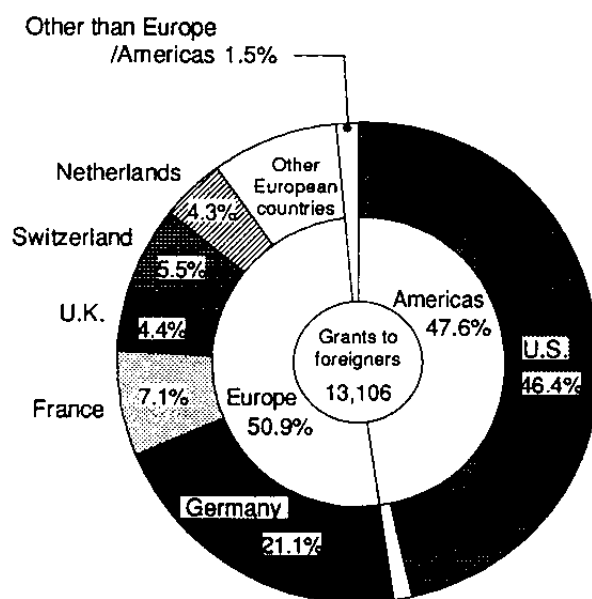
The numbers of external patent applications and grants described above show that Japanese inventors and patent applicants are expanding their patenting activities on a global scale.

Figure 5-2-4 Patent Applications and Grants in Japan by Nationality of Inventor

(A) Applications by foreigners

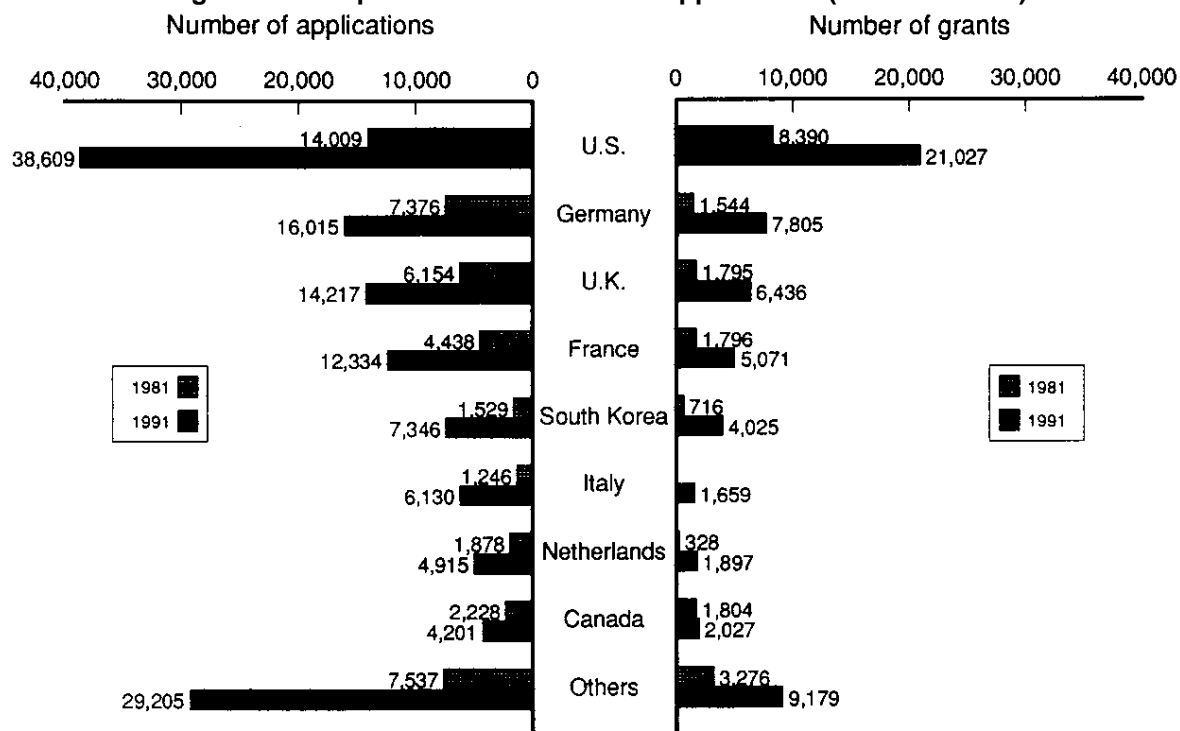


(B) Grants to foreigners



Source: Patent Agency, *Patent Agency Annual Report*  
See Table 5-2-3

**Figure 5-2-5 Japanese External Patent Applications (1981 and 1991)**



Source: Patent Agency, *Patent Agency Annual Report*

See Table 5-2-5

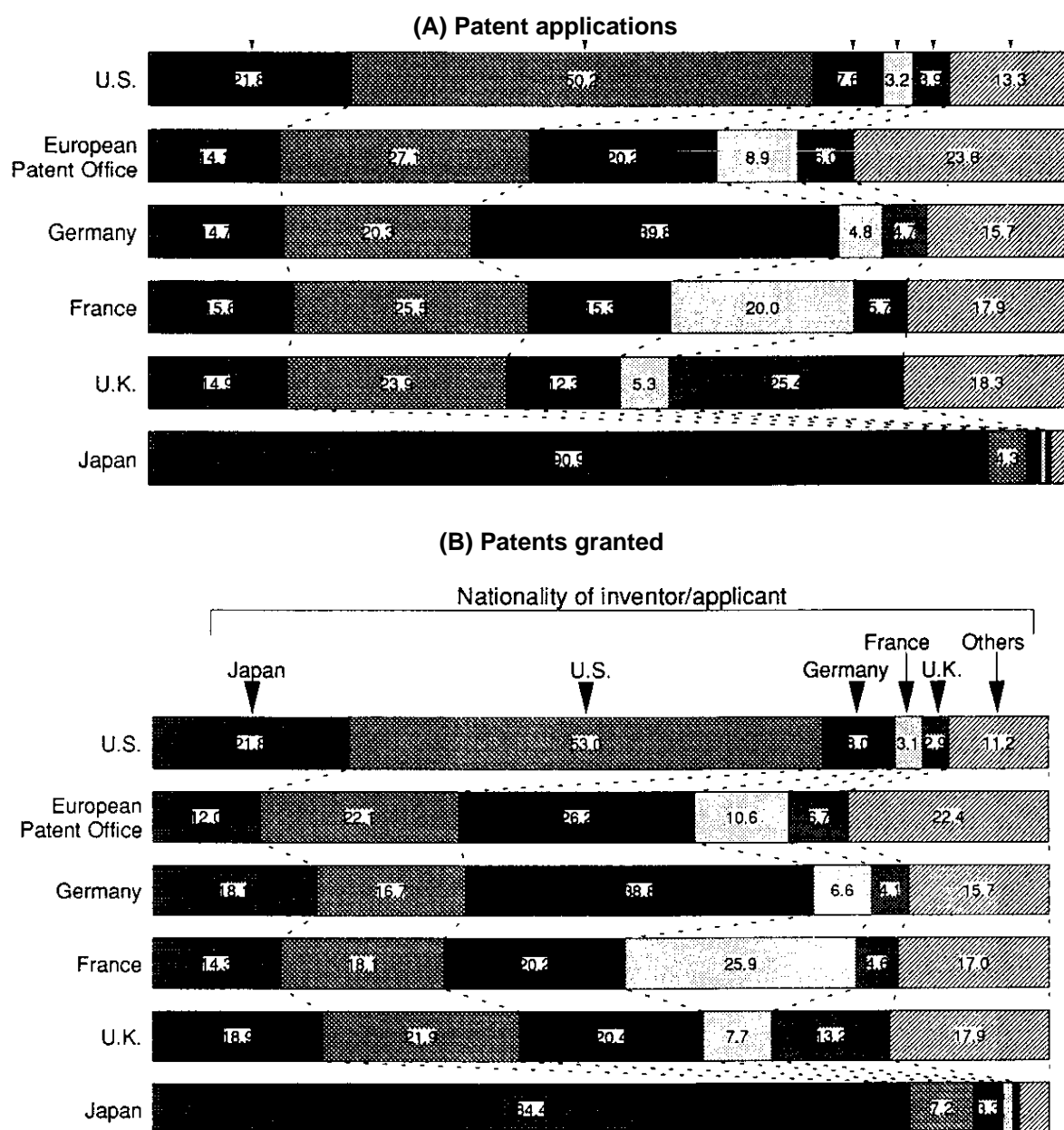
## (2) Japanese patents in the U.S. and Europe

Figure 5-2-6 shows the share of Japanese inventions to the total in the U.S. and selected countries in Europe. For the sake of comparison, a breakdown by country of Japanese patents is also shown.

Japan makes more applications for U.S. patents than any other foreign country, and in 1991 its share was 21.8%. The share of Japanese applications to the European Patent Office was 14.1%, third behind the U.S. and Germany. In Germany, Japan was again third behind Germany itself and the U.S. In France as well, Japan took third after the U.S. and France, and Japan was third in the U.K. behind the U.K. and the U.S.

There is some exchanging of places among European countries when looking at the number of patent grants. In the U.S., the situation is not much different from that for applications. In the European Patent Office, however, Germany passed the U.S. in terms of patent grants; Japan was third after the U.S. In Germany, the number of Japanese patent grants surpassed those of the U.S. and was second only to those of Germany itself. In France, the order was France, Germany, and the U.S., with Japan in fourth place. In the U.K., the number of patent grants to Japanese inventors, although below that of grants to American and German inventors, was higher than that of grants to inventors from the U.K. itself.

Figure 5-2-6 Number of Patents by Nationality of Inventor in Selected Countries (1991)



Source: Patent Agency, *Patent Agency Annual Report*  
See Table 5-2-6

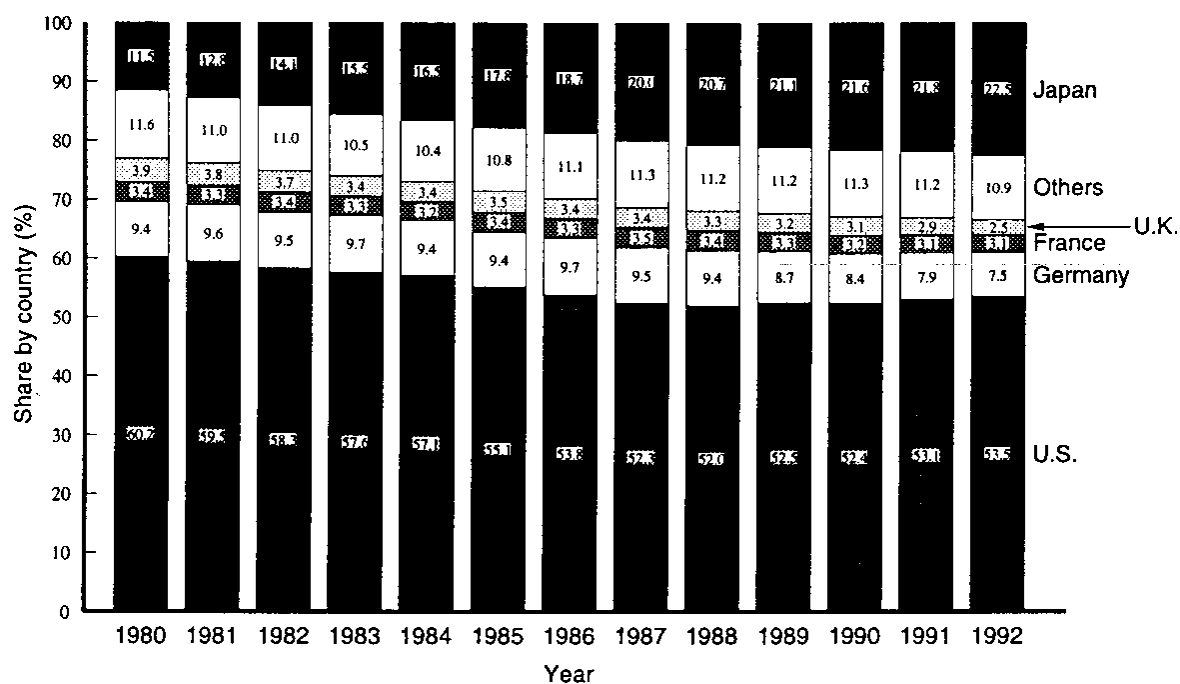
### 5.2.3 Patent grants and citations in the U.S.

The U.S. boasts the world's largest market, and it is also the prominent country in science and technology. That is likely why applications for so many of the important and high-level patents aimed at the global marketplace are submitted in the U.S. This section will discuss several indicators for patents granted in the U.S.

#### (1) Patent grant share trends by country in the U.S.

Figure 5-2-7 shows country share trends for patents granted in the U.S. The U.S.' own share continued falling until 1988 while that of U.S. patents granted to foreign inventors rose. From 1989, however, the U.S.' share has been on the upswing. Japan has a large share among foreign countries, 22.5% in 1992, and this share is not only large but also clearly growing. The increase in the share of U.S. patents to foreign inventors up to 1988 can be said to be mostly due to the contribution of Japan, and this contribution has continued to increase since.

Figure 5-2-7 Patent Grant Share Trends by Country in the U.S. (1980-92)



Source: CHI Research Inc., *International Technology Indicators Database*  
See Table 5-2-7

## (2) Patent citations

As with scientific papers, this study will do a qualitative evaluation of patents. In the U.S., data on patents cited by examiners in the process of patent screening is recorded. These patents are often cited as precedent technologies regardless of the technology's quality evaluation. Hence it cannot be said that the number cited itself is always indicative of patent quality. However, it is natural to think that the macro national number of citings reflects the country's technological level. The number of citings per patent registration in particular can be considered as indicative of the quality of R&D achievements. Hence, just as in the case of scientific papers (see Section 5.1), Figure 5-2-8 shows trends from 1980 to 1992 by plotting shares of patent registrations on the horizontal axis and those of citings on the vertical axis <sup>(1)</sup>.

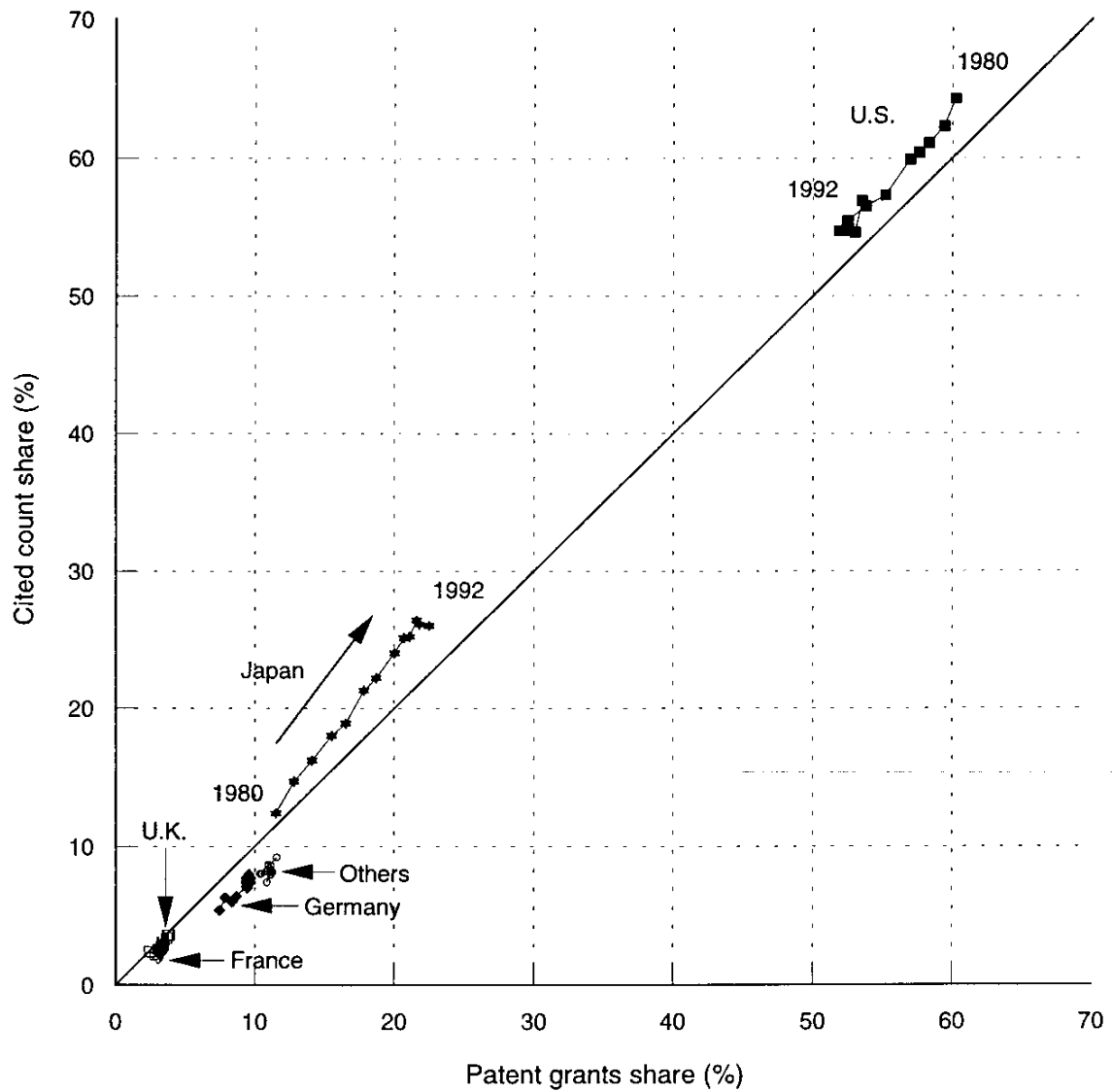
The Japanese share of citings has been greater than the number of patents granted. Therefore the relative citation index obtained by dividing the citing share by the registration share has consistently exceeded 1 during the period covered. Moreover, the citing share has been growing at a pace exceeding that of registration and it continues to grow. Given the above data, it can be said that Japanese patents granted in the U.S. have experienced great progress, not just in terms of quantity but also of quality. In contrast, the U.S. registration share and especially its citing share decreased until 1988. Since 1989, however, as its share of patent grants has recovered, so, too, has the citing share shown signs of increase. Countries other than Japan and the U.S. are included in "others". These countries' relative citation indices are on average below 1, and even looking at individual countries, no country can be found with an index as large as Japan's. This data quantitatively shows that Japan continues to occupy an important technological place in the U.S.

## (3) Number of patent grants by patent classification

Calculating the number of Japanese patents in the U.S. by patent classification, the classifications with the largest number of patents are basic electrical components, photography/cinematography/electrostatic photography, and telecommunications technology (Figure 5-2-9). As already mentioned, basic electrical components is also the top classification in the number of applications in Japan (see Figure 5-2-3), and in the U.S. it is also the top classification in patent grants. There is substantial difference in the weight of a single patent depending on the technological area, and the inclination to seek patents also differs by industry; thus, the indicators discussed here, although they do not show the importance of the achievements in each technological area, do clearly show in which technological areas Japanese inventors are actively pursuing patents. It would be appropriate to use the Japanese share per area, which will be discussed next, and the citation frequency for each area, which will be discussed after that, to indicate the areas in which Japanese technology has had a strong impact.

Figure 5-2-10 shows the changes in Japanese and U.S. shares in 1982 and 1992 in the 10 top areas by share of Japanese patents. In these areas, Japan's share has risen substantially over the ten-year period, while the U.S. share has been decreasing in many of the areas shown in the figure.

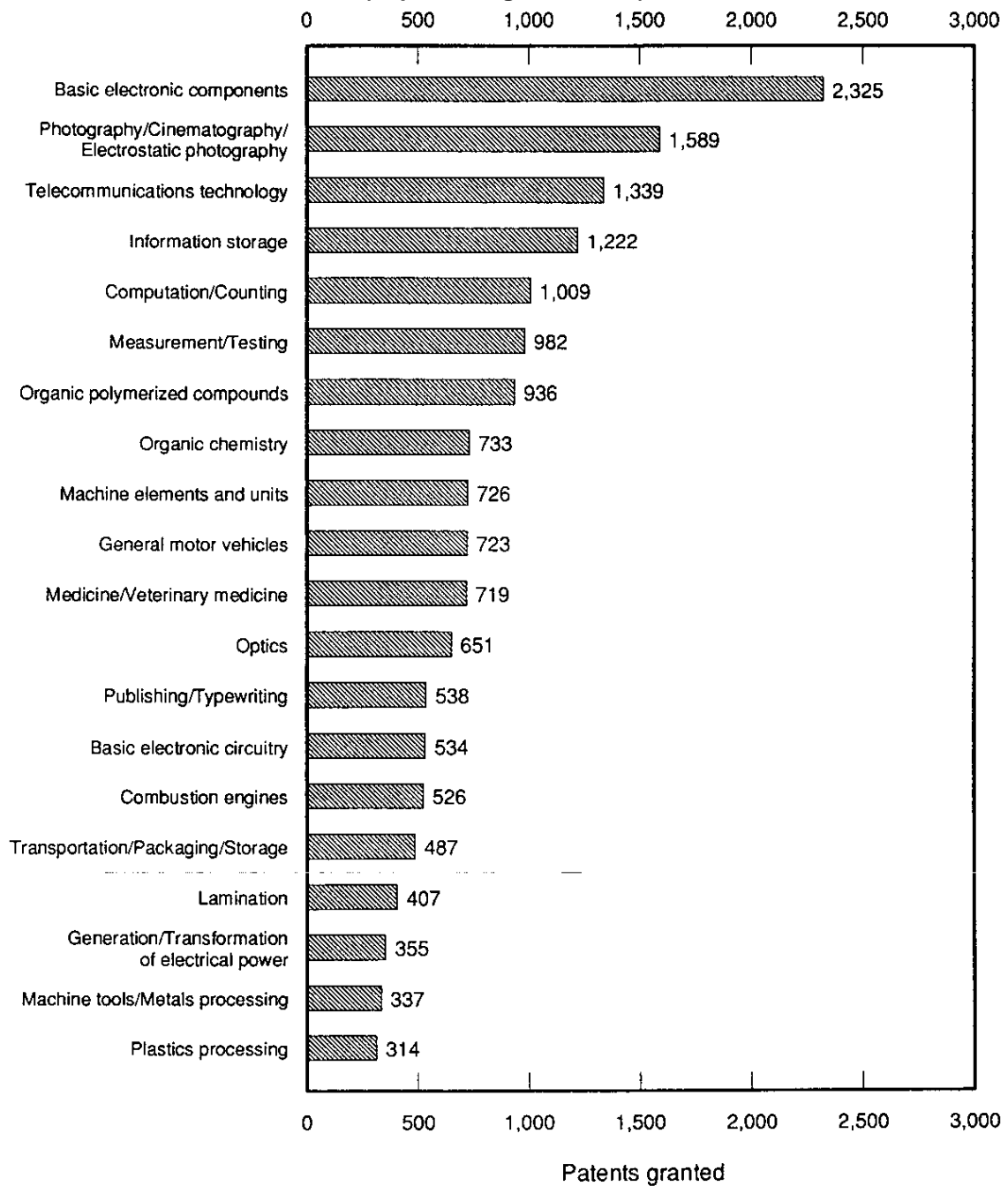
Figure 5-2-8 Frequency of Patent Cited by Country in the U.S.



Source: CHI Research Inc., *International Technology Indicators Database*  
See Tables 5-2-7 and 5-2-8

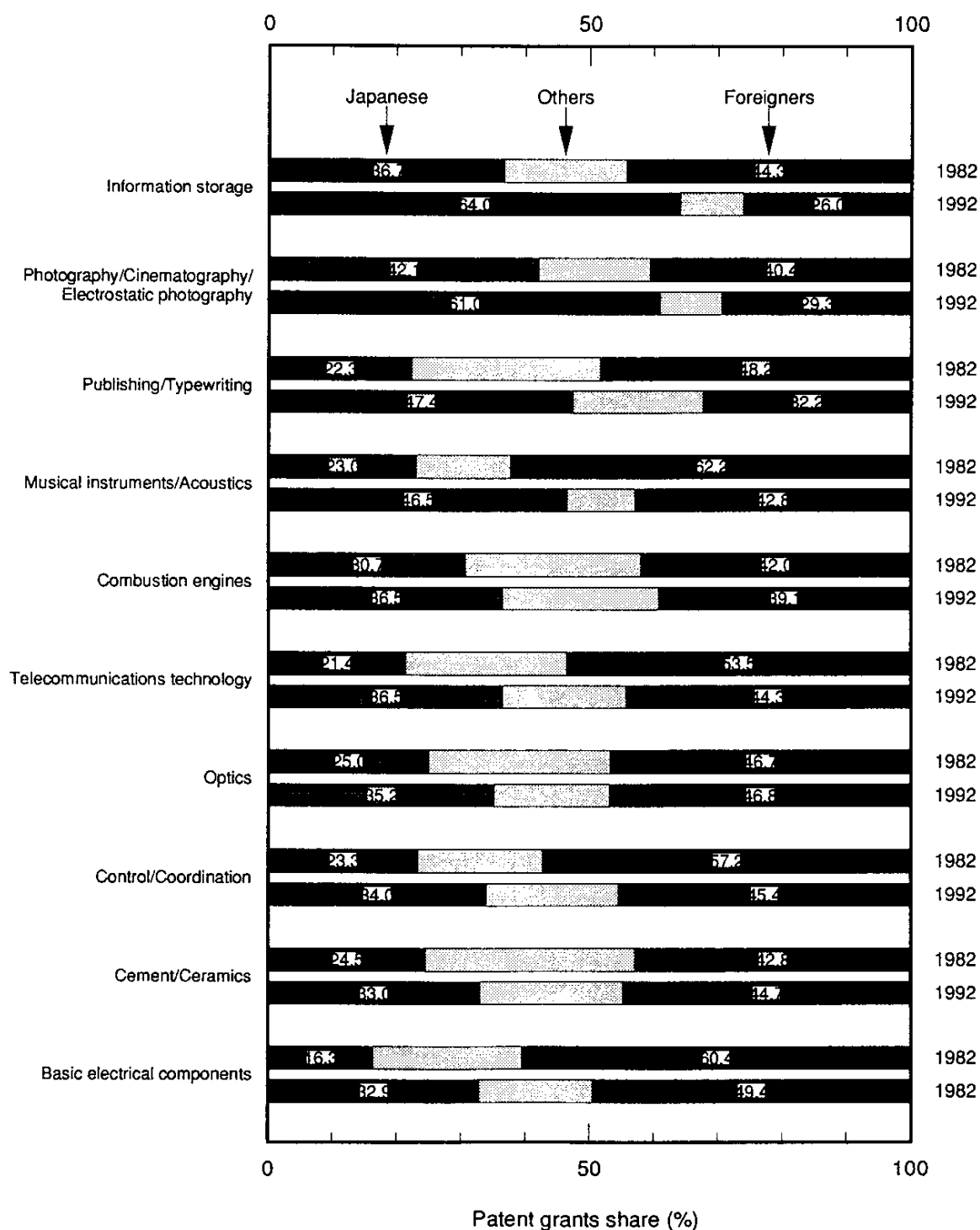


**Figure 5-2-9 Number of U.S. Patents Granted to Japanese  
(Top 20 categories, 1992)**



Source: CHI Research Inc., *International Technology Indicators Database*  
See Table 5-2-9

**Figure 5-2-10 Japanese Share of U.S. Patents  
(Top ten fields)**



Source: CHI Research Inc., *International Technology Indicators Database*  
See Table 5-2-10

#### 5.2.4 International comparison of patents

This section will attempt a general international comparison of patent indicators in order to evaluate by international standards the R&D achievements of individual countries. The basic principle employed here in making an international comparison of patent indicators has been to show the number of patents by country (nationality) of the inventor. Though this seems a natural enough method in examining the R&D achievements of individual countries, it has been common practice to calculate the number of patents as a basic patent indicator not by the country of the inventor but by the country receiving and screening the application <sup>(1)</sup>. Although the numbers of applicants and grants per national patent office are useful when seeking to compare national patenting systems, they are not suited to the objectives of this section. Therefore we have employed the following three indicators, including one not previously used, calculated by nationality of inventor.

The first indicator is the number of domestic patents. Because it is normal for inventors to first apply for and obtain patents in their own countries, the number of domestic patents is the most direct means of showing the status of invention in individual countries <sup>(2)</sup>. International comparisons are made difficult as systems differ by country, though, and one shortcoming of this indicator is that it also reflects the screening capabilities of the patent offices of individual countries, an element completely unrelated to R&D. The second indicator is the number of external patents for each country. This indicator to a certain extent avoids the problem of differences between countries in patenting systems because it covers patents granted under the systems of a variety of foreign countries. One must not forget, however, that this indicator does not include the number of patents in the home country, a matter of importance for inventors and applicants of all nationalities; the number of external patents may also increase in accordance with the international expansion of corporate activities, even when there has been no increase in the number of inventions. The third indicator shows the aggregate number of patents for each country, which includes all patents obtained by inventors from that country. This indicator is a natural one for quantifying the R&D achievements of each country, but it is not one previously used and will be employed here on a test basis. Like other patent indicators, it is not without its problems, and it is necessary to interpret this indicator in light of its special characteristics, of which more will be said later.

#### [Notes]

- (1) For OECD science and technology indicators <sup>[3]</sup>, these patents (applications) are called “national patents”(“national applications”).
- (2) In general, applications for foreign patents are more troublesome than domestic applications because of differences in language and legal practices, and often they require a considerable sum of money. Most countries around the world recognize the concept of “precedence”, so that inventors who first apply domestically and, within a given period of time, then apply abroad are not at a disadvantage, and in fact this rule is frequently used when making external applications. Thus, it is only natural that inventors and applicants would first apply to their home countries.

#### (1) Domestic and external patenting

Figure 5-2-11(A) shows on the left side the number of domestic applications and on the right side the number of external applications for certain major countries active in patenting. Both of these numbers are 3-year averages for the period 1990–92. Comparing the numbers of domestic and external applications for each country, countries other than Japan have larger numbers of external applications. As long as there are no particular biases in the home country, the number of external

applications normally exceeds the number of domestic applications because applications for the same invention in several countries are all included in the former figure. For Japan, however, the number of domestic applications exceeds that of external applications, and thus there seems to be a bias in favor of domestic applications. Such a situation arises from intense application competition, typified, as was mentioned in Section 5.2.1, by numerous strategic applications not aimed at obtaining patents. Japan has an overwhelmingly high number of domestic applications by country, more than 3.7 times the figure for the U.S., the next highest country. On the other hand, Japan is third behind the U.S. and Germany in external applications, and has less than half the number of external applications of the U.S.

Figure 5-2-11(B) shows the number of domestic and external patent grants. Comparing the number of domestic and external patent grants in each country, Japan as well as all the other countries have more external patent grants than domestic ones. While in the other countries the number of external patent grants is far above that of domestic patent grants, this difference is much smaller in Japan. As in the case of applications, then, it can be said that in patent grants, too, there is a bias in Japan towards the domestic side.

Japan has the highest number of domestic patent grants of any country, with the U.S. only slightly behind. Japan is third behind the U.S. and Germany, however, in the number of external patent grants. Still, the difference between Japan and the top-ranking U.S is not as large as in the case of external applications.

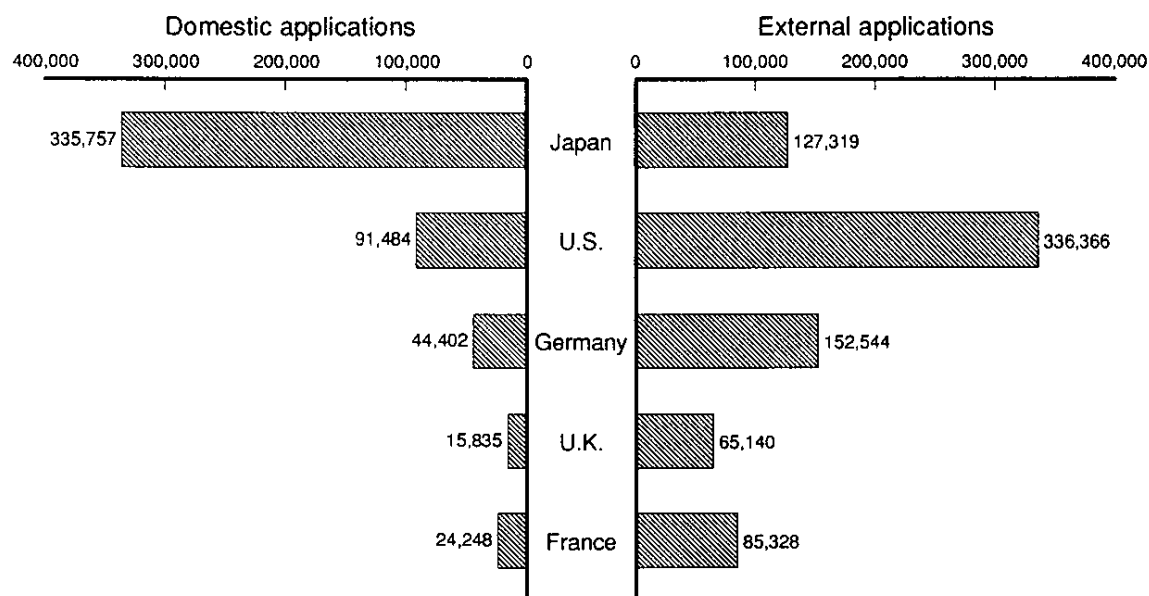
For the sake of comparison, the numbers of domestic and external applications have been shown in addition to the numbers of domestic and external patents (numbers of registered patents). The number of applications is not an appropriate indicator for international comparisons of R&D achievements, though, because this number is influenced far more by application strategy than by invention trends. The number of domestic applications is especially large in Japan because of fierce application competition among corporations and this number is so large that it should indeed be treated as an aberrant value. The number of applications will thus not be addressed below, and only the number of patents registered will be used as an indicator.

## (2) Number of domestic patents

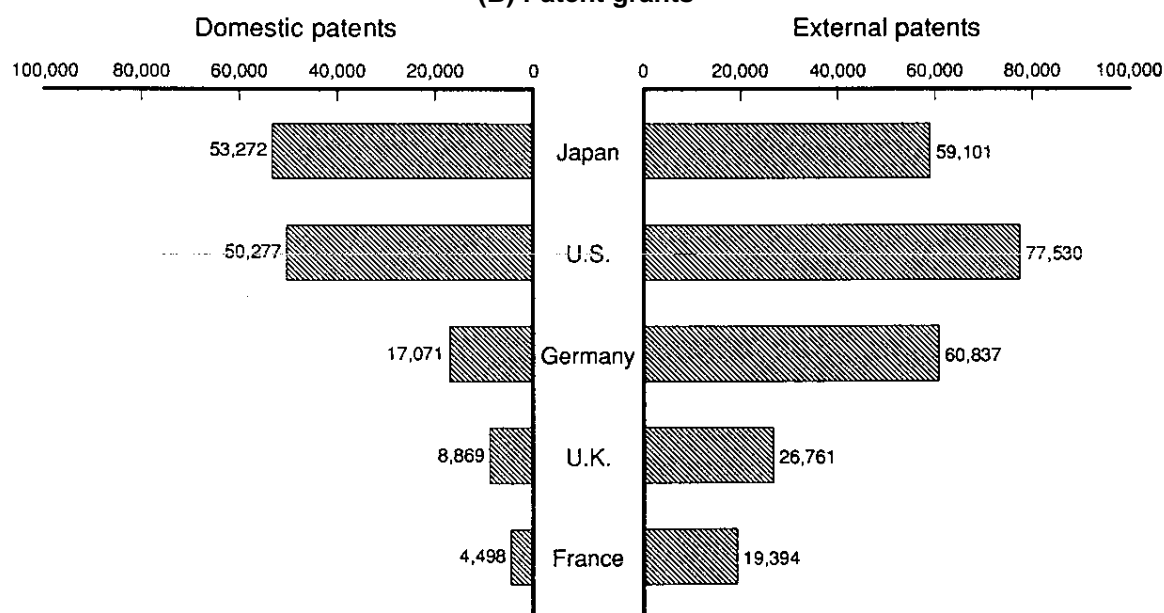
The number of domestic patents directly reflects the state of invention in each country, as was mentioned earlier. However, as became clear in the previous section (1), one must be aware that there is a relative bias in the number of patents in Japan towards domestic patents. Here primary attention will be given to chronological trends rather than to the size of the number of patents.

**Figure 5-2-11 Domestic/External Patents (Applications) (1990–92 average)**

**(A) Patent applications**



**(B) Patent grants**

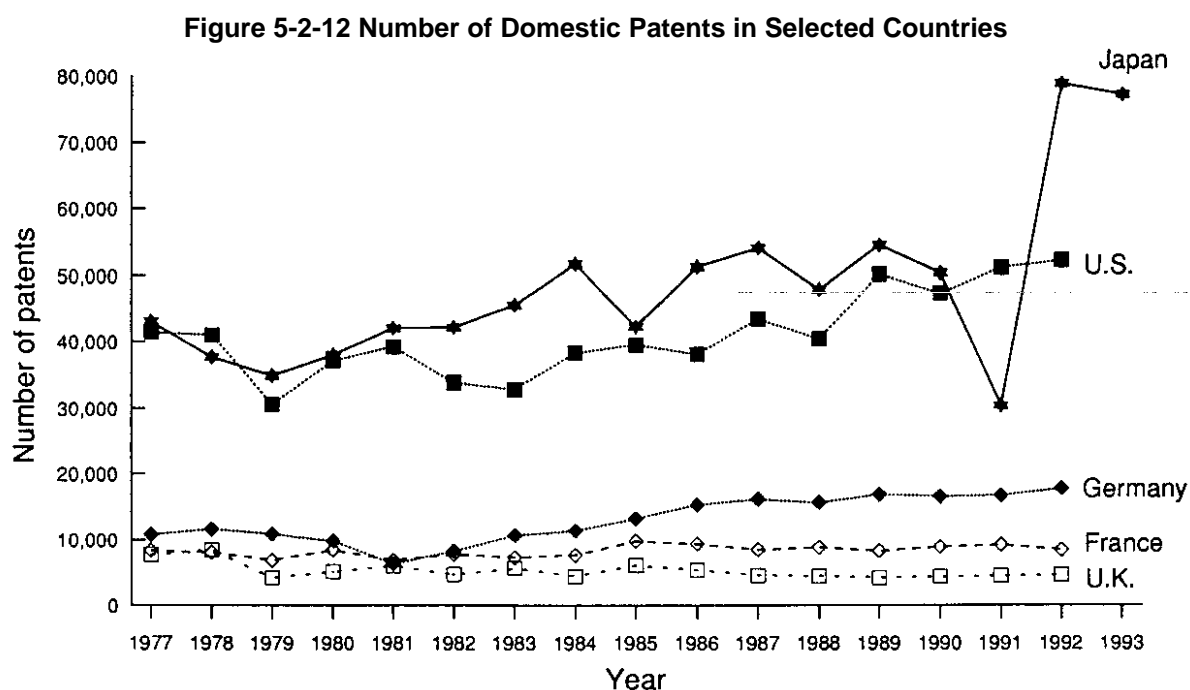


Sources: Patent Agency, *Patent Agency Annual Report*

WIPO, *International Property Statistics*

See Table 5-2-11

Figure 5-2-12 shows the trends in the number of domestic patents in selected major countries. The number of domestic patents in Japan, with the exception of a temporary drop in 1991 (see Section 5.2.1 (1)), remained generally constant throughout the period shown in the figure, and any increases have been long-term ones. The number of patents in the U.S. as well has remained on the whole constant, with some measure of increase since 1989; the numbers in France and the U.K. for the most part also held steady. After decreasing for several years up to 1981, the number in Germany has almost consistently increased since about 1982.



Sources: Patent Agency, *Patent Agency Annual Report*  
 WIPO, *International Property Statistics*

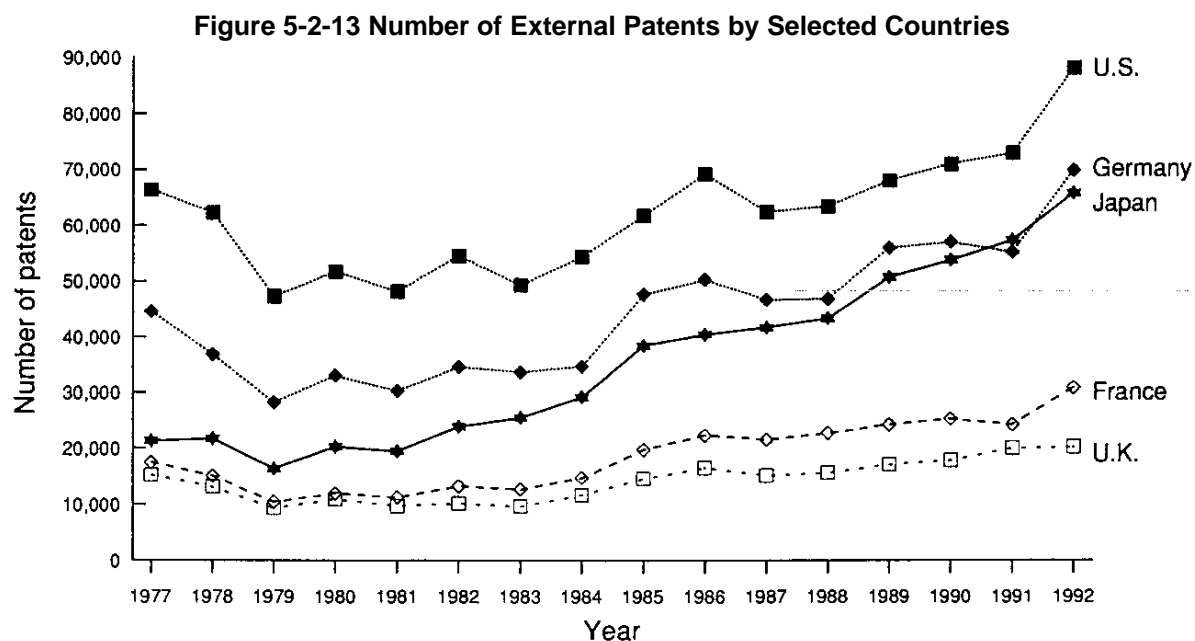
See Table 5-2-12

### (3) Number of external patents

Figure 5-2-13 shows the trends in the number of external patents in selected major countries. In general, there has been an increase in this number in all countries from about 1980. The number of external patents for Japan has kept ahead those of most other countries, and rose from a level of around 20,000 from the late 1970s until 1981 to about 66,000 by 1992.

The meaning of this increase in Japan's number of external patents should be considered. Such an increase, while perhaps a manifestation of high achievements being made in technological development, can also be interpreted as being no more than the result of Japanese corporations increasing the number of their applications to foreign countries; after all, the number of external patents includes multiple patents obtained from several countries for a single invention. It is impossible at the present point in time to conclude which of these interpretations is correct. Even if the number of external patents does not directly show the scale of technological development, though, in a broad sense it does reflect the scale of technological capabilities. Acquiring a patent abroad is an expensive and time-consuming task and only a certain level of achievement in technological development would justify the money and time needed; the patents obtained, too, are

valuable commodities. In other words Japanese corporations have invested considerable resources, pushing ahead with R&D and obtaining patents from foreign countries for their inventions, and Japan's R&D achievements and the increase in its external patents show that the global impact of Japanese technology is growing. The fact that Japan has shown greater increases in this indicator than other countries implies improvements in the capability to actually utilize the achievements (technology) derived from R&D and in the practical technological capabilities of Japan, including its international competitiveness. There was also perhaps great necessity for obtaining these various external patents, which would suggest that qualitatively as well these inventions may be regarded as high-level technology.



Sources: Patent Agency, *Patent Agency Annual Report*

WIPO, *International Property Statistics*

See Table 5-2-13

#### (4) Aggregate number of patents

The total number of patents obtained throughout the world by inventors of a given nationality will here be called the "aggregate number of patents" for that country, and below an international comparison of these numbers will be attempted. Because this indicator has not been used previously, it might be worthwhile to examine the meaning of this indicator and the significance of its use before looking at actual data.

In considering what can be shown through the aggregate number of patents, one must pay heed to the fact that this indicator is the sum of domestic and external patents. In other words, the aggregate number of patents is the sum total of the number of patents obtained by inventors in their own countries (domestic patents) and the number of patents obtained abroad (external patents). The significance of the aggregate number of patents, then, lies the fact that it is a combination of these two indicators. The number of internal patents, as was mentioned before, shows directly and relatively the state of invention in each country given that it is common for inventors first to get patents in their own countries. The number of external patents, on the other

hand, shows the technological capabilities of each country in terms of its ability to actually utilize technology and of its international competitiveness. The aggregate number of patents is, consequently, an indicator showing both the scale of R&D achievements as manifested in inventions and the international expansion of its patenting activities.

The aggregate number of patents is rather vague in meaning, and, indeed, it is possible to argue that there is no need to add together the number of domestic patents and the number of external patents. This point does merit study, as do the following advantages of using the aggregate number of patents:

1) Suitable Definition

The aggregate number of patents, as the name implies, is the number of “all” patents obtained by inventors of a given country. For that reason, the aggregate number of patents is appropriate, from the view of both its definition and its theoretical meaning, as an indicator showing quantitatively the R&D achievements of a given country.

2) Comprehensiveness

There are some patents not covered by the number of domestic patents and the number of external patents, but the aggregate number of patents covers all patents for all inventors.

3) Appropriateness for International Comparisons

The figures for domestic patents for individual countries cannot be compared on the same standards because the number of domestic patents covers patents under a variety of different systems. The conditions for individual countries are not the same for external patents, either, because the number of external patents excludes those patents in the inventor’s home country. The aggregate number of patents, however, covers patents around the world from a given country, and while conditions are not completely the same, they are in the “same ballpark”.

The fact that there is little difference between the conditions for each country means that this indicator can be used for a wide range of countries. The value of a domestic patent in a country with a small population and a small domestic market, for example, is not very great, and even if this country has many inventions this fact does not readily manifest itself in the number of domestic patents; conversely, the number of domestic patents in populous countries tends to be large. For that reason, there tends to be a bias in many countries towards either the number of domestic patents or the number of external patents, and as common indicators for countries with populations of varying sizes, these numbers present some problems. However, the aggregate number of patents is free of such bias and can be applied as a common indicator to a wide range of countries.

In view of the above, the significance of using the aggregate number of patents is as follows. First, both the number of domestic patents and the number of external patents are insufficient by themselves, and it is necessary therefore to use both of these indicators together. The fact that both indicators are essential, however, does not mean that one must necessarily add them together, and treating these two indicators separately better and more accurately shows the characteristics of a given country. For comprehensive comparison of countries, though, it is inconvenient to always have to use two indicators, and the primary advantage of using the aggregate number of patents is that countries can be compared with a single indicator, making it highly suitable for international comparisons.

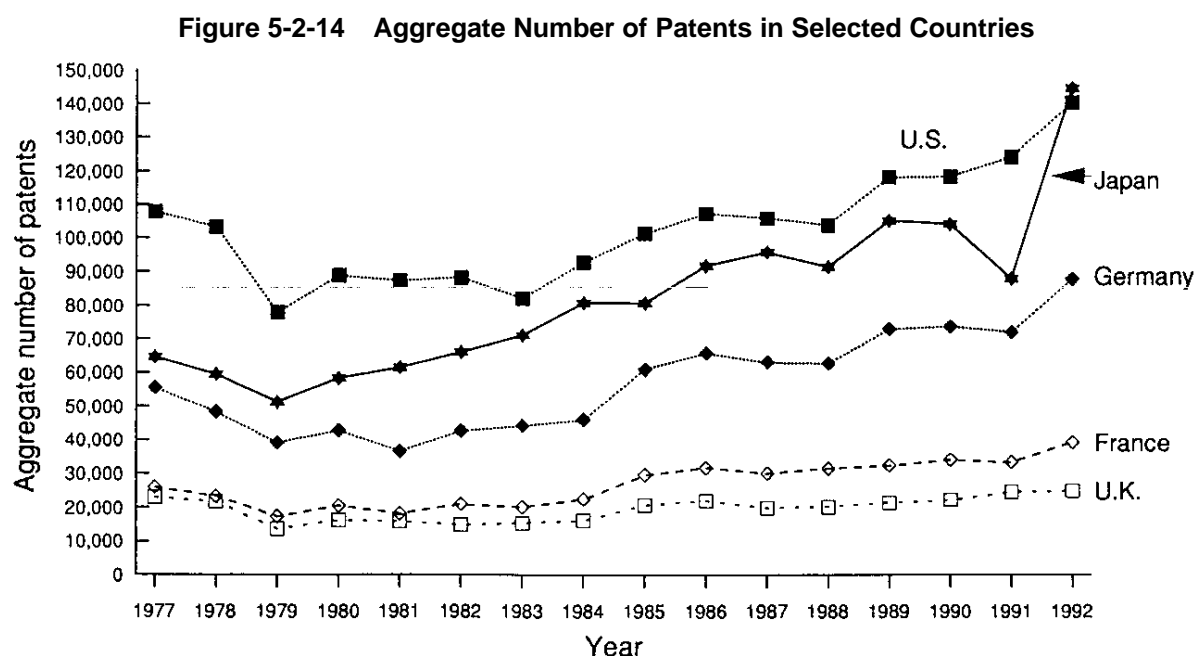
Even given this significance, however, there remain doubts about whether it is appropriate to add together two indicators on a 1:1 weight basis to derive the aggregate number of patents. Certainly one may choose not to give the number of domestic patents and the number of external patents the



same weight, but there is no avoiding the unnaturalness of any method used to add together these two indicators on a weighted basis given the absence of definitive standards for such weights. It would also seem that the weight of the number of domestic patents and the number of external patents would differ by country, and assigning a different weight to each country defeats the purpose of establishing a common indicator for all countries. Thus, the method of counting all patents, regardless of whether they were obtained domestically or abroad, with the same weight is, while not perfect, a sufficiently appropriate one. The aggregate number of patents should indeed be an indicator showing comprehensive technological capabilities and transcend any differences in weight between domestic and external patents.

Figure 5-2-14 shows the actual aggregate number of patents. Throughout the period shown in the figure, the U.S. had the highest number of patents, followed by Japan. In 1992 the number of patents for Japan surpassed that for the U.S., but this was a temporary phenomenon and merely a reaction to the sharp reduction in domestic patents in 1991 (discussed earlier). This indicator puts Japan in second place worldwide, ahead of Germany, France, and the U.K. This order matches the order for a variety of other indicators, including those for R&D expenditures, and this further demonstrates the suitability of this indicator. Japan is first in the world in the number of domestic patents but even with or below Germany in terms of external patents; here Japan is clearly placed between the U.S. and Germany. Japan's ranking in technology in the form of patents, too, seems appropriate. Needless to say, however, this indicator does not take into account differences in the size of countries.

Over the long term, there has been a general rising trend in this indicator for all countries, albeit with temporary fluctuations. The increase has been greater for Japan than in other countries. In this regard, too, the trends in the aggregate number of patents generally match the trends in other kinds of indicators, including the increase in Japan's R&D expenditures.



Sources: Patent Agency, *Patent Agency Annual Report*  
 WIPO, *International Property Statistics*  
 See Table 5-2-13

## 5.3 Industrial Standards

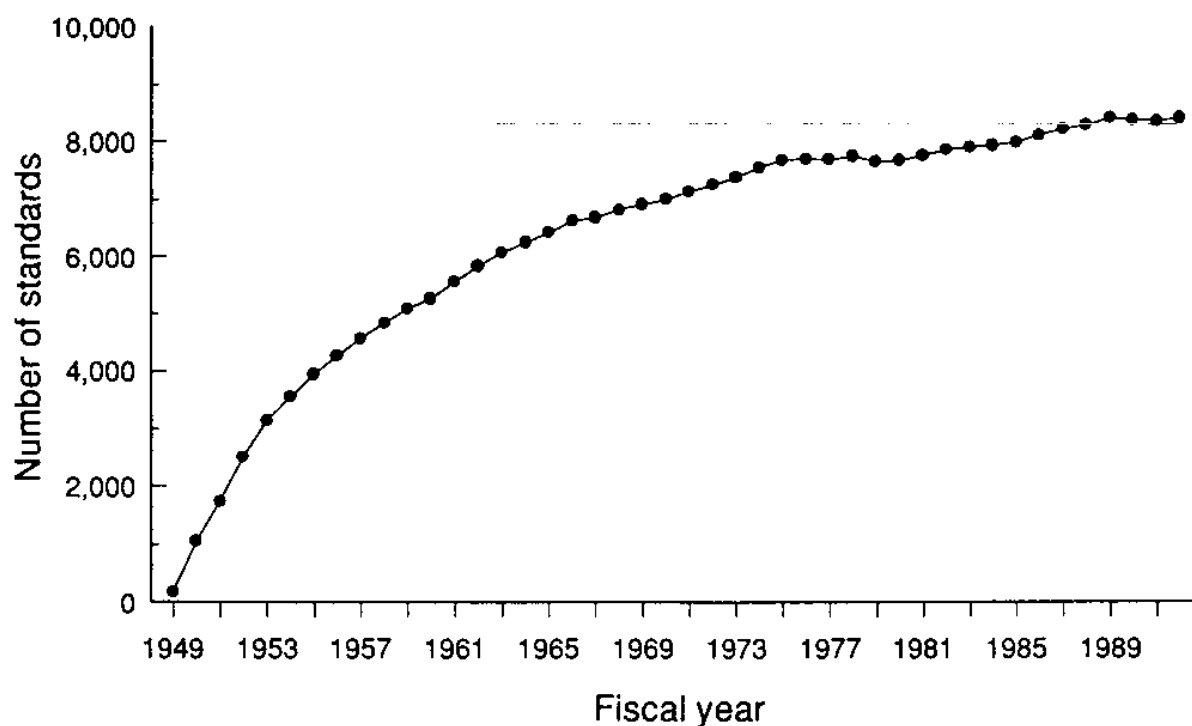
This section examines industrial standards as an indicator of the public property value of R&D achievements. From the viewpoint of production in an industrial society, it is very important to maintain uniform quality. For this reason standards play an important part in scientific and technological activities. Unified standards aid in smoothing industrial production activities while at the same time the achievements of scientific and technological activities enhance industrial standards. Standards can therefore be said to reflect the level of scientific and technological activities.

### 5.3.1 Industrial standards in Japan

There are five objectives in the standardization of scientific and technological activities: (1) unifying terms, symbols, and drawings to ensure mutual understanding; (2) ensuring the safety of persons and property; (3) ensuring uniformity and interchangeability to assure system compatibility; (4) improving product quality and performance for fit and use and (5) simplifying products to limit their kind. Achieving these objectives produces many benefits such as rationalization of production, distribution and consumption, quality development and cost reduction.

At the end of FY1992 there were a total of 8,406 JIS standards (Figure 5-3-1). Since the Industrial Standardization Law was enacted in 1949, a total of 12,164 standards have been enacted, 21,359 revised, and 3,757 abolished. Examining the number of standards over time shows a striking increase from around 1949 to 1950. This increase in the initial period is believed to have been due to development of the standards system itself. Since then, the pace of increase has gradually slowed down. The number is still increasing, however, due to technological progress and social demand.

Figure 5-3-1 Number of Japanese Industrial Standards (JIS)

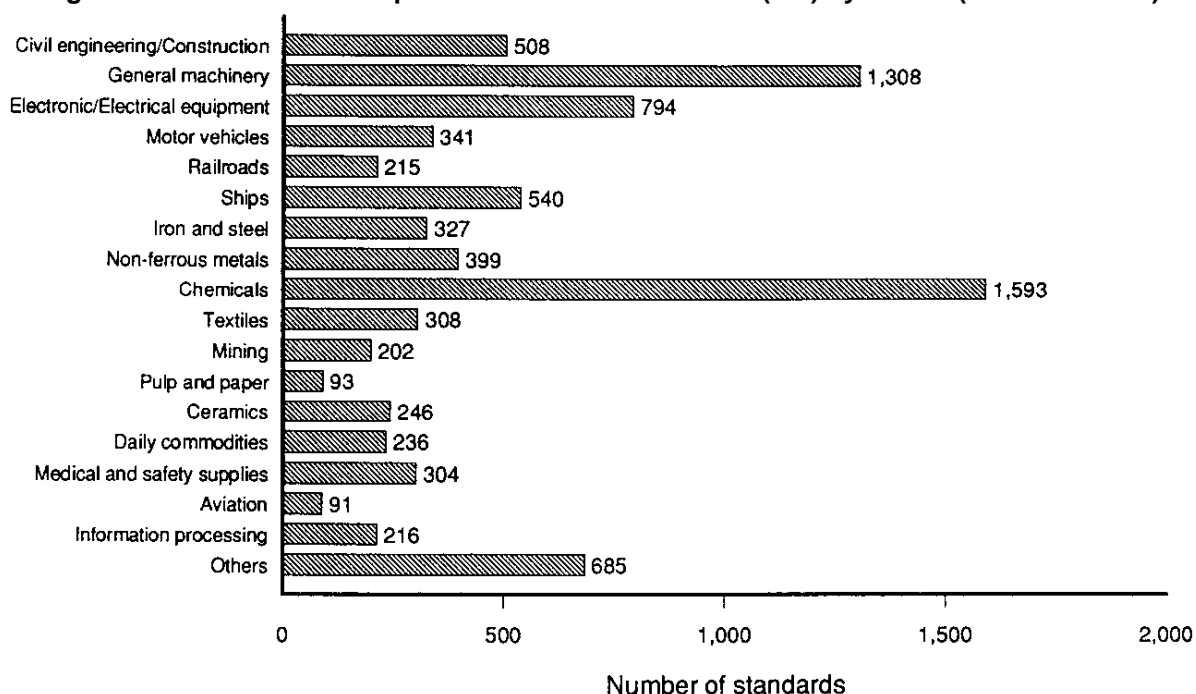


Source: Japan Standards Association, *JIS Directories*

See Table 5-3-1

Examining the number of standards by sector is useful in seeing technological trends (Figure 5-3-2). Many standards in the chemical sector were enacted in the first half of the 1950s but later revised or abolished. In contrast, there was little secular change in standards enactment in the civil engineering and construction and the general machinery sectors. Many of the standards in the electronics and electrical machinery and the information processing sectors were enacted in the 1980s. This can be interpreted as an indirect indication of the rapid changes in the industrial production patterns centering around electronics. Many of the standards in the medical safety equipment sector were enacted in the latter 1980s, and it is possible to imagine increased calls for safety technology as part of greater social demands for harmony between science and technology and human living. In the 1990s, although standards have been reduced in the electronics and electrical machinery sectors through abolition and consolidation during regular review periods, standards in the information processing and medical safety equipment sectors have been steadily increased.

**Figure 5-3-2 Number of Japanese Industrial Standards (JIS) by Sector (End of FY1992)**



Source: Japan Standards Association, *JIS Directories*

See Table 5-3-1

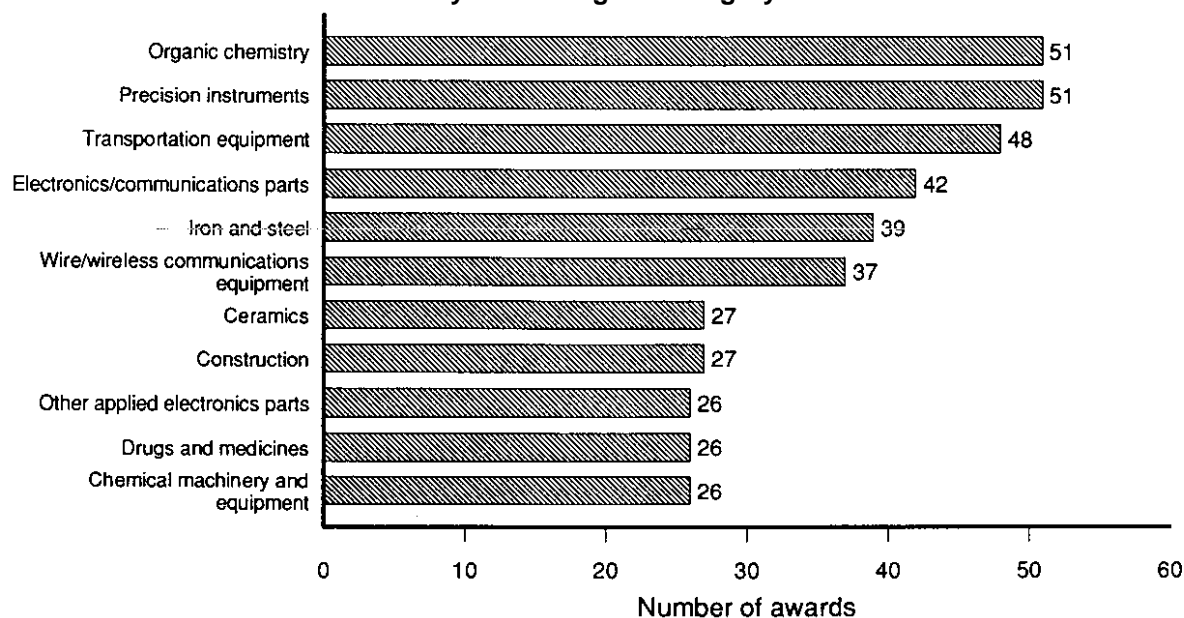
## 5.4 Awards for Achievement in Science and Technology

To illustrate the flow of science and technology in Japan thus far, this section will present one example of evaluation of scientific and technological achievements based on the Award for Persons of Scientific and Technological Merit system as an indicator to qualitatively assess the R&D achievements which have had significant impact on science and technology.

### 5.4.1 Evaluation of Japanese scientific and technological achievements through Awards for Persons of Scientific and Technological Merit

The system for awarding scientific and technological achievements is designed to select outstanding R&D achievements using uniform evaluation standards. If the system is comprehensive and the evaluation standards highly reliable, the award system provides a glimpse of scientific and technological trends. As one example, this study analyzed scientific and technological achievements for which the Award for Persons of Scientific and Technological Merit, one of the Science and Technology Agency Director-General awards, was granted. During the 33 years from 1959, when the system was inaugurated, to 1991, 690 scientific and technological achievements were selected for awards. The most often awarded achievements were those related to organic chemistry (51 awards, 7.4%), precision instruments (51 awards, 7.4%), transportation equipment (48 awards, 7.0%), electronics and communications parts (42 awards, 6.1%), iron and steel (39 awards, 5.7%), and wire and wireless communications equipment (37 awards, 5.4%) (Figure 5-4-1) Looking back over the past 30 years or so, the mainstream of science and technology appears in general to be in the heavy and chemical industries such as machinery and chemical products.

**Figure 5-4-1 Number of Awards for Persons of Scientific and Technological Merit by Technological Category**



Source: National Institute of Science and Technology Policy, *Awards System and Japanese Science and Technology Trends* (NISTEP Report No. 10), 1990

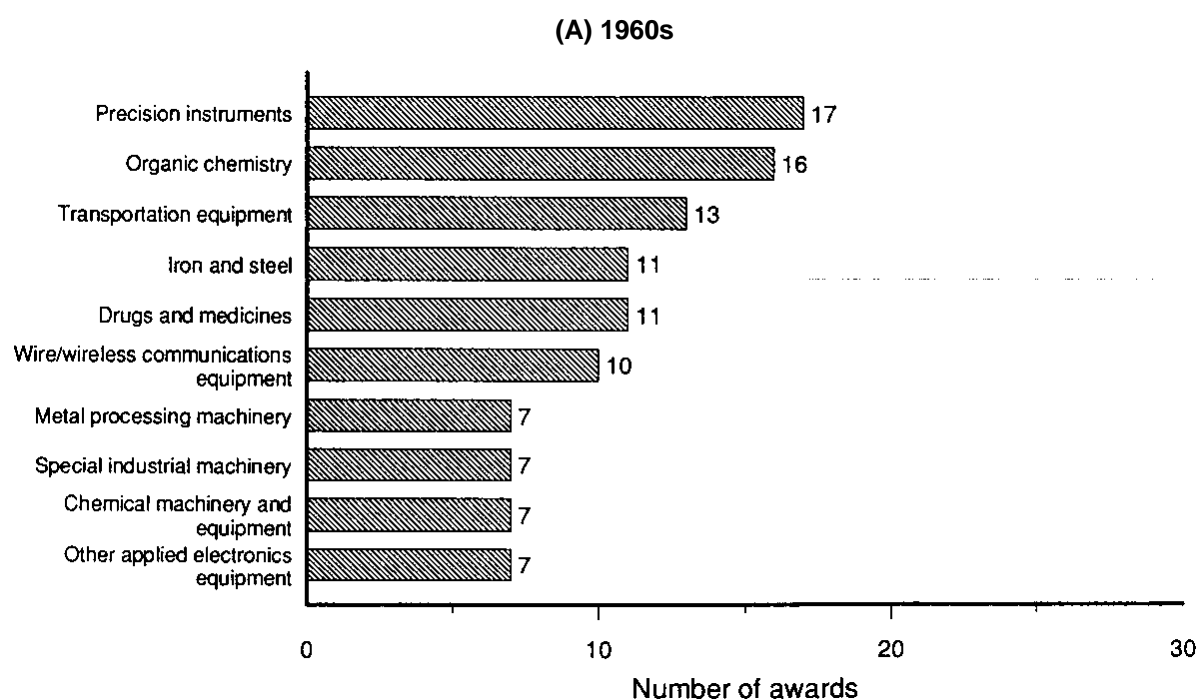
See Table 5-4-1

Changes in technology can be understood by looking at the breakdown of awards and the characteristics of key technologies by decade.

There were 193 awards in the 1960s. By technological category, the most numerous were related to precision instruments (17 cases), followed by organic chemistry (16 awards), transportation equipment (13 awards), iron and steel (11 awards), and drugs and medicines (11 awards) (Figure 5-4-2 (A)). The decade was characterized by a focus on science and technology in the heavy and chemical industries. Looking at key technologies awarded, there were many comprehensive systems, such as high-speed railway technology (the *Shinkansen* bullet train), domestically-manufactured medium-sized transport aircraft (YS-11), and skyscraper construction methods (the Kasumigaseki Building).

In the 1970s there were 154 awards. By technological category, the most numerous were those related to electronics and communications parts (14 awards), followed by organic chemistry (12 awards), chemical machinery and equipment (11 awards), iron and steel (10 awards), and construction (10 awards) (Figure 5-4-2 (B)). As is directly apparent in the fact that electronics and communications parts had the most awards, development in electronics technology proceeded at a steady pace. Looking at key recipient technologies, the mainstream comprised product and component technologies, such as semi-conductor elements using ion implantation methods, carbon fibers, liquid crystal calculators, artificial skin, and home VCRs.

**Figure 5-4-2 Number of Awards for Persons of Scientific and Technological Merit by Technological Category**



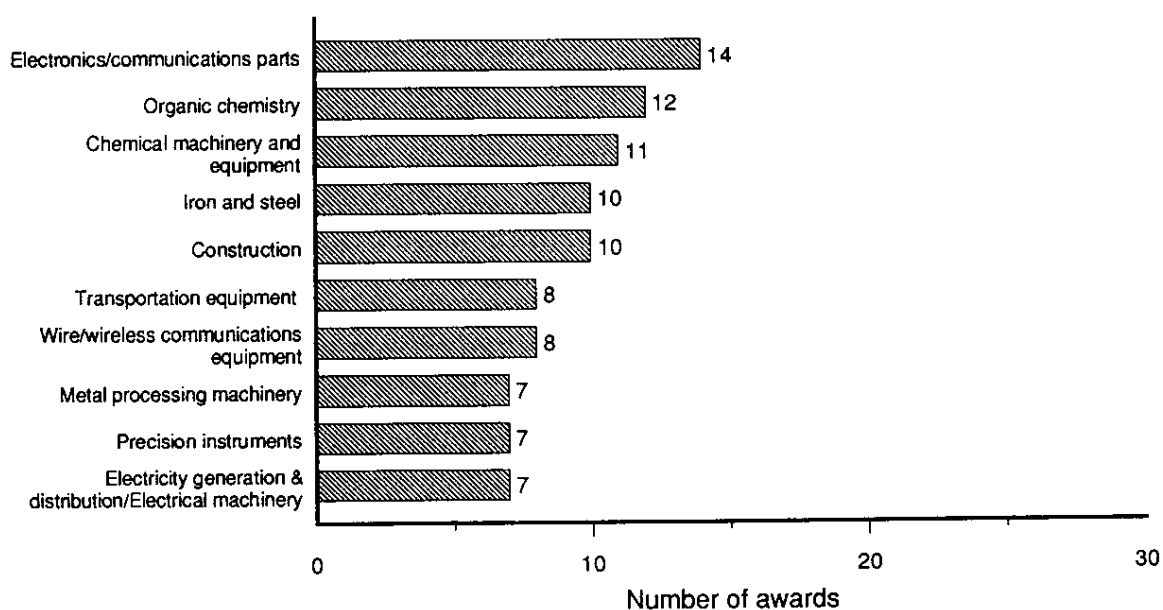
Note: Includes 1959.

Source: National Institute of Science and Technology Policy, *Awards System and Japanese Science and Technology Trends* (NISTEP Report No. 10), 1990

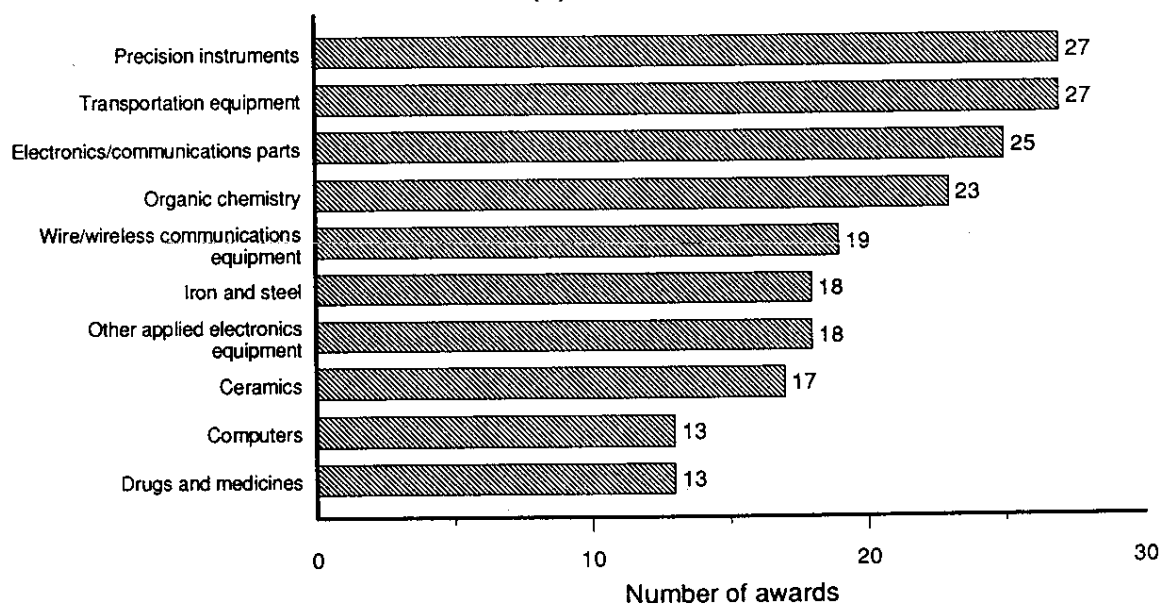
See Table 5-4-1

**Figure 5-4-2 Number of Awards for Persons of Scientific and Technological Merit  
by Technological Category**

**(B) 1970s**



**(C) 1980s**



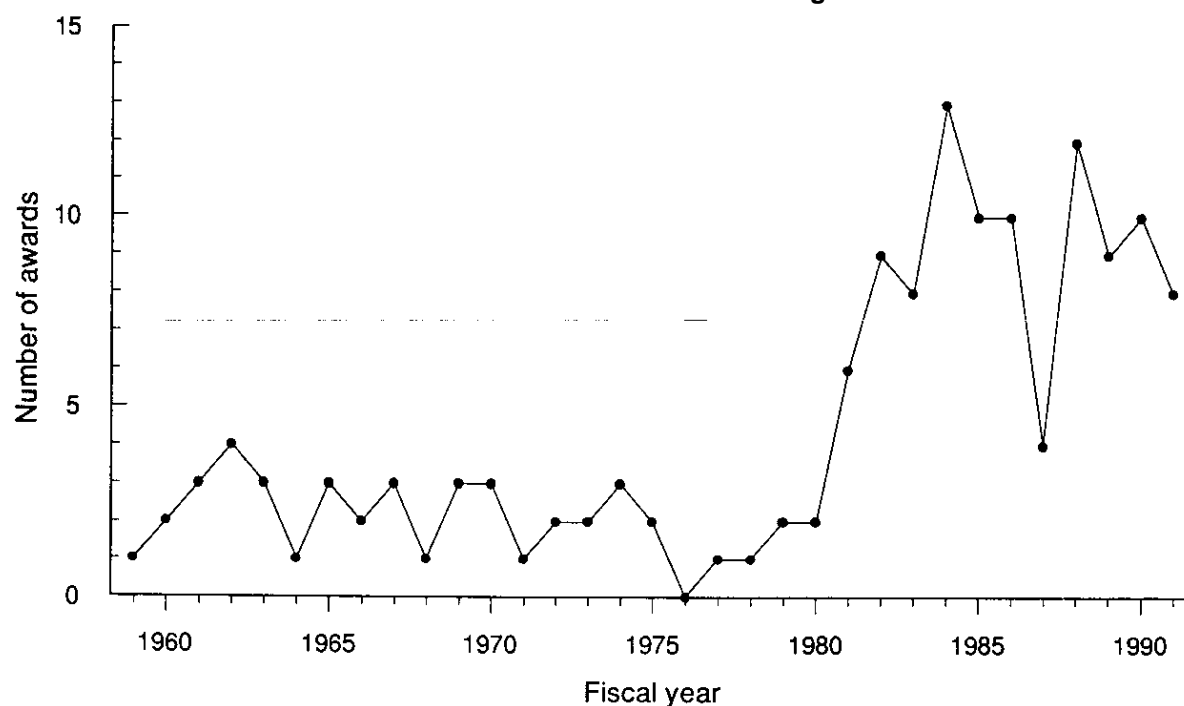
Source: National Institute of Science and Technology Policy, *Awards System and Japanese Science and Technology Trends* (NISTEP Report No. 10), 1990

See Table 5-4-1

There were 290 awards given in the 1980s. By technological category, the most numerous were related to transportation equipment (24 awards), followed by precision instruments (21 awards), electronics and communications parts (21 awards), organic chemistry (19 awards), iron and steel (17 awards), and ceramics (17 awards) (previous section, Figure 5-4-2 (C)). In the 1980s, chemistry-related science and technology appeared to be on the ebb. Key recipient technologies were led by frontier technologies, such as liquid oxygen/liquid hydrogen engines, fermentation of amino acids through gene rearrangement, beta-interferon, and nuclear magnetic resonance equipment.

The fact that frontier science and technologies rapidly took center stage from the 1980s is clear looking at the trends in the number of awards given in frontier sciences and technologies over the past 33 years (Figure 5-4-3). Frontier sciences and technologies as meant here are computers, semi-conductors, drugs and medicines, ceramics, biotechnology, nuclear power, aeronautics/astronautics, robotics, optic fibers, and lasers.

**Figure 5-4-3 Number of Awards for Persons of Scientific and Technological Merit in Frontier Sciences and Technologies**



Source: National Institute of Science and Technology Policy, *Awards System and Japanese Science and Technology Trends* (NISTEP Report No. 10), 1990

See Table 5-4-2

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- [1] Institute for Scientific Information, *Science Citation Index*
- [2] Institute for Scientific Information, *Science Citation Index Database*
- [3] Patent Agency, *Patent Agency Annual Report*
- [4] CHI Research Inc., *International Technology Indicators Database*

Chapter 5    Hiroyuki Tomizawa (Sections 5.1 – 5.2)  
                 Kazunari Takebe (Section 5.3)  
                 Akio Nishimoto (Section 5.4)



# Chapter 6

## Social Contribution of Science and Technology

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## **Chapter 6**

### **Social Contribution of Science and Technology**

To gain a systematic understanding of the overall science and technology picture, we must look at all indicators showing the effect of its extensive reach into our socio-economic lives, rather than limiting our view to research and development, which constitutes just one element of science and technology. To this end, this chapter will examine the wide range of indicators which show the contribution science and technology makes in such areas as the economy, environmental conservation, and health and welfare.

#### **6.1 Contribution to Economic Growth**

Science and technology is often pointed to as an indispensable factor in economic growth; but since the process through which science and technology leads to economic growth is complex, it is indeed no simple matter quantitatively to ascertain its actual contribution as a growth factor. Consequently, the economic statistics which form the primary data have for quite some time been interpreted and processed in various ways.

This section will outline the indicators which have been put forward to measure the extent to which science and technology contributes to economic growth.

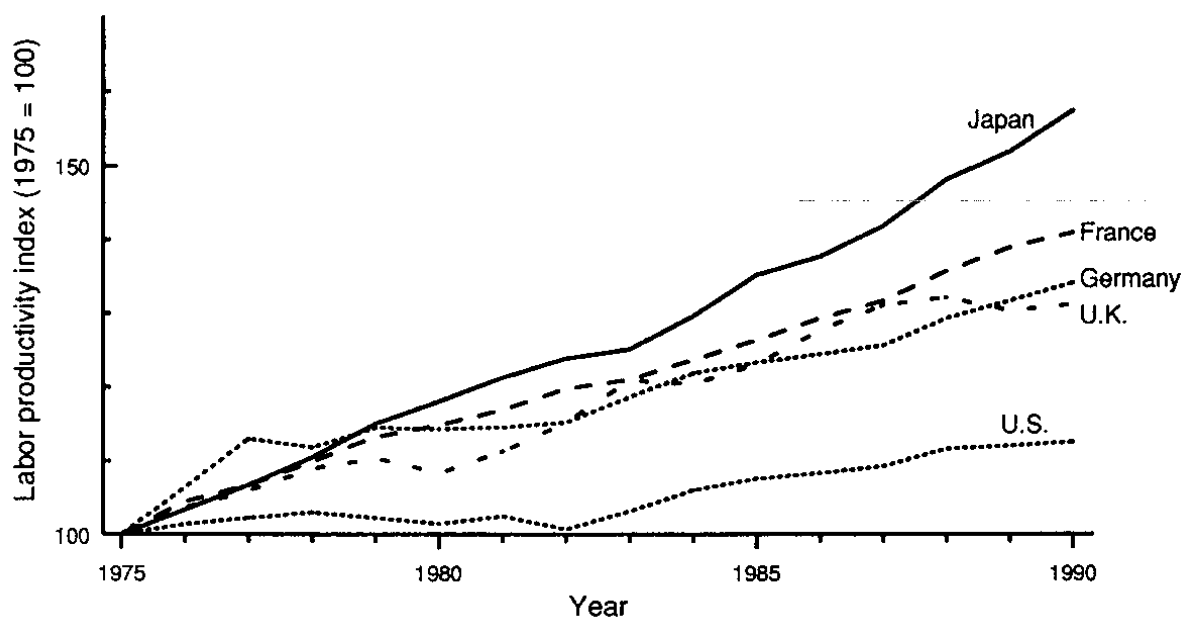
##### **6.1.1 Raising labor productivity of added value**

Technological knowledge gained from research and development raises the production output per input factor, i.e. productivity, when applied in new products or new processes. Thus the economic contribution that technological progress makes can be gauged using the rate of productivity increase as an indicator. There is a wide range of productivity indicators <sup>(1)</sup>, but here the paper will take up labor productivity of added value as a fairly typical indicator, and look at long-term trends while drawing international comparisons.

Figure 6-1-1 shows long-term trends in the labor productivity index of added value for the major industrialized countries with 1975 given a value of one hundred. As can be seen, Japan's productivity has increased at a much higher rate than that of the other countries. The reason for this higher rate is believed to be that since Japan's labor productivity level of added value was starting from quite a low base, the effect of technological progress in Japan was reflected in a remarkable productivity rise. Over the fifteen years from 1975 to 1990 Japan averaged the highest annual rise in productivity with 3.1%, followed by France with 2.3%, Germany with 2.0% and the U.K. with 1.9%; The United States average the lowest rise with just 0.8%. Such a high rise in productivity by Japan over this period has enabled it to narrow the productivity gap between itself and other nations.

Figure 6-1-2 compares Japan's labor productivity level of added value, given an index value of one hundred, with that of other countries. In 1975 the United States recorded by far the highest productivity index, while the productivity level of all other countries shown greatly exceeded that of Japan <sup>(2)</sup>. After 1975 the productivity gap between Japan and the other countries began to narrow gradually, and since 1989 Japan's productivity level has been slightly above that of the U.K.

**Figure 6-1-1 Labor productivity Index of Added Value Trends in Selected Countries**



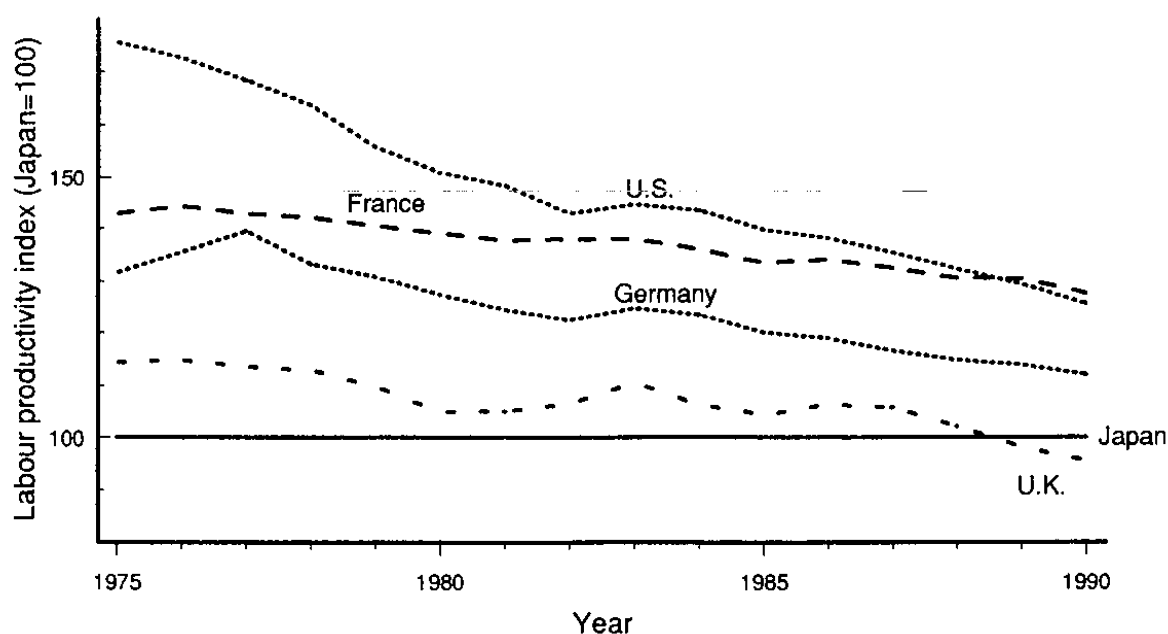
Note: The data show the index of real GDP / labor force. Currency has been converted based on the purchasing power parity of 1985 prices.

Sources: OECD, *National Accounts and Labor Force Statistics*.

Japan Productivity Center, *International Comparison of Labor Productivity*, (1992).

See Table 6-1-1

**Figure 6-1-2 International Comparison of Labor Productivity of Added Value**



Note: The data show the index of real GDP/labor force. Currency has been converted based on the purchasing power parity of 1985 prices.

Sources: same as Figure 6-1-1.

See Table 6-1-2

### 6.1.2 Measuring technological progress by total factor productivity

As indicated by the previous paragraphs, although Japan's labor productivity of added value is growing rapidly, it has yet to reach the level of productivity in the United States and France, even as of 1990. However, even though Japan's labor productivity may be lower than that of other countries, it is indeed possible for Japan to have, conversely, a higher level of productivity in other input factors, such as capital. So when comparing productivity levels, we must look at an indicator which can give a reading of the overall production effect by totaling the productivity levels of all the various input factors. The indicator which enables us to do this is total factor productivity (TFP).

In addition to the normal production factors of labor, capital and the like, there are also factors which cannot be measured by such production factors, and here technological progress plays a vital role. Such factors can be evaluated comprehensively by means of the TFP growth rate, more so than by the increase rate of productivity of individual factors. TFP growth is defined as the increase of output that exceeds the increase of factor input. In other words, TFP growth equals the increase of total output minus the increase in the input of individual factors. And this is precisely the increase in production efficiency, or the contribution of technological progress.

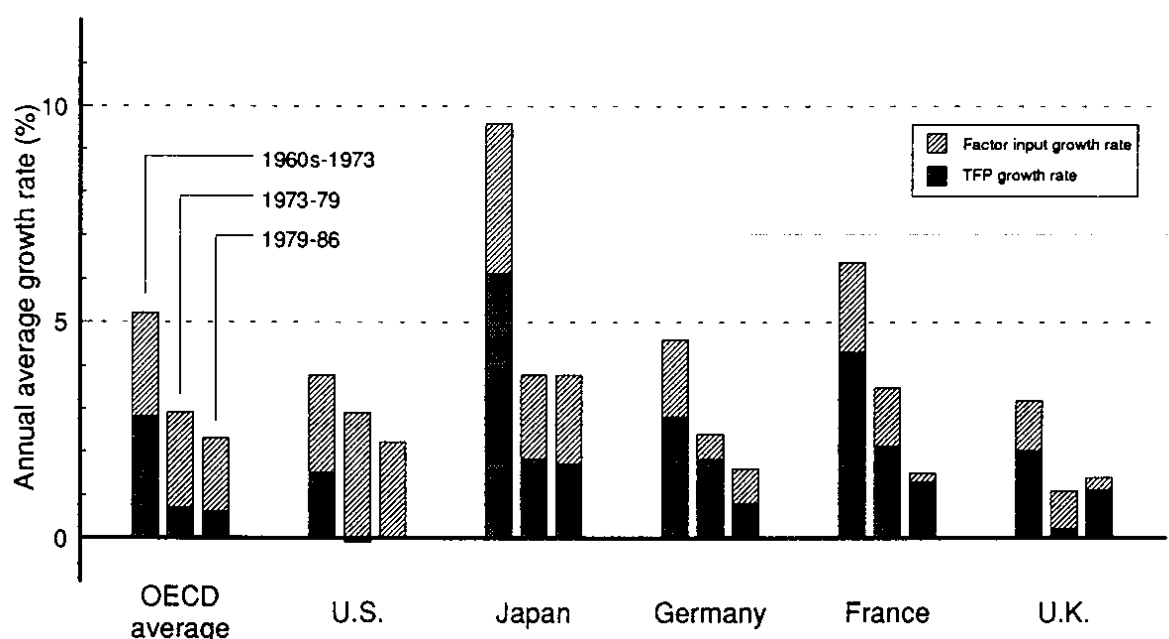
When totaling the productivity of several input factors we must consider the weight of each factor. In measuring TFP, the share of each input factor is weighted to give a weighted average of productivity<sup>(3)</sup>. Below the paper looks at fairly representative measurements that draw out international comparisons.

Figure 6-1-3 is an example of OECD measurements (1988). Focusing first on the OECD average, we can see that after the 1960s the growth rate for both factor input and TFP declined or remained stagnant, resulting in a fall in output growth (= economic growth). Here if we calculate the ratio of the TFP growth rate to the output growth rate as "the rate of contribution by technological progress to economic growth", the contribution rate of 53.8% during the period from the 1960s to 1973 dropped to 24.1% for the period 1973–79 and 26.1% for the period 1979–86. This is often used as a numerical base to support the argument that the seeds of the innovative technological achievements that have occurred to date were all planted in the 1960s.

Compared to the other countries, Japan's output growth is highest throughout all periods, while its TFP growth rate is highest in the 1960s–73 and 1979–86 periods.

Table 6-1-A shows the contribution rate of technological progress on a country basis. The contribution rate in Japan for the period up to 1973 was around 60%, but after 1973 it dropped to around the 40% mark. The most prominent drop in the contribution rate over the period was in the United States. At the same time, the contribution rate trends in the European countries were quite different for each country, though all maintained a level higher than that of Japan, with the highest rate of 86.7% recorded by France in the 1979–86 period. However, the high contribution rate in the European countries can be largely attributed to falls in the output growth rate, which functions as the denominator for the equation.

**Figure 6-1-3 Analysis of Factors for Economic Growth in the Industrial Sector in Selected Countries**



Source: Englander and Mittelstadt, *Total Factor Productivity: Macroeconomic and Structural Aspects of the Slowdown* (OECD Economic Studies No.10, Spring 1988)

See Table 6-1-3

**Table 6-1-A Contribution Rate of Technological Progress to Economic Growth**

(Unit: %)

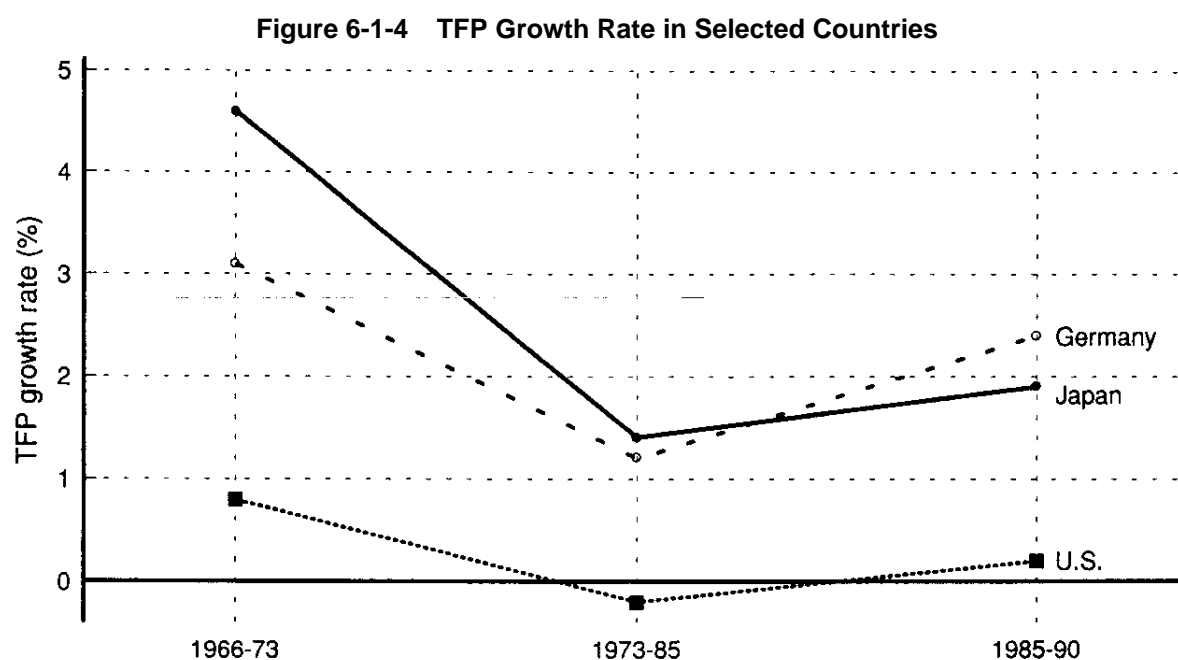
	1960s-1973	1973-79	1979-86
Japan	62.9	47.4	44.7
U.S.	39.5	-3.6	0.0
Germany	60.9	75.0	50.0
France	67.2	60.0	86.7
U.K.	62.5	18.2	78.6

Note: Based on data from Figure 6-1-3

Since data for the measurements of OECD TFP growth rates used here do not continue after 1986, next the paper will project the trends to 1990 based on data in the *Survey of Japanese Economy* (1993). In the measurements shown in Figure 6-1-4, the raw data used in the measuring are different from those used in Figure 6-1-3, so while it is not possible to make a direct evaluation that can be connected with the results in the previous figures, it can be seen that in the latter half of the 1980s the TFP growth rate in all countries picked up slightly. The TFP growth rate recovery in the latter half of the 1980s was also set out in the measurements in the Bank of Japan *Survey* (1993).

Growth in TFP is widely acknowledged as an indicator showing the contribution of technological progress to economic growth, however there are several points which must be noted when interpreting technological progress on this basis. As stated earlier, TFP growth indicates economic growth in excess of the growth of factor input, but such an increase in productivity can be achieved by an improvement in management and the like, even though it may not go hand in hand with technological progress. In cases where a linear homogeneous production function is used in the measurement <sup>(3)</sup>, the

constant returns to the scale is assumed, but in reality, economies of scale contribute somewhat to an improvement in productivity. In short, there are limitations in the TFP growth rate as a science and technology indicator in the sense that other, non-technology factors are also included.



Source: Economic Planning Agency, *Survey of Japanese Economy 1993*  
See Table 6-1-4

### 6.1.3 Return to R&D investment

Technological progress also comes from the achievements of research and development, such as new products and new processes. In other words, the intrinsic factors of technological progress shown in the TFP growth rate lie in R&D investment. Many economists therefore place great importance on evaluating the contribution to economic growth by analyzing the relationship between a rise in productivity and R&D investment, and measuring the returns to that R&D investment.

The basic frame of the model used when measuring returns to R&D investment sets the TFP growth rate as a dependent variable and the technological knowledge stock per output unit or the increase in R&D investment (flow) as the independent variable <sup>(4)</sup>. The parameter of the independent variable is an indication of the rate of returns to R&D investment, however measurements may differ significantly depending on how the data used are defined (eg, whether the added value amount or the sales amount is used in the output data) or the conditions of the regression equation (eg, existence of dummy variables to exclude external economical efficiencies which differ from industry to industry), so care is needed when comparing several measurements.

The rate of returns has been analyzed metrically numerous times since the 1950s, and Table 6-1-B looks at some of these measurements.

Measurements in Japanese companies by Odagiri and Iwata (1986) highlight a drop in the returns to R&D investment from 17% in 1966–73 to 11% in 1974–82. As this downward trend corresponds time-wise to the falling trend in the technological progress rate seen in the TFP indicators, it can be

attributed to a decline in investment opportunity itself, which is effectively connected to a rise in productivity.

Measurements by Griliches and Mairesse (1990) carried out to compare the rates of return between Japanese and United States companies show that the rates of returns for all companies in both countries in the period 1973–80 fell within the range 20–30%. Therefore, if we accept that there are no significant differences in the rate of returns between Japanese and United States companies, as revealed by measurements, it can be conjectured that Japan's TFP growth, which exceeds that of the United States, is largely dependent on factors other than R&D investment (eg, greater efficiency of production control). In this measurement, when a variable was added to cut out the effect of economies of scale the returns to R&D investment dropped, a drop that was quite conspicuous in the case of the Japanese companies. From this it can be seen that TFP growth in Japan is largely attributed to the economies of scale, much more so than in the United States.

Indicators for rate of returns can be looked upon as useful indicators for evaluating the effect of R&D activities on economic growth, provided they are arranged to enable country-based and time series comparisons using standardized methods. Resolving any problem points that remain in the standardization of measuring methods <sup>(5)</sup> is a technological issue that requires the improvement of the base model, and, at the same time, constitutes one part of the theme dealing with the systematization of science and technology indicators in the sense that it requires the arrangement of the series of the raw data used.

**Table 6-1-B Measurement of the Returns to R&D Investment <sup>\*1</sup>**

Measured by	Sample	Rate of return (%)	R <sup>2</sup>	Remarks
Odagiri, Iwata (1986)	Japan— 135 firms (1966–73)	17	0.22	Added value base <sup>*3</sup> ; Dummy variable used for each industry <sup>*4</sup>
	Japan— 168 firms (1974–82)	11	0.58	Added value base; Dummy variable used for each industry
Griliches, Mairesse (1990)	U.S.— 525 firms (1973–80)	27	0.25	Sales base; Dummy variable used for each industry
		25	0.27	Those listed above plus consideration of economies of scale
	Japan— 406 firms (1973–80)	30	0.50	Sales base; Dummy variable used for each industry
		20	0.53	Those listed above plus consideration of economies of scale

Source: Jacques Mairesse R&D and Productivity: *A Survey of Econometric Studies at the Firm Level* (OECD STI Review No.8 / April 1991)

Notes: <sup>\*1</sup> Of the results taken up in the above survey we selected relatively new measurements in which statistics such as the t value were significant.

<sup>\*2</sup> Of the overall variance of the dependent variables, R<sup>2</sup> shows the percentage of the part explained by the variance of the independent variables.

<sup>\*3</sup> Measurement which used added value for the dependent variable.

<sup>\*4</sup> Measurement which used dummy variables to cut out variations resulting from differences in industry types.



## [Notes]

- (1) Productivity indicators that are normally used are divided into the following categories. The indicator which measured output by physical quantity is referred to as physical productivity, and the indicator which measured output by value (monetary amount) is referred to as value productivity. The indicator which measured the input factor by capital (stock) is referred to as capital productivity, and the indicator which measured the input factor by labor (number of workers or total working hours) is referred to as labor productivity.

Since measurement of physical productivity is limited to cases where output can be grasped on a quantity base, it cannot be applied to measure productivity of overall economic activities, including those in the service industry. Consequently, added value productivity, which sets GNP, which itself is calculated as the total added value amount of a country, or GDP as the numerator, is used as a macroeconomic productivity indicator.

- (2) These data use the number of workers for the input labor quantity, but if the total number of working hours is used, the relatively low productivity of Japan will be even more pronounced as the average number of working hours in Japan is higher than in the other countries.
- (3) Various growth accounting formulae can be used to measure TFP growth, and many measurements have been advanced. In Solow (1957), which is one of the early important studies that tried to measure technological progress, the TFP growth rate is obtained as follows. First, the following production function is set.

$$Q = A(t) f(K, L) \quad \dots\dots\dots (1)$$

Q represents output, K represents capital, L represents labor, and A(t) represents the multiplying factor which changes the production function with the passage of time, that is, it shows the effect of technological progress. If this formula is differentiated by time and divided by Q, the following formula will be obtained.

$$\frac{\dot{Q}}{Q} = \frac{\dot{A}}{A} + A \frac{\partial f}{\partial K} \frac{\dot{K}}{Q} + A \frac{\partial f}{\partial L} \frac{\dot{L}}{Q} \quad \dots\dots\dots (2)$$

The dots in the formula mean the derived function regarding time. Here the capital share and labor share are each defined as follows.

$$w_K = \frac{\partial Q}{\partial K} \frac{K}{Q} \quad w_L = \frac{\partial Q}{\partial L} \frac{L}{Q}$$

If these are substituted in formula (2), since  $(\partial Q / \partial K) = A(\partial f / \partial K)$ , the following result can be obtained.

$$\frac{\dot{Q}}{Q} = \frac{\dot{A}}{A} + w_K \frac{\dot{K}}{K} + w_L \frac{\dot{L}}{L} \quad \dots\dots\dots (3)$$

Formula (3) indicates that TFP growth (rate of technological progress) can be obtained by subtracting the growth of various factor inputs, such as capital and labor, from output growth.

Furthermore, assuming a linear homogeneity in the production function, Solow obtained the following formula by substituting  $Q/L=q$ ,  $K/L=k$

$$\frac{\dot{q}}{q} = \frac{\dot{A}}{A} + w_K \frac{\dot{k}}{k} \quad \dots\dots\dots (4)$$

The left side of formula (4) represents the labor productivity growth rate. If the data for labor productivity, capital equipment ratio, and the capital share are given in a time series, the TFP growth rate can be measured positively. Moreover, the TFP growth rate can be obtained by

applying a weighted average to the productivity growth rate for each input factor based on the relative share of the said factors.

- (4) The following are the basic calculation methods regarding returns to R&D investment. First, the Cobb-Douglas linear homogeneous production function, which includes R&D capital stock, is set as the shift parameter.

$$Y = Ae^{\lambda t} K^{1-\alpha} L^{\alpha} R^{\gamma} \quad \dots\dots\dots (1)$$

Here,  $Y$  represents output,  $\lambda$  represents the rate of change of technological progress over time,  $R$  represents the stock of technological knowledge, and  $\gamma$  represents output elasticity of the technological knowledge stock. If TFP is express as  $T$ , then:

$$T = \frac{Y}{K^{1-\alpha} L^{\alpha}} = Ae^{\lambda t} R^{\gamma} \dots\dots\dots (2)$$

If formula (2) is differentiated by time, then:

$$\frac{\dot{T}}{T} = \lambda + \gamma \frac{\dot{R}}{R} \quad \dots\dots\dots (3)$$

Since  $\gamma$  represents output elasticity of the technological knowledge stock, and  $\frac{\partial Y}{\partial R} \frac{R}{Y}$ :

$$\frac{\dot{T}}{T} = \lambda + \frac{\partial Y}{\partial R} \frac{R}{Y} \quad \dots\dots\dots (4)$$

If the obsolescence of the technological knowledge is assumed to be so small that it can be disregarded,  $R$  is regarded as the gross R&D investment amount, and  $\partial Y / \partial R$  represents the marginal rate of returns to R&D investment.

Therefore, with the above formula, if the data for rate of TFP change and the ratio of R&D investment to output are given, the rate of returns to R&D investment can be measured positively. There are also cases where data for the net investment amount estimated as the R&D investment amount after the rate at which technological knowledge becomes obsoleted is either given a priori or obtained from the residual curve of the registered patent are used. In the above-mentioned method, the rate of returns is assumed to be constant for the observed period, but there is also a method which measures the rate of returns with the formula  $\gamma \times (Y/R)$ , estimating  $\gamma$ , considered to be constant, directly from the production function of formula (1).

- (5) The variable technological knowledge stock is introduced into the production function model used in the measurement, but since R&D capital and labor, which are counted together with this variable, are already incorporated into the data for capital and labor, it will be counted twice. Moreover, in cases where added value is considered in output, personnel expenditure, capital depreciation and the like, which are included in R&D investment, are not included in added value as an intermediary input, therefore the rate of returns to R&D investment will be underestimated if these factors are not brought back into added value.

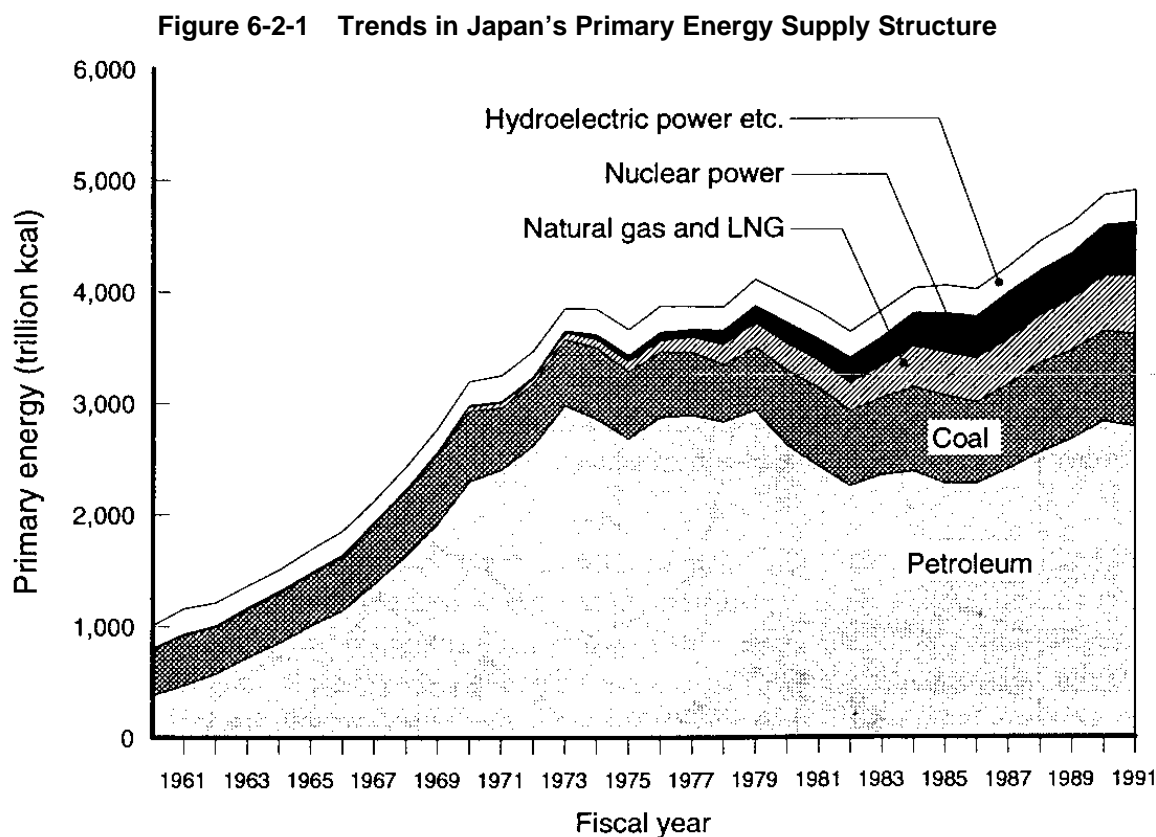
## 6.2 Contribution to Preserving the Global Environment

This section examines how Japan approaches environmental preservation by looking at the state of exhaust gas desulphurization systems and denitrification systems as concrete examples of pollution control technology and investment in pollution control equipment, and also examines the present condition of and cuts to carbon dioxide (CO<sub>2</sub>) emission, which is regarded as the main cause of global warming. Moreover, since recycling of resources is seen as playing a vital role in preserving the global environment, this section also touches on the present state of recycling, and the recycling rate and progress of recycling technology for individual items.

### 6.2.1 Investment in pollution control equipment

#### (1) Amount of investment (private sector)

During the 1960s Japan's energy consumption increased significantly at an annual rate of about 10%, and as a result, energy consumption in FY1970 was more than three times as great as in FY1960. As can be seen in Figure 6-2-1, the increase in energy consumption was met by an increase in oil supplies.



Note: "Hydroelectric power etc." includes geothermal heat and new energy.

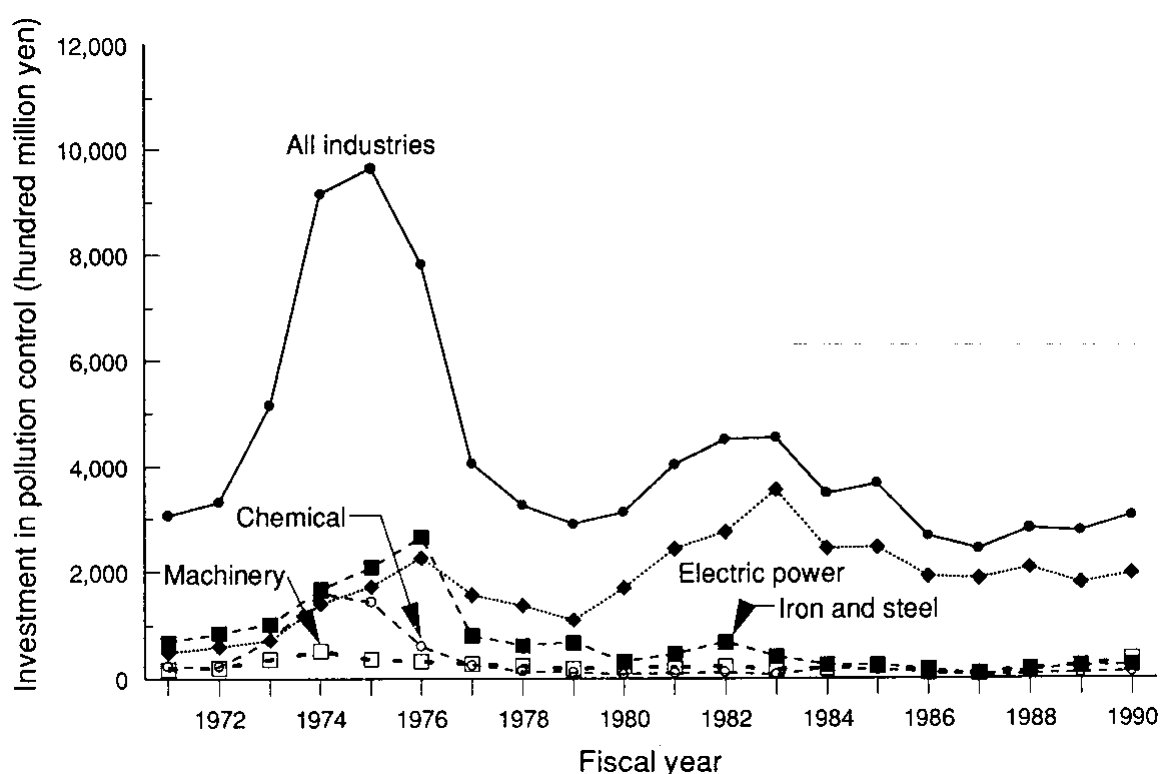
Source: Agency of Natural Resources and Energy

See Table 6-2-1

Greater energy consumption gave rise to serious environmental pollution, so the private sector pushed ahead with pollution control measures, investing 964,500 million yen, or about one-fifth of total capital investment, in pollution control equipment in FY1975. By the latter half of the 1970s installation of pollution control equipment in existing facilities had just about run its course, resulting in a leveling off of investment in pollution control equipment, although the amount did fluctuate from year to year. Then, in the early 1980s, electric power companies pushed ahead with fuel conversion to LNG, which is less of a burden on the environment, and with this, investment in pollution control equipment again rose (Figure 6-2-2).

Investment in pollution control equipment in FY1990 was 305,400 million yen, or 3.2% of total capital investment (Figure 6-2-3). By industry, the electric power industry invested the most with 196,200 million yen, followed by the machinery industry with 36,600 million yen (of which the motor vehicles industry invested 11,000 million yen), iron and steel manufacturing industry with 24,800 million yen, pulp and paper manufacturing industry with 14,300 million yen, and chemical products manufacturing industry with 12,500 million yen. These five industries alone account for more than 90% of investment by all industries. As for type of equipment, 181,200 million yen was spent on air pollution control facilities and 46,300 million yen on water pollution control facilities, and together these two kinds of facilities account for slightly less than 80% of investment.

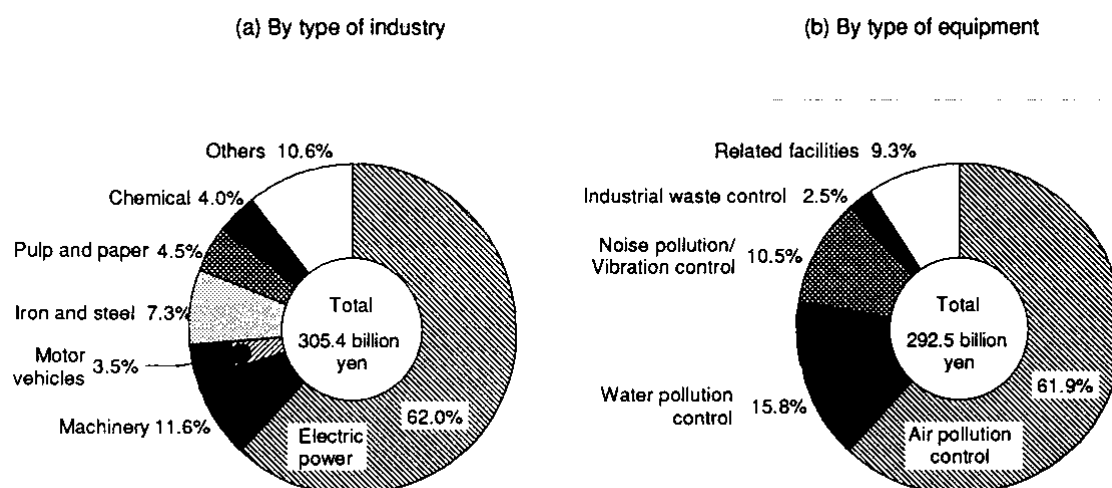
**Figure 6-2-2 Trends in Private-sector Investment in Pollution Control Equipment**



Note: "Electric power" also includes non-thermal power generation from FY1983. Capital investment is construction base.

Source: Ministry of International Trade and Industry, *Capital Investment Plans of the Major Industries*  
See Table 6-2-2

**Figure 6-2-3 Breakdown of Investment in Pollution Control Equipment (FY1990)**



Note: The pollution control equipment investment survey carried out by MITI in February 1988 reviewed industrial classifications. "Machinery" in the figure is the total of "general machinery", "electronic machinery", "electric machinery" and "motor vehicles" in the new classification. Capital investment is construction base.

Source: Ministry of International Trade and Industry, *Capital Investment Plans of the Major Industries*  
See Table 6-2-3

## (2) Amount of investment (public sector)

Whereas the private sector has concentrated on air pollution control in their capital investment, the public sector, such as local governments, has concentrated on water pollution control and waste disposal.

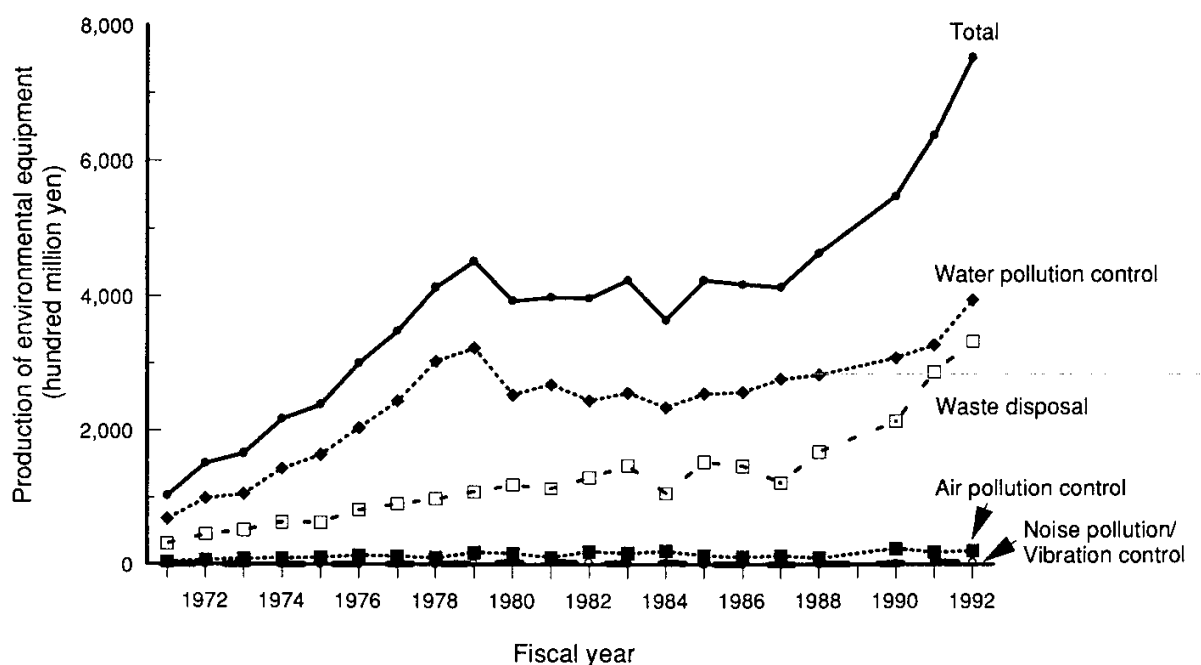
Figure 6-2-4 shows the production of environmental equipment (actual results) generated by public-sector demand. The rise in production was virtually rectilinear in the 1970s, and this is different from the fluctuations shown by private-sector investment during the same period (Figure 6-2-2). The rise in production of water pollution control equipment was particularly steep, and this can be attributed to the promotion of water pollution control measures at factories and business establishments following the enactment of the Water Pollution Control Law in 1970, and also to the gradual establishment under the budget system of sewage treatment facilities necessitated by the growing number of cases of inland water and sea pollution caused by Japan's under-developed sewerage system.

From the end of the 1970s to the latter half of the 1980s production of environmental equipment based on public-sector demand generally remained at the same level, but from about 1988 production surged, rising to 753,200 million yen in FY1992, of which water pollution control equipment accounted for the highest amount with 395,800 million yen, followed by waste disposal equipment with 333,700 million yen. This can be put down to the significant increase in the production of sewage treatment facilities due to the development and upgrading of sewerage systems and the greater use of joint sewage treatment and purifying tanks, and an increase in the production of urban waste treatment facilities brought about by a rush on the development of treatment facilities following the amendment of the Law Concerning Waste Treatment and Recycling (October 1991).

Japan's pollution control technology has contributed much to environmental preservation overseas as well. In FY1992, pollution control equipment produced for export amounted to 68,700 million yen, and accounted for 6.1% of total production. By equipment type, waste treatment equipment ranked the highest with 40,500 million yen, followed by air pollution control equipment with 23,400 million yen; together, they accounted for more than 90% of total production. By export region, Southeast Asia was highest with 57,000 million yen, followed by North America with 4,600 million yen and West Asia with 3,700 million yen. These three regions accounted for 95% of pollution control equipment exports.

Japan's pollution control and energy-saving technology is considered to be outstanding, so much is expected of the Japanese contribution to preserving the global environment through international technical cooperation.

**Figure 6-2-4 Trends in the Production of Environmental Equipment  
(Public-sector demand)**



Note: Public sector includes associations financed by local governments. Amount of environmental equipment production is payment base.

Source: Japan Society of Industrial Machinery Manufacturers, *Production of Environmental Equipment*

See Table 6-2-4

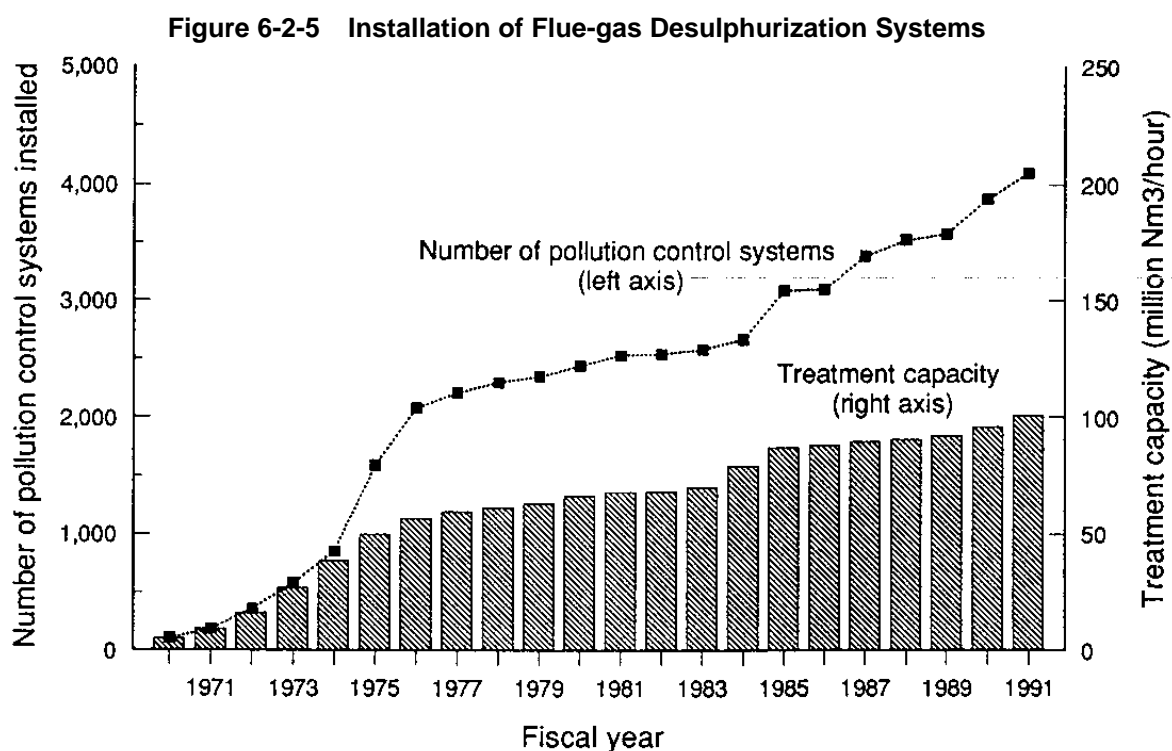
## 6.2.2 Installation of flue-gas desulphurization and denitrification systems

### (1) Sulphur oxides

Emission of sulphur oxides (SO<sub>x</sub>) can be held in check by promoting energy conservation. In fact, the oil crises in the 1970s stifled an increase in energy consumption, and prompted a drop in oil dependence through a shift in the make-up of energy supply (shift to natural gas, and an increase in nuclear power supply). This also resulted in an improvement in the levels of air pollution.

Moreover, comprehensive measures were adopted to reduce SO<sub>x</sub>, such as using low-sulphur crude oil and installing flue-gas desulphurization systems (Figure 6-2-5), and these have led to a significant drop in the concentration of sulphur dioxide in the air in Japan (Figure 6-2-6).

An international comparison reveals that energy demand in the United States is five to nine times as great as in Japan and Europe, and as a result, the level of SO<sub>x</sub> emission is about thirteen times as high (Figure 6-2-7). Moreover, all countries in North America and Europe have a higher basic emission unit value (primary energy ratio): assuming Japan has a value of 1, U.K. is 7.6, U.S. – 4.7, Germany – 1.6 and France – 2.5 (Figure 6-2-8). The reason Japan's basic emission unit is so low is that industry accounts for a high percentage of total energy consumption, and Japanese industry is well ahead of its American and European counterparts in terms of energy conservation and environmental measures. The U.K. relies heavily on coal for its energy supply, and this is reflected in its high basic emission unit value compared to the other European and North American countries.

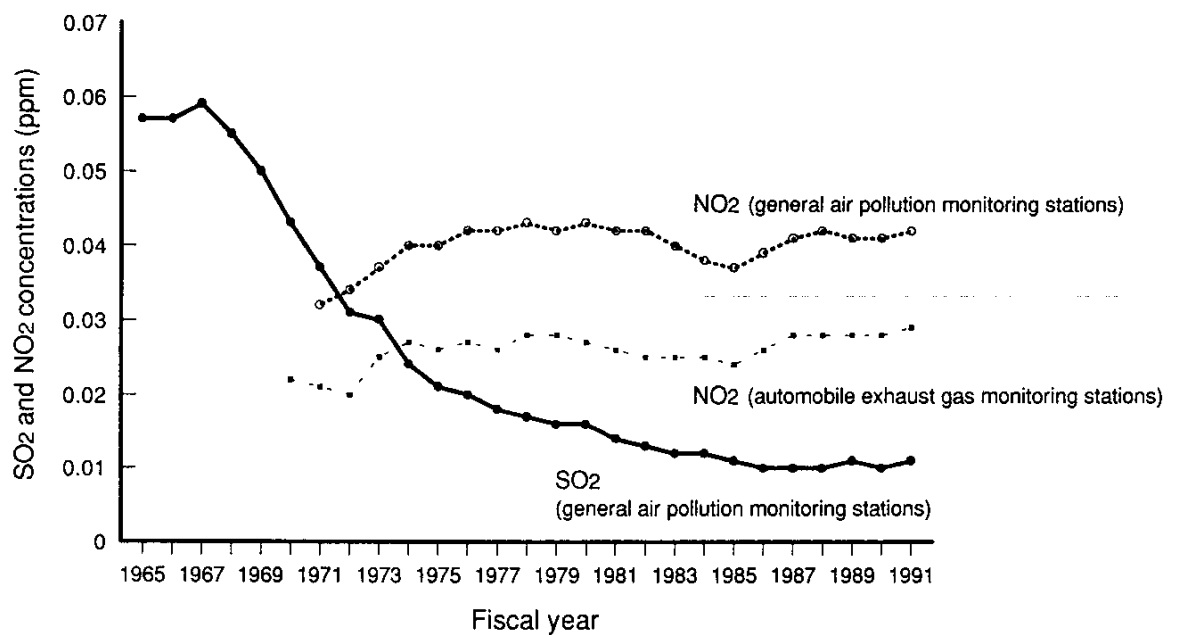


Note: N in the unit Nm<sup>3</sup>/h represents the conversion value at one atmosphere at 0°C.

Source: Air Pollution Control Division, Air Quality Bureau, *State of Installation of Smoke Treatment Systems*

See Table 6-2-5

Figure 6-2-6 Trends in SO<sub>2</sub> and NO<sub>2</sub> Concentrations

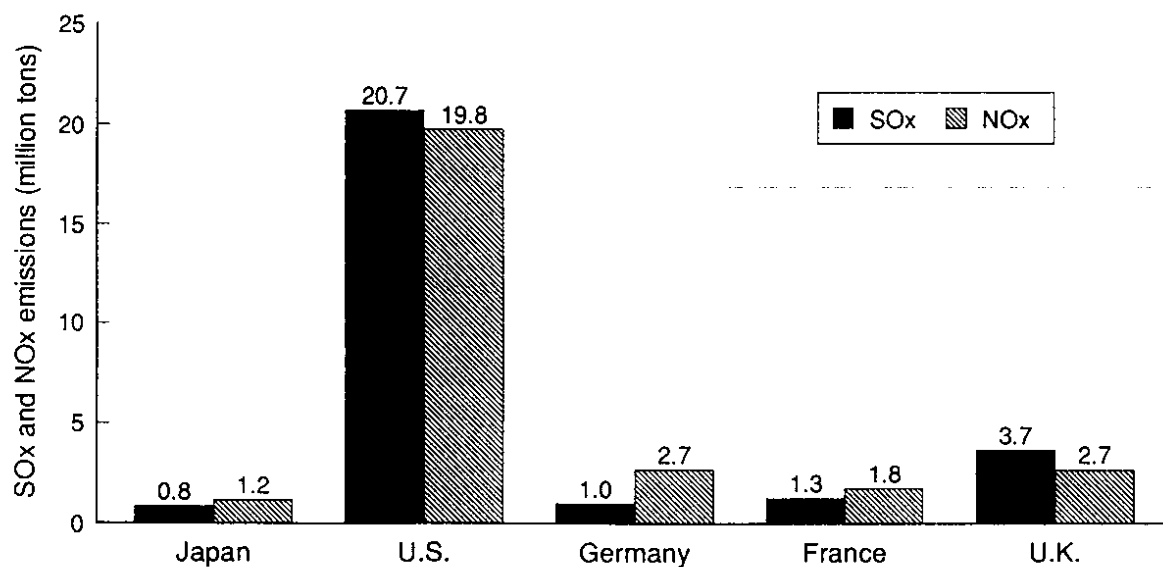


Note: Values at general air pollution monitoring stations and automobile exhaust gas monitoring stations are average values at the, respectively, 15 and 21 continuously monitoring stations.

Source: Environment Agency, *Quality of the Environment in Japan*

See Table 6-2-7

Figure 6-2-7 SO<sub>x</sub> and NO<sub>x</sub> Emissions

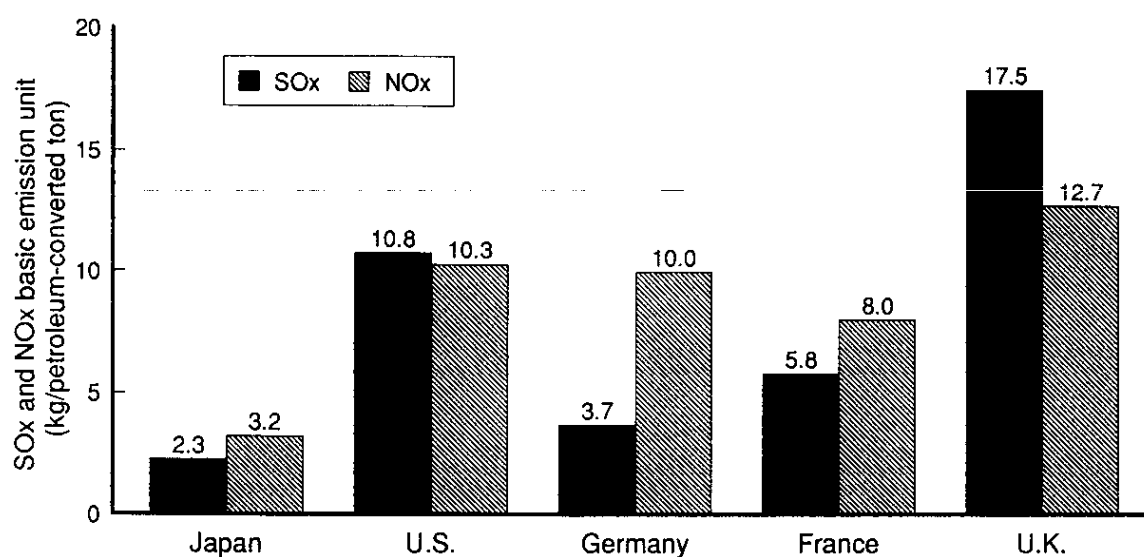


Source: OECD, *Environmental Data, Compendium 1991*

See Table 6-2-6



Figure 6-2-8 SOx and NOx Basic Emission Unit



Source: OECD, *Environmental Data, Compendium 1991*

See Table 6-2-6

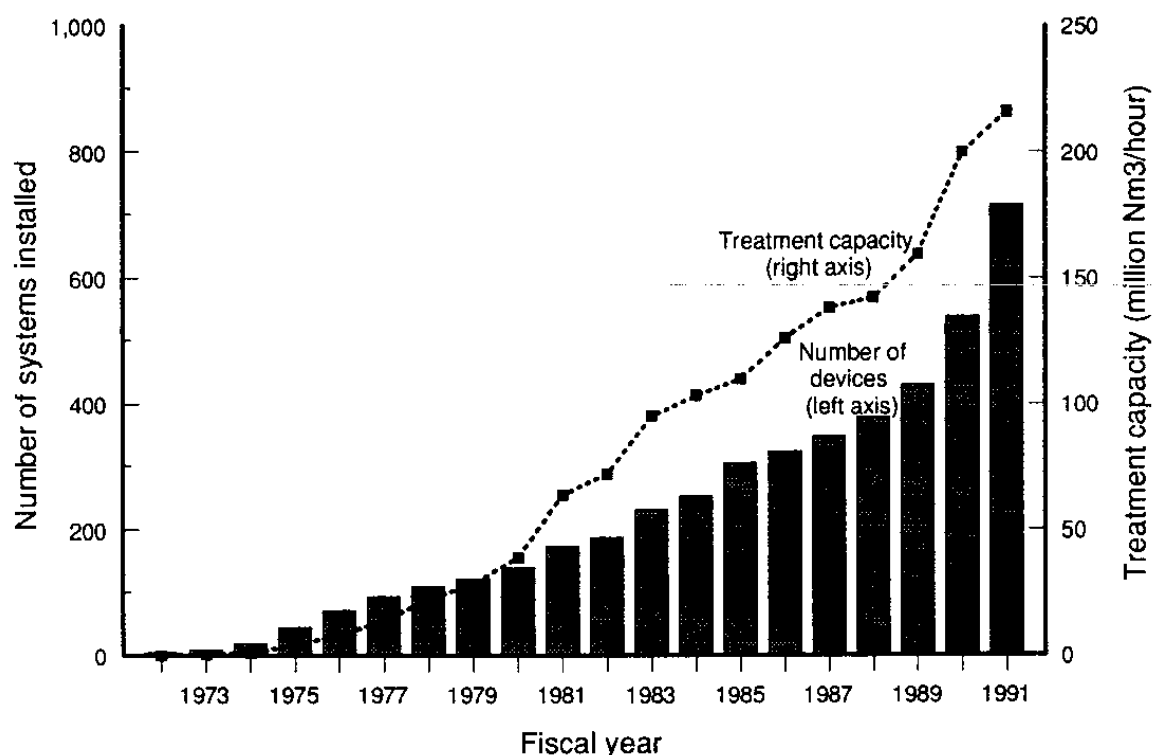
## (2) Nitrogen oxides

Since most nitrogen oxides (NOx) in the air result from the burning of fossil fuels, Japan has been promoting the development of more efficient combustion methods and establishment of denitrification systems as means of reducing NOx (Figure 6-2-9). In FY1991 gas- and petrol-powered engines became subject to the provisions of the Air Pollution Control Law, and as a result, the number of denitrification systems installed increased substantially to 715 (33% increase over the preceding fiscal year).

However in contrast to the significant improvement in SO<sub>2</sub> concentrations shown in Figure 6-2-6, NO<sub>2</sub> concentrations dropped only slightly in the years after FY1979, and in fact since FY1986 concentrations have returned to the high levels of the late 1970s. In FY1991, general air pollution monitoring stations registered an annual average value for NO<sub>2</sub> concentrations of 0.029 ppm, the worst on record.

The reason for this is that although NOx emissions from factories and other stationary sources have been decreasing, this has been more than offset by the rise in emission levels from the increased volume of motor vehicle traffic. The effect of motor vehicles on NOx concentrations is most evident in the major cities: in the Tokyo region motor vehicle exhaust accounts for 67% of NOx, while in the Yokohama region it is 32%, and in the Osaka region it is 47% (FY1985). And diesel-powered vehicles, which emit large amounts of NOx, now account for a higher percentage of motor vehicle exhaust. In response, the government enacted the Special Measures Law Concerning Reduction of Total Nitrogen Oxides Emitted from Motor Vehicles in Specified Region (Automobile NOx Law) in June 1992, and under this new law, it was able to adopt even stronger measures to counter NOx.

**Figure 6-2-9 Installation of Flue-gas Denitrification Systems**



Note: N in the unit Nm<sup>3</sup>/h represents the conversion value at one atmosphere at 0°C.

Source: Environment Agency, *State of Installation of Smoke Treatment Systems*

See Table 6-2-5

Comparisons reveal that the NO<sub>x</sub> basic emission unit value (primary energy ratio) for U.S., Germany and U.K. is three to four times as high and for France 2.5 times as high as that for Japan. France has a lower basic emission unit value than the North American and other European countries because a high percentage of its energy supply is from nuclear power generation.

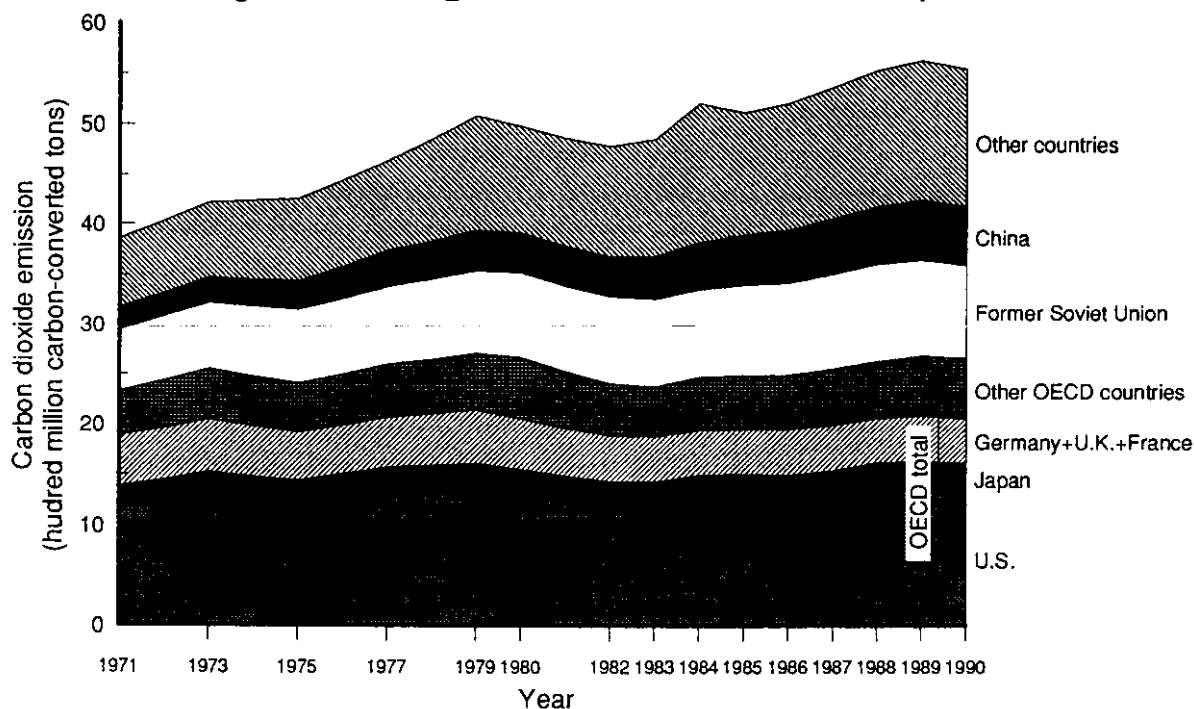
### 6.2.3 Carbon dioxide emissions

#### (1) Amount of CO<sub>2</sub> emissions

In 1971 about 93% of the world's primary energy came from fossil fuels (coal, petroleum and natural gas). And although some headway had been made in changing the energy supply make-up (mainly lowering dependence on petroleum), in 1990 fossil fuels still accounted for a high 89% of primary energy.

The amount of CO<sub>2</sub> produced world-wide by burning fossil fuels was 3,830 million tC (converted value of carbon) in 1971. In 1990 CO<sub>2</sub> emission reached 5,570 million tC, an increase of 1,740 million tC over the 1971 figure. As shown in Figure 6-2-10, between 1971 and 1990 emission levels in the OECD countries generally remained constant, while major increases were recorded in the former U.S.S.R. and China. By region, the rise in emission levels from 1971 to 1990 in Asia (not including China and Japan) was twice that of other regions.

Figure 6-2-10 CO<sub>2</sub> Emission from Fossil Fuel Consumption



Source: OECD, *Energy Balances of OECD Countries and World Energy Statistics and Balances*  
See Table 6-2-8

In 1990 the U.S. generated the highest percentage of the world's CO<sub>2</sub> emissions with 24%, followed by U.S.S.R. with 17%, China with 11%, and Japan with 5%. These four countries accounted for 57% of the world's CO<sub>2</sub> emissions. In addition, Germany accounted for 3.5%, U.K. for 2.8% and France for 1.9%. In 1990 the OECD countries accounted for 51% of the world's fossil fuel consumption, and 48% of the world's CO<sub>2</sub> emissions.

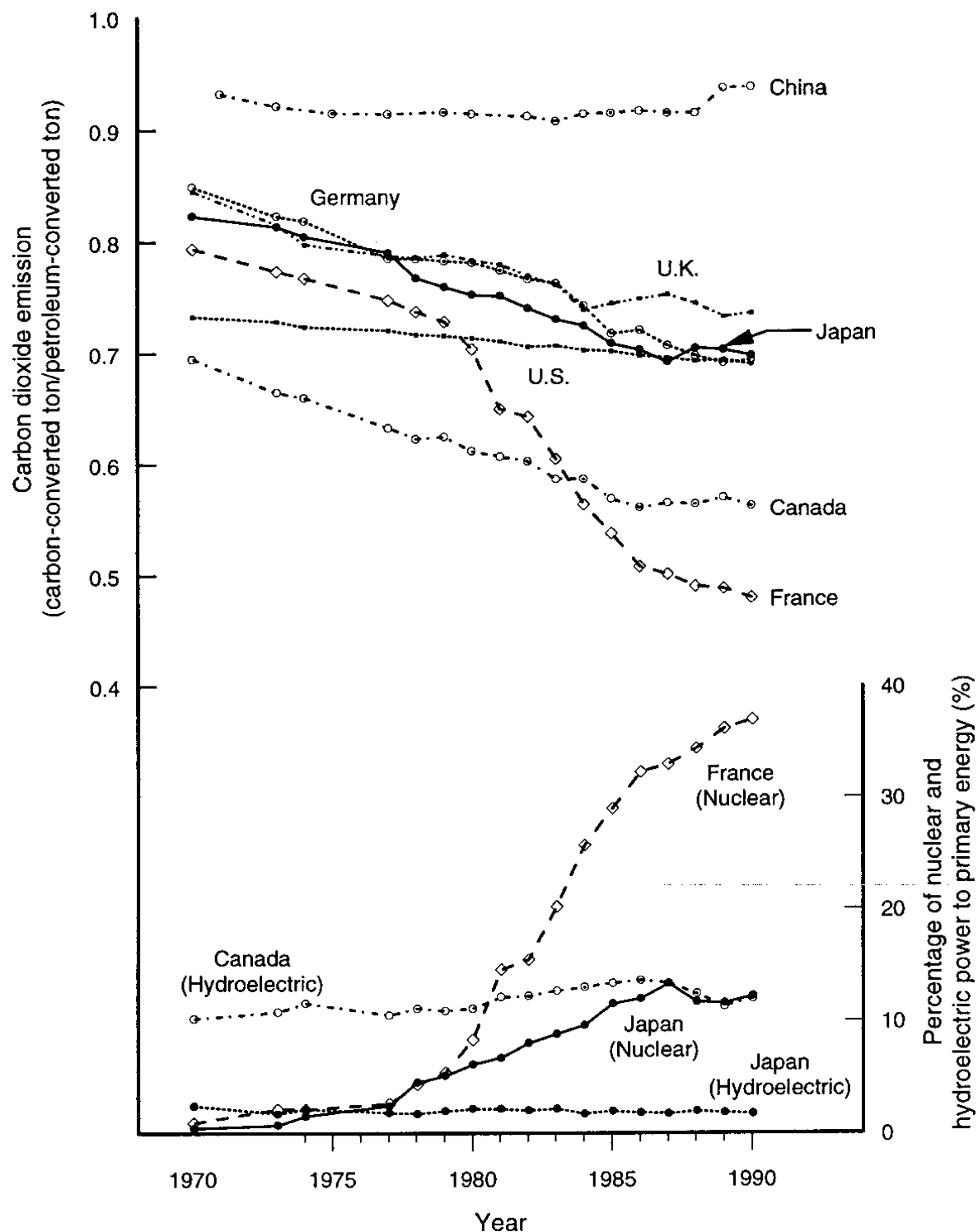
A look at the CO<sub>2</sub> basic emission unit values per primary energy unit for selected countries (kg/petroleum-converted ton) reveals that although the basic emission unit is decreasing in every case, the fall is small, and even after the oil crises there has been little change to the energy supply make-up <sup>(1)</sup> (Figure 6-2-11). France, however, has seen its basic emission unit drop significantly since 1980; but this is attributed to greater use of nuclear power for its energy needs. In 1990 nuclear power supplied about 37% of France's primary energy. In Canada, a high percentage of the country's energy supply comes from hydroelectric power, so here the basic emission unit is considerably lower than in other countries. In contrast, 79% of China's primary energy comes from coal, and this is reflected in its high basic emission unit.

In 1990 per capita emission (tC per person) was 5.2 in the U.S., 3.1 in Germany, 2.7 in U.K., 2.4 in Japan and 1.9 in France, while the OECD average stood at 3.2.

[Note]

- (1) Amount of CO<sub>2</sub> emission is a value calculated from the amount of coal, petroleum and natural gas primary energy according to OECD, *Energy Balances of OECD Countries: 1987-88, 89-90* and *World Energy Statistics and Balances 1971-97, 85-88, 89-90* and the basic emission unit according to IEZ-ORAU model.

Figure 6-2-11 CO<sub>2</sub> Emission per Primary Energy Unit and Percentage of Nuclear and Hydroelectric Power to Primary Energy



Note: Because of the limitations of data, figures for China before 1988 are calculated by TPER ratio.

Source: OECD, *Energy Balances of OECD Countries and World Energy Statistics and Balances*

See Tables 6-2-8 and 6-2-9

## (2) CO<sub>2</sub> emission control

Here, the paper will examine the control of CO<sub>2</sub> emissions through energy conservation and changes to the energy supply make-up.

First, in measuring control of CO<sub>2</sub> emissions through energy conservation the basic unit of primary energy (GDP ratio) is used as an energy conservation indicator. This ratio dropped by an average of 2% per year over the ten years from 1973 in Japan, North America and the major European countries, but over the last seven years this decrease has slowed down to an annual average of about 1%. In Japan's case, this slow-down is thought to be because the substantial advances made by Japan in improving energy use efficiency following the oil crises has diminished the scope for further energy conservation. Nevertheless, it is believed that Japan can continue contributing to the control of CO<sub>2</sub> emissions by pushing further ahead with comprehensive energy conservation measures <sup>(1)</sup>.

Regarding control through changes to the energy supply make-up, Japan has the highest dependence on petroleum among the OECD countries, and this has become a factor in Japan's high level of CO<sub>2</sub> emission. Thus, without changing the total energy supply for 1990, if Japan were to reduce energy from petroleum by 10% and make up for this loss by increasing energy from LNG, CO<sub>2</sub> emissions would drop by six million tC. If this reduction in energy from petroleum were to be made up for by an increase in energy from nuclear power, CO<sub>2</sub> emissions would drop by 20 million tC (6.7% of Japan's CO<sub>2</sub> emissions in 1990). Through this it can be seen that changing to non-fossil fuels for energy is more effective in controlling the CO<sub>2</sub> emission amount than changing from one fossil fuel to another. This is further supported by the fact that in 1990 the amount of CO<sub>2</sub> emission in the U.K., where a high proportion of the energy supply is from fossil fuels (particularly coal), was 1.5 times as great as in France, which used about the same amount of primary energy as the U.K. <sup>(2)</sup>

### [Notes]

- (1) Japan has been systematically and comprehensively promoting such global warming counter-measures as controlling CO<sub>2</sub> emissions under the "Global Warming Prevention Action Plan", formulated in October 1990.
- (2) The total supply of primary energy in 1990 was: U.K. —210.02 Mtoe; France —220.769 Mtoe. (1 toe = 10<sup>7</sup> kcal).

## 6.2.4 Recycling

Production and consumption activities utilize the earth's natural resources, and result in the generation of various kinds of waste. The proper treatment of this waste and the recycling of those items which can be used again is vital to the preservation of the global environment, and to this end, a wide range of initiatives have been adopted.

### (1) Recycling of industrial waste

First, the paper will examine the state of recycling in Japan. Figure 6-2-12 is a flow chart showing the treatment and recycling of industrial waste generated by the manufacturing industry for FY1992. The industrial waste generated (398 million tons) is divided into three categories: waste

which is disposed of directly (64 million tons); waste which can be recycled directly (93 million tons); and waste which requires intermediate treatment processes, such as incineration or dehydration (241 million tons). Waste that required intermediate treatment processes was reduced to 92 million tons, of which 27 million tons was disposed of and 65 million tons was recycled. Therefore, 158 million tons of waste, or 39% of the total waste generated, was recycled, either directly or after intermediate treatment.

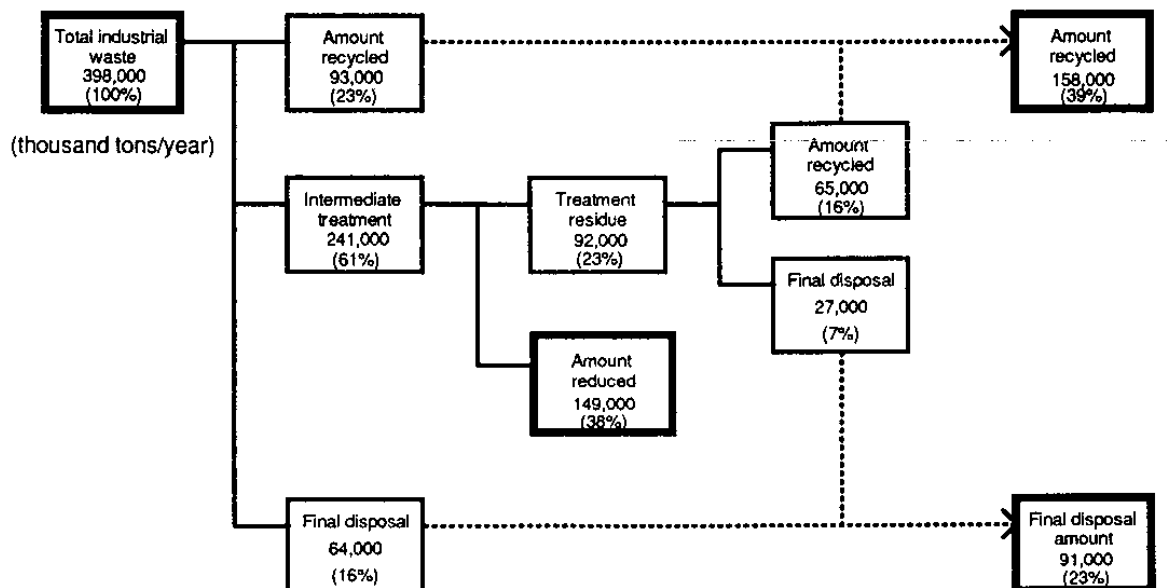
The following are examples of technology connected with the recycling of industrial waste.

Steel production generates slag at each blast furnace, converter and electric furnace process. Virtually all blast furnace slag, about 90% of converter slag and three quarters of electric furnace slag is recycled through the steel production processes, while the recycling rate for slag outside of these processes is also steadily rising. Steel slag is used in road construction and cement production, and much effort is being put into upgrading the technology to expand its usage and enhance its quality.

Coal ash is a by-product of coal power generation, and over the past few years the recycling rate has increased sharply so that now about half of the coal ash is recycled into such materials as a cement mixing agent, cement material, road-bed material and fertilizer. Technical issues in this field include developing the technology to expand its use, such as light-weight construction framework material made of compacted and solidified coal ash and construction boards made of sulphur-treated coal ash, and improve its quality.

As for motor vehicles and domestic electrical appliances, with the labeling of plastic parts, the greater use of easily recycled plastic components and the development of products which use such components, and the development of products etc. which can be easily separated or disassembled, focus is centering on the design of products and the use of materials which facilitate recycling.

**Figure 6-2-12 Treatment and Disposal Flow for Industrial Waste (FY1991)**



Note: Industrial waste includes by-products recycled or sold within the company.

Source: Ministry of Health and Welfare

## (2) Recycling of general waste

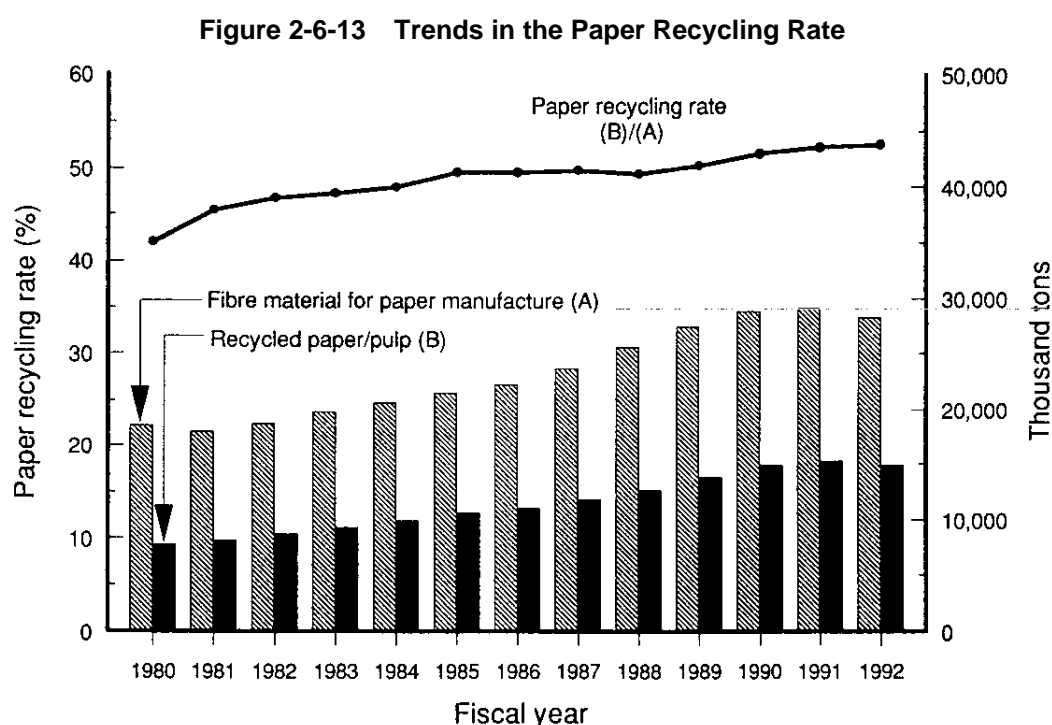
In FY1990 50 million tons of general waste, such as household garbage and office paper, were discarded by homes and businesses in Japan. Of this, 5.2% was recycled through group collection and intermediate treatment. Some waste paper, bottles, and steel and aluminium cans are included in calculations of the amount of general waste mentioned above, but those items collected for profit on a private sector base are not.

### 1) Paper recycling

The recycling of paper is playing a crucial role in conserving our forest resources and reducing garbage. In FY1992 the Japanese paper manufacturing industry consumed 28.28 million tons of fiber material, of which recycled pulp and paper accounted for 14.88 million tons, or 52.6%. As can be seen in Figure 6-2-13, the paper recycling rate hovered around 49.6% between 1985 and 1988, partly because of the drop in recycled paper prices, however since then, the rate has been increasing steadily.

The following technological areas must be enhanced to ensure that this rise continues.

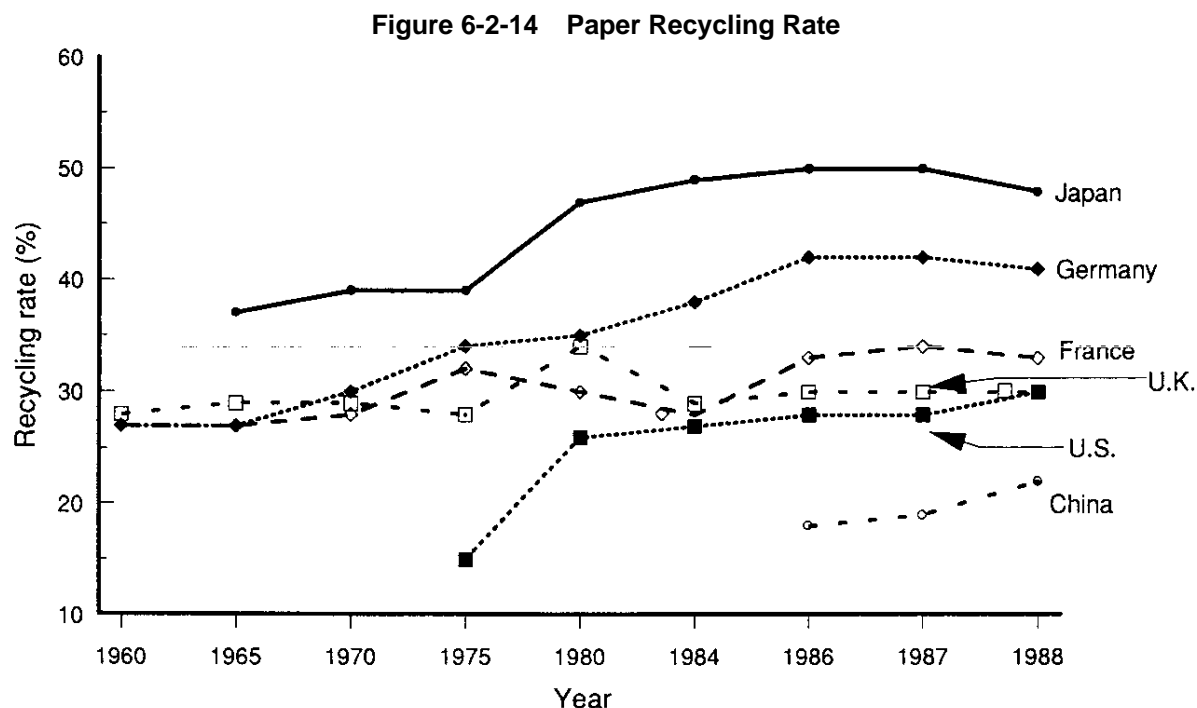
- (i) Separation technology which prevents the granulation of impurities, such as adhesives, while maintaining pulp strength.
- (ii) Technology which removes impurities efficiently.
- (iii) Technology which removes ink efficiently.
- (iv) Technology which efficiently combines chemicals to increase paper strength.



Source: Compiled by the Paper Recycling Center based on the Ministry of International Trade and Industry *Monthly Statistics on Pulp and paper*.

See Table 6-2-10

Figure 6-2-14 is an international comparison of paper recycling, and shows that over the past 20 or 30 years, most of the countries have increased the rate of paper recycling significantly. Japan is among the world's leaders in paper recycling with a rate of 48% (1988), followed by Germany with 41%, and U.S., U.K. and France with around 30%.



Note: U.S. rate for 1980 is the 1978-80 average; U.K. rate for 1975 is the 1974 rate.

Source: UNEP, *Environmental Data Report 1991/92*

See Table 6-2-11

## 2) Glass bottle recycling

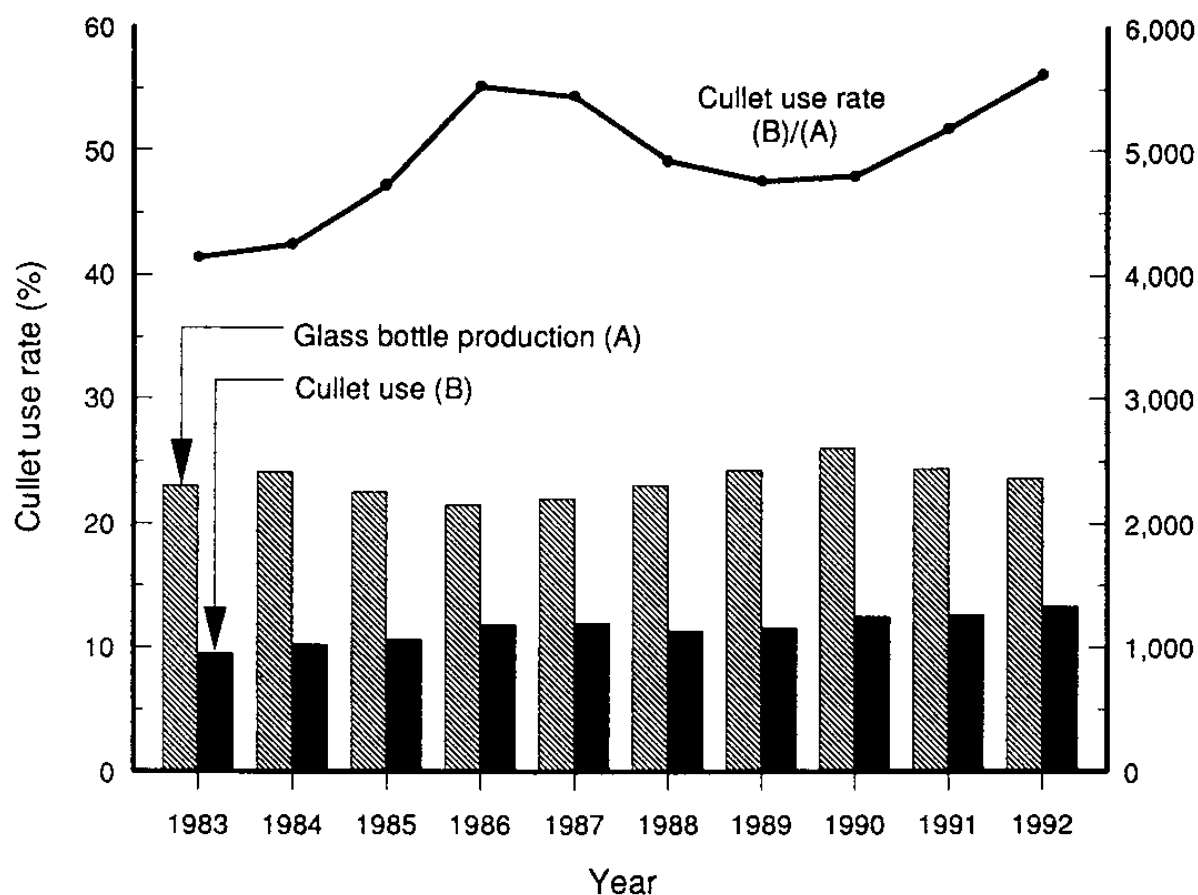
The cullet use rate by glass container manufacturers rose steadily to 55.2% in FY1986, but then fell due to the increasing cost of cullet compared to virgin raw materials. From FY1990 the rate again rose, reaching 56.2% in FY1992 (Figure 6-2-15).

Glass bottle manufacturing melts silica, the main raw material, and smaller quantities of lime and soda ash at high temperature to mold the bottles, but great savings in primary resources and manufacturing energy (3.67 million kcal/t) can be achieved through the use of cullet.

Technological aspects which require addressing include the development and improvement of (i) technology to separate the various cullet colors efficiently, and (ii) technology to remove impurities efficiently.



Figure 6-2-15 Cullet Use Rate



Source: Prepared by the Glass Bottle Association from Ministry of International Trade and Industry  
*Miscellaneous Statistics*

See Table 6-2-12

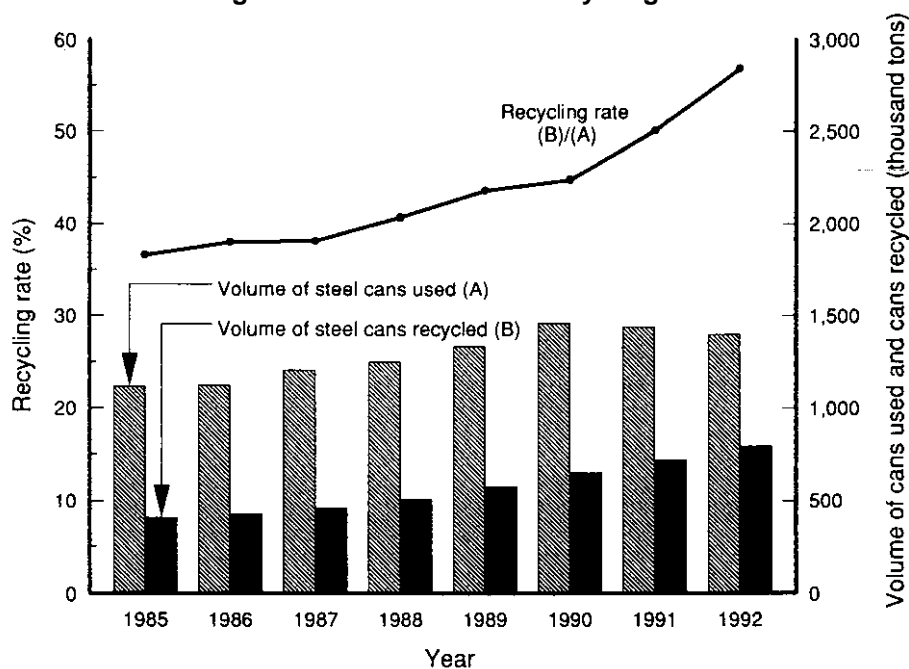
### 3) Steel and aluminium can recycling

Since the separate collection of steel and aluminium cans has become much easier with clear identification labeling, over the past few years the recycling rate has risen steadily, reaching 56.8% and 53.8%, respectively, in FY1992 (Figure 6-2-16 and Figure 6-2-17).

Steel cans are sorted, compressed, melted down in an electric furnace as scrap iron then manufactured into reinforcing rods and other metal products. As for aluminium cans, after sorting the cans are melted, and the metal used to make aluminium cans or machinery parts. In both cases, the recycling seeks to make effective use of the available resources. The energy saving effect of recycling, too, is significant as manufacturing cans from recycled aluminium requires only 3% of the considerable amount of energy needed to manufacture the cans from bauxite.

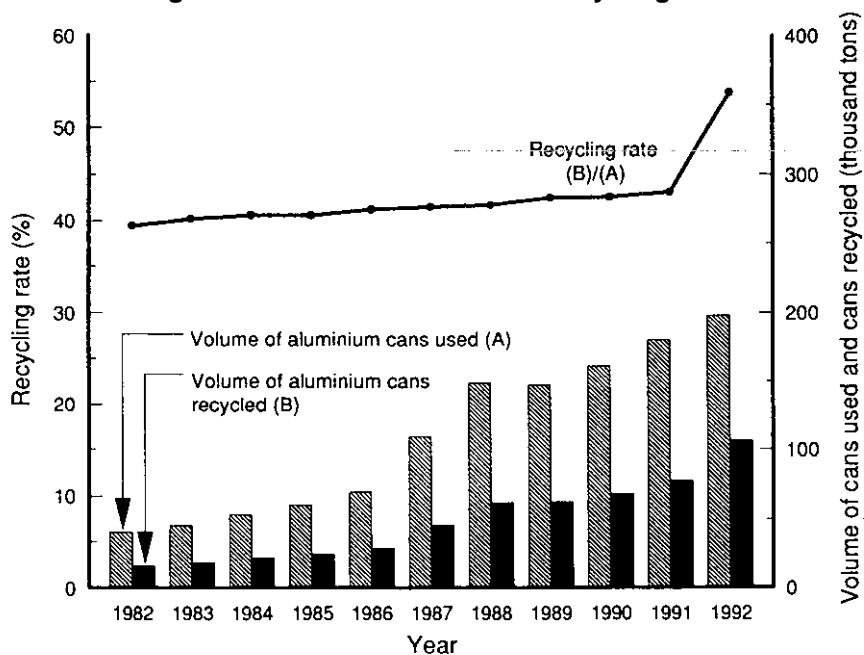
Technological issues include, for steel can recycling, the need to secure steel can scrap that does not contain impurities by improving sorting methods and upgrading processing and treatment technology to give the recycled material higher added value, and, for aluminium can recycling, the need to develop and improve the technology for removing impurities, such as magnesium and iron, to improve the recycled material's quality as secondary metal.

**Figure 6-2-16 Steel Can Recycling Rate**



Source: Empty Can Treatment Association, *Volume of Empty Cans and Recycling Rate*  
See Table 6-2-13

**Figure 6-2-17 Aluminium Can Recycling Rate**

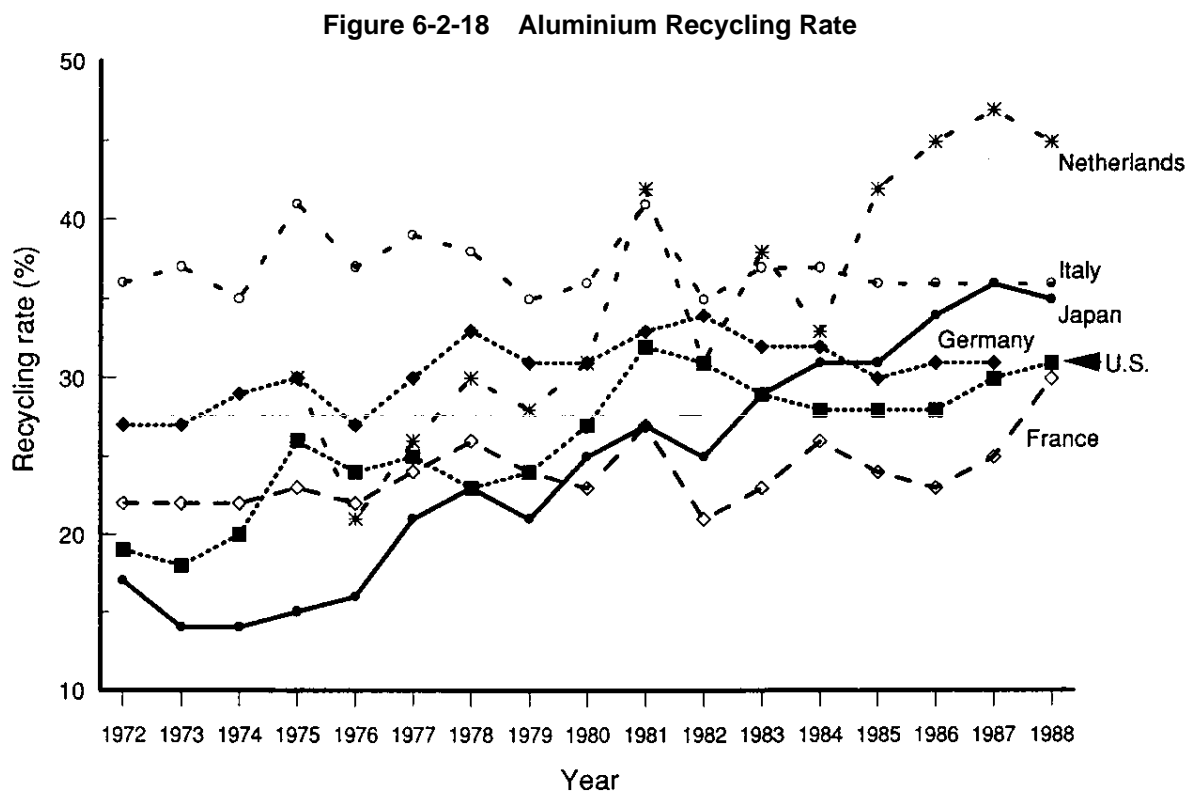


Note: The subjects of the survey for FY1992 are different from those of the previous fiscal years (subject range has been expanded) so comparisons are not possible.

Source: Aluminium Can Recycling Association, *Collection and Recycling Rate of Aluminium Drink Cans*

See Table 6-2-14

Figure 6-2-18 shows an international comparison of the recycling rate for all aluminium, including cans, and while displaying annual fluctuations, ten-year trends generally show a steady rise. In 1973 Japan's aluminium recycling rate was a very low 14%, but by 1988 it had climbed to be among the highest in the world at 35%. Although the Netherlands actually consumes a considerably smaller amount of aluminium than Japan (260,000 tons as compared to 3.44 million tons in 1988), their recycling rate has risen significantly over the period, and in 1988 it stood at 45%.



Source: UNEP, *Environmental Data Report 1991/92*  
See Table 6-2-15

## 6.3 Improvement of Medical Care and Welfare

Science and technology is also playing a key role in medical care and welfare. This section will discuss the trends in recent years in the development of drugs, the spread of medical devices, the state of advanced medical care technology, results in the treatment of diseases such as cancer, and the spread of welfare equipment.

### 6.3.1 Drugs and medical devices

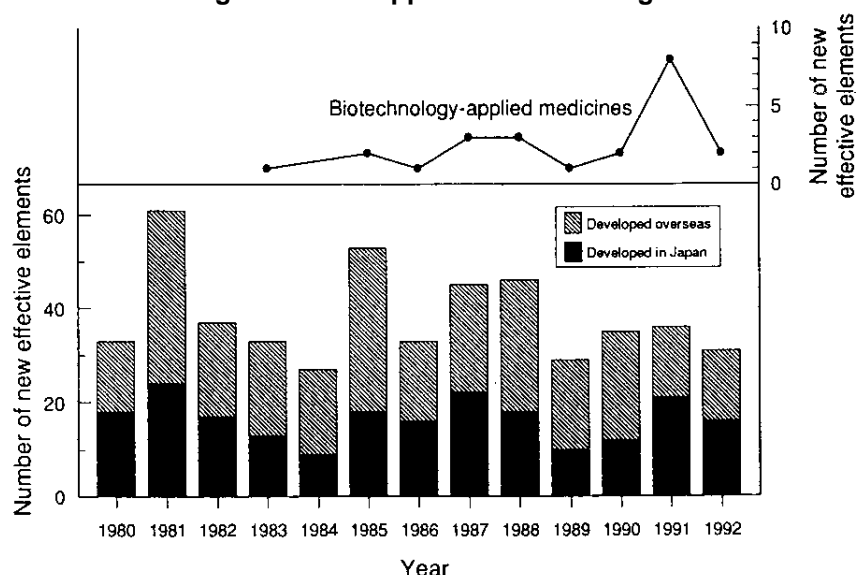
#### (1) Development of drugs

Drugs are essential for the preservation of human health and the treatment of disease, and the promotion of research and development in this field is a vital issue. As for the state of drug R&D, the Science and Technology Research Survey Report by the Management and Coordination Agency states that the percentage of in-house research expenditure to total sales is highest in the drug industry at 8.2% (FY1993), 2.5 times as high as the manufacturing industry average of 3.5%. Thus it is clear that this is a very research-intensive industry.

Regarding drug approvals under the Drugs, Cosmetics and Medical Instruments Law, in 1992 there were 3,535 approved drugs, of which 2,992 had manufacturing approval and 543 had importing approval. From among this total, 31 were approved as new drugs (new effective elements).

There have been at least 30 new drugs granted approval every year over the past few years (Figure 6-3-1). In the 1980s there tended to be more drugs developed overseas than were developed locally, but in 1991 and 1992, the situation was reversed and locally developed drugs outnumbered the overseas drugs. This is also the case with drugs (new effective elements) progressing to the clinical trial stage, where in recent years the number of local drugs has consistently exceeded the number from overseas.

Figure 6-3-1 Approval of New Drugs



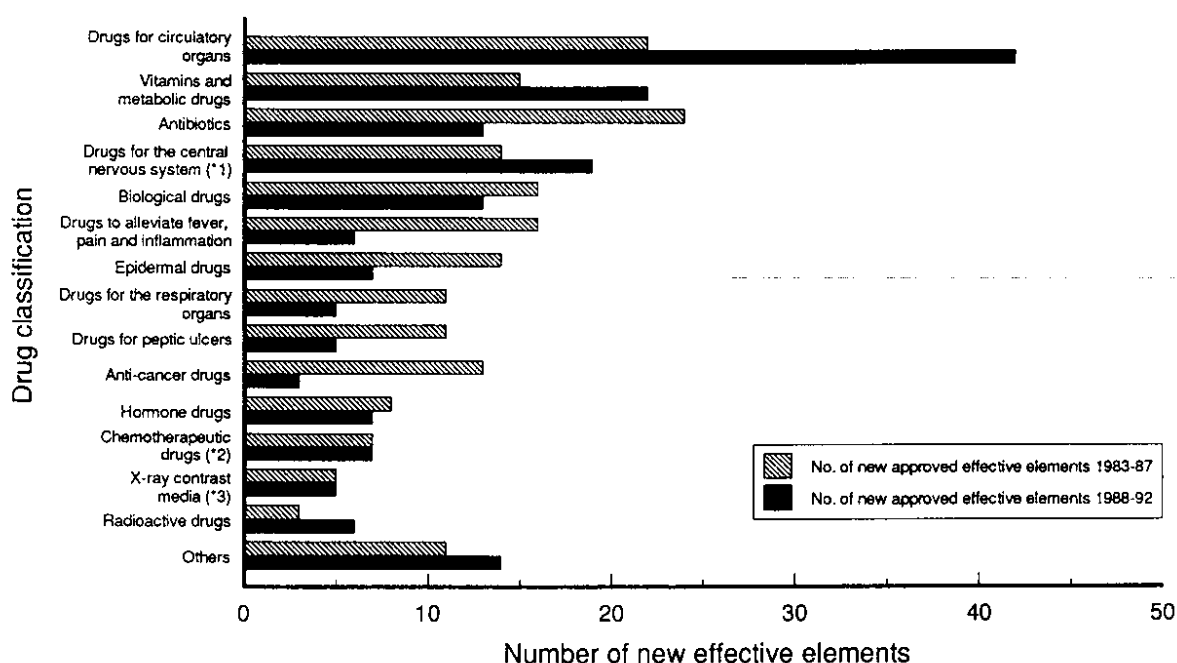
Note: The number of biotechnology-applied drugs is also included in the overall figure for new drugs.  
Drugs “developed in Japan” are those originating in Japan using local materials.

Source: Compiled from the Ministry of Health and Welfare *Pharmaceutical Affairs Bulletin*  
See Table 6-3-1

Regarding the state of new drug development by drug classification (Figure 6-3-2), the development line adopted by the drug companies has been to strike a balance between the size of the market for each drug classification and the number of rival products, taking into account the need within geriatric health care as the aging of the population advances. Over the past several years an increasing number of new drug approvals have been granted to drugs for the circulatory organs, vitamins and metabolic drugs, and drugs for the central nervous system.

Moreover, the development of drugs which apply biotechnologies such as recombinant DNA technology and cell cultivation technology has also been progressing steadily, and to date (the end of 1992), 23 such drugs, including human insulin for treating diabetes and hepatitis B vaccine, have been approved.

**Figure 6-3-2 Approval of New Drugs by Classification**



Note: (\*1) excludes drugs to alleviate fever, pain and inflammation; (\*2) excludes antibiotics; (\*3) includes other diagnostic drugs.

Source: Compiled as a five-year aggregate table from the Ministry of Health and Welfare  
*Pharmaceutical Affairs Bulletin*

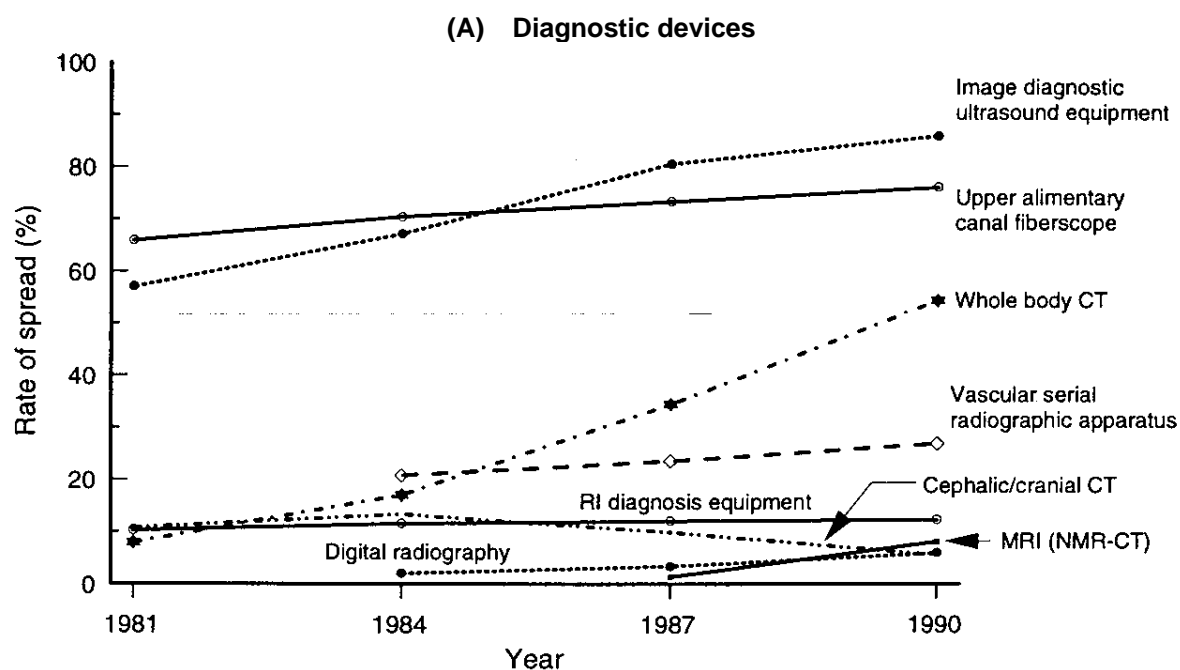
See Table 6-3-2(2) Spread of medical devices

The importance of medical devices is continuing to increase along with the growing sophistication of medical care technology. To date, developments in medical devices include the following.

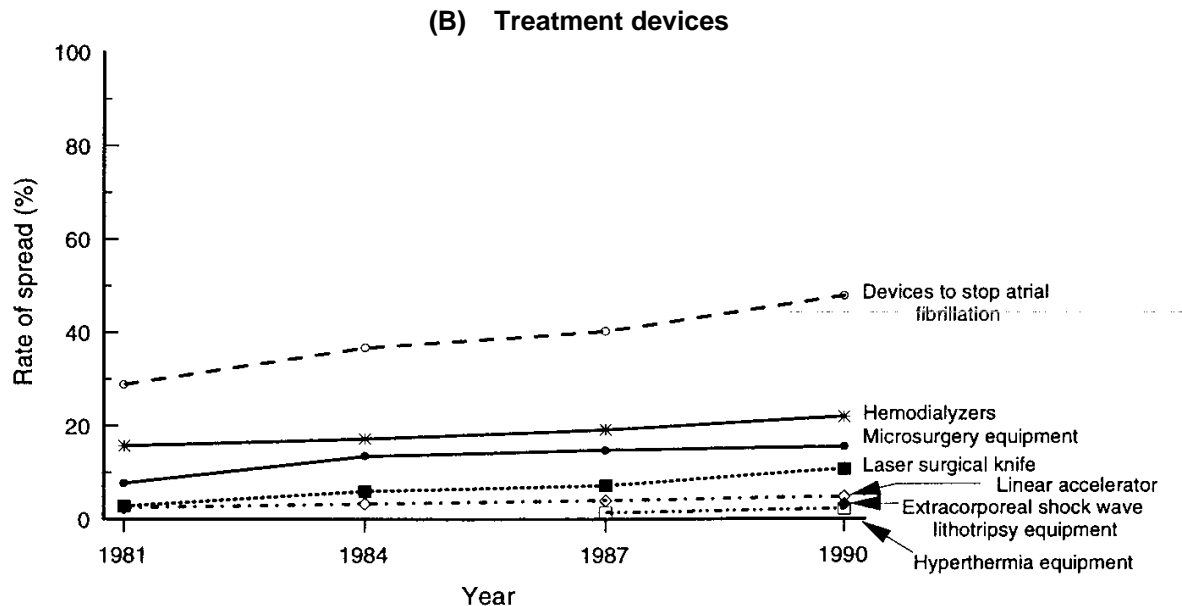
- (i) Improvement of image diagnosis  
Development and enhancement of image diagnosis equipment, including X-ray CT and MRI (magnetic resonance imaging) equipment has improved the accuracy of diagnosis and the effectiveness of treatment.
- (ii) Improvement of non-invasive treatment  
Improvements to non-invasive treatment, such as operations using endoscopes and extracorporeal shock wave lithotripsy, are reducing the burden on patients.
- (iii) Development of artificial organs etc.  
A deterioration in bodily functions through disease or the aging process can be partially compensated for through the development of artificial organs.

Figure 6-3-3 shows the spread of major medical devices in hospitals. The rate of spread is the percentage of general hospitals with the major medical devices surveyed in the Ministry of Health and Welfare Survey of Medical Care Facilities to the total number of general hospitals. From the figure it can be seen that of the image diagnostic ultrasound equipment and CT for the whole body are showing a steady rise, while the rise for MRI is quite pronounced. On the other hand, the drop in the rate for head CT is thought to be the result of hospitals' changing to whole body CT, MRI and digital radiography equipment. The rate of spread of advanced treatment devices listed here is also rising steadily, although because of their highly technical nature, the rate is lower than that for the imaging diagnosis devices.

Figure 6-3-3 Spread of Major Medical Devices in General Hospitals



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



Note: The 1981 figure for microsurgery devices is for cerebral microsurgery devices.

Source: Ministry of Health and Welfare, *Survey of Medical Care Facilities*

See Table 6-3-3

### 6.3.2 Medical care technology

Medical care such as consultation, examination, surgery and prescription is normally provided under health insurance. In addition to such general diagnosis and treatment, the medical profession is continually trying new medical techniques and carrying out research and development on more accurate diagnostic methods and more effective treatment. In response to the pace of developments in this area, in 1984 the government revised the Health Insurance Law, introducing the “highly advanced medical treatment system”(1). Under this system, approval as highly advanced medical treatment is given to the latest advanced medical techniques which meet certain conditions regarding the technology itself, staffing, facilities and equipment. This treatment includes partial liver transplantation surgery to transplant a part of the liver into children, and auto-blood-producing-cell transplantation, which seeks to restore the blood-making function through the transplantation of one’s own blood-producing cells. Such treatment as cerebrovascular surgery and extracorporeal shock wave lithotripsy, which were once classed as highly advanced medical treatments, are now covered by general health insurance in view of the extent to which the treatments are now applied and the maturation of the technologies.

Figure 6-3-4 shows the trends in the number of highly advanced medical treatment categories and the number of hospitals providing such treatment for each fiscal year. By the end of May 1993, there were 52 highly advanced medical treatment categories approved at 274 hospitals, including those treatments later covered by general health insurance (19 categories, 160 hospitals).

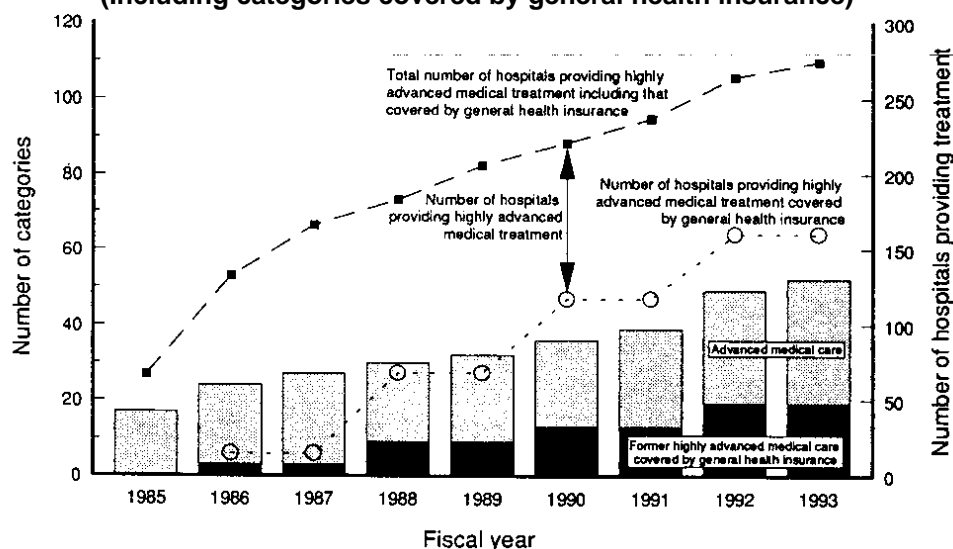
Figure 6-3-5 shows the relationship between highly advanced medical treatment categories (including those later covered by general health insurance) and the number of hospitals providing such treatment. Both the number of treatment categories and the number of hospitals providing the treatment are rising.

#### [Note]

- (1) Health insurance pays specified medical costs for a part of highly advanced medical treatment such as consultation, examination, prescription and hospitalization (the patient is required to meet a part of the specified medical costs), while the cost of highly advanced medical treatment which exceeds these common parts is to be met by the patient.



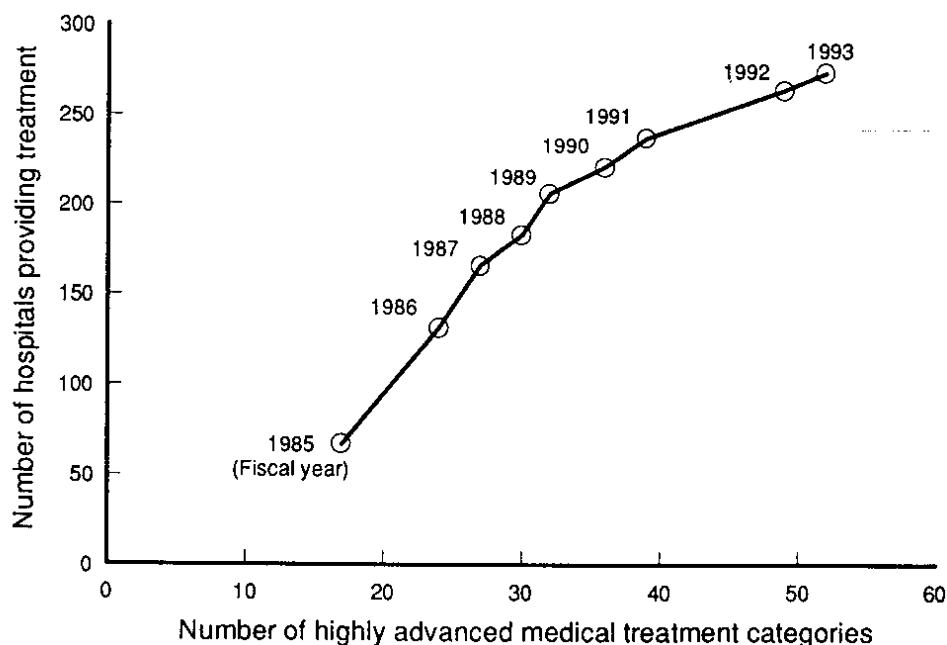
**Figure 6-3-4 Number of Highly Advanced Medical Treatment Categories and Hospitals Which Provide Such Treatment**  
(Including categories covered by general health insurance)



Source: Compiled from year-end aggregate values from Ministry of Health and Welfare data (as of end of May for FY1993).

See Table 6-3-4

**Figure 6-3-5 Number of Highly Advanced Medical Treatment Categories and Hospitals Which Provide Such Treatment**  
(Correlation between the number of treatment categories and hospitals)



Note: Includes those treatment categories covered by general health insurance.

Source: Compiled from year-end aggregate values from Ministry of Health and Welfare data (as of end of May for FY1993).

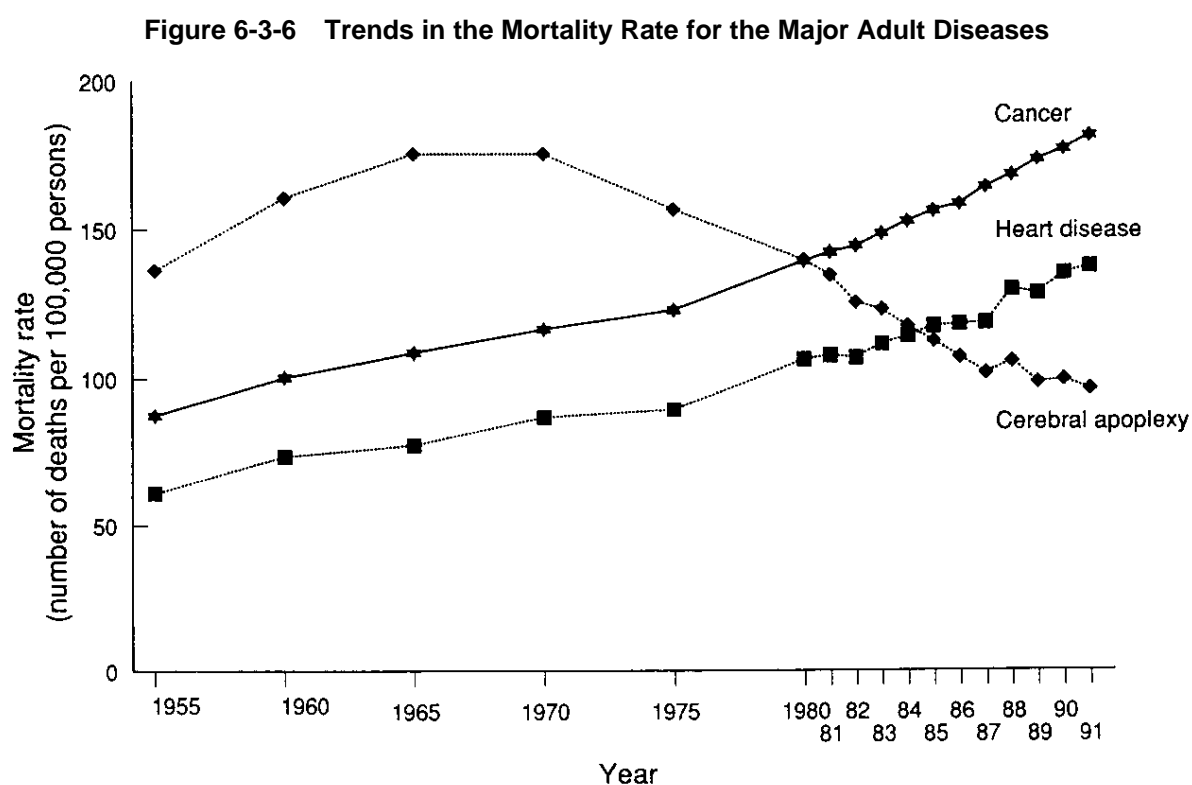
See Table 6-3-4

### 6.3.3 Mortality rate and treatment results for the three major adult diseases

The three main causes of death in Japan are cancer, heart disease and cerebrovascular disease, and this section will examine the role of medical care in human life and health through trends in the results of treatment for cancer and diseases of the circulatory system.

#### (1) Mortality rate for the three major adult diseases

Figure 6-3-6 shows trends in the mortality rates of the three major adult diseases (number of deaths per 100,000 persons). In 1981 cancer replaced cerebrovascular diseases as the primary cause of death, and in 1985 heart disease replaced cerebrovascular diseases as the number two cause of death in Japan. Since then, although the ranking of these three diseases has not changed, the mortality rate for cancer has continued to rise, reaching 181.7 in 1991, and while showing fluctuations, the mortality rate for heart disease also continued to rise to reach 137.2 in 1991. In contrast, the mortality rate for cerebrovascular disease has continued downward since the 1970s, falling to 96.2 in 1991. This can be largely attributed to the significant drop in the mortality rate for cerebral haemorrhage due to advances in the prevention of high blood pressure and development of the emergency medical care system.



Source: Ministry of Health and Welfare, *Vital Statistics*  
See Table 6-3-5

## (2) Five-year cancer survival rate

The survival rate is one gauge used to assess the treatment of diseases, and is calculated as the percentage of all patients diagnosed with a particular disease and treated for that disease at a medical institution who are still alive after a given period (e.g. five years).

Figures 6-3-7(A) and 6-3-7(B) show trends in the five-year survival rate for cancer patients hospitalized for the first time at the National Cancer Center. Although there are different fluctuations among the various body parts, overall the five-year survival rate for both males and females is rising steadily. The main reason the female five-year survival rate is higher than the male rate is that the five-year survival rate for cancers peculiar to women, such as breast cancer and cervical cancer, is higher than that for the predominantly male cancers.

The following are pointed to as factors in the improvement of treatment for such diseases.

- (i) Better treatment due to advances in medical technology—a marked improvement in early detection and the accuracy of diagnosis due to advances in image diagnostic ultrasound equipment, such as endoscopes, X-ray CT and NMR-CT.
- (ii) Advances in operating methods—introduction of safe operating methods for lung and esophagus cancers, and implementation of improved radical surgery methods, endoscope operations for early-stage stomach cancer, and operations which preserve bodily functions as much as possible thanks to advances in medical technology and in the light of growing concerns about postoperative quality of life.
- (iii) Establishment of scientific treatment research methods—shift from treatment methods based on subjective assessment through experience gained from a small number of cases to methods based on uniform and objective judgment standards.
- (iv) Advances in chemotherapy — improvement in the cure rate for malignant lymphatic cancer and in the success rate for treatment of stomach cancer.
- (v) Advances in combined treatment—improved treatment results through the rational combination of treatment methods, such as surgery, chemotherapy, radiation treatment, immunotherapy and thermotherapy.

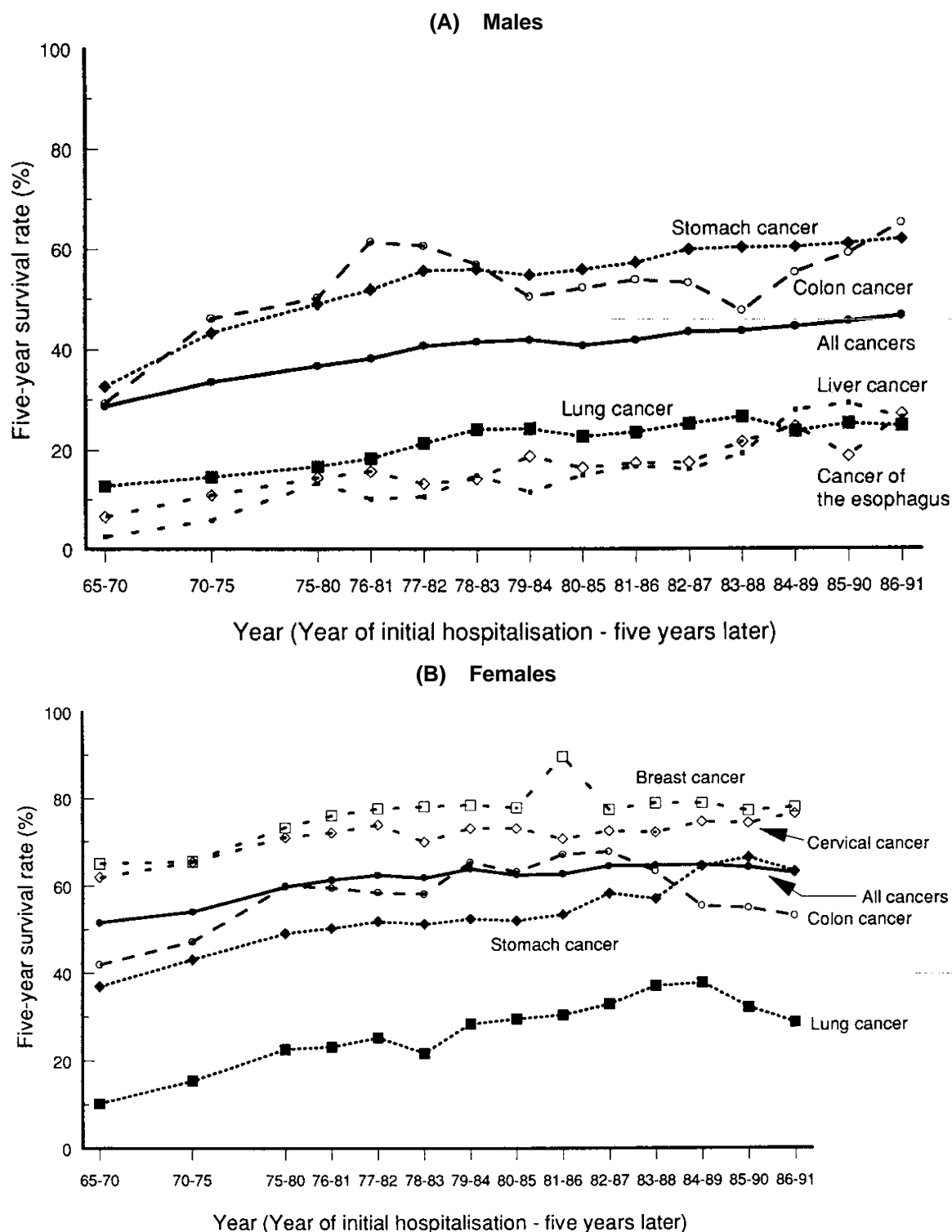
## (3) One-year survival rate for cardiovascular diseases

The mortality rate (percentage of patients who die from the disease within the first year) for cardiovascular diseases, such as heart disease and cerebrovascular disease, is lower than for cancer, while the actual number of patients is much higher.

Figure 6-3-8 shows trends (in three three-year periods) in the one-year survival rate of patients who were discharged from the National Cardiovascular Center (heart diseases and cerebrovascular diseases). This study examines significant differences between periods statistically. A significant improvement of the one-year survival rate for acute myocardial infarction and angina pectoris occurred in males, but no such change occurred in females. Among the cerebrovascular diseases, a significant improvement was seen in both sexes for cerebral haemorrhage, but there was no improvement in either males or females for subarachnoid bleeding and cerebral infarction.

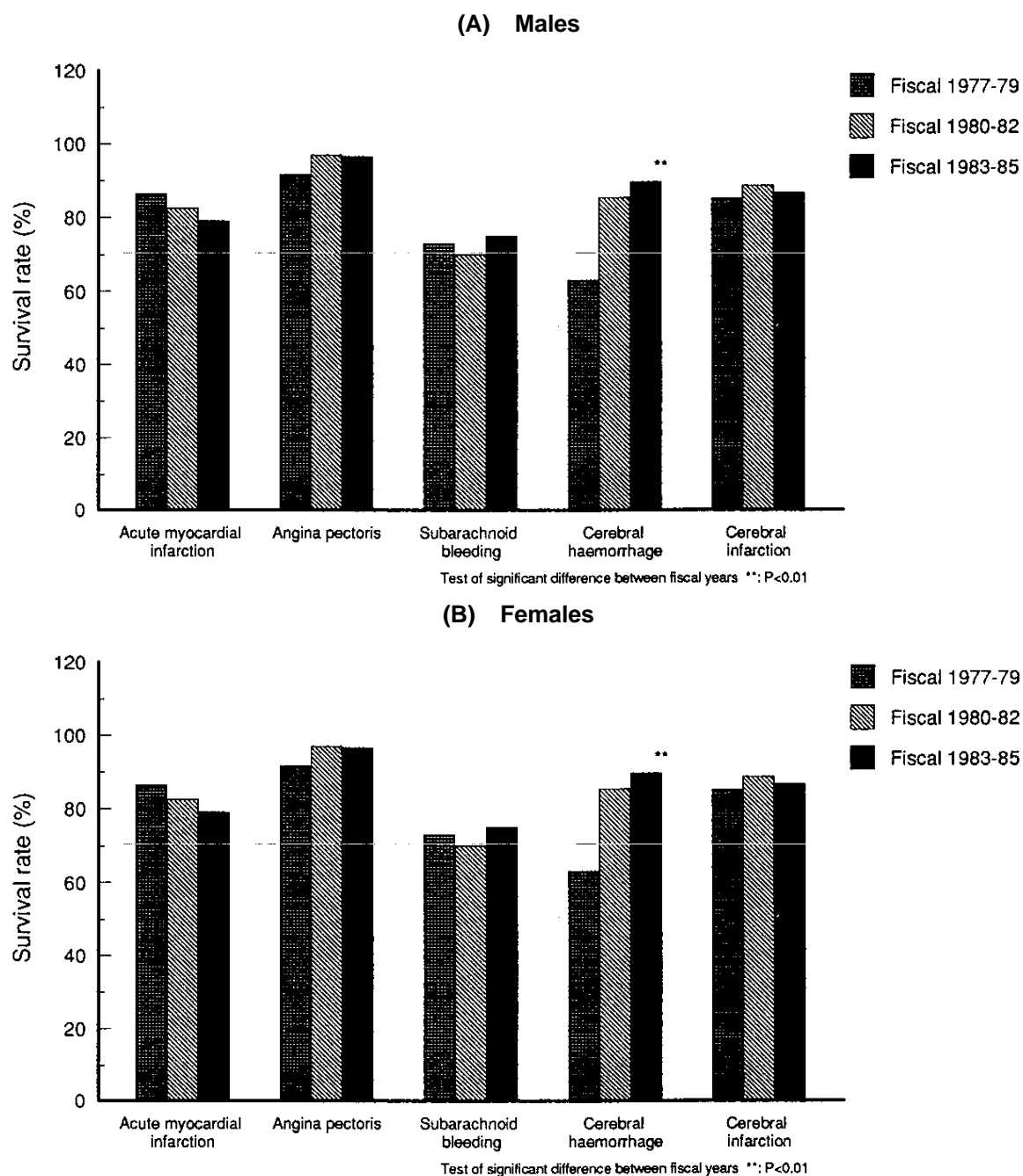
General factors in the improved results for treatment of cardiovascular diseases include developments in drug treatment for high blood pressure (anti-Ca drug, and ACE inhibitor), a serious cause of these diseases, and advances in such surgical methods as percutaneous coronary angioplasty.

**Figure 6-3-7 Trends in the Five-year Cancer Survival Rate (Patients hospitalized at the National Cancer Center for the first time)**



Source: Compiled from National Cancer Center data  
See Table 6-3-6

**Figure 6-3-8 Trends in the One-year Survival Rate for Patients with Cardiovascular Diseases Discharged from the National Cardiovascular Center**



Note: After age adjustment, the data were examined for significant differences between periods by way of  $\chi^2$  examination.

Source: National Cardiovascular Center, *Registration and Follow-up Survey of Patients with Cardiovascular Diseases*

See Table 6-2-7

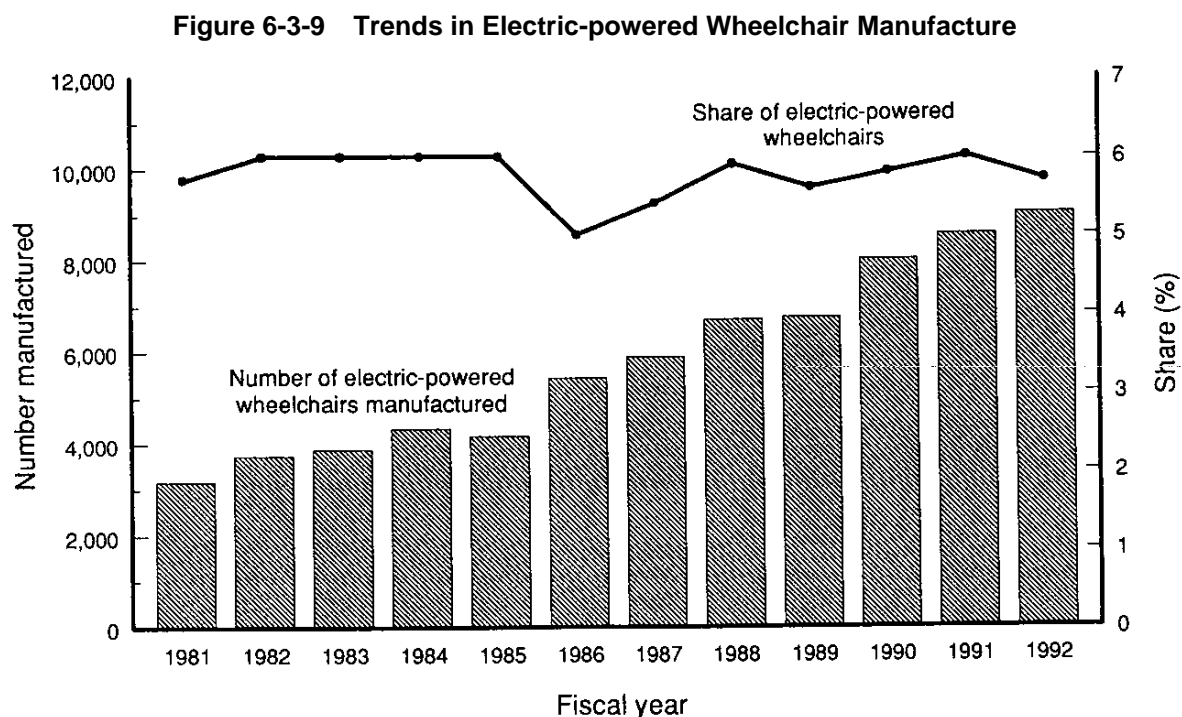
### 6.3.4 Welfare equipment

In the light of Japan's steadily aging population, there is a growing interest in welfare equipment such as devices to support elderly people whose physical functions have deteriorated, and devices that can alleviate the burden on people who provide nursing care.

A wide range of welfare equipment to support people's daily lives has been developed or improved, including equipment that assists with mobility, such as wheelchairs and elevators, equipment that assists with getting in and out of bed, such as nursing beds with reclining functions, devices which assist with bathing, portable toilets and other devices which assist with bowel and bladder movements, and communication support devices, such as hearing-aids.

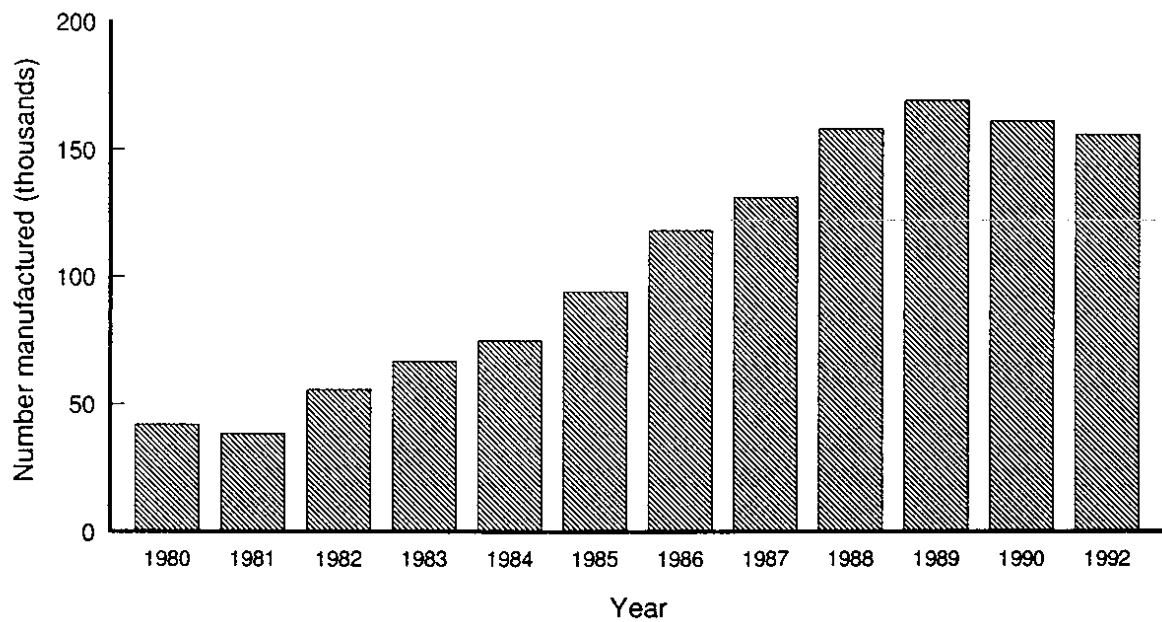
Here the paper examines trends in the manufacture of electric-powered wheelchairs and nursing beds. Figure 6-3-9 shows the trend in the number of powered wheelchairs manufactured. Since the early 1980s the number has grown almost every year, averaging a growth rate of a high 9.2% over the ten years to FY1992. The percentage of electric-powered wheelchairs to all wheelchairs manufactured, including non-powered wheelchairs, has remained at a fairly constant 6%. From this it can be seen that the use of all kinds of wheelchairs has been increasing steadily.

As for trends in the manufacture of special nursing beds (beds with reclining or other special functions) as surveyed by the National Association of Bed Manufacturers, Figure 6-3-10 shows that the average manufacturing growth rate for the seven years from 1982 to 1989 was a high 17.3%, but after peaking in 1989, the number fell or leveled off, and this held down the average growth rate for the ten years to 1992 to 10.9%. This fall or leveling off is thought to be as a result of the peak being reached in the number of hospitals and hospital beds.



Source: Compiled from Japan Association of Wheelchair Manufacturers data.  
See Table 6-3-8

**Figure 6-3-10 Trends in Nursing Bed Manufacture**



Note: The figure uses the number of beds in the category “special nursing beds” in the source data as the number of nursing beds manufactured.

Source: National Association of Bed Manufacturers data

See Table 6-3-9

Regarding welfare equipment, the types of equipment being developed are expanding from devices which are simply substitutes for or supplement functions that have been lost to devices which enrich people’s lives, including the use of leisure time, and from devices used by individuals to devices for use within housing facilities or environmental facilities. Development of welfare equipment to date has mainly focused on rehabilitation engineering, but at the same time, advances are being made in research and development on welfare devices which are both necessary and convenient to elderly or disabled people or their care-givers.

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Chapter 6 Akiya Nagata (4.1)

Kazunari Takebe (4.2 – 4.3)



# Chapter 7

## Public Opinion on Science and Technology

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## **Chapter 7**

### **Public Opinion on Science and Technology**

#### **7.1 Research into Opinions on Science and Technology**

##### **7.1.1 Public opinion polls on science and technology**

Public opinion on science and technology indicates how the general public perceives science and technology. This includes the two sides of how the results of scientific and technological activities affect public opinion, and, conversely, how public opinion affects the promotion and direction of scientific and technological activities.

Objectively gauging public opinion is by no means a simple task, and any device used must be technically well-planned. Random-sample opinion polls is the most widely used method of determining the general public's view regarding a matter.

In recent years there have been many polls focusing on science and technology, and there have also been many polls that include questions on various aspects of science and technology. Table 7-1-A lists all of the major polls carried out on a national basis in Japan since 1980 with a main theme of science and technology.

Polls on science and technology are also conducted regularly overseas, and the major polls are listed in Table 7-1-B. Moreover, an international joint study into public opinion on science and technology also has been carried out since 1990. This joint study, outlined in Table 7-1-C, was initiated by researchers and research institutions in Japan, U.S., Canada, U.K., France and the ECC, and later joined by researchers and research institutions in Germany and China in 1992.

The study provides reliable international data which is used here to draw comparisons between different countries.

##### **7.1.2 Use of poll results**

Poll results must be analyzed effectively, looking first at trends over set periods of time, then grasping the social or individual opinion structure through differences in respondents' attributes, such as age or gender differences, and finally, through analysis of opinion changes and make-up, gaining an insight to a perspective which may not always be immediately apparent.

In addition, an important effect of the survey results is to detect cultural differences (differences in values) and differences in the course (stage) of social development through international comparisons, and use this information to deepen mutual understanding or pave the way for closer exchanges.

**Table 7-1-A Major Polls on Science and Technology in Japan**

Theme	Polling organization	Polling period	Sample number	Responses received	Response rate (%)
Energy issues and nuclear power generation	Yomiuri Shimbun	Mar 1981	3,000	2,143	71.2
Computer society	Mainichi Shimbun	Dec 1981	3,000	2,356	78.9
Science and technology	Prime Minister's Office	Dec 1981	3,000	2,368	78.9
Energy issues and nuclear power generation	Yomiuri Shimbun	Apr 1982	3,000	2,039	68.0
In-vitro fertilization, brain-death and organ transplants	Yomiuri Shimbun	Oct 1982	3,000	2,139	71.3
Home information and communication services	Prime Minister's Office	Aug 1983	3,000	2,355	77.8
Brain-death and organ transplants	Yomiuri Shimbun	Feb 1984	3,000	2,124	70.8
Nuclear power	Prime Minister's Office	Mar 1984	3,000	2,255	75.1
New media	Yomiuri Shimbun	Mar 1985	3,000	2,178	72.6
Brain-death	Mainichi Shimbun	Sept 1985	5,485	4,141	75.5
Brain-death and organ transplant	Yomiuri Shimbun	Nov 1985	3,000	2,205	73.5
Information society	Prime Minister's Office	Nov 1985	3,000	2,349	78.3
Life sciences	Prime Minister's Office	Dec 1985	10,000	7,439	74.4
Interest in science and technology	Prime Minister's Office	Feb 1986	3,000	2,376	79.2
Nuclear power generation	Mainichi Shimbun	May 1986	3,000	2,252	75.0
Nuclear power generation	Mainichi Shimbun	June 1986	3,000	2,315	77.0
AIDS	Prime Minister's Office	May 1987	10,000	7,921	79.7
Insurance and medical services (including brain death)	Prime Minister's Office	June 1987	5,000	4,000	80.0
Environmental issues	Prime Minister's Office	Jan 1988	3,000	2,362	78.7
Brain death etc.	Asahi Shimbun	Mar 1988	3,000	2,345	78.2
Nuclear power generation	Asahi Shimbun	Sept 1988	3,000	2,342	78.1
Environmental conservation activities	Prime Minister's Office	Oct 1988	3,000	2,443	81.4
Brain-death and organ transplant	Yomiuri Shimbun	Dec 1989	3,000	2,063	68.8
Science & technology and society	Prime Minister's Office	Jan 1990	3,000	2,237	74.6
Global environmental issues	Prime Minister's Office	Mar 1991	5,000	3,753	75.1
General pollution	Prime Minister's Office	July 1990	3,000	2,250	75.0
Nuclear power	Prime Minister's Office	Sept 1990	5,000	3,751	75.0
Cancer	Mainichi Shimbun	Sept 1990	5,559	3,905	70.2
Medical care ethics	Prime Minister's Office	Oct 1990	3,000	2,209	73.6
Brain-death and organ transplant	Yomiuri Shimbun	Nov 1990	3,000	2,155	1.8
Energy conservation	Prime Minister's Office	Dec 1990	10,000	7,329	73.0
AIDS	Prime Minister's Office	May 1991	10,000	7,639	76.4
Conservation and use of the natural environment	Prime Minister's Office	June 1991	3,000	2,253	75.1
Living and energy	Prime Minister's Office	July 1991	3,000	2,268	75.6
Brain-death and organ transplant	Asahi Shimbun	Mar 1992	3,000	2,349	78.3
Energy conservation and the environment	Prime Minister's Office	June 1992	3,000	2,284	76.1
Terminal stage medical care	Ministry of Health and Welfare	Feb 1993	5,000	3,030	60.6
Environmental conservation	Prime Minister's Office	June 1993	5,000	3,754	75.1
Living environment and general pollution	Prime Minister's Office	June 1993	3,000	2,200	73.3
Brain-death and organ transplant	Yomiuri Shimbun	Dec 1993	3,000	2,116	70.5

**Table 7-1-B Overseas Public Opinion Polls on Science and Technology**

Country and theme	Polling organization	Polling period	Size of poll
U.S. Understanding of science and technology	Northern Illinois University, Public Opinion laboratory (conducted with the support of NSF)	1992 1990 1988	(General number each year) Sample number about 3,000 Responses received about 2,000
U.K. Understanding of science and technology	Science Museum and Oxford University	1989	Sample number 3,000 Responses received 2,009
France Science and technology	SOFRES Survey	1972 1982 1989	Sample number not known Responses received 1,515 (1982) 1,527 (1989)
EU Understanding of science and technology	ECC	1989	Sample number not known Responses received 11,677 total of 12 countries
China	China Science and Technology Association	1990	Sample number 5,000 Responses received 4,523
New Zealand	Ministry of Research, Science and Technology	1991	Sample number not known Responses received 1,012
Canada	Calgary University	1989	Sample number 2,000

**Table 7-1-C Countries and Organizations Participating in the International Comparison Study into Public Opinion on Science and Technology**

Participating country/region	Participating organization
U.S.	National Science Foundation, Division of Science Resources Studies, the Science and Engineering Indicators Program; The Chicago Academy of Science; The International Center for the Advancement of Scientific Literacy
Japan	Science and Technology Agency, National Institute of Science and Technology Policy
EC	European Commission DG XII
U.K.	The National Museum of Science & Industry, Research and Information services
Germany	Cologne University, Social Science Information Center
France	National Policy Science Foundation (C,E,V,I,P,O,F)
Canada	Calgary University, General Education Department
China	China Science and Technology Association

## 7.2 Japanese Opinions on Science and Technology

### 7.2.1 Science and technology as national strength

#### (1) Opinion that S&T is a source of national pride

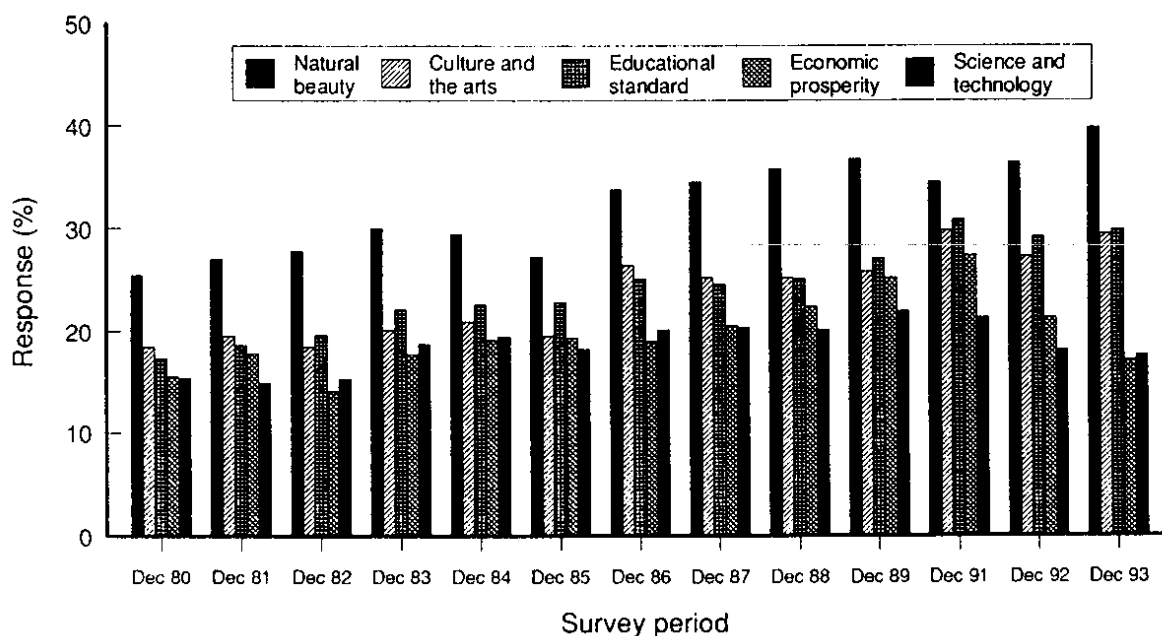
Generally speaking, the national awareness regarding science and technology had for quite some time been rising steadily due to the view that science and technology is important for the realization of economic growth. However, it is only since the 1960s that people's awareness and views regarding science and technology have been surveyed on a regular, annual basis in the form of public opinion polls. The first was conducted by the Prime Minister's Office in 1960.

Moreover, the Prime Minister's Office did not include "high level of science and technology" as one of the multiple choice responses to the question on pride in Japan in the Survey on Social Knowledge until 1980.

The response rate for "high level of science and technology" was slightly lower than such choices as "superb culture and the arts", "high educational standard" and "natural beauty", but generally around the same level as "economic prosperity". From this it can be seen that the Japanese people lay great emphasis on "the antiquity of Japanese history", "the charm of Japan's natural features", "enthusiasm for education" and the like as sources of national pride (Figure 7-2-1).

The percentage of respondents who chose "high level of science and technology" initially followed an upward trend, but from the start of the 1990s the trend reversed and the percentage began to fall. At this stage it is difficult to tell whether this is only a temporary drop or a trend that is likely to continue.

Figure 7-2-1 Aspects of Japan in Which You Feel Pride

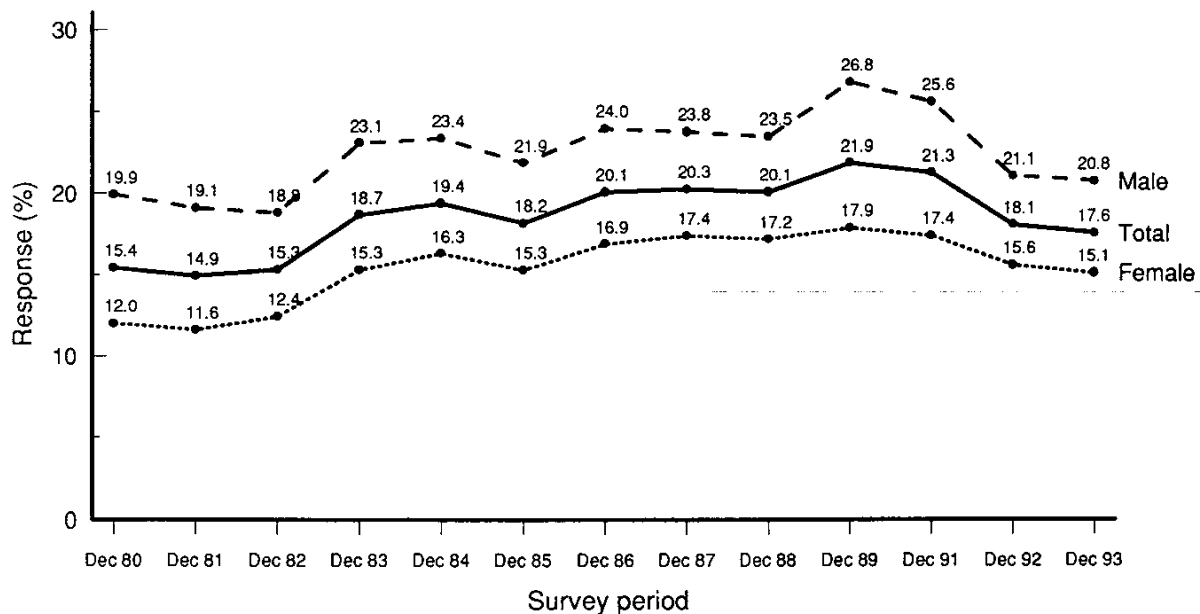


Note: Multiple response.

Source: Prime Minister's Office, Public Relations Office, *Public Opinion Poll on Social Awareness*  
See Table 7-2-1

Comparing male and female responses shows that in each survey the percentage for males was 5–9 percentage points higher than that for females, and this gap does not seem to be narrowing. By age group, the highest percentage is among young people in their twenties. The gap between the sexes is also highest in the twenties age group, indicating that even among the younger generation, males and females have a somewhat different perception of science and technology (Figure 7-2-2).

**Figure 7-2-2 Aspects of Japan in Which You Feel Pride  
(Response rate for “high level of science and technology”)**



Source: Prime Minister’s Office, Public Relations Office, *Public Opinion Poll on Social Awareness*  
See Table 7-2-2

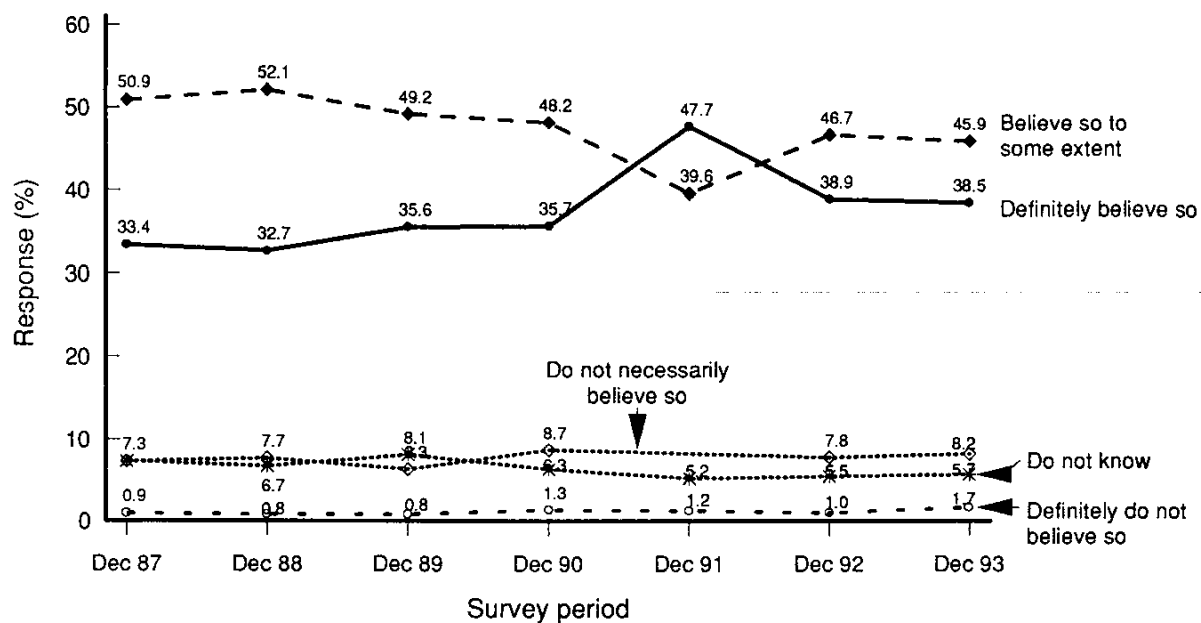
## (2) “Is Japan an advanced country in science and technology?”

Similarly, every year since 1987 the Prime Minister’s Office has included in its public opinion poll the question “Is Japan an advanced country in science and technology?”. Although the six years that this question has featured in the poll is only half of the period for the question on “national pride”, a trend in the public awareness regarding science and technology can be seen from a different perspective (Figure 7-2-3).

First, while the response rate for “definitely believe so” has increased over the six years and that for “believe so to some extent” has fallen gradually, the total positive response rate has generally remained at the same level. In contrast, there has been little change over the period in the two negative responses of “do not necessarily believe so” and “definitely do not believe so”, and together these two responses have consistently totaled around the ten percent mark. Meanwhile, the response rate for “do not know” has gradually fallen over the period.

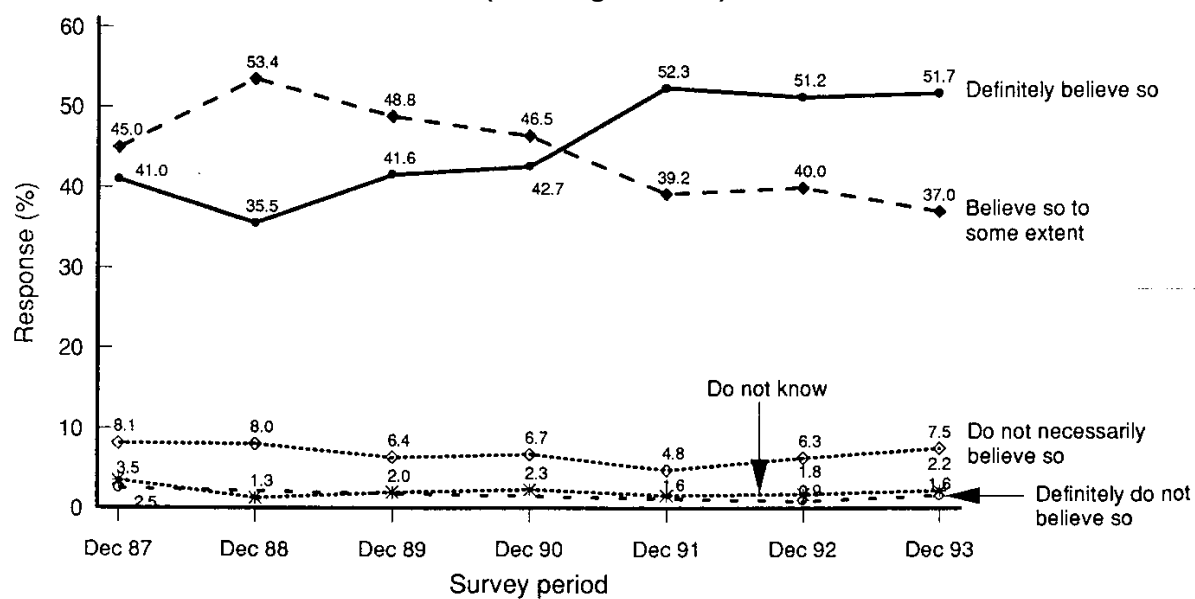
The relative position of the positive responses and the negative responses has remained steady over the period with the positive responses accounting for a significant majority, of which the response rate for the strongly positive “definitely believe so” is gradually increasing.

**Figure 7-2-3 “Is Japan an Advanced Country in Science and Technology?” (Total)**



Source: Prime Minister's Office, Public Relations Office, *Public Opinion Poll on Social Awareness*  
See Table 7-2-3

**Figure 7-2-4 “Is Japan an Advanced Country in Science and Technology?”  
(Males aged 20–29)**



Source: Prime Minister's Office, Public Relations Office, *Public Opinion Poll on Social Awareness*  
See Table 7-2-4



Except for the 20-29 age group, the response rate for the different age groups is generally showing a similar trend. The main feature about the response rate for “definitely believe so” among males aged 20–29 is not just that it is consistently higher than the corresponding rate for the other age groups, but also that it has remained at a high level since 1991, despite an across-the-board drop in the corresponding rate among other age groups in 1992 after peaking in 1991. As for differences in the male and female responses, while the gap between the two is steadily narrowing in the other age groups, in the 20–29 age group this gap is, conversely, remaining generally the same, indicating that, similar to the “national pride” responses, the awareness among the younger generation shows a characteristically different trend from that among the other age groups (Figure 7-2-4, previous page).

#### Points to note when reading the statistical values

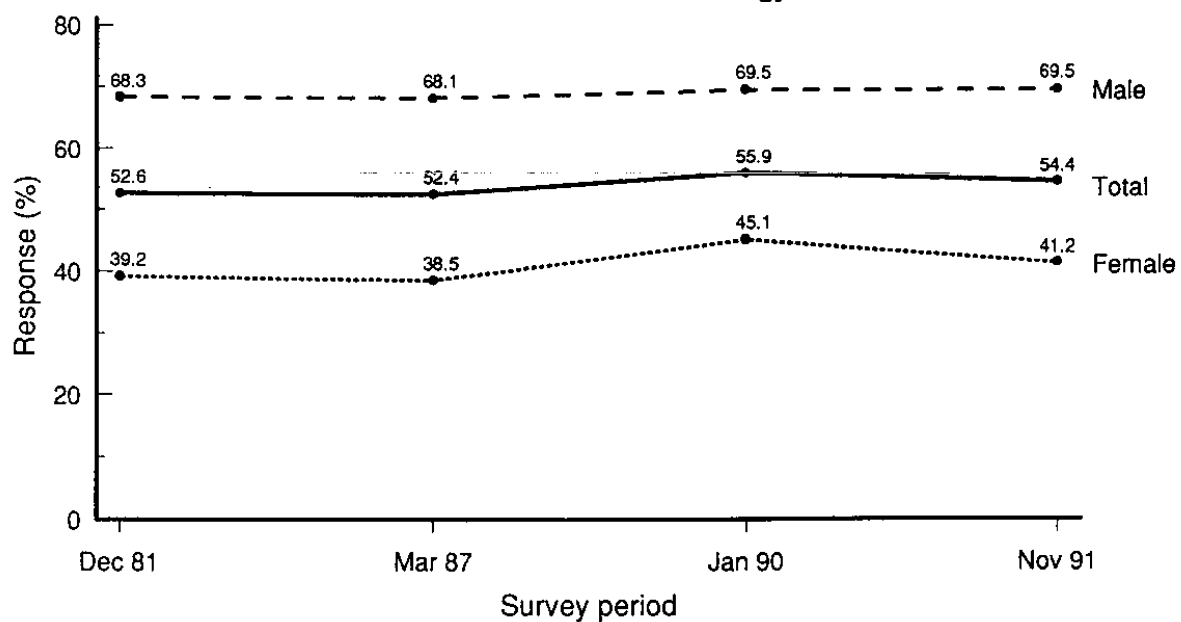
Generally when reading opinion polls it is important to keep in mind that there is a difference in the statistical error depending on the sample number. Where the sample number is large, this error can be safely ignored, but when dividing the sample by age or gender, the sample number for some groups may become quite small, and for these groups the statistical error will be somewhat greater than the error for the other groups.

### 7.2.2 Interest in science and technology

#### (1) Interest in news or topics about science and technology

As the volume of news or topics about science and technology increases, there is a general view that interest in this area is probably also increasing. However, the results of the public opinion polls do not support this view, for there is no steady rise in interest proportionate to the increasing volume of science and technology news or topics. Interest among males is quite high, while the interest among females is considerably lower, resulting in a gap of about 30 points (Figure 7-2-5).

**Figure 7-2-5 Percentage of Respondents Who “Have an Interest in News or Topics about Science and Technology”**



Source: National Institute of Science and Technology Policy, *Comparative Survey on Public Opinion Regarding Science and Technology in Japan, U.S. and Europe, 1992*

Prime Minister's Secretariat, *Public Opinion Poll on Science & Technology and Society*

See Table 7-2-5

By age group, the percentage of people in their twenties who have an interest is, unlike in the other age groups, consistently falling, while the percentage who do not have an interest is steadily increasing. This trend among people in their twenties is looked upon as an important indicator which gives a glimpse of a so-called “drift away from science and technology among the younger generation”, however, this is not necessarily supported by the responses to “national pride” and “high level of science and technology”, so there appears to be a degree of inconsistency in the results (Figure 7-2-6).

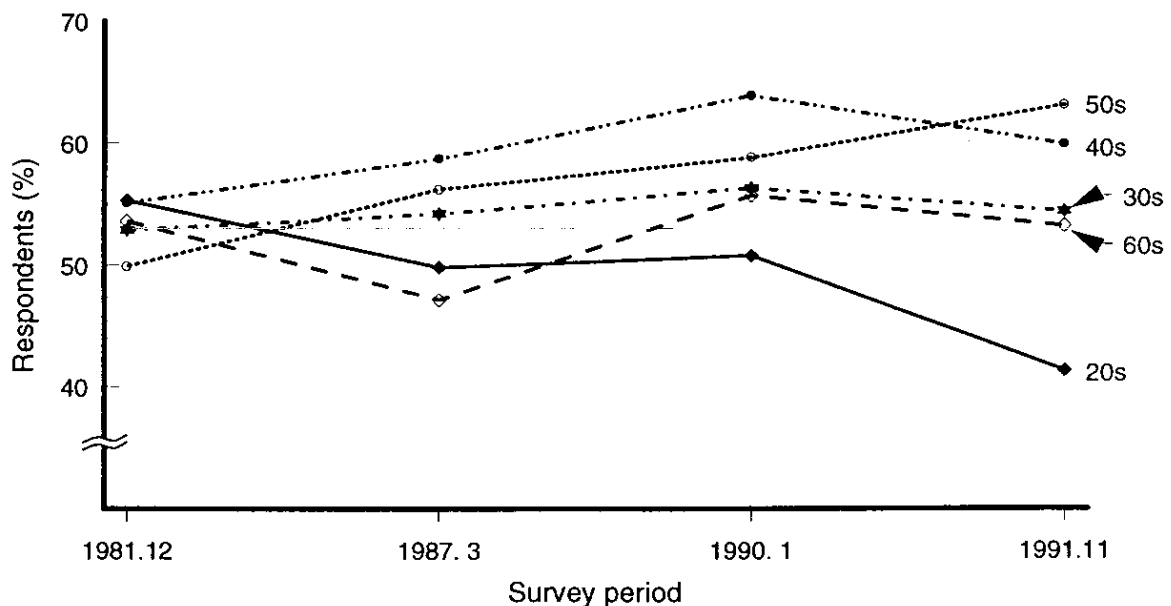
This response by the younger generation is thought to reflect the phenomenon that having reached a relatively high level, science and technology in Japan is well advanced in the maturation stage, and as a result, younger people are beginning to hold a much more diverse range of views regarding their use of and how they relate to the fruits of science and technology.

One aspect of the phenomenon pointed out in *Barbarians in a Civilized Society* may be displaying itself in the response results to this question [1].

## (2) Interest and knowledge compared to other fields

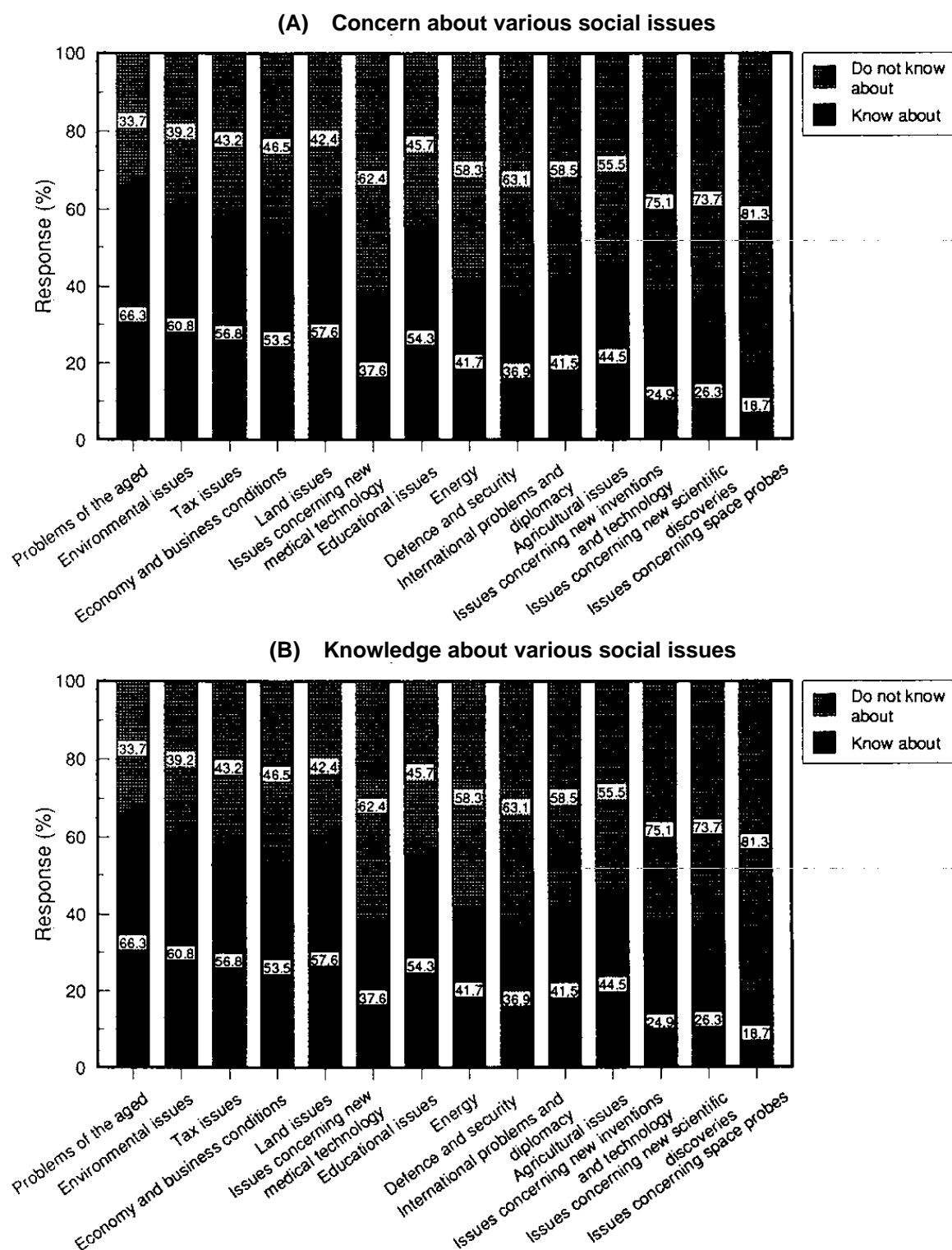
This section will compare the interest in other fields among Japanese compared to their level of interest in science and technology. Responses to the question on people’s concern regarding science and technology-related fields and fields not related to science and technology show that the highest percentage of respondents are concerned about “problems of the aged” (85.5%), followed by “environmental issues” (84.0%), “tax issues” (82.5%) and “economy and business conditions” (75.1%) (Figure 7-2-7).

**Figure 7-2-6 Percentage of Respondents Who “Have an Interest in News or Topics about Science and Technology” (by age group)**



Source: same as for Figure 7-2-5  
See Table 7-2-6

Figure 7-2-7 Concern and Knowledge about Social Issues



Source: National Institute of Science and Technology Policy, *Comparative Survey on Public Opinion Regarding Science and Technology in Japan, U.S. and Europe, 1992*

See Table 7-2-7

That is, these issues of highest concern are issues which are closely and directly related to people's own lives, and feature regularly as leading news stories on television and in the newspapers. In other words, the key factors affecting people's concern about an issue are the volume of information that is at hand and the closeness of the issue to one's own life.

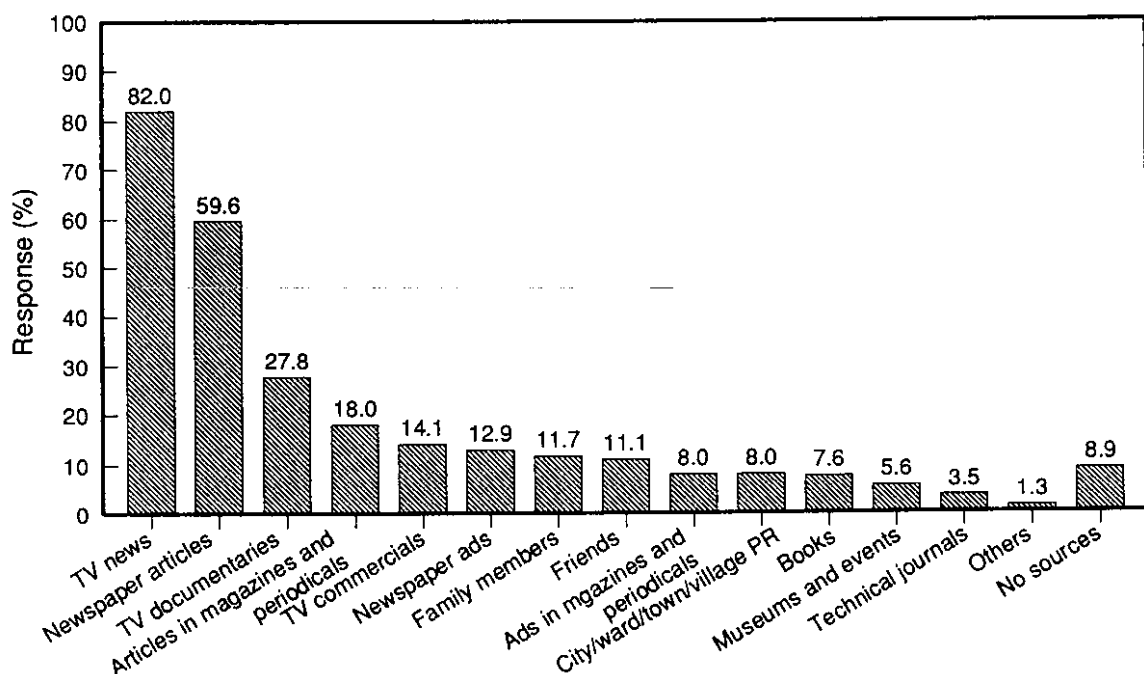
Of the issues related to science and technology, the results show that people have a high level of concern about issues that are more closely linked to their daily lives, such as "energy", "environmental issues" and "issues concerning new medical technology", and a much lower level of concern about issues that are more detached from their lives, such as "issues concerning new scientific discoveries" and "issues concerning space probes".

This does not apply just to the level of concern; a similar trend can also be seen in the level of knowledge people have about the same issues. As in the other questions, the level of concern and knowledge is higher among males than among females, though females show slightly higher concern about educational and health issues, indicating that these two issues currently are the focus of women's concern in their daily lives.

### (3) Source of information about science and technology

As for how people are informed about science and technology matters, an overwhelming 82.0% of respondents indicated "television news", while 59.6% indicated "newspaper articles" and 27.8% indicated "television documentaries". This shows that the mass media are clearly the most important sources of information regarding science and technology. And it is also an interesting characteristic of modern times that not an insignificant percentage of respondents obtain information from television commercials and newspaper and magazine advertising (Figure 7-2-8).

**Figure 7-2-8 Source of Information about Science and Technology (Multiple response)**



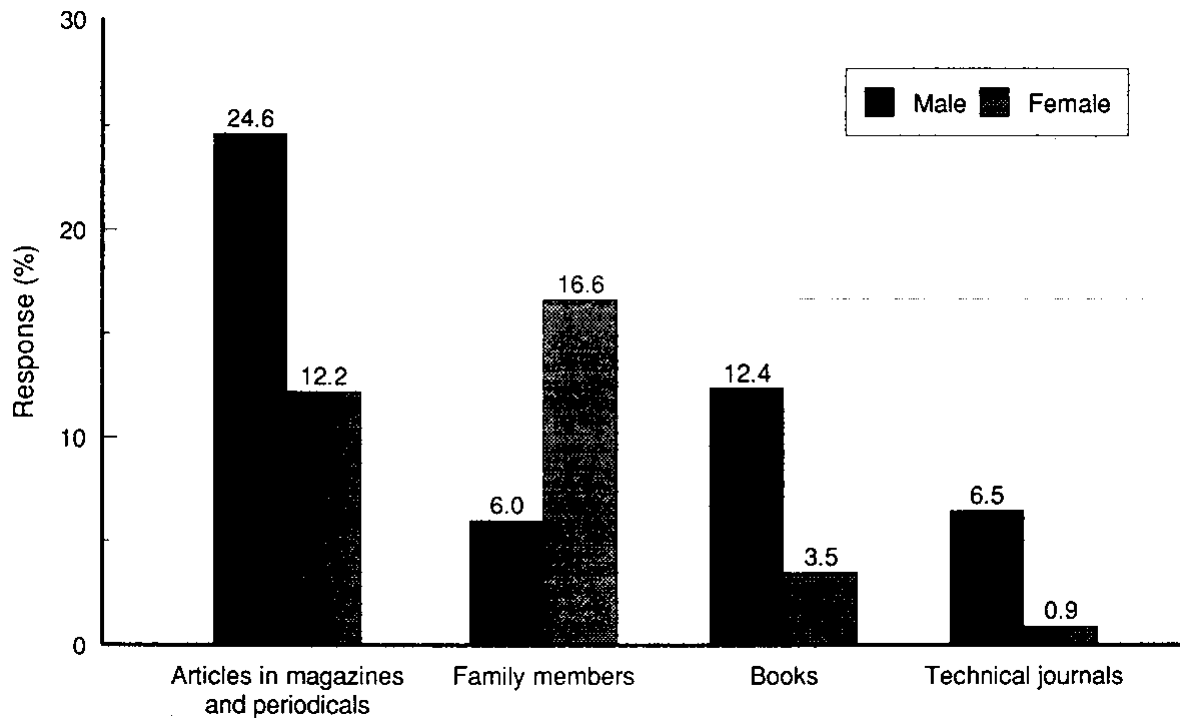
Source: National Institute of Science and Technology Policy, *Comparative Survey on Public Opinion Regarding Science and Technology in Japan, U.S. and Europe, 1992*

See Table 7-2-8

While there is not a great deal of difference between males and females regarding the more popular sources of information, such as "television news", "newspaper articles" and "television

documentaries”, a much higher percentage of males responded with “books”, “technical journals” and “articles in magazines and periodicals”, whereas a higher percentage of females obtain their information from “family members”. This trend shows that whereas men actively use written sources of information such as books and magazines, women tend to rely on conversation or the mass media for this information (Figure 7-2-9).

**Figure 7-2-9 Source of Information about Science and Technology  
(Male/female comparison)**



Note: The figure only shows information sources with a significant gap between males and females.

Source: National Institute of Science and Technology Policy, *Comparative Survey on Public Opinion Regarding Science and Technology in Japan, U.S. and Europe, 1992*

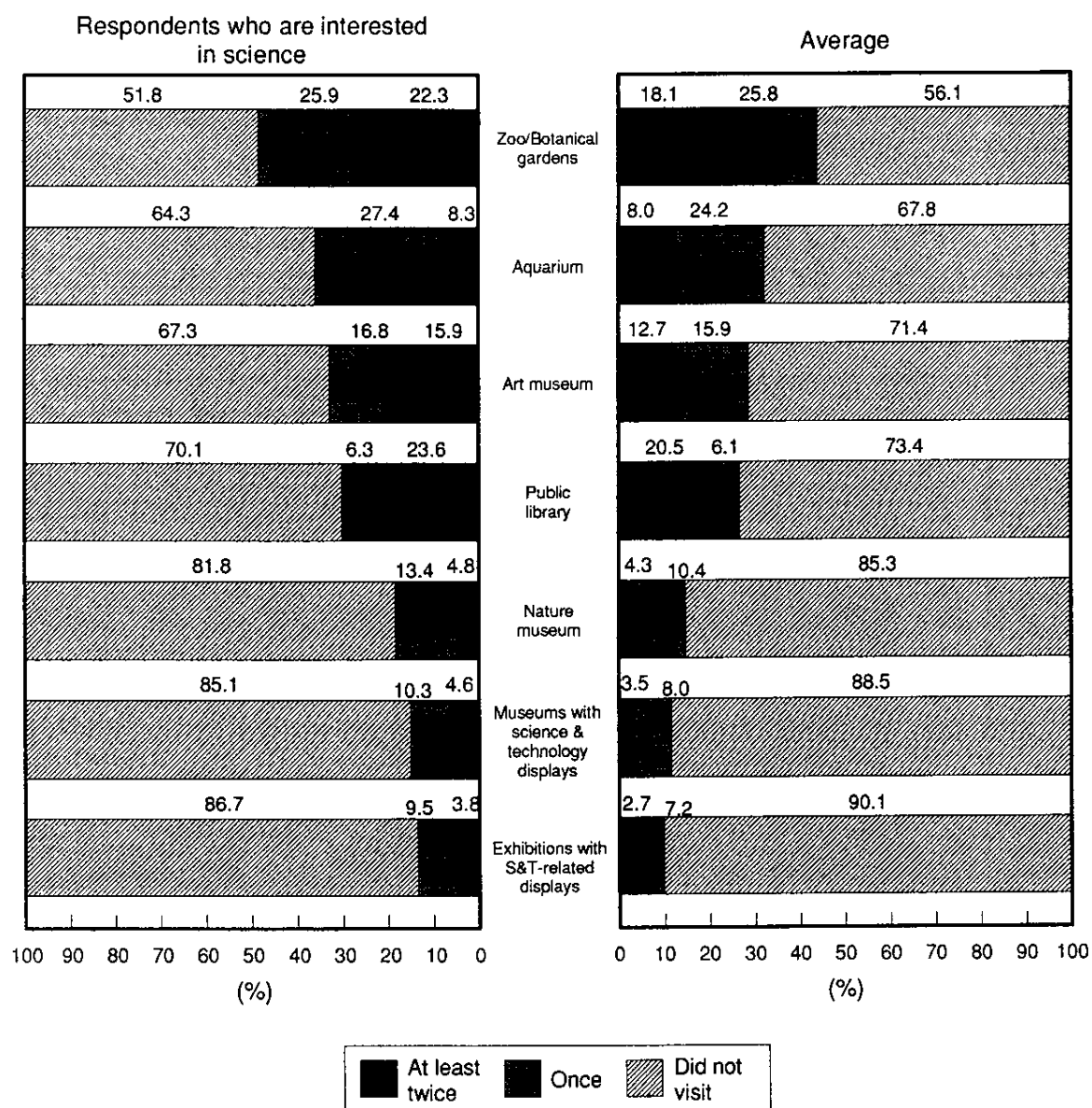
See Table 7-2-9

#### (4) Access to S&T-related facilities

Of the seven kinds of facilities listed in the question on visits to S&T-related facilities in the past twelve months, about half of respondents indicated that they visited a “zoo/botanical gardens” and about one-third indicated that they visited an “aquarium” at least once in the past year (Figure 7-2-10). In addition, about 30% of respondents indicated “public library” and “art gallery”, whereas a mere 10–15% said they visited a “museum with science & technology displays”, “nature museum” or “exhibition with S&T-related displays” during the past year.

While these figures are naturally affected by the standard of each of the facilities and how often exhibitions and displays are held, it cannot be said that S&T-related facilities are always utilized as fully as other kinds of facilities.

**Figure 7-2-10 S&T-related Facilities Visited in the Last Year**



Source: National Institute of Science and Technology Policy, *Comparative Survey on Public Opinion Regarding Science and Technology in Japan, U.S. and Europe, 1992*

See Table 7-2-10

### 7.2.3 Knowledge and understanding regarding science and technology

#### (1) Understanding of science and technology terms

The November 1991 poll asked people how well they understand the meaning of ten S&T-related terms. The results show a relatively high level of understanding of “acid rain”, “nuclear fusion”, “immunity”, “optical fiber” and “hole in the ozone layer”, whereas the level of understanding of “DNA”, “data base”, “VAN”, “IC, LSI” and “AI” was quite low.

All of the latter five terms are highly specialized, and most are abbreviated using the initial letters of the words they represent, and this is thought to be a major factor in the lower level of understanding. Even when these terms are used in the mass media, the articles or programs in which they appear are more often than not targeted specifically at specialists or experts in the field, rather than at the general reading or viewing public (Figure 7-2-11).

Classified by gender, age, academic background, and the degree of interest in science during primary and junior high school years, the percentage of respondents who indicated that they have an understanding of these terms (“understand the meaning clearly” + “understand the meaning to some degree”) was, for all terms, highest among males, young people, people with a high educational background and people who were interested in science.

#### (2) Level of scientific knowledge (theory)

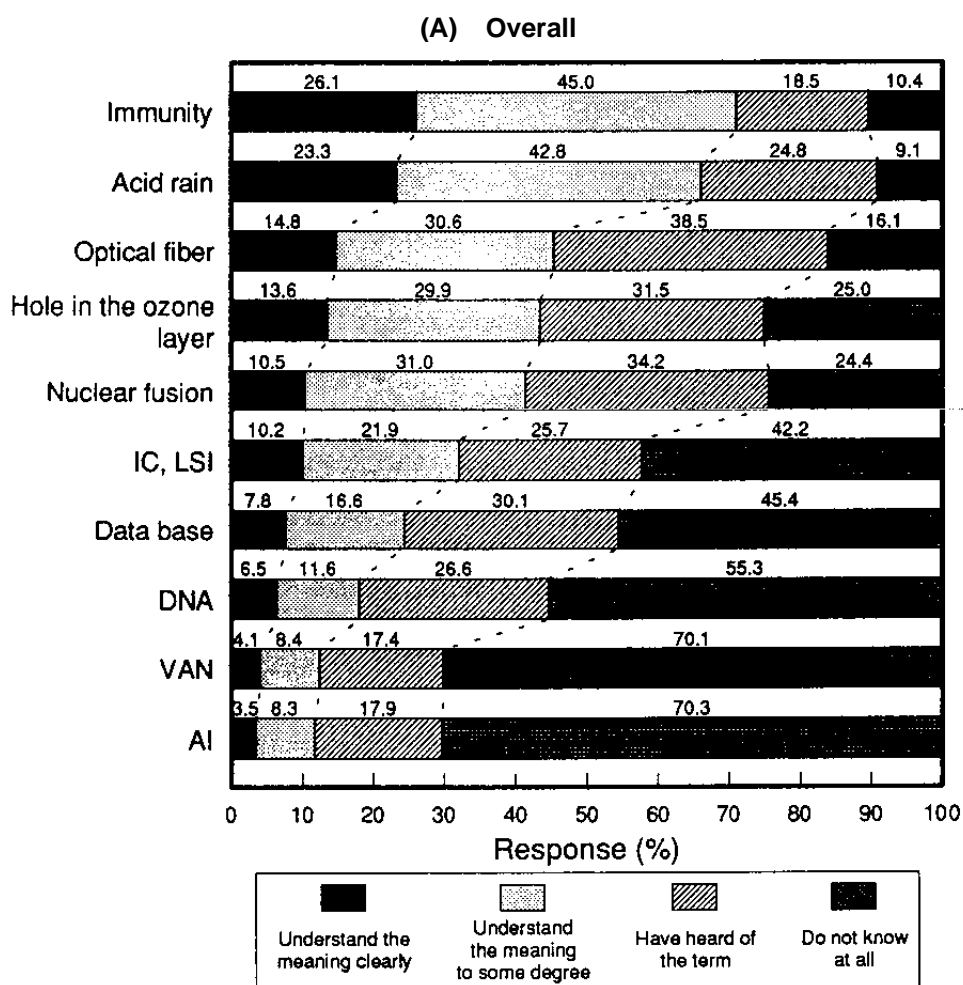
The level of understanding of scientific facts shows the level of scientific education and the capability to approach matters and issues scientifically, and can also be used to determine objectively individual’s views and attitudes regarding science and technology. To find out generally how much they understand about scientific facts, respondents were asked to indicate whether each of the following seven theories are correct or incorrect.

- Human beings evolved from primitive animal life (correct)
- Continents are moving on the earth’s surface (correct)
- Laser beams can be obtained by focusing sound waves (incorrect)
- Antibiotics also kill viruses in the same way they kill bacteria (incorrect)
- Solar rays cause skin cancer (correct)
- All radiation is man-made (incorrect)
- Electrons are smaller than atoms (correct)

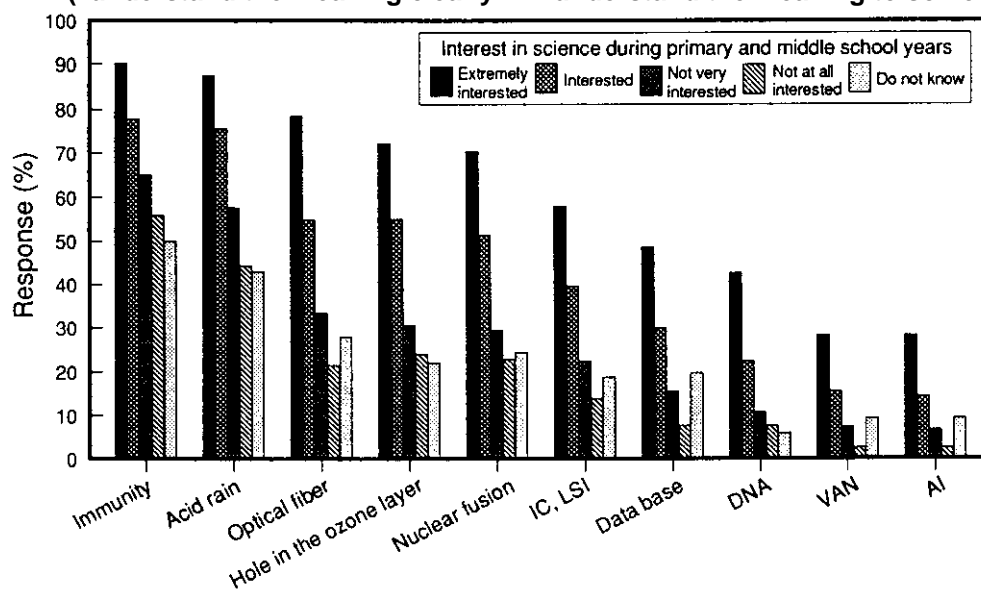
The majority of respondent gave the right “correct” answer for “human evolution” (74.3%), “movement of continents” (60.3%) and “solar rays cause skin cancer” (77.4%), while a relatively high percentage of respondents gave the wrong or a “do not know” answer for “laser generation”, “effect of antibiotics” and “size of electrons and atoms”. As well as a lack of understanding about the fact, it is thought that this high percentage for the wrong answer or “do not know” can also be put down to the respondents’ being somewhat puzzled by the impression given by the terms used (Figure 7-2-12).

Classified by gender, age, educational background, and degree of interest in science during primary and junior high school years, the percentage of correct answers was highest among males, the younger generation, people with a high educational background and people who were interested in science. The gap between males and females was especially large in the “laser generation”, “existence of radiation” and “size of electrons”.

Figure 7-2-11 Understanding of Science and Technology Terms



(B) Percentage of respondents who understand these terms  
 ("understand the meaning clearly" + "understand the meaning to some degree")



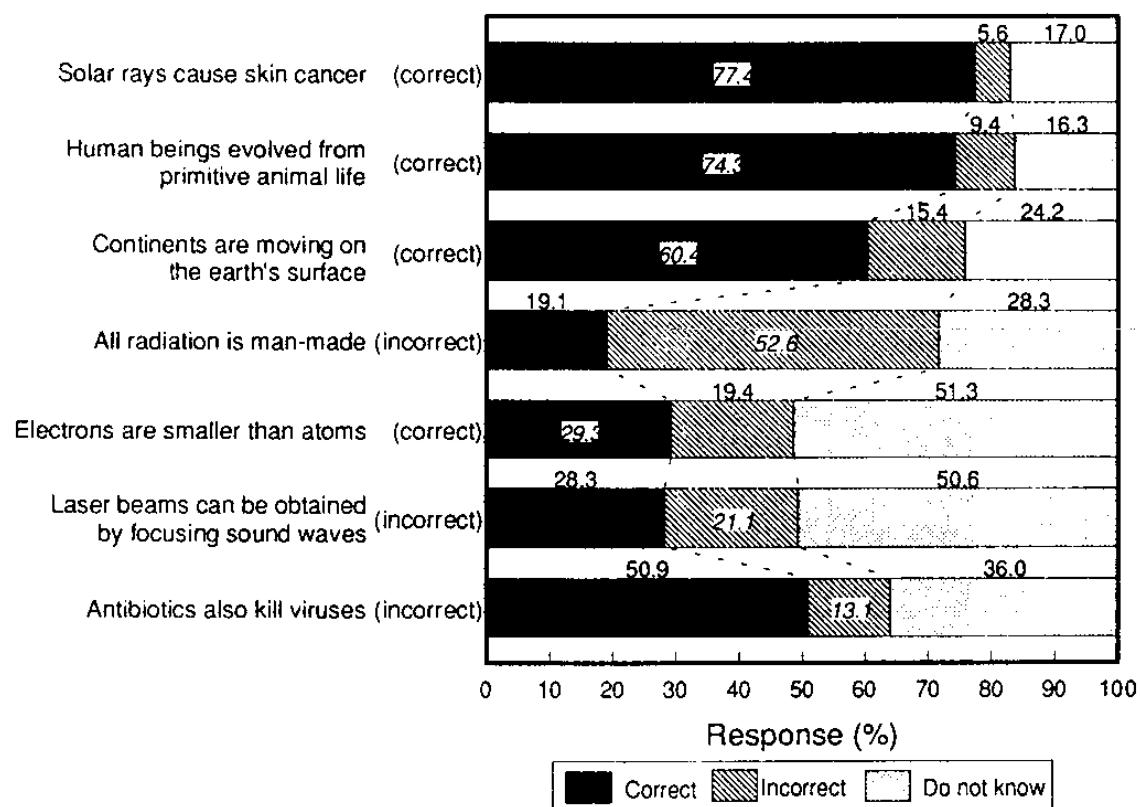
Source: National Institute of Science and Technology Policy, *Comparative Survey on Public Opinion Regarding Science and Technology in Japan, U.S. and Europe, 1992*

See Table 7-2-11



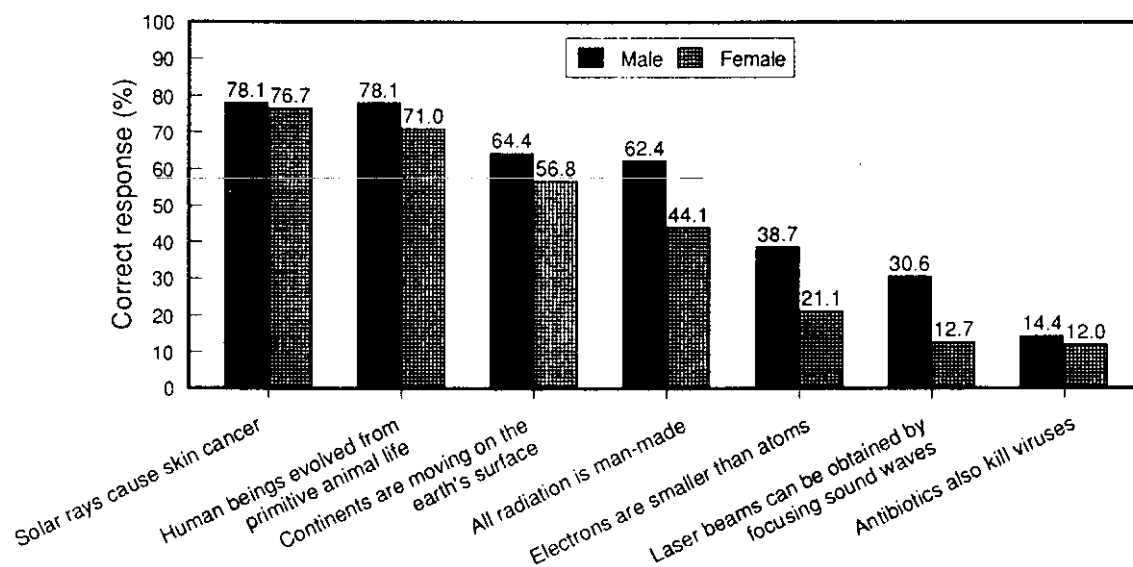
**Figure 7-2-12 Level of Scientific Knowledge**

**(A) Overall**



Note: The value shown by the shaded bar is the percentage of correct answers.

**(B) Percentage of correct answers by gender**



Source: National Institute of Science and Technology Policy, *Comparative Survey on Public Opinion Regarding Science and Technology in Japan, U.S. and Europe, 1992*

See Table 7-2-12

## 7.2.4 Awareness and attitudes regarding nature and the environment

### (1) Understanding of acid rain and the hole in ozone layer

Acid rain and the hole in the ozone layer are two of the many environmental issues that frequently appear in the mass media, and here this paper examines how well the general public understands these two global problems. First, a reasonably high 66.1% of respondents understand (“understand clearly” or “understand to some degree”) the meaning of “acid rain”, but in contrast the level of awareness about the “ozone hole” is quite poor, with only 43.5% understanding the meaning.

Only the respondents who “understand clearly” or “understand to some degree” were then asked to indicate whether three items listed as causes of acid rain were correct or incorrect. The major cause — “Nitrogen oxide and sulphur oxide gas forms into nitric acid and sulphuric acid in the atmosphere and falls to earth with the rain”—was shown as “correct” by 70.1% of respondents, while about 10% indicated this as “incorrect”. Almost 40% indicated “acid dust” and “carbonic acid gas” as “correct”, and while not entirely wrong, these two items are not the main causes, so this figure was higher than expected (Figure 7-2-13(A)).

As for the effect of acid rain, 83.9% of respondents chose “correct” for “plant and animal life is affected”, 54.4% chose “correct” for “human health is adversely affected”, and 39.1% chose “correct” for “global atmospheric temperature will rise”. The figure for the last item shows that quite a few people have misconceptions about the effect of acid rain (Figure 7-2-13 (B)).

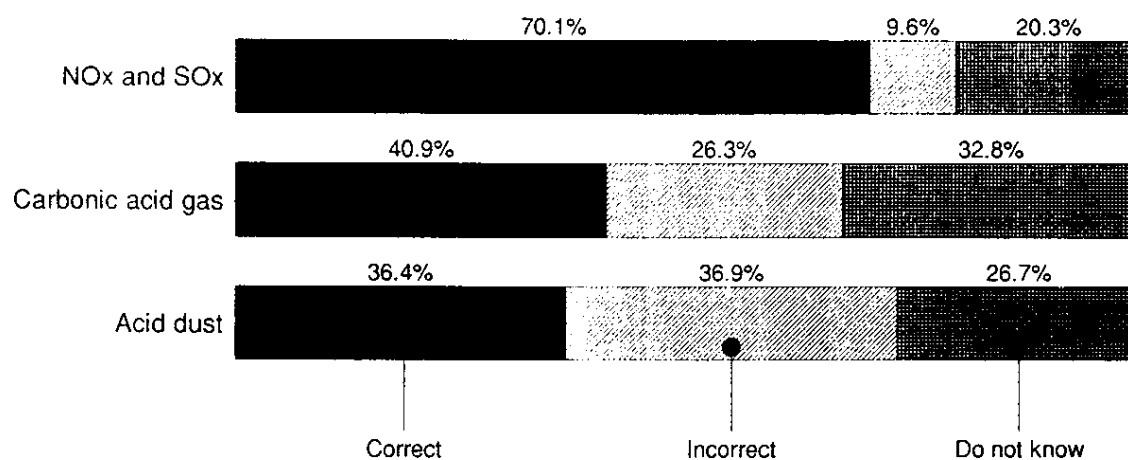
Next, as with the question on acid rain, causes of the “ozone hole” were put to respondents who said that they “understand clearly” or “understand to some degree”. In the November 1991 survey, 94.2% chose “correct” for “increase of freon gas”, indicating a high level of understanding. The period that the November survey was conducted was precisely when the problem of the ozone layer hole was taken up quite widely by the mass media, and this probably explains the considerable jump of nine points in the correct response rate over the 85.2% recorded in the January 1991 preliminary survey (Figure 7-2-14(A)).

Regarding the effect of the ozone hole, most respondents (87.7%) have a correct understanding that it is “harmful to human health because of the increase in ultraviolet radiation”. However, 60.3% chose “correct” for “rise in the global atmospheric temperature and global warming due to the green-house effect”, but here it is not clear whether the respondents have a mistaken view of the effects of carbonic acid gas, or whether they gave this response based on a correct understanding that per unit, freon gas has a greater green-house effect than carbonic acid gas. Similar to the results for the question on causes, a higher percentage of respondents gave correct answers in the main survey than in the preliminary survey, probably because of the educational effect of articles and the like in the mass media (Figure 7-2-14(B)).

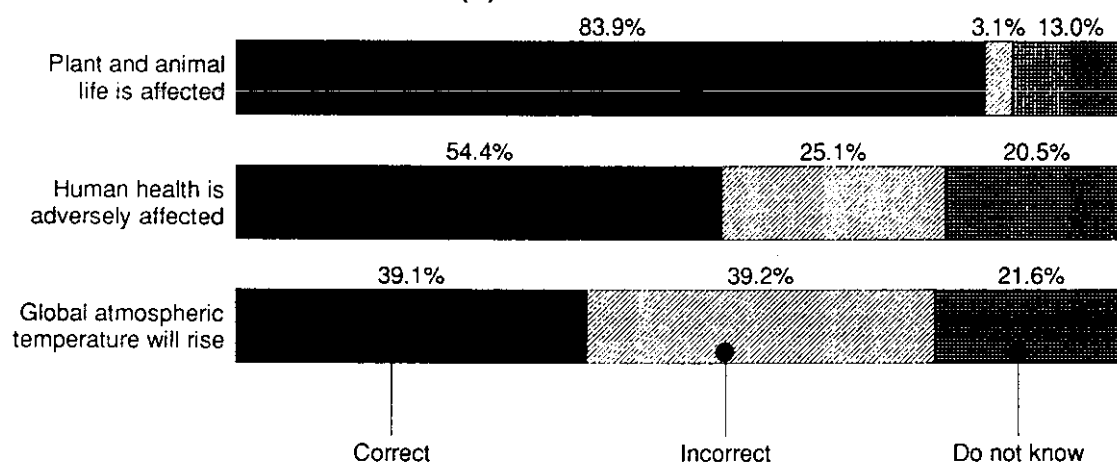
From this it can be said that people have a reasonably good understanding about the terms “acid rain” and “ozone hole”. For most items males had a higher correct response rate than females, but for the item “human health is adversely affected” the “correct” response was about the same for both sexes, perhaps supporting the view that women are especially sensitive to health issues compared to other issues.

Figure 7-2-13 Understanding about Acid rain

(A) Causes of acid rain



(B) Effect of acid rain



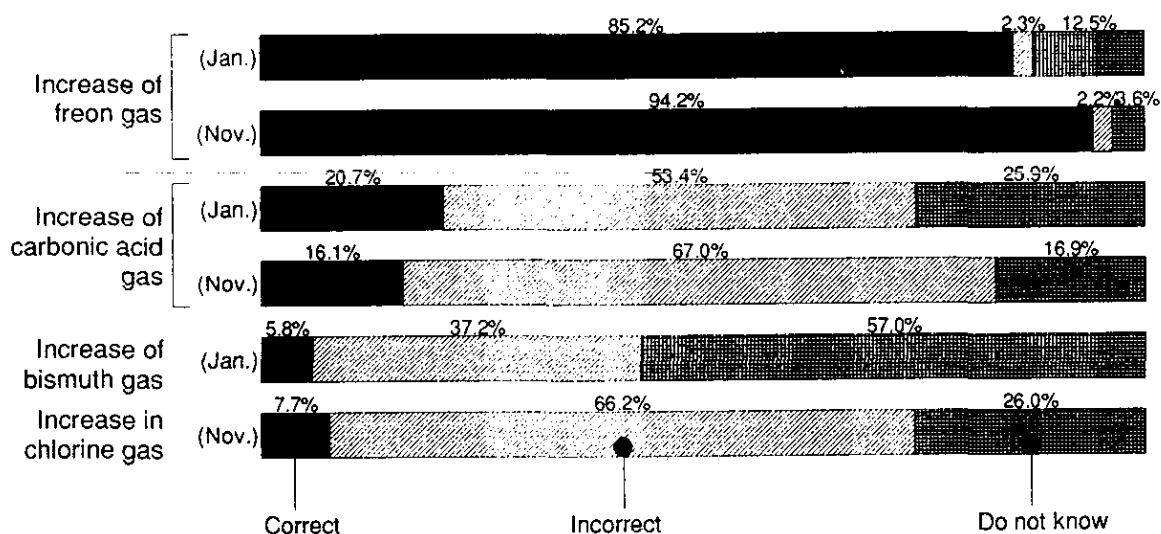
Note: Percentage of respondents who indicated that they understand the meaning of acid rain.

Source: National Institute of Science and Technology Policy, *Comparative Survey on Public Opinion Regarding Science and Technology in Japan, U.S. and Europe, 1992*

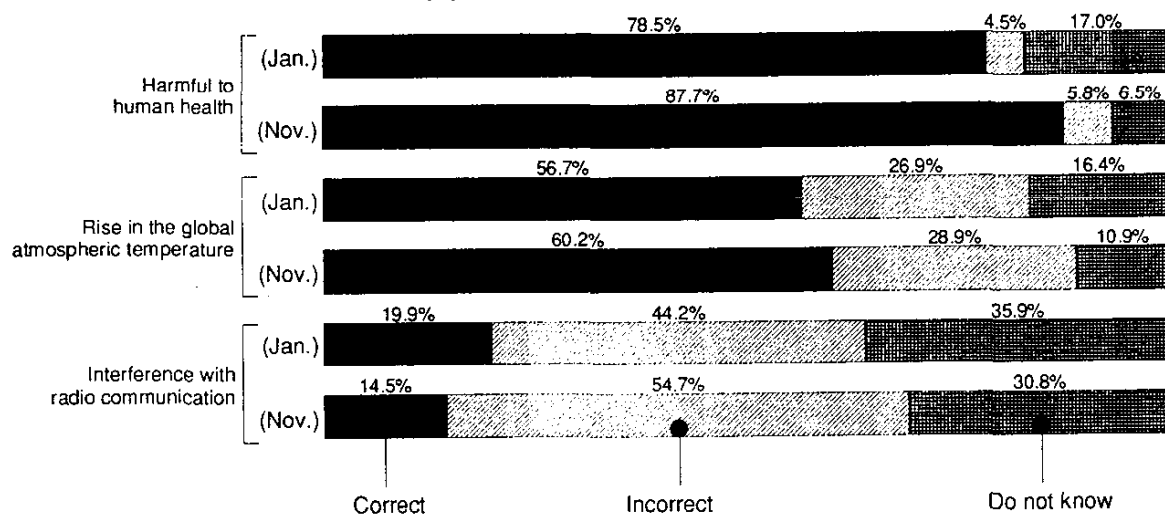
National Institute of Science and Technology Policy, *Public Opinion Poll on Science and Technology* (Preliminary Poll), January 1991 (Samples – 1,400; Effective responses – 1,015; Response rate – 72.5%)

**Figure 7-2-14 Understanding about the Hole in the Ozone Layer**

**(A) Causes of the ozone hole**



**(B) Effects of the ozone hole**



Note: Percentage of respondents who indicated that they understand the meaning of the hole in the ozone layer. Bismuth gas in the January survey was replaced by chlorine gas in the November survey. Bismuth gas is a rare earth element used in superconductors, and has no bearing on the ozone hole.

Source: same as for Figure 7-2-13

## (2) Views and attitudes regarding the natural environment

Conservation of the natural environment has for many years been one of the issues about which people feel greatest concern. Here the paper will examine people's attitude towards the following four statements regarding conservation of the natural environment.

- 1) Current standards for conservation of the natural environment are inadequate
- 2) A certain amount of environmental destruction cannot be helped for us to make our lives more affluent.
- 3) Further development which leads to destruction of the natural environment must be halted.
- 4) It is unreasonable to expect us to lower human living standards to protect wildlife habitats.

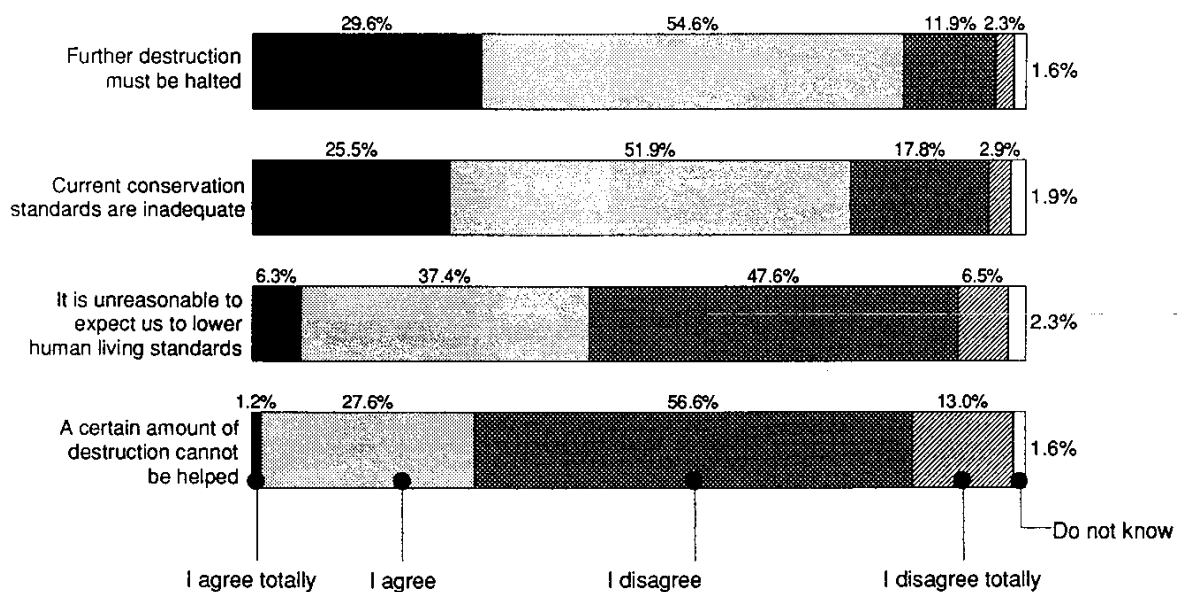
To statement 1), 77.4% responded "I agree totally" or "I agree", 28.8% responded similarly to statement 2), 84.2% to statement 3) and 43.7% to statement 4). These figures show that the Japanese people are caught in the situation where they agree with the general conservation theme but do not necessarily agree with particular aspects, inasmuch as they generally support environmental conservation, but at the same time, they also want to protect their own lifestyles.

As for statements 2) and 3), which place stress on the lifestyle and development side, the percentage of respondents who agree with the statement generally increased as the age group rose. This is particularly so regarding statement 2), with 60.5% of people in their sixties objecting to the idea of sacrificing their lifestyles for environmental conservation. This can be interpreted as reflecting a strong feeling among the generation who struggled to improve their lives amid the hardships before and during the war that they do not want to sacrifice their present hard-earned affluence.

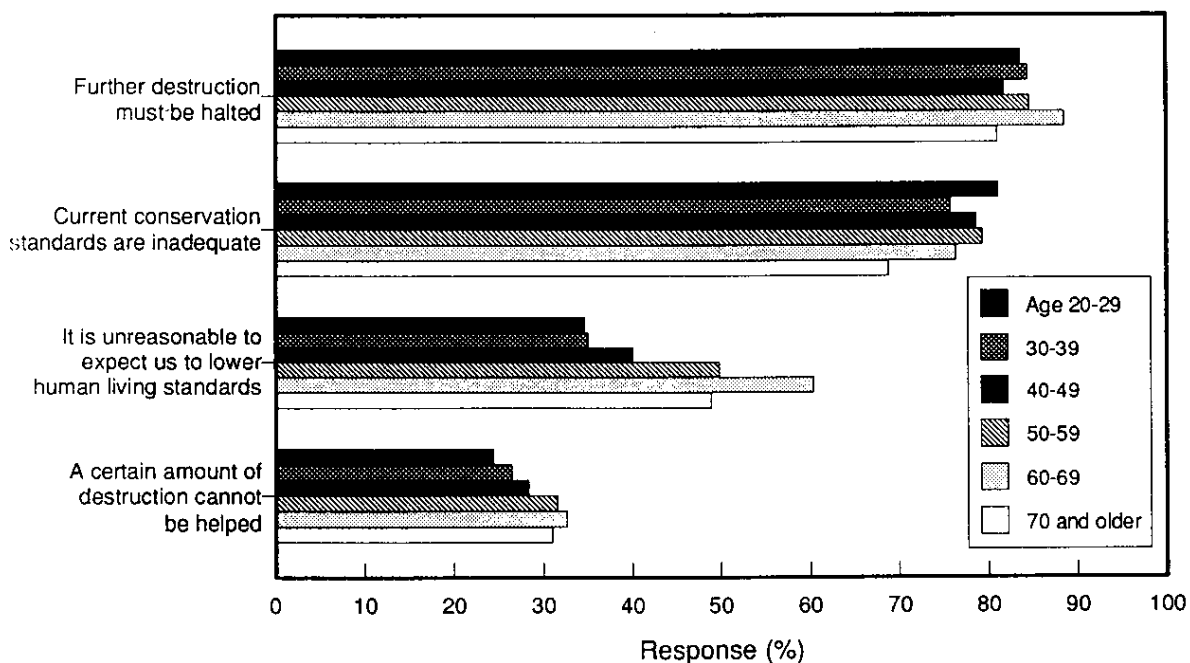
On the other hand, the young generation showed the highest level of agreement among the age groups for statement 1), indicating that this generation, which is enjoying an affluent lifestyle as a naturally given condition, has a strong desire to pursue new values in conserving the natural environment. The highest positive response was given to statement 3) in all age groups, and this shows that such a view is steadily gaining strength throughout all levels of society in today's Japan where development has extended to all parts of the country and where debate on global environmental issues is becoming much more active (Figure 7-2-15(B)).

**Figure 7-2-15 Views and Attitudes Regarding Conservation of the Natural Environment**

**(A) Overall**



**(B) Age ratio of "I agree totally" and "I agree" responses**



Source: National Institute of Science and Technology Policy, *Comparative Survey on Public Opinion Regarding Science and Technology in Japan, U.S. and Europe, 1992*

See Table 7-2-15

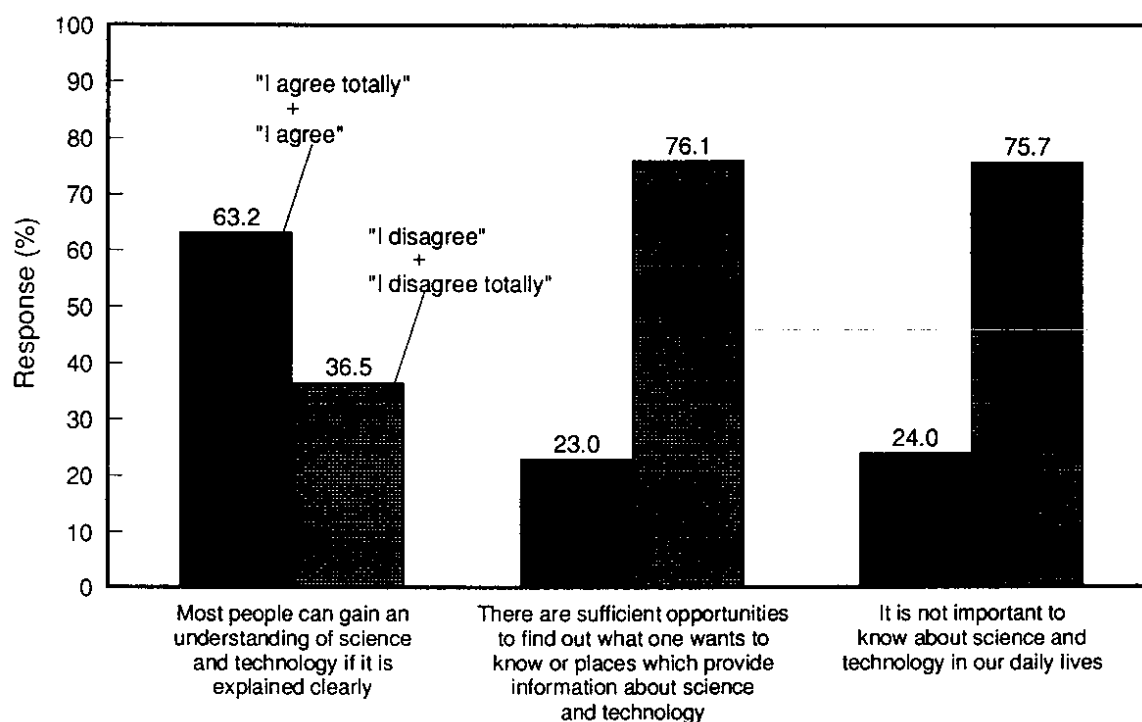
### 7.2.5 Views and attitudes regarding science and technology

#### (1) Views about the provision of science and technology information

Next the survey asked respondents' views on access to science and technology information. To the first statement "Most people can gain an understanding of science and technology if it is explained clearly," 63.2% responded in the affirmative ("I agree totally" and "I agree"). This was reversed for the next statement, with as many as 76.1% of respondents disagreeing ("I disagree" and "I disagree totally") with "There are sufficient opportunities to find out what one wants to know or places which provide information about science and technology". Finally, 75.7% disagreed with the third statement "It is not important to know about science and technology in our daily lives," thereby displaying a high awareness about the importance of science and technology (Figure 7-2-16).

From these results it can be seen that while most Japanese realize that science and technology is an important part of their daily lives, and are able to understand it, there is a fairly widespread feeling that there are not enough opportunities to learn about science and technology, nor is there enough relevant information available.

**Figure 7-2-16 Views about the Provision of Science and Technology Information**



Source: National Institute of Science and Technology Policy, *Comparative Survey on Public Opinion Regarding Science and Technology in Japan, U.S. and Europe, 1992*

See Table 7-2-16

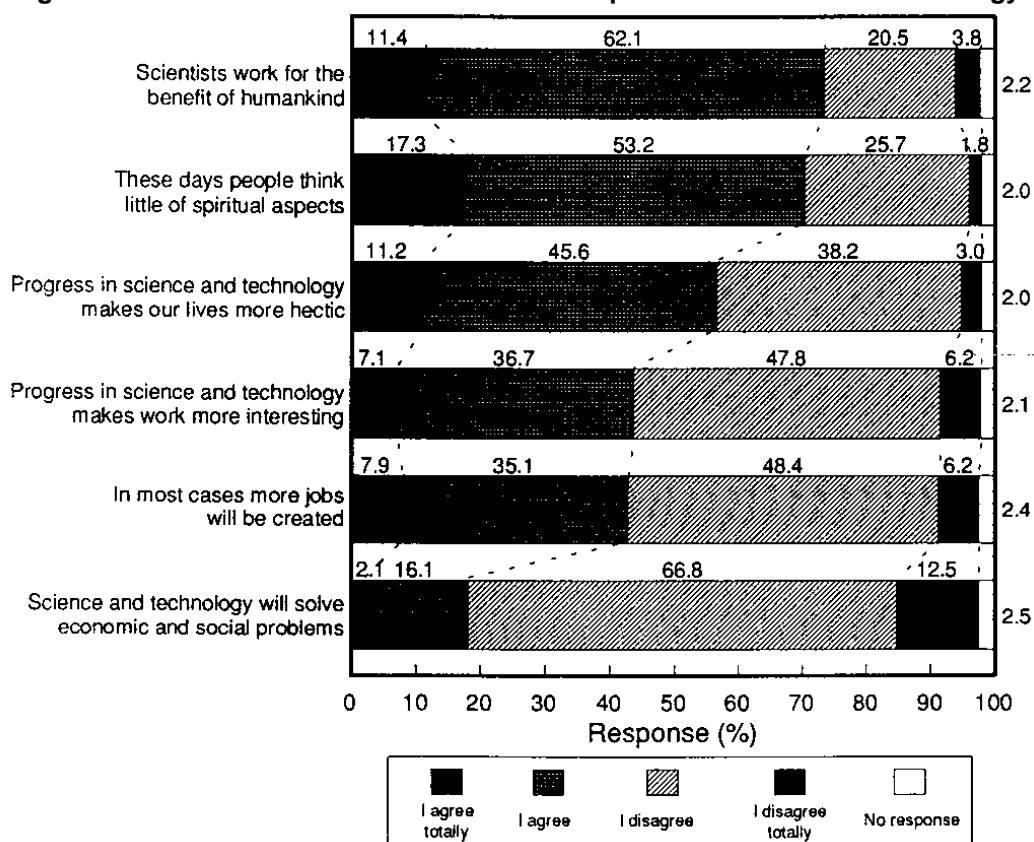
(2) Attitude towards the social impact of science and technology

To determine what impact the Japanese people believe science and technology has had on their lives, the survey asked respondents to comment on the following six views.

- Overall, in most cases more jobs will be created by automation and the spread of robots and computers than will be lost.
- Progress in science and technology makes work more interesting
- Progress in science and technology makes our lives more hectic.
- These days we rely too much on science and technology, and think little of the spiritual aspects of our lives.
- Science and technology will solve most of the economic and social problems we are facing today.
- Scientists work for the benefit of humankind.

Of the above statements, the highest level of positive response was given to the last, “Scientists work for the benefit of humankind,” indicating that the Japanese people have a high degree of confidence and trust in scientists. Conversely, in other questions, more than half of respondents expressed an unfavorable opinion about the effects of science and technology. This was particularly evident in the low 18% of respondents who agreed with the idea that science and technology will solve economic and social problems, indicating that most Japanese believe they cannot expect socio-economic problems to be resolved as a direct result of scientific and technological progress (Figure 7-2-17).

**Figure 7-2-17 Attitudes towards the Social Impact of Science and Technology**



Source: National Institute of Science and Technology Policy, *Comparative Survey on Public Opinion Regarding Science and Technology in Japan, U.S. and Europe, 1992*

See Table 7-2-17



In all cases, there is very little difference in views between males and females. By age group, the percentage of positive response for “progress in science and technology makes our lives more hectic” and “people think little of spiritual aspects” increased as the age group rose, reflecting a tendency to believe that science and technology exacerbates one’s personal sense of alienation, yet on the other hand, a seemingly inconsistent attitude emerged in that the percentage of positive responses for “science and technology will solve economic and social problems” also increased along with the age group, showing a rising expectation among the older generations of what science and technology can achieve. This inconsistency is thought to arise because the older generations are caught between two forces: one is the influence of the traditional spiritual culture in which they were raised, and the other is the reality that they have been part of the surge towards economic sufficiency through the power of science and technology.

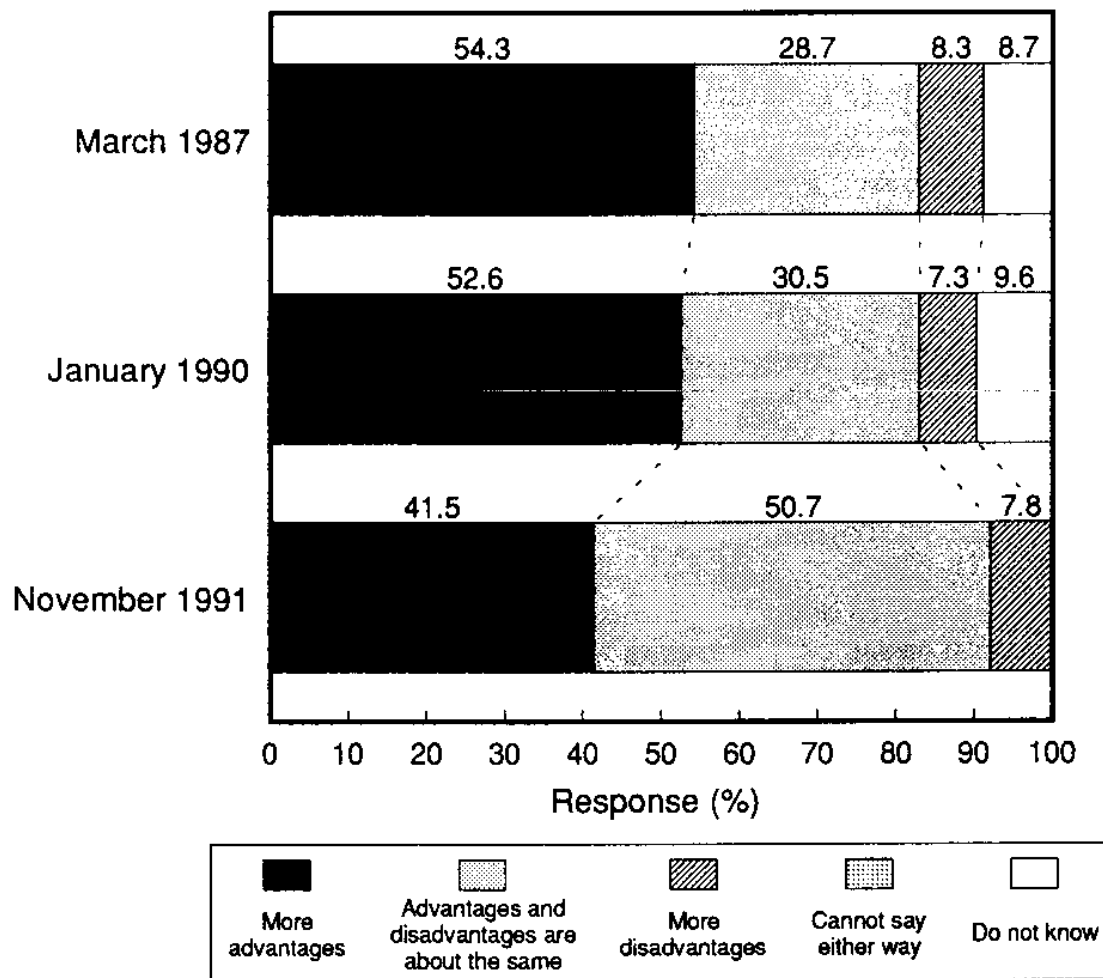
By occupation or position, more than 50% of managers and technical engineers agreed that “work becomes more interesting”, and at the same time, in all questions these two occupational categories tended to show a much stronger positive attitude towards the progress of science and technology than the other occupations or positions.

### (3) Advantages and disadvantages of science and technology

Progress of science and technology can bring many benefits to people’s lives, but at the same time, it has often been pointed out that this progress can also have a detrimental impact. Which, then, do the Japanese people believe has the greater weight, the benefits or the detrimental impact of scientific and technological progress.

The question “It is said that the progress of science and technology has both advantages and disadvantages; overall, do you believe that this progress has more advantages or more disadvantages?” was put to the survey participants, and in the latest 1991 survey, the highest percentage of respondents answered “about the same”. The same pattern was seen for both males and females (Figure 7-2-18).

Figure 7-2-18 Trends in Japanese Views on the Progress of Science and Technology



Note: The figure shows a breakdown of the response to the question "Are there more advantages or more disadvantages in the progress of science and technology?" (refer to main text).

Source: National Institute of Science and Technology Policy, *Comparative Survey on Public Opinion Regarding Science and Technology in Japan, U.S. and Europe, 1992*

Prime Minister's Secretariat, *Public Opinion Poll on Science & Technology and Society*

See Table 7-2-18

### **7.3 International Comparison of Opinions Regarding Science and Technology**

At this stage it is not possible to undertake a close international comparison of people's views and awareness regarding science and technology, for not only are there considerable gaps in the level of science and technology among countries, but there are significant differences in their respective national situations as well, and appropriate methods to measure and compare in this light are still being studied and developed.

Nonetheless, because of the closer relationship science and technology is forming with industry and society these days and the expanding influence that it is exerting on our everyday lives, coupled with the growing impact of socio-economic globalization, people in all countries are experiencing a rising interest in science and technology, not just at a domestic level, but very much at the international level as well. Against this background, the importance and significance of attempting an international comparison in this field is becoming greater.

Since 1990 Japan, U.S. and European countries have cooperated in joint studies on public understanding and the reach of science and technology, based on the results of research in individual countries. Most overseas data used to prepare the indicators used in this paper were obtained through this joint research network.

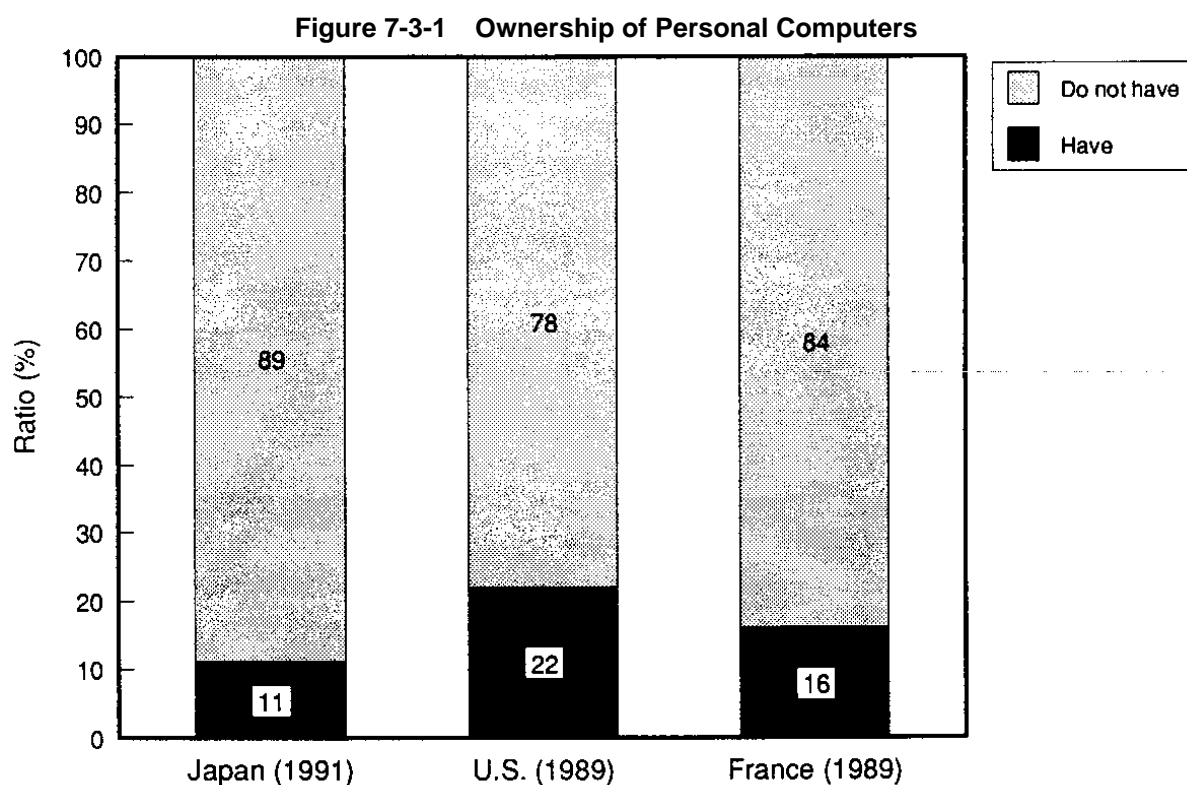
The range of data that can be used for an international comparison is by no means extensive, nevertheless, several suitable items were chosen from among the data for these indicators.

#### **7.3.1 Ownership of personal computers (comparison of Japan, U.S. and France)**

Today it is not at all unusual for many households in industrially and economically advanced countries to own at least one personal computer, and the level of ownership or use of personal computers can be seen as an indicator of the reach of high technology into individual lives in each country. Figure 7-3-1 compares the results of surveys on computer ownership in Japan, U.S. and France.

The Japanese ownership rate does not include word processors (if word processors are included the ownership rate jumps to 31.8%). In the United States and France, typewriter ownership is thought to be quite high, but in these surveys typewriters were also excluded. Many typewriters have considerably advanced and sophisticated functions, so if these were taken into account the results would undoubtedly be somewhat different.

Although the survey years are different, the results show that of the three countries the United States has the highest rate of personal computer ownership in the home, followed by France then Japan. As for actual use of the computers, in Japan only about one in four people who have a computer in the home actually use it even a small amount, while in the United States about 60% and in France slightly less than half of people with computers in the home use them.



Note: Figures for France include people whose family owns a personal computer.

Source: Japan — National Institute of Science and Technology Policy, November 1991 survey

U.S. — J.D. Miller, *The Public Understanding of Science and Technology in the United States, 1990*, North Illinois University, *Opinion Survey Institute*, 1991

France — Daniel Boy, *Attitudes of the French toward Science*, 1990

See Table 7-3-1

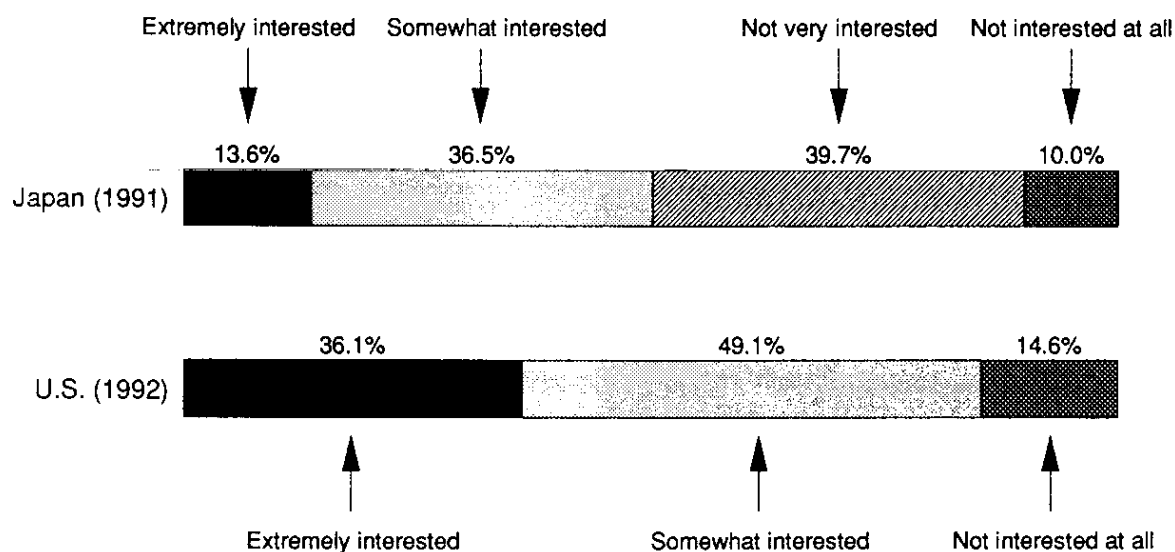
### 7.3.2 Interest in science and technology

One common feature that did appear in each of the national surveys was that people's interest in science and technology is relatively low compared to their interest or concern in other important personal issues, such as "problems of the aged", "economic trends" and "tax issues". Here, the paper compares countries in items closely connected with science and technology.

#### (1) Interest in "new scientific discoveries" and "new inventions or technologies" (Japan-U.S. comparison)

"New scientific discoveries" and "new inventions or technologies" often feature in newspapers and the like because of their relatively high degree of newsworthiness, both in Japan and the United States. The percentage of American respondents who answered "extremely interested" to each of the questions was considerably higher than the corresponding percentage of Japanese respondents (Figure 7-3-2 and Figure 7-3-3). While it is not possible to make a direct comparison as the two surveys offered a different choice of responses, as a general trend, Americans appear to have a greater interest in these matters than the Japanese have.

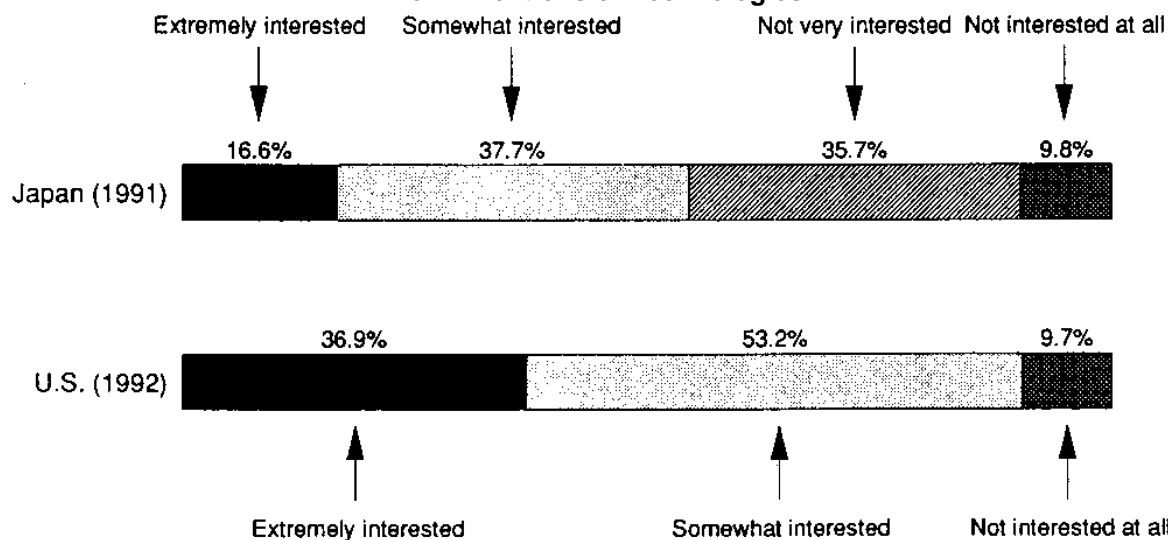
**Figure 7-3-2 Japan-U.S. Comparison of Interest in Issues Concerning  
New Scientific Discoveries**



Source: National Institute of Science and Technology Policy, *Comparative Survey on Public Opinion Regarding Science and Technology in Japan, U.S. and Europe, 1992*  
J.D. Miller, *The Public Understanding of Science and Technology in the United States, 1990*, North Illinois University, *Opinion Survey Institute*, 1991

See Table 7-3-2

**Figure 7-3-3 Japan-U.S. Comparison of Interest in Issues Concerning  
New Inventions or Technologies**



Source: National Institute of Science and Technology Policy, *Comparative Survey on Public Opinion Regarding Science and Technology in Japan, U.S. and Europe, 1992*  
J.D. Miller, *The Public Understanding of Science and Technology in the United States, 1990*, North Illinois University, *Opinion Survey Institute*, 1991

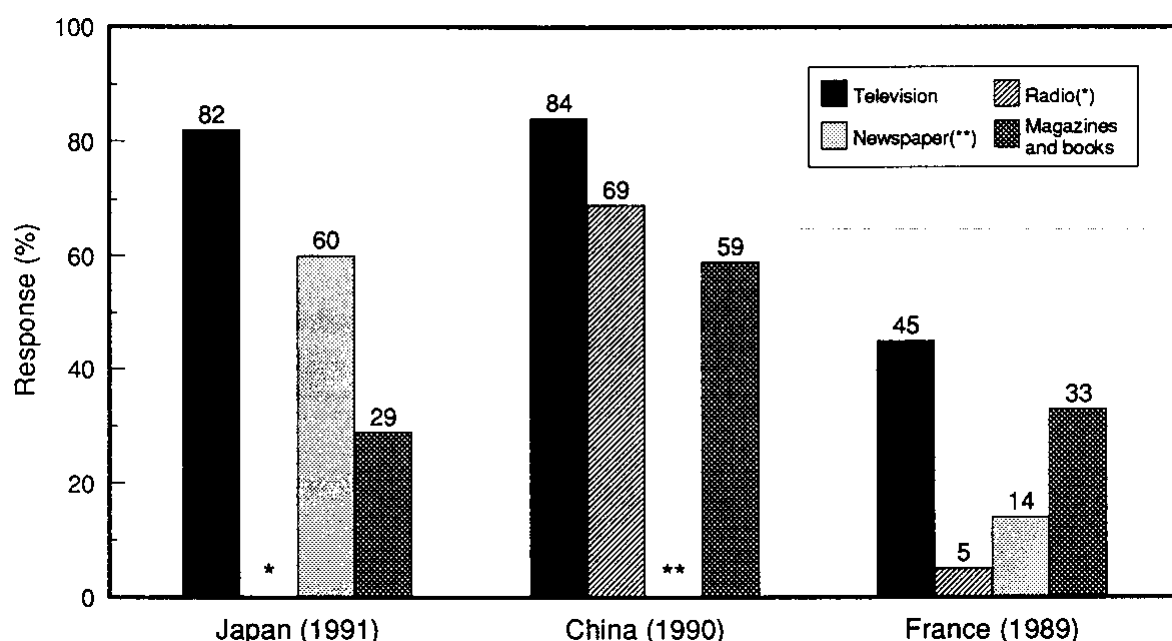
See Table 7-3-3

(2) Source of information about science and technology (comparison of Japan, China and France)

The main source of information on science and technology in each of the three countries surveyed is television. In China radio and magazines and books were also rated very highly, while in Japan newspapers were rated highly as a source of information.

The percentages in Figure 7-3-4 are the result of people's choosing what they regard as their main sources of information, but at the same time they can be thought of as a reflection of the state of science and technology reporting in each branch of the mass media in each of the countries. The reason radio and newspaper were not included in the choice of responses in, respectively, Japan and China was that neither were considered to be a popular source of information on science and technology. In the 1981 survey in Japan only five percent of respondents indicated radio, and since then the surveys have not listed radio as a separate response item. There are no similar data concerning newspapers in China.

**Figure 7-3-4 Source of Information about Science and Technology**



Note: The French survey was single response asking respondents to pick "the most important source of information"; all others were multiple response. "Radio" was not included as an option in the Japanese survey, and "newspaper" was not included in the Chinese survey.

Source: Japan — National Institute of Science and Technology Policy, *Comparative Survey on Public Opinion Regarding Science and Technology in Japan, U.S. and Europe, 1992*

Canada — E.F. Einsiedel, Calgary University, *Scientific Literacy—A Survey of Adult Canadians*

China — Z. Zhang and J. Zhang, China Research Center of Management Science, *A Survey of Public Scientific Literacy in China, 1993*

See Table 7-3-4

There are major differences in the media situation in these three countries, and these differences must be taken into account when interpreting the values for each country. The reason the rate of contact with the various media as sources of information in France is lower than in the other two countries in all items is that unlike the Japanese and Chinese surveys, the French survey was single choice asking respondents to pick “the most important source of information”, nevertheless, the fact that television is the most important source in France is exactly the same as in Japan and China. In China’s case, since it is a vast country, the survey was mainly conducted in the city areas, but it does show that the rapid spread of television is raising the medium’s role and influence as a source of information.

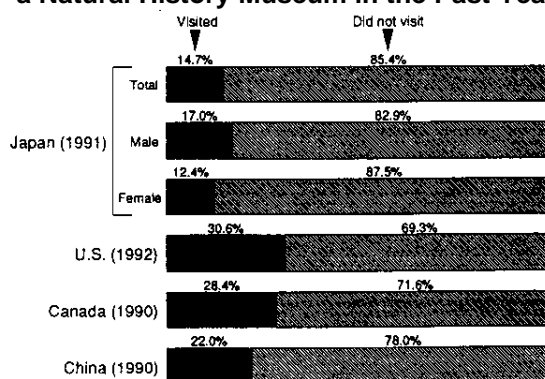
In any event, it is obvious that television occupies the paramount position as a source of science and technology information in all three countries, and its importance as a source for all information, not just about science and technology, is beyond all question.

The amount and diversity of science and technology information that people can obtain is closely linked to the level of understanding of and confidence in science and technology in each of the countries, and also to the reach of the media that provide the information.

### (3) Access to S&T-related facilities (comparison of Japan, U.S. and China)

The only information available for visits to S&T-related facilities by non-Japanese was that on natural history museums, so the comparison was made on how many times people visited natural history museums in the twelve-month period up to the time of the survey. Figure 7-3-5 shows that the people who visited these facilities most were Americans with 30%, while the percentage for Canadians was only slightly lower.

**Figure 7-3-5 International Comparison of the Percentage of People Who Visited a Natural History Museum in the Past Year**



Note: same as for Figure 7-3-4

Source: same as for Figure 7-3-4

See Table 7-3-5

In contrast, Japan recorded the lowest percentage, with slightly less than 15% of people visiting these facilities in the last year, or about half of the percentage for the United States. The Chinese percentage falls in between at 22%, but since general science museums were included in the choice of responses, this figure would probably drop somewhat if the scope is limited to natural history museums. As an aside, 11.5% of Japanese respondents visited a general science museum in the year leading up to the survey.

### 7.3.3 Views and understanding regarding science and technology

#### (1) Understanding of science and technology terms (comparison of Japan, U.S., China and U.K.)

Figures 7-3-6(A) and (B) compare how well the general public in different countries knows about “DNA” and “acid rain”, two terms that are used reasonably often in the mass media.

As for DNA, the Americans have the highest level of understanding, followed by the British, Japanese and Chinese. The fact that the Americans have a higher level of understanding of the latest scientific terms than the British, who were prime movers in the science field, would seem to reflect the passion Americans feel for science and technology. In contrast, Japanese and Chinese show a fairly low level of understanding.

Regarding acid rain, there is not a great deal of difference between Japanese and Americans in their level of understanding. It is possible that the level of understanding among the Japanese respondents may be influenced by the fact that the term was written in Chinese (ideographic) characters; and equally, had the term “DNA” been written “*IDENSHI*” [gene] in Chinese characters, the level of understanding among Japanese and Chinese respondents would perhaps have been slightly higher. This is the effect of a cultural bias brought about by differences between ideographic characters and phonetic letters, and is one of the many difficulties posed by international comparative surveys.

#### (2) Level of scientific knowledge (comparison of Japan, U.S., China and EU)

Figure 7-3-7 compares how well people in different countries understand scientifically established theories.

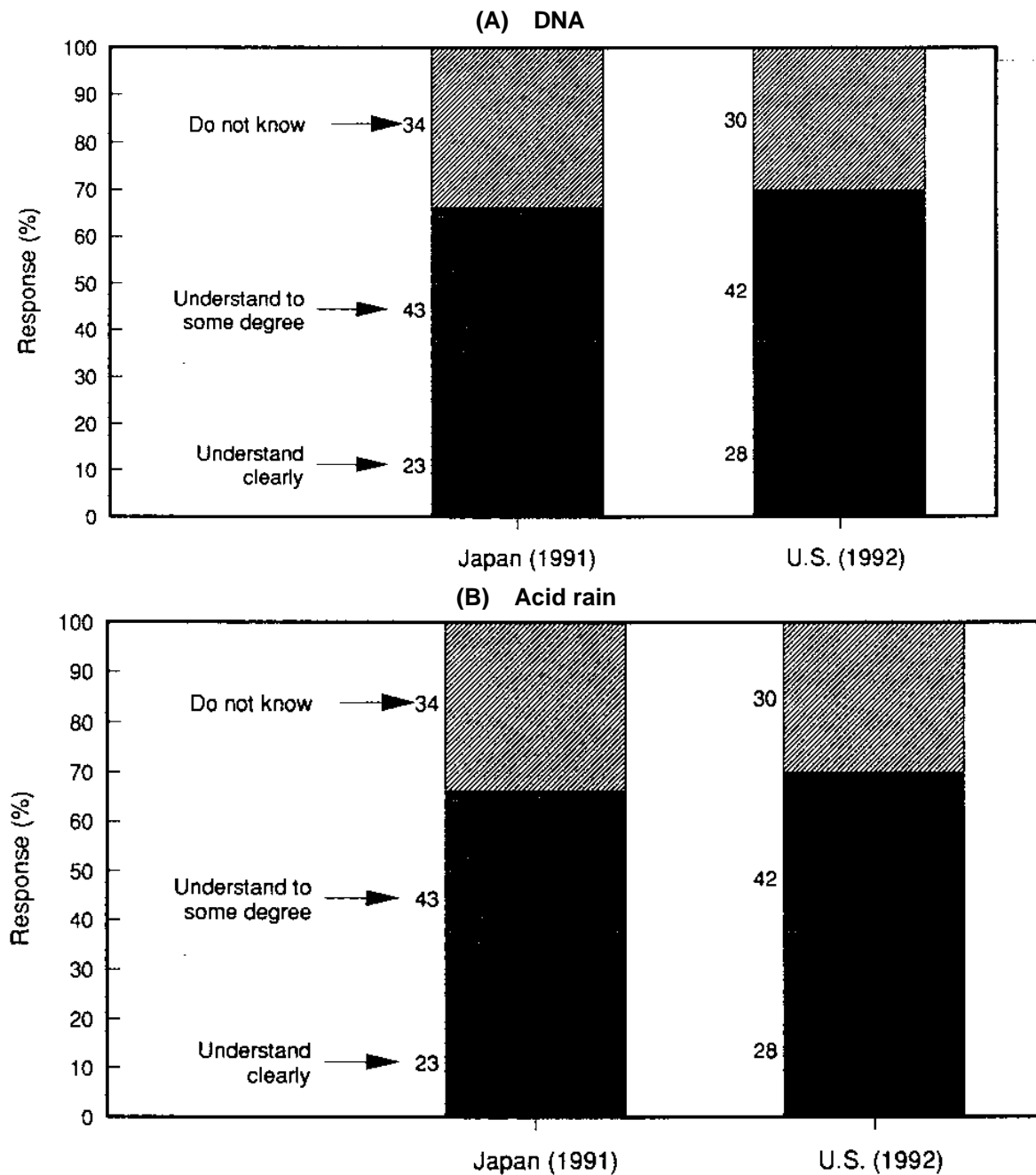
- 1) Continents are moving slowly over periods of thousands of years (correct)
- 2) Human beings evolved from primitive animal life (correct)
- 3) The universe was created by a massive explosion (correct)
- 4) Laser beams can be obtained by focusing sound waves (incorrect)
- 5) The earth’s core is extremely hot (correct)
- 6) Electrons are smaller than atoms (correct)
- 7) Antibiotics kill both viruses and bacteria (incorrect)

The rate of correct answers was generally quite high in the United States, but it is interesting to note that the correct response rate was lower than that for Japan and the EU in theories that disagree with the writing of the Bible. Japan had a lower correct response rate than the other countries for “antibiotics kill both viruses and bacteria” and “laser beams can be obtained by focusing sound waves”. China shows generally the same level of understanding as the other countries for “human beings evolved from primitive animal life”, an established theory that has been around for well over a century, though its correct response rate for relatively new theories is low, suggesting that the general public in China is not yet fully abreast of new developments in



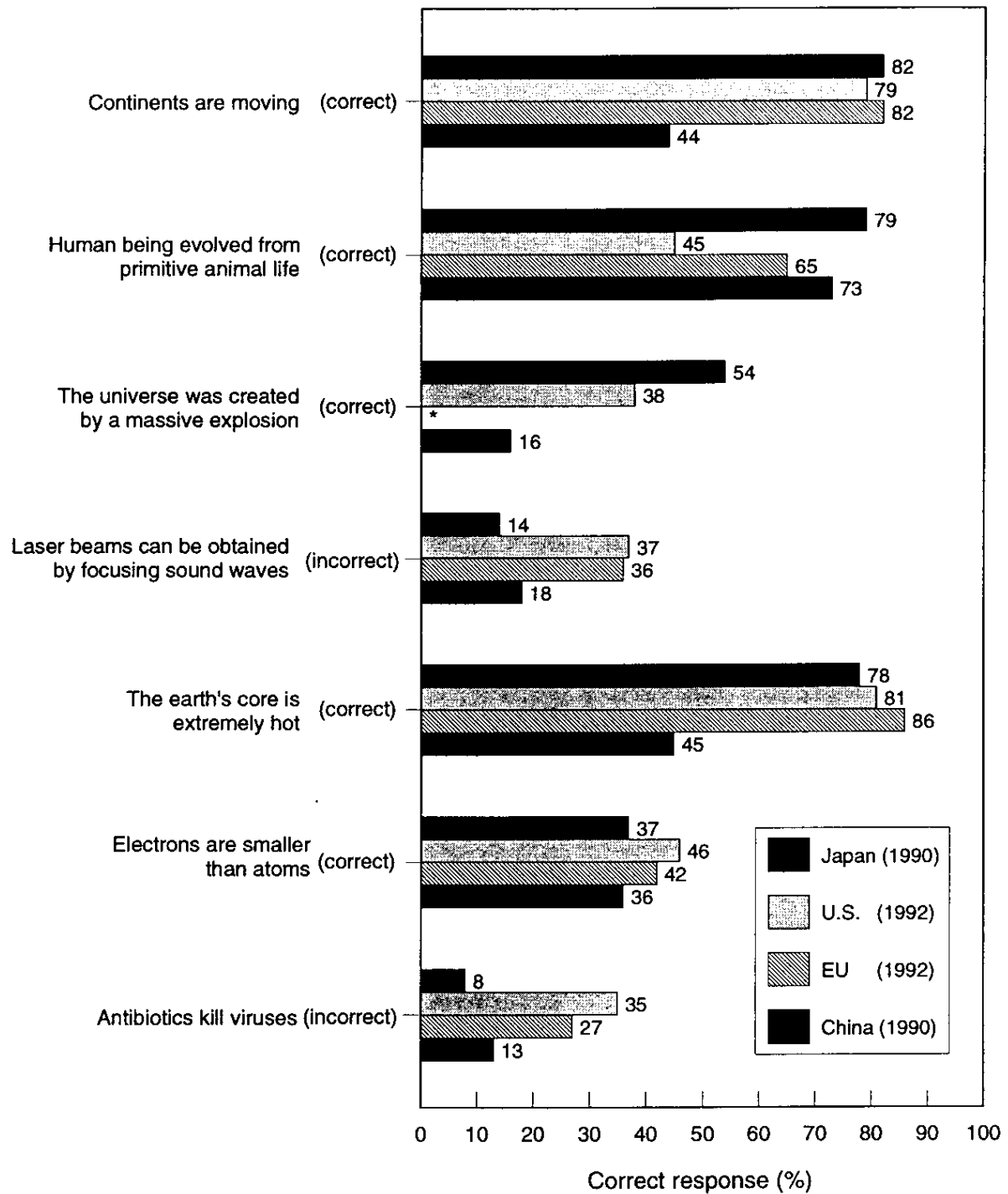
science and technology. The EU shows a relatively high correct response rate for each of the theories.

**Figure 7-3-6 Understanding of Science and Technology Terms**



Source: same as for Figure 7-3-7  
See Table 7-3-6

Figure 7-3-7 Level of Scientific Knowledge



Source: same as for Figure 7-3-8

See Table 7-3-9

### 7.3.4 Opinions and attitudes regarding science and technology

#### (1) Attitude towards the social impact of science and technology (comparison of Japan, U.S., U.K. and EU)

Figure 7-3-8 compares attitudes towards five views regarding the social impact of science and technology.

First, Japan had a lower positive response rate to the view “science makes our lives healthier, safer and more comfortable” than the other countries, possibly because the Japanese people do not actually feel the comfort or benefits resulting from the fruits of science and technology to any great extent, or because they are consciously suppressing that feeling. Next, the negative response rate by the United States for “science and technology makes our lives more hectic” is quite high, while for other countries, the positive response rate is about the same level as the U.S. negative response rate. This is perhaps because the American people, who enjoy the efficiency gained from their scientific and technological might in their vast land area do not feel the hectic pace as much as people in other countries.

As for the view “we have come to rely too much on science and forgotten about our spiritual side”, Japan had the highest positive response rate, possibly indicating that Japanese people are feeling a sense of spiritual incongruity with respect to science and technology. It is thought that the fact that the Japanese have been in contact with science and technology for a much shorter time than the Americans and Europeans and culturally they have yet to fully overcome the compromise with their inner spiritual feeling, coupled with their inability to feel the comfort and benefits of science and technology fully as mentioned earlier, is coming to the fore in their response to this view. This possibly indicates that modern science and technology is not as deeply rooted in the Japanese psyche as the nation’s spiritual culture.

As for the fourth view, “computerization and automation will increase rather than reduce jobs”, there is not a great difference in responses, with at least half of respondents in each country responding negatively. Thus it seems that a majority of people in all countries feel a certain anxiety about the future of their job.

Regarding the final view, “I can accept animal testing if it is beneficial to human beings”, again, there were no major differences among the three countries, with Japan having the highest positive response rate, followed by U.S. and U.K. The results do show that there is somewhat of a gap between the Japanese, who have a strong tendency towards practical progress in the improvement of medical technology, and the British, who have the most active animal rights and animal protection movement in the world; while the Americans are somewhere in between.

**Figure 7-3-8 Attitude towards the Social Impact of Science and Technology**

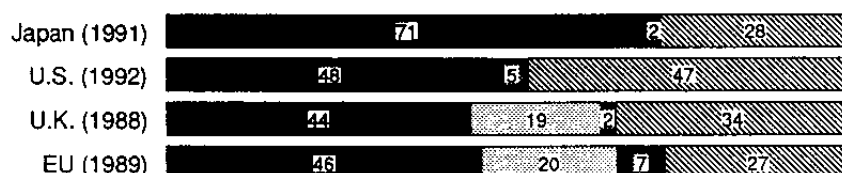
(A) Science makes our lives healthier, safer and more comfortable



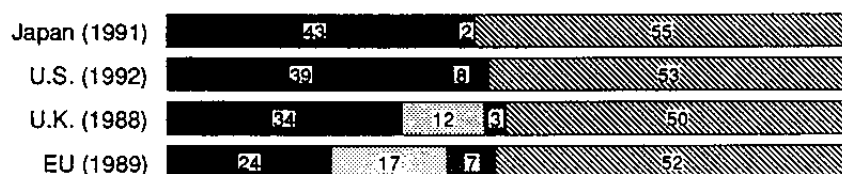
(B) Science and technology makes our lives more hectic



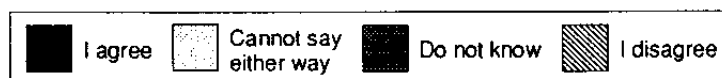
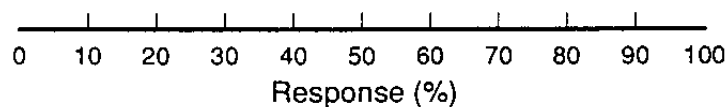
(C) We have come to rely on science and forgotten about our spiritual side



(D) Computerization will increase work



(E) I can accept animal testing if it is beneficial to human beings



Source: Japan — National Institute of Science and Technology Policy, November 1991 survey  
 U.S. — J.D. Miller, *The Public Understanding of Science and Technology in the United States, 1990*, North Illinois University, *Opinion Survey Institute*, 1991  
 U.K., E.C. — J.R. Durant, et.al., *Europeans, Science and Technology*, 1991  
 See Table 7-3-8

(2) Attitude regarding scientists (comparison of Japan, U.S. and France)

Figure 7-3-9 compares responses by people in Japan, the United States and France to the following three statements regarding views on scientists.

- 1) Scientists carry out their research for the sake of their own curiosity rather than for the benefit of people.
- 2) Scientists can pose somewhat of a risk to society because of the abundance of knowledge they possess.
- 3) Most scientists aspire to carry out research that will improve people's lives.

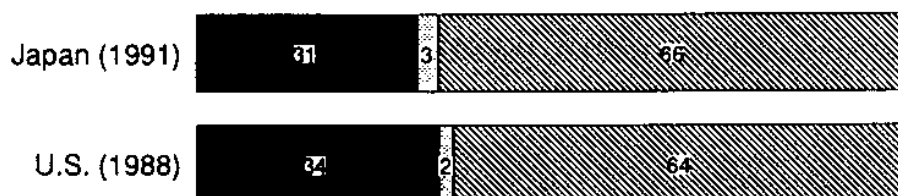
In both the Japanese and United States surveys more people responded "I disagree" than responded "I agree" to the statement "scientists carry out their research for the sake of their own curiosity", indicating that most people have a favorable attitude towards scientists.

To the statement "scientists can pose somewhat of a risk to society because of the knowledge they possess", a majority of Japanese respondents (59%) and American respondents (77%) answered "I disagree", but this was in marked contrast with the 73% of French respondents who answered "I agree".

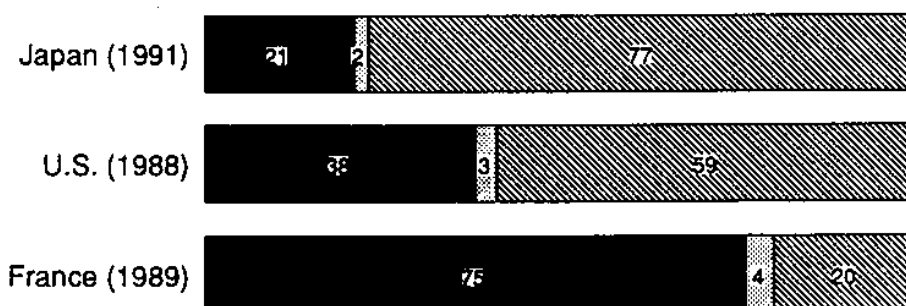
The results of responses to the statement "scientists aspire to improve people's lives" were similar in all three countries, with a majority of people (62–82%) answering "I agree", though the percentage for the Japanese survey was slightly lower than those of the other two surveys.

From the above, although there was little difference among the three countries in the view that scientists are conducting research aimed at improving people's lives, it can be said that unlike the Japanese and Americans, the French have a somewhat negative view when it comes to the issue of scientists' utilizing their own knowledge.

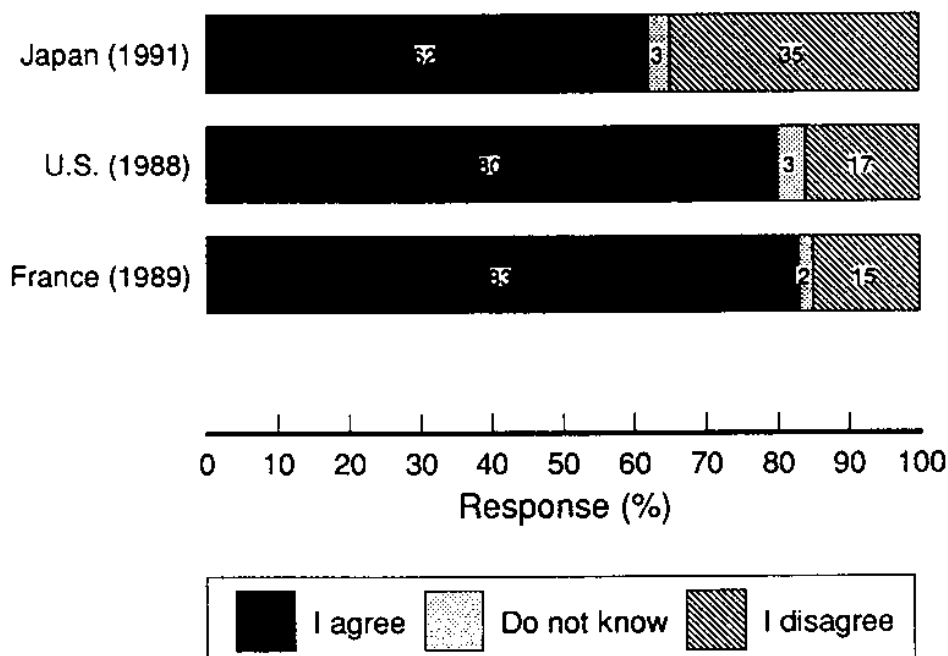
**Figure 7-3-9 International Comparison of Attitudes Regarding Scientists**  
**(A) Scientists carry out their research for the sake of their own curiosity**



**(B) Scientists can pose somewhat of a risk to society because of the knowledge they possess**



**(C) Scientists aspire to improve people's lives**



Source: Japan — National Institute of Science and Technology Policy, November 1991 survey  
 U.S. — J.D. Miller, *The Public Understanding of Science and Technology in the United States, 1990*, North Illinois University, Opinion Survey Institute, 1991  
 France — Daniel Boy, *Attitudes of the French toward Science*, 1990  
 See Table 7-3-9

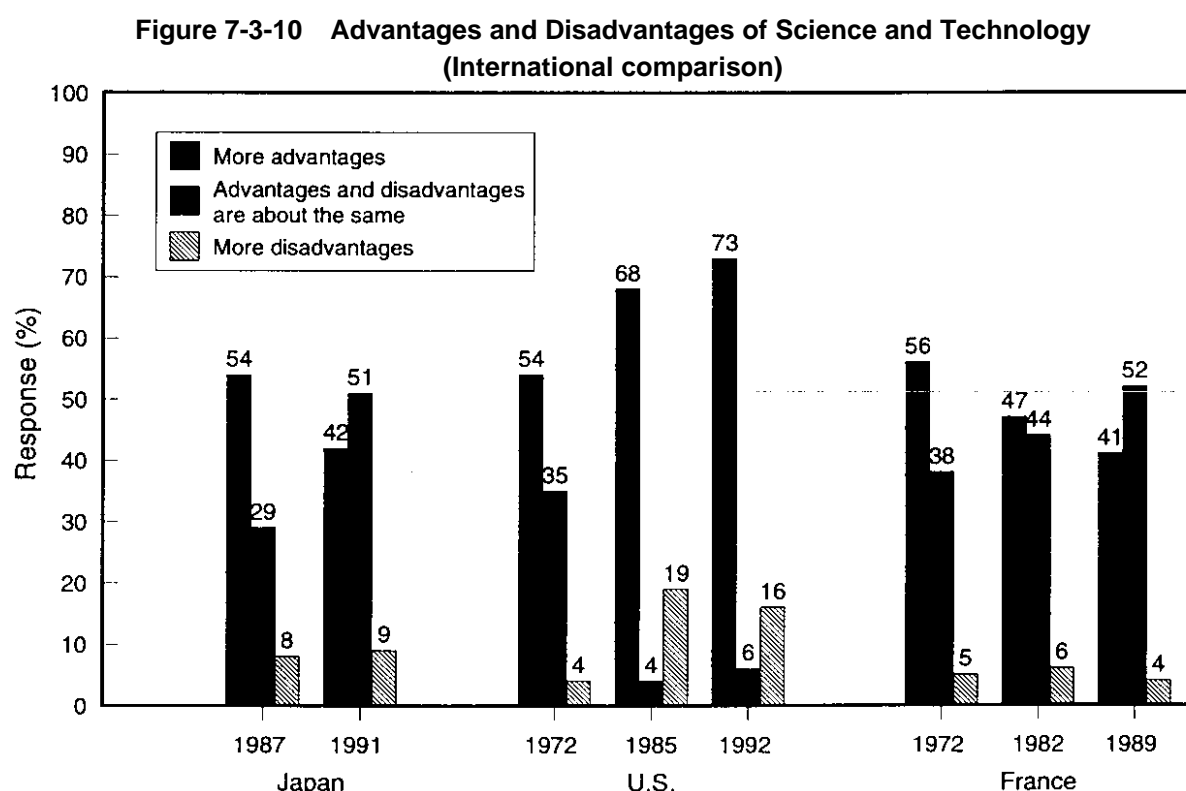
(3) Opinions on advantages and disadvantages of science and technology  
(comparison of Japan, U.S. and France)

The view as to whether, overall, advances in science and technology are advantageous or disadvantageous to people's lives is an interesting indicator reflecting the cultural characteristics of individual countries.

Figure 7-3-10 compares the results of surveys carried on two different occasions in Japan and three different occasions in the United States and France. The figure shows the percentages for the responses "generally advantageous", "generally disadvantageous" and "about the same", while the "do not know" responses have been omitted.

A key feature of the U.S. surveys is that the "advantageous" response rate increases with each successive survey. The "disadvantageous" response rate was extremely low in 1972, but increased slightly in 1985 and 1990. This rise may have been influenced by major nuclear power generation and space development accidents, but it was not enough to have any discernible effect on the growing "advantageous" view of the majority.

Conversely, the main feature of the French surveys is that the "advantageous" response rate fell steadily, while the "about the same" response rate rose to reverse their relative positions. The "disadvantageous" response rate remained steady at a very low level.



Source: Japan — National Institute of Science and Technology Policy, November 1991 survey  
 U.S. — J.D. Miller, *The Public Understanding of Science and Technology in the United States, 1990*, North Illinois University, Opinion Survey Institute, 1991  
 France — Daniel Boy, *Attitudes of the French toward Science*, 1990

See Table 7-3-10

The results of the Japanese surveys show a similar trend to the French results, with the “about the same” response rate rising, almost to the same high level in 1991 as in the French survey. The “disadvantageous” response rate is also very low, and overall, the results pattern is quite similar to the pattern formed by the French results.

It can be thought that these results are a reflection of the extent to which the fruits of science and technology are proving to be useful in improving the national life (raising general convenience and income, improving health and safety and so on) or are having an undesirable impact on people lives (causing general problems, affecting health and safety, etc.) in each country at the time of the survey.

A similar survey held in China in 1989 resulted in response rates of 82% for “advantageous” and two percent for “disadvantageous”.

## **Bibliography**

- [1] Shinichi Kobayashi, *Examination of the Hypothesis “Barbarians in a Civilized Society” — Correlation Between Science & Technology and Culture/Society*, “Research, Technology, Planning”, Vol. 6, No., 1991

Chapter 7 Hajime Nagahama



# Chapter 8

## Internationalization of Research and Development

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## Chapter 8

### Internationalization of Research and Development

A major feature of science and technology these days is the growing internationalization of research and development. In addition to the on-going socio-economic globalization, the realization that superior results can be obtained in research and development through an international interdependence is considered to be behind this trend. Moreover, in view of Japan's growing influence in the world community, a greater international contribution in research and development is expected of Japan. This chapter examines internationalization indicators concerning the base and fruits of Japan's research and development; the first section covers interchange of researchers and engineers while the second section looks at indicators for technology trade.

#### 8.1 Interchange of Researchers and Engineers

##### 8.1.1 Researchers, engineers and exchange students leaving and entering Japan

Over recent years North American and European countries have pointed out to Japan that there is an imbalance in researcher interchanges; but since there are no statistical surveys from which a precise understanding of the present researcher interchange situation can be gained, it is not always possible to describe this in quantitative terms.

This section therefore analyses the state of researcher exchanges between Japan and other countries using data contained in *Annual Report of Statistics on Legal Migrants*, published by the Ministry of Justice. These statistics give totals for the number of persons leaving Japan for overseas or entering Japan from overseas by purpose, and from these totals this section has extracted the following totals for purposes connected with research and technology development activities.

**Purpose of Overseas Travel and Residential Status Connected  
with Research and Technology Development Activities**

Purpose of overseas travel	Residential status of people entering Japan	
	Until 1989	From 1990
<ul style="list-style-type: none"> <li>• Academic research/investigation</li> <li>• Overseas study, training, acquisition of technology</li> </ul>	<ul style="list-style-type: none"> <li>• Overseas study</li> <li>• Training</li> <li>• Instructive activities</li> <li>• Art/academic activities</li> <li>• Provision of advanced technology</li> </ul>	<ul style="list-style-type: none"> <li>• overseas study</li> <li>• Training</li> <li>• Instruction</li> <li>• Research</li> <li>• Technology</li> </ul>

- Note: (1) The table is based on the travel purpose and residential status as classified in the Immigration Control and Refugee Recognition Law.
- (2) In 1990 residential status was revised following amendment of the Immigration Control and Refugee Recognition Law.
- (3) Purpose of travel consists of 11 categories, and residential status consists of 28 (18 until 1989).

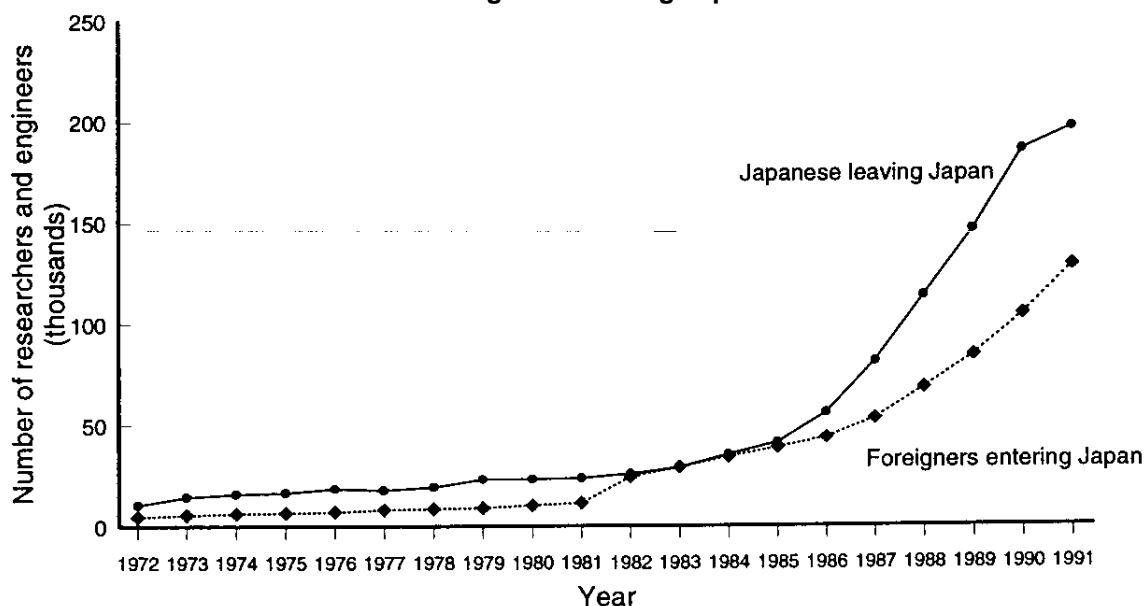
In this section all persons leaving Japan for any of the purposes mentioned above are referred to as “researchers and engineers”. It should be noted that the term “researchers and engineers” used here does not have the same meaning as “researchers” used in other parts of this paper.

#### (1) Overall trends

Figure 8-1-1 shows that in 1991 196,743 researchers and engineers left Japan for other countries (outbound researchers and engineers), accounting for 1.9% of all Japanese who left Japan (10,633,777), while 128,623 overseas researchers and engineers came to Japan (inbound researchers and engineers), or 3.3% of the 3,855,952 foreigners who entered Japan. From 1972 until the mid 1980s the number of outbound and inbound researchers and engineers showed a steady increase, but from the latter half of the 1980s it rose sharply. From this period the rise in the number of outbound researchers and engineers greatly exceeded the rise in the number of those inbound, but from 1991 the sharp rise in outbound researchers and engineers started to level off.

In an effort to ascertain factors in the rise in the numbers of researchers and engineers leaving and entering Japan since the latter half of the 1980s, this section compares trends in the total numbers of people leaving and entering Japan during the period. The percentage of researchers and engineers leaving Japan to the total number of Japanese leaving Japan rose from 0.76% in 1984 to 1.9% in 1991 while the percentage of foreign researchers and engineers entering Japan to the total number of foreigner entering Japan rose from 1.6% to 3.3% over the same period. From this it can be seen that the rise in the number of researchers and engineers in Figure 8-1-1 is not just because of an increase in the number of overseas travelers and workers brought on by the across-the-board internationalization of Japan or the strong yen, but also due to a significant extent to the internationalization of research and development.

**Figure 8-1-1 Trends in the Number of Researchers and Engineers Leaving and Entering Japan**



Source: Ministry of Justice, *Annual Report of Statistics on Legal Migrants*  
See Tables 8-1-1 and 8-1-2

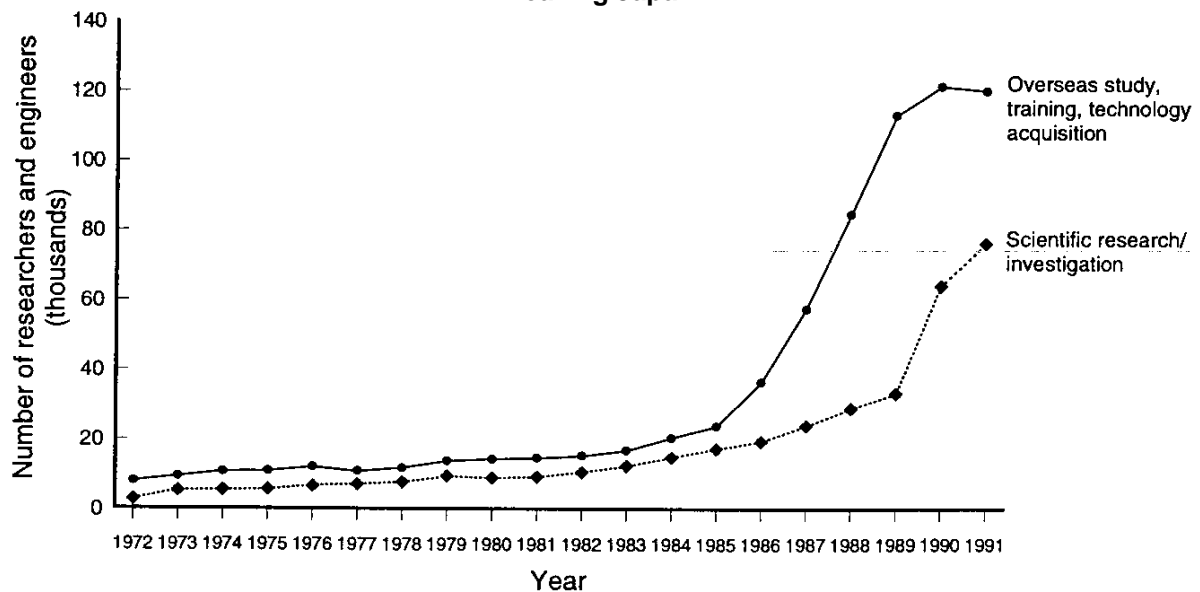
Due to a sudden rise in the number of outbound researchers and engineers from the latter half of the 1980s, by 1990 the ratio of inbound to outbound researchers and engineers had jumped from 1:1.1 to 1:1.8, though in 1991 the ratio had fallen back slightly to 1:1.5.

The large increase in inbound researchers and engineers in 1982 as shown by Figure 8-1-1 can be put down to the new inclusion of “training” as a residential status for foreigners from 1982. Changes in the residential status categories resulted in a split of the former “artistic/academic activities” into “artist” and “researcher”, who is engaged only in academic activities, while “provision of advanced technology” was expanded to “technology” to include general technology as well. Thus the revision has enabled statistics to reflect the actual state of foreign researchers and engineers entering Japan more accurately than before by making it possible to exclude unnecessary sub-categories such as “art” and adding general technology to the previously limited advanced technology.

## (2) Japanese researchers and engineers leaving Japan

The number of persons leaving Japan for the purpose of overseas study, training and acquisition of technology rose steadily until about 1985. From 1986 the number jumped sharply, continuing up until 1990 when it began to level off, then dropped slightly in 1991. On the other hand, the number of persons leaving for academic research or investigation showed a steady rise until 1990, then increased abruptly (Figure 8-1-2).

**Figure 8-1-2 Trends in the Breakdown of Japanese Researchers and Engineers Leaving Japan**



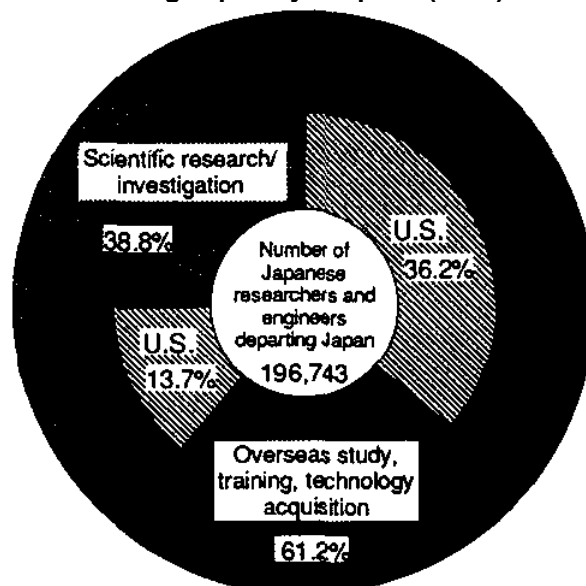
Source: Ministry of Justice, *Annual Report of Statistics on Legal Migrants*  
See Tables 8-1-1 and 8-1-2

The rise in the overseas study, training and acquisition of technology category from 1986 is thought to be caused by the sudden jump in the number of persons leaving Japan to obtain new technology or knowledge overseas with the view of reinforcing Japan’s economic base in the wake of the rising value of the yen following the Plaza Agreement in 1985. From 1990 the rise in the overseas study, training and acquisition of technology category slowed down, while the academic

research or investigation category, which consists of individual research/study or joint research/study with foreign researchers, rose sharply. Therefore although there are still many researchers and engineers leaving Japan to acquire new scientific and technological skills and knowledge from overseas, this trend does, on the other hand, suggest that the level of joint research with Japan as an equal partner is increasing in a reflection of Japan's growing national strength.

Figure 8-1-3 shows that most researchers and engineers who left Japan for the purpose of academic research/investigation or overseas study, training and acquisition of technology went to the United States or Europe. In fact almost 60% of the researchers and engineers who left Japan for overseas study, training and acquisition of technology, and about one third of those who left for academic research or investigation went to the United States, making it by far the most popular destination.

**Figure 8-1-3 Breakdown of Japanese Researchers and Engineers Leaving Japan by Purpose (1991)**



Source: Ministry of Justice, *Annual Report of Statistics on Legal Migrants*  
See Table 8-1-3

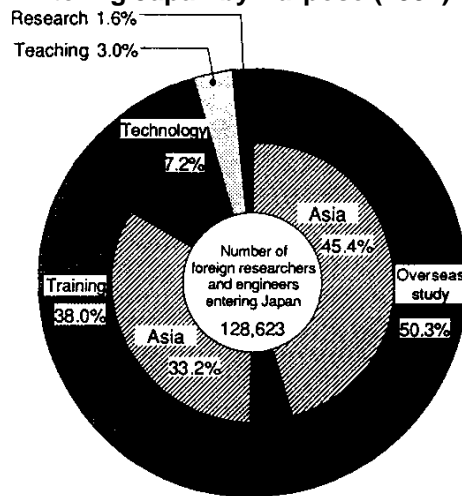
### (3) Foreign researchers and engineers entering Japan

Every year since 1972 most researchers and engineers entering Japan have done so for the purpose of "study", and since 1982, this has been followed by "training". Since the late 1980s both categories have shown generally the same high rate of increase. In 1991, 64,646 researchers and engineers came to Japan for the purpose of "study", and 48,868 came for "training", and together these two categories accounted for almost 90% of all researchers and engineers entering the country. In contrast, just over 10% came to Japan for "research", "teaching" or "technology"(Figure 8-1-4).

From this it can be said that researchers and engineers are entering Japan to acquire knowledge and technology from Japan through study and training, while an extremely small number are entering

to provide Japan with knowledge through instructive activities. Almost 90% of those entering Japan for “study” and about the same percentage of those for “training” came from Asia.

**Figure 8-1-4 Breakdown of Foreign Researchers and Engineers Entering Japan by Purpose (1991)**



Source: Ministry of Justice, *Annual Report of Statistics on Legal Migrants*  
See Table 8-1-4

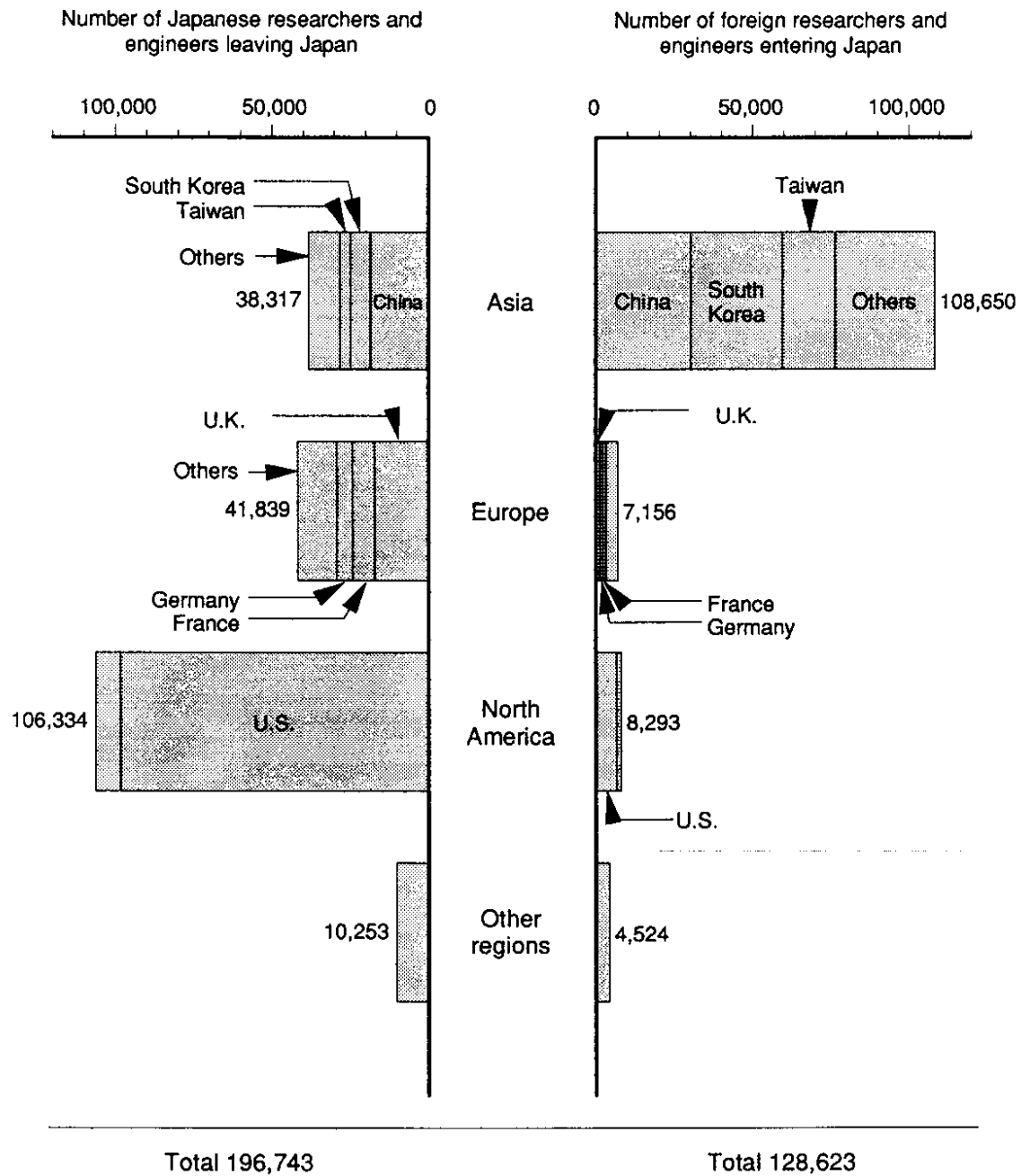
#### (4) Regional breakdown of researchers and engineers leaving and entering Japan

Since 1972 the majority of Japanese researchers and engineers leaving Japan have gone to North America, Europe or Asia. The number leaving for North America increased rapidly from the latter half of the 1980s to reach 106,334 in 1991, or more than half of all researchers and engineers leaving Japan, while 41,839 left for Europe and 38,317 left for Asia (Figure 8-1-5). More than 90% of those leaving for North America went to the United States, and of those who left for Europe, 70% went to U.K., France or Germany. Moreover, from the start of the 1990s the rate of increase in researchers and engineers going to China has been higher than the corresponding rate of increase for the United States.

As for researchers and engineers entering Japan, since 1972 the majority has consistently come from Asia. In 1991 108,650 researchers and engineers came to Japan from Asia, or more than 80% of the total number, followed by 8,293 from North America and 7,156 from Europe (Figure 8-1-5). By country, 30,322 came from China (about one-quarter of the total), 29,390 from South Korea and 16,951 from Taiwan; and together these three countries accounted for almost 60% of all researchers and engineers entering Japan, and 70% of those from the Asian region

By region, Figure 8-1-5 shows that there is a considerable imbalance between regions in the number of outbound and inbound researchers and engineers: in 1991 three-quarters of Japanese researchers and engineers leaving Japan went to North America or Europe, whereas more than 80% of overseas researchers and engineers entering Japan came from the Asian region. This imbalance stands out even more when looking at these figures by country. Whereas about half of all outbound researchers and engineers went to the United States, a mere 5% of inbound researchers and engineers came from the United States. If only the United States and Europe are considered, 66% of researchers and engineers from Japan went to the United States, while 44% of foreign researchers and engineers entering Japan came from the United States. From this it can be seen that among North American and European countries, the United States has the most active interchanges with Japan in terms of the flow of researchers and engineers.

**Figure 8-1-5 Breakdown of Researchers and Engineers Leaving and Entering Japan by Region**



Source: Ministry of Justice, *Annual Report of Statistics on Legal Migrants*  
See Tables 8-1-3 and 8-1-4



### 8.1.2 Japan's researcher acceptance system

The two main systems under which foreign researchers are hosted by public institutions in Japan are (A) researcher invitation system, and (B) fellowship system. The following table gives a broad outline of these two systems.

**Major Systems of Accepting Foreign Researchers by Japanese Public Institutions**

System	Implementing organization	Remarks (establishment year)
(A) Researcher invitation system		
• Foreign researcher invitation system (short- and long-term)	Japan Society for the Promotion of Science	(short-term: 1960, long-term: 1964)
• Bilateral scientific exchanges	Japan Society for the Promotion of Science	Based on agreements with specific countries.
• Scientific exchanges with developing countries	Japan Society for the Promotion of Science	One part of the above system.
• Foreign S&T researcher invitation system	Science and Technology Agency	General name for various kinds of systems.
(B) Fellowship system		
• Young researchers in developed countries invitation system	Japan Society for the Promotion of Science	(1979; until 1987)
• Special foreign researchers	Japan Society for the Promotion of Science	Changed from the above system (1988).
• Science and Technology Agency Fellowship System	Science and Technology Agency	(1988)

The Japan Society for the Promotion of Science Fellowship System was established with the aim of contributing to the academic development of young researchers in the United States and Europe by providing them with the opportunity to work under a Japanese professor at universities and other research institutions in Japan. Under the system, young researchers are taken in by Japanese universities and other research institutions to conduct research in the cultural/social or natural sciences for one year.

The Science and Technology Agency Fellowship System was established in FY1988 with the view of promoting international exchanges among researchers in the science and technology field by providing foreign researchers with fellowships to carry out research at national test and research establishments and the like. The system enables mainly young researchers in developed countries in North America and Europe to work in national test and research establishments in Japan for periods of between six months and two years.

This section examines the number of foreign researchers hosted under the above systems. Because of differences in culture and general customs between Japan and the North American and European countries, and especially because of the peculiarities of the Japanese language, a certain period of preparation is essential for foreign researchers who will be working in Japan. It is therefore not possible here to look at long-term and short-term researchers in the same light, so when examining

the state of researcher exchanges at Japan's public research institutions, it is more meaningful to differentiate between researchers in Japan on a long-term program and those on a short-term program.

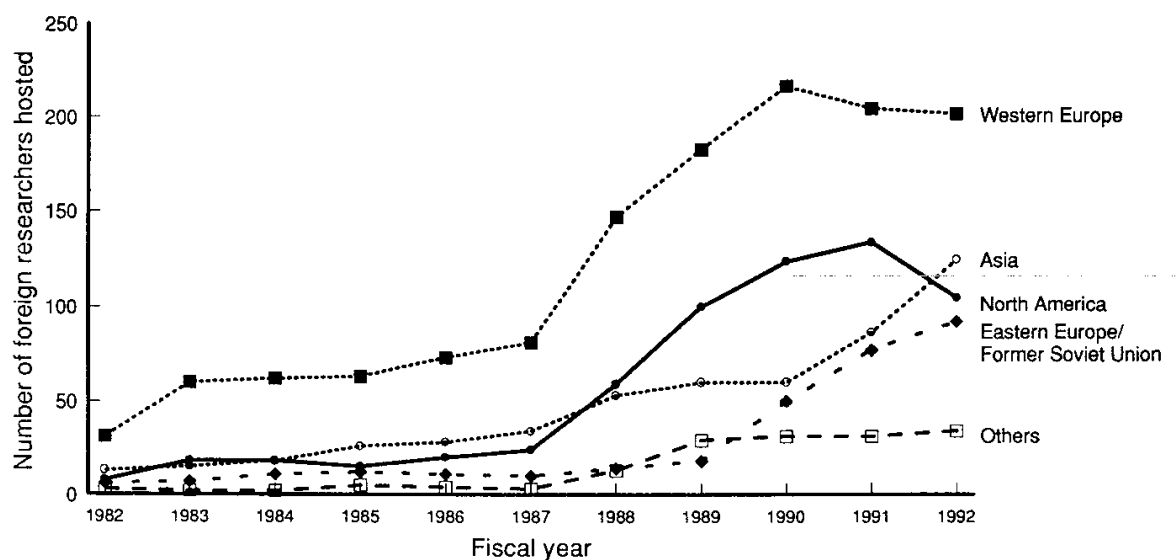
#### (1) Long-term foreign researchers

From Figure 8-1-6(A), which shows trends in the number of long-term foreign researchers (those staying in Japan for more than six months) for the past ten years, it can be clearly seen that since 1988 there has been a sudden surge in the number of foreign researchers coming to Japan under an official exchange program. This surge came as result of the sudden rise in the number of researchers under the Japan Society for the Promotion of Science special foreign researcher system, even though the number of researchers under the foreign researcher invitation system (long-term) began to fall after peaking at 85 researchers in FY1988, and also as a result of the establishment of the Science and Technology Agency Fellowship System.

Figure 8-1-6(B) shows a regional breakdown of the native countries of long-term foreign researchers, and from the figure it can be seen that the highest percentage has consistently come from Western Europe. Until FY1988 Western Europe accounted for more than half of long-term researchers, but from then its share continued to drop, and by FY1992 it had fallen to 36%. North America and Asia account for the next highest and generally an equal share (15–25%) at just under one half of that of Western Europe. Another feature of the figure which stands out is the increase in the number of researchers from Eastern Europe and countries of the former Soviet Union.

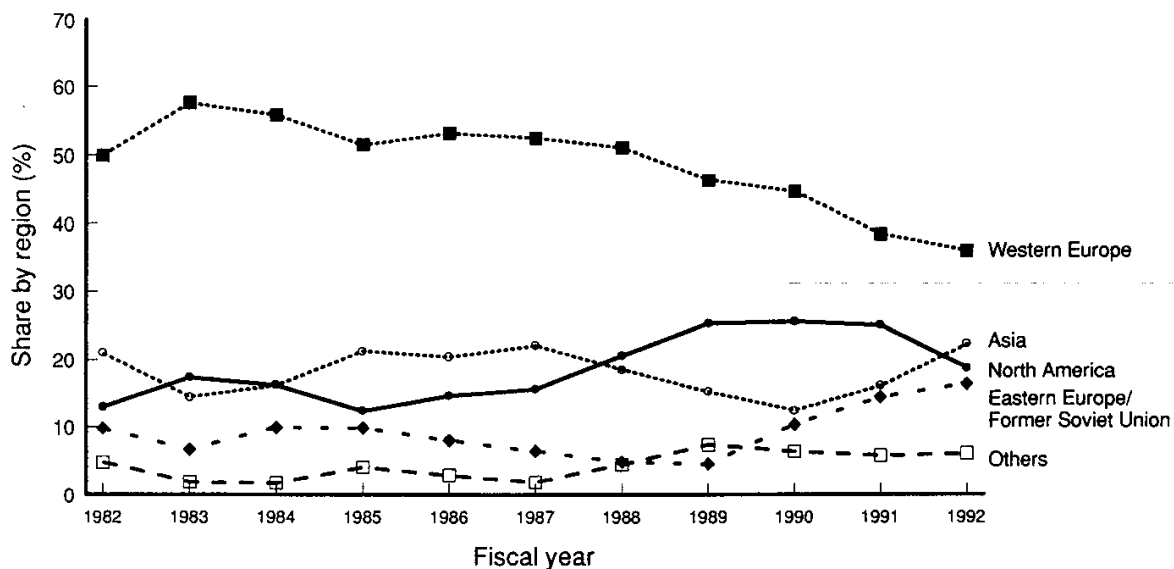
**Figure 8-1-6 Trends in the Number of Foreign Researchers Hosted under an Official Program (long-term)**

#### (A) Number



**Figure 8-1-6 Trends in the Number of Foreign Researchers Hosted under an Official Program (long-term)**

**(B) Share by region**



Source: Japan Society for the Promotion of Science, *Outline of Programs*  
 Science and Technology Agency, *International Science and Technology Handbook*  
 Science and Technology Agency, *Foreign S&T Researcher Invitation System*  
 See Table 8-1-5

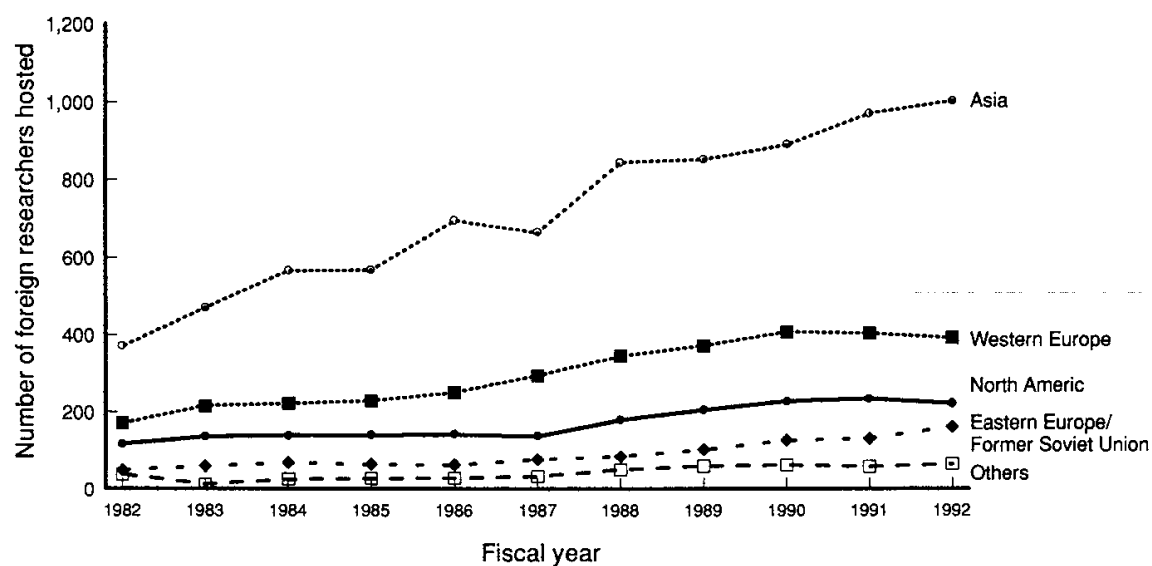
(2) Total number of foreign researchers including short-term researchers.

Figures 8-1-7(A) and 8-1-7(B) show the total number of foreign researchers in Japan under the systems mentioned above, regardless of their length of stay. The total number increased steadily from 749 in FY1982 to 1,845 in FY1992, an approximately 2.5-fold rise over the ten years. Asia holds the largest share as the native region of researchers invited to Japan with more than 50%, followed by Western Europe, North America, Eastern Europe, and the countries of the former Soviet Union. There has been little change in the regional share over the decade shown in the figure.

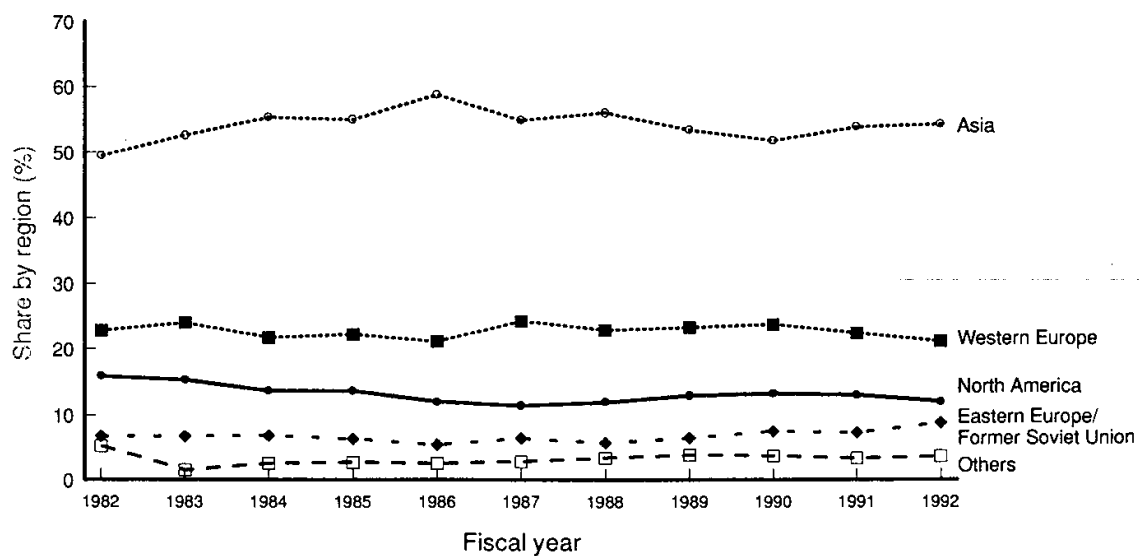
Of all foreign researchers invited to Japan, the highest percentage comes from the Asian region, but among the long-term researchers, the highest percentage comes from Western Europe. The percentage of all foreign researchers from Eastern Europe and the former Soviet Union has generally remained the same for the ten years at about 7%.

**Figure 8-1-7 Trends in the Number of Foreign Researchers Hosted under an Official Program(short- and long-term)**

**(A) Number**



**(B) Share by region**



Source: Japan Society for the Promotion of Science, *Outline of Programs*  
 Science and Technology Agency, *International Science and Technology Handbook*  
 Science and Technology Agency, *Foreign S&T Researcher Invitation System*  
 See Table 8-1-6

### 8.1.3 Dispatch of researchers and engineers to developing countries

Japan International Cooperation Agency (JICA) implements programs for dispatching researchers and engineers to developing countries, and as the quantitative details of these programs are contained in the JICA annual report, a rough idea of the state of researcher dispatch to the developing countries can be obtained from these reports. However, JICA's programs are aimed expressly at contributing to the raising of the technological level in the recipient country by transferring technology, skills and knowledge that will be useful in that country's socio-economic development, and not necessarily at improving standards at local research institutions and fostering local researchers. If the study is limited to fields within JICA's technical cooperation that are closely linked to science and technology, keeping in mind this point, it is possible to determine the state of researcher and engineer dispatch to developing countries.

The fields covered by JICA's dispatch programs range from those that are closely connected with science and technology, such as "science and culture", "agriculture, forestry and fisheries", "mining and manufacturing" and "energy", to fields that focus on administration and services and have only a very slight connection, such as "commerce and tourism", planning and administration", and "public utilities and works".

This section discusses the state of JICA's expert dispatch programs in "science and culture" (including the "human resources" category in the JICA annual report), the field most closely connected with science and technology, and also trends in the number of experts dispatched.

#### (1) Dispatch of experts

The dispatch of experts by JICA is broadly classified into that carried out as a part of project-type technical cooperation or development cooperation, and that carried out on the basis of individual requests from the developing country or an international organization. Here, totals for the dispatch of experts in all categories are based on the JICA annual report.

Figure 8-1-8 shows trends in the number of experts dispatched to developing countries in the "science/culture" field, and as can be seen, the number has been increasing almost rectilinearly since FY1983. By region, the number of experts dispatched to Asia is particularly high, and over the past ten years this region has consistently accounted for about two-thirds of all experts dispatched.

#### (2) Dispatch of Japan Overseas Cooperation Volunteers (JOCV)

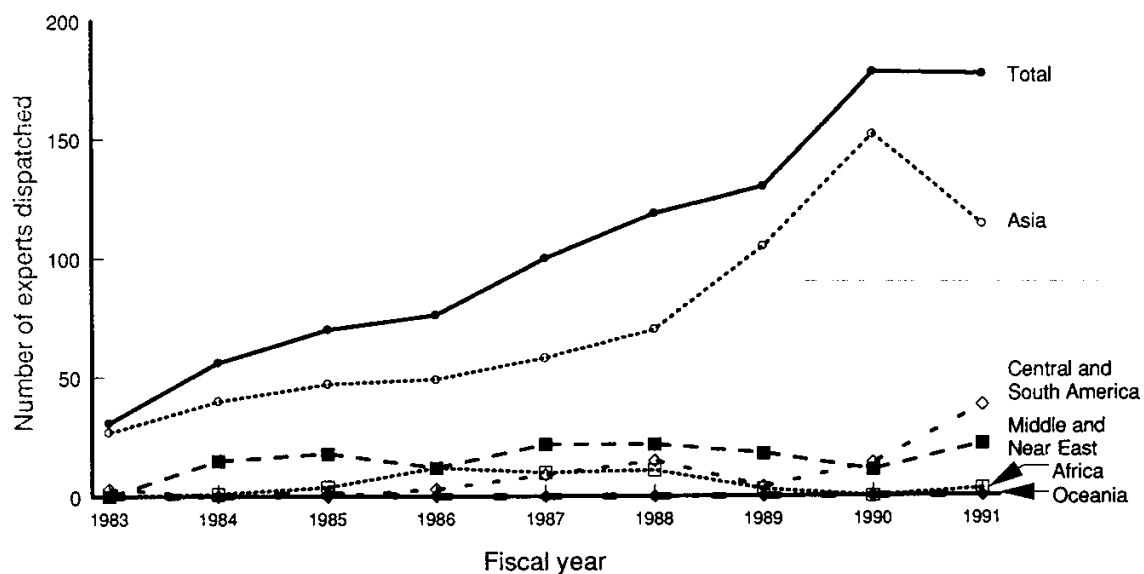
Japan Overseas Cooperation Volunteers are young people who have expressed a desire to help with the socio-economic advancement of developing countries, and are sent, at the request of the recipient country, to live among the local people and provide assistance where necessary.

As shown by Figure 8-1-9, the number of JOCV workers dispatched overseas to provide assistance in the "science/culture" field has increased steadily from 143 (6.8%) in FY1985 to 292 (10.5%) in FY1991.

By region, the highest number of volunteers were sent to Central and South America, followed by Asia, Africa and Oceania. This ranking has not changed since 1983, nor has the regional share to any significant extent, though the Central and South American share is tending to fall slightly.

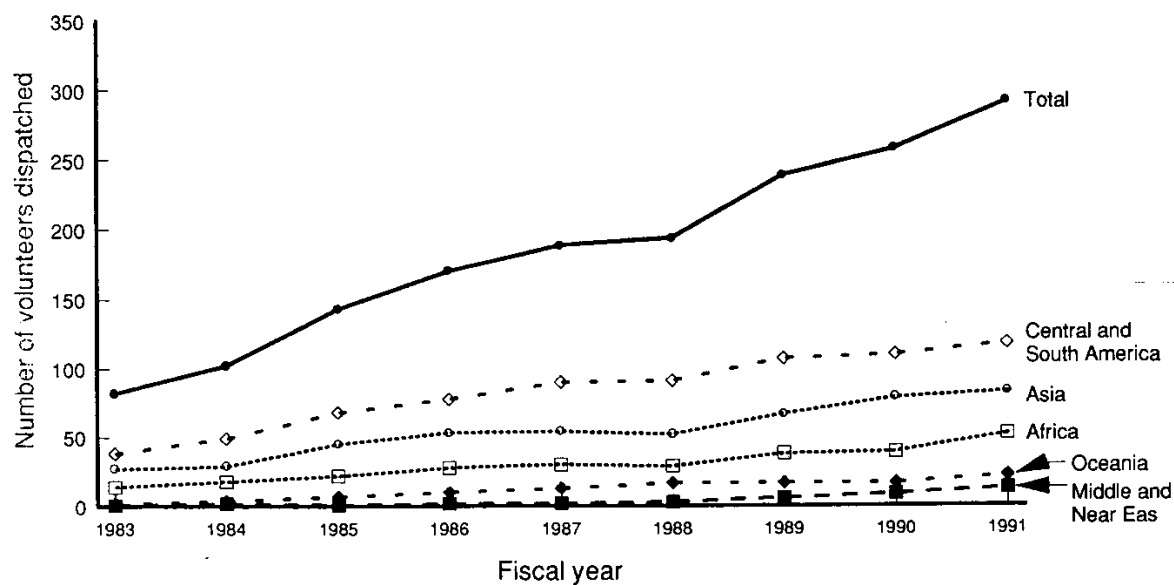
The main characteristic of the JOCV program is that while the focus of the experts dispatch program is on Asia, 40% of JOCV workers are sent to Central and South America.

**Figure 8-1-8 Trends in the Number of Experts Dispatched in the "Science/Culture" Field**



Source: Japan International Cooperation Agency, *JICA Annual Report*  
See Table 8-1-7

**Figure 8-1-9 Trends in the Number of Japan Overseas Cooperation Volunteers Dispatched in the "Science/Culture" Field**



Source: Japan International Cooperation Agency, *JICA Annual Report*  
See Table 8-1-8

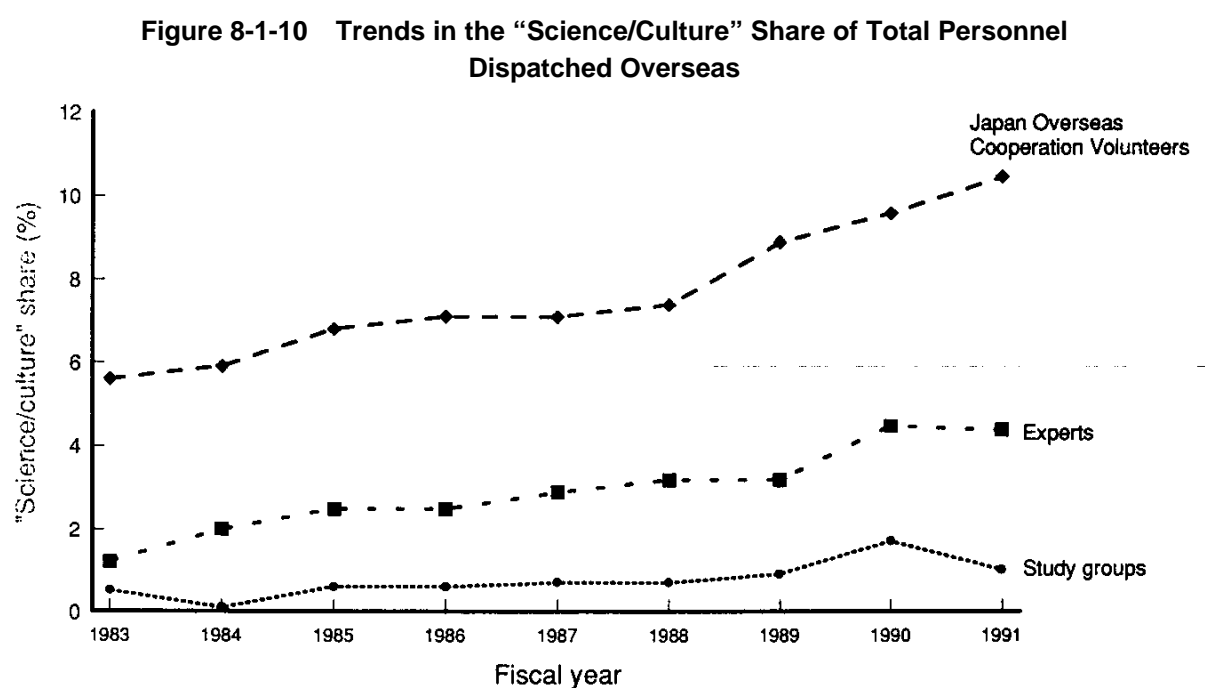
(3) “Science/culture” share of total personnel dispatched overseas

Figure 8-1-10 shows trends in the “science/culture” share of the total number of personnel dispatched overseas.

In FY1983 1.2% of experts were dispatched in the “science/culture” field, but eight years later in FY1991 this had climbed to 4.4%, so while the share of the “science/culture” field is still quite moderate, it is steadily rising.

As for JOCV, in the same period the share of the “science/culture” field rose from 5.6% to 10.5%.

This steady rise in the “science/culture” share of the total number of personnel dispatched overseas for both experts and JOCV workers is thought to reflect a growing desire in developing countries for Japanese assistance and cooperation to develop and improve their own levels of science and technology.



Source: Japan International Cooperation Agency, *JICA Annual Report*  
See Table 8-1-9

## 8.2 Technology Trade

Generally, technology export means to grant companies or individuals residing overseas the right to use technology (intellectual property rights under law, such as patents, utility models, trademark rights, design rights, and copyrights, and the so-called know-how technology rights, such as designs and blueprints) in return for an agreed amount of remuneration, while technology import means to obtain such rights from companies or individuals residing overseas in return for an agreed amount of remuneration. Combined they are called technology trade, and information on technology trade forms an important indicator of the technological level of one country in relation to other countries.

The amount of technology exports (amount of receipts) is thought to reflect the technological strength of that country to a certain extent. On the other hand, when importing technology a country must have the technological capability to fully utilize the imported technology, as well as the technological capability to modify the imported technology to suit its own needs or purposes, so the amount of technology imports (amount of payments) can also be regarded as indicator of a country's technological level. However, it is important to keep in mind that with the expansion of Japanese companies overseas in recent years, the growing technology transfers which occur within the company group, e.g. between affiliated companies overseas, will appear in the statistics as technology trade between countries.

Two publications regularly used in Japan's technology trade are the *Report on the Survey of Research & Development* by the Management and Coordination Agency and the *International Balance of Payments Statistics* by the Bank of Japan. Data in both publications vary slightly, and a more accurate understanding of Japan's technology trade situation can be obtained by making adjustments to these data, as described in a later section (8.2.3). Moreover, *Analysis of Trends in Overseas Technology Imports* by the National Institute of Science and Technology Policy will give an even better understanding of the particulars of technology imports, and this too, will be discussed in a later section (8.2.4).

### 8.2.1 Technology trade by type of industry

*Report on the Survey of Research & Development* by the Management and Coordination Agency contains a breakdown of technology trade by industry and by region, so details in this section will be based on this source.

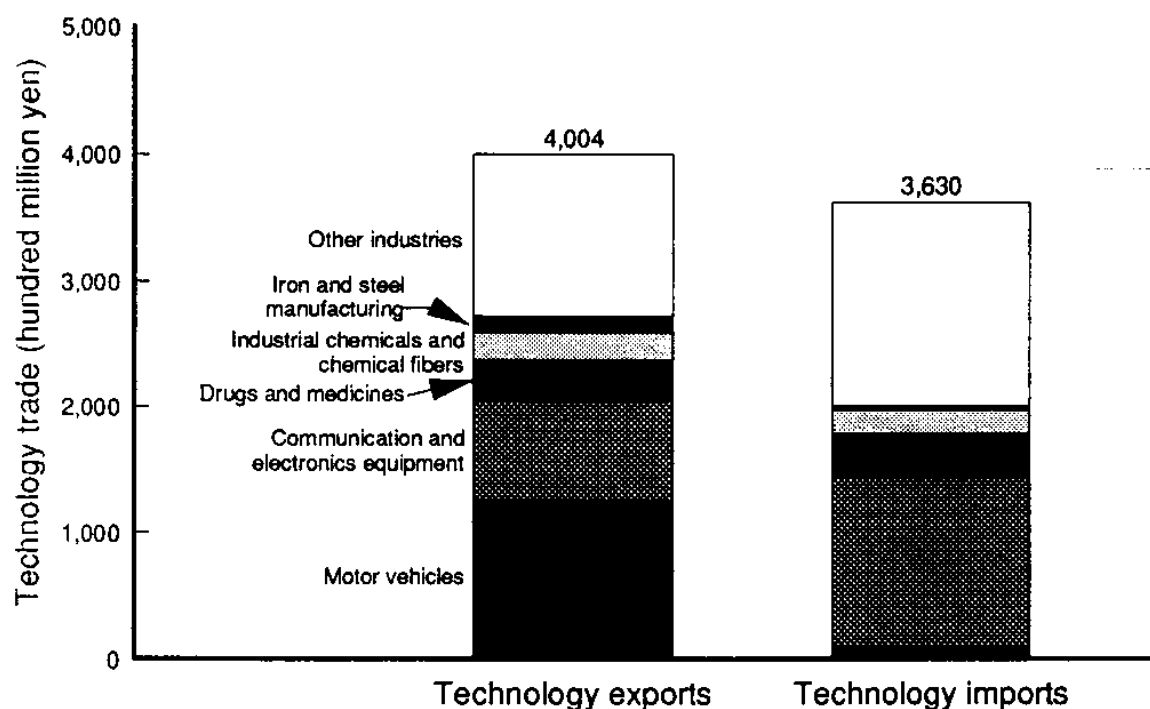
#### (1) Latest technology trade

Figure 8-2-1 shows the total amount of technology exports and imports (total amount of payments made and received) of Japanese industry as a whole in FY1993. Technology exports (payments received) amounted to 400.4 billion yen, while technology imports (payment made) amounted to 363 billion yen, resulting in a technology trade surplus of 37.4 billion yen in FY1993, or 9.3% of technology exports and 10.3% of technology imports. According to the technology trade statistics of the Management and Coordination Agency, FY1993 is the first year that Japan has enjoyed a technology trade surplus since the statistics were first taken in FY1971.

The three leading industries in technology exports are the motor vehicles industry (124.2 billion yen; 31.0% of all technology exports), communication and electronics equipment industry (80.7 billion yen; 20.2%), and the drugs and medicines industry (31 billion yen; 7.7%); and these three industries account for 58.9% of technology exports by all industries.



**Figure 8-2-1 Japan's Technology Trade (FY1993, classified by major industry)**



Source: Management and Coordination Agency, *Report on the Survey of Research & Development*  
See Table 8-2-1

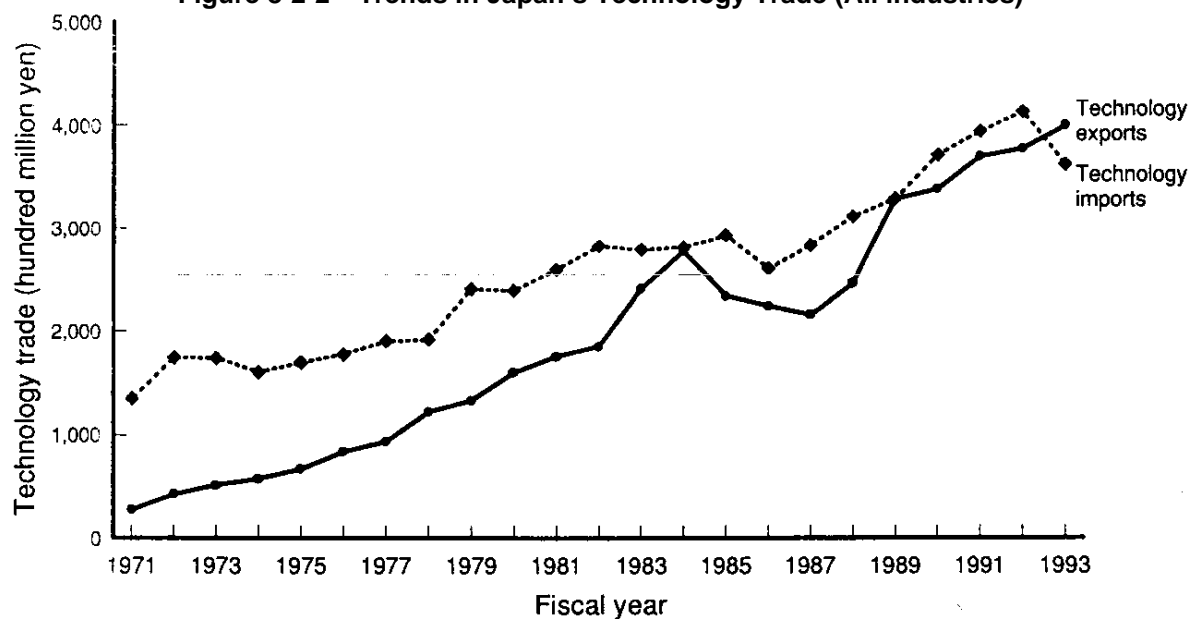
Leading technology importers are the communication and electronics equipment industry (134.7 billion; 37.1% of all technology imports), drugs and medicines industry (34.6 billion yen; 9.5%), and the industrial chemicals and chemical fibers industry (18.7 billion yen; 5.2%); these three industries account for 51.8% of technology imports by all industries. In the motor vehicles industry, technology exports of 124.2 billion yen contrast starkly with technology imports of a mere 8.7 billion (2.4% of total imports).

## (2) Trends in technology exports and imports in each industry

Figure 8-2-2 shows trends in total technology exports and imports of all industries, and Figure 8-2-3 shows the overall technology trade balance (exports/imports, logarithmic scale) of all industries and the technology trade balance for the five major industries.

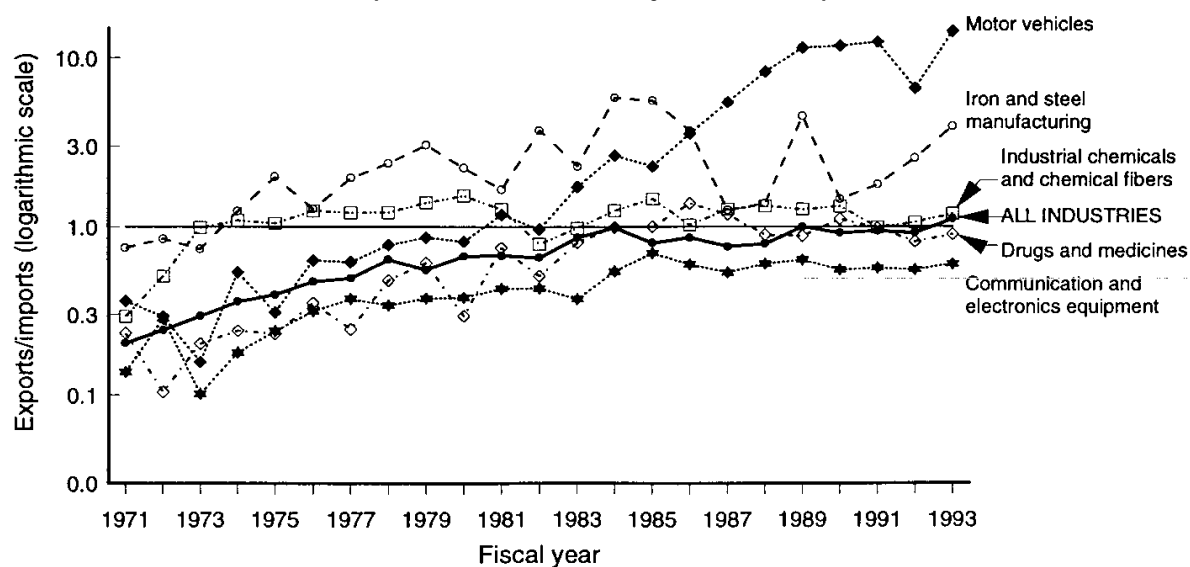
In FY1975 Japan's trade exports totaled 66.6 billion yen, while imports totaled 169.1 billion yen, giving a technology trade ratio of 0.39. Five years later in FY1980 the technology trade ratio had risen to 0.67 with exports amounting to 159.6 billion yen and imports to 239.5 billion yen, and by FY1985, the technology trade balance had reached 0.80 with exports of 234.2 billion yen and imports of 293.2 billion yen. Figure 8-2-2 shows that technology exports dropped slightly in FY1985, and technology imports dropped slightly in the following fiscal year, but after that, both imports and exports again rose steadily. After imports and exports reached a rough balance in FY1989, imports increased at a greater rate than exports, but in FY1993 this trend was reversed and the trade ratio broke through the 1.0 line for the first time.

**Figure 8-2-2 Trends in Japan's Technology Trade (All industries)**



Source: Management and Coordination Agency, *Report on the Survey of Research & Development*  
See Table 8-2-2

**Figure 8-2-3 Trends in Japan's Technology Trade Balance (All industries and major industries)**



Source: Management and Coordination Agency, *Report on the Survey of Research & Development*  
See Table 8-2-3

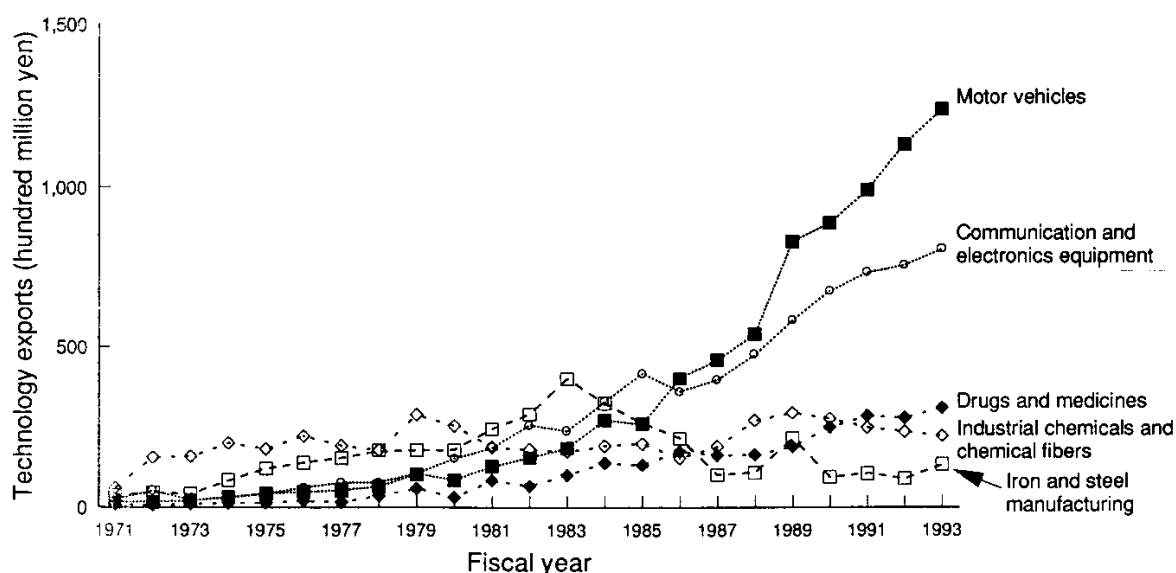
From the annual rise in Japan's technology trade ratio (exports/imports), it can be seen that overall the increase rate of technology exports is higher than the increase rate of technology imports. In one sense this points to the expanding technological might of Japan, but when the technology trade balance is expressed logarithmically, there is a need to note that while the ratio exceeded 0 for the first time in FY1993, it has a tendency to remain around the 0 mark. That is, while technology exports are increasing, technology imports are also increasing, indicating that the introduction of technology from overseas is essential for Japanese industry.

Figures 8-2-4 and 8-2-5 show trends in technology exports and imports by the five major industry groups, and trends in their technology trade ratio. When looked at in conjunction with the technology trade trends in Figure 8-2-3, these figures reveal the following characteristic in each industry group.

The increase rate of the industrial chemicals and chemical fibers industry in both technology imports and exports is lower than the all-industries average. From the end of the 1970s technology exports by the industrial chemicals and chemical fibers industry remained around 20 billion yen, while technology imports remained slightly lower at 15–20 billion yen, so from FY1973 until the present, with the exception of FY1982, 1983 and 1991, the industry has enjoyed a technology trade surplus with a trade ratio above 1.0.

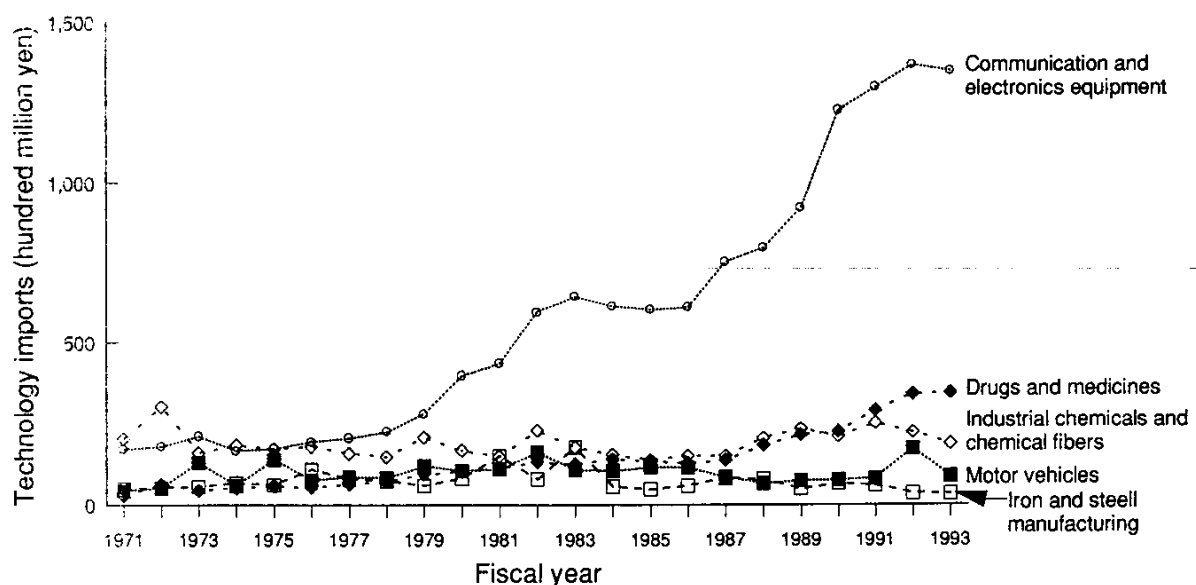
From the 1970s to mid 1985 the drugs and medicines industry had the largest technology trade deficit among the manufacturing industries, but from FY1985 the technology trade ratio rose at a slightly higher rate than that of the all-industries average and is now generally at the same level with, for the most part, an even balance between exports and imports.

**Figure 8-2-4 Trends in Technology Exports by Major Industries**



Source: Management and Coordination Agency, *Report on the Survey of Research & Development*  
See Table 8-2-4

**Figure 8-2-5 Trends in Technology Imports by Major Industries**



Source: Management and Coordination Agency, *Report on the Survey of Research & Development*  
See Table 8-2-5

After exceeding the ten billion yen mark in FY1975, technology exports by the iron and steel manufacturing industry remained at a high level, especially in the early 1980s, but after peaking in FY1983 exports fell and are now back at the ten billion yen level. Technology imports, on the other hand, have remained at 5-8 billion yen for the past 20 years, with the exception of extremely high levels of imports in FY1976, 1981 and 1983. Consequently, since FY1974 the iron and steel manufacturing industry has maintained its technology trade ratio above 1.0, and therefore, along with the industrial chemicals and chemical fibers industry, can boast of a technology trade surplus.

The communication and electronics equipment industry is one industry group which has a high level of both technology exports and technology imports. The industry's technology trade ratio is consistently lower than the overall average of the manufacturing industries, with imports about 1.7 times as high as exports. Up to FY1985 the trade ratio rose steadily to reach almost 0.7, but from FY1986 it began showing a falling trend, though in FY1993 it again rose slightly.

The motor vehicles industry moved to a technology trade surplus in FY1980, and for the past two or three years the industry has achieved a massive trade surplus, with technology exports at least ten times as high as technology imports. Looked at on a logarithmic scale, the technology trade ratio for the motor vehicles industry has risen virtually rectilinearly over the 20 years, and as stated earlier, while most of the other industries are generally hovering around the 1.0 mark, the motor vehicles industry is the only one to display a steady continuing rise after it crossed the 1.0 level. However, from FY1989 the rate of increase of technology exports slowed down, and in FY1992 the trade ratio actually fell, but in FY1993 the ratio rebounded, registering its highest value on record, mainly due to a marked drop in technology imports.

Another industry whose technology trade ratio is rising rectilinearly when plotted on a logarithmic scale is the construction industry. Since FY1975 the industry has constantly maintained a technology trade surplus, however the rise in the technology trade ratio is due not to an increase in technology exports, but to a decrease in technology imports.

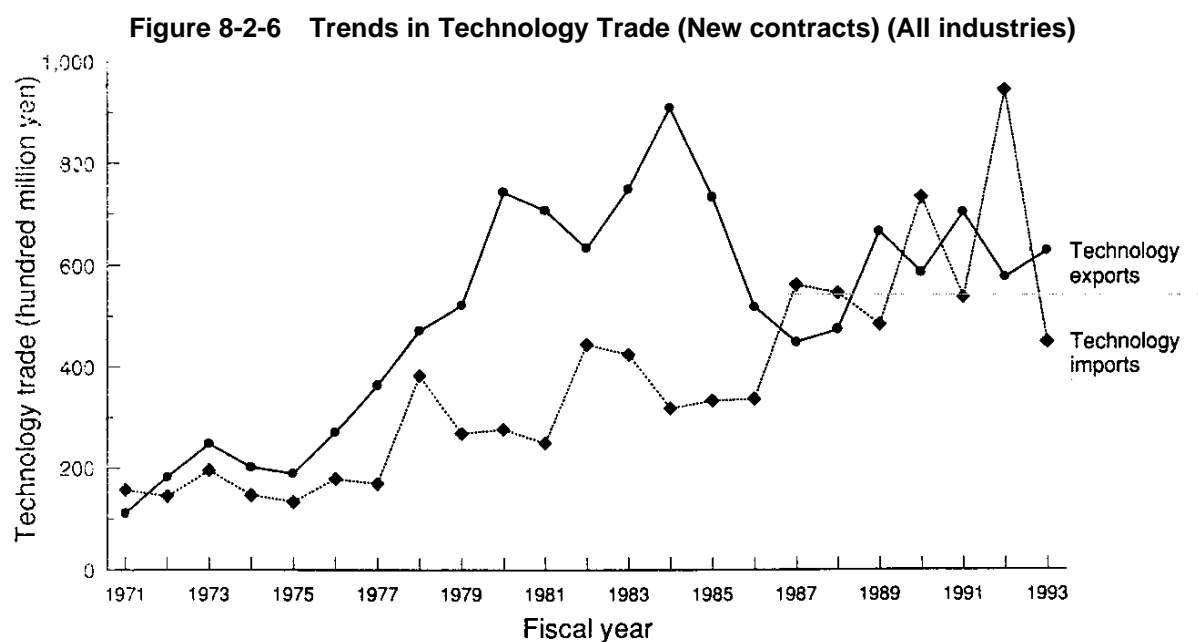
### (3) New contracts

The technology trade amounts and trade ratio mentioned to date have combined new contracts and continuing contracts, but here the paper will examine new contracts, which will give a clearer view of technology trade trends.

Technology trade is decided upon through contracts, so future trends in the overall technology trade ratio are greatly dependent on the terms of new contracts. Therefore, overall technology trade can be forecast to a certain extent from the trends in new contracts.

Figure 8-2-6 shows trends in overall technology imports and exports for new contracts (yen base). Technology exports plunged over two or three years from FY1985 due mainly to the effects of the strong yen following the Plaza Agreement, but from FY1988 exports steadily recovered. On the other hand, although fluctuating considerably, overall technology imports show a rising trend.

Japan's new contract trade balance went into surplus in FY1972 and remained there for the next 14 years, rising to exceptional levels from the end of the 1970s until mid 1980s. Exports from new contracts, however, dropped markedly over the three years from FY1985, and fell into deficit in FY1987. Since 1988 the trade ratio has fluctuated constantly, and exports and imports have reversed positions on a yearly basis. In FY1993 new contract imports dropped by 53% from the previous year, and this pushed up the trade ratio to 1.4.



Source: Management and Coordination Agency, *Report on the Survey of Research & Development*  
See Table 8-2-6

On the other hand, the overall technology trade ratio rose sharply from the 1970s through to the first half of the 1980s, but in recent years it has generally leveled off (Figure 8-2-3). The rise until the early 1980s can be put down to a greater increase of technology exports compared to technology imports, while the leveling off over the past few years is as a result of a greater increase in technology imports. From this it can be seen that trends in new contracts technology trade exert an influence on overall technology trade after a slight time lag.

### 8.2.2 Technology trade by region

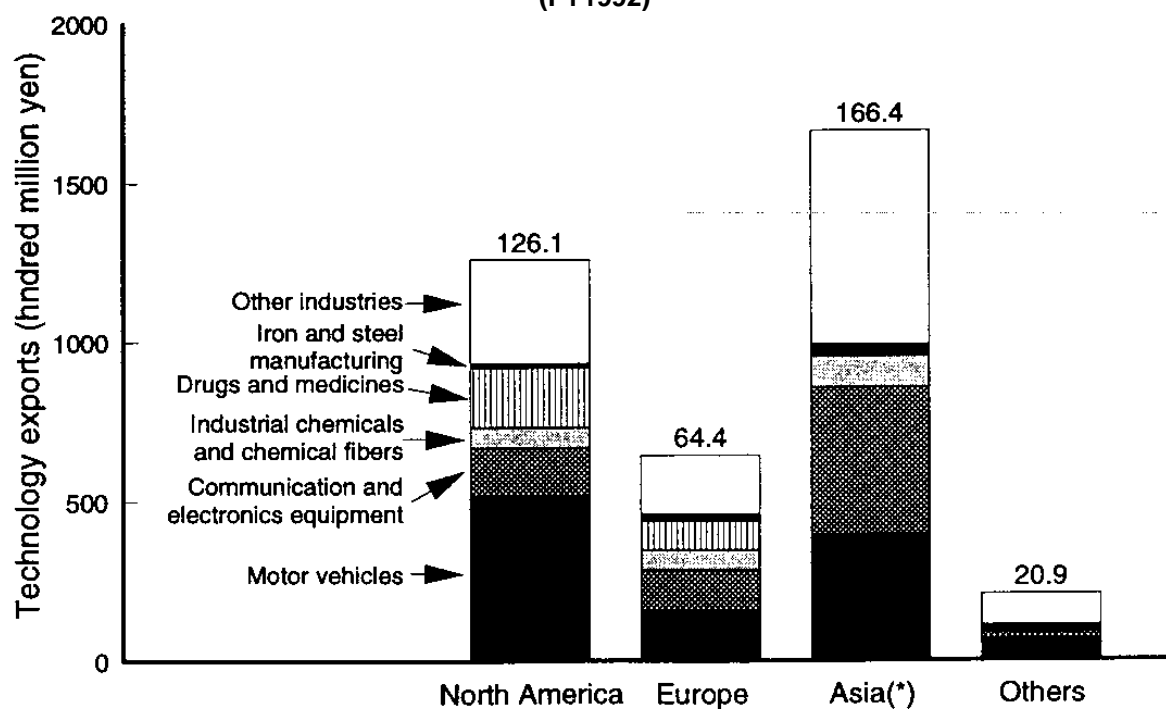
Technology trade is the flow of technology between countries, and technology trade statistics classified by region are able to clarify the flow of technology between Japan and other countries, and can also reveal the actual state of Japan's industrial technology; so from such a perspective, this section examines technology trade statistics classified by region and by industry.

Data contained in the *Cases and Value of Technology Flow by Region and by Industry* in the *Report on the Survey of Research & Development* by the Statistics Bureau of the Management and Coordination Agency are not classified into new contracts and continuing contracts, so the figures used in this section are the combined totals of new and continuing contracts.

#### (1) Technology exports

Figure 8-2-7 shows a regional breakdown of technology exports by the five major industrial groups in FY1992. Technology exports by all industries in FY1992 totaled 377.7 billion yen, of which 166.4 billion yen, or 44.1%, went to Asia (excluding West Asia; the same for the rest of this section), 126.1 billion yen (33.5%) went to North America, and 64.4 billion yen (17.1%) went to Europe.

**Figure 8-2-7 Breakdown of Japan's Technology Exports by Region and Major Industry (FY1992)**

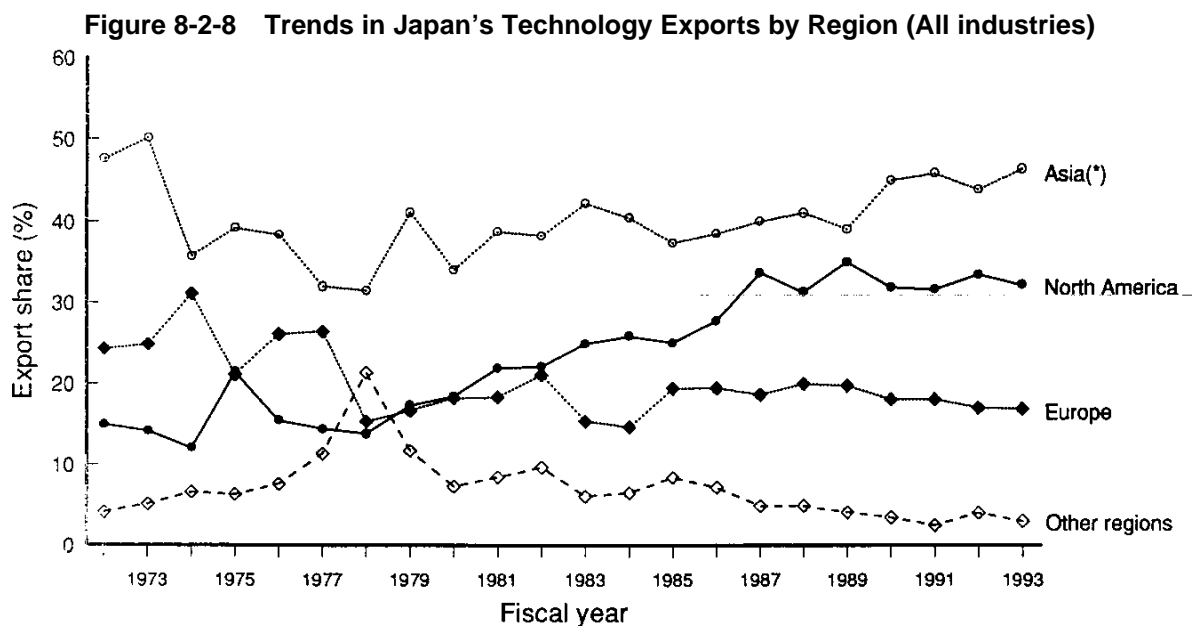


Note: "Asia" does not include West Asia.

Source: Management and Coordination Agency, *Report on the Survey of Research & Development*  
See Table 8-2-7

Most of technology exports went to countries in Southeast Asia, North America, and developed countries in Europe, though the value of exports that went to Asia is almost equal to the value of exports to North America and Europe combined. Among the major industries, the motor vehicles industry exports mainly to North America, and the communication and electronics equipment industry export mainly to Asia. Industries whose major share of exports do not head to Asia are the iron and steel manufacturing industry, transportation equipment manufacturing industry (including motor vehicles industry), and precision instruments manufacturing industry. Industries whose export share to Asia exceeds 50% are the mining industry, construction industry, industrial chemicals and chemical fibers industry, rubber products manufacturing industry, ceramics industry, non-ferrous metals and products manufacturing industry, fabricated metal products manufacturing industry, and electrical machinery manufacturing industry.

Figure 8-2-8 shows trends in the regional share of Japan's technology exports. Over the past 20 years Asia has consistently maintained the top position with an approximately 40% share ( $\pm 10\%$ ). Exports to North America have maintained second position since FY1981, and third place is held by Europe. North America's share has for the most part shown a yearly increase, and Europe's share has remained fairly constant, or has dropped slightly. The share of technology exports to developing countries outside of Asia (West Asia, Central & South America, etc.) is gradually decreasing, and in recent years has fallen below 5%.



Note: "Asia" does not include West Asia.

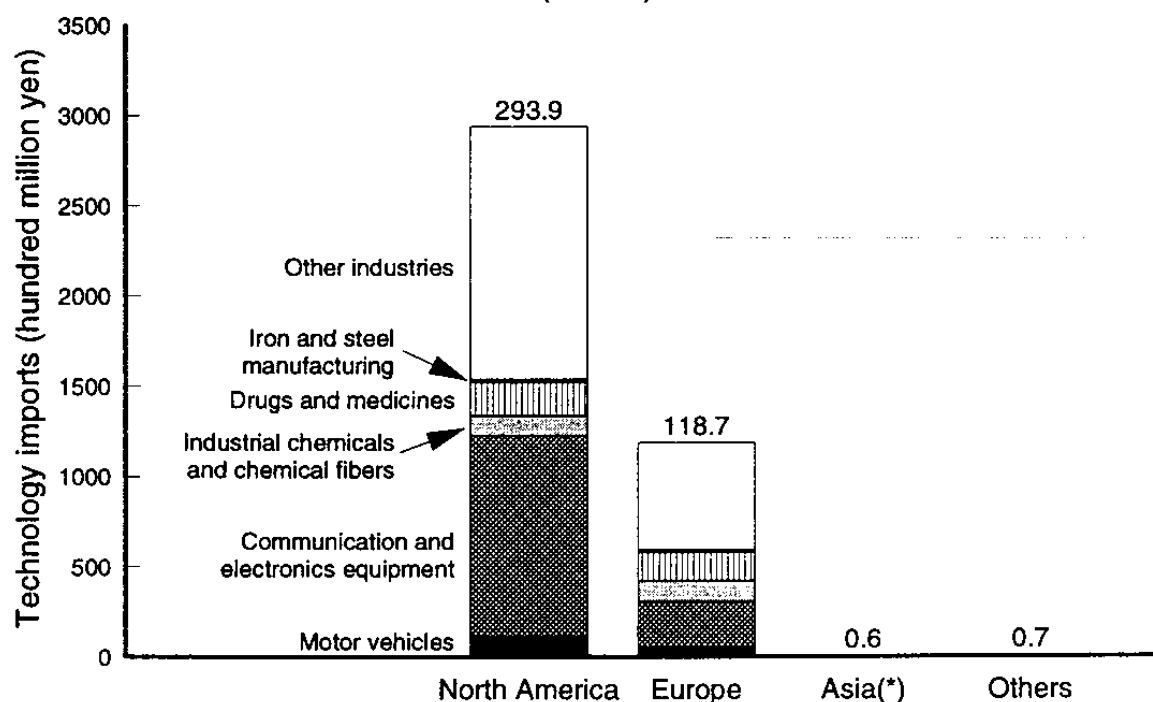
Source: Management and Coordination Agency, *Report on the Survey of Research & Development*  
See Table 8-2-8

## (2) Technology imports

### 1) Technology imports for FY1992

Figure 8-2-9 shows a regional breakdown of technology exports by Japanese industries in FY1992. Technology imports by all industries totaled 413.9 billion yen, of which 293.9 billion yen, or 71.0%, came from North America, and 118.7 billion yen (28.7%) came from Europe. Thus, 99.7% of Japan's total technology imports came from developed countries. North America supplies an overwhelming majority of Japan's technology imports, indicating that this region continues to provide the lead to Japanese technology.

**Figure 8-2-9 Breakdown of Japan's Technology Imports by Region and Major Industry (FY1992)**



Source: Management and Coordination Agency, *Report on the Survey of Research & Development*  
See Table 8-2-9

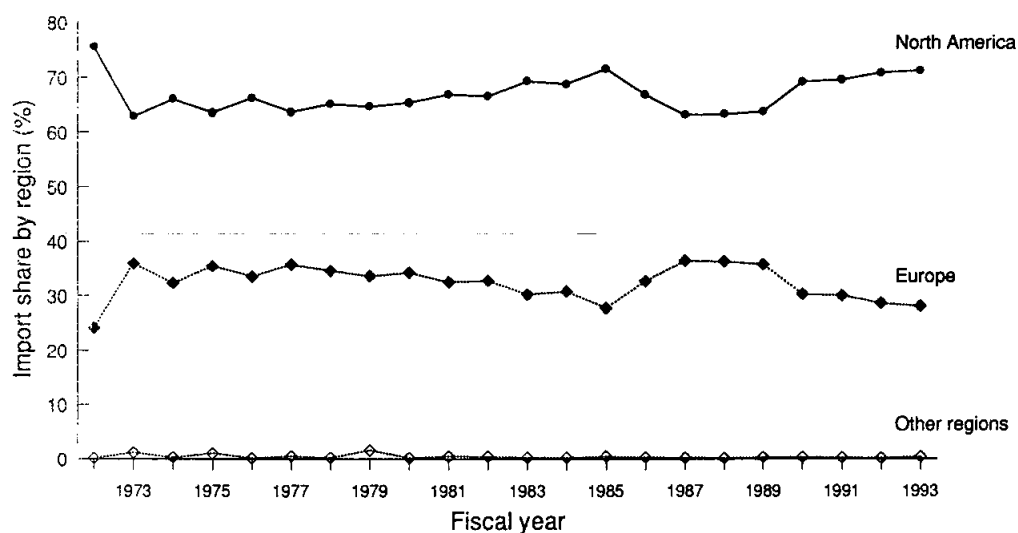
### 2) Trends in technology imports and regional share

Figure 8-2-10 shows trends in the regional share of Japan's technology imports. To date, the regions from which Japanese industry imports technology have been virtually limited to North America and Europe, and since FY1973, the share of these two regions has remained almost constant at, respectively, 60–70% and 30–40%, while imports from other regions have remained under 1%, except for odd periods during the twenty years. Thus the flow of technology into Japan has come primarily from developed countries in North America and Europe, whereas the flow from Asia is limited to an almost imperceptible trickle, although with the remarkable development in manufacturing industries in the Asian countries in recent years, technology imports from Asia are expected to increase in the near future.



As stated earlier, Japan's technology exports are mostly limited to North America, Europe and Asia, and its technology imports are limited to North America and Europe. Since FY1985 Japan's technology trade by all industries has been fairly well balanced, but from the above figures it can be seen that this balance is dependent on strong growth in technology exports to mainly the developing countries in Asia. That is, the figures reveal structural differences in Japan's technology trade according to the trading region; although the trade ratio with respect to North America and Europe is on an upward trend, Japan is still running a trade deficit, but on the other hand, Japan enjoys a massive technology trade surplus with the developing countries.

**Figure 8-2-10 Trends in Japan's Technology Imports by Region (All industries)**



Source: Management and Coordination Agency, *Report on the Survey of Research & Development*  
See Table 8-2-10

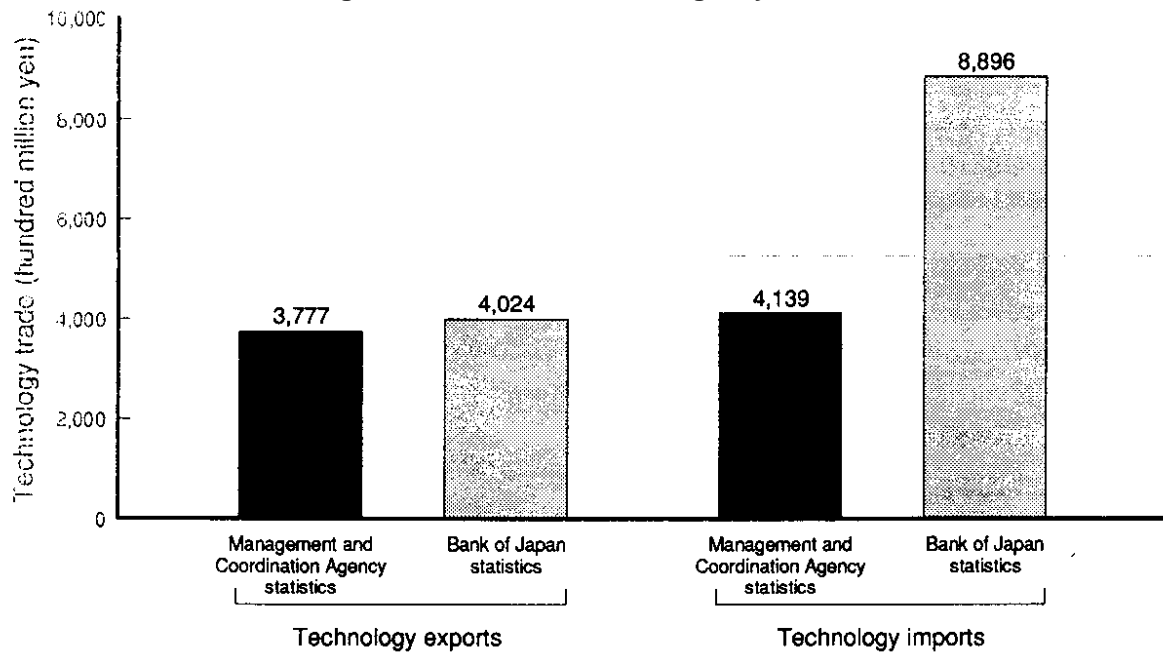
### 8.2.3 Assessment of Japan's technology trade

In Japan the most reliable statistics on technology trade are those from the Bank of Japan and the Management and Coordination Agency, however, there are major differences between the two in their import and export data (Figure 8-2-11).

Consequently, there is a significant difference in the technology trade ratios obtained from these two sets of statistics. For example, according to the Management and Coordination Agency, in FY1992 Japan's technology trade was almost balanced with a trade ratio of 0.91, whereas the Bank of Japan put the trade ratio at only 0.45, indicating a massive trade deficit. The reason for this gulf in the figures is that the Bank of Japan statistics are aimed primarily at foreign exchange management, whereas the Management and Coordination Agency statistics are prepared with an eye to ascertaining the actual state of Japan's research and development activities, so there are differences in survey methods and scope.

To determine the state of Japan's technology trade, there is a need to define the scope of the statistics as follows. First, the statistics must cover all industries, and not just the manufacturing industries; second, technical guidance carried out at the same time as plant export should be included as a part of technology exports; and third, rights which are clearly or primarily non-technical, such as trademarks, should not be included, even if they are industrial rights.

**Figure 8-2-11 Japan's Technology Trade (FY1992): Comparison of Bank of Japan and Management and Coordination Agency Statistics**



Source: Management and Coordination Agency, *Report on the Survey of Research & Development*  
 Bank of Japan, *International Balance of Payments Statistics*

See Table 8-2-11

Therefore, when the Bank of Japan and Management and Coordination Agency statistics are viewed with these points in mind, the following three factors necessitate certain adjustments to the statistics.

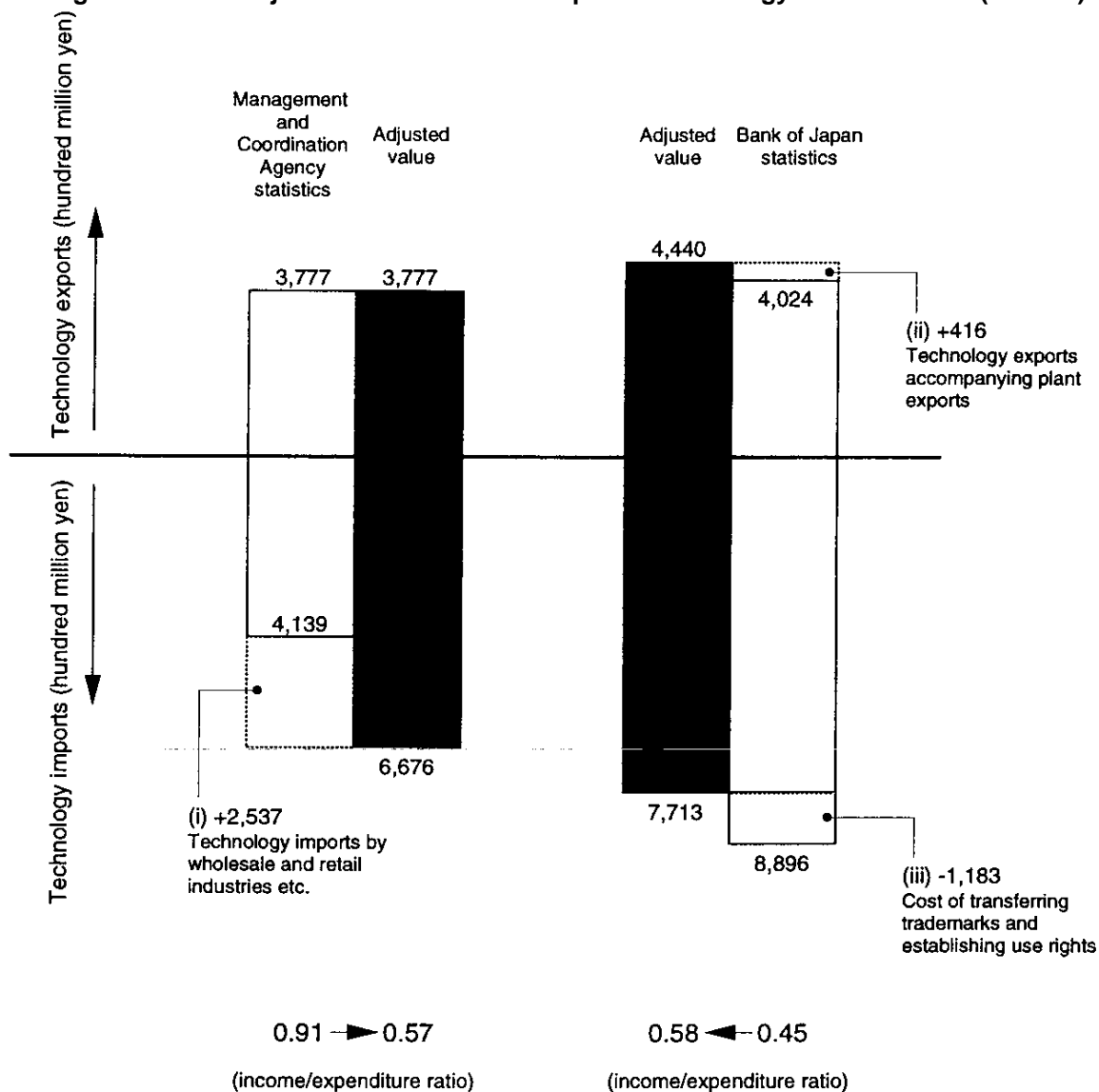
- (i) Management and Coordination Agency statistics exclude the wholesale and retail industries, food and beverage manufacturing industry, finance and insurance industries, real estate industry and the service industry.
- (ii) Bank of Japan statistics exclude payments for know-how and industry-related technical guidance accompanying plant exports.
- (iii) Bank of Japan statistics include payments for establishing transfer and use rights for trademarks.

Adjustments for the above factors were calculated into both sets of statistics for the FY1992 technology trade ratio, and the adjusted results are shown in Figure 8-2-12. Calculations of the adjusted technology trade figures for FY1992 indicate a trade ratio of about 0.6.

With FY1991 data as a yardstick, technology trade ratios were calculated back to FY1975 using this method. Figure 8-2-13 shows the technology trade ratio trends based on Bank of Japan statistics, Management and Coordination Agency statistics and these calculations.

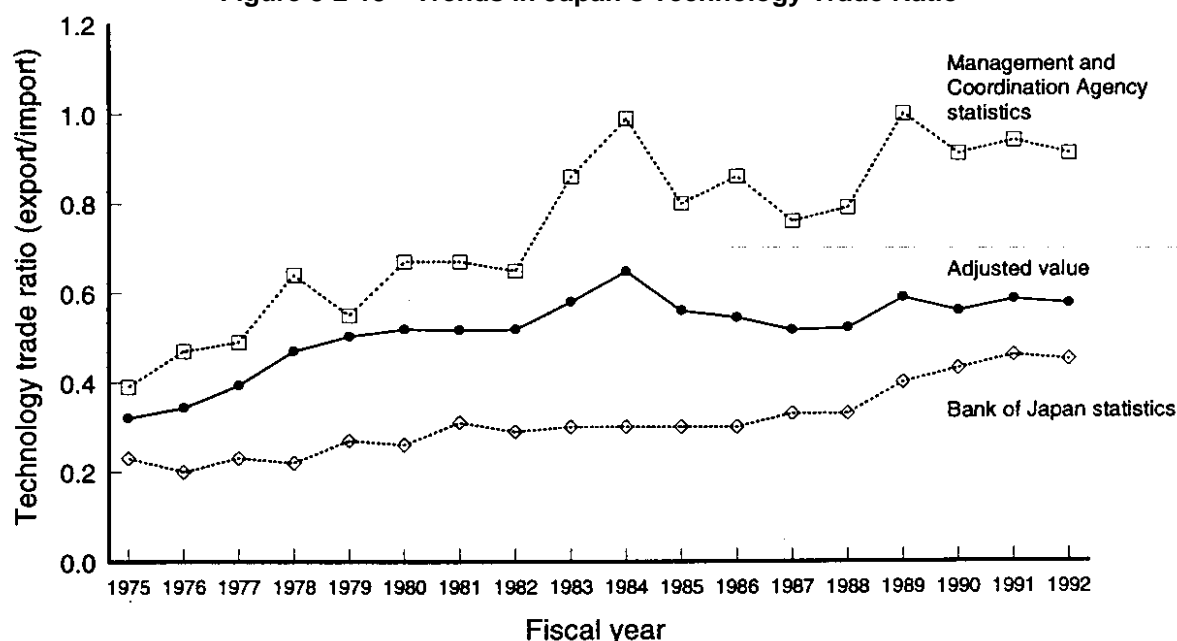
The adjusted trade ratio value in Figure 8-2-13 lies between the values based on the two sets of statistics throughout the period indicated, and consistently shows a trade deficit. If anything, though, the trade ratio is on an upward trend towards 1.0.

Figure 8-2-12 Adjusted Calculations of Japan's Technology Trade Balance (FY1992)



Source: Management and Coordination Agency, *Report on the Survey of Research & Development*  
 Bank of Japan, *International Balance of Payments Statistics*  
 See Table 8-2-12

Figure 8-2-13 Trends in Japan's Technology Trade Ratio



Source: Management and Coordination Agency, *Report on the Survey of Research & Development*  
 Bank of Japan, *International Balance of Payments Statistics*  
 See Table 8-2-13

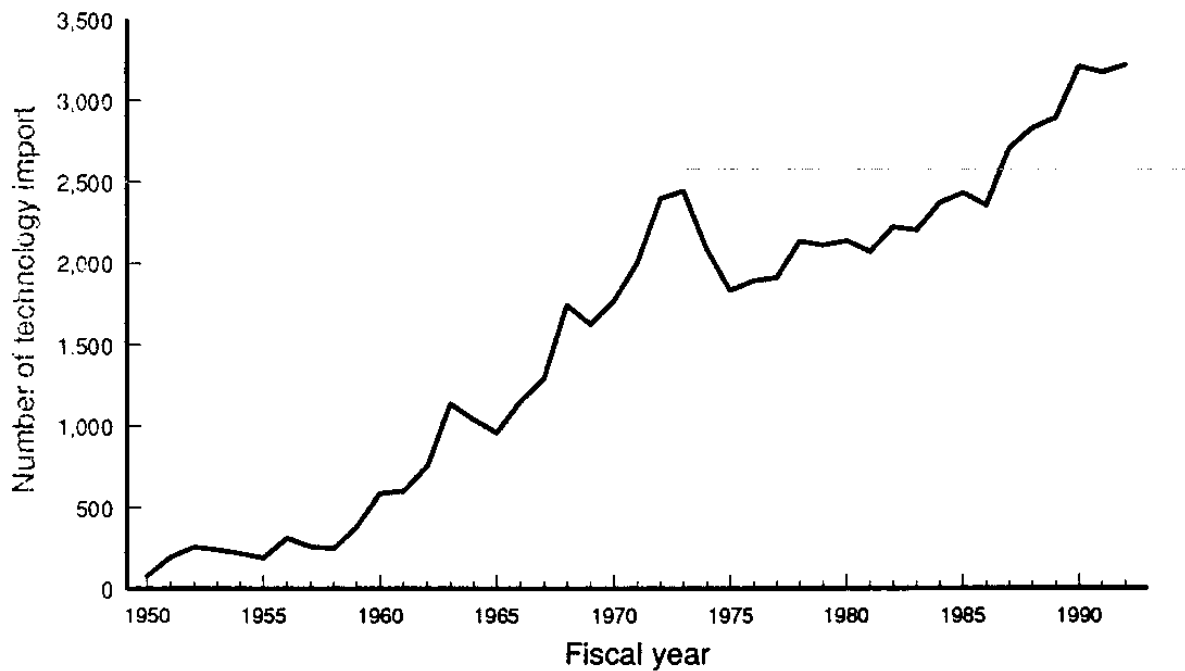
#### 8.2.4 Number of technology import contracts by field

*Analysis of Trends in Technology Imports* by the National Institute of Science and Technology Policy is one set of statistics covering Japan's technology trade, and although these statistics are limited to technology imports, they do contain data on each technological field, which are not included in the Bank of Japan and Management and Coordination Agency statistics, and can therefore clarify the fields in which technology imports play a key role.

##### (1) General trends

The trend in the total number of new technology import contracts gives a good overview of the general flow of foreign technology into Japan (Figure 8-2-14), and from this it can be seen that from the latter half of the 1950s until FY1973, overall the number of contracts increased at quite a high rate, despite the occasional fall. The number then dropped markedly, but from FY1976 it picked up and steadily increased until FY1987 when it again rose sharply. Since then the number has shown a steady upward trend. In FY1990 the number of imports rose by more than 10%, a similar rate to that two years earlier, then after a slight drop in FY1991, the number again rose in FY1992 to 1.2 times as high as the number five years earlier and 1.4 times as high as the number ten years earlier.

**Figure 8-2-14 Trends in the Number of New Foreign Technology Import Contracts**



Source: National Institute of Science and Technology Policy, *Outline of Foreign Technology Imports*  
See Table 8-2-14

## (2) Breakdown by technology field

In FY1992 there were 3,224 new technology import contracts, of which 2,132 contracts (66.1%) were in the electrical field, followed by 318 (9.9%) in the machinery field, 296 (9.2%) in the chemical field, 47 (1.5%) in the metals field, and 431 (13.4%) in other fields. Trends in the breakdown of imports by technological field in Figure 8-2-15 show that in the last five years the share of the electrical field has been growing at a considerable rate.

A further breakdown reveals that electrical equipment and supplies accounted for 2,132 contracts, general machinery and appliances for 239 contracts, chemical products for 216 contracts and apparel and textile products for 164 contracts.

An even more detailed breakdown shows that electronic devices accounted for the highest number at 1,794 contracts (of which 1,751 were for computers), followed by communication equipment with 159, electronic and communications equipment component parts with 135, drugs and medicines with 127, and outer garments with 117.

## (3) Software technology imports

The reason that the electrical field accounted for a high 66.1% of all technology import contracts in FY1992 was that there were 1,623 computer software import contracts, or 50.3% of all import contracts. Figure 8-2-16 shows that the number of computer software import contracts is growing steadily year after year, whereas the number of contracts for technology imports other than computer software is showing a gradual decline.

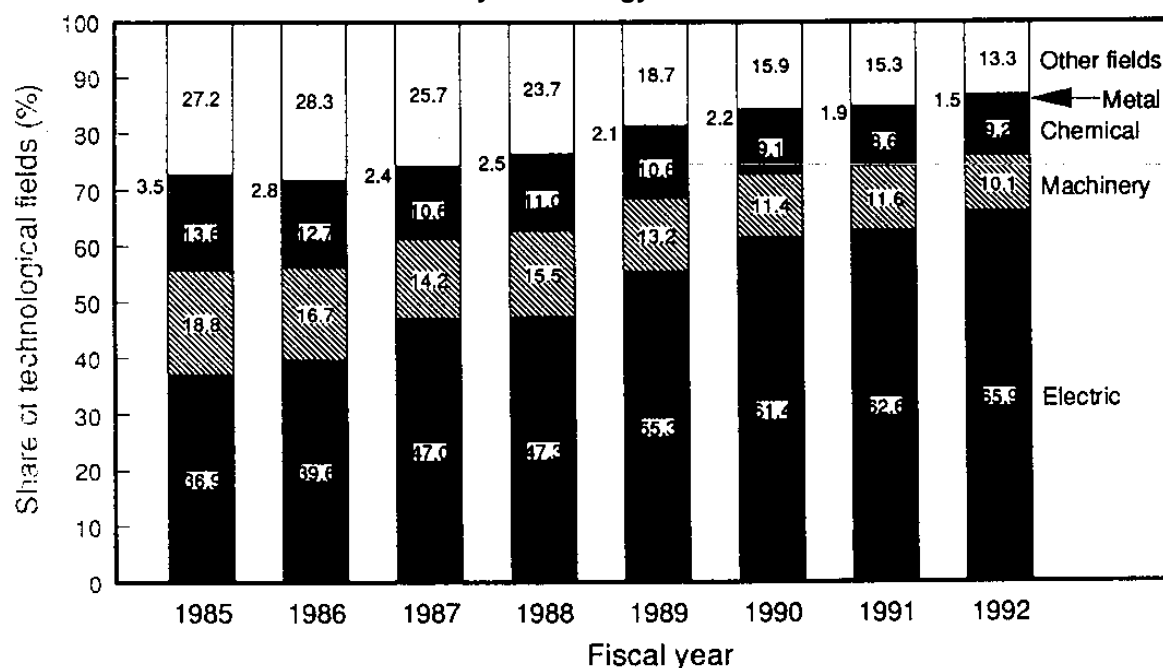
#### (4) Breakdown by field and by industry

This section further classifies the FY1992 number of technology import contracts, already broken down into technology fields, by industry to ascertain what industries are importing what kinds of technology. The major technology importer in the electrical field is the “textile, machinery and equipment, and building materials wholesale industry” (referred to here as the “textile etc. wholesale industry”) with 515 contracts, or 24.2% of all technology import contracts in the electrical field, followed by the “communication and electronics equipment industry”, and the “information services, research, and advertising industry”. The reason the “textile etc. wholesale industry” ranks first above the electrical-related industries is that it imports a large amount of software.

By far the largest software importing industries are tertiary industries such as the “textile etc. wholesale industry”, “information services, research, and advertising industry” and “goods rental and leasing industry”. Of the total number of software import contracts, industry categories outside the scope of Report on the Survey of Research and Development by the Management and Coordination Agency account for 62% (1,009 contracts), and this is one of the reasons for the differences in balance of technology trade between the Bank of Japan and the Management and Coordination Agency technology trade statistics mentioned in 8.2.3 above.

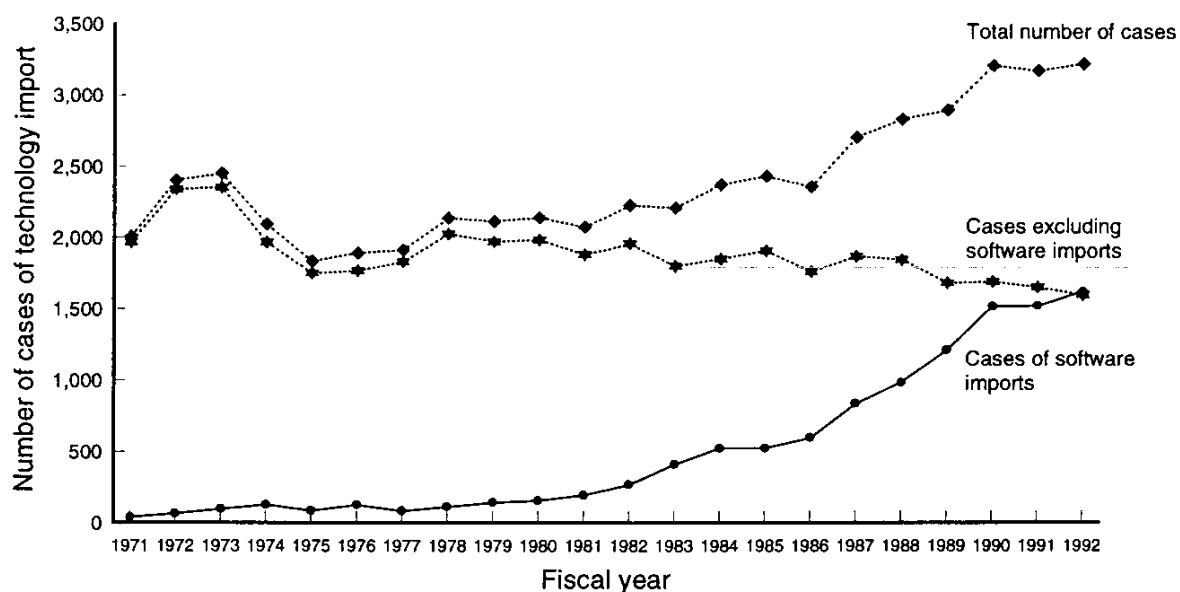
The three leading software importers in the machinery field are the “general machinery manufacturing industry”, “motor vehicles industry” and “other transportation equipment manufacturing industry”, while the leading importers in the chemical field are the “drugs and medicines industry” and “industrial chemicals and chemical fibers industry”. What does stand out in these statistics is that wholesale-related industries are ranked fourth and fifth. It is also interesting to note that tertiary industries such as the various wholesale industries were ranked highly in the other fields.

**Figure 8-2-15 Trends in the Share of Foreign Technology Import Contracts by Technology Field**



Source: National Institute of Science and Technology Policy, *Outline of Foreign Technology Imports*  
See Table 8-2-15

**Figure 8-2-16 Trends in the Number of Software Import Contracts**



Source: National Institute of Science and Technology Policy, *Outline of Foreign Technology Imports*  
See Table 8-2-16

#### (5) Breakdown by country

In FY1992 the United States accounted for the overwhelming majority of Japan's technology import contracts with 2,094 contracts (65.0%), followed by the U.K. with 220 (6.8%), France with 184 (5.7%), Germany with 157 (4.9%) and Canada with 98 (3.0%); these leading five countries accounted for 85.4% of the total number of Japan's foreign technology import contracts.

Of the 2,094 technology import contracts concluded with the United States, 1,587 contracts were in the electrical field (75.8%), and since this includes software, it is clear that technology in the electrical field, and especially software, is a key part of Japan's technology imports from the United States.

#### [Note]

The survey by National Institute of Science and Technology Policy was carried out based on reports submitted to the Bank of Japan under the Law Concerning the Management of Foreign Exchange and Foreign Trade at the time technology import contracts are concluded. Totals in the survey are the number of technology import contracts.

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# Chapter 9

## Regional Science and Technology Activities

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## **Chapter 9**

### **Regional Science and Technology Activities**

This chapter examines indicators concerning regional science and technology activities. Here the term region refers to regions within Japan, specifically prefectures, on which relevant data is readily available.

In analyzing science and technology activities, this chapter has reclassified the six original categories of the science and Technology Indicator System into three—“science and technology base”, “research and development activities”, and “fruits and contribution of science and technology”—and addresses each category in a logical sequence.

There are as yet many regional science and technology indicators which are not possible to draw up, so the usable data are quite limited. For this reason there have also been some quite indirect science and technology indicators included in an effort to bring out the actual state of regional science and technology activities. As well as regional indicators, several indicators that reflect concentration in Tokyo and dispersion to regional centers and even national level indicators that are related in some way to regional science and technology activities were also touched on.

#### **9.1 Science and Technology Base**

To gain an insight into the science and technology base in the various regions, this section looks at indicators related to human resources and S&T-related expenditure by the public sector.

For human resources, this section is not restricted to indicators which directly reflect the science and technology base, but also includes more indirect, general indicators such as population, education and labor force with a view to bringing out the relative standing of each region and ascertaining the relationship among regions in terms of human resources. That is, any bias in the data arising from size differences among regions can be eliminated by showing regional size differences through population data and the like, and also by factoring population etc. into the various data for regional indicators. Moreover, science and technology activities are rarely confined within a single region, so there is a need to understand the mutual relationship among regions, and an effective way of achieving this and also gaining a better understanding of regional indicators is to examine population movements, i.e. the interregional shift of human resources when advancing to university or entering the work force.

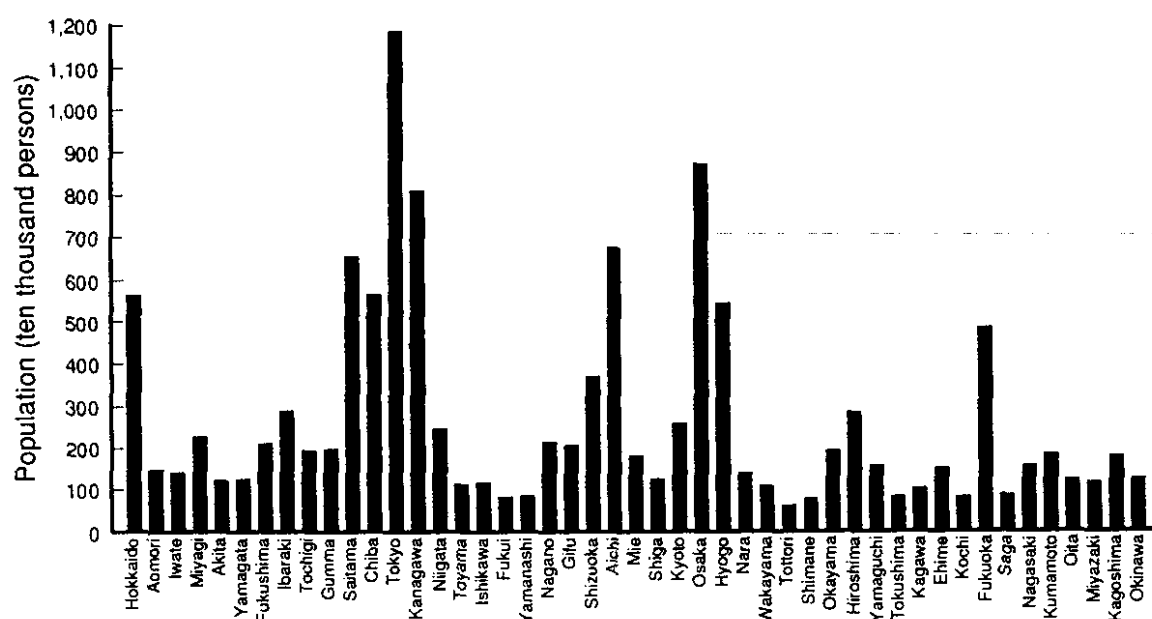
##### **9.1.1 Population**

###### **(1) Total population**

Figure 9-1-1 shows the population of prefectures as a base for ascertaining regional science and technology activities. The populations shown in the figure are the estimated populations as of 1 October 1992 according to figures released each year by the Management and Coordination Agency.

Tokyo had the largest population of the prefectures with 11.87 million, followed by Osaka (8.74 million), Kanagawa (8.1 million), Aichi (6.77 million) and Saitama (6.56 million). These are, in turn, followed by three prefectures with around five million persons, one prefecture each with four million and three million, eight prefectures with more than two million, 22 prefectures with more than one million, and seven prefectures with fewer than one million persons. The ranking of the top five prefectures has not changed since 1983 when Saitama overtook Hokkaido.

Figure 9-1-1 Prefectural Population (1992)



Source: Management and Coordination Agency, *Estimated Population as of 1 October 1992, 1993*  
See Table 9-1-1

The top five prefectures accounted for 33.8% of Japan's total population. This figure has increased gradually since 1983 when it was 33.1%, and in 1986 these five prefectures accounted for more than one-third of the total population for the first time with 33.4%. Tokyo alone accounted for 9.5% of Japan's population in 1992.

## (2) Population change

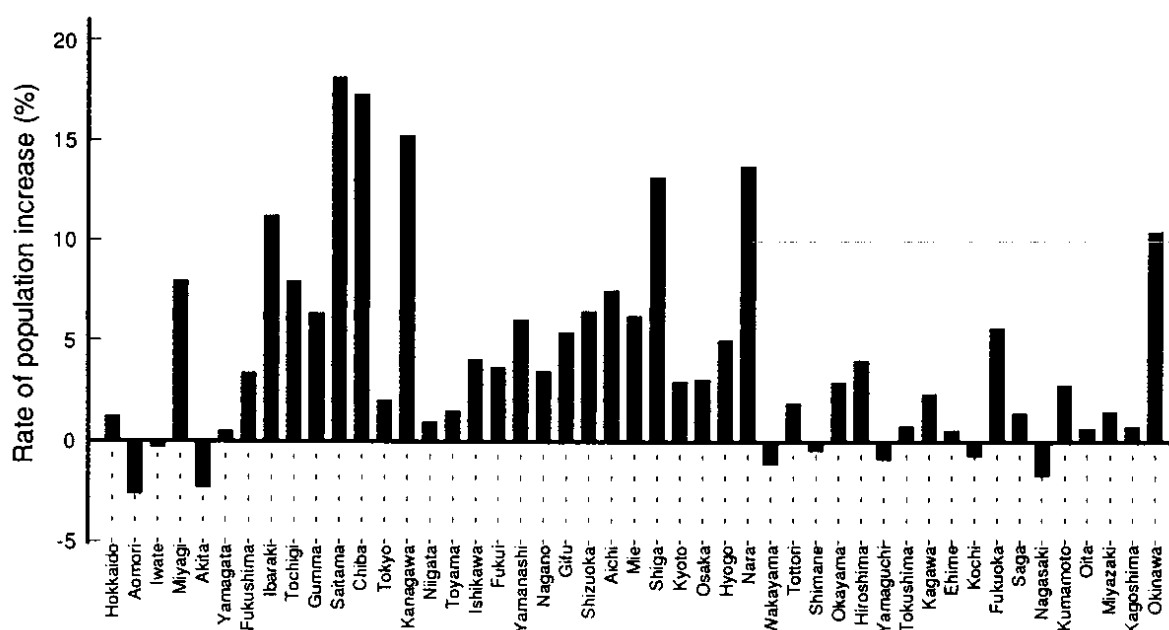
Figure 9-1-2 shows the rate of population change for each prefecture between 1980 and 1990. Saitama Prefecture experienced the highest growth rate over the ten years, followed by Chiba, Kanagawa, Nara, Shiga, Ibaraki and Okinawa, and it is interesting to note that six of the top seven prefectures are in the vicinity of Tokyo or Osaka.

The highest rate of population growth in 1992 over the preceding year was experienced by Saitama followed by Chiba, which is similar to the ten-year population growth trends, however while the ranking of the top two prefectures remained the same, the order of the next five prefectures changed slightly, with Shiga ranked third, followed by Nara, Ibaraki, Kanagawa and Okinawa.

## (3) Youth population

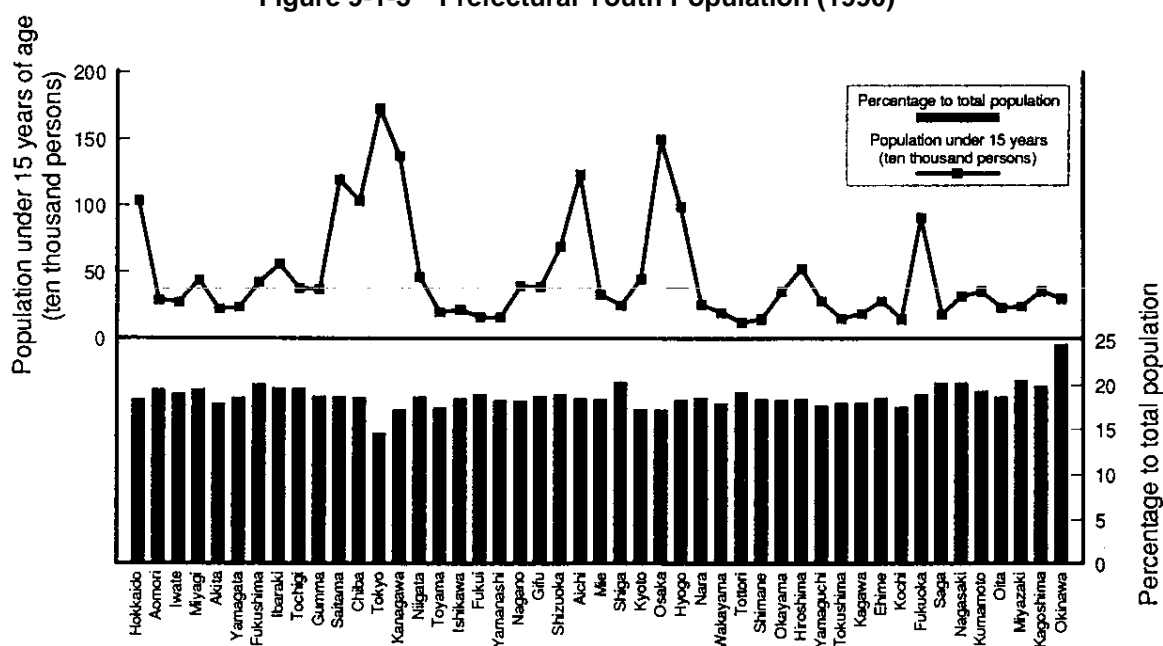
The youth population (population under 15 years of age) forms the basis for understanding the future population structure and the full potential of society. Figure 9-1-3 shows the youth population in each prefecture in 1990.

Figure 9-1-2 Prefectural Population Growth Rates (1980-90)



Source: Management and Coordination Agency, *Population Census of Japan, 1990*  
See Table 9-1-2

Figure 9-1-3 Prefectural Youth Population (1990)



Source: Management and Coordination Agency, *Population Census of Japan, 1990*  
See Table 9-1-3

As for prefectural distribution (upper part of the figure), similar to the general population, the youth population tends to be concentrated in a number of prefectures, however, the youth population concentration in Tokyo is, at 7.7% of the total youth population, lower than the corresponding level of concentration of the general population (9.6% of total population). The youth population in the top five prefectures is 31.3% of the total youth population, slightly lower than the 33.8% for the general population. In other words, compared to the general population, the youth population is less concentrated in the major urban centers.

Prefectures that have a high percentage of youth population to total population are Okinawa, Miyazaki, Shiga, Nagasaki, Saga and Fukushima with more than 20%, while at the other end of the scale, Tokyo has the smallest percentage with about 15%, while Kanagawa, Osaka, Kyoto, Toyama and Kochi are all around the 17% mark (lower part of the figure). The average of all prefectures is 18.2%.

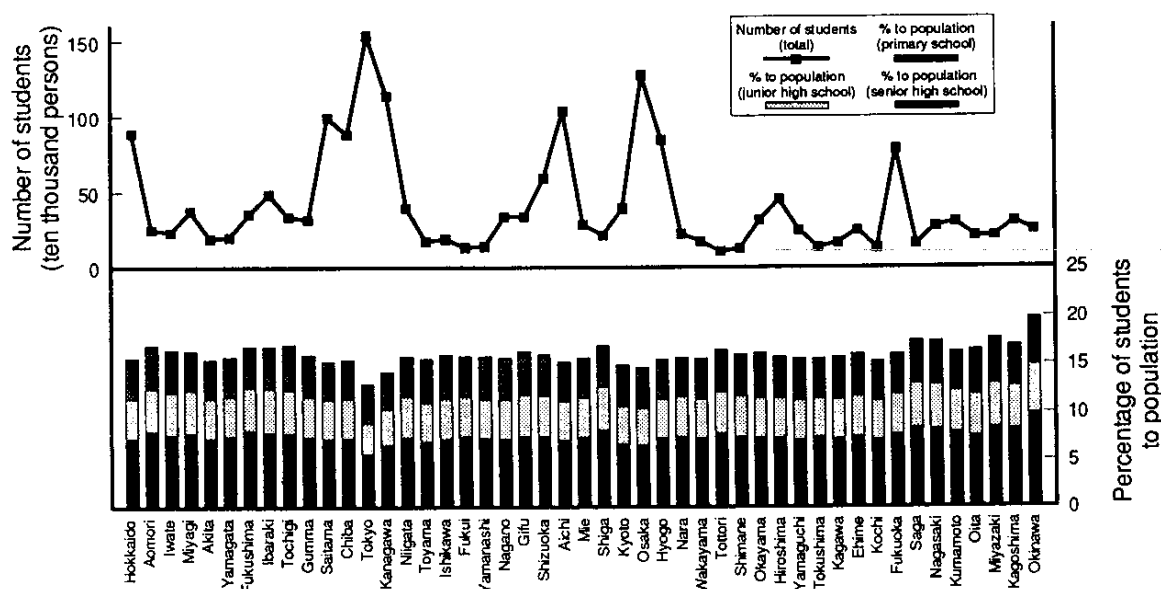
## 9.1.2 Education

### (1) Primary and secondary education

Figure 9-1-4 shows the number of primary, junior and senior high school students in each prefecture. Trends for the number of primary and junior high school students is virtually the same as for the youth population under 15 years of age mentioned earlier, however, senior high school student trends, especially when viewed as a percentage of the population, are somewhat different.

Another trend which is revealed is that the concentration of students into Tokyo and the other major urban centers increases with the student age group.

**Figure 9-1-4 Number of Primary, Junior and Senior High School Students by Prefecture (1992)**



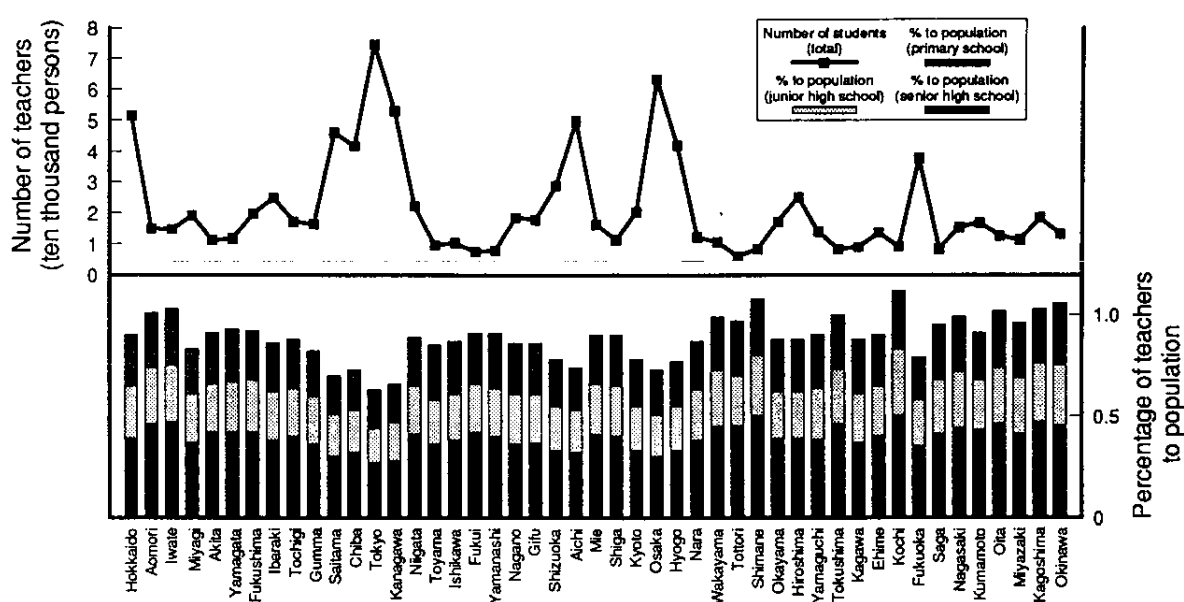
Source: Ministry of Education, *Fundamental School Research*

See Table 9-1-4

As for the number of students to the total population, as can be seen in the graph at the lower part of the figure, Okinawa, Miyazaki, Saga and Tochigi have the highest percentage of primary and junior high school students to the prefectural population, while Tokyo has the lowest percentage, however at the senior high school level, Kanagawa and Saitama have a slightly lower percentage than Tokyo.

Primary, junior and senior high school teacher numbers for the prefectures show a similar trend to student numbers, although there are differences between prefectures when the numbers are looked at as a percentage of the prefectural population (Figure 9-1-5). Prefectures with the highest percentage of teachers to population are Kochi, Shimane, Okinawa, Iwate, Kagoshima, Oita and Aomori, all over 1% and all with a relatively low population. On the other hand, those with the lowest percentage are Tokyo, Kanagawa, Saitama, Osaka, Chiba, Aichi and Hyogo, and all have a relatively high population.

**Figure 9-1-5 Number of Primary, Junior and Senior High School Teachers by Prefecture (1992)**



Source: Ministry of Education, *Fundamental School Research*  
See Table 9-1-5

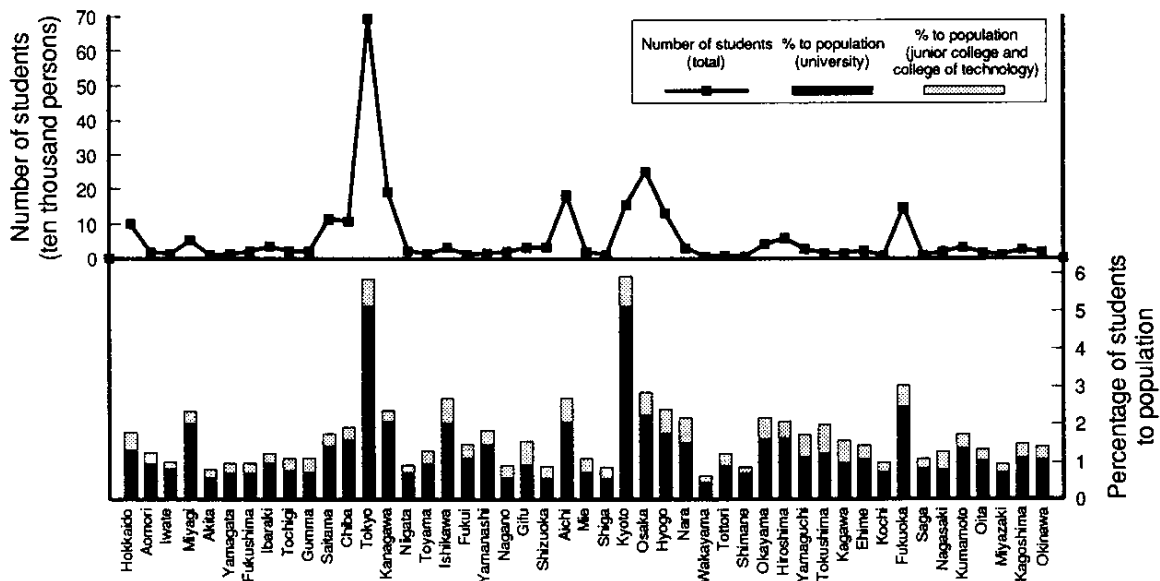
## (2) Tertiary education

Figure 9-1-6 shows the number of students at university etc. (university, junior college and college of technology) in each prefecture. The graph of student numbers at the top of the figure shows a number of peaks for specific prefectures, such as Tokyo. Prefectures with high student numbers are, in order, Tokyo, Osaka, Kanagawa, Aichi and Kyoto, a ranking slightly different from the ranking of primary and secondary student numbers in that Kyoto has replaced Saitama in the top five. The concentration of university etc. students in these prefectures is higher than the concentration of the general population, reflecting the fact that tertiary education facilities are concentrated in Tokyo and the other major urban centers.

As for the percentage of university etc. students to prefectural population, Kyoto and Tokyo have by far the highest percentage with almost 6%, followed by Fukuoka, Osaka, Aichi, Ishikawa, Hyogo, Kanagawa, Miyagi and Okayama.

As for the different tertiary educational institutions, the highest percentage of students attend university, and while the percentage of university students to prefectural population varies markedly from prefecture to prefecture, the difference between prefectures in the corresponding percentage for the students of junior colleges and colleges of technology is relatively small.

**Figure 9-1-6 Number of University etc. Students by Prefecture (1992)**



Source: Ministry of Education, *Fundamental School Research*  
See Table 9-1-6

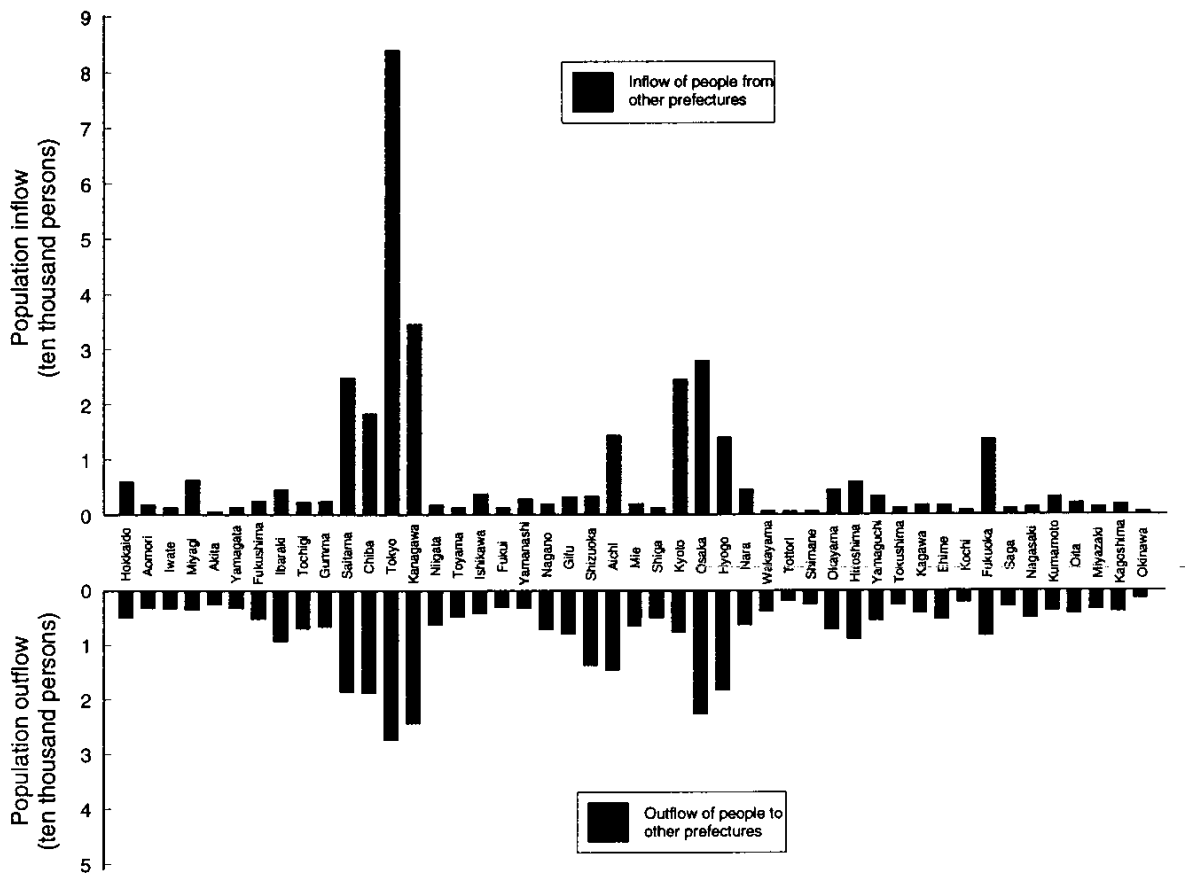
The indicators described thus far show that there are significant differences between primary and secondary education on the one hand and tertiary education on the other in the regional distribution of students. That is, tertiary educational facilities are more heavily concentrated in Tokyo and the other major urban centers than the primary and secondary educational facilities, signifying that there is considerable inter-prefectural movement as students advance from secondary to tertiary education.

The number of students who entered a university in a different prefecture from where they attended senior high school were then examined to determine the extent of this inter-prefectural movement. Among these students are those who commute every day from their home prefecture to their university in an adjacent prefecture, so while in the strict sense, it is not entirely correct to refer to these students as “migratory students”, we have grouped all of these students under this term for convenience sake. In 1992 64% (345,191) of all new university students (541,604) were migratory students, and such a high percentage shows that, unlike primary and secondary education, tertiary education is not closed in at the prefectural level.



Figure 9-1-7 shows a breakdown of migratory students in their first year at university. The upper part of the figure shows the inflow of students from other prefectures, and the lower part shows the outflow to other prefectures for each prefecture. By far the largest student inflow was in Tokyo with 84,201, or 24% of the total number of migratory students (345,191). Elsewhere, the distribution of student inflow numbers was generally proportionate to the number of university students. And although not shown in the figure, the ratio of student inflow to student outflow (inflow number / outflow number) is especially high in Tokyo and Kyoto with, respectively, 3.3 and 3.1, followed by Miyazaki (1.9) then Fukuoka, Kanagawa, Saitama, Hokkaido, Osaka and Aichi. These nine were the only prefectures with an inflow/outflow ratio greater than one.

**Figure 9-1-7 Student Movement among Prefectures When Advancing to University (1992)**



Source: Ministry of Education, *Fundamental School Research*  
See Table 9-1-7

### 9.1.3 Labor force

The labor force is quantified as a statistic in the form of participation of the population in economic activities, and the regional breakdown of the labor force reflects a region's relative standing and the mutual relationship among regions. In the broad sense, there are various data containing labor force statistics, including the *Labor Force Survey* and *Basic Survey on Employment Structure* by the Management and Coordination Agency and *Survey on Employment Trends* by the Ministry of Labor. The following table listed the major items of information contained in these surveys.

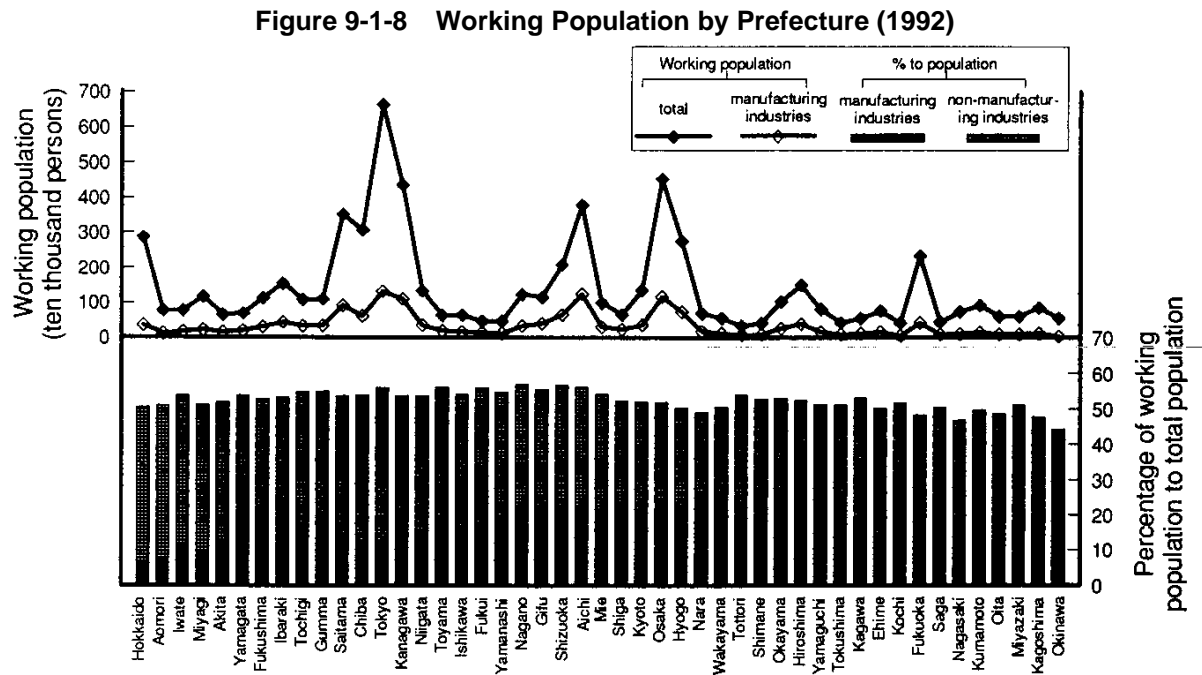
Statistical data	Definition (summary)	Statistics
• Labor force population	Population 15 years of age or older who are employed or unemployed	Management and Coordination Agency <i>Labor Force Survey</i>
• Working population	Population 15 years of age or older who normally have a job which is carried out with the aim of earning income	Management and Coordination Agency <i>Basic Survey on Employment Structure</i>
• No. of regular workers	No. of persons who are employed for an indeterminate period or for a period of not less than one month, or persons who are members of the family of a business proprietor and who work on a regular basis at the business establishment for a wage	Ministry of Labor <i>Survey on Employment Trends</i>
• No. of newly employed workers	No. of persons who are newly employed as regular workers after newly concluding an employment contract	Same as above

The above data contain a range of definitions and each has a different scope according to the statistics on which they are based, while some parts are duplicated among the data. Here, the paper will examine working population, number of regular workers, and number of newly employed workers.

#### (1) Working population

Figure 9-1-8 shows the working population by prefecture in 1992. The working population is defined as persons who have a job with the object of earning an income, and in 1992 they numbered 65.76 million, or 53% of Japan's total population. It should be noted that in the figure, the prefectural working population is the number of working persons who reside in the prefecture, not work in the prefecture. Prefectures with the largest working populations are, in order, Tokyo, Osaka, Kanagawa, Aichi and Saitama, and together, these top five prefectures account for 35% of the national working population (upper part of the figure). Tokyo alone accounts for 10% of the national working population. Top-ranking prefectures in the percentage of working population to total population are Nagano, Shizuoka, Aichi, Toyama and Fukui, followed by Tokyo (lower part of figure).

The figure also distinguishes the working population in the manufacturing industry, which is closely connected to science and technology. While Tokyo has the largest number of persons working in the manufacturing industry with 1.31 million, the figure is not significantly higher than that of the other top-ranking prefectures of Aichi (1.24 million), Osaka (1.17 million) and Kanagawa (1.09 million). The leading four prefectures in the percentage of working population to total prefectural population are Gifu, Shiga, Shizuoka and Gumma.



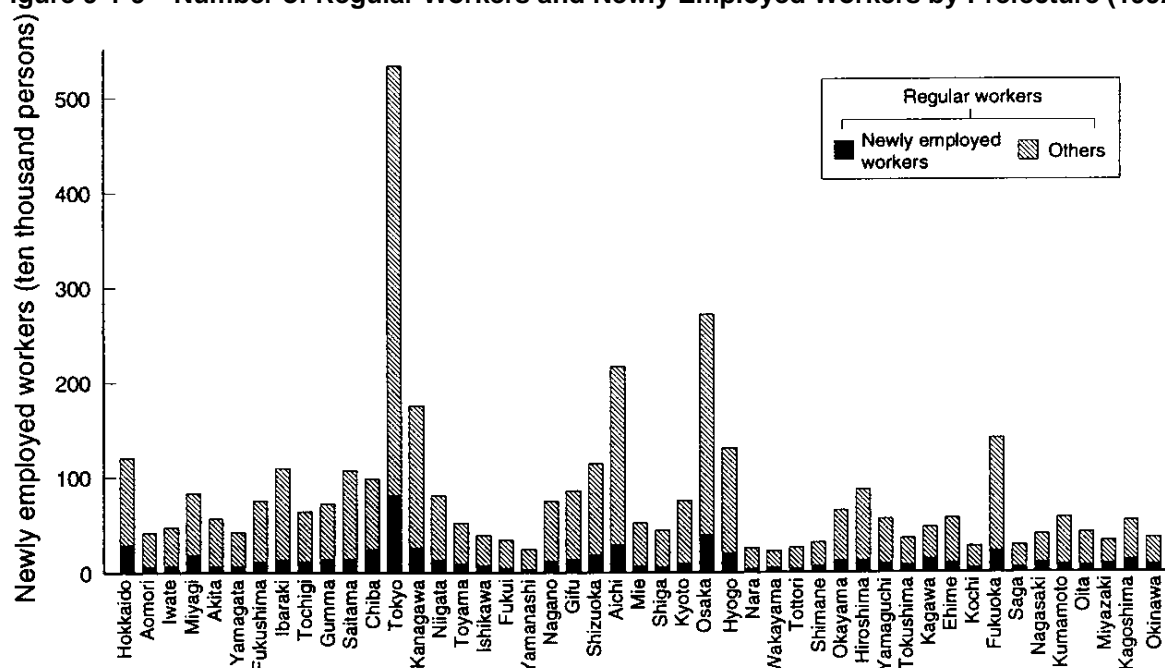
Source: Management and Coordination Agency, *Basic Survey on Employment Structure*  
See Table 9-1-8

## (2) Number of regular workers and newly employed workers

In 1992 there were 38.26 million regular workers in Japan, and 6.06 million newly employed workers, or 16% of regular workers. Figure 9-1-9 gives a breakdown of the number of regular workers and newly employed workers by prefecture. Tokyo has the highest number of regular workers (14% of the national total), followed by Osaka, Aichi, Kanagawa and Fukuoka, and together, these top five prefectures account for 35% of the national total of regular workers. Interestingly, Aichi Prefecture, which ranked fourth in population and working population, rose to third position here, and Saitama Prefecture, which was ranked fifth in population and working population, dropped to tenth. These differences are mainly due to the difference in whether “prefecture” refers to the workers’ place of residence or to their place of actual work.

The highest number of newly employed workers are in Tokyo (13% of the national total), followed by Osaka, Hokkaido, Aichi and Kanagawa, and together these five prefectures account for 33% of the total number of newly employed workers. It is also interesting to note that Hokkaido, ranked seventh in the number of regular workers, was ranked third in the number of newly employed workers.

**Figure 9-1-9 Number of Regular Workers and Newly Employed Workers by Prefecture (1992)**



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

See Table 9-1-9

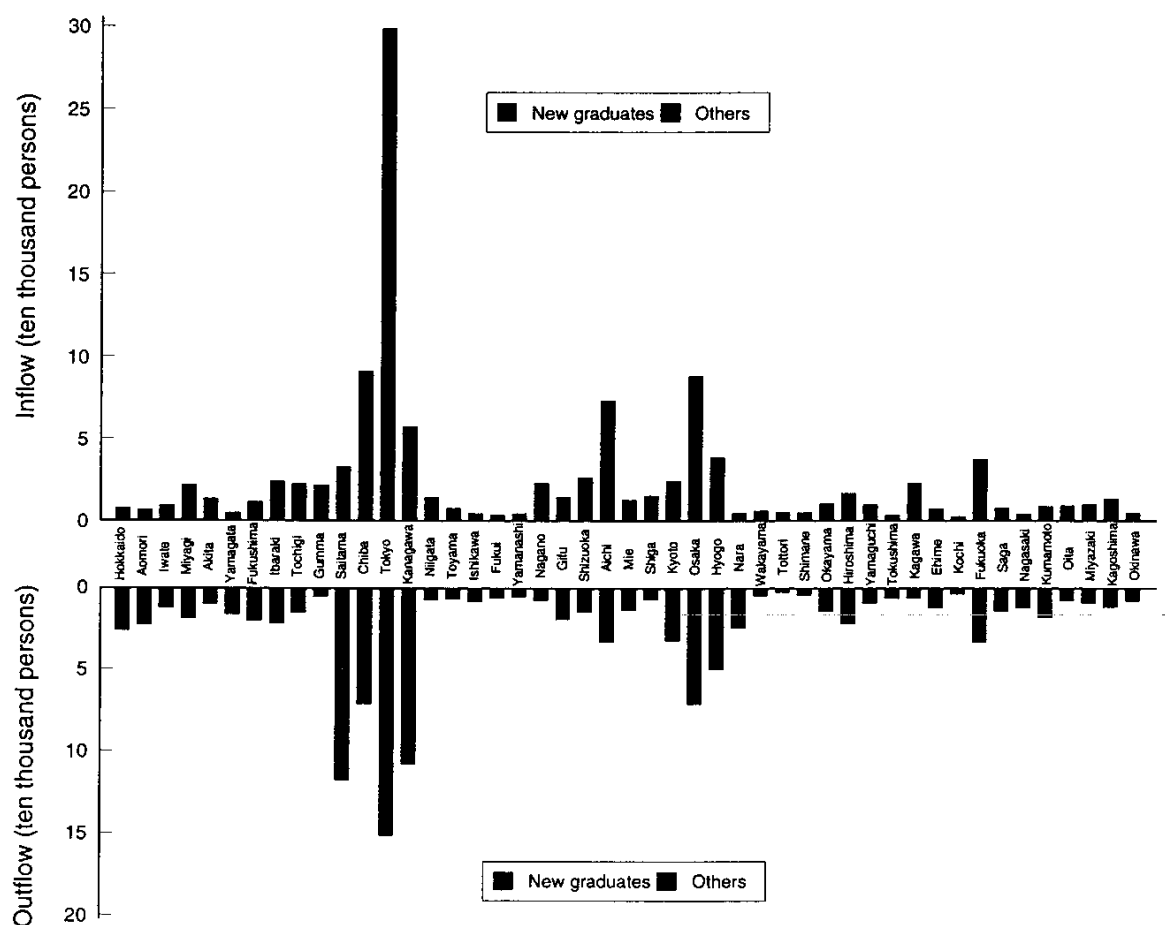
The number of newly employed workers who move to another prefecture when taking up the new employment is a useful basis for understanding the relative state of each prefecture. In 1992 this number was 1.11 million, or 18% of the total number of newly employed workers. In addition to those who moved to different prefectures, there were a total of 58,000 newly employed workers who moved from overseas or whose place of residence before taking up employment was not clear.

Figure 9-1-10 gives a prefectural breakdown of newly employed workers who moved to another prefecture to take up employment. The upper part of the figure shows the flow of newly employed workers into the prefecture, including those whose place of residence before taking up the employment was overseas or not known. As can be clearly seen when looked at with Figure 9-1-9, which shows the number of newly employed workers, the inflow is highly concentrated in a very small number of prefectures, including Tokyo. Conversely, some prefectures have a large number of newly employed workers from within the prefecture and only a very minor inflow from other prefectures. The top five prefectures for inflow are Tokyo (26% of the national total), Chiba, Osaka, Aichi and Kanagawa, and these five prefectures account for 52% of the national total.

The lower part of the figure shows the flow of newly employed workers out of the prefecture. The top five prefectures for outflow are Tokyo (14% of national total), Saitama, Kanagawa, Osaka and Chiba, and these five prefectures account for 46% of the national total. The inflow to outflow ratio (inflow/outflow) is highest in Gumma (4.1), Kagawa (3.7), and Nagano (3.1), followed by Shiga, Tottori, Aichi and Niigata with ratios higher than 2.0. There were 23 prefectures with a ratio of 1.0 or higher, including Tokyo (1.98) and Osaka.

Figure 9-1-10 also shows that of the workers who move to another prefecture when taking up employment, 330,000 were new graduates. Prefectural trends for the new graduates differ little from those for all workers who move prefectures, although the inflow to outflow ratio (inflow/outflow) does display a somewhat different trend. Gumma Prefecture has by far the highest ratio with 5.8, followed by Aichi (3.6), Tokyo (3.2), and Kagawa and Osaka, both of which are above 2.0. A total of 15 prefectures had a ratio higher than 1.0. Of the prefectures with a high ratio, Tokyo, Osaka and Aichi have a high ratio because of a large inflow from neighboring prefectures, while it is thought that the high ratio for the other prefectures is, in part, because of their reliance on human resources development in other prefectures.

**Figure 9-1-10 Movement among Prefectures by Newly Employed Workers**



Source: Ministry of Labor, *Report on the Survey on Employment Trends*  
See Table 9-1-10

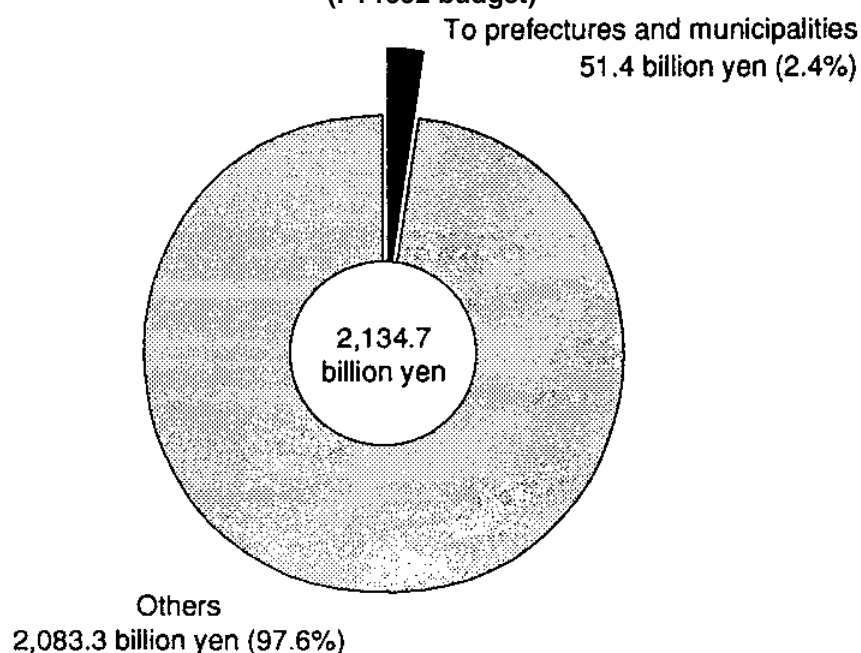
#### 9.1.4 Government S&T-related disbursements

This section looks at government S&T-related disbursements to prefectures and municipalities (referred to here as government S&T-related disbursements) as an indicator of the level of public backing for science and technology.

In FY1992 government spending on science and technology amounted to 2,134.7 billion yen, of which disbursement to prefectures and municipalities accounted for 51.4 billion yen, or an extremely small 2.4% (Figure 9-1-11). However, since the total government expenditure on science and technology is not strictly defined, this amount cannot be considered definitive either. Therefore, this section will examine the details of those disbursements.

Of the government S&T-related disbursements of 51.4 billion yen, an especially large amount was for “specified diseases treatment research expenditure” and “specified chronic infant diseases treatment research expenditure” (total of 19.4 billion; disbursed by the Ministry of Health and Welfare), which are subsidies for scientific experiment and research expenditure, and subsidies and grants connected with nuclear power generation safety and the siting of power stations (total of 16.9 billion yen; disbursed by the Science and Technology Agency). In addition, grants for promoting the siting of power stations are appropriated by the Ministry of International Trade and Industry (82.7 billion yen disbursed to prefectures and municipalities in FY1992), however since these grants have only a very tenuous link to the concept of supporting science and technology activities, they have not been included in government S&T-related disbursements.

**Figure 9-1-11 Government S&T-related Expenditure: Disbursements to local governments (FY1992 budget)**



Note: As stated in the text, the above amounts are not definitive.

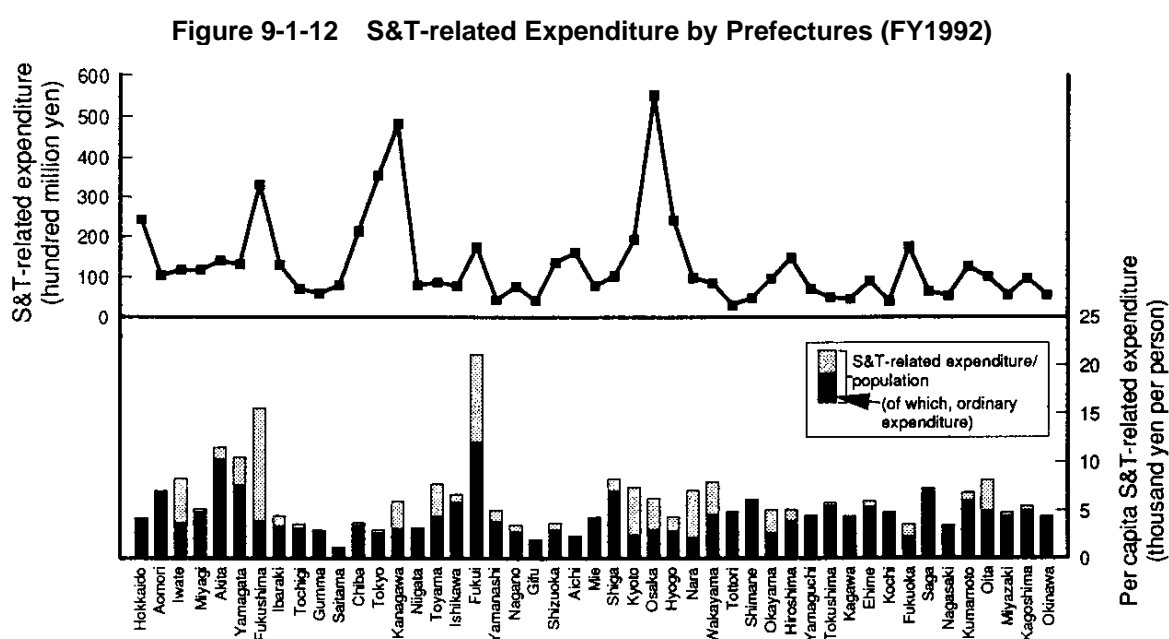
Source: Compiled by National Institute of Science and Technology Policy from Science and Technology Agency data.

See Table 9-1-11

### 9.1.5 Local government S&T-related expenditure

Figure 9-1-12 shows S&T-related expenditure by prefectures and designated cities in FY1992. Spending on science and technology by the 47 prefectures amounted to 575.1 billion yen, and by the 12 designated cities to 38.9 billion yen, for a total of 614 billion yen, equivalent to 29% of the government's science and technology budget (2,134.7 billion yen for FY1992). From this it is evident that local governments play a major part in public-sector support for science and technology.

A breakdown of the 614 billion yen into prefectures (including designated cities) reveals that the top prefectures in terms of S&T-related spending were Osaka, Kanagawa, Tokyo and Fukushima (upper part of Figure 9-1-12). Spending by the prefecture of Osaka totaled 55.3 billion yen, of which 16.3 billion yen was spent by the city of Osaka, a designated city. Kanagawa Prefecture spent 48.3 billion and of this, Yokohama, another designated city, spent 10.2 billion yen.



Note: Includes S&T-related expenditure by designated cities.

Source: National Institute of Science and Technology Policy, *Research on the Promotion of Regional Science and Technology* (NISTEP Report No.39), 1995

See Table 9-1-12

Fukui Prefecture had the highest per capita spending on science and technology with 21,000 yen (lower part of Figure 9-1-12), followed by Fukushima, Akita and Yamagata, all with per capita spending over 10,000 yen. As mentioned earlier, Fukushima also ranked highly (fourth) in S&T-related spending, however expenditure on tertiary institutions, mainly on costs involved in establishing universities, which is not a part of ordinary expenditure, accounted for 75% of this spending. This shows that it is necessary to distinguish between ordinary expenditure and that which is not.

Expenditure on public experiment and research institutions (371.7 billion yen) accounted for 61% of the total S&T-related spending by local governments, while expenditure on universities and other tertiary institutions amounted to 401.3 billion yen, or 21% of overall spending.

## 9.2 R&D Activities

No substantial data is available on expenditure for regional R&D activities, so in this light, this section will examine the state of R&D activities in public research institutions, universities and private companies and the regional distribution of R&D resources by using the number of research institutions as an indicator.

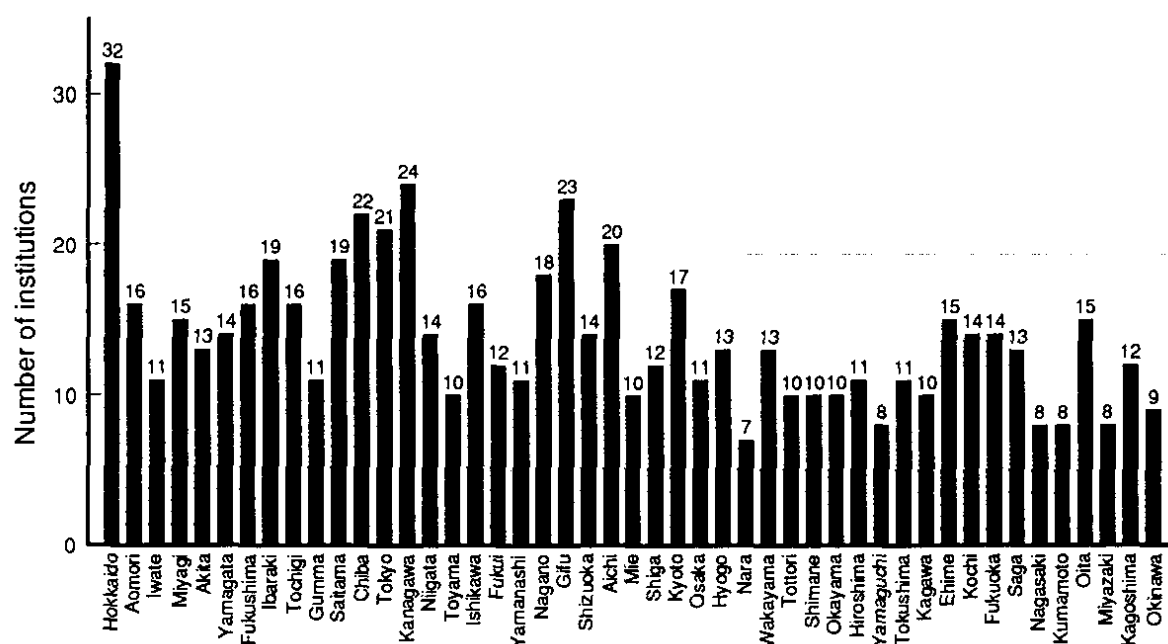
### 9.2.1 Public research institutions

#### (1) National experiment and research institutions

Figure 9-2-1 shows the regional distribution of national experiment and research institutions, and Figure 9-2-2 shows number of R&D scientists and engineers in each prefecture. Distribution of institutions among the prefectures is extremely unbalanced with a major concentration in Tokyo, and also in Ibaraki, mainly in Tsukuba Science City. National experiment and research institutions are established in 22 prefectures, while 25 prefectures do not have such an institution. In 1993 there were 103 institutions employing a total of 14,735 R&D scientists and engineers.

Previously the siting of institutions was decided on policy grounds alone, and no emphasis was placed on regional considerations, however the concentration of institutions in Tsukuba Science City was linked to regional revitalization and the various flow-on effects that this has brought about attracted much attention, so in recent years there has been a move to develop experiment and research institutions progressively in local areas, mainly in response to appeals and urging by enthusiastic local governments.

**Figure 9-2-1 Number of National Experiment and Research Institutions by Prefecture (1993)**

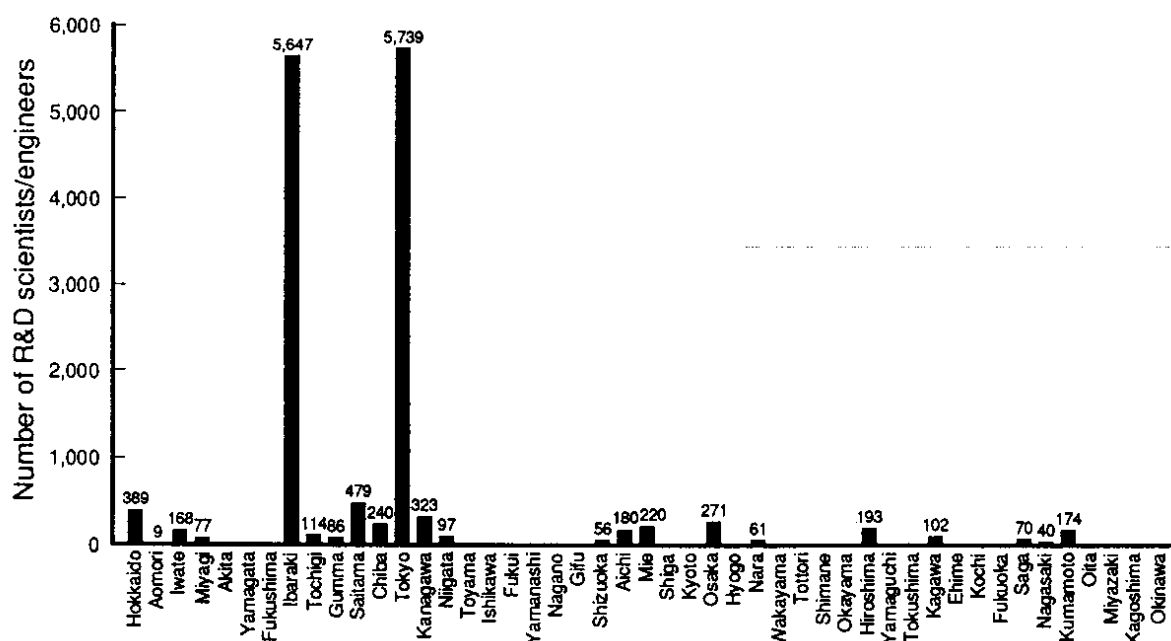


Source: Science and Technology Agency, *Handbook on Science and Technology*

See Table 9-2-1



**Figure 9-2-2 Number of R&D Scientists and Engineers at National Experiment and Research Institutions by Prefecture (1993)**



Source: Science and Technology Agency, *Handbook on Science and Technology*

See Table 9-2-1

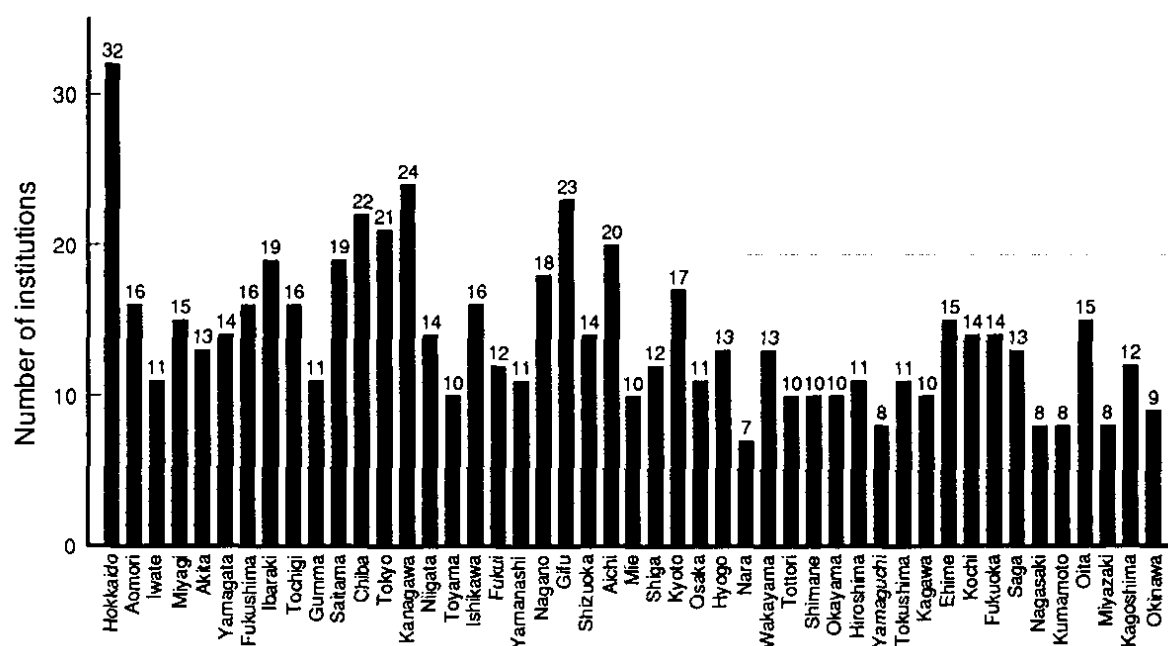
## (2) Public experiment and research institutions

Public experiment and research institutions are established by local governments under ordinances covering administrative organization, and most have been established with the primary aim of supporting industrial development in the region through the course of Japan's industrial modernization. Their activities are indeed diverse, ranging from research, experimentation and analysis to technological guidance and training. In FY1993 there were 656 public experiment and research institutions employing 15,037 R&D scientists and engineers. The R&D budget for these institutions in FY1992 totaled 282.7 billion yen.

Figure 9-2-3 shows the prefectural distribution of public experiment and research institutions. Hokkaido has the highest number with 32, followed by Kanagawa with 24 and Gifu with 23, while three other prefectures—Chiba, Tokyo and Aichi—have 20 or more institutions. At the other end, Nara has the lowest number of institutions with seven. As can be seen, an important characteristic regarding the distribution of public experiment and research institutions is that, unlike their national counterparts, public institutions are not concentrated in a small number of prefectures, which is quite natural considering they are established by local governments.

Over the past several years many local governments have pushed ahead with plans to restructure their experiment and research institutions, moving much of their commissioned test and experimental work to institutions in the tertiary sector while aiming at a much more research-oriented role. Moreover, a growing number of local governments are setting up advanced basic research institutions specializing in technical fields.

**Figure 9-2-3 Number of Public Experiment and Research Institutions by Prefecture (FY1993)**



Source: Management and Coordination Agency, *Report on the Survey of Research & Development*  
See Table 9-2-2

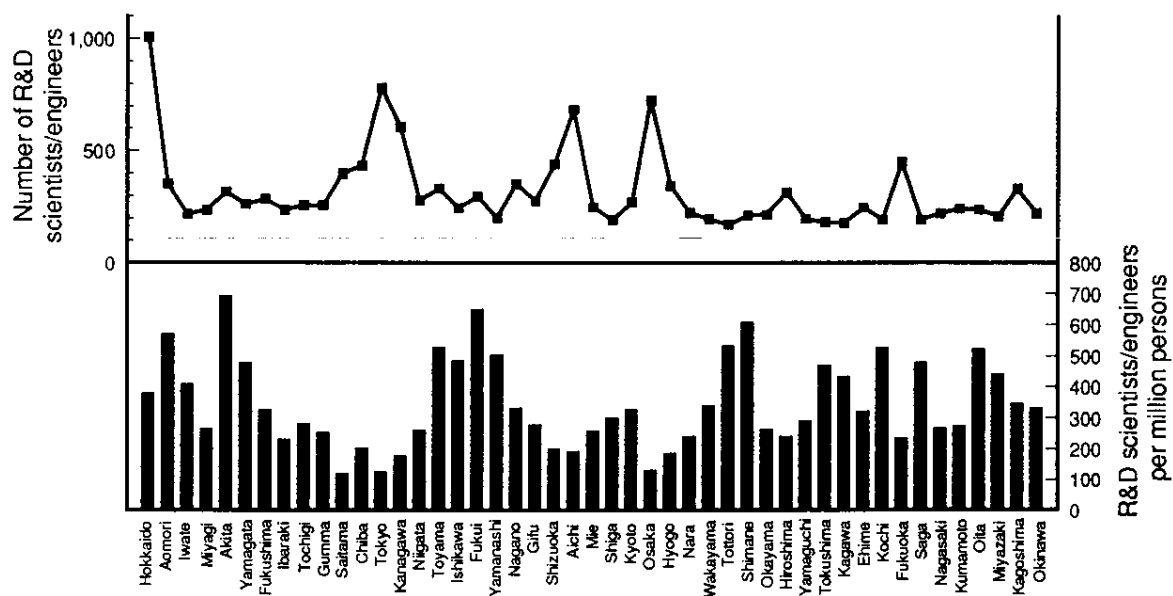
Reflecting its high number of public experiment and research institutions, Hokkaido also had the highest number of R&D scientists and engineers (Figure 9-2-4). The figure reveals differences in the nature of institutions among prefectures, for considering its large number of institutions Gifu has only a relatively small number of R&D scientists and engineers, whereas Osaka has a proportionally large number of R&D scientists and engineers for its small number of institutions.

By field of work, the highest number of institutions are in the agriculture, forestry and fisheries field, while the number in the health and environment field and the industrial field are about the same. Although active agricultural regions tend to have high numbers of R&D scientists and engineers in the agriculture, forestry and fisheries field, the actual work of public experiment and research institutions is diverse and cannot be simply classified according to regional characteristics.

Akita has the highest number of R&D scientists and engineers per million persons, followed by Fukui, Shimane, Aomori and Tottori, while prefectures with major cities, such as Saitama, Tokyo and Osaka have a comparatively low number per million persons (lower part of Figure 9-2-4).

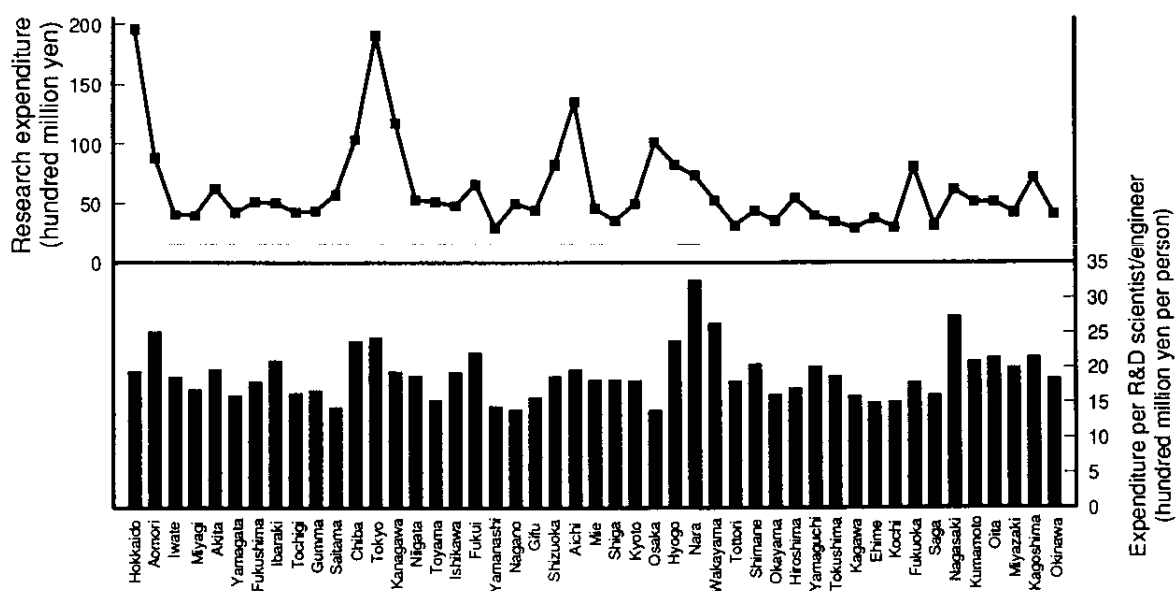
Figure 9-2-5 shows research expenditure of public experiment and research institutions by prefecture. It is important to note here that Tokyo, which ranked fifth in the number of institutions, ranked second in research expenditure. The national average R&D expenditure (including personnel expenditure) per scientist/engineer was 19.2 million yen, and overall most prefectures were around this level of spending. Nara had the highest level of R&D expenditure per scientist/engineer, followed by Nagasaki and Wakayama, all over 25 million yen, then Aomori and Tokyo. Apart from these, 15 other prefectures exceeded R&D expenditure of 20 million yen per scientist/engineer.

**Figure 9-2-4 Number of R&D Scientists and Engineers at Public Experiment and Research Institutions by Prefecture (FY1993)**



Source: Management and Coordination Agency, *Report on the Survey of Research & Development*  
See Table 9-2-2

**Figure 9-2-5 Research Expenditure of Public Experiment and Research Institutions by Prefecture (FY1992)**



Source: Management and Coordination Agency, *Report on the Survey of Research & Development*  
See Table 9-2-2

## 9.2.2 Universities

As of FY1993 there were 523 universities in Japan, and a breakdown of this number by prefecture is shown at Figure 9-2-6. Tokyo has by far the highest number of universities with 106, or 20% of the national total, followed by Osaka (35), Aichi (34), Hyogo (29), Kyoto (25) and Hokkaido (24).

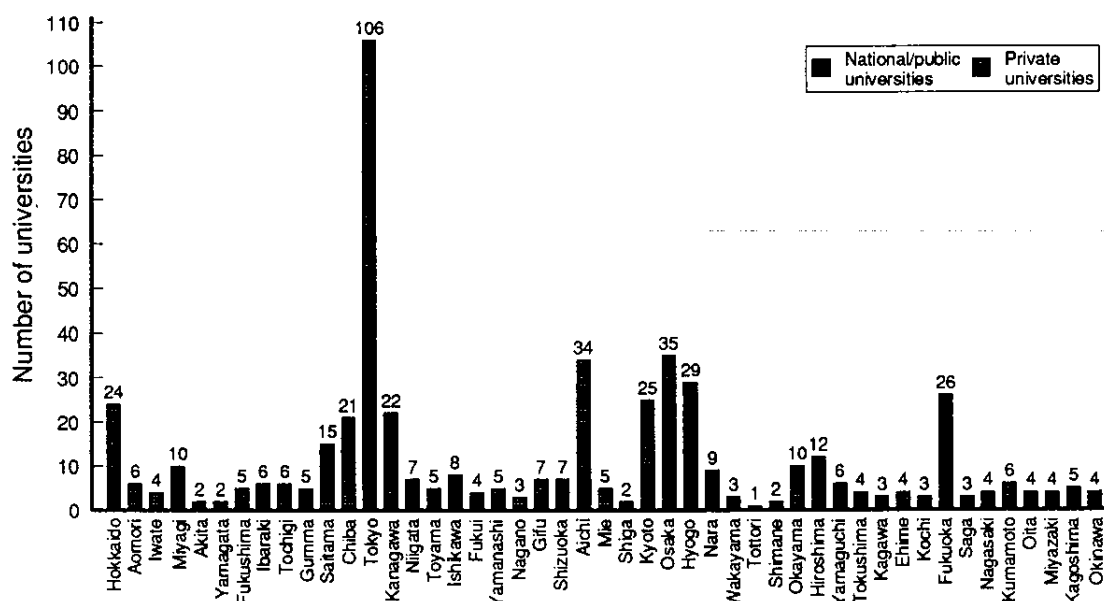
From the figure it can be seen that there is a considerable difference between national and public universities and private universities in regional distribution. As for national and public universities, while Tokyo has the highest number with 14, there is at least one university in each prefecture, so considering prefectural population and the like, there is little bias among regions. On the other hand, private universities are heavily concentrated in specific regions. The relatively even distribution of national and public universities throughout Japan is a key factor in the spread of R&D resources [6].

Figure 9-2-7 shows the number of instructors at universities. Tokyo has the highest number with 41,571, or 27% of the national total, followed by Osaka, Aichi, Fukuoka and Kyoto, and together these five prefectures account for 50% of the national total. Kanagawa was ranked third in the number of students but eighth in the number of instructors, while Fukuoka, ranked seventh in student numbers, jumped to fourth in instructor numbers.

Per capita, Tokyo has the highest number of instructors, followed by Kyoto, Ishikawa, Tokushima, Miyagi, Fukuoka and Okayama (lower part of Figure 9-2-7).

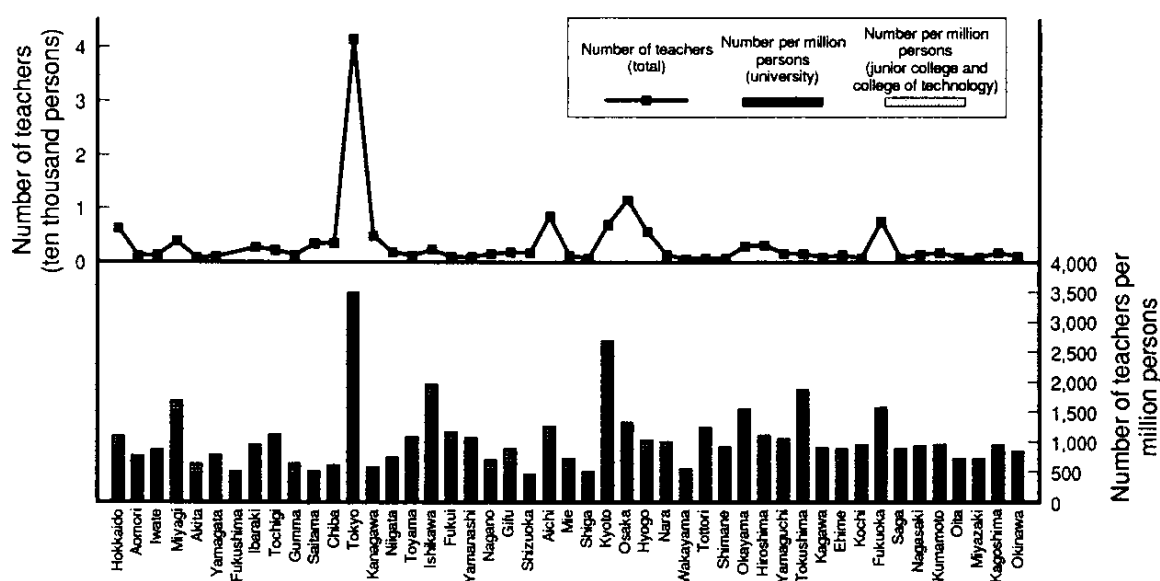
Universities with a high number of postgraduate students are quite active in research, so these numbers are a good reflection of the level of research activities. Figure 9-2-8 shows the number of postgraduate students by prefecture in FY1993. Tokyo has the highest number with 31,477, or 29% of the national total. Next are Osaka, Kyoto, Aichi and Kanagawa, and together these five prefectures account for 55% of the national total. Compared to university instructor numbers, postgraduate student numbers show a slightly higher concentration in these top-ranking prefectures. Slight differences can be seen in postgraduate student and instructor number levels, for example, Kyoto was ranked fifth in the number of instructors but second in the number of postgraduate students.

Figure 9-2-6 Number of Universities by Prefecture (FY1993)



Source: Ministry of Education, *Fundamental School Research*  
See Table 9-2-3

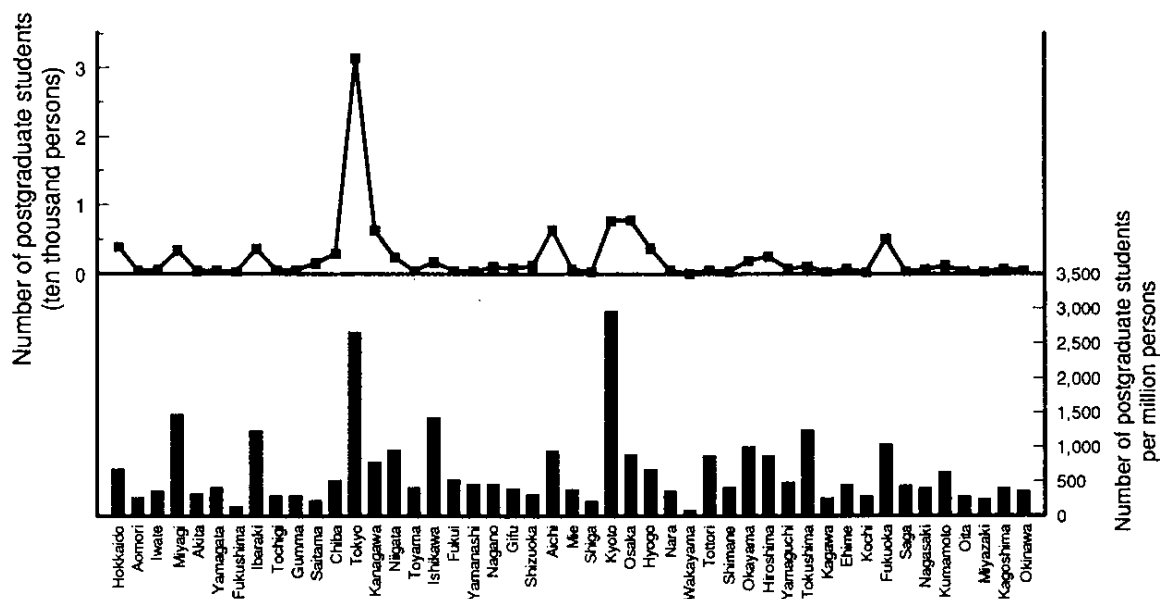
Figure 9-2-7 Number of University etc. Teachers (FY1993)



Source: Ministry of Education, *Fundamental School Research*

See Table 9-2-4

Figure 9-2-8 Number of Postgraduate Students by Prefecture (FY1993)



Source: Ministry of Education, *Fundamental School Research*

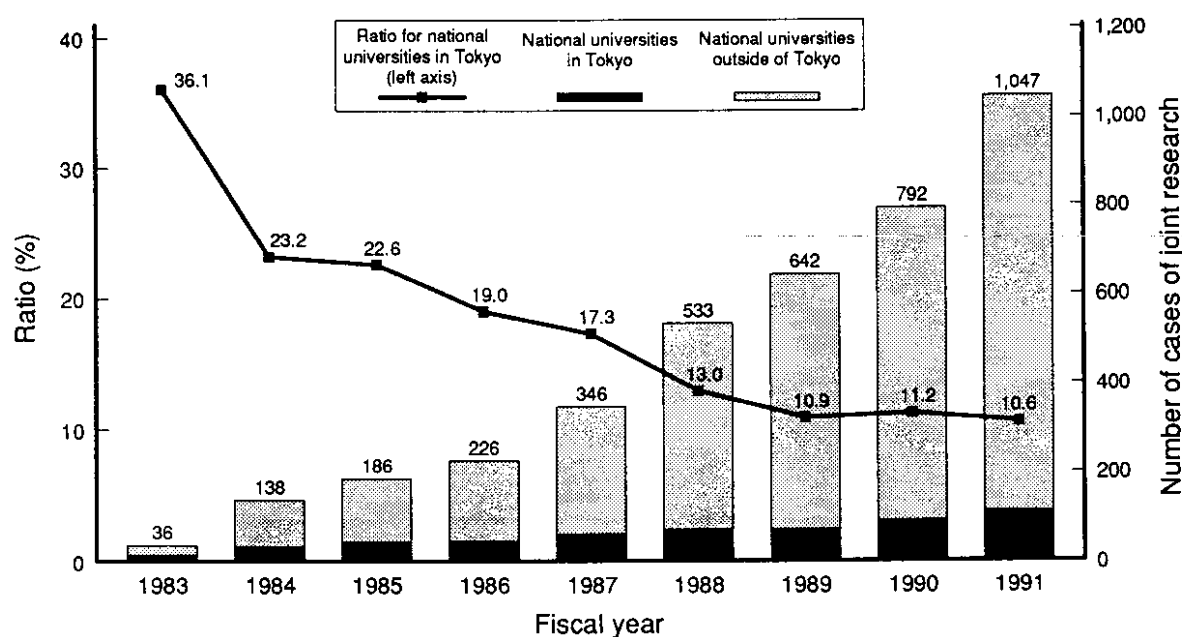
See Table 9-2-5

Per capita, Kyoto has the highest number of postgraduate students, followed by Tokyo, Miyagi, Ishikawa, Tokushima, Ibaraki and Fukuoka. Kyoto has such a high number of postgraduate students per capita because individual universities in the prefecture, such as Kyoto University, have a very high number of postgraduate students.

Of the contributions by universities to regional science and technology, next the section looks at the extent to which national universities carry out joint research with private-sector companies or local governments (Figure 9-2-9). In FY1983 there were 36 cases of joint research, but by FY1991 the number had jumped to 1,047.

Joint research by universities outside Tokyo is growing at a faster rate than that by universities in Tokyo, and as a result Tokyo universities account for a steadily declining share of all joint research. An important factor in this growth is the government's policy of promoting joint research through such measures as the establishment of national university joint research centers. National universities began setting up joint research centers in FY1987, and by FY1992 centers had been established in 28 universities. Most centers have been given the title Regional Joint Research Center, and all are expected to contribute to the region's research and development effort.

**Figure 9-2-9 Trends in the Number of Cases of Joint Research between National Universities and Private Companies etc.**



Source: Based on *The State of Joint Research with the Private Sector etc. in FY1991*  
See Table 9-2-6

### 9.2.3 Private companies

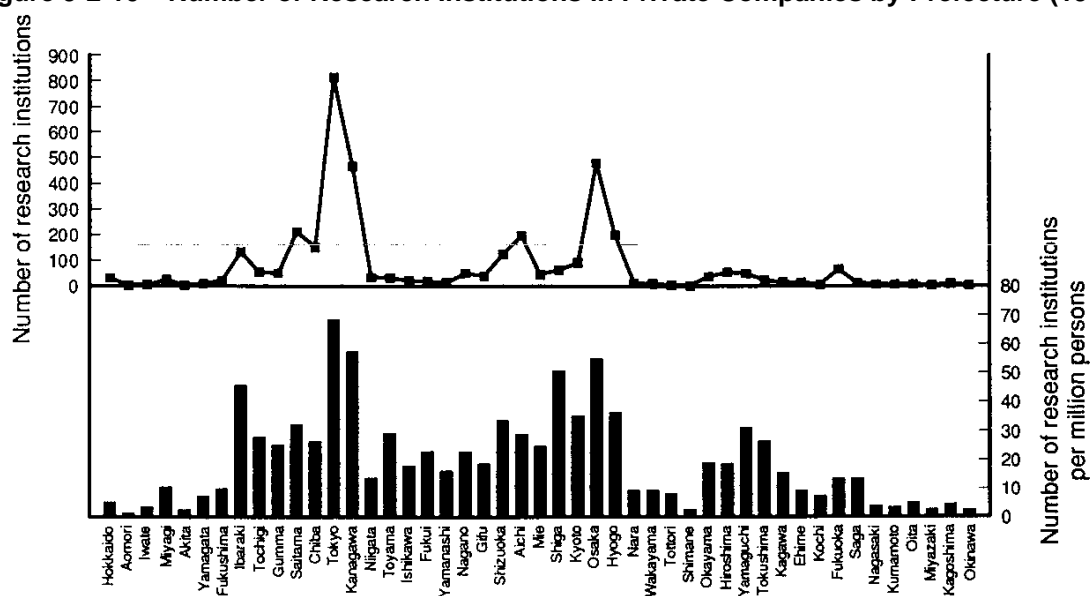
There are no data on research and development by private companies classified by prefecture that has sufficient coverage or continuity for this study, so indicators regarding the distribution of private-sector research institutions were prepared from the *Nationwide List of Research Institute*<sup>[10]</sup> (Lattice Ltd.). Here, research institutions are divisions that conduct research and development within private companies, and as well as independent research institutes, it also includes science and technology divisions. In cases where a company has more than one research division, all divisions have been counted separately.

There are a total of 3,722 research institutions within the scope of this study. By prefecture, Tokyo has the highest number with 814, or 22% of the total (Figure 9-2-10), followed by Osaka, Kanagawa, Saitama and Hyogo, and together these five prefectures account for 58% of the national total. As can be seen in the figure, a large number of private-sector research institutions are concentrated in a small number of prefectures, especially Tokyo. Other prefectures with a relatively high number of research institutions are Aichi, Chiba, Ibaraki, Shizuoka and Kyoto. The reason for the relatively high number of private-sector research institutions in Ibaraki is that, as stated earlier, there is a high concentration of national experiment and research institutions. In other words, it is thought that private companies locate their own research institutions with a view to benefiting from the effects of this concentration.

As shown in the lower part of Figure 9-2-10 there is a major disparity among prefectures in the number of research institutions per million persons. As with many other indicators, Tokyo tops the list, followed by Kanagawa, Osaka, Shiga and Ibaraki, all with more than 40 per million persons.

As mentioned before, the distribution of national research institutions is quite unbalanced with some prefectures completely devoid of even one institution, whereas public institutions are fairly evenly distributed. Private-sector institutions fall somewhere between, although there is a certain degree of prefectural bias in distribution when looked at in terms of population and general economic activities.

**Figure 9-2-10 Number of Research Institutions in Private Companies by Prefecture (1991)**



Source: Science and Technology Agency supervision, *Nationwide List of Research Institute 1992-1993*, Lattice Ltd., 1992

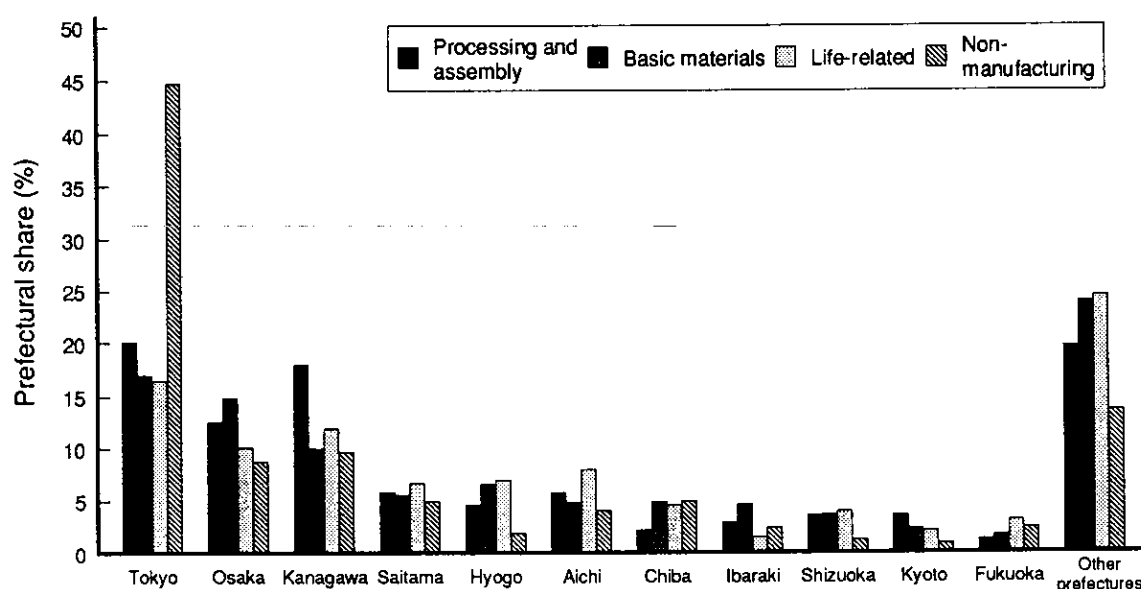
See Table 9-2-7

Next, the section looks at the number of private-sector research institutions by industry category. Here, industry has been broadly categorized into “manufacturing”, which has been further categorized into “processing and assembly”, “basic materials” and “life-related industries”, and “non-manufacturing”. The purpose of categorizing industry in this way was to better observe common characteristics among industries.

Figure 9-2-11 shows the share of private-sector research institutions held by the four industrial categories in each prefecture. The figures shows the top eleven prefectures in terms of the number of institutions individually, while all other prefectures are grouped together under “other prefectures”.

Tokyo holds the largest share of research institutions in “processing and assembly” industries, though Kanagawa also has a considerable share. The largest share in both “basic materials” and “life-related” industries is held by “other prefectures”, while Tokyo has the largest share in non-manufacturing industries. A breakdown of Tokyo’s share in non-manufacturing industries (239 institutions) reveals that institutions in “construction, facilities and consultancy” industries (156 institutions) account for 65%, and this is pushing up Tokyo’s share to its current high level.

**Figure 9-2-11 Distribution of Private Company Research Institutions by Industrial Category (1991)**



Note: The manufacturing industry category of “processing and assembly” consists of “general machinery”, “electrical machinery and electrical equipment and supplies”, “transportation equipment” and “precision instruments”; “basic materials” consists of “textiles”, “pulp and paper”, “chemical products”, “petroleum and coal products”, “rubber products”, “ceramics”, “iron and steel”, “non-ferrous metals and products” and “fabricated metal products”; “life-related” consists of “food” and “other manufacturing industries”.

Source: Science and Technology Agency supervision, *Nationwide List of Research Institute 1992-1993*, Lattice Ltd., 1992

See Table 9-2-8

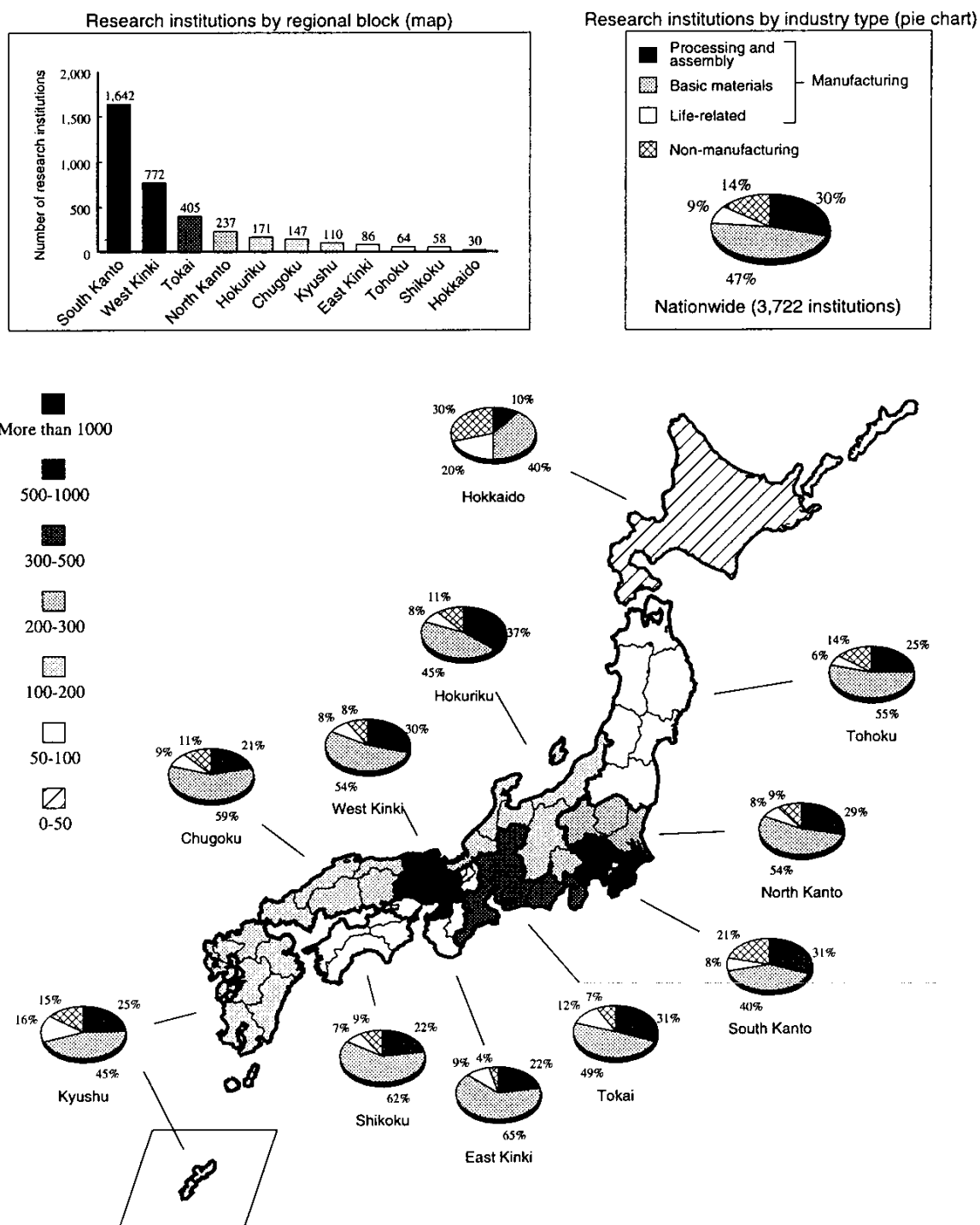


Figure 9-2-12 classifies all prefectures into eleven regional blocks, and shows the number of research institutions in each block (map shading and bar graph) and also a breakdown of these numbers into the four industrial categories (pie chart) to gain an insight into the industrial character of each block.

Southern Kanto (including Tokyo and Kanagawa) has an especially high proportion of research institutions in non-manufacturing industries, while the proportion in “basic materials” industries is slightly smaller than average. In Western Kinki (including Osaka and Hyogo) the proportion in non-manufacturing industries is quite small while the proportion in “basic materials” is higher than average. In the Tokai region the proportion in non-manufacturing industries is smaller and that in “life-related” industries is slightly larger than average. In these three regional blocks the proportion of institutions in “processing and assembly” is around the national average.

In Chugoku, Shikoku and Eastern Kinki the proportion in “basic materials” is larger than the national average, and Tohoku and Northern Kanto also had a slightly larger-than-average proportion in these industries. In Hokuriku the proportion in “processing and assembly” industries was much larger than average, and in fact was the largest among all the regional blocks. The proportion in “life-related” industries was especially large in Hokkaido and Kyushu, and Hokkaido also had a large proportion in non-manufacturing industries.

**Figure 9-2-12 Regional Distribution of Private Company Research Institutions by Industrial Category (1991)**



Source: Science and Technology, *Nationwide List of Research Institute 1991-1992* Lattice Ltd., 1992  
See Table 9-2-9

### 9.3 Achievements and Contribution of Science and Technology

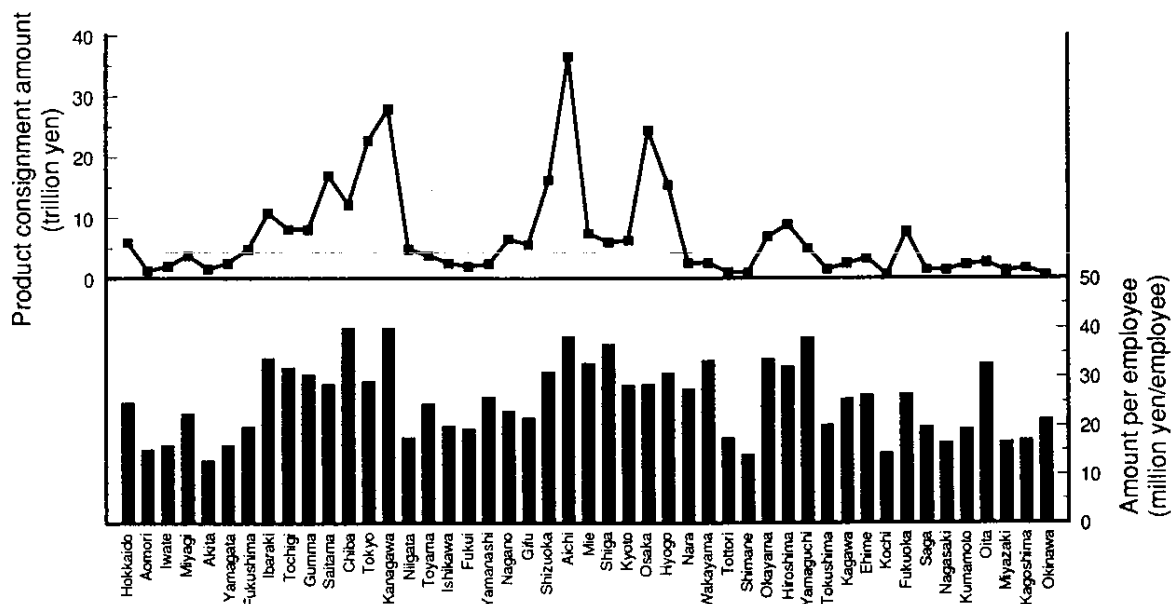
This section looks mainly at the economic effects arising from the achievements and contribution of science and technology within the various regions. The reason this section focuses on the economic effects from among the numerous facets of science and technology's social contribution is that since scientific and technological activities and economic activities are so closely intertwined, examining economic effects will give a good picture of the regional distribution of scientific and technological activities. Moreover, from a regional perspective, economic growth and development is one of the sought-after fruits of science and technology, so the following indicators are important when considering regional scientific and technological activities.

#### 9.3.1 Product consignment amount

Product manufacture requires not just capital equipment and labor input, but also an accumulation of technology, therefore it can be said that manufacturing utilizes the results of research and development. Here regional product consignment amount is examined as an indicator reflecting the extent to which the results of research and development are put to effective use in each prefecture.

Figure 9-3-1 shows the product consignment amount for each prefecture in 1990. Aichi has the highest share, accounting for 11.4% of total product consignment, followed by Kanagawa, Osaka, Tokyo and Saitama, and together these top five prefectures account for 40% of the national total. A large proportion of Aichi's product consignment is in the motor vehicles industry. And although the consignment amounts of Tokyo and Osaka are quite large, there is not the same concentration in these two prefectures seen in many other indicators.

Figure 9-3-1 Product Consignment Amount by Prefecture (1990)



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

See Table 9-3-1

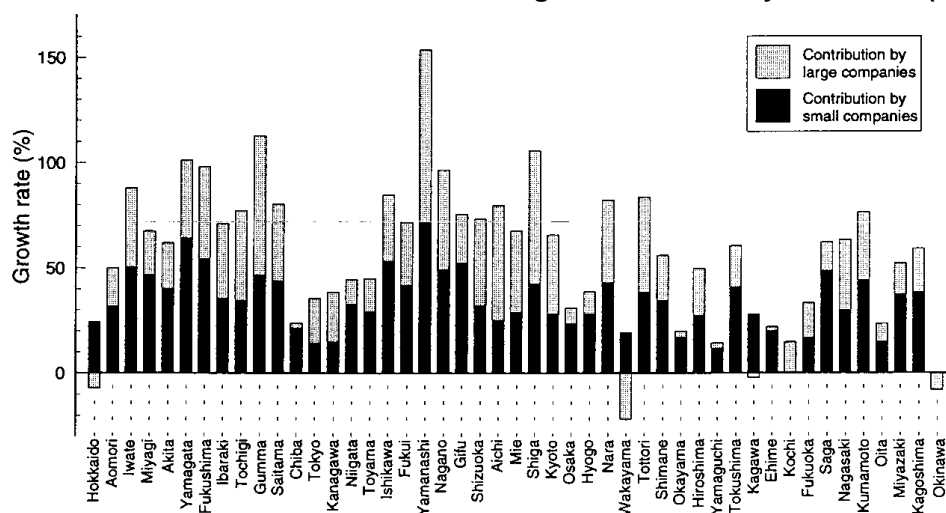
To eliminate any bias caused by differences in the size of prefectures, these data have been brought to relativity in generally the same way as has been done elsewhere in this chapter. However, here this was done by dividing the product consignment amount not by prefectural population, but by the number of employees (total number of employees at business establishments that consign manufactured products) in the prefecture (lower part of Figure 9-3-1). The national average product consignment amount per employee was 28.84 million yen. Chiba has the largest amount with more than 40 million yen per employee, followed by Kanagawa, Aichi, Yamaguchi and Shiga with 35–40 million. Tokyo and Osaka ranked sixteenth and eighteenth respectively.

Figure 9-3-2 shows the rate of increase in the product consignment amount over the ten years from 1980 to 1990 to give an overview of prefectural trends. The national product consignment amount rose 52% over this period. Of this 52% increase, small and medium-sized companies contributed 27 percentage points, and large companies contributed the remaining 25 percentage points (1).

Yamanashi Prefecture recorded the highest rate of increase at 154%, followed by Gumma, Shiga and Yamagata, all with more than 100%. The high rate of increase recorded by Yamanashi is attributed to the influx of business establishments during the 1980s because of its proximity and ease of travel to the Tokyo Metropolitan Area with the construction of the Chuo Expressway.

The contribution by large companies to the 154% increase rate of Yamanashi is, at 82 percentage points, higher than that by small and medium-sized companies (72 percentage points), however, both of these were respectively the highest contribution rates among all prefectures. As for small and medium-sized companies, Yamanashi recorded the highest contribution rate, followed by Yamagata, Fukuoka, Ishikawa, Gifu and Iwate; while for large companies, Yamanashi was followed by Gumma, Shiga, Aichi, Nagano and Tottori.

**Figure 9-3-2 Rate of Increase of Product Consignment Amount by Prefecture (1980–90)**



Note: Product consignment amount is the monetary value of manufactured products consigned, as listed in the *Statistical Tables on Japanese Manufacturing Industries*. Large companies are business establishments with 300 or more employees, while small and medium-sized companies are business establishments with fewer than 300 employees. Figures for Kochi and Okinawa are the total product consignment amount, as there is no clear breakdown into large companies and small and medium-sized companies.

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

See Table 9-3-2

**[Note]**

- (1) The following method was used to calculate the respective contribution by large companies and small and medium-sized companies to the overall rate of increase. The product consignment amount in year  $y$  is represented by  $S(y)$ ; the consignment amount of large companies is represented by  $S_{LE}(y)$ ; and the consignment amount of small and medium-sized companies is represented by  $S_{SME}(y)$ ; the rate of increase from year  $y$  to year  $y'$  is represented by  ${}_yS(y' \leftarrow y)$ . Therefore the rate of increase in product consignment from 1980 to 1990 is represented by the following equation.

$$\begin{aligned}\Delta S(90 \leftarrow 80) &= \frac{S(90) - S(80)}{S(80)} = \frac{[S_{LE}(90) - S_{LE}(80)] + [S_{SME}(90) - S_{SME}(80)]}{S(80)} \\ &= \Delta S_{LE}(90 \leftarrow 80) + \Delta S_{SME}(90 \leftarrow 80)\end{aligned}$$

Therefore, the rate of increase in overall consignment  $\Delta S$  can be broken down into the increase rate due to large companies  $\Delta S_{LE}$  and that due to small and medium-sized companies  $\Delta S_{SME}$ .

### 9.3.2 Applications for industrial rights

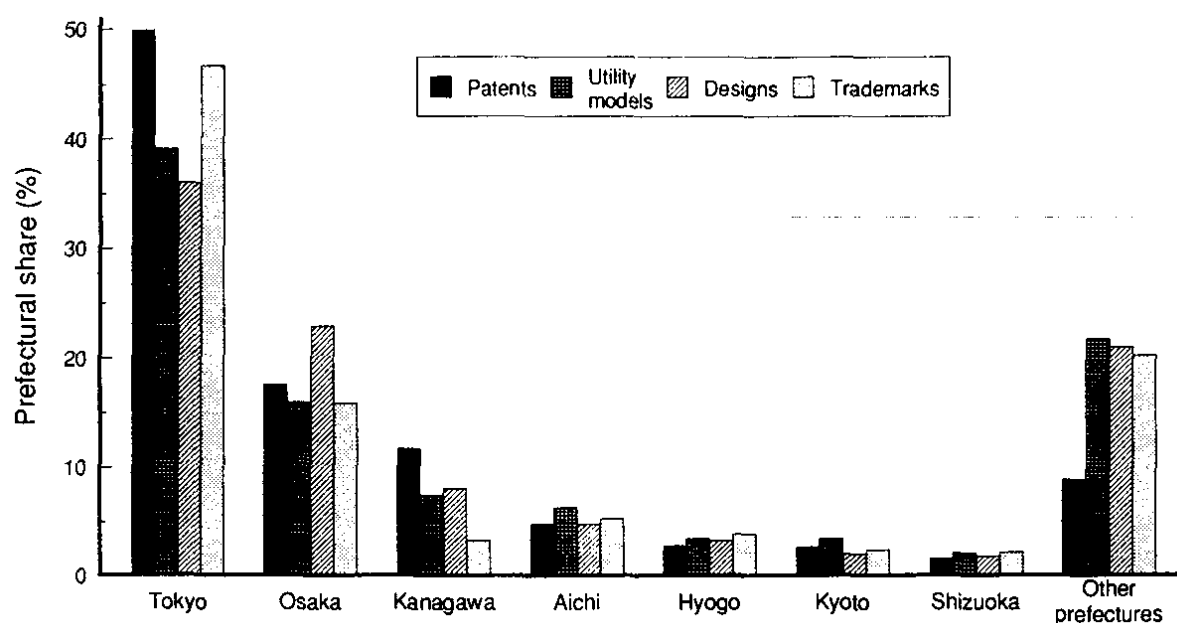
Industrial rights is a general term used for patents, utility models, designs and trademarks, and along with copyright, they are key intellectual rights (also referred to as intellectual property rights). In addition to the number of applications for patents, which is considered to be an indicator of R&D achievements, this section also examines the number of applications for utility models, designs and trademarks from the viewpoint of regional S&T activities and manufacturing.

The number of application by prefecture is worked out on the basis of the address of the applicant. In the case of patents, often the person making the application is not the inventor of the subject device etc., and occasionally the company patenting an invention will lodge the application from the head office or other office separate from the establishment where the device etc. was actually invented; consequently the number of applications does not always give a true indication of the R&D achievements of each prefecture. Nonetheless, the general nature of S&T and manufacturing activities in the prefectures can be revealed to a certain degree by comparing patents with the other industrial rights.

Figure 9-3-3 shows the general concentration of industrial rights applications in the seven leading prefectures in 1992, giving each of the four industrial rights—patents, utility models, designs and trademarks—as a percentage share of their respective overall numbers so that all four can be compared on an equal base.

Of the four kinds of industrial rights, patents have the highest concentration of applications in the seven leading prefectures, particularly Tokyo, while the total share of the prefectures other than the seven listed comes to a mere 8.9%. This is thought to be a clear reflection of the concentration of company technological management functions in Tokyo especially and the other major urban centers to a slightly lesser extent. On the other hand, applications for utility models are less concentrated than patent applications, with “other prefectures” holding more than a 20% share. The utility-model system was set up to protect “smaller inventions” with a lower degree of novelty, and most utility-model applications are made by small and medium-sized companies. Design rights are intellectual property rights covering designs, and it is quite noticeable in the figure that the percentage of applications for designs compared to applications for other industrial rights within the prefecture is quite high in Osaka, but quite low in Tokyo. The percentage of applications for trademarks is very high in Tokyo, second only to that for patents. The reason for Tokyo’s high share of trademark applications compared to other prefectures is thought to be that many company head offices are located in Tokyo and trademark applications is normally a function of head offices.

**Figure 9-3-3 Applications for Industrial Rights by the Top Seven Prefectures (1992)**



Source: Patent Office, *Patent Office Annual Report*  
See Table 9-3-3

### 9.3.3 Venture companies

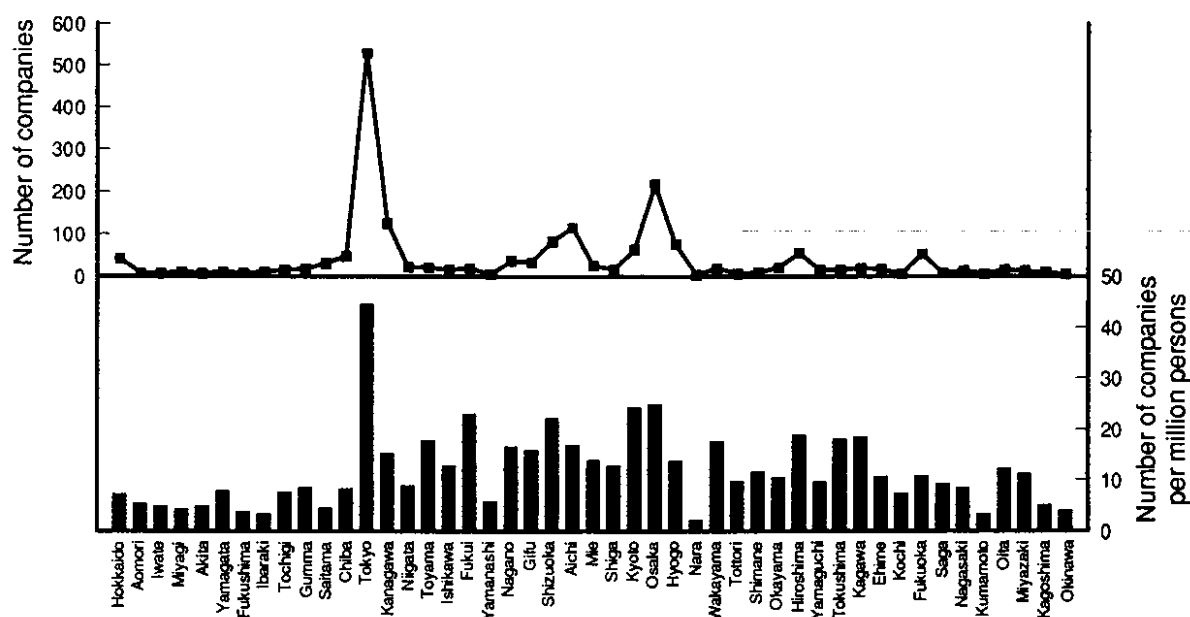
Generally, venture companies are small companies formed to enter into completely new fields before the major companies have established their presence. Venture companies are classified into R&D-type companies and niche-type companies. The R&D-type companies are characterized by their use of human resources with highly specialized knowledge and skills to incorporate the latest technologies into their manufactured products. This section focuses on the R&D-type company as an indicator based on the view that these companies play a significant role in regional development through science and technology. There is no hard and fast definition of venture companies, so here the paper looks at the companies listed in the *Nikkei Venture Company Yearbook* <sup>[11]</sup>, published by the Nihon Keizai Shimbun <sup>(1)</sup>.

In 1992 there were 1,907 venture companies in Japan, and these are broken down by prefecture in Figure 9-3-4. Tokyo has the highest number with 529, or 28% of the national total, followed by Osaka, Kanagawa, Aichi and Shizuoka, and together these five prefectures account for 56% of the national total.

Tokyo has by far the largest number of venture companies per million persons at 45, followed by Osaka, Kyoto, Fukui and Shizuoka, all with more than 20. The national average is 15.

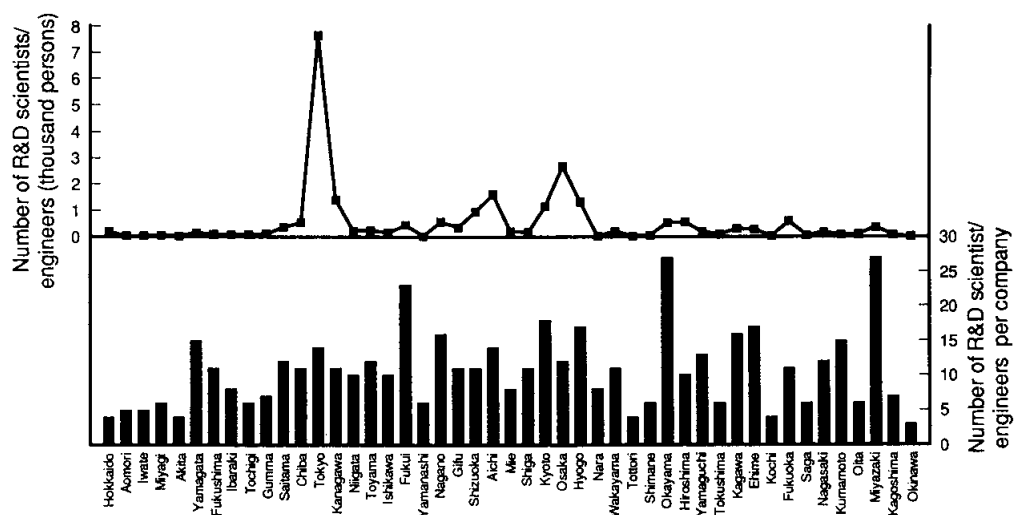
There are 24,494 R&D scientists and engineers employed by venture companies, or an average of 13 per company. Figure 9-3-5 gives a prefectural breakdown of this number. 60% of the R&D scientists and engineers are concentrated in the top five prefectures, 31% in Tokyo alone, and this is slightly higher than the concentration of venture companies. Miyazaki and Okayama have the highest number of R&D scientists and engineers per company, followed by Fukui; all three have more than 20 per company.

Figure 9-3-4 Number of Venture Companies by Prefecture (1992)



Source: Nihon Keizai Shimbun, *Nikkei Venture Company Yearbook* (1993 Edition), 1993  
See Table 9-3-4

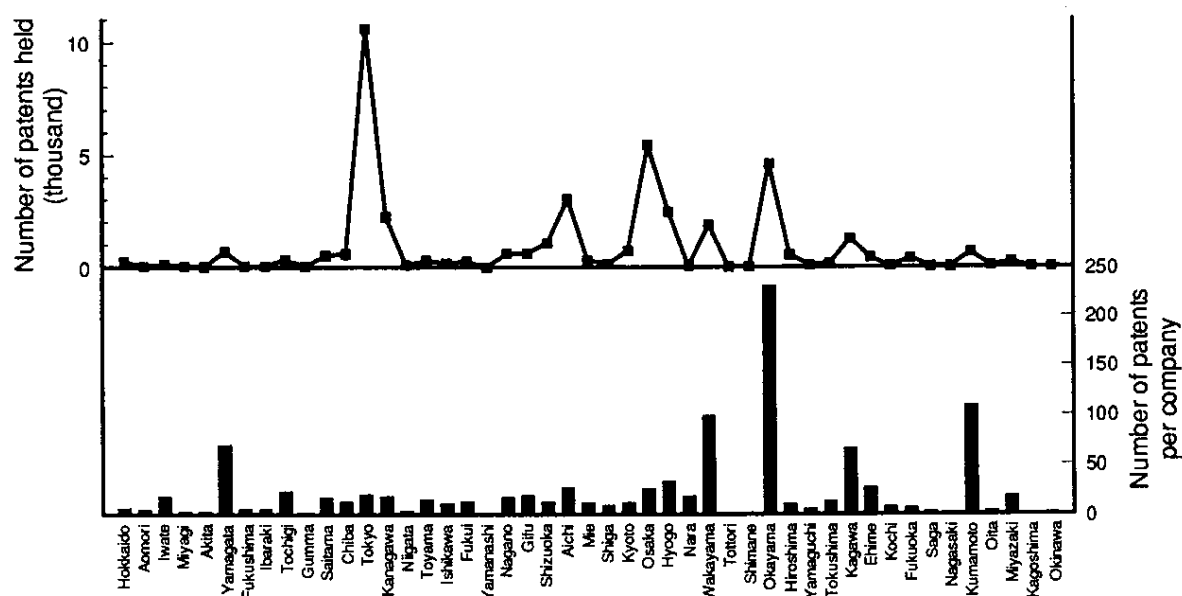
Figure 9-3-5 Number of R&D Scientists and Engineers at Venture Companies by Prefecture (1992)



Source: Nihon Keizai Shimbun, *Nikkei Venture Company Yearbook* (1993 Edition), 1993  
See Table 9-3-4

Venture companies in Japan hold 41,265 patents, or an average of 22 patents per company. It is interesting to note that Okayama is next after Tokyo and Osaka in the number of patents held by venture companies. Moreover, in the average number of patents per company, Okayama with 231 is well ahead of the next prefecture. Other prefectures with a relatively high number of patents per company are Kumamoto, Wakayama, Yamagata and Kagawa. The reason these prefectures rank so highly is that individual companies hold large numbers of patents, and while this does not give a true indication of the overall technological capability of each of these prefectures, it does suggest that they have managed to attract venture companies that are actively engaged in technological development.

**Figure 9-3-6 Number of Patents Held by Venture Companies by Prefecture (1992)**



Source: Nihon Keizai Shimbun, *Nikkei Venture Company Yearbook* (1993 Edition), 1993  
See Table 9-3-4

#### [Note]

- (1) Among the criteria for listing in the *Nikkei Venture Company Yearbook* are that the company: has its own unique technology and know-how; has maintained a high growth rate over the past several years; and is a relatively young company, or, if a company with a long tradition, recently converted to a new industrial category.

### 9.3.4 Gross prefectural product and prefectural income levels

Regional S&T activities in any form are thought to be reflected in gross prefectural product and prefectural income levels, so this section takes up these two indicators to examine the contribution by S&T to regional economic growth.



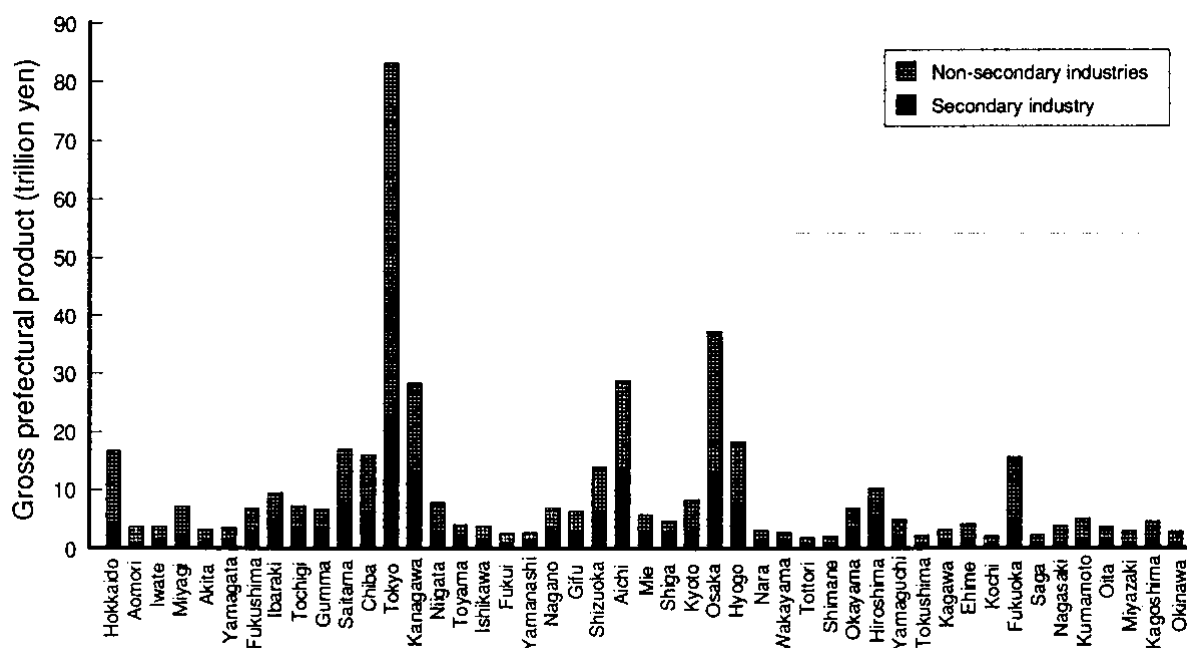
### (1) Gross prefectural product

Gross prefectural product is obtained by subtracting interim input from output in each prefecture, and represents the value which has been newly added by production activities within the prefecture during a set period. Gross prefectural product is based on the concept of “activities within the prefecture”, which covers economic activities that occur within the prefecture, regardless of where the people who carry out those activities reside. On the other hand, the idea of “activities by prefectural residents” covers the economic activities of residents of the prefecture, regardless of where those activities occur. In prefectural economic calculations, production and expenditure is based on the former, while distribution is based on the latter.

Figure 9-3-7 shows gross prefectural product for each prefecture in 1990. Tokyo has the highest gross prefectural product, accounting for 19% of the total of all prefectures. Next are Osaka, Aichi, Kanagawa and Hyogo, and together these five prefectures account for 47% of the total.

The figure also breaks gross prefectural product down into secondary industry, which accounts for most of R&D expenditure, and non-secondary industries. As for the secondary industry, Tokyo accounts for 14% of the total, which is somewhat lower than its share for overall gross prefectural product, while Aichi jumped above Osaka to occupy second place. The top five prefectures account for 42% of the total. As for the non-secondary industries on the other hand, Tokyo's share is 21%, and the top five prefectures account for 45% of the total. Tokyo has the largest share of overall gross prefectural product in the tertiary industry.

**Figure 9-3-7 Gross Prefectural Product (1990)**

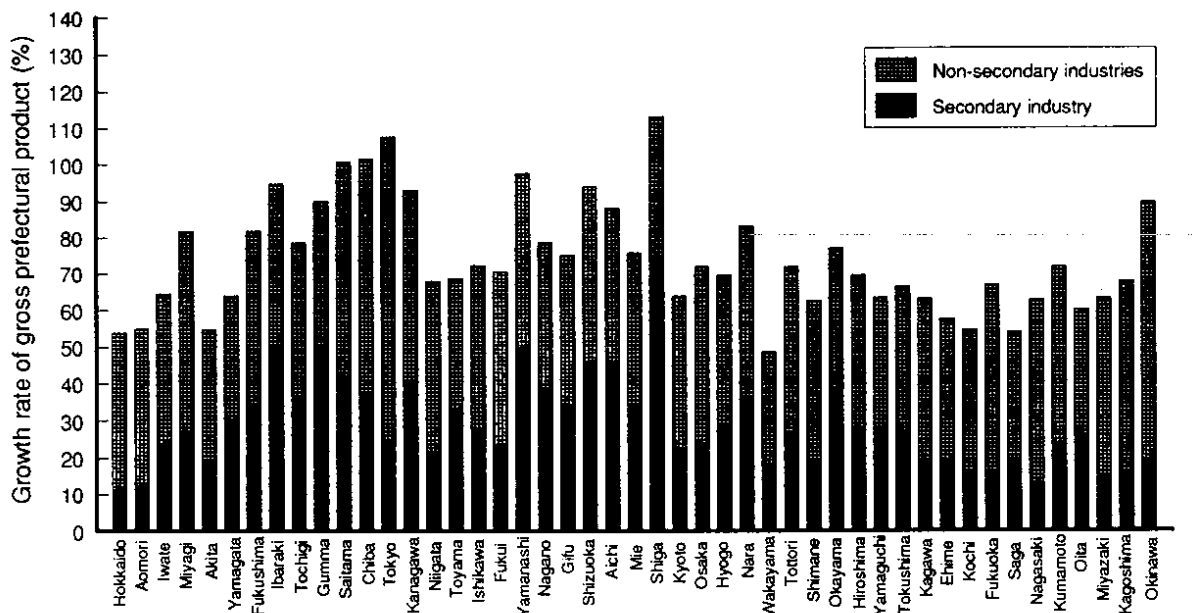


Source: Economic Planning Agency, *Annual Report on Prefectural Economies*

See Table 9-3-5

Figure 9-3-8 shows the growth rate of gross prefectural product from 1980 to 1990 to give an overview of trends over the ten-year period. The prefectural growth rate averaged 82%, and of this rate, the non-secondary industries contributed most with 52 percentage points, while the secondary industry contributed 30 percentage points. By prefecture, Shiga recorded the highest growth rate over the period, followed by Tokyo, Chiba and Gumma, all with more than 100%. The contribution by the secondary industry was highest in Shiga, while other prefectures with a high secondary industry contribution include Gumma, Yamanashi, Ibaraki and Aichi, and these five were the only prefectures in which the secondary industry made a greater contribution to gross prefectural product growth than the non-secondary industries. On the other hand, prefectures that recorded a particularly high contribution by non-secondary industries include Tokyo, Okinawa, Chiba, Saitama and Miyagi. The tertiary industry accounts for most of the contribution by the non-secondary industries in Tokyo.

**Figure 9-3-8 Growth Rate of Gross Prefectural Product (1980–90)**



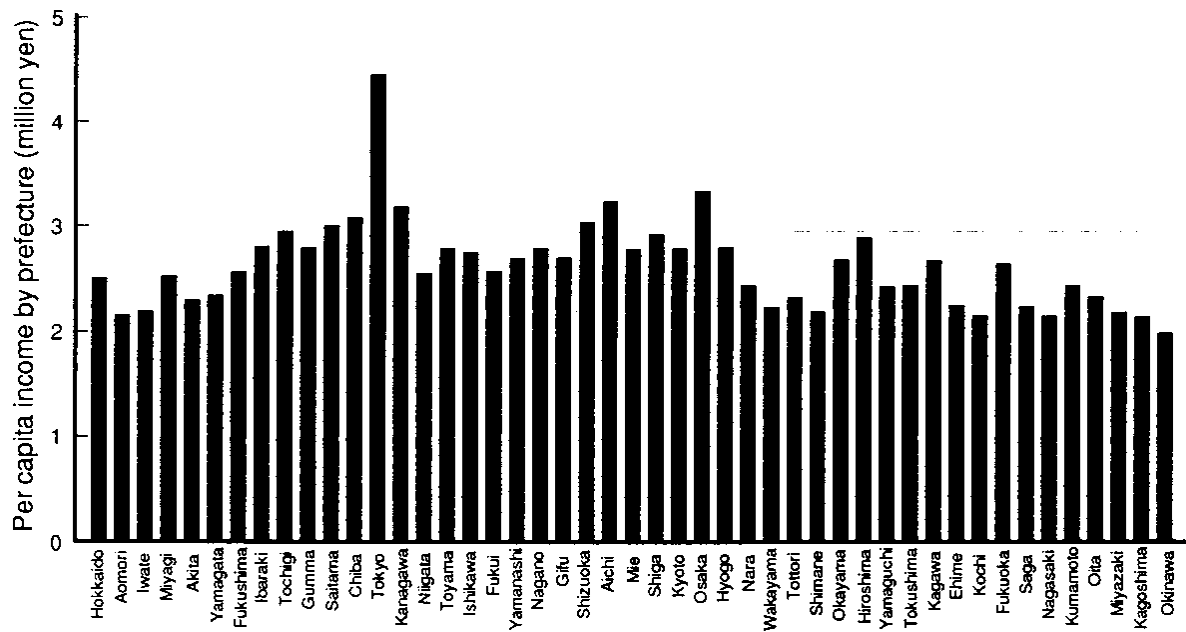
Source: Economic Planning Agency, *Annual Report on Prefectural Economies*  
See Table 9-3-6

## (2) Income levels

Prefectural residents' income is the total amount of income earned by residents of the prefecture from wages, rent, company profit and the like. This income is an indicator of distribution, and is based on the idea of "activities by prefectural residents", in which the income of prefectural residents is considered, regardless of where the economic activities from which that income is derived occur.

Figure 9-3-9 shows the per capita income levels of each prefecture for 1990. The national average is 2.94 million yen. Tokyo stands above all other prefectures at 4.47 million yen, followed by Hyogo, Aichi, Kanagawa, Chiba, Shizuoka and Saitama, and all exceed three million yen.

Figure 9-3-9 Per capita Income by Prefecture (1990)

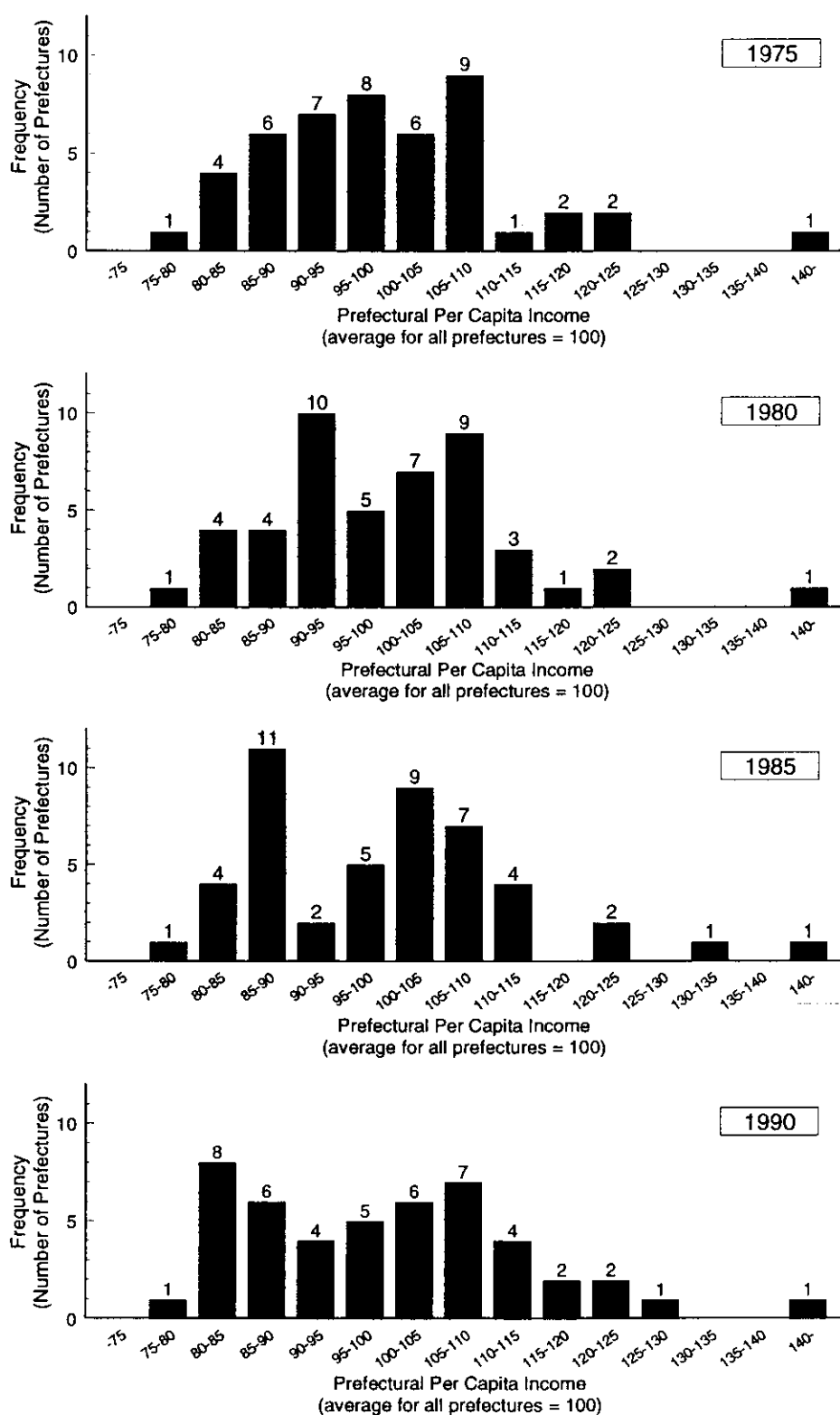


Source: Economic Planning Agency, *Annual Report on Prefectural Economies*  
See Table 9-3-7

An insight into the state of development within a region can be obtained by looking at the distribution of prefectural per capita income levels and how that distribution has changed over time. Figure 9-3-10 shows the frequency distribution for per capita income of the 47 prefectures. The  $x$ -axis represents per capita income (average per capita income = 100), and the  $y$ -axis represents the frequency (number of prefectures). Distribution that is spread out along the  $x$ -axis indicates a considerable disparity among regions, while distribution that is clustered towards the center of the  $x$ -axis indicates little regional disparity.

In the 1975 graph there are a relatively large number of prefectures positioned towards the center, but in the 1990 graph, the prefectures are much more spread out, indicating that there is a widening gap in per capita income levels among prefectures. Although per capita income does not necessarily reflect the affluence of a prefecture, a widening of the income gap does hint at problems in the overall plan of balanced regional and national land development.

**Figure 9-3-10 Trends in the Distribution of Prefectural Per Capita Income Levels**



Source: Economic Planning Agency, *Annual Report on Prefectural Economies*  
See Table 9-3-7

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# Chapter 10

## Composite Indicators: International Comparison of Overall Strengths in Science and Technology

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## Chapter 10

### Composite Indicators: International Comparison of Overall Strengths in Science and Technology

#### 10.1 Purpose and Significance of Integrating Indicators

This report has so far charted S&T activities through the use of a broad range of indicators. These activities are far too complex to express with an isolated figure, so it has been necessary to turn to complex numerical values or tables. Science and technology indicators prepared on the basis of numerous tables are able to express S&T activities in a much more multifaceted and detailed manner than single numerical values.

On the other hand, however, even if S&T activities are expressed through copious numerical values, one question that still remains is how can we find out the overall S&T position of a country at a glance without wading laboriously through all these figures; and from this arises a desire to illustrate the S&T activities of a country in a compact form involving only one or two sets of figures. There is also a desire to arrange such figures into a time series format and draw comparisons with other countries to find out exactly where Japan stands in the world in terms of science and technology. Giving an illustration of a particular situation by the use of no more than one or two indicators is generally quite beneficial for grasping an overall view of the situation. Such an approach can also bring out changes that have taken place over given periods of time, and also makes it possible to compare a number of different situations.

GNP is such an indicator, in that it gives a comprehensive indication of a country's overall economic activities. *New Social Indicators* <sup>[3]</sup> published by the Economic Planning Agency produces social indicators for each prefecture, and such an undertaking is said to be in effect a manifestation of the desire to grasp a situation by expressing it through a single numerical value.

There are also similar desires and demands regarding S&T activities, and this chapter seeks to address such demands. However, as with the major controversy and heated debate that swelled up when the *New Social Indicators* was released, there are various problems in expressing the S&T activities of a country in a single indicator, including whether it is even appropriate to do so. It is therefore important not just to produce a composite science and technology indicator, but also to explain how it was derived so that people can judge the appropriateness of the exercise for themselves. This chapter attempts to achieve this.

To show actual S&T activities in a single indicator, the numerous indicators raised in previous chapters were combined statistically into "composite indicators". The reason this method was adopted was that there were no indicators defined within a theoretical structure as in the case of GNP in economic activities (macroeconomic theory for GNP). The composite indicator is characterized as follows. First, the composite indicator approach does not require a prior understanding of the cause and effect relationship among indicators; rather, this will emerge in the process of combining the indicators. In this respect, the composite indicator is a fitting indicator of S&T activities in which cause and effect relationships are often inextricably intertwined. Second, composite indicator implies a summarization of many indicators. Generally, in cases where various aspects of a situation are shown by many indicators, the overall state of the situation can be grasped by combining those indicators. And if necessary, the detailed situation can also be understood by looking back over the individual indicators. In other words, not only are composite indicators useful in themselves, but they also enable us to gain



a deeper understanding of the situation, i.e. S&T activities, when interpreted in conjunction with individual indicators.

This paper has adopted principal component analysis from within the multi-variable analysis method as the statistical method to draw up composite indicators. Factor analysis is an effective way of clarifying the structure of the situation, so here the paper will combine indicators through principal component analysis and attempt to analyze the structure through factor analysis.

## 10.2 Method of Combining Indicators

### 10.2.1 S&T statistics used

Each of the individual indicators used to draw up the composite indicator form annual data for each country. That is, the data form a three-dimensional structure comprising individual indicators, country and year. Of these, for “country” this paper selected developed countries on the grounds that reasonably detailed statistics are available and it will be possible to obtain a clear view of Japan’s position on the international S&T stage. The countries chosen are Japan, U.S., Germany, France and U.K. For “year”, because of statistical limitations the paper examined the nine years from 1981 to 1989.

As for individual indicators, the paper has chosen those that show the important aspects of S&T activities, that are available on all of the five countries, and that make it possible to draw comparisons among the countries. These individual indicators have been divided into S&T activity input and output. To be exact, all variables when looked at over the long term possess both input and output characteristics, e.g. past output indicators can become future input indicators. Here the paper classified the indicators after determining whether their respective basic characteristics are more closely aligned to input or output. Specifically, the following 13 indicators were chosen.

#### (1) S&T activities input indicators

- 1) Number of persons with a Bachelor of Science degree (B.Sc. number): the number of persons who have been granted a bachelor’s degree in science from the department of natural science of a university [1].
- 2) Number of persons with a Bachelor of Engineering (B.Eng. number): the number of persons who have been granted a bachelor’s degree in engineering from the department of engineering of a university [1]. Although there are slight differences among countries in the way natural science and engineering fields are classified, in time-series analysis these will be influenced by trends in the increase and decrease of numbers, so there are not expected to be any major problems caused by these differences.
- 3) Number of R&D scientists/engineers: the number of persons with at least two years’ experience in research after graduating from university and who are currently engaged in research and development [2]. Though based on OECD standards, the definition of a researcher in each of the countries does differ somewhat. Moreover, while the other developed countries have adopted the FTE (full-time equivalent) method, Japan has not.
- 4) R&D expenditure: the amount of direct expenditure on research and development [2]. This has the same problem as the number of R&D scientists/engineers regarding definition and FTE.
- 5) Technology imports: the amount of payment to foreign countries for technology use rights. For technology imports, cross licenses have been excluded, and the definition and survey methods are different from country to country.

#### (2) S&T activities output indicators

- 6) Number of scientific papers: the number of scientific papers appearing in scientific journals. Specifically, the number of papers recorded in the SCI (Science Citation Index), a science and engineering database [3]. One problem with this is that there is somewhat of a bias in scientific journals (a larger number of English-language journals and clinical medicine journals).

- 7) Number of scientific paper citations: number of times a paper appearing in a scientific journal is cited in other scientific papers [3]. Here the same problem arises as in the previous statistics, and in addition, the older a paper is, the more times it tends to have been cited compared to a more recent paper. Therefore, the total number of citations from 1 (88 were extrapolated from 1 (81–87 values, and the number of citations for each country was obtained by dividing the total number of citations by the past average share of the country.
- 8) Number of domestic patents: number of patents registered in the country of the inventor [4].
- 9) Number of external patents: number of patents registered in countries other than the country of the inventor [4]. There are differences in the character of domestic and overseas patents, e.g. domestic patents are easier to obtain than overseas patents, and since external patents are generally of a higher standing than domestic patents, as the internationalization of industry progresses and the importance of intellectual property rights expands, the number of external patents will increase.
- 10) Number of patent citations: number of existing patents cited at the time of patent registration [5]. Since the United States Patent Office is the only organization to maintain these statistics, the number is actually the number of times patents registered in the United States are cited. And as the patents are only those registered in the United States, the result cannot but be heavily biased towards the United States. In citation here, there is also the same problem as in the citation of papers, so the number of patents cited in recent years has been extrapolated through a similar process.
- 11) Technology exports: the amount of payment from foreign countries for the provision of technology use rights [1]. Here the same problems arise as in technology imports, however the role and nature of technology exports in S&T activities is clearer than that of technology imports.
- 12) Product output: the amount of production by secondary industries [1]. This statistic shows the outcome of S&T activities.
- 13) High tech product output: the amount of production of “high tech” products [1]. The definition of high tech products is set by the United States Department of Commerce based on the ratio of R&D expenditure to total sales. This statistic gives a much better indication of the outcome of S&T activities than the previous statistic.

Here the paper will conduct a principal component analysis, which is a multi-variable analysis method, and factor analysis on the above data.

These are three-dimensional data, but since principal component analysis is geared to two-dimensional data, it is necessary to extend it to three dimensions. So the group developed a three-dimensional principal component analysis model and applied factor analysis (see Reference (2) Supplementation to analysis results).

## 10.3 Analysis Results

### 10.3.1 Structural analysis of S&T activities by factor analysis

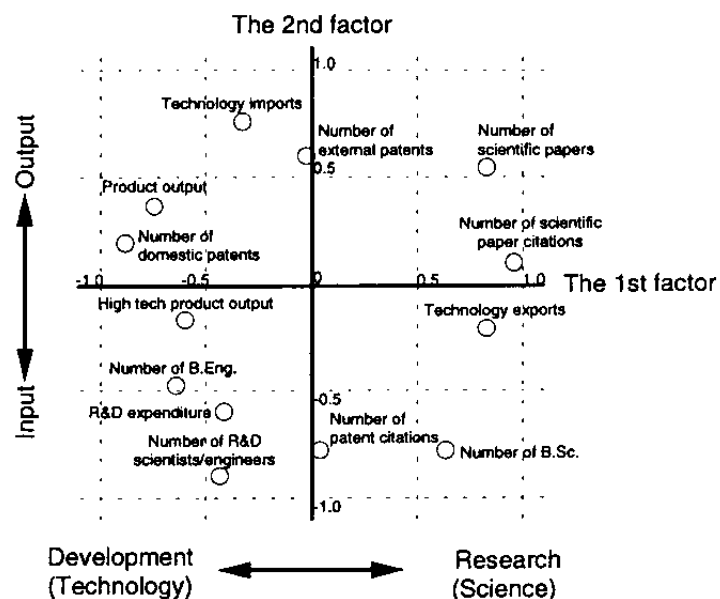
Before showing the composite indicator by principal component analysis, here the paper discusses the results of the factor analysis to clarify the relationship among variables, i.e. the structure. The aim of the factor analysis is therefore to clarify the structure by quantifying the relationship among variables. Therefore to eliminate differences arising from the different country scales so that the structure can be properly comprehended, the thirteen variables relating to S&T activities have been made relative among the five countries. This involved dividing people-related variables (number of R&D scientists/engineers, and the number of B.Sc. and B.Eng.) by population, dividing variables connected with monetary values (R&D expenditure, technology imports and exports, product output and high tech product output) by GNP, and dividing variables connected with R&D output (number of scientific papers, scientific paper citations, number of domestic and external patents, and patent citations) by the number of researchers, so as to cut out any direct effect that differences in the scale of the country may have on each of the variables. Once this was done, factor analysis was then carried out on the variables.

Figure 10-3-1 shows the structure of the variables resulting from factor analysis (see Reference (1) Outline of principal component analysis and factor analysis). The structure shown is common to the S&T activities of the five countries between 1980 and 1989. Variables connected with science and research, or the more basic activities, excluding technology exports, are distributed along the right-hand side of Factor 1 (x-axis), while the variables connected with technology, development and production, or the more applied activities, are distributed along the left-hand side. Thus Factor 1 has a science-technology or basic-applied nature. As for Factor 2, output-related variables are distributed along the upper part, and input-related variables are distributed along the lower part. Factor 2 is thus regarded as the input-output factor. Next, the paper will explain the positioning of each variable and each country based on this interpretation.

“R&D expenditure” and “number of R&D scientists/engineers,” are positioned slightly towards the applied and input sides. This positioning is thought to be appropriate because a breakdown of R&D expenditure and researcher numbers for each country reveals a greater allocation to applied research and development than to basic research, and also these are clearly input variables. As for “number of B.Sc.” and “number of B.Eng.,” the former is basic while the latter is applied, and both are on the input side so their respective positions are considered to be appropriate. “Number of papers” and “number of scientific paper citations” are both positioned towards the basic and output sides. As for patent-related variables, “number of domestic patents” has a strong applied character, while “number of external patents” shows a much weaker applied character. Both are plotted on the output side so their respective positions are appropriate, although “number of patent citations”, which is thought to be an output variable, has appeared on the input side. “Product output” and “high tech product output” are both positioned on the applied side, so the result is considered to be appropriate.

On the other hand, the positioning of “technology exports” and “technology imports” at a glance does not fit in with the interpretation mentioned earlier. That is, “technology exports”, which is regarded as an indicator of technology, is positioned on the right-hand side of the figure (towards the basic or science side), while “technology imports”, which is regarded as an indicator of input, is positioned on the upper part of the figure (in the output side). This apparent anomaly can, however, also be interpreted as showing that since “technology exports” indicates a strength in creative technology, there is a strong connection with science and basic research, so in this light, “technology exports” does not always indicate a strength in technology or the applied aspects. Moreover, “technology imports” shows an ability to utilize technology, and therefore is not necessarily an indicator of input. In any event, a more detailed analysis of what is contained in the data on these points is required in the future.

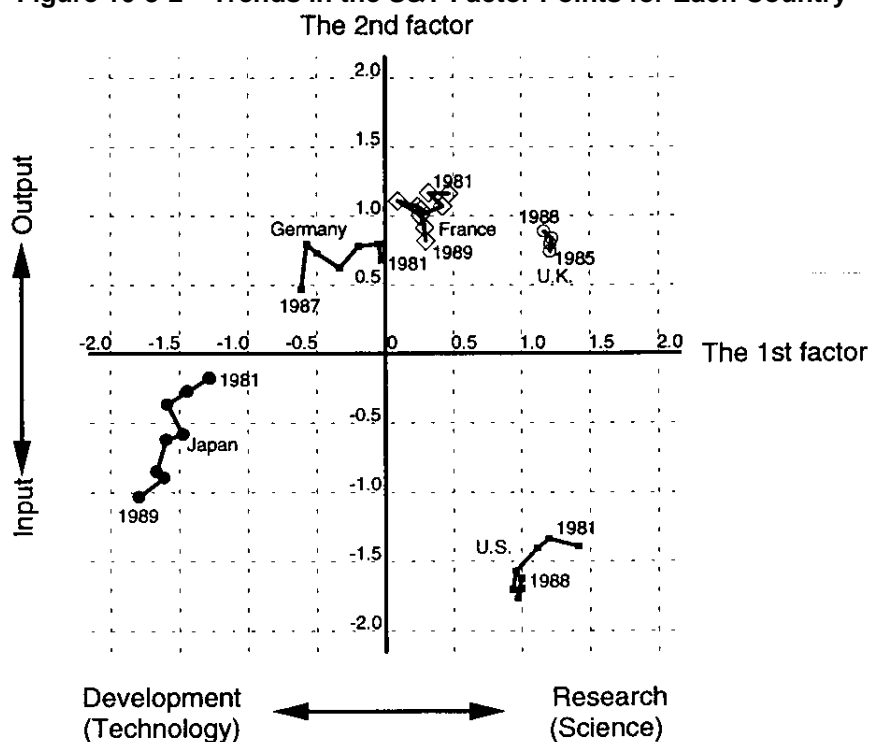
**Figure 10-3-1 Structure of S&T Activity Variables (Factor load)**



Note: The mutual relationship among variables (actual relationship) appears in the positioning of the variables in factor analysis, so they may be in a different position from the meaning indicated by the defining name of the variable.

See Table 10-2

**Figure 10-3-2 Trends in the S&T Factor Points for Each Country**



See Table 10-3

Figure 10-3-2 shows the factor points for each country obtained in this way. Japan is positioned towards technology/applied and also towards input, while the United States has a strong science/basic and input leaning. Germany is on the side of technology/applied and output, while U.K. and France lean towards science/basic and output. A common trend among all countries except France is that the technology/applied aspect is increasing. As for Factor 1 (science/basic–technology/applied), Japan and Germany lean towards technology/applied aspects whereas the other countries lean towards science/basic aspects, and this is in line with what is generally said about the S&T activities of each country, so it is a fair representation of their respective characters. As for Factor 2 (input–output), the reason Japan is positioned in the input part is that its S&T activities are heavily weighted towards development, while the United States leans towards input because a large proportion of its S&T activities is in the area of military research.

### 10.3.2 S&T activities input and output drawing up of composite indicators through principal component analysis

To draw up composite indicators, we carried out a principal component analysis of the same variables as those in the factor analysis and adopted the primary principal component obtained from this as a composite indicator. In view of the structure made clear through the factor analysis discussed in the previous paragraph, we first classified the 13 variables into input and output variables, then attempted to obtain an integrated indicator for each of the two variable classifications. As mentioned earlier in the chapter, all variables when looked at over the long term possess both input and output characteristics, however here we classified each variable after checking its primary character.

Figure 10-3-3 shows national trends in the composite indicator obtained from principal component analysis of the input variables. Japan's indicator value is about half of that of the United States, while those of France, U.K. and Germany are grouped together at about half of that of Japan. The United States showed a marked increase in the early part of the 1980s, but this slowed down somewhat in the latter half of the decade. Japan has shown a steady increase throughout the period, while the European countries have remained generally at the same level.

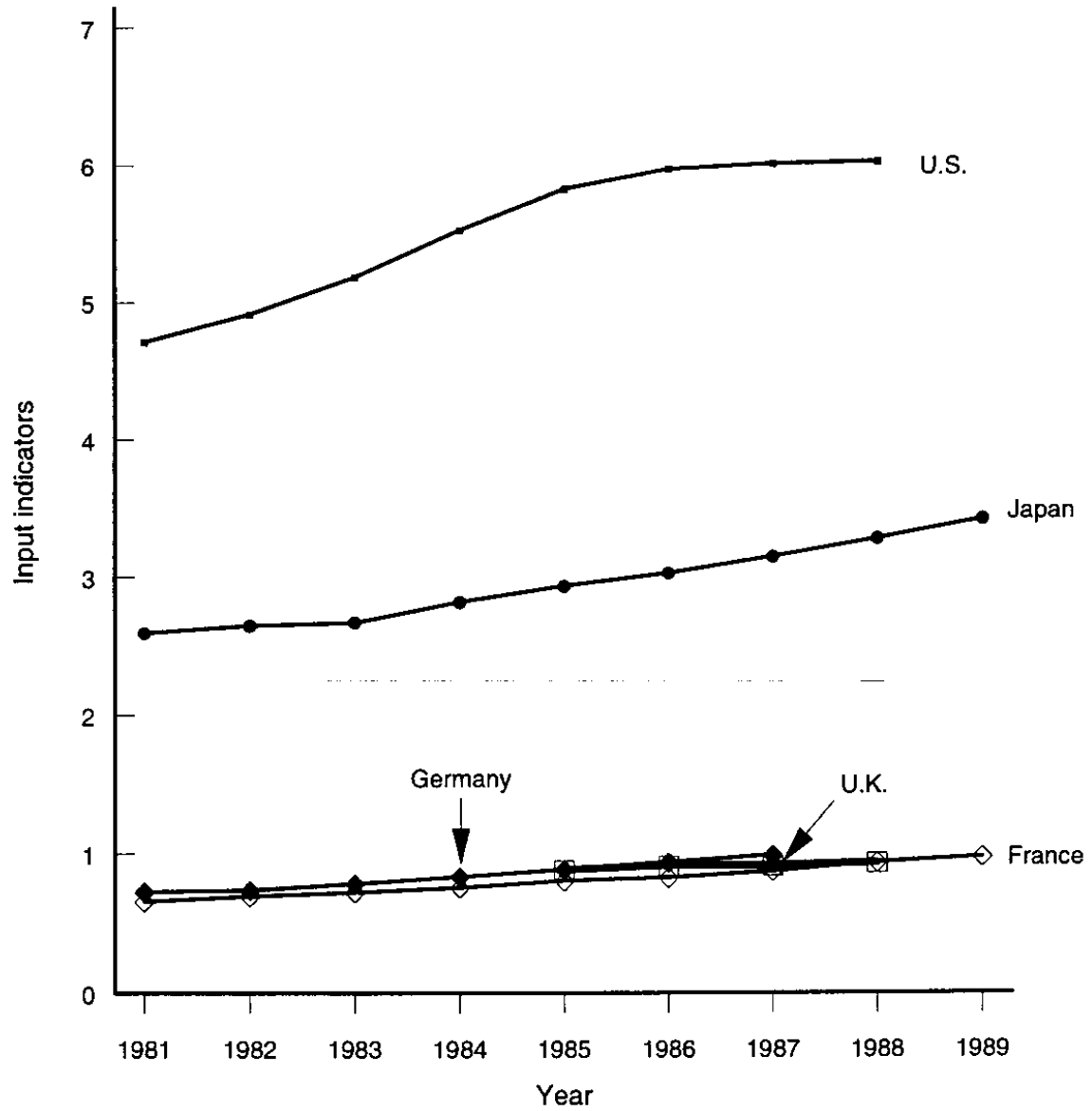
Figure 10-3-4 shows national trends in the composite indicator obtained from output variables. The countries are positioned at roughly the same level as in the case of input variables, although Japan is at a lower level relative to the United States and Germany. However, Japan is increasing at a prominent rate.

In Figure 10-3-5 composite indicators for input are represented by the  $x$ -axis and composite indicators for output are represented by the  $y$ -axis. The figure shows that in all countries there is a strong quantitative relationship between input and output. The United States showed a steady increase in input in the early part of the 1980s while output either decreased or remained at around the same level, however, during the latter half of the 1980s output soared as input leveled off. On the other hand, in Japan both input and output increased steadily during the period, and it worth noting that the rise in output has consistently exceeded the rise in input. In both Japan and the United States in recent years output has increased at a higher rate than input, indicating that their performance has improved. Still, the rise in both countries is only just above the average <sup>(1)</sup>, represented by the oblique straight line in the center of the figure, and below the rise shown by Germany. The input and output indicators of the three European countries are less than half those of Japan, however they are all above the average line, and especially in Germany's case the improvement in performance has been striking.

#### [Note]

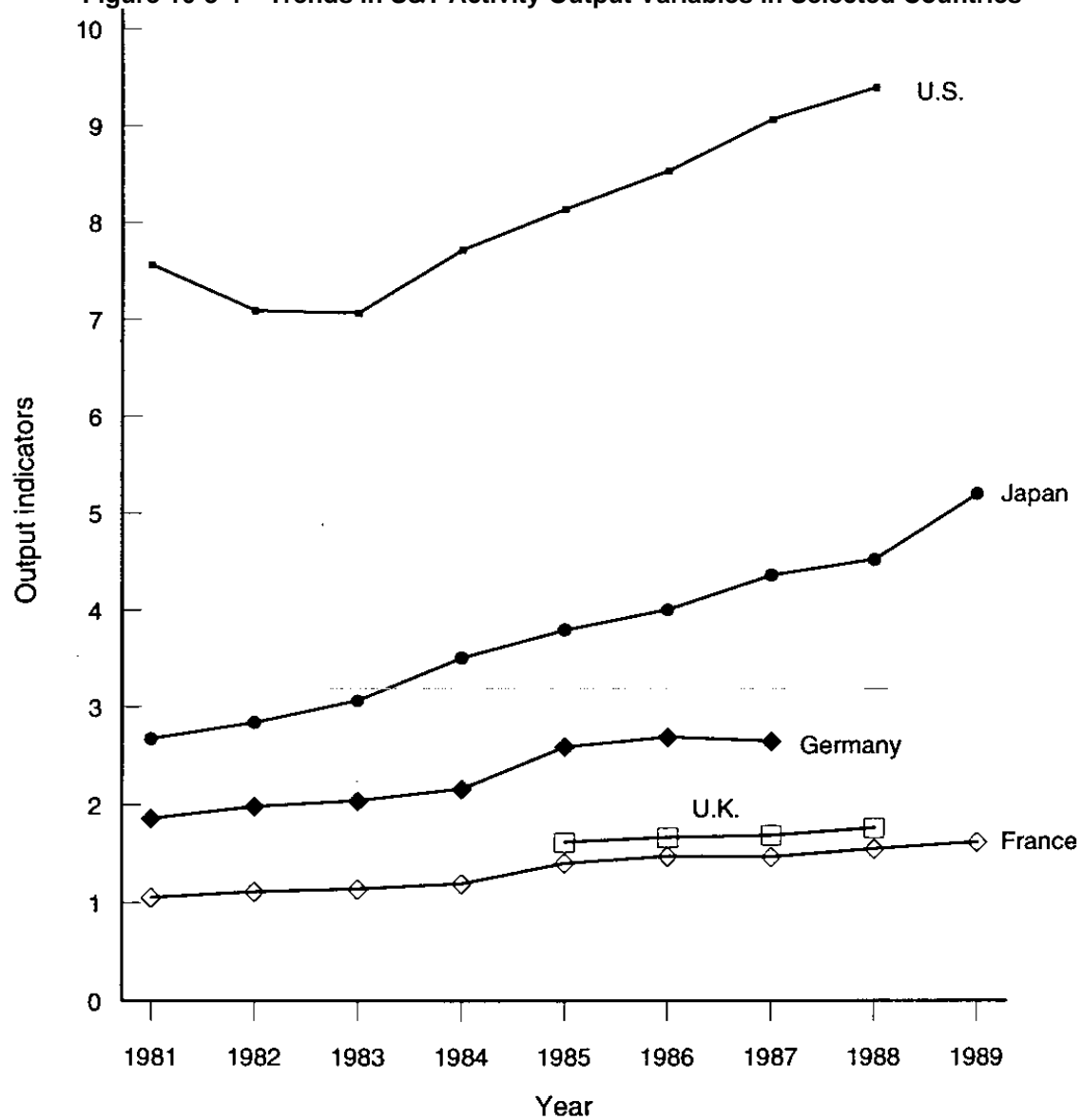
(1) Average here is the geometrical mean of the ratio of input composite indicator and output composite indicator (output/input).

Figure 10-3-3 Trends in S&T Activity Input Variables in Selected Countries



See Table 10-5

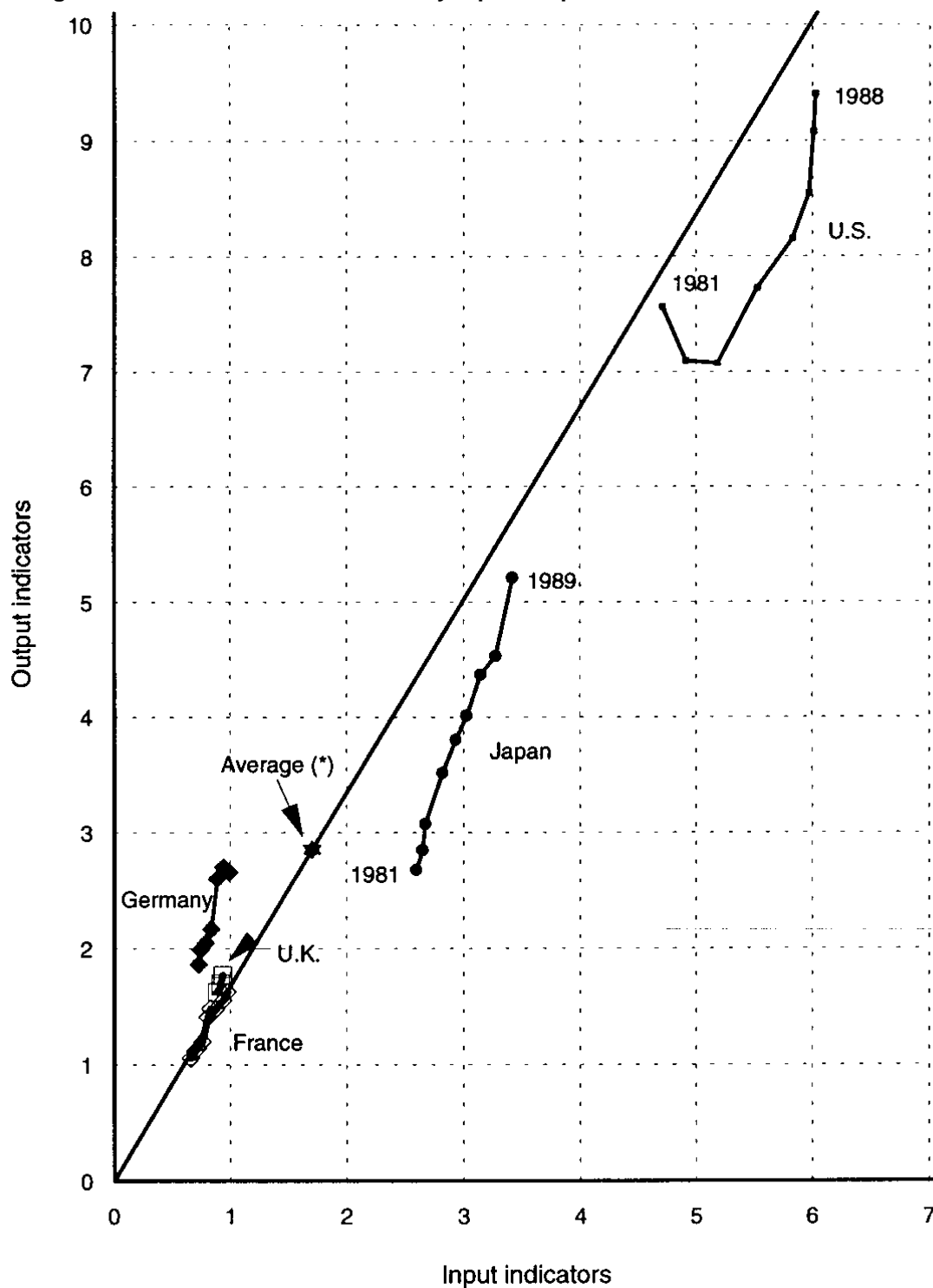
Figure 10-3-4 Trends in S&T Activity Output Variables in Selected Countries



See Table 10-5



Figure 10-3-5 Trends in S&T Activity Input/Output Variables in Selected Countries



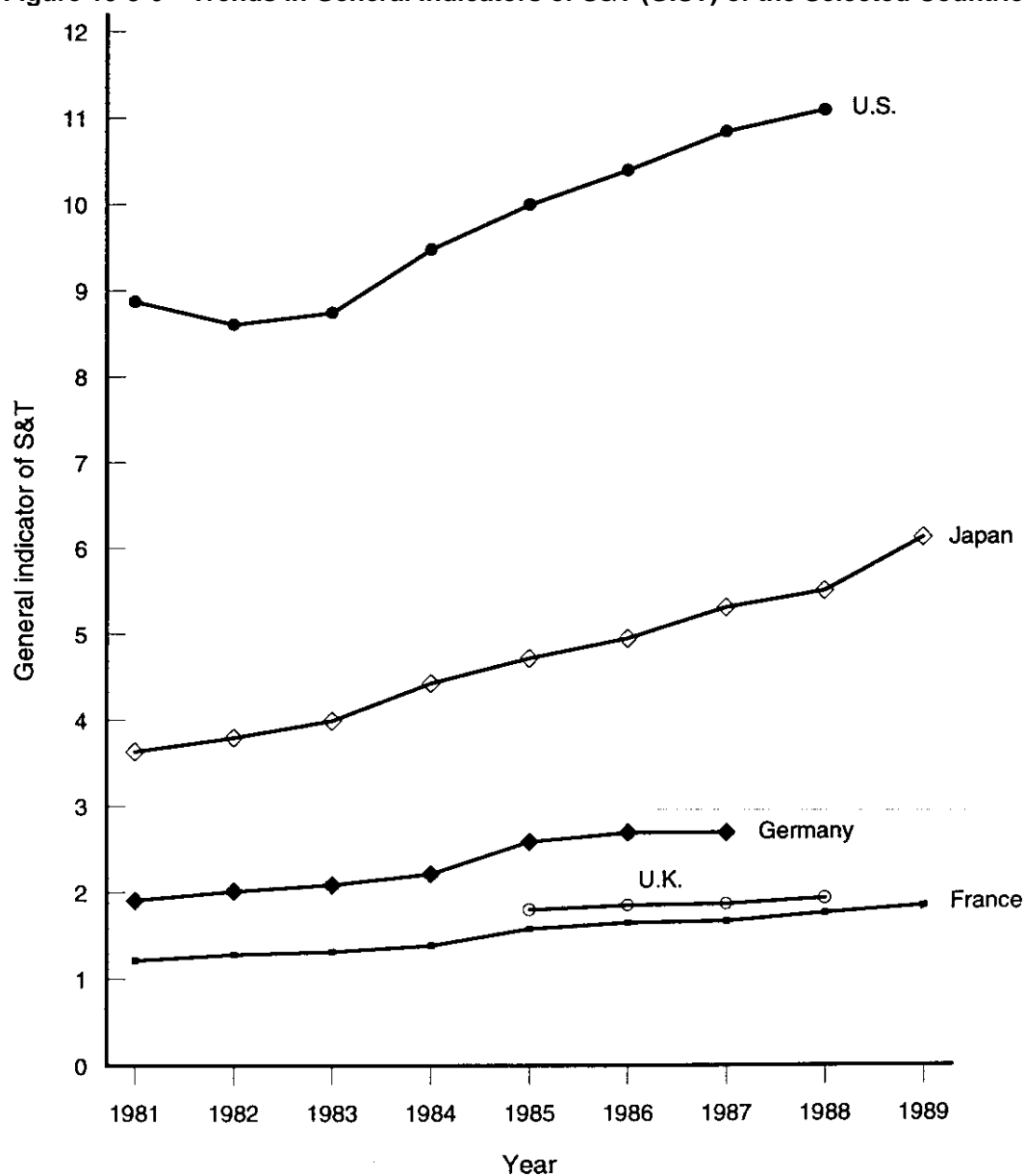
Note: The average is the geometrical mean of the composite indicators of each country and each year. The straight line which connects the origin and the plotted average represents the geometrical mean of the input/output ratio.

See Table 10-5

### 10.3.3 General assessment of S&T activities drawing up of an integrated indicator through principal component analysis

So far this chapter has drawn up composite indicators that represent the S&T activities of a country by a single numerical value. This integrated indicator can be called “General Indicator of Science and Technology (GIST)”. Figure 10-3-6 shows trends in GIST of each country obtained through principal component analysis. Japan is about half of the United States, and Germany, U.K. and France are about half of Japan, in that order. In recent years Japan and the United States have been on an upward trend, while the European countries have remained generally at the same level. The characteristic value that expresses the descriptive capacity of this indicator is 10.1, or 77.7%. Therefore it can be said that this indicator has a descriptive capacity of almost 80%.

**Figure 10-3-6 Trends in General Indicators of S&T (GIST) of the Selected Countries**



See Table 10-7

For two years from 1981 the indicator for the United States fell or leveled off, mainly because the number of domestic and external patents, the number of patent citations, technology exports and product output dropped, and the figures in the other areas did not rise enough to compensate for this drop. It is important to note that all of the variables which induced this drop were S&T activity output variables.

One method of checking whether the composite indicators shown here are appropriate, that is, they comprehensively reflect the S&T activities of the five countries, is a comparison with GNP. The relationship between the economic activities shown by GNP and S&T activities is by no means simple, however there is no doubting the strong links between the two. And indeed, there is a correlation between the composite indicators shown here and the GNP of each of the five countries. However there are a number of points which must be looked into when composite indicators are compared with GNP, including the problem of what to do with the various units of measurement. And it may also be necessary to take into account a time lag when examining any correlation. In any event, further detailed analysis is required.

## Reference (1) Outline of principal component analysis and factor analysis

This section will broadly explain principal component analysis and factor analysis without adhering to mathematical rigidity to help readers who are not familiar with these methods to gain an intuitive understanding of the processes and results. For a more detailed explanation refer to the book on the multi-variable analysis method (shown in the bibliography at the end of the chapter). Here, different from the order in the main text, principal component analysis will be described first, then factor analysis. The reason for this is that in the drawing up of composite indicators, factor analysis is a supplementary method, and, if anything, principal component analysis is the simpler of the two, so it will be easier to understand if principal component analysis is explained first.

### (1) Principal component analysis

Principal component analysis is one method of expressing the overall characteristics of a given subject by the following simple equation when the subject consists of a number of variables, such as  $x_1, x_2, \dots, x_p$ :

$$a_1x_1 + a_2x_2 + \dots + a_px_p$$

That is, when there are many variables, this is a method of summarizing those many variables into one quantity (or a small number of quantities) by adding an appropriate coefficient— $a_1, a_2, \dots, a_p$ —to each of the variables.

Here we shall look at the case in the text as a concrete example. For the analysis in this paper, 13 variables, such as “R&D expenditure”, “number of R&D scientists/engineers” and “number of scientific papers”, were used as variables (indicators) expressing the situation of S&T activities in various countries. Each of the variables was weighted, e.g. R&D expenditure was given a weight of 2, number of scientific papers a weight of 1, etc., then totaled to give a composite indicator. Various composite indicators can be obtained depending upon how the variables are weighted. In principal component analysis, the coefficient used to arrive at comprehensive indicators is determined by logical methods, which will be explained next. The coefficients set as a result of the analysis in this chapter are shown in Table 10-6.

In principal component analysis, the values of several variables— $x_1, x_2, \dots, x_p$ —are represented by a small number of independent comprehensive indicators— $z_1, z_2, \dots, z_m$ —with as little loss of information as possible.

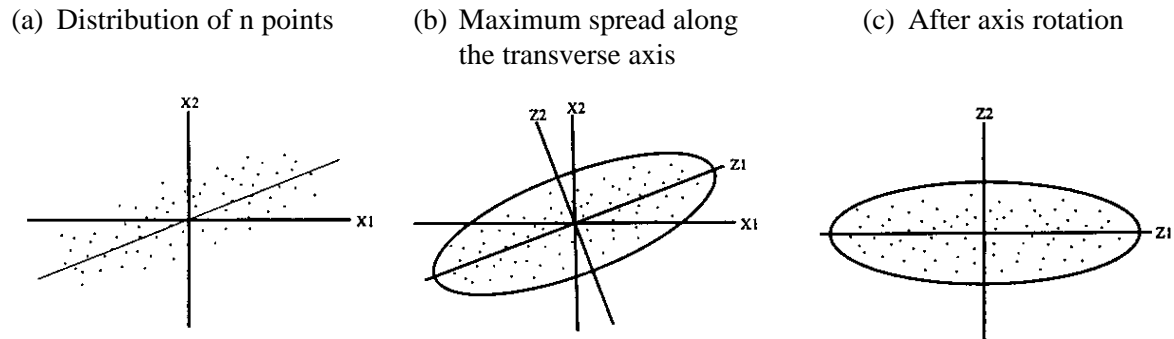
$$\begin{cases} z_1 = a_{11}x_1 + a_{12}x_2 + \dots + a_{1p}x_p \\ z_2 = a_{21}x_1 + a_{22}x_2 + \dots + a_{2p}x_p \\ \dots \dots \dots \\ z_m = a_{m1}x_1 + a_{m2}x_2 + \dots + a_{mp}x_p \end{cases}$$

The indicators  $z_1, z_2, \dots, z_m$  are referred to, respectively, as first, second, ..., and  $m$  principal component. Since the object is to summarize a large number of variables, it is preferable to have as small a number of principal components as possible. Two criteria must be met when obtaining these principal components. Briefly, first there must be minimal information loss, and second,  $z_1, z_2, \dots, z_m$  must be independent of each other. The first means that it does not matter what summation method is used as long as there is minimal information loss, for different methods can result in different degrees of loss. The second means that the given number ( $m$ ) of principal components must not be correlated in any way. The way to obtain coefficients that satisfy these criteria will be explained later.

The above explanation has tended towards the abstract, so here we shall look at principal component analysis in a more concrete form. The example will use the simplest case of  $p=2$ , i.e. there are two variables, and  $n$  situations are expressed by the two variables  $x_1$  and  $x_2$ . In this case, the S&T

activities of  $n$  countries are expressed by the two variables of R&D expenditure and number of researchers. Here a distribution diagram of  $n$  situations is shown in Figure 10-3-7(a).

**Figure 10-3-7**



From the distribution of  $n$  points, it can be seen that there is some form of correlation between variables  $x_1$  and  $x_2$ . If there is a proportional relationship between two variables,  $n$  points will be distributed along a straight line, and in this case one variable is sufficient. In Figure 10-3-7(a), the relationship is not perfectly proportional, although it is nearly proportional, so in approximations a single variable is sufficient. In Figure 10-3-7(b), an ellipse is drawn around the circumference of  $n$  points to show the shape of their distribution. In this case, a new variable  $z_1$  is inserted along the transverse axis, and  $z_2$  is inserted along the conjugate axis (right angles to the transverse axis). This corresponds to a change of coordinates. Here  $z_1$  is the first principal component and  $z_2$  is the second principal component. At this point the following characteristics can be observed.

- 1) There will be greater variance of  $n$  points on the  $z_1$  axis than on any other straight line drawn on this plane (conversely, distribution along the  $z_2$  axis is smallest).
- 2) There is no correlation regarding the  $z_1, z_2$  coordinates of  $n$  points.

The first characteristics can be understood from the fact that in Figure 10-3-7(b)  $n$  points are greatly dispersed along the  $z_1$  axis, keeping in mind that variance is a quantity which indicates the size of the dispersion (the sum of the square of the divergence from average). The second characteristic can be understood from the fact that in Figure 10-3-7(c)  $z_1$  and  $z_2$  are independent. As for a change of coordinates, to actually obtain principal components  $z_1$  and  $z_2$ , the coefficients  $a_1$  and  $a_2$  were set to meet the above characteristics.

$$\begin{cases} z_1 = a_{11}x_1 + a_{12}x_2 \\ z_2 = a_{21}x_1 + a_{22}x_2 \end{cases}$$

In the distribution shown in the figure,  $n$  points are greatly dispersed along the  $z_1$  axis, so when observing data on  $n$  situations (samples), a considerable proportion can be understood solely through  $z_1$ . Therefore if the information shown by the  $z_2$  axis is disregarded, the information contained in the two variables  $x_1$  and  $x_2$  can be summarized in  $z_1$ . In the case where the variables  $x_1$  and  $x_2$  are completely independent of the data on  $n$  situations, and  $n$  points are distributed in the shape of a circle and not an ellipse, regardless of the direction of the new coordinate axes  $z_1$  and  $z_2$  both contain an equal amount of information, so neither can be disregarded. In this case, principal component analysis

Next, the paper will examine a general case with  $p$  number of variables. When there are  $p$  variables  $x_1, x_2, \dots, x_p$ , these, with qualifications, can be represented by the following small number of principal components.

$$\begin{cases} z_1 = a_{11}x_1 + a_{12}x_2 + \dots + a_{1p}x_p \\ z_2 = a_{21}x_1 + a_{22}x_2 + \dots + a_{2p}x_p \\ \dots \dots \dots \\ z_k = a_{k1}x_1 + a_{k2}x_2 + \dots + a_{kp}x_p \\ \dots \dots \dots \\ z_m = a_{m1}x_1 + a_{m2}x_2 + \dots + a_{mp}x_p \end{cases}$$

Here,

$$a_{k1}^2 + a_{k2}^2 + \dots + a_{kp}^2 = 1 \quad (k = 1, 2, \dots, m)$$

The qualifications attached when obtaining principal components are those described in the case of two variables but expanded to  $p$  variables. The following are two of the various ways of expressing this.

- 1) Under this formula, coefficients  $a_{11}, a_{12}, \dots, a_{1p}$  of the first principal component  $z_1$  are set so that there is maximum dispersion with respect to  $z_1$ . Next, the coefficient of the second principal component  $z_2$  is set so that  $z_1$  and  $z_2$  are independent under the above formula, and there is maximum dispersion with respect to  $z_1$ . This is repeated throughout, with the coefficient of  $k$  principal component set so that it is independent of  $z_1, z_2, \dots, z_{k-1}$ , and there is maximum dispersion with respect to  $z_1$ .
- 2) The variables obtained by making a right-angled change to variables  $x_1, x_2, \dots, x_p$  are set as  $z_1, z_2, \dots, z_p$ . These new variables are set so that they are independent of each other, and are arranged in the sequence  $z_1, z_2, \dots, z_m$  in order from the largest variance.

Under the above conditions, the principal component can be obtained if the actually observed data are calculated into variables  $x_1, x_2, \dots, x_p$ . It is preferable that the number of principal components  $m$  is as small as possible, but the number to be adopted as  $m$  is determined by the extent to which information loss can be tolerated. The method used when actually calculating is to convert the variance/covariance matrix or the correlation matrix for the observed data into a diagonal matrix.

## (2) Factor analysis

Factor analysis is mathematically somewhat more complex, so here the paper discusses only the broad outline of the concept. Factor analysis is in some aspects similar to principal component analysis, therefore it is quite easy to understand through these similarities.

Factor analysis is a method of describing information contained in many variables through a small number of latent factors. Latent factors are factors considered to be inherent in the data of many observed variables, although they are not able to be observed directly. It is thought that because of the existence of such factors, a correlation occurs among variables. A comparison of the two shows that while principal component analysis summarizes data on the basis of observed results, factor analysis hypothesizes a statistical model which displays the relationship between the observed data and the latent factors, and when this model is well aligned to the actual data, phenomena can be explained by way of the latent factors.

The following is a hypothesized model in factor analysis.

$$\begin{cases} x_1 = a_{11}f_1 + a_{12}f_2 + \dots + a_{1m}f_m + \epsilon_1 \\ x_2 = a_{21}f_1 + a_{22}f_2 + \dots + a_{2m}f_m + \epsilon_2 \\ \dots \dots \dots \\ x_p = a_{p1}f_1 + a_{p2}f_2 + \dots + a_{pm}f_m + \epsilon_p \end{cases}$$

Here,  $x_1, x_2, \dots, x_p$  are the observed  $p$  number of variables, and  $f_1, f_2, \dots, f_m$  are the  $m$  number of latent common factors, and  $\epsilon_1, \epsilon_2, \dots, \epsilon_p$  are the latent variables referred to as special factors.

The coefficient  $a_{ik}$  ( $i=1, 2, \dots, p$ ;  $k=1, 2, \dots, m$ ) is a constant referred to as factor load of the  $k$  common factor to  $i$  characteristics.

This model assumes the  $p$  number of observed variables contain a common part which can be described by way of linear combination of common factors whose number  $m$  is unknown, and a part  $\epsilon_1$  which is entirely unique. The problem that has to be worked out in factor analysis is the estimation of the unknown factor load and common factors based on the observed data. The right-hand side of the above equations are all unknown, and the basis for solving them has not been established, so various methods have been suggested. These, however, have been omitted here.

## Reference (2)    **Supplementation of analysis results**

Here the paper will supplement the omitted details concerning the principal component analysis and factor analysis results reported on in this chapter. The following explanation is aimed at readers who have a certain level of knowledge about principal component analysis and factor analysis.

### (1)    **Handling of three-dimensional data**

As stated in the main text, the data analyzed in this chapter has a three-dimensional structure of “variable”, “country” and “year”, however principal component analysis and factor analysis deal with two-dimensional data so these methods of analysis must be expanded to three-dimensional. Therefore analysis was carried out using the following three-dimensional models.

The three-dimensional principal component model can be described as follows.

$$Z_{k,jt} = \sum_i l_{k,i} \cdot X_{i,jt} \dots \dots \dots (1)$$

$Z_{k,jt}$  : k S&T composite indicator in year t in country j

$l_{k,i}$  : factor load of the k integrated indicator of the i variable

$X_{i,jt}$  : measured value of i variable in year t in country j

Needless to say, it is preferable for there to be as small a number of integrated indicators as possible; this can be a single indicator when statistically that single indicator is sufficient. In this case, the attached symbol k is unnecessary.

It is assumed that the principal component analysis method will be applied after the three-dimensional data have been converted to two-dimensional in this model. That is, the usual principal component analysis is applied after the two-dimensional data [year × variable] of each country is arranged in order from the top down to form the two-dimensional composition of [(country × year) × variable].

The three dimensional model is also used for factor analysis.

$$X_{jt,i} = \sum_k f_{jt,k} \cdot a_{k,i} + \epsilon_{jt,i} \dots \dots \dots (2)$$

$X_{jt,i}$  : measured value of i variable in year t in country j

$a_{k,i}$  : factor load of the k factor of the i variable

$f_{jt,k}$  : factor point of k factor in year t in country j

$\epsilon_{jt,i}$  : special factor regarding variable i of year t in country j

Although the models for principal component analysis and factor analysis are different, they both use the same data of  $x_{jt,i}$ . A comparison of the two models shows that from the attached letters,  $z_{k,jt}$  closely corresponds to  $f_{jt,k}$ , and  $l_{k,i}$  closely corresponds to  $a_{k,i}$ . In fact, the coefficients can be interchanged.

### (2)    **Factor analysis using absolute quantities**

Although omitted from the main text, factor analysis was also carried out using the absolute quantities of the variables to gain a deeper structural understanding. Absolute quantities are variable quantities that have not been brought to relativity through division by population or GNP. From this, a



factor which is thought to indicate “scale of S&T activities” has been obtained as Factor 1. That is, the factor reflects the size of the absolute quantity of the variable. Factor points of a major country like the United States are high, while those of the three European countries are low. The factor points of Japan generally lie between these two groups. Each variable contributed to Factor 1 with about the same weight. On the other hand, the factors “science—technology” or “basic—applied” were obtained as Factor 2, and these are thought to be the same as Factor 1 when relative quantities are used.

Apart from the above, an analysis was also carried out by calculating each country’s share of each of the variables and using these as the new variables. The result was almost the same as that for absolute quantities.

### **(3) Input and output principal component analysis (supplement)**

This section supplements the results of principal component analysis which classified variables into input and output in section 10.3.2.

Regarding input, as in the case of factor analysis, technology import tends to be independent of other input variables. The characteristic value of the composite input indicator is 3.56, and its percentage is 71.3%. Regarding output, the number of domestic patents was somewhat more independent than other variables. The characteristic value of the composite output indicator is 6.64, and its percentage is 82.9%.

### **(4) Comprehensive principal component analysis (supplement)**

This section supplements the results of principal component analysis on all 13 variables.

The factor load for technology import is 0.01, and those for all other variables are around 0.3 (see Table 10-6). This result indicates that the characteristics of technology import are different from those of the other S&T activity variables. Variables with a high level of correlation with technology import are number of domestic patents (0.580) and B.Eng. number (0.450). These are thought to be S&T activities which are at a separate dimension from international evaluation and therefore display different characteristics from true technological development for the particular country. It goes without saying that further detailed analysis is required.

## Data source

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- [4] Patent Office, *Annual Report of the Patent Office*
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- [6] Management and Coordination Agency, *Report on the Survey of Research & Development*

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Chapter 10 Fujio Niwa

Hiroyuki Tomizawa



## **STATISTICAL TABLES**

Table 2-1-1 Environmental Conditions for Science Education and Their Relationship to Interest in Science

	Number of students in a class					Hours of science class					Hours of experiment/observation relative to total science class hours (%)					Average age of science teachers (years old)					Length of higher education received by science teachers (years)					Number of male science teachers relative to total science teachers (%)					Degree of interest in science*		
	E	J	S			E	J	S			E	J	S			E	J	S			E	J	S			E	J	S			E	J	S
			P	C	B			P	C	B			P	C	B			P	C	B			P	C	B			P	C	B			
Japan	38	42	39	40	36	10	13	7	6	5	41	32	15	22	19	35	38	42	43	40	3.3	3.8	4.2	4.3	4.4	50	85	95	98	83	2.50	1.88	1.75
South Korea	55	65	58	59	58	13	12	7	4	7	38	52	-	-	-	35	35	38	38	38	2.1	4.1	4.4	4.5	4.4	58	65	96	90	84	2.44	-	1.88
Hong Kong	38	40	-	-	-	5	10	13	13	17	13	41	31	37	36	37	31	31	31	32	1.9	2.8	3.9	4.0	4.0	38	66	94	82	55	2.44	2.25	2.38
Philippines	40	48	-	-	-	11	19	-	-	-	40	46	-	-	-	41	33	-	-	-	4.5	4.8	-	-	-	9	10	-	-	-	2.56	2.56	-
Singapore	37	38	24	24	24	11	8-20	7	13	19	27	32	39	38	46	37	35	32	34	37	2.7	3.6	4.0	3.0	4.0	29	38	39	0	0	2.56	2.19	2.13
Thailand	-	42	41	24	41	-	10	10	6	10	-	49	48	50	44	-	28	32	31	32	-	4.0	4.5	4.4	4.4	-	50	84	46	35	-	-	-
Australia	29	28	17	18	19	5	15	8	8	5	33	37	30	32	37	33	34	35	36	36	3.5	4.6	4.9	5.0	4.8	44	74	87	80	55	2.38	2.13	2.06
Finland	24	16	22	22	26	14	13	5	4	4	17	37	31	50	17	42	39	41	36	45	4.1	5.7	5.9	5.8	5.9	50	49	75	52	55	2.44	2.06	1.94
Sweden	23	-	24	24	22	6	15	6	-	6	-	-	-	-	-	47	45	-	-	-	2.0	2.0	-	-	-	38	73	-	-	-	2.31	2.06	2.38
Norway	20	23	24	-	-	8	10	5	5	5	-	-	-	-	-	41	36	-	-	-	3.3	4.7	-	-	-	35	82	-	-	-	2.44	2.13	-
U.K.	28	28	12	12	11	3	10	8	10	8	38	42	32	35	35	39	36	39	38	37	3.5	4.3	4.5	4.8	4.7	40	69	86	82	66	2.38	2.19	2.13
Poland	27	25	30	31	31	16	23	6	10	10	21	23	22	29	26	38	37	40	40	41	3.8	4.1	5.2	5.6	5.5	15	25	38	23	12	2.56	2.50	2.13
Hungary	28	28	29	11	30	10	22	12	17	14	26	27	21	-	24	38	38	40	-	42	2.9	4.0	5.4	-	5.4	16	30	62	-	38	2.56	2.50	2.00
Italy	-	27	-	-	-	-	-	6	5	6	13	11	7	18	22	45	42	41	43	39	0.9	4.2	4.2	4.5	4.0	13	39	48	41	39	2.63	-	-
Canada (ON)	25	30	-	-	-	5	14	-	-	-	15	27	25	26	28	41	40	43	37	39	3.9	4.8	5.5	5.6	5.8	22	73	95	80	77	2.50	2.25	-
U.S.	24	22	17	-	17	10	20	-	-	-	-	-	-	-	-	40	38	43	43	43	3.3	3.4	6.4	5.8	5.9	29	70	94	65	51	-	-	-
Av. for Australia, Europe and U.S.	25	25	22	20	22	9	16	7	8	7	23	29	24	32	27	40	39	40	39	40	3.1	4.2	5.3	5.3	5.3	30	58	73	60	49	2.47	2.23	2.11
Israel	32	-	-	-	-	8	12	-	-	15	42	31	-	-	-	34	35	-	-	-	2.6	4.8	-	-	-	7	30	-	-	-	-	-	-
Nigeria	32	36	-	-	-	-	-	-	-	-	26	32	-	-	-	28	33	-	-	-	1.1	4.8	-	-	-	74	79	-	-	-	2.50	2.75	-
Ghana	-	39	31	31	16	-	-	19	20	21	-	29	50	50	31	-	30	28	29	32	-	4.2	5.0	4.3	3.8	-	93	100	50	80	-	-	-

Note 1: E, J and S denote elementary, junior high and senior high schools, respectively. P, C and B denote physics, chemistry and biology class students, or physics, chemistry and biology teachers, respectively.

Note 2: Degree of interest in science:      interested      greater than 2.0  
    not sure      equal to 2.0  
    not interested      smaller than 2.0

Source: Compiled from "International Comparison of Science Education" (1993) published by National Institute of Educational Research.

Table 2-1-2 18-year-old Population

Year	Total population (x1000)	18-year-old population (x1000)	Percentage of 18-year-old	Year	Total population (x1000)	18-year-old population (x1000)	Percentage of 18-year-old
1920	55,963	1,093	2.0%	1968	101,331	2,222	2.2%
1921	56,666	1,093	1.9%	1969	102,536	2,222	2.2%
1922	57,390	1,043	1.8%	1970	103,720	1,891	1.8%
1923	58,119	1,051	1.8%	1971	105,145	1,813	1.7%
1924	58,876	1,024	1.7%	1972	107,595	1,812	1.7%
1925	59,737	1,158	1.9%	1973	109,104	1,707	1.6%
1926	60,741	1,188	2.0%	1974	110,573	1,706	1.5%
1927	61,659	1,237	2.0%	1975	111,940	1,536	1.4%
1928	62,595	1,219	1.9%	1976	113,094	1,582	1.4%
1929	63,461	1,255	2.0%	1977	114,165	1,581	1.4%
1930	64,450	1,302	2.0%	1978	115,190	1,589	1.4%
1931	65,457	1,307	2.0%	1979	116,155	1,571	1.4%
1932	66,434	1,328	2.0%	1980	117,060	1,590	1.4%
1933	67,432	1,290	1.9%	1981	117,884	1,638	1.4%
1934	68,309	1,311	1.9%	1982	118,693	1,681	1.4%
1935	69,254	1,281	1.8%	1983	119,483	1,794	1.5%
1936	70,114	1,257	1.8%	1984	120,235	1,444	1.2%
1937	70,630	1,221	1.7%	1985	121,049	1,859	1.5%
1938	71,013	1,481	2.1%	1986	121,699	1,851	1.5%
1939	71,380	1,391	1.9%	1987	122,336	1,894	1.5%
1940	71,933	1,440	2.0%	1988	122,965	1,922	1.6%
1941	72,218	-	-	1989	123,593	1,979	1.6%
1942	72,880	-	-	1990	123,611	2,027	1.6%
1943	73,903	-	-	1991	124,043	2,068	1.7%
1944	74,433	1,542	2.1%	1992	124,433	2,035	1.6%
1945	72,147	1,604	2.2%	1993	124,836	1,924	1.5%
1946	75,750	1,601	2.1%	1994	125,260	1,842	1.5%
1947	78,101	1,616	2.1%	1995	125,711	1,751	1.4%
1948	80,002	1,639	2.0%	1996	126,194	1,707	1.4%
1949	81,773	1,695	2.1%	1997	126,712	1,638	1.3%
1950	83,200	1,710	2.1%	1998	127,265	1,596	1.3%
1951	84,541	1,720	2.0%	1999	127,848	1,528	1.2%
1952	85,808	1,699	2.0%	2000	128,457	1,509	1.2%
1953	86,981	1,744	2.0%	2001	129,083	1,504	1.2%
1954	88,239	1,812	2.1%	2002	129,714	1,488	1.1%
1955	89,276	1,767	2.0%	2003	130,341	1,437	1.1%
1956	90,172	1,694	1.9%	2004	130,949	1,372	1.0%
1957	90,928	1,575	1.7%	2005	131,530	1,341	1.0%
1958	91,767	1,788	1.9%	2006	132,073	1,297	1.0%
1959	92,641	1,958	2.1%	2007	132,571	1,254	0.9%
1960	93,419	1,949	2.1%	2008	133,018	1,203	0.9%
1961	94,287	1,889	2.0%	2009	133,409	1,204	0.9%
1962	95,181	1,950	2.0%	2010	133,739	1,214	0.9%
1963	96,156	1,601	1.7%	2011	134,007	1,214	0.9%
1964	97,182	1,503	1.5%	2012	134,213	1,225	0.9%
1965	98,275	2,295	2.3%	2013	134,356	1,244	0.9%
1966	99,036	2,422	2.4%	2014	134,438	1,271	0.9%
1967	100,196	2,450	2.4%	2015	134,460	1,303	1.0%

Note (1): Figures for 1920, 1925, 1930, 1935, 1940, 1947, 1950, 1955, 1960, 1965, 1970, 1975, 1980 and 1985 are cited from the census.

Figures for other years up to 1990 are provided by the statistics Bureau, Management and Coordination Agency, Prime Minister's Office.

Note (2): Figures for 1991 and thereafter are cited from "Population Projection for Japan: 1991-2090 (Estimates as of September 1992)" published by the Institute of Population Problems, Ministry of Health and Welfare.

Table 2-2-1 Students Advancing to Senior High Scho

Year	Junior high Number of graduates	Senior high (full-time) Number of incoming students	Senior high (full-time) Advancement rate (%)
1955	1,663,184	730,169	43.9
1960	1,770,483	914,911	51.7
1965	2,359,558	1,547,080	65.6
1970	1,667,064	1,284,507	77.1
1975	1,580,495	1,398,527	88.5
1980	1,723,025	1,578,499	91.6
1985	1,882,034	1,719,907	91.4
1990	1,981,503	1,821,364	91.9
1991	1,860,300	1,716,345	92.3
1992	1,773,712	1,645,199	92.8

Note: Students graduate their schools in March.

Source: Ministry of Education, "Fundamental School Research"

Table 2-2-2 Ratio of Senior High School Students in Industrial Courses

Year	Total number of students (x1000)	Number of students in industrial courses (x1000)	Percentage of students in industrial courses (%)
1955	2,572	237	9.2
1960	3,226	324	10.0
1965	5,066	624	12.3
1970	4,223	566	13.4
1975	4,327	509	11.8
1980	4,616	475	10.3
1985	5,172	478	9.3
1990	5,617	486	8.7
1991	5,448	473	8.7
1992	5,212	454	8.7

Sources: Ministry of Education, "Fundamental School Research"

Table 2-2-3 Ratio of Senior High School Students in Information Science Courses

		(Number of students)				
Year		1980	1985	1990	1991	1992
Industrial courses	Total (A)	474,515	478,416	486,132	472,804	454,358
	Students in information- related courses (B)	4,021	5,806	17,325	20,088	23,191
	Percentage	0.8	1.2	3.6	4.2	5.1
Commercial courses	Total (C)	579,170	582,232	583,447	561,369	532,465
	Students in information- related courses (D)	16,652	20,254	53,581	60,898	67,609
	Percentage	2.9	3.5	9.2	10.8	12.7
Total	Total (A+C)	1,053,685	1,060,648	1,069,579	1,034,173	986,823
	Index	100	101	102	98	94
	Students in information- related courses (B+D)	20,673	26,060	70,906	80,986	90,800
	Index	100	126	343	392	439

Source: Ministry of Education, "Fundamental School Research"



Table 2-2-4 Applicants to and Enrollees in Colleges and Universities by Department

## Number of Applicants

Year	Science and engineering			Total	Index	Economics and commerce			Total	Index	Law	Index	Grand total	Index
	Physical science	Engineering	Sci./Eng.			Economic s	Management	Commerce						
1965	22,413	157,492	47,777	227,682	100	175,232	30,001	102,523	307,756	100	125,553	100	1,203,337	100
1966	27,102	199,106	59,368	285,576	125	211,445	52,742	132,813	397,000	129	151,960	121	1,516,506	126
1967	31,688	234,112	78,568	344,368	151	246,992	65,020	146,897	458,909	149	188,812	150	1,769,995	147
1968	34,374	261,313	86,877	382,564	168	267,815	74,565	144,199	486,579	158	198,445	158	1,896,060	158
1969	40,420	306,548	92,543	439,511	193	265,659	86,235	141,042	492,936	160	206,568	165	1,979,647	165
1970	46,479	322,576	104,226	473,281	208	250,796	80,225	124,084	455,105	148	191,825	153	1,943,207	161
1971	46,829	325,135	109,799	481,763	212	248,190	84,235	115,688	448,113	146	188,749	150	1,952,684	162
1972	47,191	313,287	106,013	466,491	205	250,772	78,478	115,946	445,196	145	196,400	156	1,975,590	164
1973	45,286	310,176	107,975	463,437	204	254,655	96,149	125,356	476,160	155	204,032	163	2,071,785	172
1974	52,490	337,122	108,822	498,434	219	300,445	111,452	152,160	564,057	183	242,681	193	2,320,113	193
1975	60,014	349,144	124,647	533,805	234	389,523	134,707	190,389	714,619	232	299,032	238	2,756,699	229
1976	62,424	332,459	117,215	512,098	225	395,539	150,427	195,884	741,850	241	286,219	228	2,794,518	232
1977	64,195	349,181	120,161	533,537	234	430,667	159,840	208,173	798,680	260	308,325	246	2,975,894	246
1978	66,952	373,095	132,629	572,676	252	472,516	165,347	221,260	859,123	279	311,668	248	3,127,128	260
1979	53,958	308,982	115,038	477,978	210	429,936	157,658	207,933	795,527	258	311,198	248	2,796,686	232
1980	52,952	281,322	112,326	446,600	196	420,018	147,727	194,758	762,503	248	289,953	231	2,658,633	221
1981	50,019	272,593	124,336	446,948	196	408,180	144,787	196,098	749,065	243	287,251	229	2,608,930	217
1982	52,585	294,623	125,042	472,250	207	394,581	146,792	202,601	743,974	242	270,759	216	2,590,165	215
1983	56,904	349,973	137,948	544,825	239	410,354	145,831	199,848	756,033	246	268,009	213	2,697,177	224
1984	62,747	403,791	150,600	617,138	271	410,166	138,783	209,009	757,958	246	282,483	225	2,794,692	232
1985	64,377	433,731	158,064	656,172	288	391,138	127,862	199,739	718,739	234	254,015	202	2,729,799	227
1986	64,473	498,932	161,813	725,218	319	398,389	140,357	222,089	760,835	247	257,729	205	2,918,628	243
1987	81,487	603,939	162,554	847,980	372	504,440	155,445	250,967	910,852	296	312,032	249	3,541,188	294
1988	74,493	572,371	173,802	820,666	360	589,439	183,683	286,080	1,059,202	344	324,984	259	3,766,338	313
1989	73,060	574,500	197,038	844,598	371	668,600	221,336	330,393	1,220,329	397	378,694	302	4,119,609	342
1990	80,306	600,699	213,576	894,581	393	776,144	247,173	359,687	1,383,004	449	433,788	346	4,639,980	386
1991	80,958	615,782	223,413	920,153	404	825,578	276,989	367,200	1,469,767	478	442,903	353	4,937,867	410
1992	85,615	623,367	221,760	930,742	409	810,159	269,174	348,304	1,427,637	464	457,215	364	5,062,862	421

## Enrollees

Year	Science and engineering			Total	Index	Economics and commerce			Total	Index	Law	Index	Grand total	Index
	Physical science	Engineering	Sci./Eng.			Economic s	Management	Commerce						
1965	5,688	37,831	10,925	54,444	100	35,057	5,323	21,022	61,402	100	23,036	100	249,917	100
1966	6,309	44,529	12,168	63,006	116	41,376	8,287	23,083	72,746	118	25,969	113	292,958	117
1967	6,615	47,603	13,527	67,745	124	44,913	10,003	23,174	78,090	127	29,241	127	312,747	125
1968	6,721	50,214	13,694	70,629	130	45,769	10,810	24,635	81,214	132	30,795	134	325,632	130
1969	6,761	53,842	14,029	74,632	137	46,599	11,735	24,183	82,517	134	29,896	130	329,374	132
1970	7,306	55,029	13,175	75,510	139	46,528	12,251	24,487	83,266	136	30,921	134	333,037	133
1971	7,249	59,046	14,683	80,978	149	49,110	12,695	25,523	87,328	142	33,166	144	357,821	143
1972	7,696	59,777	14,624	82,097	151	52,083	13,876	26,692	92,651	151	35,731	155	376,147	151
1973	7,924	60,976	15,234	84,134	155	52,334	14,866	27,512	94,712	154	36,698	159	389,560	156
1974	7,778	62,565	15,362	85,705	157	56,313	16,520	29,335	102,168	166	38,405	167	407,528	163
1975	7,888	65,899	14,902	88,689	163	58,894	16,445	30,798	106,137	173	39,334	171	423,942	170
1976	7,980	65,271	14,819	88,070	162	58,011	16,628	29,925	104,564	170	36,980	161	420,616	168
1977	8,460	67,101	14,369	89,930	165	60,125	15,622	29,731	105,478	172	37,824	164	428,412	171
1978	8,797	66,708	13,581	89,086	164	58,973	15,385	30,296	104,654	170	37,871	164	425,718	170
1979	8,993	62,241	13,099	84,333	155	55,642	14,219	28,831	98,692	161	35,154	153	407,635	163
1980	9,322	64,432	12,852	86,606	159	56,533	14,573	28,750	99,856	163	35,605	155	412,473	165
1981	9,559	64,412	14,424	88,395	162	55,826	13,593	28,131	97,550	159	36,011	156	413,236	165
1982	9,654	66,202	13,990	89,846	165	54,805	13,656	27,042	95,503	156	35,164	153	414,536	166
1983	9,869	66,831	14,786	91,486	168	55,965	13,214	26,838	96,017	156	35,872	156	420,458	168
1984	9,921	65,928	13,627	89,476	164	54,562	12,930	26,966	94,458	154	35,131	153	416,002	166
1985	9,759	65,937	13,326	89,022	164	53,505	13,009	26,587	93,101	152	34,982	152	411,993	165
1986	9,848	70,051	13,817	93,716	172	58,040	13,567	27,310	98,917	161	37,971	165	436,896	175
1987	10,368	74,597	14,962	99,927	184	62,377	15,546	28,727	106,650	174	40,958	178	465,503	186
1988	10,492	75,223	14,103	99,818	183	63,472	15,938	29,058	108,468	177	41,687	181	472,965	189
1989	10,680	73,511	16,323	100,514	185	62,828	16,266	28,376	107,470	175	42,431	184	476,786	191
1990	11,087	76,117	17,349	104,553	192	65,688	16,881	28,161	110,730	180	42,908	186	492,340	197
1991	11,607	80,608	18,188	110,403	203	72,047	19,820	28,578	120,445	196	45,750	199	521,899	209
1992	12,139	82,213	19,319	113,671	209	70,048	20,477	30,047	120,572	196	47,542	206	541,604	217

Note: Each figure shows the number of students in departments that have exactly the name given in the table.

Students in departments with other names, such as the department of politics and economics and the department of basic engineering, are not included. So, the numbers of students are smaller than those in Table 2-4-2.

Source: Ministry of Education, "Fundamental School Research"

Table 2-2-5 Female Applicants in Colleges and Universities by Department

Year	Science and engineering			Total	Index	Economics and commerce			Total	Index	Law	Index	Grand total	Index
	Physical science	Engineering	Sci./Eng.			Economics	Management	Commerce						
1965	1,730	422	467	2,619	1.2%	2,269	208	1,110	3,587	1.2%	3,441	2.7%	168,893	14.0%
1966	2,640	715	1,051	4,406	1.5%	3,486	705	1,920	6,111	1.5%	5,309	3.5%	231,149	15.2%
1967	3,260	1,042	1,379	5,681	1.6%	4,458	1,021	2,520	7,999	1.7%	7,036	3.7%	259,752	14.7%
1968	3,875	1,194	1,630	6,699	1.8%	5,439	1,474	2,762	9,675	2.0%	7,947	4.0%	275,987	14.6%
1969	4,572	1,561	1,721	7,854	1.8%	6,476	1,509	2,949	10,934	2.2%	8,446	4.1%	283,185	14.3%
1970	4,598	1,659	1,917	8,174	1.7%	6,095	1,498	3,190	10,783	2.4%	8,355	4.4%	282,166	14.5%
1971	4,805	1,922	1,739	8,466	1.8%	8,306	2,049	3,594	13,949	3.1%	9,952	5.3%	312,924	16.0%
1972	4,986	1,900	2,307	9,193	2.0%	8,779	2,403	3,974	15,156	3.4%	11,141	5.7%	346,083	17.5%
1973	5,088	2,097	2,608	9,793	2.1%	10,065	3,636	5,003	18,704	3.9%	13,078	6.4%	390,937	18.9%
1974	6,177	2,636	2,598	11,411	2.3%	13,410	4,722	6,890	25,022	4.4%	16,169	6.7%	442,144	19.1%
1975	6,742	2,624	3,029	12,395	2.3%	20,250	6,188	9,046	35,484	5.0%	19,635	6.6%	526,435	19.1%
1976	7,568	2,683	3,666	13,917	2.7%	20,635	7,110	9,603	37,348	5.0%	18,457	6.4%	545,715	19.5%
1977	8,433	3,649	4,121	16,203	3.0%	21,585	8,307	10,673	40,565	5.1%	21,235	6.9%	572,742	19.4%
1978	8,571	4,328	5,040	17,939	3.1%	21,355	8,425	10,778	40,558	4.7%	21,316	6.8%	576,527	18.4%
1979	6,926	4,099	4,773	15,798	3.3%	19,333	7,982	9,508	36,823	4.6%	21,737	7.0%	519,424	18.6%
1980	6,904	4,572	4,622	16,098	3.6%	18,021	6,709	9,196	33,926	4.4%	20,315	7.0%	496,125	18.7%
1981	6,857	4,869	5,084	16,810	3.8%	16,261	6,244	8,257	30,762	4.1%	20,678	7.2%	470,345	18.0%
1982	8,168	6,235	5,891	20,294	4.3%	16,547	6,613	8,609	31,769	4.3%	20,308	7.5%	469,815	18.1%
1983	8,877	8,023	6,842	23,742	4.4%	17,935	6,700	8,617	33,252	4.4%	22,156	8.3%	496,811	18.4%
1984	9,338	9,751	7,178	26,267	4.3%	19,818	7,296	10,616	37,730	5.0%	24,123	8.5%	522,564	18.7%
1985	9,392	10,702	7,912	28,006	4.3%	19,110	6,825	10,148	36,083	5.0%	23,519	9.3%	503,450	18.4%
1986	9,996	11,271	7,582	28,849	4.0%	20,922	8,251	12,236	41,409	5.4%	25,308	9.8%	550,959	18.9%
1987	13,026	14,270	7,675	34,971	4.1%	29,844	10,217	16,534	56,595	6.2%	33,213	10.6%	694,876	19.6%
1988	11,788	15,123	8,325	35,236	4.3%	41,620	13,307	21,496	76,423	7.2%	40,236	12.4%	773,170	20.5%
1989	11,893	16,984	9,879	38,756	4.6%	51,627	19,076	27,666	98,369	8.1%	49,689	13.1%	854,880	20.8%
1990	13,585	22,180	11,831	47,596	5.3%	62,368	23,404	33,989	119,761	8.7%	59,143	13.6%	1,004,160	21.6%
1991	14,664	27,045	13,335	55,044	6.0%	69,383	29,606	36,472	135,461	9.2%	64,032	14.5%	1,110,583	22.5%
1992	17,845	31,099	14,889	63,833	6.9%	71,669	29,419	36,203	137,291	9.6%	69,012	15.1%	1,192,426	23.6%

Note: Each figure shows the number of students in departments that have exactly the name given in the table.

Students in departments with other names, such as the department of politics and economics and the department of basic engineering, are not included.

Source: Ministry of Education, "Fundamental School Research"

Table 2-2-6 Admission Competitiveness of Colleges and Universities by Department

Year	Science and engineering			Total	Index	Economics and commerce			Total	Index	Law	Index	Grand total	Index
	Physical science	Engineering	Sci./Eng.			Economics	Management	Commerce						
1965	3.9	4.2	4.4	4.2	100	5.0	5.6	4.9	5.0	100	5.5	100	4.8	100
1966	4.3	4.5	4.9	4.5	108	5.1	6.4	5.8	5.5	109	5.9	107	5.2	108
1967	4.8	4.9	5.8	5.1	122	5.5	6.5	6.3	5.9	117	6.5	118	5.7	118
1968	5.1	5.2	6.3	5.4	130	5.9	6.9	5.9	6.0	120	6.4	118	5.8	121
1969	6.0	5.7	6.6	5.9	141	5.7	7.3	5.8	6.0	119	6.9	127	6.0	125
1970	6.4	5.9	7.9	6.3	150	5.4	6.5	5.1	5.5	109	6.2	114	5.8	121
1971	6.5	5.5	7.5	5.9	142	5.1	6.6	4.5	5.1	102	5.7	104	5.5	113
1972	6.1	5.2	7.2	5.7	136	4.8	5.7	4.3	4.8	96	5.5	101	5.3	109
1973	5.7	5.1	7.1	5.5	132	4.9	6.5	4.6	5.0	100	5.6	102	5.3	110
1974	6.7	5.4	7.1	5.8	139	5.3	6.7	5.2	5.5	110	6.3	116	5.7	118
1975	7.6	5.3	8.4	6.0	144	6.6	8.2	6.2	6.7	134	7.6	139	6.5	135
1976	7.8	5.1	7.9	5.8	139	6.8	9.0	6.5	7.1	142	7.7	142	6.6	138
1977	7.6	5.2	8.4	5.9	142	7.2	10.2	7.0	7.6	151	8.2	150	6.9	143
1978	7.6	5.6	9.8	6.4	154	8.0	10.7	7.3	8.2	164	8.2	151	7.3	153
1979	6.0	5.0	8.8	5.7	136	7.7	11.1	7.2	8.1	161	8.9	162	6.9	142
1980	5.7	4.4	8.7	5.2	123	7.4	10.1	6.8	7.6	152	8.1	149	6.4	134
1981	5.2	4.2	8.6	5.1	121	7.3	10.7	7.0	7.7	153	8.0	146	6.3	131
1982	5.4	4.5	8.9	5.3	126	7.2	10.7	7.5	7.8	155	7.7	141	6.2	130
1983	5.8	5.2	9.3	6.0	142	7.3	11.0	7.4	7.9	157	7.5	137	6.4	133
1984	6.3	6.1	11.1	6.9	165	7.5	10.7	7.8	8.0	160	8.0	148	6.7	140
1985	6.6	6.6	11.9	7.4	176	7.3	9.8	7.5	7.7	154	7.3	133	6.6	138
1986	6.5	7.1	11.7	7.7	185	6.9	10.3	8.1	7.7	153	6.8	125	6.7	139
1987	7.9	8.1	10.9	8.5	203	8.1	10.0	8.7	8.5	170	7.6	140	7.6	158
1988	7.1	7.6	12.3	8.2	197	9.3	11.5	9.8	9.8	195	7.8	143	8.0	165
1989	6.8	7.8	12.1	8.4	201	10.6	13.6	11.6	11.4	227	8.9	164	8.6	179
1990	7.2	7.9	12.3	8.6	205	11.8	14.6	12.8	12.5	249	10.1	185	9.4	196
1991	7.0	7.6	12.3	8.3	199	11.5	14.0	12.8	12.2	243	9.7	178	9.5	196
1992	7.1	7.6	11.5	8.2	196	11.6	13.1	11.6	11.8	236	9.6	176	9.3	194

Note: Each figure shows the number of students in departments that have exactly the name given in the table.

Students in departments with other names, such as the department of politics and economics and the department of basic engineering, are not included.

Source: Ministry of Education, "Fundamental School Research"

Table 2-2-7 Employment/Academic Advancement of Senior High School Graduates

Year	All courses								
	Number of graduates	Enrolled in university	Employed				Percentage of employed graduates		
				Manufacturing	Financial and insurance	Service	Manufacturing	Financial and insurance	Service
1965	1,160,075	284,330	700,261	254,616	63,274	47,127	36.4	9.0	6.7
1966	1,556,983	369,517	902,826	301,583	63,153	80,538	33.4	7.0	8.9
1967	1,603,122	367,407	941,366	341,511	55,479	78,102	36.3	5.9	8.3
1968	1,601,499	356,087	942,953	334,842	57,865	74,968	35.5	6.1	8.0
1969	1,496,972	333,880	882,349	319,802	59,609	75,013	36.2	6.8	8.5
1970	1,402,962	326,318	816,716	301,040	65,233	68,188	36.9	8.0	8.3
1971	1,359,654	348,848	760,217	275,963	69,121	69,457	36.3	9.1	9.1
1972	1,318,531	370,213	698,582	214,618	72,573	72,315	30.7	10.4	10.4
1973	1,325,777	398,200	668,044	213,810	71,520	68,691	32.0	10.7	10.3
1974	1,336,839	415,897	641,980	215,233	73,694	64,078	33.5	11.5	10.0
1975	1,327,407	439,173	591,437	184,000	68,089	67,762	31.1	11.5	11.5
1976	1,325,087	437,907	559,232	149,439	50,491	74,993	26.7	9.0	13.4
1977	1,403,343	466,517	596,943	178,517	57,953	76,544	29.9	9.7	12.8
1978	1,392,320	456,436	596,591	167,794	54,960	85,636	28.1	9.2	14.4
1979	1,383,539	442,022	591,414	161,345	46,585	90,068	27.3	7.9	15.2
1980	1,399,292	445,875	599,693	178,431	48,493	88,256	29.8	8.1	14.7
1981	1,424,273	447,416	613,267	200,307	50,312	89,924	32.7	8.2	14.7
1982	1,449,100	447,761	621,038	213,619	44,802	93,697	34.4	7.2	15.1
1983	1,519,424	456,995	630,541	208,525	37,600	105,905	33.1	6.0	16.8
1984	1,482,312	439,250	607,237	219,972	34,334	99,971	36.2	5.7	16.5
1985	1,373,713	418,952	563,912	225,295	26,905	90,545	40.0	4.8	16.1
1986	1,620,425	490,870	640,193	248,391	25,563	109,253	38.8	4.0	17.1
1987	1,654,685	512,928	605,697	202,627	24,684	114,042	33.5	4.1	18.8
1988	1,653,156	511,491	594,217	200,077	23,094	112,513	33.7	3.9	18.9
1989	1,700,789	521,396	606,150	224,340	22,166	109,234	37.0	3.7	18.0
1990	1,766,917	539,953	622,330	234,767	24,312	110,103	37.7	3.9	17.7
1991	1,803,221	571,340	620,614	231,120	24,557	113,456	37.2	4.0	18.3
1992	1,807,175	591,520	597,658	216,903	22,304	110,162	36.3	3.7	18.4

Year	General courses								
	Number of graduates	Enrolled in university	Employed				Percentage of employed graduates		
				Manufacturing	Financial and insurance	Service	Manufacturing	Financial and insurance	Service
1965	685,048	251,509	297,526	92,433	36,250	25,082	31.1	12.2	8.4
1966	928,834	326,328	378,537	109,186	35,400	41,851	28.8	9.4	11.1
1967	963,197	326,909	400,073	128,745	32,103	40,515	32.2	8.0	10.1
1968	459,950	315,987	-	-	-	-	-	-	-
1969	890,473	296,254	365,647	117,405	32,239	39,005	32.1	8.8	10.7
1970	831,515	288,313	330,800	107,135	33,411	33,553	32.4	10.1	10.1
1971	802,599	304,684	297,735	92,787	33,679	32,725	31.2	11.3	11.0
1972	773,784	317,069	261,516	67,496	32,602	32,500	25.8	12.5	12.4
1973	781,480	336,814	243,658	66,928	30,923	29,076	27.5	12.7	11.9
1974	799,462	350,041	231,187	67,227	30,628	20,255	29.1	13.2	8.8
1975	807,145	366,220	210,200	55,612	27,333	27,926	26.5	13.0	13.3
1976	820,524	367,729	197,428	46,626	23,603	29,795	23.6	12.0	15.1
1977	893,040	396,396	223,104	58,955	23,954	31,857	26.4	10.7	14.3
1978	903,727	396,108	232,540	57,850	23,626	36,215	24.9	10.2	15.6
1979	911,652	388,497	235,624	56,354	20,933	39,463	23.9	8.9	16.7
1980	938,992	396,556	247,328	64,458	22,807	39,609	26.1	9.2	16.0
1981	966,365	400,292	260,223	74,178	23,926	41,509	28.5	9.2	16.0
1982	997,373	403,158	271,013	81,815	21,817	44,801	30.2	8.1	16.5
1983	1,061,297	413,697	280,120	80,765	18,883	51,270	28.8	6.7	18.3
1984	1,046,289	399,436	273,280	86,542	17,492	49,834	31.7	6.4	18.2
1985	969,919	381,650	254,037	88,732	13,756	45,140	34.9	5.4	17.8
1986	1,166,032	448,363	297,687	101,225	13,444	55,100	34.0	4.5	18.5
1987	1,206,511	468,648	280,384	80,596	12,515	57,125	28.7	4.5	20.4
1988	1,207,590	466,077	273,617	79,697	11,112	56,610	29.1	4.1	20.7
1989	1,251,620	476,007	280,790	91,063	10,404	54,684	32.4	3.7	19.5
1990	1,310,978	494,448	291,946	98,082	11,274	54,271	33.6	3.9	18.6
1991	1,344,387	524,579	292,589	97,796	11,348	55,795	33.4	3.9	19.1
1992	1,348,902	542,103	278,470	90,362	10,137	53,366	32.4	3.6	19.2

Year	Industrial courses •@								
	Number of graduates	Enrolled in university	Employed				Percentage of employed graduates		
				Manufacturing	Financial and insurance	Service	Manufacturing	Financial and insurance	Service
1965	195,564	13,166	120,120	77,853	115	3,761	64.8	0.1	3.1
1966	182,245	11,895	161,079	94,723	187	7,294	58.8	0.1	4.5
1967	189,995	10,897	169,705	104,759	150	7,608	61.7	0.1	4.5
1968	191,134	10,753	-	-	-	-	-	-	-
1969	179,360	9,380	160,241	99,950	161	6,319	62.4	0.1	3.9
1970	172,171	9,779	152,192	95,533	180	6,369	62.8	0.1	4.2
1971	170,875	11,861	146,876	90,481	288	7,597	61.6	0.2	5.2
1972	169,562	14,945	140,061	76,080	315	8,479	54.3	0.2	6.1
1973	172,621	17,754	138,504	74,356	410	8,936	53.7	0.3	6.5
1974	168,248	18,162	133,616	72,163	505	8,595	54.0	0.4	6.4
1975	160,743	20,194	122,193	64,319	608	8,179	52.6	0.5	6.7
1976	157,599	20,219	116,371	49,834	464	10,864	42.8	0.4	9.3
1977	157,676	20,660	119,679	56,500	445	10,432	47.2	0.4	8.7
1978	149,052	16,675	116,180	51,070	319	11,737	44.0	0.3	10.1
1979	144,848	14,300	114,444	47,690	228	11,831	41.7	0.2	10.3
1980	143,056	13,111	115,215	52,893	246	11,305	45.9	0.2	9.8
1981	143,487	12,804	116,733	59,243	217	11,002	50.8	0.2	9.4
1982	142,395	12,274	116,368	61,512	223	11,282	52.9	0.2	9.7
1983	144,507	11,554	116,944	60,833	149	13,116	52.0	0.1	11.2
1984	140,356	10,549	113,796	63,749	157	11,958	56.0	0.1	10.5
1985	134,046	9,879	109,601	66,334	199	10,979	60.5	0.2	10.0
1986	146,714	10,485	118,732	71,122	135	13,155	59.9	0.1	11.1
1987	145,408	10,578	114,409	60,102	143	14,921	52.5	0.1	13.0
1988	146,128	10,575	113,193	57,894	153	14,576	51.1	0.1	12.9
1989	147,403	9,721	116,410	64,038	166	14,194	55.0	0.1	12.2
1990	148,998	9,275	118,061	65,156	158	15,176	55.2	0.1	12.9
1991	149,329	8,811	118,009	62,661	175	15,529	53.1	0.1	13.2
1992	150,947	8,971	117,488	60,102	215	15,612	51.2	0.2	13.3

Note: The number for "Enrolled in university" includes graduates enrolled in universities, colleges or other similar institutes.  
Source: Ministry of Education, "Fundamental School Research"

Table 2-3-1 Enrollment in Junior Colleges

Year	Department										
	Total	Humanities	Sociology	Liberal arts	Engineering	Agriculture	Health	Household science	Education	Art	Others
1965	80,563	-	-	*116	6,873	-	-	-	-	-	-
1966	108,052	-	-	*499	8,388	-	-	-	-	-	-
1967	121,263	-	-	*782	9,356	-	-	-	-	-	-
1968	127,365	24,186	13,760	*80	9,865	1,888	2,537	46,157	20,683	5,793	2,416
1969	128,124	25,546	14,065	*109	9,837	1,680	2,652	44,326	21,432	6,170	2,307
1970	126,659	26,109	14,248	*85	9,414	1,707	2,678	41,317	22,332	6,474	2,295
1971	136,392	29,604	14,973	*90	10,000	1,615	3,039	43,126	24,678	6,941	2,326
1972	141,631	30,348	14,931	*97	9,495	1,619	3,247	42,994	28,500	7,686	2,714
1973	154,771	33,857	16,251	*71	10,151	1,950	3,507	45,538	32,365	8,317	2,764
1974	164,077	36,124	16,934	*82	9,581	1,940	3,732	47,511	36,306	8,835	3,041
1975	174,930	37,681	18,167	*85	9,843	2,045	4,952	50,047	39,794	8,942	3,374
1976	174,683	37,266	17,153	*79	8,765	2,073	4,956	48,974	43,292	8,837	3,288
1977	183,224	39,617	16,857	3,701	8,904	2,201	5,619	51,118	46,306	9,801	100
1978	181,181	39,513	16,398	3,463	9,294	2,113	6,091	50,730	43,530	9,962	87
1979	176,979	39,390	15,354	3,501	8,474	1,999	6,030	49,014	43,468	9,664	85
1980	178,215	39,631	15,495	3,564	8,287	1,913	6,352	49,270	44,083	9,545	75
1981	179,071	39,978	15,512	3,564	8,234	1,906	6,769	49,789	43,409	9,802	108
1982	179,601	40,068	15,953	3,959	8,504	1,901	7,180	49,953	42,042	9,734	307
1983	183,871	41,179	16,952	4,075	8,650	2,038	7,419	51,164	41,859	9,737	798
1984	181,223	42,156	16,867	4,299	8,500	1,942	7,746	49,735	39,415	9,296	1,267
1985	173,503	42,710	16,851	3,979	8,522	1,971	7,864	46,242	35,443	8,589	1,332
1986	206,083	51,904	21,006	5,030	9,530	2,091	8,470	55,950	40,124	9,798	2,180
1987	215,088	55,977	23,927	5,448	10,556	2,032	8,800	56,774	39,072	9,958	2,544
1988	218,036	56,259	25,675	5,770	10,319	1,935	9,354	57,061	38,847	10,161	2,655
1989	225,364	59,134	27,469	5,560	10,379	1,817	9,833	57,750	38,888	10,642	2,892
1990	235,195	62,475	30,118	7,488	11,000	1,902	10,165	59,179	39,156	10,651	3,061
1991	249,552	67,409	33,181	8,807	11,764	1,940	10,656	61,439	39,817	11,374	3,165
1992	254,676	70,310	34,717	9,426	11,636	1,884	10,828	61,404	39,019	11,866	3,586

## Female enrollment

Year	Department										
	Total	Humanities	Sociology	Liberal arts	Engineering	Agriculture	Health	Household science	Education	Art	Others
1965	63,763	-	-	*74	293	-	-	-	-	-	-
1966	88,531	-	-	*330	299	-	-	-	-	-	-
1967	100,943	-	-	*540	311	-	-	-	-	-	-
1968	106,437	23,302	5,903	*70	311	243	2,224	46,074	20,557	5,368	2,385
1969	107,386	24,610	6,224	*94	307	229	2,406	44,235	21,315	5,678	2,288
1970	106,952	25,271	6,837	*79	364	222	2,462	41,237	22,237	5,960	2,283
1971	116,018	28,735	7,512	*79	299	279	2,771	43,024	24,595	6,416	2,308
1972	122,274	29,595	7,971	*88	308	252	2,979	42,894	28,409	7,083	2,695
1973	134,028	33,015	8,994	*64	341	329	3,235	45,395	32,242	7,691	2,722
1974	144,008	35,403	9,712	*79	365	337	3,405	47,394	36,189	8,126	2,998
1975	154,110	36,878	10,490	*0	467	331	4,594	49,946	39,631	8,360	3,330
1976	155,871	36,541	10,362	*0	510	364	4,532	48,889	43,182	8,163	3,255
1977	164,427	38,896	10,521	3,628	638	377	5,153	51,036	46,129	8,963	86
1978	162,334	38,696	10,475	3,391	738	386	5,474	50,649	43,138	9,309	78
1979	159,850	38,575	10,089	3,416	755	389	5,399	48,952	43,083	9,118	74
1980	161,960	38,831	10,717	3,478	952	352	5,695	49,194	43,699	8,978	64
1981	163,193	39,208	10,787	3,479	1,135	341	6,089	49,736	43,097	9,221	100
1982	163,688	39,399	11,145	3,864	1,340	392	6,525	49,899	41,730	9,091	303
1983	168,006	40,476	12,355	3,992	1,534	391	6,663	51,117	41,536	9,153	789
1984	165,252	41,329	12,194	4,207	1,471	442	6,918	49,654	39,106	8,672	1,259
1985	157,826	41,921	12,436	3,914	1,475	493	6,927	46,165	35,223	7,955	1,317
1986	189,483	51,038	16,458	4,960	1,967	563	7,535	55,867	39,923	9,010	2,162
1987	197,590	55,194	19,055	5,393	2,272	550	7,899	56,700	38,879	9,125	2,523
1988	200,364	55,379	20,522	5,703	2,351	576	8,317	56,944	38,636	9,304	2,632
1989	208,350	58,301	22,354	6,542	2,863	605	8,754	57,614	38,662	9,786	2,869
1990	217,474	61,459	24,715	7,458	3,255	709	9,125	59,041	38,838	9,816	3,058
1991	230,761	66,201	27,220	8,769	3,862	774	9,663	61,259	39,357	10,496	3,160
1992	235,516	69,048	28,389	9,392	3,819	763	9,869	61,160	38,652	10,841	3,583

Note: Figures marked with an asterisk in the "Liberal arts" column show the number of students in the department of physical science  
Source: Ministry of Education, "Fundamental School Research"

Table 2-3-2 Enrollment in Colleges of Technology

Yaeear	Total	Male	Female
1965	7,465	7,338	127
1966	7,681	7,534	147
1967	8,392	8,256	135
1968	9,363	9,238	125
1969	9,937	9,801	136
1970	10,318	10,151	167
1971	10,301	10,169	132
1972	10,015	9,871	144
1973	9,908	9,759	149
1974	10,006	9,822	184
1975	9,540	9,367	173
1976	9,581	9,429	152
1977	9,539	9,362	177
1978	9,637	9,462	175
1979	9,715	9,509	206
1980	9,729	9,486	243
1981	9,764	9,505	259
1982	9,814	9,517	297
1983	9,985	9,631	354
1984	9,968	9,553	415
1985	10,207	9,757	450
1986	10,432	9,869	563
1987	10,439	9,750	689
1988	10,824	9,897	927
1989	10,986	9,798	1,188
1990	11,127	9,719	1,408
1991	11,191	9,450	1,741
1992	11,300	9,405	1,895

Source: Ministry of Education, "Fundamental School Research"

Table 2-3-3 Employment/Academic Advancement of Graduates of Junior College  
(Industrial Department) and College of Technology

Year	Junior college (industrial department)					
	Number of graduates	Enrolled in university	Employed	Manufacturing	Financial and insurance	Information-related service
1965	5,083	543	4,419	2,572	7	231
1966	5,179	406	4,528	2,475	13	243
1967	5,414	618	4,533	2,243	16	349
1968	6,459	597	5,541	2,640	27	302
1969	7,385	884	6,125	2,641	18	341
1970	6,596	403	5,688	2,484	32	594
1971	7,964	992	6,447	3,072	36	310
1972	7,483	757	5,276	2,173	24	364
1973	8,235	817	5,632	1,888	17	416
1974	7,741	723	6,123	2,134	44	483
1975	7,816	791	6,246	1,924	30	507
1976	7,182	874	5,321	2,005	19	537
1977	7,554	780	5,869	2,026	51	434
1978	7,119	597	5,509	1,724	23	451
1979	6,932	641	5,482	1,677	61	908
1980	7,080	570	5,604	1,784	48	677
1981	6,678	543	5,350	2,024	46	421
1982	6,222	545	5,224	1,945	58	628
1983	6,234	490	5,180	1,854	50	649
1984	6,516	521	5,351	1,912	86	891
1985	7,002	494	5,816	1,955	115	1,013
1986	6,967	537	5,657	1,615	98	1,082
1987	7,006	461	5,452	1,540	88	1,098
1988	7,937	599	6,420	1,666	196	1,205
1989	9,051	603	7,474	2,154	260	1,379
1990	9,110	627	7,624	2,307	226	1,552
1991	9,419	684	7,968	2,310	324	1,855
1992	9,941	697	8,377	2,678	311	1,932

Year	College of technology					
	Number of graduates	Enrolled in university	Employed	Manufacturing	Financial and insurance	Information-related service
1965	285	4	274	200	2	1
1966	433	1	430	314	0	2
1967	2,431	132	2,273	1,592	0	45
1968	4,421	143	4,217	3,162	2	31
1969	5,616	156	5,397	4,179	0	59
1970	6,245	133	6,042	4,723	0	40
1971	6,282	128	6,042	4,662	0	69
1972	6,998	186	6,631	4,668	0	100
1973	7,569	217	7,052	4,156	0	179
1974	8,100	260	7,530	4,533	4	183
1975	8,346	380	7,542	4,462	13	307
1976	8,578	385	7,559	3,935	19	430
1977	8,125	351	7,298	3,934	16	545
1978	8,137	616	7,129	3,455	5	592
1979	8,485	701	7,503	3,508	7	691
1980	7,951	658	7,083	3,674	11	628
1981	7,933	652	7,101	3,960	9	586
1982	7,930	631	7,163	4,201	6	596
1983	8,139	714	7,289	4,389	5	655
1984	8,133	762	7,239	4,323	12	863
1985	8,031	769	7,150	4,431	4	890
1986	8,293	783	7,375	4,765	4	874
1987	8,329	790	7,378	4,675	6	990
1988	8,713	888	7,678	4,413	63	1,201
1989	8,706	982	7,563	4,624	7	1,135
1990	9,038	1,125	7,760	4,837	10	1,077
1991	9,257	1,286	7,792	4,860	8	1,002
1992	9,280	1,363	7,696	4,740	4	984

Year	Total for junior college (industrial department) and college of technology						
	Employed				Percentage of employed graduates		
		Manufacturing	Financial and insurance	Information-related service	Manufacturing	Financial and insurance	Information-related service
1965	4,693	2,772	9	232	59.1	0.2	4.9
1966	4,958	2,789	13	245	56.3	0.3	4.9
1967	6,806	3,835	16	394	56.3	0.2	5.8
1968	9,758	5,802	29	333	59.5	0.3	3.4
1969	11,522	6,820	18	400	59.2	0.2	3.5
1970	11,730	7,207	32	634	61.4	0.3	5.4
1971	12,489	7,734	36	379	61.9	0.3	3.0
1972	11,907	6,841	24	464	57.5	0.2	3.9
1973	12,684	6,044	17	595	47.7	0.1	4.7
1974	13,653	6,667	48	666	48.8	0.4	4.9
1975	13,788	6,386	43	814	46.3	0.3	5.9
1976	12,880	5,940	38	967	46.1	0.3	7.5
1977	13,167	5,960	67	979	45.3	0.5	7.4
1978	12,638	5,179	28	1,043	41.0	0.2	8.3
1979	12,985	5,185	68	1,599	39.9	0.5	12.3
1980	12,687	5,458	59	1,305	43.0	0.5	10.3
1981	12,451	5,984	55	1,007	48.1	0.4	8.1
1982	12,387	6,146	64	1,224	49.6	0.5	9.9
1983	12,469	6,243	55	1,304	50.1	0.4	10.5
1984	12,590	6,235	98	1,754	49.5	0.8	13.9
1985	12,966	6,386	119	1,903	49.3	0.9	14.7
1986	13,032	6,380	102	1,956	49.0	0.8	15.0
1987	12,830	6,215	94	2,088	48.4	0.7	16.3
1988	14,098	6,079	259	2,406	43.1	1.8	17.1
1989	15,037	6,778	267	2,514	45.1	1.8	16.7
1990	15,384	7,144	236	2,629	46.4	1.5	17.1
1991	15,760	7,170	332	2,857	45.5	2.1	18.1
1992	16,073	7,418	315	2,916	46.2	2.0	18.1

Note: Graduates from the department of physical science of junior college are not included because of their small number  
Source: Ministry of Education, "Fundamental School Research"

Table 2-4-1 Enrollment in Colleges and Universities by Department

Year	Department											
	Total	Humanities	Social sciences	Physical science	Engineering	Agriculture	Health	Mercantile	Household science	Education	Art	Others
1965	249,917	-	-	-	56,140	-	-	-	-	-	-	-
1966	292,958	-	-	-	65,954	-	-	-	-	-	-	-
1967	312,747	-	-	-	71,069	-	-	-	-	-	-	-
1968	325,632	42,278	137,721	9,924	64,001	11,955	6,815	320	6,047	21,839	7,331	17,401
1969	329,374	43,060	138,736	9,769	69,873	12,286	7,175	323	6,029	22,629	7,384	12,110
1970	333,037	39,665	140,246	10,499	69,663	12,127	6,934	327	5,934	23,313	7,192	17,137
1971	357,821	43,642	148,922	10,577	75,775	12,827	7,113	325	6,301	25,293	8,491	18,555
1972	376,147	48,631	158,772	10,888	76,526	13,419	7,745	368	6,520	26,503	8,959	17,816
1973	389,560	51,073	162,936	11,301	78,114	14,149	8,272	349	7,076	28,321	9,344	18,625
1974	407,528	52,187	173,167	12,239	79,762	14,675	8,634	364	7,481	29,904	9,532	19,583
1975	423,942	54,112	180,515	12,078	82,586	14,726	19,589	364	8,078	31,889	9,716	10,289
1976	420,616	54,325	175,639	12,299	81,682	14,238	20,162	361	8,049	32,912	10,532	10,417
1977	428,412	56,047	178,282	12,659	83,848	14,260	20,839	361	8,252	33,035	10,609	10,220
1978	425,718	55,908	176,441	13,213	82,699	14,049	21,415	361	8,260	32,356	10,658	10,358
1979	407,635	54,884	166,295	12,468	77,439	13,982	21,132	353	7,850	32,303	10,695	10,234
1980	412,437	56,161	166,453	12,716	79,209	14,418	21,592	359	7,982	32,350	10,670	10,527
1981	413,236	56,136	165,958	12,990	79,635	14,381	21,683	354	7,893	32,649	10,881	10,676
1982	414,536	57,224	164,228	13,303	81,163	14,188	21,779	365	8,015	32,823	10,888	10,560
1983	420,458	59,786	165,388	13,679	82,387	14,481	22,319	365	8,275	32,975	11,186	9,617
1984	416,002	59,736	162,764	13,597	80,454	14,556	22,457	360	8,089	33,335	11,253	9,401
1985	411,993	59,595	160,338	13,778	80,249	14,434	22,168	364	7,909	33,403	10,709	9,046
1986	436,896	63,976	172,539	13,966	84,878	14,768	22,214	378	8,754	33,888	11,292	10,243
1987	465,503	69,204	185,368	14,897	91,104	14,984	22,710	410	9,113	34,595	11,581	11,537
1988	472,965	72,217	191,021	14,950	91,578	14,875	22,033	406	8,949	34,210	11,499	11,227
1989	476,786	74,214	190,611	15,899	91,792	15,631	21,629	411	9,181	33,828	11,795	11,795
1990	492,340	76,115	196,659	16,940	95,401	16,527	21,651	222	9,218	34,946	12,230	12,431
1991	521,899	80,870	211,627	17,454	101,533	16,311	22,622	209	9,765	34,889	13,222	13,397
1992	541,604	86,813	219,150	18,313	104,316	16,607	22,561	216	10,115	35,532	13,672	14,309

Note: Figures for "Engineering" in and before 1967 show the total numbers of students in the department of science and engineering.

Source: Ministry of Education, "Fundamental School Research"



Table 2-4-2 Female Enrollment in Colleges and Universities by Department

Year	Science and engineering			Total	Female	Economics and commerce			Total	Female	Law	Female	Grand total	Female
	Physical science	Engineering	Sci./Eng.			Economics	Management	Commerce						
1965	581	150	151	882	1.6%	686	56	399	1,141	1.9%	818	3.6%	44,232	17.7%
1966	805	205	321	1,268	2.0%	998	166	500	1,664	2.3%	1,247	4.8%	55,037	18.8%
1967	961	307	336	1,604	2.4%	1,222	194	623	2,039	2.6%	1,399	4.8%	58,499	18.7%
1968	1,026	273	319	1,618	2.3%	1,324	225	678	2,227	2.7%	1,466	4.8%	60,519	18.6%
1969	966	360	340	1,666	2.2%	1,325	252	701	2,281	2.8%	1,470	4.9%	60,585	18.4%
1970	923	365	311	1,599	2.1%	1,442	295	828	2,565	3.1%	1,586	5.1%	62,093	18.6%
1971	1,026	448	334	1,808	2.2%	1,843	428	891	3,162	3.6%	2,080	6.3%	72,002	20.1%
1972	1,066	435	323	1,824	2.2%	2,126	565	1,044	3,735	4.0%	2,409	6.7%	79,163	21.0%
1973	1,126	472	435	2,033	2.4%	2,501	735	1,274	4,510	4.8%	2,704	7.4%	86,235	22.1%
1974	1,179	580	452	2,211	2.6%	2,852	806	1,555	5,213	5.1%	3,013	7.8%	92,014	22.6%
1975	1,185	572	456	2,213	2.5%	3,426	850	1,841	6,117	5.8%	2,975	7.6%	97,111	22.9%
1976	1,269	589	522	2,380	2.7%	3,345	1,065	1,771	6,181	5.9%	2,801	7.6%	98,267	23.4%
1977	1,387	759	608	2,754	3.1%	3,447	1,006	1,894	6,347	6.0%	2,849	7.5%	100,209	23.4%
1978	1,339	880	552	2,771	3.1%	3,003	932	1,648	5,583	5.3%	2,919	7.7%	96,436	22.7%
1979	1,403	870	605	2,878	3.4%	2,973	825	1,558	5,356	5.4%	2,861	8.1%	93,394	22.9%
1980	1,499	1,194	575	3,268	3.8%	2,897	871	1,637	5,405	5.4%	2,980	8.4%	95,115	23.1%
1981	1,670	1,319	730	3,719	4.2%	2,847	816	1,394	5,057	5.2%	3,232	9.0%	95,922	23.2%
1982	1,766	1,508	859	4,133	4.6%	2,781	797	1,387	4,965	5.2%	3,195	9.1%	97,272	23.5%
1983	1,826	1,762	965	4,553	5.0%	3,106	879	1,470	5,455	5.7%	3,697	10.3%	102,880	24.5%
1984	1,838	1,825	863	4,526	5.1%	3,394	962	1,744	6,100	6.5%	3,787	10.8%	103,770	24.9%
1985	1,741	1,891	833	4,465	5.0%	3,451	992	1,699	6,142	6.6%	3,969	11.3%	104,033	25.3%
1986	1,827	2,033	849	4,709	5.0%	4,060	1,119	1,914	7,093	7.2%	4,538	12.0%	113,119	25.9%
1987	1,862	2,090	968	4,920	4.9%	5,059	1,370	2,424	8,853	8.3%	5,566	13.6%	124,514	26.7%
1988	1,983	2,521	850	5,354	5.4%	6,171	1,757	2,877	10,805	10.0%	6,415	15.4%	132,008	27.9%
1989	2,159	2,857	956	5,972	5.9%	7,327	2,308	3,418	13,053	12.1%	7,324	17.3%	138,722	29.1%
1990	2,215	3,682	1,238	7,135	6.8%	8,486	2,670	3,930	15,086	13.6%	7,948	18.5%	148,646	30.2%
1991	2,465	4,671	1,436	8,572	7.8%	9,592	3,478	4,401	17,471	14.5%	8,883	19.4%	160,665	30.8%
1992	2,861	5,413	1,574	9,848	8.7%	10,372	3,836	4,957	19,165	15.9%	9,823	20.7%	172,608	31.9%

Note: Each figure shows the number of students in departments that have exactly the name given in the table.

Students in departments with other names, such as the department of politics and economics and the department of basic engineering, are not included.

Source: Ministry of Education, "Fundamental School Research"

Table 2-4-3 Enrollment in the Departments of Natural Science and Engineering by Gender

Year	Natural science			Engineering		
	Male	Female	Female (%)	Male	Female	Female (%)
1965	-	-	-	55,212	928	1.7%
1966	-	-	-	64,576	1,378	2.1%
1967	-	-	-	69,471	1,598	2.2%
1968	8,397	1,527	15.4%	63,620	381	0.6%
1969	8,363	1,406	14.4%	68,382	491	0.7%
1970	9,169	1,330	12.7%	69,179	484	0.7%
1971	9,152	1,425	13.5%	75,172	603	0.8%
1972	9,274	1,614	14.8%	75,950	576	0.8%
1973	9,532	1,769	15.7%	77,447	667	0.9%
1974	10,342	1,897	15.5%	78,975	787	1.0%
1975	10,212	1,866	15.4%	81,778	808	1.0%
1976	10,248	2,051	16.7%	80,810	872	1.1%
1977	10,450	2,209	17.5%	82,760	1,088	1.3%
1978	11,071	2,142	16.2%	81,463	1,236	1.5%
1979	10,376	2,092	16.8%	76,174	1,265	1.6%
1980	10,508	2,208	17.4%	77,607	1,602	2.0%
1981	10,628	2,362	18.2%	77,877	1,758	2.2%
1982	10,772	2,531	19.0%	79,098	2,065	2.5%
1983	11,051	2,628	19.2%	80,048	2,339	2.8%
1984	10,998	2,599	19.1%	78,055	2,399	3.0%
1985	11,191	2,587	18.8%	77,830	2,419	3.0%
1986	11,270	2,696	19.3%	82,323	2,555	3.0%
1987	12,137	2,760	18.5%	88,348	2,756	3.0%
1988	12,057	2,893	19.4%	88,334	3,244	3.5%
1989	12,764	3,135	19.7%	88,010	3,782	4.1%
1990	13,601	3,339	19.7%	90,549	4,852	5.1%
1991	13,807	3,647	20.9%	95,337	6,196	6.1%
1992	14,210	4,103	22.4%	97,121	7,195	6.9%

Note: Figures for "Engineering" in and before 1967 show the total numbers of students in the department of science and engineering.

The figures in the "Female (%)" column show the proportion of female students to the total number of students.

Source: Ministry of Education, "Fundamental School Research"

Table 2-4-4 Number of University and Other Information Science Courses and Admission Limits

Type of course		Number			Index		
		1975	1985	1990	1975	1985	1990
University	Institutes	42	67	156	100	159.5	371.4
	Courses	50	78	190	100	156.0	380.0
	Capacity	2,694	5,320	15,974	100	197.5	592.9
Junior college	Institutes	8	12	47	100	150.0	587.5
	Courses	9	13	51	100	144.4	566.7
	Capacity	385	815	5,590	100	211.7	1451.9
College of technology	Institutes	2	7	34	100	350.0	1700.0
	Courses	2	7	37	100	350.0	1850.0
	Capacity	80	280	1,485	100	350.0	1856.3
Total	Institutes	52	86	237	100	165.4	455.8
	Courses	61	98	278	100	160.7	455.7
	Capacity	3,159	6,415	23,049	100	203.1	729.6
Special school	Institutes	-	137	306	-	100	223.4
	Courses	-	294	720	-	100	244.9
	Capacity	-	22,396	54,034	-	100	241.3

Source: Ministry of Education

Table 2-4-5 Employment/Academic Advancement of Science and Engineering Graduates

Department of natural science																		
Year	Total graduates	Enrolled in graduate school	Doing nothing	Others	Employed	Agriculture, forestry	Mining	Constructio	Manufacturi	Wholesale, retailing	Financial, insurance	Real estate	Transport, communicatio	Utilities	Services	Information	Public service	Others
1965	4,748	1,024	137	65	3,522	6	27	53	1,806	115	79	2	40	11	1,174	67	129	80
1966	5,389	1,191	251	116	3,831	2	23	63	1,605	164	68	0	39	10	1,618	121	148	91
1967	5,569	1,267	315	93	3,894	4	28	48	1,728	167	40	2	51	17	1,566	136	127	116
1968	6,033	1,218	309	169	4,337	2	30	64	2,067	297	76	3	65	14	1,314	182	147	258
1969	6,838	1,274	439	238	4,887	12	32	87	2,448	353	122	13	87	26	1,352	251	155	200
1970	7,209	1,380	537	276	5,016	2	45	107	2,924	307	126	0	71	17	1,172	185	183	62
1971	7,935	1,162	701	222	5,850	28	28	107	3,494	335	170	2	67	41	1,291	325	252	35
1972	9,084	1,479	1,048	451	5,885	4	54	137	2,915	347	259	1	95	12	1,492	311	404	165
1973	8,764	1,338	1,134	499	5,793	6	33	202	2,427	418	213	14	113	19	1,743	390	387	218
1974	9,053	1,394	682	564	6,413	8	32	166	2,757	424	323	15	108	24	1,994	585	473	89
1975	9,504	1,576	1,069	451	6,408	6	18	103	2,346	537	349	10	121	33	2,314	660	465	106
1976	10,012	1,803	1,392	670	6,147	11	23	129	1,836	658	323	11	53	32	2,514	560	376	181
1977	10,234	1,701	1,344	712	6,477	4	14	94	2,020	699	282	30	70	28	2,675	679	372	189
1978	10,688	1,785	1,584	557	6,762	4	26	146	1,839	695	268	11	89	42	2,968	850	541	133
1979	11,077	1,875	1,704	527	6,971	13	18	137	2,120	510	190	14	71	23	3,002	828	655	218
1980	11,554	1,941	1,427	596	7,590	42	5	172	2,165	586	172	10	76	29	3,569	919	623	141
1981	11,803	2,008	1,421	536	7,838	28	33	228	2,563	539	169	3	44	21	3,390	1,146	668	152
1982	11,755	2,164	1,361	553	7,677	4	72	174	2,997	514	152	4	45	20	3,247	1,274	334	114
1983	11,723	2,194	1,348	334	7,847	16	56	134	3,056	307	143	8	64	30	3,417	1,274	422	194
1984	12,234	2,279	1,315	336	8,304	20	24	124	2,903	497	200	8	97	7	3,862	1,669	468	94
1985	12,698	2,445	1,105	382	8,766	4	33	90	3,440	271	172	7	65	11	4,153	1,905	448	72
1986	12,814	2,613	950	400	8,851	8	17	71	3,557	296	236	4	133	45	3,938	1,928	446	100
1987	13,389	2,817	962	349	9,261	18	44	78	3,610	346	250	6	141	30	4,326	2,368	321	91
1988	13,388	3,007	863	259	9,259	29	22	133	3,083	338	380	13	291	77	4,397	2,621	377	118
1989	13,295	3,124	545	309	9,269	4	11	115	3,831	364	488	21	229	34	3,613	2,187	505	53
1990	13,420	3,325	508	282	9,252	15	18	114	4,022	326	586	14	309	48	3,146	1,923	397	258
1991	14,217	3,654	542	315	9,661	4	19	109	4,302	299	534	44	338	33	3,427	2,184	346	207
1992	14,176	3,950	566	272	9,337	27	17	148	4,467	259	377	26	272	30	3,126	2,200	476	111

Department of engineering

Year	Total graduates	Enrolled in graduate school	Doing nothing	Others	Employed	Agriculture, forestry	Mining	Constructio	Manufacturi	Wholesale, retailing	Financial, insurance	Real estate	Transport, communicatio	Utilities	Services	Information	Public service	Others
1965	30,121	2,869	102	452	26,698	10	179	4,510	17,656	854	94	41	638	291	1,067	189	994	364
1966	33,956	3,874	458	403	29,221	17	205	4,501	18,319	1,179	63	46	839	407	1,470	314	1,637	538
1967	37,263	3,765	432	694	32,372	19	233	5,164	19,952	1,482	96	60	1,146	456	1,381	439	1,605	778
1968	38,352	3,761	316	626	33,649	16	137	5,955	20,759	1,722	106	167	989	355	1,370	621	1,097	976
1969	43,414	4,359	437	1,174	37,444	41	134	6,672	22,906	2,170	143	144	856	352	1,373	647	1,163	1,490
1970	48,481	4,806	647	1,045	41,983	1	218	6,612	28,782	1,911	218	98	833	618	1,002	389	1,414	276
1971	55,850	4,352	873	866	49,759	112	84	10,226	31,104	1,797	265	143	1,378	528	1,704	1,196	2,032	386
1972	59,698	5,229	1,140	1,814	51,134	67	234	12,488	27,773	2,539	312	204	1,218	695	1,737	1,055	2,990	877
1973	62,961	5,877	1,439	2,650	52,995	16	175	13,025	27,875	2,584	348	327	1,426	691	2,739	1,741	3,097	692
1974	62,953	5,602	1,044	2,362	53,945	58	125	13,120	27,547	3,068	380	253	1,054	768	3,007	1,873	3,363	1,112
1975	65,422	6,614	2,263	2,311	54,234	27	201	11,609	27,848	4,210	641	220	1,308	635	3,487	2,712	3,266	782
1976	67,036	7,433	3,515	2,768	53,320	25	233	10,641	27,834	3,824	641	224	1,485	822	3,867	2,433	2,280	1,444
1977	69,221	7,270	3,297	1,997	56,657	115	178	10,366	30,295	3,993	725	255	1,107	700	4,249	3,045	3,348	1,326
1978	71,167	6,998	3,179	2,375	58,615	138	251	11,098	30,528	3,841	612	242	1,402	777	4,610	3,071	4,042	1,074
1979	74,128	6,945	2,442	2,320	62,421	150	144	12,625	27,828	6,798	566	248	1,824	858	5,438	4,271	4,862	1,080
1980	73,508	7,213	2,025	2,139	62,131	78	213	12,178	31,473	5,322	457	101	1,322	717	5,521	4,121	4,207	542
1981	75,188	7,597	2,056	1,896	63,639	85	217	12,069	35,254	3,745	255	317	1,299	667	5,706	4,509	3,589	436
1982	73,593	8,249	1,610	1,353	62,381	79	295	12,302	35,717	2,925	221	254	1,110	698	5,493	4,601	2,955	332
1983	69,620	8,327	1,716	1,357	58,220	66	157	11,077	33,477	2,752	260	213	605	778	5,600	4,770	2,822	413
1984	70,486	9,225	1,630	1,237	58,394	61	193	10,225	33,176	2,888	323	333	600	530	7,180	6,398	2,552	333
1985	71,396	9,905	1,381	894	59,216	43	247	9,352	35,373	2,058	454	216	740	728	6,887	5,881	2,762	356
1986	73,316	10,507	1,402	1,128	60,279	18	263	9,109	35,916	2,108	367	246	859	612	8,150	7,086	2,283	348
1987	75,843	11,431	1,553	976	61,883	64	166	9,252	36,197	2,269	586	284	1,070	688	8,592	7,713	2,369	346
1988	76,362	12,314	1,341	885	61,822	48	65	9,897	32,829	2,820	1,193	253	1,531	803	9,375	8,611	2,778	229
1989	75,678	12,484	1,083	816	61,256	40	110	9,783	33,077	2,455	1,017	309	1,760	758	8,931	8,028	2,799	218
1990	80,136	13,466	1,025	597	65,016	24	140	9,913	36,535	2,330	1,480	317	1,642	783	8,606	7,898	2,910	335
1991	86,115	15,466	941	771	68,899	9	103	10,493	38,429	2,067	1,409	422	2,012	950	9,642	8,984	3,000	365
1992	87,404	17,139	1,128	815	68,259	46	158	11,086	37,281	2,281	916	313	1,929	968	9,518	8,885	3,338	430

Source: Ministry of Education, "Fundamental School Research"

Table 2-5-1 Enrollment in Master's Courses

Year	Department											
	Total	Humanities	Social sciences	Physical science	Engineering	Agriculture	Health	Mercantile marine	Household science	Education	Art	Others
1965	8,341	-	-	-	4,397	-	-	-	-	-	-	-
1966	10,309	-	-	-	5,477	-	-	-	-	-	-	-
1967	10,684	-	-	-	5,500	-	-	-	-	-	-	-
1968	10,974	1,811	1,662	1,401	4,180	869	378	-	88	367	218	-
1969	11,999	1,894	1,740	1,489	4,661	985	440	-	106	420	264	-
1970	12,357	1,913	1,768	1,408	5,071	1,033	463	-	95	348	258	-
1971	13,129	2,160	1,876	1,344	5,286	1,155	476	-	101	420	311	-
1972	14,723	2,228	2,021	1,536	6,243	1,316	512	-	124	427	316	-
1973	14,457	2,182	1,966	1,449	6,180	1,214	500	-	122	482	362	-
1974	14,448	2,197	1,861	1,494	6,133	1,217	492	-	122	511	421	-
1975	15,770	2,171	1,808	1,642	7,096	1,393	528	20	137	535	440	-
1976	16,941	2,144	1,916	1,736	7,875	1,546	547	26	99	583	469	-
1977	16,687	2,059	1,848	1,766	7,650	1,414	602	34	115	617	507	75
1978	16,258	1,989	1,814	1,760	7,379	1,360	576	24	137	620	490	109
1979	16,187	2,031	1,658	1,798	7,174	1,290	733	22	123	723	499	136
1980	16,844	2,036	1,573	1,858	7,572	1,257	774	21	127	948	528	150
1981	17,857	2,151	1,621	1,922	7,902	1,419	838	14	137	1,125	578	150
1982	19,717	2,129	1,758	2,050	8,585	2,168	884	14	118	1,273	591	147
1983	20,549	2,143	1,806	2,124	8,870	2,349	937	33	120	1,441	568	158
1984	22,201	2,125	1,857	2,174	9,884	2,469	1,016	25	153	1,728	603	167
1985	23,594	2,220	1,982	2,357	10,687	2,442	1,045	23	140	1,888	604	206
1986	25,164	2,327	2,094	2,557	11,422	2,610	1,107	22	172	1,965	650	238
1987	26,644	2,315	2,271	2,775	12,275	2,855	1,169	36	163	1,964	608	213
1988	27,342	2,380	2,401	2,968	13,109	1,904	1,232	49	170	2,225	663	241
1989	28,177	2,337	2,553	3,125	13,459	1,929	1,333	44	191	2,283	671	252
1990	30,733	2,400	2,927	3,291	14,697	2,101	1,376	55	206	2,684	713	280
1991	34,927	2,692	3,457	3,614	16,741	2,433	1,500	64	233	2,978	730	485
1992	38,709	3,046	3,849	3,935	18,471	2,701	1,742	71	255	3,173	765	701

Note: Figures for "Engineering" in and before 1967 show the total numbers of students in the department of science and engineering.  
Source: Ministry of Education, "Fundamental School Research"

Table 2-5-2 Admission Competitiveness of and Enrollment in Natural Science and Engineering Master's Courses by Gender

Admission competitiveness

Year	Natural science			Engineering		
	Applicants	Enrollment	Competitiveness	Applicants	Enrollment	Competitiveness
1965	-	-	-	7,232	4,397	1.64
1966	-	-	-	9,768	5,477	1.78
1967	-	-	-	10,465	5,500	1.90
1968	3,920	1,401	2.80	6,938	4,180	1.66
1969	4,425	1,489	2.97	8,500	4,661	1.82
1970	4,877	1,408	3.46	9,102	5,071	1.79
1971	6,067	1,344	4.51	11,069	5,286	2.09
1972	6,645	1,536	4.33	12,849	6,243	2.06
1973	7,076	1,449	4.88	12,922	6,180	2.09
1974	6,230	1,494	4.17	11,677	6,133	1.90
1975	6,654	1,642	4.05	13,409	7,096	1.89
1976	6,801	1,736	3.92	16,084	7,875	2.04
1977	7,023	1,766	3.98	15,572	7,650	2.04
1978	6,292	1,760	3.58	14,061	7,379	1.91
1979	5,950	1,798	3.31	13,139	7,174	1.83
1980	5,590	1,858	3.01	12,692	7,572	1.68
1981	5,215	1,922	2.71	12,407	7,902	1.57
1982	5,286	2,050	2.58	12,904	8,585	1.50
1983	5,115	2,124	2.41	12,865	8,870	1.45
1984	4,987	2,174	2.29	14,189	9,884	1.44
1985	5,193	2,357	2.20	15,255	10,687	1.43
1986	5,213	2,557	2.04	16,034	11,422	1.40
1987	5,634	2,775	2.03	17,127	12,275	1.40
1988	5,810	2,968	1.96	18,281	13,109	1.39
1989	5,975	3,125	1.91	18,571	13,459	1.38
1990	6,235	3,291	1.89	20,084	14,697	1.37
1991	6,842	3,614	1.89	22,396	16,741	1.34
1992	7,294	3,935	1.85	24,878	18,471	1.35

Breakdown of enrolled students by gender

Year	Natural science			Engineering		
	Male	Female	Female (%)	Male	Female	Female (%)
1965	-	-	-	-	-	-
1966	-	-	-	-	-	-
1967	-	-	-	5,400	100	1.8%
1968	1,293	108	7.7%	4,158	22	0.5%
1969	1,398	91	6.1%	4,643	18	0.4%
1970	1,291	117	8.3%	5,055	16	0.3%
1971	1,242	102	7.6%	5,254	32	0.6%
1972	1,423	113	7.4%	6,211	32	0.5%
1973	1,327	122	8.4%	6,149	31	0.5%
1974	1,380	114	7.6%	6,092	41	0.7%
1975	1,515	127	7.7%	7,060	36	0.5%
1976	1,608	128	7.4%	7,833	42	0.5%
1977	1,629	137	7.8%	7,591	59	0.8%
1978	1,612	148	8.4%	7,310	69	0.9%
1979	1,629	169	9.4%	7,094	80	1.1%
1980	1,713	145	7.8%	7,491	81	1.1%
1981	1,768	154	8.0%	7,818	84	1.1%
1982	1,884	166	8.1%	8,468	117	1.4%
1983	1,954	170	8.0%	8,735	135	1.5%
1984	1,981	193	8.9%	9,716	168	1.7%
1985	2,146	211	9.0%	10,493	194	1.8%
1986	2,324	233	9.1%	11,148	274	2.4%
1987	2,488	287	10.3%	11,970	305	2.5%
1988	2,658	310	10.4%	12,756	353	2.7%
1989	2,758	367	11.7%	13,040	419	3.1%
1990	2,880	411	12.5%	14,197	500	3.4%
1991	3,136	478	13.2%	16,100	641	3.8%
1992	3,390	545	13.9%	17,677	794	4.3%

Note: Figures for "Engineering" in and before 1967 show the total numbers of students in the department of science and engineering.

Source: Ministry of Education, "Fundamental School Research"

Table 2-5-3 Advancement to Master's and Doctorate Courses in Natural Science

Year	Advancement to master's course			Advancement to doctorate course			
	Total college graduates	Enrollment in master's course	Advancement rate	Total graduates from master's course	Enrollment in doctorate course	Advancement rate (relative to college)	Advancement rate (relative to master's course)
	(a)	(b)	(b)/(a)	(c)	(d)	(d)/(c)	(d)/(a)*
1965	4,748	1,024	21.6%	-	-	-	-
1966	5,389	1,191	22.1%	-	-	-	-
1967	5,569	1,267	22.8%	1,131	615	54.4%	13.0%
1968	6,033	1,218	20.2%	1,288	681	52.9%	12.6%
1969	6,838	1,274	18.6%	1,281	730	57.0%	13.1%
1970	7,209	1,380	19.1%	1,302	710	54.5%	11.8%
1971	7,935	1,162	14.6%	1,389	723	52.1%	10.6%
1972	9,084	1,479	16.3%	1,350	708	52.4%	9.8%
1973	8,764	1,338	15.3%	1,455	748	51.4%	9.4%
1974	9,053	1,394	15.4%	1,482	703	47.4%	7.7%
1975	9,504	1,576	16.6%	1,382	619	44.8%	7.1%
1976	10,012	1,803	18.0%	1,472	786	53.4%	8.7%
1977	10,234	1,701	16.6%	1,594	765	48.0%	8.0%
1978	10,688	1,785	16.7%	1,625	710	43.7%	7.1%
1979	11,077	1,875	16.9%	1,666	661	39.7%	6.5%
1980	11,554	1,941	16.8%	1,649	632	38.3%	5.9%
1981	11,803	2,008	17.0%	1,665	605	36.3%	5.5%
1982	11,755	2,164	18.4%	1,716	611	35.6%	5.3%
1983	11,723	2,194	18.7%	1,813	624	34.4%	5.3%
1984	12,234	2,279	18.6%	1,910	659	34.5%	5.6%
1985	12,698	2,445	19.3%	1,992	612	30.7%	5.2%
1986	12,814	2,613	20.4%	2,019	655	32.4%	5.4%
1987	13,389	2,817	21.0%	2,213	753	34.0%	5.9%
1988	13,388	3,007	22.5%	2,377	752	31.6%	5.9%
1989	13,295	3,124	23.5%	2,598	802	30.9%	6.0%
1990	13,420	3,325	24.8%	2,805	833	29.7%	6.2%
1991	14,217	3,654	25.7%	2,913	907	31.1%	6.8%
1992	14,176	3,950	27.9%	3,067	949	30.9%	7.1%

(Advancement rate relative to master's course) = (enrollment in doctorate course)/(number of college graduates 2 years before)

Source: Ministry of Education, "Fundamental School Research"

Table 2-5-4 Advancement to Master's and Doctorate Courses in Engineering

Year	Advancement to master's course			Advancement to doctorate course			
	Total college graduates	Enrollment in master's course	Advancement rate	Total graduates from master's course graduates	Enrollment in doctorate course	Advancement rate (relative to college)	Advancement rate (relative to master's course)
	(a)	(b)	(b)/(a)	(c)	(d)	(d)/(c)	(d)/(a)*
1965	30,121	2,869	9.5%	-	-	-	-
1966	33,956	3,874	11.4%	-	-	-	-
1967	37,263	3,765	10.1%	3,102	720	23.2%	2.4%
1968	38,352	3,761	9.8%	3,918	764	19.5%	2.2%
1969	43,414	4,395	10.1%	3,965	726	18.3%	1.9%
1970	48,481	4,806	9.9%	3,891	626	16.1%	1.6%
1971	55,850	4,352	7.8%	4,660	690	14.8%	1.6%
1972	59,698	5,229	8.8%	4,915	698	14.2%	1.4%
1973	62,961	5,877	9.3%	5,436	686	12.6%	1.2%
1974	62,953	5,602	8.9%	6,090	687	11.3%	1.2%
1975	65,422	6,614	10.1%	6,060	686	11.3%	1.1%
1976	67,036	7,433	11.1%	5,799	726	12.5%	1.2%
1977	69,221	7,270	10.5%	6,923	718	10.4%	1.1%
1978	71,167	6,998	9.8%	7,640	653	8.5%	1.0%
1979	74,128	6,945	9.4%	7,613	652	8.6%	0.9%
1980	73,508	7,213	9.8%	7,135	559	7.8%	0.8%
1981	75,188	7,597	10.1%	6,976	565	8.1%	0.8%
1982	73,593	8,249	11.2%	7,363	574	7.8%	0.8%
1983	69,620	8,327	12.0%	7,703	569	7.4%	0.8%
1984	70,486	9,225	13.1%	8,311	609	7.3%	0.8%
1985	71,396	9,905	13.9%	8,628	720	8.3%	1.0%
1986	73,316	10,507	14.3%	9,620	892	9.3%	1.3%
1987	75,843	11,431	15.1%	10,413	874	8.4%	1.2%
1988	76,362	12,314	16.1%	11,129	995	8.9%	1.4%
1989	75,678	12,484	16.5%	11,915	982	8.2%	1.3%
1990	80,136	13,466	16.8%	12,774	1,041	8.1%	1.4%
1991	86,115	15,466	18.0%	13,141	1,171	8.9%	1.5%
1992	87,404	17,139	19.6%	14,351	1,266	8.8%	1.6%

(Advancement rate relative to master's course) = (enrollment in doctorate course)/(number of college graduates 2 years before)

Source: Ministry of Education, "Fundamental School Research"



Table 2-5-5 Employment/Academic Advancement of Natural Science and Engineering Master's Graduates

Natural science																			
Year	Total graduates	Enrolled in graduate school	Doing nothing	Others	Employed	Agriculture, forestry,	Mining	Construction	Manufacturing	Wholesale, retailing	Financial, insurance	Real estate	Transport, communication	Utilities	Services			Public service	Others
																Information			
1965	786	465	26	18	277	0	0	0	106	1	0	0	2	2	151	0		7	8
1966	922	562	31	11	318	0	0	1	104	0	1	0	11	0	196	2		3	2
1967	1,131	615	51	30	435	0	6	2	150	4	0	0	4	1	245	2		6	21
1968	1,288	681	47	22	538	1	5	5	207	2	0	0	3	0	281	8		13	21
1969	1,281	730	46	33	472	1	3	2	241	2	2	1	2	3	201	5		9	5
1970	1,302	710	60	28	504	0	5	2	278	2	4	1	3	0	184	11		20	5
1971	1,389	723	92	30	544	0	6	2	348	2	1	1	12	1	144	13		17	10
1972	1,350	708	129	26	487	0	9	4	295	2	1	0	8	0	129	16		29	10
1973	1,455	748	110	73	524	0	9	4	255	2	1	0	19	2	171	11		34	27
1974	1,482	703	106	63	610	0	9	5	349	3	2	0	8	3	178	14		40	13
1975	1,382	619	97	42	624	1	4	8	307	8	3	0	15	2	225	17		35	16
1976	1,472	786	149	63	474	1	6	8	188	3	3	0	15	4	191	11		31	24
1977	1,594	765	136	46	647	0	5	11	307	8	9	0	10	2	242	33		35	18
1978	1,625	710	174	41	700	1	9	2	328	6	3	0	14	7	263	44		48	19
1979	1,666	661	150	66	789	0	8	9	391	11	5	0	15	5	289	41		45	11
1980	1,649	632	166	42	809	0	3	5	438	7	3	1	20	3	276	38		44	9
1981	1,665	605	144	46	870	2	11	10	501	16	4	0	19	5	251	38		47	4
1982	1,716	611	154	29	922	0	22	10	631	6	3	0	17	2	195	46		29	7
1983	1,813	624	159	25	1,005	0	18	6	668	5	2	0	17	3	234	53		27	25
1984	1,910	659	122	17	1,112	0	21	8	725	8	2	1	24	3	272	69		38	10
1985	1,992	612	150	22	1,208	0	19	6	783	4	9	1	18	4	299	71		51	14
1986	2,019	655	121	20	1,223	0	15	5	823	6	8	0	20	4	280	84		50	12
1987	2,213	753	124	30	1,306	4	9	11	880	7	15	0	38	6	287	93		37	12
1988	2,377	752	116	50	1,459	4	6	8	914	7	37	1	74	5	306	116		72	25
1989	2,598	802	107	63	1,626	1	11	7	1,107	10	31	0	77	6	299	92		60	17
1990	2,805	833	81	62	1,829	3	19	19	1,237	8	48	0	83	12	284	106		71	45
1991	2,913	907	108	48	1,850	2	12	14	1,295	12	31	1	77	13	299	129		79	15
1992	3,067	949	108	41	1,969	3	11	14	1,365	6	31	0	64	23	318	126		97	37

Engineering																			
Year	Total graduates	Enrolled in graduate school	Doing nothing	Others	Employed	Agriculture, forestry,	Mining	Construction	Manufacturing	Wholesale, retailing	Financial, insurance	Real estate	Transport, communication	Utilities	Services			Public service	Others
																Information			
1965	1,666	547	15	94	1,010	0	6	73	672	5	0	0	25	19	130	4		75	5
1966	2,241	553	43	107	1,538	0	11	91	925	2	0	1	68	25	322	17		75	18
1967	3,102	720	66	160	2,156	0	10	147	1,313	10	1	5	101	28	376	12		131	34
1968	3,918	764	54	120	2,980	0	21	186	2,029	16	0	4	92	34	388	18		143	67
1969	3,965	726	65	133	3,041	0	12	223	2,065	12	8	6	115	46	348	25		171	35
1970	3,891	626	86	103	3,076	0	17	256	2,157	12	5	11	109	60	295	41		123	31
1971	4,660	690	84	152	3,734	1	15	308	2,696	7	3	15	143	67	244	37		146	89
1972	4,915	698	95	117	4,005	0	18	353	2,803	19	5	11	140	104	276	41		181	95
1973	5,436	686	159	206	4,385	0	21	436	2,885	26	9	7	183	111	397	65		203	106
1974	6,090	687	116	164	5,123	1	19	443	3,533	24	12	25	217	143	364	98		230	112
1975	6,060	686	191	165	5,018	0	28	390	3,537	29	10	15	224	112	343	76		227	103
1976	5,799	726	434	160	4,479	3	24	387	2,840	25	14	17	222	128	473	169		172	174
1977	6,923	718	331	195	5,679	1	24	485	3,821	40	24	19	222	160	559	203		236	88
1978	7,640	653	344	216	6,427	3	26	597	4,195	71	14	16	245	178	577	215		400	105
1979	7,613	652	224	136	6,601	2	41	626	4,369	54	15	13	258	181	509	200		429	104
1980	7,135	559	177	105	6,294	0	65	495	4,400	39	10	12	218	209	491	206		302	53
1981	6,976	565	133	71	6,207	1	36	505	4,515	12	7	12	177	175	415	181		278	74
1982	7,363	574	127	82	6,580	1	26	535	4,807	25	8	15	204	194	411	194		278	76
1983	7,703	569	158	67	6,909	0	44	600	5,034	32	14	10	164	203	407	201		294	107
1984	8,311	609	134	37	7,531	2	38	685	5,473	29	7	20	207	193	511	283		298	68
1985	8,628	720	170	72	7,666	0	47	623	5,608	57	16	26	218	245	501	254		291	34
1986	9,620	892	149	92	8,487	2	32	678	6,182	58	27	14	288	245	601	330		332	28
1987	10,413	874	196	148	9,195	4	27	706	6,536	72	72	23	362	338	656	360		362	37
1988	11,129	995	178	132	9,824	1	23	730	6,585	83	114	27	531	411	831	504		427	61
1989	11,915	982	138	165	10,630	3	38	685	7,260	71	174	38	672	387	757	464		424	121
1990	12,774	1,041	149	179	11,405	3	31	768	7,808	97	162	43	651	443	768	522		480	131
1991	13,141	1,171	161	176	11,633	0	43	790	8,201	71	126	30	548	403	873	604		451	97
1992	14,351	1,266	181	300	12,603	1	39	938	8,831	67	89	26	665	500	836	583		460	152

Source: Ministry of Education

Table 2-6-1 Enrollment in Doctorate Courses

Year	Department										
	Total	Humanities	Social sciences	Physical science	Engineering	Agriculture	Health	Household science	Education	Art	Others
1965	3,551	-	-	-	1,017	-	-	-	-	-	-
1966	3,773	-	-	-	1,177	-	-	-	-	-	-
1967	3,780	-	-	-	1,393	-	-	-	-	-	-
1968	3,773	525	430	689	793	272	939	-	122	3	-
1969	3,513	558	457	741	763	264	640	-	86	4	-
1970	3,336	485	506	725	678	285	533	-	118	6	-
1971	3,791	595	548	746	753	282	728	2	135	2	-
1972	3,979	602	601	743	747	290	865	3	121	7	-
1973	4,076	676	536	766	726	317	901	8	144	2	-
1974	4,182	708	575	735	740	299	962	7	151	5	-
1975	4,158	715	539	625	761	276	1,066	14	158	4	-
1976	4,466	684	569	745	774	297	1,233	9	150	5	-
1977	4,539	714	537	725	800	297	1,324	10	116	14	2
1978	4,623	670	540	716	737	340	1,474	7	127	8	4
1979	4,845	736	573	666	686	313	1,706	4	131	19	11
1980	4,669	723	492	657	638	294	1,696	12	123	15	19
1981	4,753	757	496	622	625	272	1,800	10	128	22	21
1982	4,914	726	511	623	635	293	1,945	17	120	17	27
1983	5,322	802	513	646	650	287	2,236	13	132	20	23
1984	5,749	808	558	695	715	328	2,445	13	143	13	31
1985	5,877	803	538	689	832	358	2,448	16	138	18	37
1986	6,645	829	552	701	1,089	417	2,820	12	148	19	58
1987	6,848	837	557	845	1,062	402	2,906	13	141	21	64
1988	7,170	900	559	802	1,244	495	2,899	18	145	26	82
1989	7,478	899	607	929	1,258	502	2,973	27	153	31	99
1990	7,813	917	606	929	1,399	580	3,076	21	165	24	96
1991	8,505	930	642	1,021	1,715	675	3,206	16	160	28	112
1992	9,481	1,066	742	1,076	2,010	775	3,395	25	193	23	176

Note: Figures for "Engineering" in and before 1967 show the total numbers of students in the department of science and engineering.  
Source: Ministry of Education, "Fundamental School Research"

Table 2-6-2 Admission Competitiveness of Doctorate Courses and Enrollment by Gender

## Admission competitiveness

Year	Natural science			Engineering		
	Applicants	Enrollment	Competitiveness	Applicants	Enrollment	Competitiveness
1966	-	-	-	1,300	1,177	1.10
1967	-	-	-	1,501	1,393	1.08
1968	769	689	1.12	897	793	1.13
1969	810	741	1.09	890	763	1.17
1970	839	725	1.16	790	678	1.17
1971	853	746	1.14	829	753	1.10
1972	866	743	1.17	851	747	1.14
1973	852	766	1.11	868	726	1.20
1974	859	735	1.17	865	740	1.17
1975	739	625	1.18	871	761	1.14
1976	889	745	1.19	933	774	1.21
1977	825	725	1.14	950	800	1.19
1978	856	716	1.20	870	737	1.18
1979	787	666	1.18	806	686	1.17
1980	772	657	1.18	745	638	1.17
1981	723	622	1.16	723	625	1.16
1982	717	623	1.15	732	635	1.15
1983	725	646	1.12	749	650	1.15
1984	770	695	1.11	784	715	1.10
1985	784	689	1.14	917	832	1.10
1986	752	701	1.07	1,192	1,089	1.09
1987	910	845	1.08	1,161	1,062	1.09
1988	883	802	1.10	1,350	1,244	1.09
1989	1,014	929	1.09	1,384	1,258	1.10
1990	1,005	929	1.08	1,597	1,399	1.14
1991	1,115	1,021	1.09	1,871	1,715	1.09
1992	1,188	1,076	1.10	2,218	2,010	1.10

## Breakdown of enrolled students by gender

Year	Natural science			Engineering		
	Male	Female	Female (%)	Male	Female	Female (%)
1965	-	-	-	-	-	-
1966	-	-	-	-	-	-
1967	-	-	-	1,340	53	3.8%
1968	662	27	3.9%	789	4	0.5%
1969	707	34	4.6%	762	1	0.1%
1970	686	39	5.4%	676	2	0.3%
1971	712	34	4.6%	750	3	0.4%
1972	703	40	5.4%	740	7	0.9%
1973	731	35	4.6%	721	5	0.7%
1974	697	38	5.2%	731	9	1.2%
1975	599	26	4.2%	754	7	0.9%
1976	709	36	4.8%	762	12	1.6%
1977	695	30	4.1%	793	7	0.9%
1978	676	40	5.6%	730	7	0.9%
1979	631	35	5.3%	672	14	2.0%
1980	619	38	5.8%	615	23	3.6%
1981	578	44	7.1%	609	16	2.6%
1982	576	47	7.5%	618	17	2.7%
1983	612	34	5.3%	631	19	2.9%
1984	651	44	6.3%	697	18	2.5%
1985	642	47	6.8%	811	21	2.5%
1986	648	53	7.6%	1,033	56	5.1%
1987	792	53	6.3%	1,003	59	5.6%
1988	742	60	7.5%	1,186	58	4.7%
1989	847	82	8.8%	1,195	63	5.0%
1990	864	65	7.0%	1,335	64	4.6%
1991	902	119	11.7%	1,613	102	5.9%
1992	983	93	8.6%	1,902	108	5.4%

Note: Figures for "Engineering" in and before 1967 show the total numbers of students in the department of science and engineering.

Source: Ministry of Education, "Fundamental School Research"

Table 2-6-3 Employment of Natural Science and Engineering Doctorate Course Graduates

Natural science																		
	Total graduates	Enrolled in graduate school	Doing nothing	Others	Employed	Agriculture, forestry,	Mining	Constructi	Manufacturi	Wholesale, retailing	Financial, insurance	Real estate	Transport, communicatio	Utilities	Services	Information	Public service	Others
Year																		
1965	238	0	63	8	167	0	0	0	11	0	0	0	0	0	148	0	6	2
1966	268	0	60	15	193	0	0	0	10	0	0	0	0	0	177	0	6	0
1967	274	0	70	14	190	1	0	0	18	0	0	0	1	0	164	1	3	3
1968	321	0	81	13	227	0	0	0	12	0	0	0	1	0	208	0	0	6
1969	355	0	106	10	239	0	0	0	24	0	0	0	0	1	204	2	6	4
1970	391	0	153	19	219	0	0	0	47	0	0	0	3	0	158	3	8	3
1971	461	0	193	7	261	0	2	1	56	0	0	0	0	0	189	14	5	8
1972	518	0	238	37	243	1	0	0	44	0	0	0	0	0	179	9	9	10
1973	506	0	242	46	218	0	0	2	42	1	0	0	0	1	149	10	9	14
1974	509	0	191	65	253	1	0	0	54	0	0	0	1	1	163	4	7	25
1975	494	1	201	52	240	0	1	1	56	1	0	0	3	0	167	5	4	7
1976	485	1	262	53	169	0	3	0	24	0	0	0	2	0	135	2	3	2
1977	567	8	277	59	223	0	1	0	35	1	0	0	1	0	160	8	4	21
1978	500	2	299	29	170	0	1	0	35	0	0	0	0	0	116	1	13	5
1979	555	2	302	20	231	0	1	2	46	2	0	0	1	0	160	2	19	0
1980	589	2	309	19	259	0	2	1	61	0	0	0	2	0	177	9	12	4
1981	607	1	313	66	227	0	4	1	74	2	0	0	1	0	126	5	18	1
1982	569	0	302	26	241	0	0	1	71	1	0	0	5	1	149	10	11	2
1983	582	0	297	53	232	0	2	2	77	0	0	0	0	0	147	7	4	0
1984	529	1	241	39	248	0	3	3	83	1	0	0	1	0	124	4	9	24
1985	610	0	278	45	287	0	6	0	98	0	1	0	3	0	122	7	28	29
1986	564	0	241	25	298	0	0	0	81	0	0	0	1	0	151	9	45	20
1987	605	3	258	61	283	0	2	0	73	1	1	0	1	1	178	14	18	8
1988	589	1	248	42	298	0	1	0	71	0	0	0	2	1	186	13	27	10
1989	675	1	256	90	328	0	1	2	83	1	0	0	2	1	184	10	38	16
1990	634	0	240	73	321	0	2	3	104	0	0	0	2	0	176	8	19	15
1991	674	2	273	52	347	0	0	1	90	0	1	0	4	0	210	16	39	2
1992	730	4	243	53	430	0	0	6	115	0	0	0	2	3	245	19	47	12

Engineering																		
	Total graduates	Enrolled in graduate school	Doing nothing	Others	Employed	Agriculture, forestry, fishery	Mining	Constructi on	Manufacturi ng	Wholesale, retailing	Financial, insurance	Real estate	Transport, communication	Utilities	Services	Information	Public service	Others
Year																		
1965	170	0	13	7	150	0	0	3	21	0	0	0	0	2	103	0	13	8
1966	213	0	5	14	194	0	0	4	39	0	0	0	2	0	134	0	13	2
1967	287	0	15	23	249	0	1	1	40	0	0	0	6	0	188	2	9	4
1968	407	0	35	18	354	0	0	3	51	0	0	0	1	4	270	1	21	4
1969	461	0	38	38	385	0	0	4	62	1	1	0	5	1	204	2	6	4
1970	590	0	68	81	441	0	1	7	145	0	0	0	4	1	255	0	18	10
1971	533	0	68	17	448	0	0	13	126	0	0	0	6	0	261	1	9	33
1972	544	0	92	14	438	0	0	6	104	0	2	1	11	6	250	3	8	50
1973	513	0	109		373	0	1	10	93	0	0	0	11	3	219	3	5	31
1974	598	0	31	15	466	0	2	16	122	0	2	0	14	3	226	17	22	59
1975	570	0	126	40	404	0	0	6	124	0	0	0	8	8	176	4	26	56
1976	551	2	160	46	343	1	1	12	81	0	0	0	12	1	183	5	21	31
1977	659	2	167	56	434	0	0	9	156	1	0	0	11	2	204	9	5	46
1978	573	1	161	70	341	0	0	8	108	1	0	0	19	4	177	6	8	16
1979	656	0	135	93	428	0	0	17	183	0	0	0	13	0	197	6	6	12
1980	657	1	175	47	434	1	4	15	174	0	0	0	9	3	191	7	24	13
1981	685	6	159	82	438	1	0	7	179	0	1	2	12	0	182	7	20	34
1982	621	6	92	103	420	0	0	11	140	0	0	0	10	0	212	12	21	26
1983	579	6	94	66	413	0	3	17	155	0	0	0	13	1	176	6	28	20
1984	563	4	139	8	412	0	3	17	148	2	0	0	7	5	199	14	12	19
1985	552	1	114	26	411	0	0	4	139	1	0	0	7	2	188	10	40	30
1986	588	1	126	59	402	0	1	4	151	0	1	0	7	3	215	7	9	11
1987	638	0	131	98	409	0	1	8	110	0	2	0	8	3	237	12	30	10
1988	721	1	141	87	492	0	2	20	138	1	0	0	7	3	276	16	27	18
1989	915	0	194	97	624	0	1	11	207	0	0	0	10	4	306	13	36	49
1990	937	4	150	142	641	0	8	21	218	0	1	0	11	4	297	20	35	46
1991	1,048	0	96	202	750	0	0	31	242	1	1	0	15	9	366	18	45	40
1992	1,141	3	134	206	798	0	4	31	313	1	0	1	18	7	340	23	50	33

Source: Ministry of Education

Table 2-6-4 Number of Doctorates Conferred

Academic Year		1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Physical science	Course Doc.	348	344	349	345	354	388	441	425	469	457	433	429	397	459	497	479	464	518	531	522
	Dissertation Doc.	303	341	308	306	322	329	402	357	345	365	358	333	377	348	363	341	373	363	345	313
	Total	651	685	657	651	676	717	843	782	814	822	791	762	774	807	860	820	837	881	876	835
Engineering	Course Doc.	428	381	436	479	456	490	485	523	545	523	541	506	489	447	480	505	621	788	794	882
	Dissertation Doc.	417	472	494	521	530	589	558	643	650	663	695	772	801	844	924	988	926	929	982	1,085
	Total	845	853	930	1,000	986	1,079	1,043	1,166	1,195	1,186	1,236	1,278	1,290	1,291	1,404	1,493	1,547	1,717	1,776	1,967
Interdisciplinary studies	Course Doc.	-	-	-	-	-	-	-	2	4	6	14	30	32	37	36	53	70	136	179	212
	Dissertation Doc.	-	-	-	-	-	-	-	1	2	4	4	11	20	12	18	28	39	32	77	112
	Total	-	-	-	-	-	-	-	3	6	10	18	41	52	49	54	81	109	168	256	324
Arts, humanities and social sciences	Course Doc.	26	34	26	30	38	45	36	32	34	40	44	50	47	47	51	57	69	75	76	120
	Dissertation Doc.	127	137	108	132	136	167	149	120	133	147	128	147	161	167	185	203	223	226	236	232
	Total	153	171	134	162	174	212	185	152	167	187	172	197	208	214	236	260	292	301	312	352
Medicine	Course Doc.	796	636	424	425	448	483	459	552	635	742	850	958	1,086	1,167	1,318	1,502	1,642	1,639	1,944	1,941
	Dissertation Doc.	1,126	1,150	1,125	1,304	1,389	1,540	1,695	1,944	1,922	2,054	2,188	2,170	2,491	2,417	2,463	2,713	2,961	3,093	2,987	3,381
	Total	1,922	1,786	1,549	1,729	1,837	2,023	2,154	2,496	2,557	2,796	3,038	3,128	3,577	3,584	3,781	4,215	4,603	4,732	4,931	5,322
Dentistry	Course Doc.	123	131	105	109	140	150	159	145	197	216	225	242	252	237	258	330	342	333	388	375
	Dissertation Doc.	195	170	181	210	184	220	200	222	222	276	311	323	279	313	335	358	365	359	375	346
	Total	318	301	286	319	324	370	359	367	419	492	536	565	531	550	593	688	707	692	763	721
Pharmacology and health	Course Doc.	76	52	83	100	83	98	92	114	105	113	126	131	106	138	127	128	126	138	166	159
	Dissertation Doc.	86	95	113	111	127	149	128	126	119	136	153	184	180	230	226	202	221	227	255	234
	Total	162	147	196	211	210	247	220	240	224	249	279	315	286	368	353	330	347	365	421	393
Agriculture	Course Doc.	95	135	133	132	124	148	174	163	145	178	176	146	171	174	214	172	247	287	256	299
	Dissertation Doc.	223	239	214	285	222	276	276	223	222	285	295	309	291	373	406	392	367	384	374	319
	Total	318	374	347	417	346	424	450	386	367	463	471	455	462	547	620	564	614	671	630	618
Others	Course Doc.	11	7	19	14	12	12	13	18	20	15	15	24	21	19	23	26	27	35	48	38
	Dissertation Doc.	27	28	30	26	27	54	55	38	43	49	43	45	32	48	54	56	74	40	56	63
	Total	38	35	49	40	39	66	68	56	63	64	58	69	53	67	77	82	101	75	104	101
Total	Course Doc.	1,903	1,720	1,575	1,634	1,655	1,814	1,859	1,974	2,154	2,290	2,424	2,516	2,601	2,725	3,004	3,252	3,608	3,949	4,382	4,548
	Dissertation Doc.	2,504	2,632	2,573	2,895	2,937	3,324	3,463	3,674	3,658	3,979	4,175	4,294	4,632	4,752	4,974	5,281	5,549	5,653	5,687	6,085
	Total	4,407	4,352	4,148	4,529	4,592	5,138	5,322	5,648	5,812	6,269	6,599	6,810	7,233	7,477	7,978	8,533	9,157	9,602	10,069	10,633

Source: Figures for years up to 1986 are cited from "Compilation of Higher Education Statistical Data" published by the Research Center for University Education, Hiroshima University. Figures for years after 1986 are based on data from the Ministry of Education.

Table 2-6-5 Number of Natural Science and Engineering Doctorates Conferred

Year	Natural science				Engineering			
	Course doctorates	Dissertation doctorates	Total	Rate of dissertation doctorates	Course doctorates	Dissertation doctorates	Total	Rate of dissertation doctorates
1957	47	0	47	0%	25	0	25	0%
1958	117	1	118	1%	83	0	83	0%
1959	145	4	149	3%	66	0	66	0%
1960	139	23	162	14%	72	6	78	8%
1961	173	59	232	25%	69	17	86	20%
1962	137	138	275	50%	84	54	138	39%
1963	160	180	340	53%	94	116	210	55%
1964	164	260	424	61%	112	209	321	65%
1965	159	257	416	62%	156	263	419	63%
1966	182	288	470	61%	193	299	492	61%
1967	201	253	454	56%	272	333	605	55%
1968	240	274	514	53%	305	323	628	51%
1969	265	271	536	51%	400	338	738	46%
1970	323	287	610	47%	425	428	853	50%
1971	348	303	651	47%	428	417	845	49%
1972	344	341	685	50%	381	472	853	55%
1973	349	308	657	47%	436	494	930	53%
1974	345	306	651	47%	479	521	1,000	52%
1975	354	322	676	48%	456	530	986	54%
1976	388	329	717	46%	490	589	1,079	55%
1977	441	402	843	48%	485	558	1,043	53%
1978	425	357	782	46%	523	643	1,166	55%
1979	469	345	814	42%	545	650	1,195	54%
1980	457	365	822	44%	523	663	1,186	56%
1981	433	358	791	45%	541	695	1,236	56%
1982	429	333	762	44%	506	772	1,278	60%
1983	397	377	774	49%	489	801	1,290	62%
1984	459	348	807	43%	447	844	1,291	65%
1985	497	363	860	42%	480	924	1,404	66%
1986	479	341	820	42%	505	988	1,493	66%
1987	464	373	837	45%	621	926	1,547	60%
1988	518	363	881	41%	788	929	1,717	54%
1989	531	345	876	39%	792	982	1,774	55%
1990	522	313	835	37%	882	1,085	1,967	55%

Source: Figures for years up to 1987 are cited from "Numerical U.S.-Japan Comparison in Number of Natural Science Doctorates Conferred" (NISTEP REPORT NO.7, National Institute of Science and Technology Policy, Science and Technology Agency). Figures for years af

Table 2-6-6 Number of Doctorates Conferred in Japan and the U.S.

## Natural science

Japan								U.S.			
Year	Popu- lation (x10,000)	Course doc.		Dissertation doc.		Total		Year	Popu- lation (x10,000)	No. of doc.	No. of doc. per 100,000 of pop.
		No. of doc.	No. of doc. per 100,000 of pop.	No. of doc.	No. of doc. per 100,000 of pop.	No. of doc.	No. of doc. per 100,000 of pop.				
1980	11,706	455	0.389	-	-	-	-	1981	23,014	6,537	2.840
		457	0.390	365	0.312	822	0.702		-	7,742	3.364
1981	11,790	429	0.364	-	-	-	-	1982	23,252	6,600	2.838
		433	0.367	358	0.304	791	0.671		-	7,964	3.425
1982	11,873	423	0.356	-	-	-	-	1983	23,480	6,478	2.759
		429	0.361	333	0.280	762	0.642		-	7,881	3.356
1983	11,954	389	0.325	-	-	-	-	1984	23,700	6,531	2.756
		397	0.332	377	0.315	774	0.647		-	8,037	3.391
1984	12,031	448	0.372	-	-	-	-	1985	23,928	6,324	2.643
		459	0.382	348	0.289	807	0.671		-	8,012	3.348
1985	12,105	483	0.399	-	-	-	-	1986	24,162	6,237	2.581
		497	0.411	363	0.300	860	0.710		-	8,216	3.400
1986	12,167	454	0.373	-	-	-	-	1987	24,393	6,216	2.548
		479	0.394	341	0.280	820	0.674		-	8,416	3.450
1987	12,226	428	0.350	-	-	-	-	1988	24,633	6,462	2.623
		464	0.380	373	0.305	837	0.685		-	8,901	3.613
1988	12,278	463	0.377	-	-	-	-	1989	24,824	6,373	2.567
		518	0.422	363	0.296	881	0.718		-	8,954	3.607
1989	12,359	474	0.384	-	-	-	-	1990	25,152	6,492	2.581
		531	0.430	345	0.279	-	0.709		-	9,988	3.971

## Engineering

Japan								U.S.			
Year	Popu- lation (x10,000)	Course doc.		Dissertation doc.		Total		Year	Popu- lation (x10,000)	No. of doc.	No. of doc. per 100,000 of pop.
		No. of doc.	No. of doc. per 100,000 of pop.	No. of doc.	No. of doc. per 100,000 of pop.	No. of doc.	No. of doc. per 100,000 of pop.				
1980	11,706	501	0.428	-	-	-	-	1981	23,014	1,659	0.721
		523	0.447	663	0.566	1186	1.013		-	2,760	1.199
1981	11,790	506	0.429	-	-	-	-	1982	23,252	1,620	0.697
		541	0.459	695	0.589	1236	1.048		-	2,866	1.233
1982	11,873	462	0.389	-	-	-	-	1983	23,480	1,689	0.719
		506	0.426	772	0.650	1278	1.076		-	3,067	1.306
1983	11,954	436	0.365	-	-	-	-	1984	23,700	1,708	0.721
		489	0.409	801	0.670	1290	1.079		-	3,208	1.354
1984	12,031	389	0.323	-	-	-	-	1985	23,928	1,807	0.755
		447	0.372	844	0.702	1291	1.073		-	3,476	1.453
1985	12,105	407	0.336	-	-	-	-	1986	24,162	1,975	0.817
		480	0.397	924	0.763	1404	1.160		-	3,775	1.562
1986	12,167	402	0.330	-	-	-	-	1987	24,393	2,188	0.897
		505	0.415	988	0.812	1493	1.227		-	4,162	1.706
1987	12,226	461	0.377	-	-	-	-	1988	24,633	2,470	1.003
		621	0.508	926	0.757	1547	1.265		-	4,704	1.910
1988	12,278	534	0.435	-	-	-	-	1989	24,824	2,608	1.051
		788	0.642	929	0.757	1717	1.398		-	5,148	2.074
1989	12,359	537	0.435	-	-	-	-	1990	25,152	2,699	1.073
		792	0.641	982	0.795	1774	1.435		-	5,596	2.225

Note: Figures in the upper lines do not include the number of doctorates conferred to foreigners.

Figures in the lower lines include the number of doctorates conferred to foreigners.

Source Japanese population is calendar-year population based on census or estimates published by Statistics Bureau, Management and Coordination Agency. Population of the U.S. are cited from UN Monthly Report.

The number of doctorates conferred in Japan to Japanese researchers for years up to 1988 are cited from "Numerical U.S.-Japan Comparison in Number of Natural Science Doctorates" published by National Institute of Science and Technology. The figure for 1

The number of doctorates conferred in the U.S. to researchers excluding foreigners is cited from "Science and Engineering Doctorates". NSF. The figure includes the doctorates conferred to foreigner researchers having U.S. citizenship.

Table 3-1-1 Japan's Governmental S&T Budget

(million yen)			
FY	Nominal budget	Real budget	GNP deflator
1971	295,290	694,800	42.5
1972	360,865	793,110	45.5
1973	441,853	840,025	52.6
1974	541,084	868,514	62.3
1975	677,321	1,026,244	66.0
1976	771,960	1,081,176	71.4
1977	870,604	1,150,071	75.7
1978	990,489	1,252,198	79.1
1979	1,153,259	1,425,536	80.9
1980	1,294,893	1,516,268	85.4
1981	1,403,148	1,598,118	87.8
1982	1,453,578	1,633,234	89.0
1983	1,461,859	1,617,101	90.4
1984	1,483,839	1,604,150	92.5
1985	1,532,869	1,632,448	93.9
1986	1,606,386	1,685,610	95.3
1987	1,662,336	1,744,319	95.3
1988	1,715,746	1,792,838	95.7
1989	1,815,199	1,854,136	97.9
1990	1,920,871	1,920,871	100.0
1991	2,022,631	1,982,972	102.0
1992	2,134,676	-	-
1993	2,266,265	-	-
1994	2,358,474	-	-

Source: Science and Technology Agency



Table 3-1-2 S&amp;T Budget and General Expenditures Growth Rates

FY	S&T Budget - Total		S&T Budget - General Account		General Expenditures	
	Budget (million yen)	Yearly growth (%)	Budget (million yen)	Yearly growth (%)	Budget (million yen)	Yearly growth (%)
1987	1,662,336	-	799,543	-		-
1988	1,715,746	3.2	822,463	2.9	32,982,107	1.2
1989	1,815,199	5.8	862,451	4.9	34,080,487	3.3
1990	1,920,871	5.8	903,831	4.8	35,373,115	3.8
1991	2,022,631	5.3	953,933	5.5	37,036,529	4.7
1992	2,134,676	5.5	1,011,009	6.0	38,698,811	4.5
1993	2,266,265	6.2	1,076,370	6.5	39,916,800	3.1
1994	2,358,474	4.1	1,130,331	5.0	40,854,842	2.3

Source: Science and Technology Agency

Table 3-1-3 Composition of S&amp;T Budget (FY 1994)

	Budget (mil. yen)	Proportion (%)
S&T budget in General Account	1,130,331	47.9
S&T promotion	636,421	27.0
Other research expenditures	493,910	20.9
S&T budget in Special Account	1,228,143	52.1
National Schools Special Account	854,327	36.2
Total S&T budget	2,358,474	100.0

Source: Science and Technology Agency

Table 3-1-4 S&amp;T Budget by Content

Item / Year	(billion yen)						
	1988	1989	1990	1991	1992	1993	1994
National university expenditures	6,218	6,575	6,897	7,287	7,730	8,157	8,543
National research institute expenditures	2,561	2,777	2,944	3,189	3,419	3,665	3,772
Grants/Government investment	8,143	8,544	9,067	9,445	9,869	10,493	10,919
Administrative and other expenditures	235	260	301	305	329	347	350
Total	17,157	18,156	19,209	20,226	21,347	22,663	23,585

Source: Science and Technology Agency

Table 3-1-5 Share by Government Ministry/Agency of S&amp;T Budget (FY 1994)

	Budget (mil. yen)	Share (%)
Ministry of Education	1,100,356	46.7
Science and Technology Agency	605,238	25.7
Ministry of International Trade and Industry	283,653	12.0
Defense Agency	140,788	6.0
Ministry of Agriculture, Forestry, and Fisheries	82,660	3.5
Ministry of Health and Welfare	69,891	3.0
Others	75,888	3.2
Total	2,358,474	100.0

Source: Science and Technology Agency

Table 3-1-6 Ratio of S&amp;T Budget to National Budget in Selected Countries

	(%)				
FY	Japan	U.S.	Germany	France	U.K.
1982	2.9	4.9	4.7	6.1	3.2
1983	2.9	4.7	4.6	6.4	3.3
1984	2.9	4.9	4.6	6.8	3.3
1985	2.9	5.0	5.0	6.0	3.4
1986	3.0	5.3	4.9	6.1	3.3
1987	3.1	5.3	4.9	6.2	4.0
1988	3.0	5.3	4.8	6.2	3.9
1989	3.0	5.3	4.8	6.2	3.9
1990	2.9	5.1	4.0	6.4	3.7
1991	2.9	4.7	4.2	6.1	3.5
1992	3.0	4.7	4.2	5.9	3.3
1993	3.1	4.9	3.9	5.9	3.2
1994	3.2	4.6	-	-	-

Source: Science and Technology Agency

Note (1): The categories of account for the total budget and S&T budget are different among the

(2): Only the federal budget is shown for Germany.

(3): The 1994 figure for the U.S. is an estimate.

Table 3-1-7 Ratio of S&amp;T Budget to GNP in Selected Countries

FY	Japan		
	S&T Budget (¥100 mil.)	GNP (¥100 mil.)	Ratio to GNP (%)
1982	14,536	2,734,615	0.53
1983	14,619	2,859,973	0.51
1984	14,838	3,057,253	0.49
1985	15,329	3,253,705	0.47
1986	16,064	3,396,853	0.47
1987	16,623	3,562,636	0.47
1988	17,157	3,792,300	0.45
1989	18,152	4,058,039	0.45
1990	19,209	4,353,616	0.44
1991	20,226	4,590,187	0.44
1992	21,347	4,701,166	0.45
1993	22,663	4,733,649	0.48
1994	23,585	-	-

FY	U.S.		
	Budget (\$100 mil.)	GNP (\$100 mil.)	Ratio to GNP (%)
1982	34,660	3,179,800	1.09
1983	35,900	3,434,400	1.05
1984	40,986	3,801,500	1.08
1985	47,216	4,053,600	1.16
1986	52,141	4,277,700	1.22
1987	53,256	4,544,500	1.17
1988	56,100	4,908,200	1.14
1989	60,760	5,266,800	1.15
1990	63,810	5,567,800	1.15
1991	62,183	5,737,100	1.08
1992	64,728	6,045,800	1.07
1993	68,378	6,378,100	1.07
1994	68,064	-	-

FY	German		
	S&T Budget (M100 mil.)	GNP (M100 mil.)	Ratio to GNP (%)
1982	11,552	1,590,300	0.73
1983	11,440	1,675,700	0.68
1984	11,680	1,763,300	0.66
1985	12,767	1,834,500	0.70
1986	12,898	1,936,100	0.67
1987	13,144	2,003,000	0.66
1988	13,255	2,108,000	0.63
1989	14,036	2,249,100	0.62
1990	15,149	2,448,200	0.62
1991	16,853	2,826,600	0.60
1992	17,969	3,021,800	0.59
1993	17,939	-	-
1994	-	-	-

FY	France		
	S&T Budget (F100 mil.)	GNP (F100 mil.)	Ratio to GNP (%)
1982	39,841	3,628,000	1.10
1983	46,738	3,994,800	1.17
1984	54,441	4,338,400	1.25
1985	60,121	4,674,500	1.29
1986	63,330	5,052,700	1.25
1987	64,655	5,324,200	1.21
1988	71,767	5,723,400	1.25
1989	75,008	6,149,100	1.22
1990	78,054	6,473,000	1.21
1991	78,773	6,708,500	1.17
1992	78,500	6,925,800	1.13
1993	80,586	-	-

FY	U.K.		
	S&T Budget (£100 mil.)	GNP (£100 mil.)	Ratio to GNP (%)
1982	3,519	278,920	1.26
1983	3,795	305,090	1.24
1984	4,054	326,370	1.24
1985	4,351	357,090	1.22
1986	4,367	384,610	1.14
1987	4,418	421,260	1.05
1988	4,504	467,940	0.96
1989	4,638	511,790	0.91
1990	4,835	544,340	0.89
1991	5,048	586,120	0.86
1992	5,199	594,510	0.87
1993	5,449	-	-

Source: Science and Technology Agency

Table 3-1-8 Japan's S&amp;T Budget by Socio-economic Objective

Fiscal year	(million yen)						1993 Ratio
	1988	1989	1990	1991	1992	1993	
Agriculture, forestry, and fisheries	66,642	68,037	70,108	73,557	76,177	81,030	3.6
Industrial development	82,670	83,111	82,558	85,556	82,663	85,239	3.8
Energy	383,349	402,452	433,339	441,993	455,660	480,770	21.2
Infrastructure	29,416	30,687	32,628	38,166	39,970	43,250	1.9
Protection of the environment	7,752	7,831	9,099	10,745	11,362	12,117	0.5
Health	44,059	48,370	51,242	56,144	61,338	64,343	2.8
Social development and services	17,926	19,137	19,476	21,439	21,937	23,579	1.0
Earth and atmosphere	17,395	18,791	20,728	20,586	22,785	24,554	1.1
Advancement of knowledge	879,391	927,977	971,654	1,021,225	1,083,933	1,148,274	50.7
Civil space	104,447	115,737	125,770	138,176	151,863	165,935	7.3
Defense	82,700	93,068	104,268	115,045	126,989	137,175	6.1

Source: Science and Technology Agency

Table 3-1-9 S&amp;T Budgets in Selected Countries by Socio-economic Objective

	U.S (1990)	
	Budget (\$100 mil.)	Ratio (%)
Agriculture, forestry, and fisheries	1,257	2.0
Promotion of industrial development	139	0.2
Energy	2,911	4.6
Infrastructure	1,221	1.9
Protection of the environment	394	0.6
Health	8,573	13.4
Social development and services	697	1.1
Earth and atmosphere	660	1.0
Advancement of knowledge	2,499	3.9
Civil space	5,577	8.7
Defense	39,877	62.5

	German (1990)	
	Budget (M100 mil.)	Ratio (%)
Agriculture, forestry, and fisheries	483	1.9
Promotion of industrial development	3,105	12.5
Energy	1,482	6.0
Infrastructure	476	1.9
Protection of the environment	1,034	4.2
Health	832	3.3
Social development and services	612	2.5
Earth and atmosphere	574	2.3
Advancement of knowledge	11,337	45.6
Civil space	1,514	6.1
Defense	3,404	13.7

	France (1989)	
	Budget (F100 mil.)	Ratio (%)
Agriculture, forestry, and fisheries	3,392	4.1
Promotion of industrial development	11,102	13.3
Energy	2,918	3.5
Infrastructure	705	0.8
Protection of the environment	596	0.7
Health	2,769	3.3
Social development and services	410	0.5
Earth and atmosphere	1,366	1.6
Advancement of knowledge	22,673	27.1
Civil space	6,453	7.7
Defense	31,000	37.0

	U.K. (1990)	
	Budget (£100 mil.)	Ratio (%)
Agriculture, forestry, and fisheries	222	4.4
Promotion of industrial development	466	9.2
Energy	144	2.8
Infrastructure	71	1.4
Protection of the environment	73	1.4
Health	267	5.3
Social development and services	111	2.2
Earth and atmosphere	140	2.8
Advancement of knowledge	1,099	21.7
Civil space	155	3.1
Defense	2,308	45.5

Source: OECD, "Main Science and Technology Indicators : 1992/2", 1993.

Table 3-2-1 Activities of S&amp;T Support Foundations

•@

Year	1986	1987	1988	1989	1990	1991	1992	1993	•@
Number of foundations	171	-	199	253	244	290	352	399	•@
Number of programs	-	-	482	642	673	802	933	1041	•@
By area of activity									
Physical science	66		147	172	285	380	447	489	•@
Agriculture							332	375	
Engineering	76		179	219			448	484	•@
Medical science	68		162	192	230	312	389	435	•@
Pharmacology							354	390	
Education/Sports/Youth	44		74	106	114	202	209	267	
Cultural preservation/promotion	43		91	116			177	214	
Performing arts							178	219	
Humanities					137	213	269	303	•@
Social sciences	46		111	140			278	309	•@
International cultural exchange					74	122	169	198	
International development/cooperation							133	151	
Social welfare	29		54	80	86	142	196	246	
Environment	24		44	56	-	-	128	181	•@
Other areas	18		34	52	61	98	114	139	
By type of activity									
Grant for R&D	126		188	250	245	298	366	384	
Grant for sending researchers abroad	50		67	82	94	114	122	131	
Grant for inviting foreign researchers	21		32	41	46	65	74	78	
Grant for conferences	36		44	63	82	100	125	142	
Grant for publishing	19		28	34	37	48	63	70	
Grant for facilities	21		33	39	43	59	58	68	
Other grants	43		60	85	79	109	146	198	
Direct overseas grant	9		9	14	27	39	42	50	
Scholarship for Japanese in Japan	32		37	62	62	72	115	104	
Scholarship for Japanese overseas								37	
Scholarship for foreign researchers	23		23	49	66	70	92	98	
Awarding	39		56	64	70	86	101	105	
By area of grant									
Natural science	45		55	72				190	
Agriculture								140	
Engineering	55		73	95				190	
Medical science	51		72	92				182	
Pharmacology								146	
Education/Sports/Youth	23		27	38				74	
Cultural preservation/promotion	28		35	46				47	
Performing arts								49	
Humanities								105	
Social sciences	27		40	54				106	
International cultural exchange								41	
International development/cooperation								27	
Social welfare	17		17	25				67	
Environment	15		18	25				55	
Other areas	6		10	13				29	
Annual operating expenses	9,748	11,462	16,867	19,516	24,951	39,000	46,000	-	
R&D grant	-	4,711	6,340	-	-	-	10,947	-	

Source: "Present Status of Supportive Foundations in Japan", Supportive Foundations Data Center

"Survey and Analysis on Activities of Subsidy-Granting Type Nonprofit Foundations", No.1 and No.2,

Supportive Foundations Data Center

Table 3-2-2 Number of Learned Societies

Area of study	1966	1970	1975	1980	1986	1992	1993
Humanities	382	302	209	271	357	366	366
Law/Political science	68	55	39	46	50	53	53
Economics	102	91	36	46	71	77	77
Physical science	81	75	91	137	151	129	129
Engineering	135	129	148	164	143	174	174
Agriculture	40	36	56	67	122	126	126
Medical Science	232	210	206	272	342	406	406
Total	1,040	898	785	1,003	1,236	1,331	1,331

Source: Science Council of Japan, "Academic Research Bodies in Japan (1993)"

Table 3-2-3 Number of Individual Members in Learned Societies

Area of study	1966	1970	1975	1980	1986	1992	1993
Humanities	56,465	192,296	152,923	190,206	250,270	301,193	270,905
Law/Political science	7,455	87,831	17,109	21,274	24,680	30,322	28,531
Economics	11,606	173,861	18,436	36,764	45,627	75,018	73,495
Physical science	82,796	44,380	133,542	168,973	222,525	186,147	167,680
Engineering	319,497	435,088	523,203	531,841	515,457	631,757	586,879
Agriculture	40,546	53,732	86,828	87,723	165,558	192,500	181,095
Medical science	259,569	401,406	407,796	1,022,113	871,735	1,847,709	1,777,813
Total	777,934	1,388,594	1,339,837	2,058,894	2,095,852	3,264,646	3,086,398

Source: Science Council of Japan, "Academic Research Bodies in Japan (1993)"

Table 3-2-4 Number of Individual Members per Learned Society

Area of study	1966	1970	1975	1980	1986	1992	1993
Humanities	148	637	732	702	701	823	740
Law/Political science	110	1,597	439	462	494	572	538
Economics	114	1,911	512	799	643	974	954
Physical science	1,022	592	1,467	1,233	1,474	1,443	1,300
Engineering	2,367	3,373	3,535	3,243	3,605	3,631	3,373
Agriculture	1,014	1,493	1,551	1,309	1,357	1,528	1,437
Medical science	1,119	1,911	1,980	3,758	2,549	4,551	4,379
Total	748	1,546	1,707	2,053	1,696	2,453	2,319

Source: Science Council of Japan, "Academic Research Bodies in Japan (1993)"

Table 3-2-5 Number of Learned Societies by Year of Establishment

	-1900	-1910	-1920	-1930	-1940	-1945	-1950	-1955
Physical science	8	1	5	8	8	5	10	15
Engineering	7	1	6	8	13	2	23	15
Agriculture	1	0	2	12	2	1	8	24
Medicine/Dentistry / Pharmacology	13	4	5	22	13	4	23	24
Subtotal	29	6	18	50	36	12	64	78
Grand total	36	9	23	61	51	20	145	139

	-1900	-1910	-1920	-1930	-1940	-1945	-1950	-1955
Physical science	14	11	3	14	14	6	6	1
Engineering	18	13	12	13	13	10	18	2
Agriculture	15	16	6	15	8	7	8	0
Medicine/Dentistry / Pharmacology	42	41	27	46	56	56	23	7
Subtotal	89	81	48	88	91	79	55	10
Grand total	133	128	83	129	141	144	71	14

Source: Science Council of Japan, "Academic Research Bodies in Japan (1993)"

Table 3-2-6 Number of Books Published

Year	Number of books published								Total
	Natural sciences	Technology	Industry	Social sciences	Philosophy/ History	Literature/ Language	Arts	Other	
1960	893	1,356	812	2,579	1,362	3,160	698	2,262	13,122
1965	1,012	1,606	806	2,872	1,722	3,210	900	2,110	14,238
1970	1,427	1,933	894	4,262	2,115	3,986	1,712	2,425	18,754
1975	1,781	2,022	1,003	4,551	2,952	5,438	2,209	2,771	22,727
1980	2,300	2,552	1,129	6,251	3,290	6,136	3,260	2,973	27,891
1985	2,605	2,657	1,266	7,178	3,582	6,889	3,107	3,937	31,221
1986	3,078	3,459	1,602	8,996	4,108	7,316	3,170	5,287	37,016
1987	2,954	3,357	1,663	9,162	4,144	7,708	3,063	4,959	37,010
1988	2,884	3,535	1,679	9,030	4,281	8,694	3,112	5,082	38,297
1989	2,763	3,500	1,723	9,518	4,340	9,167	3,359	5,328	39,698
1990	2,970	3,446	1,698	9,798	4,243	9,618	3,348	5,455	40,576
1991	3,036	3,601	1,866	10,251	4,637	9,682	3,785	5,487	42,345
1992	3,574	3,597	1,862	10,415	5,226	10,358	4,746	5,817	45,595

Source: Shuppan News Company, "Publications Annual"

Table 3-2-7 Number of Magazines Published

Year	Number of magazines published						Total
	Natural sciences	Industry/ Engineering	Industry	Literature/ Language	Arts	Other	
1960	175	263	206	434	202	941	2,221
1965	170	387	231	220	183	981	2,172
1970	184	387	187	295	210	1,056	2,319
1975	241	439	230	391	257	1,192	2,750
1980	282	463	254	517	370	1,439	3,325
1985	322	493	255	601	454	1,558	3,683
1986	329	518	258	626	450	1,596	3,777
1987	339	498	272	587	482	1,602	3,780
1988	352	463	296	573	511	1,583	3,778
1989	365	477	303	559	527	1,633	3,864
1990	368	464	316	555	557	1,629	3,889
1991	393	463	320	567	559	1,616	3,918
1992	395	458	320	576	545	1,557	3,851

Source: Shuppan News Company, "Publications Annual"



Table 3-2-8 Number of Public Libraries and Books in Public Library Collections

Year	Number of libraries	Of which public ones	Number of books (x1000)								Total
			Natural sciences	Engineering Technology	Industry	Social sciences	Philosophy/ History	Literature/ Language	Arts	Other(*)	
1981	1,437	929	4,314	4,168	2,245	9,349	9830	28960	5,054	14026	77,946
1984	1,642	1,027	5,479	5,428	2,732	11,669	11590	35455	6,688	24927	103,968
1987	1,801	1,128	7,001	7,134	3,371	14,421	14071	42185	8,372	37058	133,613
1990	1,950	1,218	8,696	9,006	4,220	17,964	17227	52354	10,591	41636	161,694

Note: "Other" books include those which have not yet been pigeonholed.

Source: Management and Coordination Agency, "Report on the Survey on Society and Education"

Table 3-2-9 Number of Museums and Number of Visitors

Year	Number of museums					Total
	Science os/Aquariums/ Botanical gardens	Historical	Art	General/Other		
1971	48	85	97	85	60	375
1975	52	78	113	101	65	409
1978	59	83	136	135	80	493
1981	67	93	174	160	84	578
1984	77	97	211	193	98	676
1987	83	99	224	223	108	737
1990	81	101	258	252	107	799

Year	Number of visitors (x1000)					Total
	Science os/Aquariums/ Botanical gardens	Historical	Art	General/Other		
1974	10,255	52,751	14,340	9,907	6,404	93,657
1977	10,646	55,664	13,749	11,244	7,185	98,488
1980	13,769	54,221	26,449	16,562	5,279	116,280
1983	13,207	49,399	18,879	19,473	8,208	109,166
1986	12,117	58,329	19,246	21,687	8,812	120,191
1989	12,563	56,896	18,583	32,127	10,153	130,322

Source: Management and Coordination Agency, "Report on the Survey on Society and Education"

Table 3-2-10 Academic Backgrounds of Executives of Listed Companies (1993)

## (A) Total executives

(persons, %)

	Number of companies	Arts				Natural sciences			Subtotal			Unclassifiable	Total
		Economics	Law	Commerce	Others	Physical science/ Engineering	Agriculture	Medicine/ pharmacology	Arts	Natural sciences			
Total listed companies	2,128	10,143 30.2%	6,714 20.0%	4,503 13.4%	1,732 5.2%	9,176 27.3%	1,053 3.1%	285 0.8%	33,606 100.0%	23,092 68.7%	10,514 31.3%	6,291	39,897
mfg.	1,227	5,044 27.2%	3,192 17.2%	2,248 12.1%	761 4.1%	6,347 34.2%	717 3.9%	258 1.4%	18,567 100.0%	11,245 60.6%	7,322 39.4%	2,900	21,467
non-mfg	901	5,099 33.9%	3,522 23.4%	2,255 15.0%	971 6.5%	2,829 18.8%	336 2.2%	27 0.2%	15,039 100.0%	11,847 78.8%	3,192 21.2%	3,391	18,430
More than ¥10 bil. in capital	762	5,231 31.3%	3,757 22.5%	2,071 12.4%	845 5.0%	4,188 25.0%	471 2.8%	170 1.0%	16,733 100.0%	11,904 71.1%	4,829 28.9%	1,995	18,728
mfg.	388	2,258 26.7%	1,580 18.7%	880 10.4%	326 3.9%	2,927 34.6%	318 3.8%	165 2.0%	8,454 100.0%	5,044 59.7%	3,410 40.3%	810	9,264
non-mfg	374	2,973 35.9%	2,177 26.3%	1,191 14.4%	519 6.3%	1,261 15.2%	153 1.8%	5 0.1%	8,279 100.0%	6,860 82.9%	1,419 17.1%	1,185	9,464
Less than ¥10 bil. in capital	1,366	4,912 29.1%	2,957 17.5%	2,432 14.4%	887 5.3%	4,988 29.6%	582 3.4%	115 0.7%	16,873 100.0%	11,188 66.3%	5,685 33.7%	4,296	21,169
mfg.	839	2,786 27.5%	1,612 15.9%	1,368 13.5%	435 4.3%	3,420 33.8%	399 3.9%	93 0.9%	10,113 100.0%	6,201 61.3%	3,912 38.7%	2,090	12,203
non-mfg	527	2,126 31.4%	1,345 19.9%	1,064 15.7%	452 6.7%	1,568 23.2%	183 2.7%	22 0.3%	6,760 100.0%	4,987 73.8%	1,773 26.2%	2,206	8,966

## (B) Presidents

(persons, %)

	Number of companies	Arts				Natural sciences			Subtotal			Unclassifiable	Total
		Economics	Law	Commerce	Others	Physical science/ Engineering	Agriculture	Medicine/ pharmacology	Arts	Natural sciences			
Total listed companies	2,127	563 30.5%	405 22.0%	219 11.9%	68 3.7%	539 29.2%	41 2.2%	10 0.5%	1,845 100.0%	1,255 68.0%	590 32.0%	282	2,127
mfg.	1,227	296 27.5%	200 18.6%	121 11.2%	34 3.2%	390 36.2%	27 2.5%	8 0.7%	1,076 100.0%	651 60.5%	425 39.5%	151	1,227
non-mfg	900	267 34.7%	205 26.7%	98 12.7%	34 4.4%	149 19.4%	14 1.8%	2 0.3%	769 100.0%	604 78.5%	165 21.5%	131	900
More than ¥10 bil. in capital	761	220 31.6%	194 27.8%	78 11.2%	19 2.7%	166 23.8%	16 2.3%	4 0.6%	697 100.0%	511 73.3%	186 26.7%	64	761
mfg.	388	104 29.1%	83 23.2%	33 9.2%	7 2.0%	117 32.7%	10 2.8%	4 1.1%	358 100.0%	227 63.4%	131 36.6%	30	388
non-mfg	373	116 34.2%	111 32.7%	45 13.3%	12 3.5%	49 14.5%	6 1.8%	0 0.0%	339 100.0%	284 83.8%	55 16.2%	34	373
Less than ¥10 bil. in capital	1,366	343 29.9%	211 18.4%	141 12.3%	49 4.3%	373 32.5%	25 2.2%	6 0.5%	1,148 100.0%	744 64.8%	404 35.2%	218	1,366
mfg.	839	192 26.7%	117 16.3%	88 12.3%	27 3.8%	273 38.0%	17 2.4%	4 0.6%	718 100.0%	424 59.1%	294 40.9%	121	839
non-mfg	527	151 35.1%	94 21.9%	53 12.3%	22 5.1%	100 23.3%	8 1.9%	2 0.5%	430 100.0%	320 74.4%	110 25.6%	97	527

Source: Toyo Keizai Shinbun Company, "Executive Quarterly Database"

Table 3-2-11 Number of Top Corporate Executives of Listed Companies by Academic Background (1993)

(1) Number of executives

Industry	Number of companies	Number of Executives (A)	Unclassifiable (B)	Covered by analysis (C):(A)-(B)	Science and engineering graduates (D)	Ratio (D)/(C)
Fisheries/Forestry	7	118	9	109	41	37.6%
Mining	10	157	12	145	52	35.9%
Construction	154	3979	673	3306	1910	57.8%
Food	106	1869	327	1542	455	29.5%
Textiles	78	1174	158	1016	336	33.1%
Pulp & paper	33	612	72	540	192	35.6%
Chemicals	184	3359	315	3044	1293	42.5%
Petroleum & coal	13	283	31	252	78	31.0%
Rubber	21	392	34	358	111	31.0%
Glass & cement	59	949	78	871	301	34.6%
Iron & steel	57	1062	64	998	395	39.6%
Non-ferrous metals	37	703	33	670	260	38.8%
Fabricated metals	63	1080	230	850	310	36.5%
General machinery	189	2942	523	2419	986	40.8%
Electrical machinery	197	3466	499	2967	1371	46.2%
Transportation machinery	87	1853	197	1656	778	47.0%
Precision instruments	35	589	74	515	223	43.3%
Other manufacturing	68	1134	265	869	233	26.8%
Commerce	248	4638	1081	3557	385	10.8%
Finance/Insurance	180	4161	552	3609	72	2.0%
Real estate	34	550	75	475	47	9.9%
Warehousing/Transportation	110	1983	312	1671	228	13.6%
Communications	9	214	19	195	40	20.5%
Electricity/Gas	19	488	18	470	165	35.1%
Services	130	2142	640	1502	252	16.8%
All industries	2128	39897	6291	33606	10514	31.3%

(2) Presidents

Industry	Number of companies	Number of executives (A)	Unclassifiable (B)	Covered by analysis (C):(A)-(B)	Science and engineering graduates (D)	Ratio (D)/(C)
Fisheries/Forestry	7	7	1	6	1	16.7%
Mining	10	10	0	10	3	30.0%
Construction	154	154	18	136	81	59.6%
Food	106	106	14	92	18	19.6%
Textiles	78	78	3	75	19	25.3%
Pulp & paper	33	33	5	28	8	28.6%
Chemicals	184	184	14	170	59	34.7%
Petroleum & coal	13	13	0	13	3	23.1%
Rubber	21	21	1	20	5	25.0%
Glass & cement	59	59	6	53	20	37.7%
Iron & steel	57	57	3	54	24	44.4%
Non-ferrous metals	37	37	1	36	16	44.4%
Fabricated metals	63	63	10	53	19	35.8%
General machinery	189	189	35	154	72	46.8%
Electrical machinery	197	197	32	165	95	57.6%
Transportation machinery	87	87	10	77	44	57.1%
Precision instruments	35	35	4	31	14	45.2%
Other manufacturing	68	68	13	55	9	16.4%
Commerce	248	248	46	202	29	14.4%
Finance/Insurance	180	180	6	174	5	2.9%
Real estate	34	34	6	28	3	10.7%
Warehousing/Transportation	110	110	13	97	19	19.6%
Communications	9	9	0	9	2	22.2%
Electricity/Gas	19	19	2	17	5	29.4%
Services	129	129	39	90	17	18.9%
All industries	2127	2127	282	1845	590	32.0%

Source: Toyo Keizai Shinbun Company, "Executive Quarterly Database"

Table 4-1-1A R&amp;D Expenditures in Selected Countries (National Currencies)

Year	Japan (mil. yen)	U.S. (mil. dollars)	Germany (mil. marks)	France (mil. francs)	U.K. (mil. pounds)
1970	1,355,505	26,134	14,090	14,955	-
1971	1,532,372	26,676	17,210	16,621	-
1972	1,791,871	28,476	18,570	18,277	1,354.6
1973	2,215,836	30,718	19,810	19,789	-
1974	2,716,032	32,863	21,560	23,031	-
1975	2,974,573	35,213	23,710	26,203	2,221.5
1976	3,320,685	39,018	24,820	29,774	-
1977	3,651,319	42,783	26,840	33,185	-
1978	4,045,864	48,128	-	37,671	3,622.3
1979	4,583,630	54,953	33,538	44,123	-
1980	5,246,248	62,610	-	51,014	-
1981	5,982,356	71,869	38,794	62,471	5,921.1
1982	6,528,700	80,018	-	74,836	-
1983	7,180,782	89,143	43,247	84,671	6,583.0
1984	7,893,931	101,142	-	96,198	-
1985	8,890,299	113,818	50,807	105,917	8,093.0
1986	9,192,932	119,531	53,901	113,260	8,768.0
1987	9,836,640	125,353	57,768	121,364	9,383.0
1988	10,627,572	133,742	60,228	130,631	10,227.0
1989	11,815,482	140,771	63,893	143,553	11,288.0
1990	13,078,315	146,434	66,680	157,146	12,019.0
1991	13,771,524	145,383	74,505	163,092	12,161.0
1992	13,909,493	154,500	77,600	169,100	12,619.0
1993	13,709,100	160,750	-	-	-

Table 4-1-1B R&D Expenditures in Selected Countries (R&D Purchasing Parity Calculations)  
(million yen)

Year	Japan	U.S.	Germany	France	U.K.
1970	1,355,505	5,851,061	938,656	735,023	-
1971	1,532,372	5,950,512	1,124,173	808,491	-
1972	1,791,871	6,330,324	1,210,133	876,324	1,045,562.2
1973	2,215,836	7,146,595	1,368,315	987,222	-
1974	2,716,032	8,426,723	1,670,610	1,228,078	-
1975	2,974,573	8,846,624	1,875,745	1,349,041	1,595,796.0
1976	3,320,685	9,939,328	2,035,139	1,477,122	-
1977	3,651,319	10,800,268	2,249,251	1,594,208	-
1978	4,045,864	11,741,295	-	1,720,802	2,108,661.5
1979	4,583,630	12,717,936	2,806,281	1,897,965	-
1980	5,246,248	13,951,126	-	2,073,694	-
1981	5,982,356	15,176,816	3,189,925	2,325,917	2,594,508.6
1982	6,528,700	16,355,723	-	2,538,056	-
1983	7,180,782	17,749,990	3,394,946	2,625,192	2,592,613.0
1984	7,893,931	19,858,131	-	2,811,174	-
1985	8,890,299	22,079,752	3,925,210	2,976,315	2,965,734.5
1986	9,192,932	22,521,932	4,111,534	3,097,536	3,137,024.6
1987	9,836,640	22,764,097	4,339,929	3,248,240	3,215,315.5
1988	10,627,572	23,483,459	4,457,552	3,393,144	3,314,484.8
1989	11,815,482	24,286,048	4,686,701	3,667,569	3,478,033.9
1990	13,078,315	24,901,315	4,893,030	4,051,994	3,605,396.4
1991	13,771,524	23,930,042	5,355,250	4,142,738	3,451,207.9
1992	13,909,493	25,088,034	5,383,897	4,280,193	3,485,580.8
1993	13,709,100	25,720,000	-	-	-

Table 4-1-1C R&D Expenditures in Selected Countries (GDP Purchasing Parity Calculations)  
(million yen)

Year	Japan	U.S.	Germany	France	U.K.
1970	1,355,505	6,690,304	1,096,202	803,084	-
1971	1,532,372	6,855,732	1,307,960	885,899	-
1972	1,791,871	7,375,284	1,411,320	959,543	1,131,091.0
1973	2,215,836	8,416,732	1,596,686	1,080,479	-
1974	2,716,032	9,990,352	1,961,960	1,358,829	-
1975	2,974,573	10,493,474	2,193,175	1,475,229	1,750,542.0
1976	3,320,685	11,705,400	2,370,310	1,613,751	-
1977	3,651,319	12,749,334	2,622,268	1,748,850	-
1978	4,045,864	14,005,248	-	1,887,317	2,325,516.6
1979	4,583,630	15,112,075	3,259,894	2,064,956	-
1980	5,246,248	16,403,820	-	2,229,312	-
1981	5,982,356	17,751,643	3,712,586	2,530,076	2,753,311.5
1982	6,528,700	18,884,248	-	2,761,448	-
1983	7,180,782	20,502,890	3,931,152	2,861,880	2,771,443.0
1984	7,893,931	22,756,950	-	3,068,716	-
1985	8,890,299	25,267,596	4,547,227	3,230,469	3,148,177.0
1986	9,192,932	26,416,351	4,764,848	3,341,170	3,340,608.0
1987	9,836,640	26,950,895	4,985,378	3,471,010	3,415,412.0
1988	10,627,572	27,952,078	5,131,426	3,631,542	3,497,634.0
1989	11,815,482	28,858,055	5,405,348	3,918,997	3,725,040.0
1990	13,078,315	29,286,800	5,587,784	4,242,942	3,761,947.0
1991	13,771,524	28,640,451	6,139,212	4,387,175	3,684,783.0
1992	13,909,493	30,100,032	6,173,681	4,524,281	3,693,335.4
1993	13,709,100	30,912,225	-	-	-

Note: The R&D expenditures include those in humanities and social sciences.

Source: Japan - Management & Coordination Agency, "Report on the Survey on Science and Technology Research"

U.S. - National Science Foundation, "National Patterns of R&D Resources: 1992"

Germany - Bundesministerium für Forschung und Technologie, "Bundesbericht Forschung: 1993"

France and the U.K. - Science and Technology Agency, "White Paper on Science and Technology"

Table 4-1-2A R&amp;D Purchasing Power Parity in Selected Countries

Year	Japan (yen/dollar)	U.S. (dollar/dollar)	Germany (mark/dollar)	France (franc/dollar)	U.K. (pound/dollar)
1970	223.9	1.00	3.36	4.56	0.27
1971	223.1	1.00	3.41	4.59	0.28
1972	222.3	1.00	3.41	4.64	0.29
1973	232.7	1.00	3.37	4.66	0.29
1974	256.4	1.00	3.31	4.81	0.31
1975	251.2	1.00	3.18	4.88	0.35
1976	254.7	1.00	3.11	5.13	0.38
1977	252.4	1.00	3.01	5.25	0.41
1978	244.0	1.00	2.91	5.34	0.42
1979	231.4	1.00	2.77	5.38	0.43
1980	222.8	1.00	2.66	5.48	0.47
1981	211.2	1.00	2.57	5.67	0.48
1982	204.4	1.00	2.54	6.03	0.49
1983	199.1	1.00	2.54	6.42	0.51
1984	196.3	1.00	2.52	6.72	0.52
1985	194.0	1.00	2.51	6.90	0.53
1986	188.4	1.00	2.47	6.89	0.53
1987	181.6	1.00	2.42	6.79	0.53
1988	175.6	1.00	2.37	6.76	0.54
1989	172.5	1.00	2.35	6.75	0.56
1990	170.1	1.00	2.32	6.60	0.57
1991	164.6	1.00	2.29	6.48	0.58
1992	162.4	1.00	2.34	6.42	0.59
1993	160.0	1.00	-	-	-

Table 4-1-2B GDP Purchasing Power Parity in Selected Countries

Year	Japan (yen/dollar)	U.S. (dollar/dollar)	Germany (mark/dollar)	France (franc/dollar)	U.K. (pound/dollar)
1970	256.0	1.00	3.29	4.77	0.287
1971	257.0	1.00	3.38	4.82	0.299
1972	259.0	1.00	3.41	4.93	0.310
1973	274.0	1.00	3.40	5.02	0.310
1974	304.0	1.00	3.34	5.15	0.327
1975	298.0	1.00	3.22	5.29	0.378
1976	300.0	1.00	3.14	5.54	0.409
1977	298.0	1.00	3.05	5.65	0.437
1978	291.0	1.00	2.96	5.81	0.453
1979	275.0	1.00	2.83	5.88	0.476
1980	262.0	1.00	2.72	6.00	0.522
1981	247.0	1.00	2.58	6.10	0.531
1982	236.0	1.00	2.53	6.40	0.538
1983	230.0	1.00	2.53	6.80	0.546
1984	225.0	1.00	2.49	7.05	0.551
1985	222.0	1.00	2.48	7.28	0.571
1986	221.0	1.00	2.50	7.49	0.580
1987	215.0	1.00	2.49	7.52	0.591
1988	209.0	1.00	2.45	7.52	0.611
1989	205.0	1.00	2.42	7.51	0.621
1990	200.0	1.00	2.39	7.41	0.639
1991	197.0	1.00	2.39	7.32	0.650
1992	194.8	1.00	2.45	7.28	0.666
1993	192.3	1.00	-	-	-

Table 4-1-2C Exchange Rates in Selected Countries

Year	Japan (yen/dollar)	U.S. (dollar/dollar)	Germany (mark/dollar)	France (franc/dollar)	U.K. (pound/dollar)
1970	358.1	1.00	3.647	5.55	0.417
1971	349.3	1.00	3.491	5.54	0.411
1972	303.2	1.00	3.189	5.04	0.400
1973	271.7	1.00	2.673	4.45	0.408
1974	292.1	1.00	2.650	4.81	0.438
1975	296.8	1.00	2.460	4.29	0.450
1976	296.6	1.00	2.518	4.78	0.554
1977	268.5	1.00	2.322	4.91	0.573
1978	210.4	1.00	2.008	4.51	0.521
1979	219.1	1.00	1.833	4.25	0.471
1980	226.7	1.00	1.817	4.23	0.430
1981	220.5	1.00	2.260	5.44	0.493
1982	249.1	1.00	2.427	6.57	0.571
1983	237.5	1.00	2.553	7.62	0.659
1984	237.5	1.00	2.846	8.74	0.748
1985	238.5	1.00	2.943	8.98	0.771
1986	168.5	1.00	2.171	6.93	0.682
1987	144.6	1.00	1.797	6.01	0.610
1988	128.2	1.00	1.757	5.96	0.562
1989	138.0	1.00	1.881	6.38	0.610
1990	144.8	1.00	1.616	5.45	0.560
1991	134.7	1.00	1.659	5.64	0.565
1992	126.7	1.00	1.562	5.29	0.566
1993	111.2	1.00	-	-	-

Source: Science and Technology Agency, National Institute of Science and Technology Policy, "Developing R&D Purchasing Power Parities" (NISTEP Report No. 31), 1994

Table 4-1-3A Ratio of R&D Expenditures to GNP in Selected Countries  
(%)

Year	Japan	U.S.	Germany	France	U.K.
1970	1.80	2.57	2.09	1.88	-
1971	1.85	2.41	2.29	1.87	-
1972	1.86	2.34	2.25	1.85	2.09
1973	1.90	2.25	2.16	1.75	-
1974	1.97	2.23	2.19	1.76	-
1975	1.95	2.20	2.31	1.78	2.10
1976	1.94	2.19	2.21	1.75	-
1977	1.92	2.14	2.24	1.73	-
1978	1.94	2.13	-	1.72	2.15
1979	2.03	2.18	2.41	1.77	-
1980	2.14	2.28	-	1.81	-
1981	2.30	2.35	2.52	1.97	2.32
1982	2.39	2.52	-	2.06	-
1983	2.51	2.60	2.58	2.12	2.16
1984	2.58	2.66	-	2.22	-
1985	2.73	2.81	2.77	2.27	2.27
1986	2.71	2.79	2.78	2.24	2.28
1987	2.76	2.76	2.88	2.28	2.23
1988	2.80	2.72	2.86	2.28	2.19
1989	2.91	2.67	2.84	2.33	2.21
1990	3.00	2.63	2.72	2.43	2.21
1991	3.00	2.53	2.64	2.43	2.15
1992	2.96	2.56	2.57	2.44	2.12
1993	2.90	2.52	-	-	-

Source: Same as for Table 4-1-1

Note: The R&D expenditures include those in humanities and social sciences.

Table 4-1-3B GNP in Selected Countries

Year	Japan (bil. yen)	U.S. (bil. dollars)	Germany (bil. marks)	France (bil. francs)	U.K. (bil. pounds)
1970	75,152	1,017	676	797	52.0
1971	82,806	1,105	750	887	58.0
1972	96,539	1,216	824	990	64.9
1973	116,679	1,362	919	1,132	74.9
1974	138,156	1,474	984	1,307	84.5
1975	152,209	1,599	1,028	1,470	105.7
1976	171,153	1,786	1,124	1,704	125.2
1977	190,035	1,995	1,196	1,922	145.7
1978	208,781	2,255	1,289	2,187	168.5
1979	225,402	2,521	1,394	2,490	199.6
1980	245,360	2,742	1,477	2,821	231.5
1981	260,334	3,064	1,540	3,175	254.9
1982	273,462	3,180	1,590	3,628	278.9
1983	285,997	3,434	1,676	3,995	305.1
1984	305,725	3,802	1,763	4,338	326.4
1985	325,371	4,054	1,835	4,675	357.1
1986	339,685	4,278	1,936	5,053	384.6
1987	356,264	4,545	2,003	5,324	421.3
1988	379,230	4,908	2,108	5,723	467.9
1989	405,804	5,267	2,249	6,150	511.8
1990	435,362	5,568	2,448	6,473	544.3
1991	459,019	5,737	2,827	6,709	566.1
1992	470,117	6,046	3,022	6,926	594.5
1993	473,365	6,378	-	-	-

Source: Japan - Economic Planning Agency, "Annual Report on National Economy"  
U.S. - Department of Commerce, "Survey of Current Business"  
Germany - OECD, "National Accounts", "Economic Surveys"  
France and U.K - OECD, "National Accounts"  
Science and Technology Agency, "White Paper on Science and Technology"

Table 4-1-4A National Defense R&amp;D Expenditures in Selected Countries (National Currencies)

Year	Japan (mil. yen)	U.S. (mil. dollars)	Germany (mil. marks)	France (mil. francs)	U.K. (mil. pounds)
1970	11,065	8,021	1,151.0	3,455	242.6
1971	12,305	8,108	1,178.9	3,900	285.0
1972	14,096	8,837	1,018.7	3,900	327.3
1973	15,575	9,139	1,352.0	4,350	431.8
1974	16,156	9,406	1,411.1	4,650	436.1
1975	16,649	9,715	1,405.0	5,050	549.9
1976	18,825	9,819	1,490.0	5,610	705.3
1977	21,826	10,874	1,596.0	6,100	825.1
1978	24,272	12,077	1,731.3	7,740	875.2
1979	27,649	12,129	1,847.4	9,660	1,160.5
1980	29,599	14,643	1,730.1	13,610	1,493.4
1981	32,573	16,937	1,572.3	15,670	1,575.9
1982	36,487	19,809	1,646.8	17,300	1,593.7
1983	39,452	22,298	1,834.5	18,160	1,792.3
1984	44,607	25,765	1,936.7	20,240	1,877.7
1985	58,677	30,360	2,058.9	22,370	2,018.2
1986	66,133	35,656	2,590.4	24,460	1,941.5
1987	74,135	37,097	2,807.4	26,620	1,910.7
1988	82,700	38,032	2,759.1	32,410	1,879.8
1989	93,068	40,366	3,023.4	32,980	2,028.6
1990	104,268	41,078	3,384.2	34,700	2,062.9
1991	115,045	37,887	3,234.5	33,000	2,267.0
1992	126,989	38,170	3,262.6	30,500	2,220.9
1993	137,175	40,396	-	-	-

Table 4-1-4B National Defense R&D Expenditures in Selected Countries  
(GDP Purchasing Parity Calculations)

Year	Japan	U.S.	Germany	France	U.K.
(million yen)					
1970	11,065	2,053,376	89,548	185,534	216,399
1971	12,305	2,083,756	89,596	207,870	245,100
1972	14,096	2,288,783	77,421	204,750	273,296
1973	15,575	2,504,086	108,971	237,510	381,711
1974	16,156	2,859,424	128,410	274,350	405,573
1975	16,649	2,895,070	129,963	284,315	433,321
1976	18,825	2,945,700	142,295	304,062	516,985
1977	21,826	3,240,452	155,929	321,470	562,718
1978	24,272	3,514,407	170,187	387,774	561,878
1979	27,649	3,335,475	179,567	452,088	670,769
1980	29,599	3,836,466	166,609	594,757	749,687
1981	32,573	4,183,439	150,469	634,635	732,794
1982	36,487	4,674,924	153,646	638,370	699,634
1983	39,452	5,128,540	166,756	613,808	754,558
1984	44,607	5,797,125	175,078	645,656	766,102
1985	58,677	6,739,920	184,272	682,285	785,080
1986	66,133	7,879,976	228,991	721,570	739,712
1987	74,135	7,975,855	242,279	761,332	695,495
1988	82,700	7,948,688	235,075	900,998	642,892
1989	93,068	8,275,030	255,780	900,354	669,438
1990	104,268	8,215,600	283,596	936,900	645,688
1991	115,045	7,463,739	266,523	887,700	686,901
1992	126,989	7,436,364	259,565	816,029	650,014
1993	137,175	7,768,151	-	-	-

Note: Definitions and meanings of "National Defense R&D Expenditures" are slightly different

Japan - the expenditures of Defense Agency covered by the nation's S&T budget.

U.S. - the defense R&D expenditures covered each year by the federal budget.

France - R&D support from Defense Department.

Source: Same as for Table 4-1-1. Data for Japan are cited from Science and Technology Agency.

Table 4-1-5A Civilian R&amp;D Expenditures in Selected Countries (National Currencies)

Year	Japan (mil. yen)	U.S. (mil. dollars)	Germany (mil. marks)	France (mil. francs)	U.K. (mil. pounds)
1970	1,344,440	18,113	12,939.0	11,500	-
1971	1,520,067	18,568	16,031.1	12,721	-
1972	1,777,775	19,639	17,551.3	14,377	1,027.3
1973	2,200,261	21,579	18,458.0	15,439	-
1974	2,699,876	23,457	20,148.9	18,381	-
1975	2,957,924	25,498	22,305.0	21,153	1,671.6
1976	3,301,860	29,199	23,330.0	24,164	-
1977	3,629,493	31,909	25,244.0	27,085	-
1978	4,021,592	36,051	-	29,931	2,747.1
1979	4,555,981	42,824	31,690.6	34,463	-
1980	5,216,649	47,967	-	37,404	-
1981	5,949,783	54,932	37,221.7	46,801	4,345.2
1982	6,492,213	60,209	-	57,536	-
1983	7,141,330	66,845	41,412.5	66,511	4,790.7
1984	7,849,324	75,377	-	75,958	-
1985	8,831,622	83,458	48,748.1	83,547	6,074.8
1986	9,126,799	83,875	51,310.6	88,800	6,826.5
1987	9,762,505	88,256	54,960.6	94,744	7,472.3
1988	10,544,872	95,710	57,468.9	98,221	8,347.2
1989	11,722,414	100,405	60,869.6	110,573	9,259.4
1990	12,974,047	105,356	63,295.8	122,446	9,956.1
1991	13,656,479	107,496	71,270.5	130,092	9,894.0
1992	13,782,504	116,330	74,337.4	138,600	10,398.1
1993	13,571,925	120,354	-	-	-

Table 4-1-5B Ratio of Civilian R&amp;D Expenditures to GNP in Selected Countries (%)

Year	Japan	U.S.	Germany	France	U.K.
1970	1.79	1.78	1.91	1.44	-
1971	1.84	1.68	2.14	1.43	-
1972	1.84	1.62	2.13	1.45	1.58
1973	1.89	1.58	2.01	1.36	-
1974	1.95	1.59	2.05	1.41	-
1975	1.94	1.59	2.17	1.44	1.58
1976	1.93	1.64	2.08	1.42	-
1977	1.91	1.60	2.11	1.41	-
1978	1.93	1.60	-	1.37	1.63
1979	2.02	1.70	2.27	1.38	-
1980	2.13	1.75	-	1.33	-
1981	2.29	1.79	2.42	1.47	1.70
1982	2.37	1.89	-	1.59	-
1983	2.50	1.95	2.47	1.66	1.57
1984	2.57	1.98	-	1.75	-
1985	2.71	2.06	2.66	1.79	1.70
1986	2.69	1.96	2.65	1.76	1.77
1987	2.74	1.94	2.74	1.78	1.77
1988	2.78	1.95	2.73	1.72	1.78
1989	2.89	1.91	2.71	1.80	1.81
1990	2.98	1.89	2.59	1.89	1.83
1991	2.98	1.87	2.52	1.94	1.75
1992	2.93	1.92	2.46	2.00	1.75
1993	2.87	1.89	-	-	-

Source: Same as for Table 4-1-4



Table 4-1-6A R&amp;D Expenditures in Japan

(million yen) •@ •@

	Support		Use	
		(%)		(%)
Industries	9,882,935	71.1	9,560,685	68.7
Government bodies	2,696,717	19.4	1,160,101	8.3
Universities	1,231,821	8.9	2,576,281	18.5
Private R&D instit	84,615	0.6	612,427	4.4
Overseas	13,405	0.1	-	-
Total	13,909,493	100.0	13,909,493	100.0

Note: Government bodies as supporters include governmental research institutes and public universities.

Universities as supporters are private universities.

Governmental bodies as users are governmental research institutes.

R&amp;D expenditures include those in natural sciences and humanities/social sciences (for Japan and other countries below).

Source: Management &amp; Coordination Agency, "Report on the Survey on Science and Technology Research"

Table 4-1-6B R&amp;D Expenditures in the U.S.

(million dollars) •@ •@

	Support		Use	
		(%)		(%)
Industries	81,050	51.5	110,300	70.1
Government bodies	68,200	43.3	17,600	11.2
Universities	5,250	3.3	24,100	15.3
Private R&D instit	2,910	1.8	5,400	3.4
Overseas	157,400	100.0	157,400	100.0
Total				

Note: Government bodies as supporters are the federal government and federal research institutes.

Universities as supporters are private universities.

Governmental bodies as users are federal research institutes.

Source: NSF, "National Patterns of R&amp;D Resources: 1992", USA.

Table 4-1-6C R&amp;D Expenditures in Germany

(million marks) •@ •@

	Support		Use	
		(%)		(%)
Industries	45,040	60.5	51,320	68.9
Government bodies	27,290	36.6	2,975	4.0
Universities	-	-	11,760	15.8
Private R&D instit	445	0.6	8,450	11.3
Overseas	1,730	2.3	-	-
Total	74,505	100.0	74,505	100.0

Note: Government bodies as supporters include federal research institutes.

Governmental bodies as users are federal research institutes.

Universities as users are universities (both public and private).

Source: Bundesministerium für Forschung und Technologie, "Bundesbericht Forschung: 1993"

Table 4-1-6D R&amp;D Expenditures in France

(million francs) •@ •@

	Support		Use	
		(%)		(%)
Industries	68,348	43.5	94,956	60.4
Government bodies	75,866	48.3	38,006	24.2
Universities	436	0.3	22,905	14.6
Private R&D instit	668	0.4	1,295	0.8
Overseas	11,845	7.5	-	-
Total	157,162	100.0	157,162	100.0

Note: Government bodies as supporters are public research institutes.

Governmental bodies as users are the same as those as supporters.

Source: Science and Technology Agency, "White Paper on Science and Technology"

Table 4-1-6E R&amp;D Expenditures in the U.K.

(million pounds) •@ •@

	Support		Use	
		(%)		(%)
Industries	6,268	49.7	7,930	62.8
Government bodies	4,464	35.4	2,032	16.1
Universities	98	0.8	2,141	17.0
Private R&D instit	415	3.3	516	4.1
Overseas	1,374	10.9	-	-
Total	12,619	100.0	12,619	100.0

Note: Universities as supporters are private universities.

Governmental bodies as users are governmental research institutes.

Source: Science and Technology Agency, "White Paper on Science and Technology"

Table 4-1-7 R&amp;D Expenditure Use in Japan and the U.S. by Sector

Year	Japan: R&D expenditures (million yen)				Total
	Industry	Universities	Government R&D institutes	Private R&D institutes	
1970	823,265	365,877	147,525	18,838	1,355,505
1971	895,020	423,441	190,586	23,325	1,532,372
1972	1,044,928	478,684	242,836	25,424	1,791,872
1973	1,301,927	574,163	307,659	32,088	2,215,837
1974	1,589,053	717,585	325,158	84,236	2,716,032
1975	1,684,847	839,798	364,005	85,923	2,974,573
1976	1,882,231	934,016	402,536	101,902	3,320,685
1977	2,109,500	1,012,297	440,691	88,831	3,651,319
1978	2,291,002	1,151,074	502,957	100,831	4,045,864
1979	2,664,913	1,258,326	565,787	94,604	4,583,630
1980	3,142,256	1,340,074	618,378	145,540	5,246,248
1981	3,629,793	1,445,645	661,397	245,521	5,982,356
1982	4,039,018	1,540,422	673,082	276,178	6,528,700
1983	4,560,127	1,649,646	691,359	279,651	7,180,783
1984	5,136,634	1,724,187	725,685	307,425	7,893,931
1985	5,939,947	1,789,780	810,759	349,812	8,890,299
1986	6,120,163	1,832,575	840,223	399,971	9,192,932
1987	6,494,268	1,957,921	943,179	441,273	9,836,641
1988	7,219,318	2,014,073	935,255	458,925	10,627,571
1989	8,233,820	2,129,372	953,755	498,535	11,815,482
1990	9,267,166	2,296,992	976,867	537,291	13,078,315
1991	9,743,048	2,407,927	1,047,096	573,453	13,771,524
1992	9,560,685	2,576,281	1,160,101	612,427	13,909,493
1993	9,053,600	2,758,700	1,278,700	618,200	13,709,100

Year	U.S: R&D expenditures (million yen)				Total
	Industry	Universities	Government R&D institutes	Private R&D institutes	
1970	4,625,152	786,432	1,044,224	234,496	6,690,304
1971	4,708,240	826,512	1,086,596	234,384	6,855,732
1972	5,063,968	876,197	1,188,551	246,568	7,375,284
1973	5,822,226	1,014,074	1,304,788	275,644	8,416,732
1974	6,957,648	1,181,648	1,492,944	358,112	9,990,352
1975	7,207,726	1,310,008	1,595,492	380,248	10,493,474
1976	8,099,100	1,462,800	1,730,700	412,800	11,705,400
1977	8,887,850	1,624,398	1,791,576	445,510	12,749,334
1978	9,691,464	1,845,522	1,981,710	486,552	14,005,248
1979	10,512,150	2,011,625	2,039,950	548,350	15,112,075
1980	11,660,310	2,180,626	1,999,584	563,300	16,403,820
1981	12,797,070	2,305,251	2,081,222	568,100	17,751,643
1982	13,841,400	2,313,272	2,157,276	572,300	18,884,248
1983	15,011,640	2,442,140	2,433,860	615,250	20,502,890
1984	16,830,000	2,648,250	2,603,700	675,000	22,756,950
1985	18,701,058	2,932,398	2,873,790	760,350	25,267,596
1986	19,408,883	3,275,883	2,991,235	740,350	26,416,351
1987	19,813,325	3,517,400	2,883,795	736,375	26,950,895
1988	20,458,801	3,761,373	2,984,729	747,175	27,952,078
1989	20,880,070	4,047,930	3,099,805	830,250	28,858,055
1990	20,921,200	4,235,200	3,200,400	930,000	29,286,800
1991	20,142,462	4,471,703	3,001,886	1,024,400	28,640,451
1992	21,001,835	4,743,921	3,234,049	1,120,228	30,100,032
1993	21,595,290	4,970,955	3,192,180	1,153,800	30,912,225

Note: R&D expenditures include those in natural sciences and humanities. R&D expenditures for the U.S. have been converted to yen figures using GDP purchasing power parity.

"Government research institutes include those operated by local governments (Japan) or state governments (US).

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

Table 4-1-8 R&amp;D Expenditure Flow in Selected Countries

(A) Japan (1992)

(million yen)

		Performer				Total
		Industries	Government bodies	Universities	Private R&D institutes	
Source	Industries	9,437,551 (9,273,352)	18,109	64,778	362,498	9,882,934
	Government bodies	103,220	1,141,645 (693,382)	1,276,628 (1,113,343)	175,224	2,696,717
	Universities	67	16	1,231,657 (1,231,603)	80	1,231,821
	Private R&D institutes	8,709	323	2,700	72,883 (69,995)	84,615
	Overseas	11,137	8	519	1,742	13,405
	Total	9,560,685	1,160,101	2,576,280	612,427	13,909,493

Note: Figures in parentheses show funds on hand.

Government bodies as sources include government R&amp;D institutes and public universities.

Universities as sources are private universities.

Government bodies as performers are government R&amp;D institutes.

R&amp;D expenditures include those in natural sciences and humanities.

Source: Statistics Bureau, Management &amp; Coordination Agency, "Report on the Survey of Research and Development".

(B) U.S. (1992)

(million yen; conversion based on purchasing power parity)

		Performer				Total
		Industries	Government bodies	Universities	Private R&D institutes	
Source	Industries	15,405,000	-	263,250	136,500	15,804,750
	Government bodies	6,103,500	3,432,000	3,120,000	643,500	13,299,000
	Universities	-	-	1,023,750	-	1,023,750
	institutes	-	-	292,500	273,000	567,450
	Total	21,508,500	3,432,000	4,699,500	1,053,000	30,693,000

Note: Government bodies as sources are the federal government and federal R&amp;D institutes.

Universities as sources are private universities.

Government bodies as performers are federal R&amp;D institutes.

Source: NSF, "National Patterns of R&amp;D Resources: 1992", USA

(C) Germany (1991)

(million yen; conversion based on purchasing power parity)

		Performer				Total
		Industries	Government bodies	Universities	Private R&D institutes	
Source	Industries	3,628,896	8,240	74,160	-	3,711,296
	Government bodies	454,848	234,428	894,864	664,556	2,248,696
	Universities	-	-	-	-	-
	institutes	13,184	-	-	23,484	36,668
	Overseas	131,840	2,472	-	8,240	142,552
	Total	4,228,768	245,140	969,024	696,280	6,139,212

Note: Government bodies as sources include federal R&amp;D institutes.

Government bodies as performers are government R&amp;D institutes.

Universities as performers are public and private universities.

Source: Bundesministerium für Forschung und Technologie, "Bundesbericht Forschung: 1993"

(D) France (1990)

(million yen; conversion based on purchasing power parity)

		Performer				Total
		Industries	Government bodies	Universities	Private R&D institutes	
Source	Industries	1,770,903	38,610	30,051	5,859	2,048,382
	Government bodies	506,682	955,071	574,587	12,042	1,845,396
	Universities	243	1,242	9,693	621	11,772
	institutes	864	783	486	15,903	18,036
	Overseas	285,120	30,483	3,672	540	319,815
	Total	2,563,812	1,026,162	618,435	34,965	4,243,374

Note: Government bodies as sources are public R&amp;D institutes.

Government bodies as performers are the same as the sources.

Source: Science and Technology Agency, "White Paper on Science and Technology"

(E) U.K. (1992)

(million yen; conversion based on purchasing power parity)

		Performer				Total
		Industries	Government bodies	Universities	Private R&D institutes	
Source	Industries	1,655,450	60,651	48,345	72,078	1,836,524
	Government bodies	320,542	505,132	440,672	41,606	1,307,952
	Universities	-	-	28,714	-	28,714
	institutes	-	19,338	72,078	30,179	121,595
	Overseas	347,498	9,962	37,797	7,325	402,582
	Total	2,323,490	595,376	627,313	151,188	3,697,367

Note: Universities as sources are private universities.

•@ Government bodies as performers are government R&amp;D institutes.

Source: Science and Technology Agency, "White Paper on Science and Technology"

Table 4-1-9 R&amp;D Expenditures in Selected Countries by Nature of Work

Year	Japan: R&D expenditures (million yen)			Total	Breakdown (%)		
	Basic research	Applied research	Development		Basic	Applied	Develop- ment
1980	707,641	1,164,869	2,726,504	4,599,014	15.4	25.3	59.3
1981	768,152	1,349,650	3,150,661	5,268,463	14.6	25.6	59.8
1982	861,300	1,509,826	3,490,056	5,861,183	14.7	25.8	59.5
1983	944,858	1,642,246	3,891,265	6,478,368	14.6	25.3	60.1
1984	1,009,651	1,793,723	4,349,565	7,152,938	14.1	25.1	60.8
1985	1,080,846	2,014,856	4,993,118	8,088,820	13.4	24.9	61.7
1986	1,157,250	2,044,128	5,192,495	8,393,873	13.8	24.4	61.9
1987	1,306,645	2,181,749	5,506,339	8,994,733	14.5	24.3	61.2
1988	1,347,078	2,361,349	6,051,139	9,759,566	13.8	24.2	62.0
1989	1,452,953	2,604,269	6,859,136	10,916,358	13.3	23.9	62.8
1990	1,577,700	2,923,559	7,590,307	12,091,566	13.0	24.2	62.8
1991	1,694,909	3,129,088	7,893,543	12,717,539	13.3	24.6	62.1
1992	1,783,077	3,115,674	7,895,840	12,794,589	13.9	24.4	61.7

Year	U.S.: R&D expenditures (million dollars)			Total	Breakdown (%)		
	Basic research	Applied research	Development		Basic	Applied	Develop- ment
1981	9,599	16,360	45,909	71,868	13.4	22.8	63.9
1982	10,433	18,153	51,432	80,018	13.0	22.7	64.3
1983	11,634	20,262	57,243	89,139	13.1	22.7	64.2
1984	12,909	22,378	65,852	101,139	12.8	22.1	65.1
1985	14,198	25,330	74,291	113,819	12.5	22.3	65.3
1986	16,590	27,070	75,869	119,529	13.9	22.6	63.5
1987	17,999	27,680	79,674	125,353	14.4	22.1	63.6
1988	18,709	29,130	85,901	133,740	14.0	21.8	64.2
1989	21,190	31,974	87,599	140,763	15.1	22.7	62.2
1990	21,303	33,944	90,905	146,152	14.6	23.2	62.2
1991	23,350	34,980	92,470	150,800	15.5	23.2	61.3
1992	24,830	36,690	95,880	157,400	15.8	23.3	60.9

Year	Germany: R&D expenditures (million marks)			Total	Breakdown (%)		
	Basic research	Applied research/ development			Basic	Applied	Develop- ment
1981	6,271		27,052	33,324	18.8		81.2
1983	7,664		29,756	37,420	20.5		79.5
1985	7,917		35,179	43,096	18.4		81.6
1987	9,576		40,002	49,578	19.3		80.7
1989	10,996		44,465	55,460	19.8		80.2

Year	France: R&D expenditures (million francs)			Total	Breakdown (%)		
	Basic research	Applied research	Development		Basic	Applied	Develop
1986	22,543	38,126	52,591	113,260	19.9	33.7	46.4
1987	24,726	39,892	56,746	121,364	20.4	32.9	46.8
1988	26,552	44,069	60,010	130,631	20.3	33.7	45.9
1989	29,075	45,336	69,142	143,553	20.3	31.6	48.2
1990	31,628	48,985	76,550	157,162	20.1	31.2	48.7

Note: R&D expenditures include those in natural sciences and humanities except for Germany, for which 1981 R&D expenditures cover natural sciences only. Applied research and basic research are not distinguished in Germany.

Source: Management & Coordination Agency, "Report on the Survey of Research and Development" NSF, "National Patterns of R&D Resources: 1992", USA.  
OECD, "Basic Science & Technology Statistics", 1993.

Table 4-1-10 Basic Research Expenditure in Japan and the U.S. by Sector

Year	Japan: Basic Research Expenditure (million yen)				Total
	Industry	Government R&D institutes	Universities	Private R&D institutes	
1975	87,229	51,897	215,640	4,431	359,197
1980	157,413	89,498	443,722	1,708	707,641
1985	351,657	99,496	596,060	33,633	1,080,846
1990	589,072	133,109	766,662	88,857	1,577,700
1991	660,219	146,336	791,841	96,514	1,694,910
1992	656,014	185,894	846,465	94,705	1,783,078

Year	U.S.: Basic Research Expenditure (million yen)				Total
	Industry	Government R&D institutes	Universities	Private R&D institutes	
1975	214,620	215,796	837,606	124,950	1,392,972
1980	345,825	308,502	1,348,326	198,360	2,201,013
1985	629,640	423,060	1,826,440	243,100	3,122,240
1990	957,255	461,370	2,551,380	339,300	4,309,305
1991	835,243	467,186	2,695,010	362,900	4,360,339
1992	873,000	523,800	2,929,400	403,520	4,729,720

Note: Same as for Table 4-1-4

Source: Same as for Table 4-1-7

Table 4-1-11 R&amp;D Scientists and Engineers in Selected Countries

(Unit : person)

Year	Japan	U.S.	Germany	U.K.	France
1970	218,339	543,800	-	-	58,500
1971	242,155	523,500	90,206	-	60,100
1972	247,309	515,000	-	-	61,200
1973	279,186	514,600	101,019	-	62,700
1974	292,097	520,600	-	-	64,100
1975	310,111	527,400	103,736	-	65,300
1976	316,860	535,200	-	-	67,000
1977	329,447	560,600	110,972	-	67,981
1978	331,467	586,600	-	-	-
1979	341,488	614,500	116,888	-	72,889
1980	363,534	651,100	-	-	-
1981	379,405	683,200	128,472	-	85,500
1982	392,625	711,800	-	-	90,076
1983	406,042	751,600	134,746	-	92,682
1984	435,340	797,600	-	-	98,205
1985	447,719	841,600	147,637	120,328	102,336
1986	473,296	882,300	-	134,000	104,953
1987	487,779	910,200	165,614	133,000	109,359
1988	513,267	927,300	-	137,000	115,163
1989	535,008	949,300	176,402	134,000	120,659
1990	560,276	-	-	130,000	123,939
1991	582,815	-	191,200	126,000	129,205
1992	598,333	-	-	123,000	-
1993	622,410	-	-	-	-
1994	641,100	-	-	-	-

Note : value for 1991 of Grmany is Estimated.

Source : Japan-Management & Coordination Agency, "Report on the Survey on Science and Technology Research"

U.S.-National Science Foundation, "National Pattens of R&D Resources: 1992"

Germany-Bundesministerium fur Forschung und Technologie, "Bundesbericht Forschung: 1993"

France and the U.K.-Science and Technology Agency, "White Paper on Science and Technology"

Table 4-1-12(A) Number of R&D Scientists and Engineers per labor Population in Selected Countries  
(Unit : person/10,000 persons)

Year	Japan	U.S.	Germany	U.K.	France
1980	64.3	60.0	-	-	-
1981	66.5	61.9	46.9	-	36.3
1982	68.0	63.6	-	-	37.9
1983	68.9	66.4	48.8	-	39.1
1984	73.5	69.2	-	-	41.1
1985	75.1	71.8	51.1	43.4	42.8
1986	78.6	73.8	-	44.4	43.7
1987	80.2	74.9	56.4	44.1	45.4
1988	83.2	75.2	-	44.4	47.6
1989	85.3	75.6	59.2	42.8	49.7
1990	87.8	-	-	41.5	50.8
1991	89.6	-	49.0*	-	-

Note : Value for 1991 of Germany is Estimated.

Source : Same as for Table 4-1-11

Table 4-1-12(B) Labor Population in Selected Countries

(Unit :1,000 person)

Year	Japan	U.S.	Germany	U.K.	France
1980	56,500	108,544	27,220	26,840	23,370
1981	57,070	110,315	27,420	26,740	23,530
1982	57,740	111,872	27,542	26,678	23,740
1983	58,890	113,226	27,589	26,610	23,714
1984	59,270	115,241	27,629	27,265	23,867
1985	59,630	117,167	28,897	27,714	23,917
1986	60,200	119,540	29,188	27,791	23,999
1987	60,840	121,602	29,386	27,979	24,109
1988	61,660	123,378	29,607	28,255	24,169
1989	62,700	125,557	29,799	28,427	24,297
1990	63,840	126,424	30,378	28,479	24,414
1991	65,050	126,867	39,060	28,264	24,619

Source : OECD, "Main Science and Technology Indicators"

Table 4-1-13(A) Number of R&D Scientists and Engineers Population in Selected Countries  
(Unit : person/10,000 persons)

Year	Japan	U.S.	Germany	U.K.	France
1980	31.1	28.6	-	-	-
1981	32.2	29.7	20.8	-	15.8
1982	33.1	30.6	-	-	16.5
1983	34.0	32.0	21.9	-	16.9
1984	36.3	33.7	-	-	17.9
1985	37.1	35.2	24.2	21.3	18.5
1986	39.0	36.5	-	21.7	18.9
1987	40.0	37.3	27.1	21.7	19.7
1988	41.9	37.6	-	22.0	20.6
1989	43.5	38.2	28.4	21.2	21.4
1990	45.4	-	-	20.6	21.9
1991	47.0	-	24.0*	-	-

Table 4-1-13(B) Population in Selected Countries

(Unit :1,000 persons)

Year	Japan	U.S.	Germany	U.K.	France
1980	116,800	227,757	61,566	56,314	53,880
1981	117,650	230,138	61,682	56,379	54,182
1982	118,450	232,520	61,638	56,335	54,480
1983	119,260	234,799	61,423	56,377	54,729
1984	120,020	237,011	61,175	56,488	54,947
1985	120,750	239,279	61,024	56,618	55,170
1986	121,490	241,625	61,066	56,763	55,394
1987	122,090	243,942	61,077	56,930	55,630
1988	122,610	246,307	61,450	57,065	55,884
1989	123,120	248,781	62,063	57,236	56,423
1990	123,540	249,924	63,254	57,411	56,735
1991	123,920	252,688	79,819	57,649	57,050

Source : Same as for Table 4-1-12



Table 4-2-1 R&amp;D Expenditures in Key Industries

Year	R&D expenditures (million yen)					All industries	
	Manufacturing					Total	
	Chemical products	Iron & steel	General machinery	Electrical machinery	Transportation equipment		
1970	175,132	36,565	72,352	227,817	94,882	760,870	823,265
1971	193,682	40,881	75,195	229,168	112,951	810,719	895,020
1972	199,235	41,379	67,370	276,729	163,911	953,194	1,044,928
1973	238,189	59,595	86,925	341,492	215,088	1,193,515	1,301,927
1974	304,235	80,424	146,208	397,388	242,250	1,459,385	1,589,053
1975	322,099	89,211	115,524	400,495	289,465	1,536,514	1,684,847
1976	351,886	99,835	138,624	491,667	286,635	1,727,415	1,882,231
1977	385,952	103,681	171,252	501,291	357,724	1,923,105	2,109,500
1978	404,208	107,921	160,535	580,521	404,155	2,098,741	2,291,002
1979	489,829	119,992	185,749	694,212	445,614	2,447,099	2,664,913
1980	558,252	147,064	218,877	817,224	510,454	2,895,571	3,142,256
1981	617,354	169,653	242,096	1,006,225	627,433	3,374,224	3,629,793
1982	687,493	182,772	281,024	1,176,356	671,923	3,755,536	4,039,018
1983	774,532	186,088	311,678	1,416,231	714,511	4,257,191	4,560,127
1984	852,793	192,091	337,492	1,634,539	808,177	4,776,501	5,136,634
1985	936,360	240,409	382,698	1,938,183	935,661	5,543,618	5,939,947
1986	983,585	255,290	379,095	1,979,973	989,796	5,739,603	6,120,163
1987	1,095,887	245,176	418,769	2,163,544	969,615	6,101,202	6,494,268
1988	1,190,226	249,734	450,979	2,451,594	1,086,442	6,754,620	7,219,318
1989	1,313,882	268,131	558,974	2,808,123	1,244,625	7,706,193	8,233,820
1990	1,416,775	303,805	650,332	3,146,253	1,496,073	8,660,299	9,267,166
1991	1,547,707	360,054	674,413	3,382,777	1,508,671	9,195,415	9,743,048
1992	1,604,722	311,485	651,960	3,220,513	1,498,626	8,971,137	9,560,685
1993	1,561,400	286,100	661,100	3,019,800	1,297,100	8,454,600	9,053,600

Source: Management &amp; Coordination Agency, "Report on the Survey of Research and Development"

Table 4-2-2 Non-core Business R&amp;D Expenditures by Industrial Category (1992)

Industry	R&D expenditures (mil. yen)		Total	Ratio of Non-core businesses (%)
	Core businesses	Non-core businesses		
Agriculture, forestry and fisheries	3,192	3,104	6,296	49.3
Mining	8,495	20,539	29,034	70.7
Construction	203,423	30,221	233,644	12.9
Food	113,275	70,810	184,085	38.5
Textiles	24,145	53,938	78,083	69.1
Pulp and paper	31,885	10,134	42,019	24.1
Printing and publishing	11,832	19,190	31,022	61.9
Chemical products	-	-	1,538,328	-
Industrial chemicals, chemical fib	327,925	251,421	579,346	43.4
Oils and paints	70,303	76,844	147,147	52.2
Drugs and medicines	591,894	29,619	621,513	4.8
Other chemical products	120,124	70,198	190,322	36.9
Petroleum and coal products	43,157	45,181	88,338	51.1
Plastic products	-	-	108,268	-
Rubber products	104,982	24,776	129,758	19.1
Ceramics	100,387	103,378	203,765	50.7
Iron and steel	163,551	146,788	310,339	47.3
Non-ferrous metals and products	67,173	75,747	142,920	53.0
Fabricated metal products	61,123	47,203	108,326	43.6
General machinery	367,975	223,195	591,170	37.8
Electrical machinery	-	-	3,143,560	-
Communication and electronics equipment	1,631,609	576,972	2,208,581	26.1
Electrical machinery equipment and supplies	306,942	628,038	934,980	67.2
Transportation equipment	-	-	1,479,984	-
Motor vehicles	1,218,819	53,304	1,272,123	4.2
Other transportation equipment	50,644	157,218	207,862	75.6
Precision instruments	101,623	208,072	309,695	67.2
Other manufacturing products	-	-	118,018	-
Transport, communication, public uti	107,313	202,489	309,802	65.4
Total	5,831,791	3,128,379	9,186,454	34.1

Source: Management &amp; Coordination Agency, "Report on the Survey of Research and Development"

Table 4-2-3 Non-core Business Ratio of R&amp;D Expenditures by Industrial Category

Industry	Ratio of non-core business (%)				
	1988	1989	1990	1991	1992
Agriculture, forestry and fisheries	33.9	50.6	58.1	53.1	49.3
Mining	59.8	64.4	74.0	59.5	70.7
Construction	12.9	14.4	14.2	13.0	12.9
Food	42.2	44.3	43.1	37.5	38.5
Textiles	71.8	62.3	64.7	71.3	69.1
Pulp and paper	24.7	24.0	23.4	24.8	24.1
Printing and publishing	54.5	62.1	67.7	57.5	61.9
Chemical products	-	-	-	-	-
Industrial chemicals, chemical fi	46.4	48.7	48.9	48.2	43.4
Oils and paints	49.7	48.2	50.5	51.4	52.2
Drugs and medicines	5.5	5.2	5.7	4.6	4.8
Other chemical products	22.8	23.7	35.2	37.4	36.9
Petroleum and coal products	52.7	51.1	53.5	55.6	51.1
Plastic products	-	-	-	-	-
Rubber products	17.6	21.3	17.3	16.9	19.1
Ceramics	50.8	51.2	49.8	49.8	50.7
Iron and steel	48.6	50.2	48.7	49.1	47.3
Non-ferrous metals and products	52.1	52.3	51.4	51.5	53.0
Fabricated metal products	41.8	38.5	37.9	41.4	43.6
General machinery	35.7	35.0	38.6	38.9	37.8
Electrical machinery	-	-	-	-	-
Communication and electronics	29.6	28.3	26.8	27.6	26.1
equipment					
Electrical machinery equipment	68.5	68.0	70.9	65.3	67.2
and supplies					
Transportation equipment	-	-	-	-	-
Motor vehicles	4.5	4.3	4.3	3.7	4.2
Other transportation equipment	78.4	72.9	73.9	70.3	75.6
Precision instruments	48.2	58.1	65.3	63.2	67.2
Other manufacturing products	-	-	-	-	-
Transport, communication, public	74.0	76.2	73.4	70.3	65.4
Total	35.7	35.5	36.1	34.8	34.1

Source: Management &amp; Coordination Agency, "Report on the Survey of Research and Development"

Table 4-2-4 R&amp;D Expenditures by Key Product Area

Year	R&D expenditures (mil. yen)							Total
	Communicatio n and electronics equipment	Motor vehicles	Electrical machinery	General machinery	Drugs and medicines	Org./inorg. chemicals, chemical fertilizers/fibers	Others	
1969	71,485	57,470	67,732	44,225	25,314	71,235	129,110	466,571
1970	106,417	74,747	92,759	71,250	41,395	87,181	216,660	690,409
1971	139,644	89,207	106,184	78,388	51,561	88,205	265,936	819,125
1972	166,350	113,895	129,934	90,605	54,946	92,450	306,629	954,809
1973	203,640	156,332	154,525	126,047	66,048	95,928	401,863	1,204,383
1974	237,926	187,724	181,172	156,227	83,455	133,437	466,402	1,446,343
1975	231,568	187,222	192,898	149,593	96,505	128,377	533,320	1,519,483
1976	271,408	220,083	222,697	189,564	115,710	136,740	573,129	1,729,331
1977	315,415	276,710	223,089	204,136	125,673	145,613	637,437	1,928,073
1978	361,603	337,381	256,118	206,022	139,668	144,158	677,520	2,122,470
1979	422,348	378,301	308,455	240,051	182,821	155,537	776,335	2,463,848
1980	503,948	428,436	354,488	282,889	207,949	206,487	929,386	2,913,583
1981	604,221	521,821	451,915	304,560	242,975	216,593	1,030,648	3,372,733
1982	729,643	584,034	530,448	355,806	281,296	210,029	1,118,837	3,810,093
1983	906,778	652,772	555,054	407,143	334,371	224,501	1,231,143	4,311,762
1984	1,106,482	726,659	620,289	461,540	346,519	265,169	1,353,611	4,880,269
1985	1,372,511	853,317	687,485	496,757	386,281	304,025	1,535,023	5,635,399
1986	1,490,484	902,650	650,551	505,549	398,572	340,780	1,554,487	5,843,073
1987	1,613,089	890,673	698,145	521,239	460,189	357,952	1,653,345	6,194,632
1988	1,910,708	1,037,060	744,165	549,075	498,023	409,086	1,760,125	6,908,242
1989	2,258,036	1,194,162	840,447	642,538	566,890	452,454	1,914,945	7,869,472
1990	2,590,980	1,420,733	857,301	767,208	627,419	469,043	2,158,516	8,891,200
1991	2,657,226	1,417,647	1,017,297	795,173	701,812	489,841	2,270,603	9,349,599
1992	2,560,692	1,403,297	914,654	827,209	762,454	485,631	2,232,517	9,186,454

Source: Management &amp; Coordination Agency, "Report on the Survey of Research and Development"

Table 4-2-5 R&amp;D Expenditures by Product Area (1992 internal R&amp;D expenditures)

Product area	Breakdown by product area (mil. yen)	Breakdown by business		Penetration rate (%)
		Core business	Non-core business	
Agriculture, forestry and fisheries	22,282	3,192	19,090	85.7
Mining	10,940	8,495	2,445	22.3
Construction	243,503	203,423	40,080	16.5
Food	135,435	113,275	22,160	16.4
Textiles	29,416	24,145	5,271	17.9
Pulp and paper	42,799	31,885	10,914	25.5
Printing and publishing	16,217	11,832	4,385	27.0
Chemical products	1,662,928	-	-	-
Industrial chemicals (*)	485,631	327,925	157,706	32.5
Oils and paints	87,200	70,303	16,897	19.4
Drugs and medicines	762,454	591,894	170,560	22.4
Other chemical products	327,643	120,124	207,519	63.3
Petroleum and coal products	50,962	43,157	7,805	15.3
Rubber products	112,964	104,982	7,982	7.1
Ceramics	125,173	100,387	24,786	19.8
Iron and steel	168,237	163,551	4,686	2.8
Non-ferrous metals and products	92,830	67,173	25,657	27.6
Fabricated metal products	104,948	61,123	43,825	41.8
General machinery	827,209	367,975	459,234	55.5
Electrical machinery	3,475,346	-	-	-
Communication and electrical equipment	2,560,692	1,631,609	929,083	36.3
Electrical machinery equipment and supplies (*)	914,654	306,942	607,712	66.4
Transportation equipment	1,505,915	-	-	-
Motor vehicles	1,403,297	1,218,819	184,478	13.1
Other transportation equipment	102,618	50,644	51,974	50.6
Precision instruments	205,239	101,623	103,616	50.5
Other manufacturing products	214,465	-	-	-
Electricity, gas	109,031	107,313	1,718	1.6
Other products	30,614	-	-	-
Total	9,186,453	5,831,791	3,109,583	33.8

Note: Industrial chemicals include chemical fertilizers, organic/inorganic chemical products and chemical fibers.

Electrical machinery equipment and supplies include electrical appliances.

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

Table 4-2-6 Rate of Penetration from Other Industries by Product Area

Product area	Penetration rate (%)				
	1988	1989	1990	1991	1992
Agriculture, forestry and fisheries	75.1	90.1	82.1	87.9	85.7
Mining	24.7	28.1	33.9	15.0	22.3
Construction	23.5	23.1	18.6	20.1	16.5
Food	15.3	13.5	16.2	16.4	16.4
Textiles	21.0	18.7	19.5	24.8	17.9
Pulp and paper	21.4	22.2	22.2	27.8	25.5
Printing and publishing	23.2	21.4	21.4	32.9	27.0
Chemical products	-	-	-	-	-
Industrial chemicals (*)	36.1	38.8	37.6	36.9	32.5
Oils and paints	21.2	16.9	18.6	16.1	19.4
Drugs and medicines	24.3	26.8	25.2	22.8	22.4
Other chemical products	64.0	64.6	69.2	67.6	63.3
Petroleum and coal products	16.0	14.8	18.2	14.5	15.3
Rubber products	6.5	7.9	7.3	9.0	7.1
Ceramics	24.4	23.1	22.6	17.2	19.8
Iron and steel	4.8	3.5	3.8	2.4	2.8
Non-ferrous metals and products	35.7	32.7	37.6	35.8	27.6
Fabricated metal products	45.6	42.7	37.6	46.7	41.8
General machinery	53.6	50.7	53.3	53.4	55.5
Electrical machinery	-	-	-	-	-
Communication and electronic equipment	38.6	39.5	40.4	36.6	36.3
Electrical machinery equipment and supplies (*)	69.8	68.5	68.1	66.5	66.4
Transportation equipment	-	-	-	-	-
Motor vehicles	14.6	13.9	13.9	13.2	13.1
Other transportation equipment	54.0	52.7	52.2	48.2	50.6
Precision instruments	41.0	44.3	47.9	47.7	50.5
Other manufacturing products	-	-	-	-	-
Electricity, gas	3.4	2.9	3.9	0.7	1.6
Other products	-	-	-	-	-

Note: Industrial chemicals include chemical fertilizers, organic/inorganic chemical products and chemical fibers

Electrical machinery equipment and supplies include electrical appliances.

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

Table 4-2-7 Number of R&amp;D Scientists/Engineers by Key Industry

Year	Number of R&D Scientists/Engineers						All industries	
	Manufacturing					Total for manufacturing		
	Chemical products	General machinery	Electrical machinery	Transportation equipment	Precision instruments	Other mfg.		
1960	8,651	2,993	9,942	2,633	1,754	13,951	39,924	42,938
1961	9,149	4,350	8,685	2,685	960	14,514	40,343	43,608
1962	9,874	3,029	9,525	3,794	1,217	15,104	42,543	46,110
1963	12,063	4,568	11,643	4,546	1,028	15,866	49,714	54,073
1964	15,292	4,033	14,707	4,572	1,266	16,112	55,982	60,009
1965	14,520	5,963	13,460	3,447	1,508	16,016	54,914	58,997
1966	15,824	6,733	15,897	3,468	2,062	16,929	60,913	65,357
1967	16,859	5,470	17,801	4,391	2,166	18,752	65,439	69,164
1968	19,075	7,123	19,915	5,151	2,548	22,911	76,723	81,664
1969	19,451	7,503	21,780	5,927	2,167	20,671	77,499	82,516
1970	21,565	8,192	25,722	6,419	2,757	22,978	87,633	94,060
1971	24,669	10,600	31,227	7,740	3,367	25,299	102,902	111,244
1972	25,232	9,754	33,183	8,423	3,283	25,392	105,267	112,763
1973	26,207	10,242	36,789	10,587	5,193	28,526	117,544	124,795
1974	25,876	10,561	38,738	12,184	4,351	30,496	122,206	130,690
1975	27,220	20,934	42,645	12,329	3,799	30,198	137,125	146,604
1976	27,614	11,749	43,873	16,089	3,950	32,541	135,816	145,216
1977	28,259	13,426	49,465	13,705	4,590	32,394	141,839	151,437
1978	29,228	14,375	47,939	13,855	4,935	33,686	144,018	153,706
1979	29,506	12,642	51,174	15,132	5,685	34,111	148,250	157,279
1980	31,556	15,273	55,467	16,169	6,188	39,214	163,867	173,244
1981	32,847	15,390	58,873	17,682	7,061	43,235	175,088	184,889
1982	33,970	15,666	63,193	18,158	8,096	44,400	183,483	192,942
1983	35,822	17,024	68,243	18,615	8,270	42,634	190,608	201,137
1984	37,594	19,588	78,427	21,036	10,107	46,551	213,303	223,882
1985	38,888	19,694	80,077	22,123	10,791	47,868	219,441	231,097
1986	42,523	21,313	89,824	23,892	11,545	50,695	239,792	251,771
1987	43,503	21,146	94,067	25,148	11,522	53,063	248,449	260,846
1988	46,914	23,184	104,416	26,348	11,049	55,331	267,242	279,298
1989	49,170	24,677	112,387	27,993	12,374	54,646	281,247	294,202
1990	52,196	27,382	119,386	29,383	13,796	58,234	300,377	313,948
1991	53,820	27,887	125,983	32,112	14,438	62,110	316,350	330,996
1992	55,592	29,015	129,310	33,435	14,841	63,645	325,838	340,809
1993	58,205	30,800	134,918	35,669	15,979	64,341	339,912	356,406
1994	59,240	31,510	140,539	35,674	17,593	66,590	351,146	367,278

Source: Management &amp; Coordination Agency, "Report on the Survey of Research and Development"

Table 4-2-8 Number of R&amp;D Scientists/Engineers by Company/Specialty

Year	Number of R&D Scientists/Engineers							Total
	Natural sciences					Total for natural sciences	Humanities	
	Physical science	Engineer- ing	Agri- culture	Health	Others		social sciences	
1960	16,036	19,525	1,252	1,544	1,567	39,924	-	39,924
1961	18,071	17,651	1,859	1,695	1,067	40,343	-	40,343
1962	16,686	20,654	1,073	2,101	2,029	42,543	-	42,543
1963	19,956	24,281	1,537	2,264	1,676	49,714	-	49,714
1964	22,534	25,946	1,834	3,054	2,520	55,982	-	55,982
1965	22,903	25,877	1,687	2,491	1,956	54,914	-	54,914
1966	24,035	29,983	1,696	2,683	2,516	60,913	-	60,913
1967	26,856	30,768	2,347	2,926	2,542	65,439	-	65,439
1968	31,393	37,132	2,343	2,893	2,962	76,723	-	76,723
1969	29,464	39,644	3,342	3,135	1,914	77,499	-	77,499
1970	34,219	45,488	2,997	3,044	1,585	87,333	300	87,633
1971	38,514	55,325	2,825	3,767	1,977	102,408	494	102,902
1972	39,326	56,150	3,216	3,847	2,304	104,843	424	105,267
1973	43,900	64,056	3,463	3,774	1,948	117,141	403	117,544
1974	42,675	68,398	3,891	4,176	2,653	121,793	413	122,206
1975	48,004	77,947	3,702	4,103	2,856	136,612	513	137,125
1976	46,888	75,959	4,479	4,216	3,615	135,157	659	135,816
1977	45,141	83,104	4,518	4,620	3,534	140,916	924	141,839
1978	46,476	83,777	4,326	4,859	3,793	143,230	788	144,018
1979	46,836	85,792	4,789	5,029	4,767	147,213	1,037	148,250
1980	50,056	96,255	5,551	5,776	4,920	162,558	1,309	163,867
1981	54,565	101,303	5,831	5,805	6,145	173,649	1,439	175,088
1982	53,702	108,624	5,921	6,101	7,262	181,610	1,873	183,483
1983	55,880	112,585	6,384	6,439	7,623	188,911	1,697	190,608
1984	60,110	126,878	6,354	7,266	9,894	210,502	2,801	213,303
1985	60,723	131,882	7,163	7,527	9,350	216,645	2,796	219,441
1986	66,249	144,421	7,417	8,033	10,608	236,728	3,064	239,792
1987	68,500	149,406	8,278	8,103	11,203	245,490	2,959	248,449
1988	70,774	162,896	9,342	9,123	11,862	263,997	3,245	267,242
1989	74,148	172,159	9,085	9,560	13,038	277,990	3,257	281,247
1990	80,227	183,538	8,501	10,159	14,748	297,173	3,204	300,377
1991	81,011	194,705	9,892	10,937	16,180	312,726	3,625	316,350
1992	84,220	199,290	9,053	11,907	17,800	322,270	3,568	325,838
1993	84,857	209,137	8,928	13,122	20,675	336,719	3,193	339,912

Source: Management &amp; Coordination Agency, "Report on the Survey of Research and Development"



Table 4-2-9 Ratio of R&amp;D Expenditures to Sales

	(%)											
	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1 All industries	1.26	1.33	1.41	1.42	1.49	1.48	1.45	1.48	1.55	1.64	1.55	1.54
2 Agriculture, forestry and fisheries	0.28	0.44	0.18	0.18	0.15	0.41	0.32	0.24	0.31	0.60	0.45	0.17
3 Mining	0.60	0.57	0.79	0.59	0.54	0.60	0.61	0.59	0.54	0.61	0.53	0.63
4 Construction	0.46	0.30	0.37	0.31	0.41	0.39	0.50	0.49	0.54	0.43	0.41	0.47
5 Manufacturing	1.42	1.55	1.62	1.64	1.65	1.66	1.61	1.64	1.71	1.83	1.72	1.74
6 Food	0.57	0.58	0.47	0.48	0.54	0.50	0.49	0.49	0.50	0.51	0.51	0.58
7 Textiles	0.58	0.61	0.72	0.66	0.73	0.78	0.71	0.66	0.56	0.77	0.82	0.77
8 Pulp and paper	0.58	0.51	0.55	0.54	1.00	0.54	0.49	0.47	0.46	0.49	0.42	0.41
9 Printing and publishing	0.33	0.44	0.30	0.51	0.39	0.42	0.43	0.46	0.41	0.36	0.27	0.26
10 Chemical products	2.22	2.42	2.56	2.44	2.35	2.33	2.46	2.39	2.62	2.71	2.54	2.55
11 Industrial chemicals and chemical fibers	1.99	2.02	2.05	1.88	1.86	1.83	1.84	1.69	1.87	1.92	1.71	1.85
12 Oils and paints	1.91	2.03	2.15	2.34	2.19	2.38	2.40	2.40	2.71	2.73	2.17	2.48
13 Drugs and medicines	3.62	4.13	4.66	4.62	4.11	4.37	4.91	5.05	4.84	5.00	5.53	5.45
14 Other chemical products	2.24	2.81	3.01	2.69	2.94	2.78	2.76	2.88	3.12	3.03	2.88	2.19
15 Petroleum and coal products	0.36	0.41	0.45	0.45	0.28	0.18	0.18	0.18	0.23	0.27	0.18	0.30
16 Plastic products	-	-	-	-	-	-	-	-	-	-	-	-
17 Rubber products	1.25	1.40	1.59	1.73	1.79	1.85	2.20	2.25	1.96	2.60	2.44	2.10
18 Ceramics	1.01	1.14	1.09	1.06	1.06	1.10	1.25	1.40	1.22	1.29	1.27	1.30
19 Iron and steel	0.71	0.75	0.83	0.81	0.84	1.01	1.05	1.02	1.11	1.08	1.04	1.14
20 Non-ferrous metals and products	0.91	1.07	1.12	1.22	0.87	1.07	1.01	0.96	1.01	1.00	0.87	1.03
21 Fabricated metal products	0.78	0.89	0.69	1.06	0.95	1.01	1.10	1.00	1.18	1.08	1.28	1.15
22 Ordinary machinery	1.45	1.52	1.78	1.49	1.55	1.93	1.74	1.79	2.01	1.93	1.85	1.90
23 Electrical machinery	2.99	3.31	3.37	3.41	3.64	3.72	3.75	3.66	3.61	3.74	3.55	3.71
24 Electrical machinery equipment and supplies	2.75	3.10	2.96	2.78	3.22	3.10	3.29	3.49	3.49	3.59	3.19	3.35
25 Communication and electronic equipment	3.21	3.48	3.77	4.04	4.04	4.28	4.17	3.80	3.71	3.89	3.91	3.94
26 Transportation equipment	1.52	1.74	1.86	2.10	2.18	2.14	1.95	2.08	2.27	2.44	2.36	2.34
27 Motor vehicles	1.71	1.90	2.01	2.21	2.51	2.38	1.77	2.20	2.32	2.60	2.51	2.38
28 Other transportation equipment	0.98	1.24	1.39	1.88	1.57	1.61	2.48	1.76	2.12	1.90	1.85	2.15
29 Precision instruments	1.88	2.26	2.49	2.76	2.68	2.66	2.74	2.37	2.91	3.15	2.96	3.02
30 Other manufacturing products	0.77	0.76	0.90	1.00	1.09	1.31	1.29	1.38	1.28	1.30	1.00	1.26
31 Transport/communications/utilities	0.62	0.66	0.72	0.27	1.51	1.17	1.13	1.08	1.21	1.20	1.20	0.89

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1 All industries	1.67	1.84	2.03	2.00	2.32	2.57	2.59	2.61	2.72	2.79	2.81	2.83	2.76
2 Agriculture, forestry and fisheries	0.26	0.27	0.26	0.24	0.24	0.24	0.31	0.38	0.21	0.50	0.25	0.28	0.43
3 Mining	0.53	0.71	0.66	0.68	1.11	1.40	1.18	1.58	1.17	1.36	1.41	1.38	1.17
4 Construction	0.38	0.43	0.54	0.48	0.50	0.56	0.52	0.50	0.53	0.56	0.46	0.55	0.54
5 Manufacturing	1.92	2.15	2.31	2.34	2.69	3.03	3.14	3.15	3.29	3.36	3.47	3.52	3.47
6 Food	0.35	0.63	0.70	0.60	0.77	0.85	0.99	0.89	1.07	0.98	0.95	0.93	1.01
7 Textiles	1.09	1.13	0.90	1.16	1.18	1.23	1.42	1.50	1.71	1.76	1.81	2.31	1.98
8 Pulp and paper	0.43	0.52	0.63	0.66	0.71	0.80	0.77	0.87	0.79	0.88	0.87	0.85	0.88
9 Printing and publishing	0.21	0.39	0.43	0.61	0.68	0.64	0.80	0.63	0.71	0.88	0.91	0.87	0.81
10 Chemical products	2.63	3.05	3.34	3.46	3.79	4.31	4.53	4.63	4.89	5.24	5.39	5.45	5.45
11 Industrial chemicals and chemical fibers	2.01	2.17	2.32	2.47	2.80	3.56	3.76	3.92	4.09	4.01	4.19	4.19	4.34
12 Oils and paints	2.56	2.66	2.83	3.09	3.14	3.42	3.85	3.74	3.93	3.90	4.20	4.38	4.48
13 Drugs and medicines	5.85	5.56	6.59	6.49	7.04	6.89	6.96	6.94	7.50	8.02	8.66	8.70	8.23
14 Other chemical products	3.03	3.43	6.40	3.76	3.61	3.87	4.00	4.11	4.11	4.06	4.29	4.56	4.69
15 Petroleum and coal products	0.18	0.20	0.26	0.27	0.38	0.62	0.64	0.83	0.72	0.64	0.66	0.67	0.65
16 Plastic products	-	-	-	1.94	1.75	2.09	2.16	2.21	2.73	2.37	2.08	2.35	2.17
17 Rubber products	2.33	2.47	2.40	2.62	2.86	2.92	3.25	3.19	3.25	3.20	3.18	3.46	3.39
18 Ceramics	1.39	1.64	1.82	1.96	2.61	2.87	2.82	2.73	2.75	2.60	3.00	2.69	2.46
19 Iron and steel	1.30	1.50	1.60	1.52	1.94	2.54	2.40	2.13	2.21	2.33	2.84	2.58	2.72
20 Non-ferrous metals and products	1.30	1.57	1.49	1.64	1.92	2.11	1.90	2.00	1.91	1.80	2.17	2.23	2.41
21 Fabricated metal products	1.22	1.43	1.31	1.46	1.53	1.61	1.50	1.48	1.36	1.60	1.60	1.52	1.48
22 Ordinary machinery	2.10	2.34	2.57	2.59	2.74	2.77	2.99	2.60	2.83	2.99	3.14	3.10	3.34
23 Electrical machinery	4.06	4.52	4.70	4.55	5.10	5.50	5.61	5.53	5.89	5.86	6.31	6.17	6.04
24 Electrical machinery equipment and supplies	3.80	4.17	4.40	4.45	4.82	5.23	5.26	5.25	5.47	5.36	5.66	5.66	5.81
25 Communication and electronic equipment	4.21	4.72	4.85	4.60	5.25	5.63	5.78	5.66	6.10	6.12	6.63	6.42	6.16
26 Transportation equipment	2.62	2.69	2.66	2.76	2.90	3.21	3.22	3.31	3.40	3.65	3.32	3.45	3.15
27 Motor vehicles	2.82	3.02	2.89	2.90	2.96	3.20	3.17	3.31	3.48	3.73	3.33	3.54	3.19
28 Other transportation equipment	1.94	1.67	1.86	2.20	2.61	3.28	3.45	3.31	2.93	3.20	3.24	2.97	2.96
29 Precision instruments	3.47	3.97	4.02	4.08	4.49	4.59	4.91	4.85	5.16	5.94	4.85	5.79	5.66
30 Other manufacturing products	1.20	1.42	1.40	0.92	0.97	1.07	1.12	1.14	1.19	1.21	1.21	1.38	1.51
31 Transport/communications/utilities	0.94	0.80	1.04	0.92	1.07	1.00	0.87	0.98	1.09	1.10	0.85	0.87	0.88

Source: Management &amp; Coordination Agency, "Report on the Survey of Research and Development"

Table 4-2-10 Number of R&amp;D Scientists/Engineers per 100,000 Employees

	(per 100,000 employees)											
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1 All industries	147	160	188	206	197	222	209	237	240	254	261	277
2 Agriculture, forestry, and fisheries	102	65	32	41	38	65	146	102	192	79	181	78
3 Mining	77	60	81	80	117	102	90	95	88	135	143	117
4 Construction	88	125	85	86	99	107	109	129	109	122	119	111
5 Manufacturing	180	194	211	230	246	277	258	296	301	320	323	348
6 Food	144	140	113	149	142	146	145	146	146	145	154	191
7 Textiles	80	81	83	72	119	110	104	113	78	112	177	125
8 Pulp and paper	111	92	123	125	157	132	97	131	133	151	147	149
9 Printing and publishing	89	83	63	59	69	72	76	81	65	93	74	67
10 Chemical industries	345	385	409	441	445	453	472	507	550	980	567	588
11 General chemical products (excluding pharmaceuticals)	284	316	338	365	360	373	384	419	473	493	499	527
12 Oils and paints	590	615	594	683	661	765	720	349	816	905	717	809
13 Drugs and medicines	417	439	520	519	508	535	562	610	592	622	628	638
14 Other chemical products	380	411	449	428	512	404	460	479	539	534	527	536
15 Petroleum and coal	139	137	467	168	190	193	212	218	214	231	242	356
16 Plastics	-	-	-	-	-	-	-	-	-	-	-	-
17 Rubber	129	133	144	155	137	173	215	223	206	284	327	311
18 Ceramics	112	113	128	142	163	158	148	187	172	166	228	209
19 Iron and steel	83	87	94	99	107	108	103	108	121	126	128	142
20 Non-ferrous metals	134	156	171	179	174	180	185	189	209	222	231	242
21 Fabricated metals	115	120	97	157	146	166	164	205	218	177	189	227
22 Ordinary machinery	145	159	177	186	203	336	231	251	261	268	309	299
23 Electrical	278	316	367	367	422	484	495	554	584	617	553	609
24 Electrical machinery (*)	228	263	320	338	409	426	455	498	508	550	462	531
25 Communication and electronic equipment	330	363	414	398	434	542	531	604	659	681	656	659
26 Transportation equipment	132	144	162	168	178	188	177	219	225	251	257	275
27 Motor vehicles	151	158	182	192	224	212	167	240	249	272	273	296
28 Other transportation equipment	95	113	121	138	122	151	200	185	183	208	218	223
29 Precision instruments	180	210	230	344	323	300	326	324	383	394	406	405
30 Other manufacturing products	116	114	132	160	192	191	196	200	210	208	159	249
31 Transport/communications/utilities	25	27	25	28	32	36	32	33	36	34	36	36

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1 All industries	287	301	340	345	382	426	441	456	476	487	497	517	542
2 Agriculture, forestry, and fisheries	63	100	75	71	124	119	138	183	171	171	140	79	205
3 Mining	107	150	19	173	235	249	280	279	252	327	385	359	342
4 Construction	115	112	141	121	122	151	152	149	135	156	138	162	147
5 Manufacturing	359	390	421	432	468	508	537	556	577	582	593	622	654
6 Food	190	202	200	185	225	241	232	215	230	238	236	235	274
7 Textiles	145	149	159	162	213	186	237	208	280	297	306	337	294
8 Pulp and paper	162	174	216	192	172	200	204	202	201	201	200	237	264
9 Printing and publishing	77	99	74	133	108	130	134	165	136	174	171	194	142
10 Chemical industries	637	656	697	719	784	808	849	899	938	962	973	960	987
11 General chemical products (excluding pharmaceuticals)	557	598	628	654	711	746	804	839	853	862	903	884	927
12 Oils and paints	864	901	907	962	964	989	1090	1145	1172	1239	1197	1203	1265
13 Drugs and medicines	662	645	703	725	796	784	819	829	875	900	933	934	947
14 Other chemical products	656	662	718	715	821	874	847	1013	1088	1154	1070	1018	1009
15 Petroleum and coal	262	283	315	312	394	426	461	488	455	466	441	427	447
16 Plastics	-	-	-	384	338	388	365	420	377	363	370	358	424
17 Rubber	359	360	357	377	392	413	418	418	481	477	435	492	524
18 Ceramics	214	234	277	276	355	335	362	381	372	405	434	450	411
19 Iron and steel	142	150	159	168	177	197	224	232	247	248	264	262	275
20 Non-ferrous metals	249	301	280	320	316	317	329	356	349	354	393	371	399
21 Fabricated metals	206	236	209	246	260	303	293	273	255	250	271	268	312
22 Ordinary machinery	320	333	388	407	425	418	469	452	472	479	500	508	538
23 Electrical	632	698	727	714	767	830	862	935	978	954	991	1018	1103
24 Electrical machinery (*)	542	604	617	621	647	664	682	701	770	710	750	794	878
25 Communication and electronic equipment	691	756	793	768	836	921	958	1065	1094	1106	1127	1140	1229
26 Transportation equipment	279	281	318	335	325	394	438	437	445	452	443	496	511
27 Motor vehicles	298	303	344	354	331	402	453	450	458	465	458	517	534
28 Other transportation equipment	236	231	256	282	304	362	382	382	388	398	381	410	415
29 Precision instruments	437	515	541	650	664	666	670	704	831	808	765	877	933
30 Other manufacturing products	252	236	289	217	257	288	358	320	315	353	316	374	349
31 Transport/communications/utilities	35	39	39	44	56	71	51	54	64	71	80	78	83

Source: Management &amp; Coordination Agency, "Report on the Survey of Research and Development"

Table 4-3-1 R&amp;D Expenditures in Universities

Year	R&D Expenditures (million yen)									
	National	Public	Private	Total	Natural sciences				Total for natural sciences	Humanities Others
					Physical science	Engineer- ing	Agri- culture	Health		
1959	30,454	3,730	14,513	48,696	5,296	8,312	3,649	10,306	27,563	21,079
1960	31,400	5,027	16,057	52,485	4,951	11,013	4,476	10,198	30,637	21,847
1961	40,200	6,346	23,195	69,741	7,079	15,408	5,490	13,439	41,454	28,259
1962	50,771	7,887	31,353	90,012	9,217	21,349	6,645	16,919	54,131	35,877
1963	59,360	8,629	39,141	107,130	10,220	25,030	7,718	19,693	62,661	44,469
1964	71,019	9,379	49,165	129,563	10,469	34,853	9,419	22,562	77,304	52,259
1965	87,059	13,242	83,342	183,643	16,071	42,047	11,408	35,522	105,048	78,595
1966	105,573	12,577	83,765	201,914	17,795	49,986	13,244	37,832	118,856	83,058
1967	121,235	14,109	94,093	229,436	18,402	57,095	15,136	48,231	138,865	90,572
1968	131,890	17,540	109,033	258,463	17,456	61,049	16,437	60,889	155,831	102,632
1969	147,823	20,205	131,206	299,233	21,904	71,411	19,576	64,558	177,449	121,785
1970	179,040	25,369	161,468	365,877	25,705	83,709	22,967	85,062	217,444	148,433
1971	195,487	29,461	198,494	423,441	28,415	95,396	26,400	100,222	250,433	173,009
1972	215,131	32,368	231,185	478,684	30,291	105,271	29,314	124,020	288,896	189,788
1973	254,889	36,791	282,483	574,163	38,098	122,200	33,409	164,522	358,229	215,934
1974	333,171	44,029	340,385	717,585	54,798	156,415	41,638	192,390	445,241	272,344
1975	381,472	48,788	409,538	839,798	65,465	185,149	45,604	220,063	516,281	323,517
1976	415,654	51,406	466,955	934,016	76,786	201,839	50,058	258,970	587,654	346,362
1977	455,191	57,578	499,528	1,012,297	95,016	222,007	55,602	257,073	629,698	382,600
1978	518,622	58,042	574,411	1,151,074	105,288	249,097	60,477	297,756	712,618	438,456
1979	560,089	64,970	633,268	1,258,326	116,618	274,836	66,220	320,009	777,683	480,644
1980	594,339	67,734	678,001	1,340,074	109,394	301,575	70,946	341,985	823,900	516,174
1981	643,472	72,582	729,591	1,445,645	131,467	319,279	72,245	362,368	885,359	560,286
1982	675,850	75,986	788,586	1,540,422	142,574	330,106	75,731	399,800	948,211	592,212
1983	711,364	78,097	860,184	1,649,646	147,985	358,749	80,672	440,951	1,028,356	621,290
1984	749,826	81,964	892,398	1,724,187	155,118	370,732	86,935	450,990	1,063,775	660,412
1985	756,686	88,645	944,449	1,789,780	162,031	371,364	85,337	456,678	1,075,410	714,369
1986	786,462	90,608	955,505	1,832,575	163,376	393,056	88,030	477,403	1,121,864	710,711
1987	843,900	96,756	1,017,264	1,957,921	175,609	431,438	91,551	510,982	1,209,579	748,342
1988	860,678	97,888	1,055,508	2,014,073	179,200	444,840	92,435	523,076	1,239,551	774,523
1989	899,221	114,331	1,115,819	2,129,372	187,047	481,826	99,800	542,957	1,311,631	817,741
1990	961,724	126,936	1,208,331	2,296,992	204,660	503,494	106,028	592,166	1,406,347	890,644
1991	1,001,800	124,153	1,281,974	2,407,927	212,565	529,219	104,142	614,906	1,460,833	947,094
1992	1,077,675	138,430	1,360,176	2,576,281	230,821	566,503	114,971	653,746	1,566,041	1,010,239
1993	1,191,700	145,000	1,422,100	2,758,700	260,400	617,900	117,500	689,700	1,685,500	1,073,200

Source: Management &amp; Coordination Agency, "Report on the Survey of Research and Development"

Table 4-3-2 Number of R&amp;D Scientists/Engineers in Universities

Year	Number of R&D Scientists/Engineers									
	National	Public	Private	Total	Natural sciences				Total for natural sciences	Humanities
					Physical science	Engineering	Agri-culture	Health		
1961	28,550	5,552	24,267	58,369	3,533	7,677	3,906	13,121	28,255	30,114
1962	27,818	5,672	18,931	52,421	3,769	8,037	3,880	12,642	28,337	24,055
1963	31,446	5,941	22,992	60,379	4,078	9,403	3,869	16,097	33,421	26,928
1964	33,538	5,975	25,401	64,914	4,693	10,601	4,172	16,956	36,430	28,484
1965	35,416	6,208	27,072	68,696	4,245	13,606	4,281	17,001	39,133	29,563
1966	36,473	7,192	31,846	75,511	5,114	13,923	4,221	20,367	43,625	31,886
1967	41,781	6,747	36,823	85,351	5,833	16,058	4,564	22,094	48,549	36,802
1968	46,425	7,538	39,926	93,889	5,607	18,466	4,994	25,213	54,280	39,609
1969	45,182	6,865	40,750	92,797	5,469	18,045	4,925	23,934	52,373	40,424
1970	47,323	7,286	44,804	99,413	6,717	20,001	5,438	23,084	55,240	44,173
1971	49,563	7,491	48,139	105,193	6,686	21,119	5,721	26,221	59,747	45,446
1972	50,650	7,328	49,140	107,118	6,505	22,178	5,783	26,037	60,503	46,615
1973	59,031	10,128	55,983	125,142	7,964	23,716	6,296	37,183	75,159	49,983
1974	62,079	9,838	58,350	130,267	8,362	24,587	6,562	39,688	79,199	51,068
1975	63,129	10,144	61,185	134,458	8,246	24,896	6,663	42,103	81,908	52,550
1976	66,842	10,639	64,348	141,829	9,313	27,048	6,797	44,866	88,024	53,805
1977	69,167	11,068	67,119	147,354	10,135	27,515	6,906	48,223	92,779	54,575
1978	68,119	10,682	68,161	146,962	10,845	27,149	6,636	46,878	91,508	55,454
1979	70,856	10,589	71,812	153,257	10,634	27,501	7,170	51,419	96,724	56,533
1980	74,586	10,915	72,945	158,446	10,994	27,820	7,175	54,711	100,700	57,746
1981	75,002	10,870	74,991	160,863	10,659	28,272	7,068	56,593	102,592	58,271
1982	76,050	11,094	76,120	163,264	10,996	27,592	7,065	58,459	104,112	59,152
1983	79,148	11,751	79,204	170,103	11,177	28,102	7,213	63,438	109,930	60,173
1984	81,622	12,008	82,211	175,841	11,365	28,519	7,210	67,089	114,183	61,658
1985	83,576	12,206	84,824	180,606	11,491	28,805	7,241	70,481	118,018	62,588
1986	84,988	12,342	87,740	185,070	11,572	29,354	7,452	72,946	121,324	63,746
1987	86,915	12,651	90,031	189,597	11,534	30,094	7,409	75,197	124,234	65,363
1988	89,413	12,847	93,168	195,428	11,857	30,983	7,518	77,751	128,109	67,319
1989	91,417	13,256	96,057	200,730	12,214	32,282	7,696	79,530	131,722	69,008
1990	93,751	13,423	98,335	205,509	12,528	33,279	7,779	80,547	134,133	71,376
1991	95,342	13,600	100,956	209,898	12,629	34,253	8,160	81,844	136,886	73,012
1992	97,379	13,463	103,620	214,462	13,235	35,575	8,352	82,755	139,917	74,545
1993	102,040	14,244	105,722	222,006	14,272	37,673	8,924	85,022	145,891	76,115
1994	106,285	14,709	108,170	229,164	16,173	39,722	9,163	86,390	151,448	77,716

Source: Management &amp; Coordination Agency, "Report on the Survey of Research and Development"

Table 4-3-3 R&amp;D Expenditures per R&amp;D Scientist/Engineer in Universities

Year	R&D Expenditures									
	National	Public	Private	Total	Natural sciences		Total for natural sciences		Humanities	
					Physical science	Engineering	Agriculture	Health		Others
1960	1,100	905	662	899	1,401	1,435	1,146	777	1,084	725
1961	1,445	1,119	1,225	1,330	1,878	1,917	1,415	1,063	1,463	1,175
1962	1,615	1,328	1,364	1,491	2,260	2,270	1,717	1,051	1,620	1,332
1963	1,770	1,444	1,541	1,650	2,178	2,361	1,850	1,161	1,720	1,561
1964	2,005	1,511	1,816	1,886	2,466	2,562	2,200	1,327	1,975	1,768
1965	2,387	1,841	2,617	2,432	3,143	3,020	2,703	1,744	2,408	2,465
1966	2,527	1,864	2,275	2,366	3,051	3,113	2,902	1,712	2,448	2,257
1967	2,611	1,872	2,357	2,444	3,282	3,092	3,031	1,913	2,558	2,287
1968	2,919	2,555	2,676	2,785	3,192	3,383	3,337	2,544	2,975	2,539
1969	3,124	2,773	2,928	3,010	3,261	3,570	3,600	2,797	3,212	2,757
1970	3,612	3,387	3,354	3,478	3,845	3,964	4,015	3,244	3,639	3,266
1971	3,860	4,020	4,039	3,953	4,368	4,301	4,565	3,849	4,139	3,711
1972	3,644	3,196	4,130	3,825	3,803	4,439	4,656	3,335	3,844	3,797
1973	4,106	3,740	4,841	4,408	4,556	4,970	5,091	4,145	4,523	4,228
1974	5,278	4,340	5,563	5,337	6,645	6,283	6,249	4,570	5,436	5,183
1975	5,707	4,586	6,364	5,921	7,029	6,845	6,709	4,905	5,865	6,013
1976	6,009	4,645	6,957	6,339	7,576	7,336	7,248	5,370	6,334	6,347
1977	6,682	5,390	7,329	6,888	8,761	8,177	8,379	5,484	6,881	6,899
1978	7,319	5,481	7,999	7,511	9,901	9,058	8,435	5,791	7,368	7,756
1979	7,509	5,952	8,681	7,942	10,607	9,879	9,229	5,849	7,723	8,323
1980	7,924	6,231	9,041	8,331	10,263	10,667	10,038	6,043	8,031	8,858
1981	8,461	6,542	9,585	8,855	11,956	11,571	10,226	6,199	8,504	9,472
1982	8,539	6,466	9,956	9,056	12,756	11,747	10,499	6,302	8,626	9,842
1983	8,715	6,504	10,463	9,381	13,021	12,579	11,189	6,573	9,006	10,076
1984	8,972	6,715	10,521	9,547	13,499	12,870	12,006	6,399	9,014	10,552
1985	8,903	7,182	10,764	9,671	14,002	12,651	11,452	6,260	8,864	11,206
1986	9,049	7,162	10,613	9,666	14,165	13,061	11,881	6,349	9,030	10,873
1987	9,438	7,531	10,919	10,019	14,811	13,925	12,178	6,572	9,442	11,116
1988	9,415	7,384	10,988	10,034	14,672	13,780	12,011	6,577	9,410	11,224
1989	9,592	8,518	11,347	10,361	14,930	14,478	12,829	6,741	9,779	11,457
1990	10,087	9,334	11,969	10,943	16,206	14,699	12,994	7,235	10,274	12,199
1991	10,288	9,222	12,372	11,228	16,061	14,876	12,469	7,430	10,441	12,705
1992	10,561	9,718	12,866	11,605	16,173	15,037	12,883	7,689	10,734	13,273
1993	11,212	9,858	13,147	12,038	16,101	15,556	12,823	7,984	11,129	13,809

Source: Management &amp; Coordination Agency, "Report on the Survey of Research and Development"

Table 4-4-1 R&amp;D Expenditures in R&amp;D Organizations

Year	R&D expenditures (¥1000/person)				Total	Breakdown (%)			
	National	Public	Private	Semi-governmental		National	Public	Private	Semi-governmental
1959	12,432	8,345	6,028	-	26,804	46.4	31.1	22.5	-
1960	16,875	8,522	4,022	4,589	34,008	49.6	25.1	11.8	13.5
1961	19,090	12,102	4,492	6,266	41,950	45.5	28.8	10.7	14.9
1962	20,507	16,267	6,040	7,001	49,815	41.2	32.7	12.1	14.1
1963	22,584	18,024	6,957	6,264	53,829	42.0	33.5	12.9	11.6
1964	27,197	22,269	8,680	6,573	64,720	42.0	34.4	13.4	10.2
1965	31,101	24,875	9,295	7,322	72,593	42.8	34.3	12.8	10.1
1966	36,182	29,291	10,303	6,765	82,540	43.8	35.5	12.5	8.2
1967	38,768	33,700	11,286	10,324	94,078	41.2	35.8	12.0	11.0
1968	44,338	38,885	11,987	19,462	114,673	38.7	33.9	10.5	17.0
1969	47,349	45,342	17,842	26,535	137,068	34.5	33.1	13.0	19.4
1970	54,562	57,481	18,838	35,482	166,363	32.8	34.6	11.3	21.3
1971	61,362	67,648	23,325	61,575	213,911	28.7	31.6	10.9	28.8
1972	71,736	76,303	25,424	94,797	268,260	26.7	28.4	9.5	35.3
1973	86,959	95,527	32,088	125,174	339,747	25.6	28.1	9.4	36.8
1974	108,784	115,215	84,236	101,158	409,394	26.6	28.1	20.6	24.7
1975	124,132	118,750	85,923	121,124	449,928	27.6	26.4	19.1	26.9
1976	130,195	124,922	101,902	147,420	504,438	25.8	24.8	20.2	29.2
1977	148,171	139,287	88,831	153,232	529,522	28.0	26.3	16.8	28.9
1978	164,070	145,281	100,831	193,606	603,788	27.2	24.1	16.7	32.1
1979	186,925	159,938	94,604	218,924	660,391	28.3	24.2	14.3	33.2
1980	194,293	177,176	145,540	246,908	763,918	25.4	23.2	19.1	32.3
1981	201,256	191,162	245,521	268,979	906,918	22.2	21.1	27.1	29.7
1982	203,343	189,702	276,178	280,038	949,260	21.4	20.0	29.1	29.5
1983	208,767	191,567	279,651	291,025	971,010	21.5	19.7	28.8	30.0
1984	215,853	199,622	307,425	310,209	1,033,110	20.9	19.3	29.8	30.0
1985	235,950	206,935	349,812	367,874	1,160,571	20.3	17.8	30.1	31.7
1986	244,828	209,212	399,971	386,183	1,240,194	19.7	16.9	32.3	31.1
1987	308,246	215,583	441,273	419,348	1,384,452	22.3	15.6	31.9	30.3
1988	272,506	223,677	458,925	439,072	1,394,180	19.5	16.0	32.9	31.5
1989	284,261	240,902	498,535	428,592	1,452,290	19.6	16.6	34.3	29.5
1990	318,959	270,303	537,291	387,605	1,514,158	21.1	17.9	35.5	25.6
1991	321,988	282,730	573,453	442,378	1,620,549	19.9	17.4	35.4	27.3
1992	373,004	288,631	612,427	498,466	1,772,528	21.0	16.3	34.6	28.1
1993	422,200	300,100	618,200	556,400	1,896,800	22.3	15.8	32.6	29.3

Source: Management &amp; Coordination Agency, "Report on the Survey of Research and Development"

Table 4-4-2 Number of R&amp;D Scientists/Engineers in R&amp;D Organizations

Year	Number of R&D Scientists/Engineers				Total	Breakdown (%)			
	National	Public	Private	Semi-governmental		National	Public	Private	Semi-governmental
1961	7,506	6,710	1,930	710	16,856	44.5	39.8	11.4	4.2
1962	7,838	7,749	1,357	730	17,674	44.3	43.8	7.7	4.1
1963	8,275	8,787	1,545	783	19,390	42.7	45.3	8.0	4.0
1964	8,383	8,933	1,521	841	19,678	42.6	45.4	7.7	4.3
1965	8,878	9,687	1,647	933	21,145	42.0	45.8	7.8	4.4
1966	8,896	10,045	1,781	838	21,560	41.3	46.6	8.3	3.9
1967	9,127	10,645	1,673	1,119	22,564	40.4	47.2	7.4	5.0
1968	9,174	11,171	1,881	1,193	23,419	39.2	47.7	8.0	5.1
1969	9,353	11,467	1,910	1,350	24,080	38.8	47.6	7.9	5.6
1970	9,308	11,951	2,166	1,441	24,866	37.4	48.1	8.7	5.8
1971	9,668	12,282	2,294	1,474	25,718	37.6	47.8	8.9	5.7
1972	9,701	13,424	2,566	1,737	27,428	35.4	48.9	9.4	6.3
1973	9,800	14,116	2,619	2,714	29,249	33.5	48.3	9.0	9.3
1974	9,730	15,099	2,726	3,585	31,140	31.2	48.5	8.8	11.5
1975	9,817	14,581	2,641	2,010	29,049	33.8	50.2	9.1	6.9
1976	9,897	14,762	3,043	2,113	29,815	33.2	49.5	10.2	7.1
1977	9,948	14,743	3,883	2,082	30,656	32.5	48.1	12.7	6.8
1978	10,262	14,835	3,551	2,151	30,799	33.3	48.2	11.5	7.0
1979	10,281	14,785	3,637	2,249	30,952	33.2	47.8	11.8	7.3
1980	10,465	15,204	3,771	2,404	31,844	32.9	47.7	11.8	7.5
1981	10,706	15,497	4,861	2,589	33,653	31.8	46.0	14.4	7.7
1982	10,704	15,655	7,408	2,652	36,419	29.4	43.0	20.3	7.3
1983	10,795	15,269	5,971	2,767	34,802	31.0	43.9	17.2	8.0
1984	10,777	15,287	6,856	2,697	35,617	30.3	42.9	19.2	7.6
1985	10,641	15,464	7,198	2,713	36,016	29.5	42.9	20.0	7.5
1986	10,770	15,340	7,565	2,780	36,455	29.5	42.1	20.8	7.6
1987	10,697	15,294	8,427	2,918	37,336	28.7	41.0	22.6	7.8
1988	10,766	15,004	9,632	3,139	38,541	27.9	38.9	25.0	8.1
1989	10,899	15,215	10,788	3,174	40,076	27.2	38.0	26.9	7.9
1990	10,864	15,094	11,497	3,364	40,819	26.6	37.0	28.2	8.2
1991	10,895	15,107	12,405	3,514	41,921	26.0	36.0	29.6	8.4
1992	10,943	15,037	13,459	3,623	43,062	25.4	34.9	31.3	8.4
1993	11,096	15,048	14,104	3,750	43,998	25.2	34.2	32.1	8.5
1994	11,210	14,862	14,734	3,835	44,641	25.1	33.3	33.0	8.6

Source: Management &amp; Coordination Agency, "Report on the Survey of Research and Development"

Table 4-4-3 R&amp;D Expenditures per R&amp;D Scientist/Engineer in R&amp;D Organizations

Year	R&D expenditures (¥1000/person)				Total
	National	Public	Private	Semi-governmental	
1960	2,248	1,270	2,084	6,463	2,018
1961	2,436	1,562	3,310	8,584	2,374
1962	2,478	1,851	3,909	8,941	2,569
1963	2,694	2,018	4,574	7,448	2,735
1964	3,063	2,299	5,270	7,045	3,061
1965	3,496	2,476	5,219	8,737	3,367
1966	3,964	2,752	6,158	6,046	3,658
1967	4,226	3,017	6,000	8,654	4,017
1968	4,741	3,391	6,276	14,416	4,762
1969	5,087	3,794	8,237	18,414	5,512
1970	5,644	4,680	8,212	24,072	6,469
1971	6,325	5,039	9,090	35,449	7,799
1972	7,320	5,405	9,708	34,929	9,172
1973	8,937	6,327	11,771	34,916	10,910
1974	11,081	7,902	31,895	50,327	14,093
1975	12,542	8,044	28,236	57,323	15,091
1976	13,088	8,473	26,243	70,807	16,455
1977	14,439	9,389	25,016	71,238	17,193
1978	15,959	9,826	27,724	86,085	19,507
1979	17,862	10,519	25,087	91,067	20,738
1980	18,148	11,433	29,940	95,368	22,700
1981	18,802	12,211	33,143	101,425	24,902
1982	18,837	12,424	46,253	101,206	27,276
1983	19,372	12,531	40,789	107,907	27,263
1984	20,285	12,909	42,710	114,342	28,685
1985	21,908	13,490	46,241	132,329	31,836
1986	22,888	13,679	47,463	132,345	33,217
1987	28,631	14,368	45,813	133,593	35,922
1988	25,003	14,701	42,540	138,334	34,788
1989	26,165	15,960	43,362	127,405	35,579
1990	29,276	17,893	43,312	110,303	36,119
1991	29,424	18,802	42,607	122,103	37,633
1992	33,616	19,181	43,422	132,924	40,287
1993	37,663	20,192	41,957	145,085	42,490

Source: Management &amp; Coordination Agency, "Report on the Survey of Research and Development"



Table 5-1-1 Country Share Trends in the Output of Scientific Papers

Year	Number of papers										World
	U.S.	Japan	U.K.	Germany	former W.Germ.	former E.Germ.	France	Soviet Union	Canada	Others	
1981	148,627	26,828	35,736	33,092	27,947	5,145	22,843	32,158	17,301	86,933	403,518
1982	151,292	27,901	36,429	33,966	28,566	5,400	23,250	33,583	17,843	88,803	413,067
1983	152,494	29,256	37,597	33,735	28,414	5,321	23,240	35,337	18,523	91,308	421,490
1984	153,730	30,256	36,973	33,084	28,146	4,938	23,125	34,713	19,359	90,603	421,843
1985	163,778	33,667	40,310	36,331	31,306	5,025	24,703	36,173	21,014	95,361	451,337
1986	169,242	35,413	41,406	36,992	31,729	5,263	26,762	35,006	21,965	100,958	467,744
1987	168,999	35,634	41,446	37,355	32,220	5,135	26,773	32,714	22,555	101,416	466,892
1988	175,644	39,924	41,880	38,176	33,056	5,120	27,868	35,406	23,454	104,387	486,739
1989	182,048	41,318	42,940	40,299	35,050	5,249	29,461	35,812	24,219	110,214	506,311
1990	187,780	43,862	44,391	41,600	36,314	5,286	30,159	35,321	24,887	111,727	519,727
1991	195,659	45,700	46,441	43,666	38,600	5,064	31,448	34,829	26,188	107,758	531,689
1992	203,370	51,562	50,692	45,803	-	-	34,769	36,797	28,268	113,568	564,829

Year	Share in output (%)										World
	U.S.	Japan	U.K.	Germany	former W.Germ.	former E.Germ.	France	Soviet Union	Canada	Others	
1981	36.8	6.6	8.9	8.2	6.9	1.3	5.7	8.0	4.3	21.5	100.0
1982	36.6	6.8	8.8	8.2	6.9	1.3	5.6	8.1	4.3	21.5	100.0
1983	36.2	6.9	8.9	8.0	6.7	1.3	5.5	8.4	4.4	21.7	100.0
1984	36.4	7.2	8.8	7.8	6.7	1.2	5.5	8.2	4.6	21.5	100.0
1985	36.3	7.5	8.9	8.0	6.9	1.1	5.5	8.0	4.7	21.1	100.0
1986	36.2	7.6	8.9	7.9	6.8	1.1	5.7	7.5	4.7	21.6	100.0
1987	36.2	7.6	8.9	8.0	6.9	1.1	5.7	7.0	4.8	21.7	100.0
1988	36.1	8.2	8.6	7.8	6.8	1.1	5.7	7.3	4.8	21.4	100.0
1989	36.0	8.2	8.5	8.0	6.9	1.0	5.8	7.1	4.8	21.8	100.0
1990	36.1	8.4	8.5	8.0	7.0	1.0	5.8	6.8	4.8	21.5	100.0
1991	36.8	8.6	8.7	8.2	7.3	1.0	5.9	6.6	4.9	20.3	100.0
1992	36.0	9.1	9.0	8.1	-	-	6.2	6.5	5.0	20.1	100.0

Source: "Science Citation Index Database"

Table 5-1-2 Scientific Paper Citation Frequency in Selected Countries

Year	Cited Count										World
	U.S.	Japan	U.K.	Germany	former W.Germ.	former E.Germ.	France	Soviet Union	Canada	Others	
1981	2,771,531	276,611	545,970	334,034	314,887	19,147	240,466	83,899	238,954	608,274	5,099,739
1982	2,645,488	282,544	529,764	335,075	314,242	20,833	237,434	79,305	236,036	575,517	4,921,163
1983	2,613,695	281,274	520,936	333,422	313,185	20,237	233,395	74,104	229,555	552,679	4,839,060
1984	2,507,595	281,875	502,905	307,601	290,539	17,062	227,570	71,799	221,099	488,748	4,609,192
1985	2,427,589	277,153	469,230	314,963	298,116	16,847	226,854	68,881	222,766	485,205	4,492,641
1986	2,251,327	275,538	436,235	292,780	277,537	15,243	219,973	56,218	201,212	432,657	4,165,940
1987	2,055,975	248,510	388,653	278,394	264,592	13,802	203,274	45,405	182,872	358,513	3,761,596
1988	1,761,975	238,321	320,752	234,677	224,033	10,644	177,597	42,056	158,804	306,790	3,240,972
1989	1,390,142	193,141	262,613	198,092	188,645	9,447	143,077	34,611	127,596	236,481	2,585,753
1990	952,969	135,111	187,403	143,498	137,301	6,197	101,517	24,692	88,835	145,108	1,779,133
1991	467,288	67,503	91,736	72,347	68,976	3,369	52,741	13,017	43,731	58,734	867,097
1992	79,565	12,633	18,797	13,994	0	0	9,432	3,153	8,038	7,679	153,291

Year	Cited Count Share (%)										World
	U.S.	Japan	U.K.	Germany	former W.Germ.	former E.Germ.	France	Soviet Union	Canada	Others	
1981	54.3%	5.4%	10.7%	6.6%	6.2%	0.4%	4.7%	1.6%	4.7%	11.9%	100.0%
1982	53.8%	5.7%	10.8%	6.8%	6.4%	0.4%	4.8%	1.6%	4.8%	11.7%	100.0%
1983	54.0%	5.8%	10.8%	6.9%	6.5%	0.4%	4.8%	1.5%	4.7%	11.4%	100.0%
1984	54.4%	6.1%	10.9%	6.7%	6.3%	0.4%	4.9%	1.6%	4.8%	10.6%	100.0%
1985	54.0%	6.2%	10.4%	7.0%	6.6%	0.4%	5.0%	1.5%	5.0%	10.8%	100.0%
1986	54.0%	6.6%	10.5%	7.0%	6.7%	0.4%	5.3%	1.3%	4.8%	10.4%	100.0%
1987	54.7%	6.6%	10.3%	7.4%	7.0%	0.4%	5.4%	1.2%	4.9%	9.5%	100.0%
1988	54.4%	7.4%	9.9%	7.2%	6.9%	0.3%	5.5%	1.3%	4.9%	9.5%	100.0%
1989	53.8%	7.5%	10.2%	7.7%	7.3%	0.4%	5.5%	1.3%	4.9%	9.1%	100.0%
1990	53.6%	7.6%	10.5%	8.1%	7.7%	0.3%	5.7%	1.4%	5.0%	8.2%	100.0%
1991	53.9%	7.8%	10.6%	8.3%	8.0%	0.4%	6.1%	1.5%	5.0%	6.8%	100.0%
1992	51.9%	8.2%	12.3%	9.1%	0.0%	0.0%	6.2%	2.1%	5.2%	5.0%	100.0%

Note: Cited count of a publication shows the number of times it was cited in the years up to 1992.

Source: "Science Citation Index Database"

Table 5-1-3 Paper Share by Academic Field in Japan and the U.S. (1990)

Field	Number of published papers			World
	Japan	U.S.	Others	
Agriculture	5,499	14,227	26,249	45,975
Astrophysics	944	8,760	9,316	19,020
Biology/Biochemistry	25,062	98,654	115,652	239,368
Chemistry	26,239	56,322	142,999	225,560
Clinical medicine	17,999	137,318	185,356	340,673
Computer science	1,222	11,765	9,943	22,930
Engineering	10,315	40,887	52,712	103,914
Ecology/Environmental science	1,324	16,026	18,808	36,158
Earth science	1,442	17,824	24,715	43,981
Immunology	2,674	16,196	15,680	34,550
Molecular biology/Genetics	6,943	37,074	44,361	88,378
Material science	8,734	18,733	30,540	58,007
Mathematics	1,585	12,671	15,831	30,087
Interdisciplinary	417	4,817	18,527	23,761
Neurology	4,645	30,886	29,040	64,571
Physics	25,114	68,407	121,474	214,995
Zoology/Botany	7,862	44,371	70,839	123,072
Pharmacology	8,555	17,417	30,169	56,141
Total	141,124	586,809	888,312	1,616,245

Field	Cited coun share (%)			World
	Japan	U.S.	Others	
Agriculture	12	31	57	100
Astrophysics	5	46	49	100
Biology/Biochemistry	10	41	48	100
Chemistry	12	25	63	100
Clinical medicine	5	40	54	100
Computer science	5	51	43	100
Engineering	10	39	51	100
Ecology/Environmental science	4	44	52	100
Earth science	3	41	56	100
Immunology	8	47	45	100
Molecular biology/Genetics	8	42	50	100
Material science	15	32	53	100
Mathematics	5	42	53	100
Interdisciplinary	2	20	78	100
Neurology	7	48	45	100
Physics	12	32	57	100
Zoology/Botany	6	36	58	100
Pharmacology	15	31	54	100
Total	9	36	55	100

Source: "Science Citation Index Database"

Table 5-1-4 Japanese Scientific Paper Citation Frequency by Academic Field (1990-1992)

Field	Japan		World	
	Number of papers	Cited count	Number of papers	Cited count
Agriculture	5,499	4,515	45,975	31,700
Astrophysics	944	2,417	19,020	44,918
Biology/Biochemistry	25,062	57,032	239,368	637,116
Chemistry	26,239	39,477	225,560	347,234
Clinical medicine	17,999	19,562	340,673	482,809
Computer science	1,222	408	22,930	11,876
Engineering	10,315	6,043	103,914	68,618
Ecology/Environmental science	1,324	865	36,158	37,093
Earth Science	1,442	1,628	43,981	61,648
Immunology	2,674	6,937	34,550	125,820
Molecular biology/Genetics	6,943	20,028	88,378	379,638
Material science	8,734	7,479	58,007	48,262
Mathematics	1,585	677	30,087	15,082
Interdisciplinary	417	619	23,761	18,561
Neurology	4,645	9,432	64,571	174,986
Physics	25,114	43,069	214,995	375,657
Zoology/Botany	7,862	6,238	123,072	113,428
Pharmacology	8,555	10,922	56,141	95,674
Total	141,124	215,247	1,616,245	2,799,521

Field	Japanese share (%)		Cited count per paper	
	Number of papers	Cited count	Japan	World
Agriculture	12.0	14.2	0.82	0.69
Astrophysics	5.0	5.4	2.56	2.36
Biology/Biochemistry	10.5	9.0	2.28	2.66
Chemistry	11.6	11.4	1.50	1.54
Clinical medicine	5.3	4.1	1.09	1.42
Computer science	5.3	3.4	0.33	0.52
Engineering	9.9	8.8	0.59	0.66
Ecology/Environmental science	3.7	2.3	0.65	1.03
Earth Science	3.3	2.6	1.13	1.40
Immunology	7.7	5.5	2.59	3.64
Molecular biology/Genetics	7.9	5.3	2.88	4.30
Material science	15.1	15.5	0.86	0.83
Mathematics	5.3	4.5	0.43	0.50
Interdisciplinary	1.8	3.3	1.48	0.78
Neurology	7.2	5.4	2.03	2.71
Physics	11.7	11.5	1.71	1.75
Zoology/Botany	6.4	5.5	0.79	0.92
Pharmacology	15.2	11.4	1.28	1.70
Total	8.7	7.7	1.53	1.73

Source: "Science Citation Index Database"

Table 5-2-1 Patenting Trends in Japan

Year	Number of applications			Number of grants		
	Japanese	Foreigner	Total	Japanese	Foreigner	Total
1970	100,522	30,309	130,831	21,390	9,488	30,878
1971	78,425	27,360	105,785	24,795	11,652	36,447
1972	101,328	29,072	130,400	29,101	12,353	41,454
1973	115,221	29,593	144,814	30,937	11,391	42,328
1974	121,509	27,810	149,319	30,873	8,753	39,626
1975	135,118	24,703	159,821	36,992	9,736	46,728
1976	135,762	25,254	161,016	32,465	7,852	40,317
1977	135,991	25,015	161,006	43,047	9,561	52,608
1978	141,517	24,575	166,092	37,648	7,856	45,504
1979	150,623	23,946	174,569	34,863	9,241	44,104
1980	165,730	25,290	191,020	38,032	8,074	46,106
1981	191,645	26,616	218,261	42,080	8,824	50,904
1982	210,922	26,591	237,513	42,223	8,378	50,601
1983	227,743	27,213	254,956	45,578	9,123	54,701
1984	256,205	28,562	284,767	51,690	10,110	61,800
1985	274,373	28,622	302,995	42,323	7,777	50,100
1986	290,202	29,887	320,089	51,276	8,624	59,900
1987	311,006	30,089	341,095	54,087	8,313	62,400
1988	308,908	30,491	339,399	47,912	7,388	55,300
1989	317,566	33,641	351,207	54,743	8,558	63,301
1990	333,230	34,360	367,590	50,370	9,031	59,401
1991	335,933	33,463	369,396	30,453	5,647	36,100
1992	338,019	33,875	371,894	78,994	13,106	92,100
1993	332,345	34,141	366,486	77,311	11,089	88,400

Source: Patent Agency, "Patent Agency Annual Report"

Table 5-2-2 Patenting Trends in Japan by Sector

Year	Number of patent applications							Total
	Electricity	Physics	Mechanical engineering	Construction	Chemicals/Metallurgy/Textiles	Processing/Control/Transportation	Daily commodities	
1980	41,693	41,123	19,520	5,418	31,572	37,711	12,063	189,100
1981	47,421	50,251	23,104	6,180	34,016	42,039	13,388	216,399
1982	53,385	54,963	24,899	6,347	35,638	45,552	14,435	235,219
1983	57,717	60,239	25,132	7,017	37,424	49,102	15,738	252,369
1984	65,957	69,138	27,364	7,292	40,405	53,621	18,163	281,940
1985	71,028	75,933	25,721	7,261	42,838	56,473	17,599	296,853
1986	75,235	82,267	25,457	7,617	44,862	57,340	18,944	311,722
1987	85,351	91,414	24,753	7,782	48,831	57,421	21,331	336,883
1988	83,510	90,954	24,978	8,436	48,703	58,382	21,269	336,232
1989	85,390	93,570	25,739	9,405	50,230	58,757	22,760	345,851
1990	83,579	92,871	24,090	9,705	45,726	57,332	21,210	334,513
1991	84,880	92,946	24,781	9,624	42,076	58,114	20,004	332,425
1992	85,186	91,189	26,100	12,002	45,638	63,525	21,220	344,860

Year	Share in number of patent applications							Total
	Electricity	Physics	Mechanical engineering	Construction	Chemicals/Metallurgy/Textiles	Processing/Control/Transportation	Daily commodities	
1980	22.0	21.7	10.3	2.9	16.7	19.9	6.4	100.0
1981	21.9	23.2	10.7	2.9	15.7	19.4	6.2	100.0
1982	22.7	23.4	10.6	2.7	15.2	19.4	6.1	100.0
1983	22.9	23.9	10.0	2.8	14.8	19.5	6.2	100.0
1984	23.4	24.5	9.7	2.6	14.3	19.0	6.4	100.0
1985	23.9	25.6	8.7	2.4	14.4	19.0	5.9	100.0
1986	24.1	26.4	8.3	2.4	14.4	18.4	6.1	100.0
1987	25.3	27.1	7.3	2.3	14.5	17.0	6.3	100.0
1988	24.8	27.1	7.4	2.5	14.5	17.4	6.3	100.0
1989	24.7	27.1	7.4	2.7	14.5	17.0	6.6	100.0
1990	25.0	27.8	7.2	2.9	13.7	17.1	6.3	100.0
1991	25.5	28.0	7.5	2.9	12.7	17.5	6.0	100.0
1992	24.7	26.4	7.6	3.5	13.2	18.4	6.2	100.0

Year	Number of patent grants								Total
	Electricity	Physics	Mechanical engineering	Construction	Chemicals/Metallurgy/Textiles	Processing/Control/Transportation	Daily commodities	Others	
1980	8,365	7,216	3,984	2,082	10,204	11,153	3,037	65	46,106
1981	9,249	8,142	4,520	2,140	11,557	11,194	4,034	68	50,904
1982	9,426	8,503	4,207	1,838	11,682	10,405	4,508	32	50,601
1983	10,373	8,776	4,590	1,895	13,042	11,533	4,481	11	54,701
1984	11,779	11,005	5,614	2,238	13,738	13,607	3,819	0	61,800
1985	8,875	8,155	4,431	1,858	12,519	10,825	3,433	4	50,100
1986	10,055	10,664	5,800	1,991	14,924	11,964	4,501	1	59,900
1987	10,215	10,942	6,576	2,082	14,611	13,172	4,802	0	62,400
1988	10,306	9,710	5,279	1,717	12,442	11,708	4,138	0	55,300
1989	12,237	10,398	5,971	2,145	13,921	13,567	5,062	0	63,301
1990	10,924	10,385	5,969	1,872	13,124	12,486	4,640	0	59,400
1991	5,712	6,440	3,673	1,332	7,677	8,316	2,950	0	36,100
1992	15,290	17,073	8,417	4,350	17,669	20,648	8,639	14	92,100
1993	15,141	19,333	7,294	4,364	16,225	17,964	7,806	0	88,400

Year	Share in number of patent grants								Total
	Electricity	Physics	Mechanical engineering	Construction	Chemicals/Metallurgy/Textiles	Processing/Control/Transportation	Daily commodities	Others	
1980	18.1	15.7	8.6	4.5	22.1	24.2	6.6	0.1	100.0
1981	18.2	16.0	8.9	4.2	22.7	22.0	7.9	0.1	100.0
1982	18.6	16.8	8.3	3.6	23.1	20.6	8.9	0.1	100.0
1983	19.0	16.0	8.4	3.5	23.8	21.1	8.2	0.0	100.0
1984	19.1	17.8	9.1	3.6	22.2	22.0	6.2	0.0	100.0
1985	17.7	16.3	8.8	3.7	25.0	21.6	6.9	0.0	100.0
1986	16.8	17.8	9.7	3.3	24.9	20.0	7.5	0.0	100.0
1987	16.4	17.5	10.5	3.3	23.4	21.1	7.7	0.0	100.0
1988	18.6	17.6	9.5	3.1	22.5	21.2	7.5	0.0	100.0
1989	19.3	16.4	9.4	3.4	22.0	21.4	8.0	0.0	100.0
1990	18.4	17.5	10.0	3.2	22.1	21.0	7.8	0.0	100.0
1991	15.8	17.8	10.2	3.7	21.3	23.0	8.2	0.0	100.0
1992	16.6	18.5	9.1	4.7	19.2	22.4	9.4	0.0	100.0
1993	17.1	21.9	8.3	4.9	18.4	20.3	8.8	0.0	100.0

Source: Patent Agency, "Patent Agency Annual Report"

Table 5-2-3 Patent Applications in Japan by Classification (top 20 classifications, 199

Category	Number of patent applications		Total	Share	Accumulative share
	Japanese	Foreigner			
H01 Basic electrical components	36,992	2,064	39,056	11.3%	11.3%
H04 Telecommunications technology	24,789	1,364	26,153	7.6%	18.9%
G06 Computation/Counting	21,303	1,183	22,486	6.5%	25.4%
G01 Measurement/Testing	16,263	1,224	17,487	5.1%	30.5%
G03 Photo/Cinema/Electrostatic photo	13,725	647	14,372	4.2%	34.7%
G11 Information storage	13,637	556	14,193	4.1%	38.8%
G02 Optics	9,524	428	9,952	2.9%	41.7%
C08 Organic polymerized compounds	8,460	1,280	9,740	2.8%	44.5%
B65 Transportation/Packaging/Storage	8,592	791	9,383	2.7%	47.2%
B41 Publishing/Typewriting	8,160	490	8,650	2.5%	49.7%
A61 Medicine/Veterinary medicine	6,827	1,528	8,355	2.4%	52.1%
H02 Power generation, transformation, distribution	7,076	290	7,366	2.1%	54.3%
C07 Organic chemistry	5,026	2,123	7,149	2.1%	56.4%
B60 General motor vehicles	6,516	511	7,027	2.0%	58.4%
F16 Machine elements and units	5,988	786	6,774	2.0%	60.4%
H05 Other uncategorized electrical tech	5,897	188	6,085	1.8%	62.1%
E04 Buildings	5,628	74	5,702	1.7%	63.8%
B29 Plastics processing	5,128	319	5,447	1.6%	65.4%
B23 Machine tools/Metals processing	5,158	267	5,425	1.6%	66.9%
H03 Basic electronic circuitry	5,036	371	5,407	1.6%	68.5%
Others	101,148	7,503	108,651	31.5%	-
Total	320,873	23,987	344,860	100.0%	100.0%

Source: Patent Agency, "Patent Agency Annual Report"

Table 5-2-4 Patent Applications and Grant to Foreigners in Japan (1992)

	Applications	Grants
(by area)		
Asia	1,369	81
Europe	15,739	6,669
Africa	33	12
Americas	16,333	6,240
Oceania	319	60
Others	82	44
Other than Europe/Americas	1,803	197
Total for foreigners	33,875	13,106
Total for Japanese/foreigners	371,894	92,100
(by country)		
U.S.	15,930	6,080
Canada	335	124
Germany	5,198	2,762
France	2,173	928
U.K.	1,740	573
Netherlands	1,367	566
Switzerland	1,299	725
Italy	806	298
Sweden	527	291
South Korea	990	31
Taiwan	181	21
Australia	295	52

Source: Patent Agency, "Patent Agency Annual Report"



Table 5-2-5 Japanese External Patent Grants (Applications) (1981, 1991)

Country	Applications		Grants	
	1981	1991	1981	1991
U.S.	14,009	38,609	8,390	21,027
Germany	7,376	16,015	1,544	7,805
U.K.	6,154	14,217	1,795	6,436
France	4,438	12,334	1,796	5,071
South Korea	1,529	7,346	716	4,025
Italy	1,246	6,130	-	1,659
Netherlands	1,878	4,915	328	1,897
Canada	2,228	4,201	1,804	2,027
Others	7,537	29,205	3,276	9,179
Total	46,395	132,972	19,649	57,467

Source: Patent Agency, "Patent Agency Annual Report"

Table 5-2-6 Number of Patents by Nationality of Inventor in Selected Countries (199

Patent applications

(Country)	(Nationality of inventor)						Total no. of applications
	Japan	U.S.	Germany	France	U.K.	Others	
U.S.	38,609	89,024	13,510	5,735	6,919	23,591	177,388
Eur. Pat. Office	58,051	111,508	83,045	36,499	24,749	97,195	411,047
Germany	16,015	22,153	43,404	5,270	5,155	17,190	109,187
France	12,334	20,198	12,099	15,819	4,481	14,144	79,075
U.K.	14,217	22,796	11,720	5,104	24,253	17,443	95,533
Japan	335,933	15,720	5,367	2,351	1,801	8,224	369,396

Patent grants

(Country)	(Nationality of inventor)						Total no. of grants
	Japan	U.S.	Germany	France	U.K.	Others	
U.S.	21,027	51,184	7,680	3,030	2,800	10,793	96,514
Eur. Pat. Office	21,756	40,184	47,749	19,345	12,124	40,813	181,971
Germany	7,805	7,220	16,756	2,846	1,779	6,784	43,190
France	5,071	6,445	7,182	9,221	1,629	6,033	35,581
U.K.	6,436	7,465	6,958	2,634	4,492	6,089	34,074
Japan	30,453	2,589	1,177	401	258	1,222	36,100

Share in number of applications

(Country)	(Nationality of inventor)						Share
	Japan	U.S.	Germany	France	U.K.	Others	
U.S.	0	1	0	0	0	0	1
Eur. Pat. Office	0	0	0	0	0	0	1
Germany	0	0	0	0	0	0	1
France	0	0	0	0	0	0	1
U.K.	0	0	0	0	0	0	1
Japan	1	0	0	0	0	0	1

Share in number of grants

(Country)	(Nationality of inventor)						Share
	Japan	U.S.	Germany	France	U.K.	Others	
U.S.	0	1	0	0	0	0	1
Eur. Pat. Office	0	0	0	0	0	0	1
Germany	0	0	0	0	0	0	1
France	0	0	0	0	0	0	1
U.K.	0	0	0	0	0	0	1
Japan	1	0	0	0	0	0	1

Source: Patent Agency, "Patent Agency Annual Report"

Table 5-2-7 Patent Grant Share Trends by Country in the U.S. 1980-1992

Number of patents

Year	U.S.	Japan	Germany	Former W.Germ.	Former E.Germ.	France	U.K.	Others	World
1980	37,214	7,136	5,802	5,767	35	2,096	2,416	7,147	61,811
1981	39,069	8,402	6,334	6,283	51	2,183	2,506	7,266	65,759
1982	33,756	8,162	5,480	5,423	58	1,983	2,152	6,346	57,879
1983	32,744	8,804	5,492	5,439	53	1,899	1,956	5,958	56,854
1984	38,311	11,112	6,309	6,242	66	2,157	2,279	7,021	67,189
1985	39,549	12,756	6,704	6,651	53	2,401	2,504	7,740	71,653
1986	38,103	13,220	6,858	6,806	52	2,367	2,411	7,893	70,852
1987	43,479	16,570	7,883	7,818	64	2,870	2,781	9,373	82,955
1988	40,452	16,158	7,357	7,312	46	2,647	2,592	8,716	77,922
1989	50,135	20,177	8,332	8,282	50	3,139	3,103	10,664	95,550
1990	47,332	19,519	7,620	7,587	33	2,859	2,796	10,244	90,370
1991	51,135	21,027	7,670	7,648	22	3,040	2,800	10,856	96,528
1992	52,162	21,919	7,315	7,304	10	3,024	2,425	10,611	97,455
Total	543,440	184,961	89,155	88,561	594	32,665	32,721	109,836	992,778

Share in number of patents (%)

Year	U.S.	Japan	Germany	Former W.Germ.	Former E.Germ.	France	U.K.	Others	World
1980	60	12	9	9	0	3	4	12	100
1981	59	13	10	10	0	3	4	11	100
1982	58	14	9	9	0	3	4	11	100
1983	58	15	10	10	0	3	3	10	100
1984	57	17	9	9	0	3	3	10	100
1985	55	18	9	9	0	3	3	11	100
1986	54	19	10	10	0	3	3	11	100
1987	52	20	10	9	0	3	3	11	100
1988	52	21	9	9	0	3	3	11	100
1989	52	21	9	9	0	3	3	11	100
1990	52	22	8	8	0	3	3	11	100
1991	53	22	8	8	0	3	3	11	100
1992	54	22	8	7	0	3	2	11	100
Total	55	19	9	9	0	3	3	11	100

Source: CHI Research Inc., "International Technology Indicators Database"

Table 5-2-8 Frequency of U.S.-Granted Patents Cited in Selected Countries 1980-1992

Cited count

Year	U.S.	Japan	Germany	Former W.Germ.	Former E.Germ.	France	U.K.	Others	World
1980	179,217	34,460	21,554	21,486	68	7,879	9,973	25,589	278,671
1981	182,438	43,126	23,542	23,369	173	7,874	10,445	25,226	292,651
1982	155,299	41,078	19,752	19,530	222	7,289	8,732	22,122	254,272
1983	144,979	43,121	18,534	18,415	120	6,938	7,375	19,100	240,047
1984	160,987	50,815	19,912	19,787	125	7,216	8,360	21,528	268,817
1985	153,840	57,250	20,116	20,019	97	6,978	8,262	22,140	268,586
1986	137,188	53,861	17,872	17,766	106	6,448	7,410	20,015	242,794
1987	140,457	60,882	17,782	17,691	90	6,681	7,140	20,732	253,672
1988	102,814	47,143	13,288	13,233	55	4,739	5,208	14,860	188,050
1989	84,618	38,564	9,810	9,758	53	3,532	4,006	12,345	152,874
1990	47,188	22,785	5,184	5,168	16	1,907	2,200	6,946	86,211
1991	17,695	8,469	2,042	2,039	4	741	700	2,787	32,434
1992	1,238	566	117	117	0	41	53	162	2,176
Total	1,507,956	502,118	189,506	188,378	1,128	68,262	79,862	213,552	2,561,256

Cited count share (%)

Year	U.S.	Japan	Germany	Former W.Germ.	Former E.Germ.	France	U.K.	Others	World
1980	64.3	12.4	7.7	7.7	0.0	2.8	3.6	9.2	100.0
1981	62.3	14.7	8.0	8.0	0.1	2.7	3.6	8.6	100.0
1982	61.1	16.2	7.8	7.7	0.1	2.9	3.4	8.7	100.0
1983	60.4	18.0	7.7	7.7	0.0	2.9	3.1	8.0	100.0
1984	59.9	18.9	7.4	7.4	0.0	2.7	3.1	8.0	100.0
1985	57.3	21.3	7.5	7.5	0.0	2.6	3.1	8.2	100.0
1986	56.5	22.2	7.4	7.3	0.0	2.7	3.1	8.2	100.0
1987	55.4	24.0	7.0	7.0	0.0	2.6	2.8	8.2	100.0
1988	54.7	25.1	7.1	7.0	0.0	2.5	2.8	7.9	100.0
1989	55.4	25.2	6.4	6.4	0.0	2.3	2.6	8.1	100.0
1990	54.7	26.4	6.0	6.0	0.0	2.2	2.6	8.1	100.0
1991	54.6	26.1	6.3	6.3	0.0	2.3	2.2	8.6	100.0
1992	56.9	26.0	5.4	5.4	0.0	1.9	2.4	7.4	100.0
Total	58.9	19.6	7.4	7.4	0.0	2.7	3.1	8.3	100.0

Source: CHI Research Inc., "International Technology Indicators Database"

Table 5-2-9 Number of U.S. Patents Granted by International Patent Classification:  
Patents Granted to Japanese (top 20 classifications)

Category	Patents granted to Japanese		Patents granted to Americans		Total	
	Number	share	Number	share	Number	share
H01 Basic electronic components	2,325	32.9%	3,490	49.4%	7,064	100.0%
G03 Photo/Cinema/Electrostatic p	1,589	61.0%	762	29.3%	2,604	100.0%
H04 Telecommunications technolo	1,339	36.5%	1,627	44.3%	3,674	100.0%
G11 Information storage	1,222	64.1%	495	26.0%	1,906	100.0%
G06 Computation/Counting	1,009	32.2%	1,770	56.4%	3,136	100.0%
G01 Measurement/Testing	982	18.5%	3,091	58.1%	5,319	100.0%
C08 Organic polymerized compou	936	25.1%	1,872	50.2%	3,729	100.0%
C07 Organic chemistry	733	16.7%	2,119	48.3%	4,389	100.0%
F16 Machine elements and units	726	19.9%	1,805	49.6%	3,640	100.0%
B60 General motor vehicles	723	31.0%	1,058	45.4%	2,333	100.0%
A61 Medicine/Veterinary medicin	719	10.7%	4,335	64.7%	6,701	100.0%
G02 Optics	651	35.2%	864	46.8%	1,847	100.0%
B41 Publishing/Typewriting	538	47.4%	365	32.2%	1,135	100.0%
H03 Basic electronic circuitry	534	30.0%	912	51.3%	1,778	100.0%
F02 Combustion engines	526	36.5%	564	39.1%	1,442	100.0%
B65 Transportation/Packaging/Sto	487	12.7%	2,280	59.4%	3,842	100.0%
B32 Lamination	407	26.0%	857	54.8%	1,565	100.0%
H02 Power generation/Conversion	355	27.6%	601	46.8%	1,283	100.0%
B23 Machine tools/Metals process	337	20.8%	827	51.0%	1,620	100.0%
B29 Plastics processing	314	24.2%	601	46.3%	1,298	100.0%
Other categories	5,469	14.7%	21,864	58.9%	37,145	100.0%
All categories	21,919	22.5%	52,160	53.5%	97,450	100.0%

Source: CHI Research Inc., "International Technology Indicators Database"

Table 5-2-10 Number of U.S. Patents Granted by International Patent Classification:  
Japanese Share (top 10 fields): 1982 and 1992

Number of patents granted

Category	Patents granted to Japanese		Patents granted to Americans		Total	
	1982	1992	1982	1992	1982	1992
G11 Information storage	306	1,222	369	495	834	1,906
G03 Photo/Cinema/Electrostatic pl	698	1,589	671	762	1,658	2,604
B41 Publishing/Typewriting	90	538	196	365	406	1,135
G10 Musical instruments/Acoustic	71	178	191	163	308	382
F02 Combustion engines	316	526	433	564	1,031	1,442
H04 Telecommunications technolo	350	1,339	873	1,627	1,633	3,674
G02 Optics	139	651	260	864	558	1,847
G05 Control/Coordination	122	210	298	281	521	618
C04 Cement/Ceramics	59	163	103	220	240	493
H01 Basic electronic circuitry	567	2,325	2,093	3,490	3,467	7,064

Patent grants share (%)

Category	Patents granted to Japanese		Patents granted to Americans		Total	
	1982	1992	1982	1992	1982	1992
G11 Information storage	0	1	0	0	1	100.0%
G03 Photo/Cinema/Electrostatic pl	0	1	0	0	1	100.0%
B41 Publishing/Typewriting	0	0	0	0	1	100.0%
G10 Musical instruments/Acoustic	0	0	1	0	1	100.0%
F02 Combustion engines	0	0	0	0	1	100.0%
H04 Telecommunications technolo	0	0	1	0	1	100.0%
G02 Optics	0	0	0	0	1	100.0%
G05 Control/Coordination	0	0	1	0	1	100.0%
C04 Cement/Ceramics	0	0	0	0	1	100.0%
H01 Basic electronic circuitry	0	0	1	0	1	100.0%

Source: CHI Research Inc., "International Technology Indicators Database"

Table 5-2-11 Domestic/External Patents (Applications) in Selected Countries  
1990-1992 Average

Nationality of applicant	Number of patent applications		Total
	Domestic	External	
Japan	335,757	127,319	463,076
U.S.	91,484	336,366	427,850
Germany	44,402	152,544	196,945
France	15,835	65,140	80,975
U.K.	24,248	85,328	109,576

Nationality of applicant	Number of patent grants		Total
	Domestic	External	
Japan	53,272	59,101	112,373
U.S.	50,277	77,530	127,807
Germany	17,071	60,837	77,908
France	8,869	26,761	35,629
U.K.	4,498	19,394	23,892

Note: The numbers include applications and grants applied under the Patent Cooperation Treaty or European Patent Convention.

Source: Patent Agency, "Patent Agency Annual Report"

Table 5-2-12 Number of Domestic Patents

Year	Japan	U.S.	Germany	France	U.K.
1977	43,047	41,383	10,815	8,361	7,722
1978	37,648	40,979	11,581	8,083	8,464
1979	34,863	30,605	10,895	6,846	4,182
1980	38,032	37,152	9,826	8,438	5,158
1981	42,080	39,225	6,357	6,855	6,067
1982	42,223	33,896	8,279	7,764	4,686
1983	45,578	32,872	10,709	7,323	5,655
1984	51,690	38,364	11,402	7,651	4,442
1985	42,323	39,544	13,215	9,835	6,087
1986	51,276	38,124	15,347	9,362	5,403
1987	54,087	43,518	16,194	8,523	4,609
1988	47,912	40,479	15,704	8,822	4,447
1989	54,473	50,185	16,904	8,301	4,234
1990	50,370	47,393	16,625	8,923	4,361
1991	30,453	51,184	16,756	9,221	4,492
1992	78,994	52,254	17,833	8,462	4,642
1993	77,311	-	-	-	-

Source: Patent Agency, "Patent Agency Annual Report"

Table 5-2-13 Nuber of External Patents

Year	Japan	U.S.	Germany	France	U.K.
1977	21,308	66,371	44,612	17,447	15,196
1978	21,685	62,282	36,807	15,049	13,095
1979	16,350	47,342	28,186	10,411	9,314
1980	20,289	51,772	33,063	11,941	10,878
1981	19,468	48,213	30,269	11,236	9,701
1982	23,860	54,526	34,634	13,200	10,168
1983	25,522	49,391	33,676	12,738	9,649
1984	29,170	54,460	34,744	14,770	11,674
1985	38,450	61,869	47,766	19,736	14,596
1986	40,476	69,265	50,356	22,313	16,555
1987	41,751	62,530	46,804	21,540	15,201
1988	43,426	63,488	46,963	22,690	15,695
1989	50,824	68,168	56,087	24,193	17,160
1990	53,890	71,136	57,123	25,197	17,863
1991	57,467	73,079	55,325	24,182	20,069
1992	65,945	88,375	70,063	30,903	20,250

Source: Patent Agency, "Patent Agency Annual Report"

Table 5-2-14 Total Number of Patents

Year	Japan	U.S.	Germany	France	U.K.
1977	64,355	107,754	55,427	25,808	22,918
1978	59,333	103,261	48,388	23,132	21,559
1979	51,213	77,947	39,081	17,257	13,496
1980	58,321	88,924	42,889	20,379	16,036
1981	61,548	87,438	36,626	18,091	15,768
1982	66,083	88,422	42,913	20,964	14,854
1983	71,100	82,263	44,385	20,061	15,304
1984	80,860	92,824	46,146	22,421	16,116
1985	80,773	101,413	60,981	29,571	20,683
1986	91,752	107,389	65,703	31,675	21,958
1987	95,838	106,048	62,998	30,063	19,810
1988	91,338	103,967	62,667	31,512	20,142
1989	105,297	118,353	72,991	32,494	21,394
1990	104,260	118,529	73,748	34,120	22,224
1991	87,920	124,263	72,081	33,403	24,561
1992	144,939	140,629	87,896	39,365	24,892

Source: Patent Agency, "Patent Agency Annual Report"



Table 5-3-1 Establishment, Revision, Confirmation, and Abolition of Japanese Industrial Standards (JIS)

Year	Establishment	Revision	Confirmation*	Abolition	Number of standards
1949	187	1	0	0	187
1950	867	11	0	2	1,052
1951	698	42	0	4	1,746
1952	778	71	117	15	2,509
1953	690	476	365	51	3,148
1954	450	418	351	34	3,564
1955	416	547	567	32	3,948
1956	406	763	833	86	4,268
1957	352	624	656	59	4,561
1958	375	634	890	111	4,825
1959	337	680	1,140	88	5,074
1960	321	1,015	621	140	5,255
1961	406	367	1,242	110	5,551
1962	350	350	1,114	70	5,831
1963	317	504	1,147	74	6,074
1964	277	285	2,336	100	6,251
1965	221	382	1,009	50	6,422
1966	230	341	1,744	18	6,634
1967	164	201	1,946	117	6,681
1968	226	691	1,670	84	6,823
1969	179	37	1,679	89	6,913
1970	234	441	2,353	151	6,996
1971	209	429	1,756	77	7,128
1972	179	457	1,347	58	7,249
1973	154	306	2,515	26	7,377
1974	220	623	1,953	46	7,551
1975	230	1,213	2,000	103	7,678
1976	143	1,159	792	122	7,699
1977	113	754	1,430	125	7,687
1978	188	909	2,479	131	7,744
1979	134	616	1,983	232	7,646
1980	132	398	440	107	7,671
1981	137	404	53	55	7,753
1982	156	399	767	57	7,852
1983	130	384	2,022	87	7,895
1984	160	370	1,387	124	7,931
1985	124	349	1,020	77	7,978
1986	193	344	766	61	8,110
1987	197	481	1,018	84	8,223
1988	196	496	1,401	131	8,288
1989	180	434	1,002	54	8,414
1990	174	402	606	211	8,377
1991	148	444	932	165	8,360
1992	186	764	580	139	8,406

Note: For the Japanese Industrial Standards, review for revision etc is conducted under Provision 15 of the Industrial Standards Law. "Confirmation" indicates that it was confirmed that the standard did not require revision.

Source: Japan Standards Association, "JIS Directories"

Table 5-3-2 Number of Japanese Industrial Standards (JIS)  
(end of FY1992)

Category		Number of standards	Breakdown (%)
Civil engineering/Construc	A	508	6.0
General machinery	B	1,308	15.6
Electronic/Electrical equip	C	794	9.4
Motor vehicles	D	341	4.1
Railroads	E	215	2.6
Ships	F	540	6.4
Iron and steel	G	327	3.9
Non-ferrous metals	H	399	4.7
Chemicals	K	1,593	19.0
Textiles	L	308	3.7
Mining	M	202	2.4
Pulp and paper	P	93	1.1
Ceramics	R	246	2.9
Daily commodities	S	236	2.8
Medical and safety supplie	T	304	3.6
Aviation	W	91	1.1
Information processing	X	216	2.6
Others	Z	685	8.1
Total		8,406	100

Source: Source: Japan Standards Association, "JIS Directories"

Table 5-4-1 Number of Awards for Persons of Scientific and Technological Merit

Technical field	Category	Year of awarding				Number of awards
		1960s	1970s	1980s	1990s	
Machinery	Boiler, motor	3	0	5	3	11
	Agricultural, construction, mining equipment	2	3	4	1	10
	Machine tool for metal	7	7	7	0	21
	Fiber processing machine	3	3	3	0	9
	Special industrial machine	7	4	7	0	18
	Pump, compressor, air blower	1	1	2	0	4
	Power unit	5	1	1	0	7
	Other general industrial equipment	0	3	3	2	8
	Other equipment	1	5	9	2	17
	Transportation equipment	13	8	24	3	48
	Precision machinery	17	7	21	6	51
	Subtotal	59	42	86	17	204
Electrical	Generator etc. for industrial use	6	7	10	0	23
	Lighting etc. for home use	1	0	0	1	2
	Wired/Wireless communications equipment	10	8	13	6	37
	Radio, TV, audio equipment	3	4	2	0	9
	Other communications equipment	0	2	1	0	3
	Computer	2	4	11	2	19
	Other electronic equipment	7	1	16	2	26
	Electronic/Communication parts	3	14	21	4	42
	Other electrical equipment	4	1	1	1	7
	Subtotal	36	39	77	16	168
Chemical	Inorganic	3	1	2	1	7
	Organic	16	12	19	4	51
	Chemical fibers	4	1	0	0	5
	Fat processing, soap	1	1	0	0	2
	Drugs and medicines	11	2	11	2	26
	Other chemical products	4	4	6	1	15
	Oil/Coal products	1	0	2	0	3
	Chemical machinery	7	11	7	1	26
	Subtotal	47	32	47	9	135
Metal	Iron and steel	11	10	17	1	39
	Non-ferrous	5	5	7	3	20
	Fabricated metal products	5	4	7	3	19
	Subtotal	21	19	31	7	78
Other	Agriculture, forestry and fisheries	3	1	6	1	11
	Mining	2	0	0	0	2
	Construction	5	10	11	1	27
	Food, tobacco	6	4	6	2	18
	Textiles	2	0	0	0	2
	Coat	0	0	0	0	0
	Other clothing, textile products	0	0	0	0	0
	Wood products, furniture	0	0	0	0	0
	Pulp, paper, printing	0	0	0	0	0
	Rubber products	0	0	2	0	2
	Leather products, fur	0	1	0	0	1
	Ceramics	5	5	17	0	27
	Precious metals, ornaments	0	0	0	0	0
	Leisure products	0	0	0	0	0
	Plastic products	1	1	2	0	4
	Unclassifiable manufacturing	3	0	0	0	3
	Other industries	3	0	5	0	8
	Subtotal	30	22	49	4	105
Total		193	154	290	53	690

Note: "1960s" include 1959. "1990s" include only 1990 and 1991.

Source: National Institute of Science and Technology Policy, "Awards System and Japanese Science and Technology Trends" (NISTEP Report No. 10), 1990. 1990 and 1991 data are added.

Table 5-4-2 Number of Awards for Persons of Scientific and Technological Merit in Frontier Sciences and Technologies

Year	Computer	Semi-conductor	Drugs and medicines	Nuclear power	Aviation, astronautics	Biotechnology	Optical fiber	Ceramics	Laser	Robot	Total
1959			1								1
1960			2								2
1961	1		2								3
1962			3	1							4
1963			1	1	1						3
1964	1										1
1965				2						1	3
1966	1		1								2
1967	1							1	1		3
1968		1									1
1969	1	1				1					3
1970	2		1								3
1971	1										1
1972		1						1			2
1973	1	1									2
1974		2						1			3
1975		1	1								2
1976											0
1977							1				1
1978	1										1
1979						2					2
1980		1				1					2
1981	2		1	1		1		1			6
1982	3		1	2		2		1			9
1983			2					1	3	2	8
1984	1	3	2				3			4	13
1985	2	2	2			2	1		1		10
1986	2	3	2					3			10
1987	1					1		2			4
1988	2	1	1	1	4	1		2			12
1989	2	2		4				1			9
1990	1	1	1	3	1	1	2				10
1991	1	3			1			1	1	1	8
Total	27	23	24	15	7	12	7	15	6	8	144

Source: National Institute of Science and Technology Policy, "Awards System and Japanese Science and Technology Trends" (NISTEP Report No. 10), 1990. 1990 and 1991 data are added.

Table 6-1-1 Labor Productivity Indices in Selected Countries

(1975 index = 100)					
Year	Japan	U.S.	Germany	France	U.K.
1975	100.0	100.0	100.0	100.0	100.0
1976	103.3	101.4	106.3	104.4	103.6
1977	106.7	102.2	113.1	106.7	105.9
1978	110.5	103.0	111.9	109.9	109.0
1979	115.1	102.2	114.6	113.3	110.4
1980	118.1	101.5	114.4	114.9	108.3
1981	121.3	102.4	114.7	117.0	111.3
1982	123.9	100.7	115.3	119.8	115.3
1983	125.1	103.1	118.7	121.0	120.9
1984	129.7	106.0	121.9	123.7	120.4
1985	135.2	107.6	123.4	126.4	123.2
1986	137.7	108.3	124.5	129.4	127.8
1987	141.9	109.3	125.7	131.8	131.2
1988	148.2	111.7	129.4	135.7	132.2
1989	152.1	112.1	131.8	139.0	130.4
1990	157.6	112.7	134.2	141.0	131.3

Note 1: The data show the index of real GDP divided by labor force.

Note 2: Currency has been converted based on the purchasing power parity of 1985 prices

Data: OECD "National Accounts" and "Labor Force Statistics"

Source: "International Comparison of Labour Productivity" (1992)

Table 6-1-2 International Comparison of Labor Productivity

(Japan=100)					
Year	Japan	U.S.	Germany	France	U.K.
1975	100.0	175.7	131.6	142.8	114.5
1976	100.0	172.6	135.4	144.3	114.8
1977	100.0	168.3	139.5	142.8	113.6
1978	100.0	163.7	133.2	142.0	112.9
1979	100.0	155.9	130.9	140.4	109.8
1980	100.0	151.0	127.4	139.0	105.0
1981	100.0	148.3	124.4	137.7	105.1
1982	100.0	142.9	122.5	138.0	106.5
1983	100.0	144.8	124.8	138.1	110.6
1984	100.0	143.6	123.6	136.1	106.3
1985	100.0	139.8	120.0	133.5	104.3
1986	100.0	138.2	119.0	134.1	106.3
1987	100.0	135.4	116.6	132.5	105.8
1988	100.0	132.4	114.8	130.7	102.1
1989	100.0	129.5	114.0	130.5	98.1
1990	100.0	125.7	112.1	127.7	95.4

Note 1: The data show the index of real GDP divided by labor force.

Note 2: Currency has been converted based on the purchasing power parity of 1985 prices.

Data: OECD "National Accounts" and "Labor Force Statistics"

Source: "International Comparison of Labour Productivity" (1992)

Table 6-2-1 Japan's Primary Energy Supply

Year	Primary energy supply (trillion kcal)					Total supply
	Petroleum	Coal	Natural gas and LPG	Nuclear	Hydro/ Others	
1960	379.29	415.22	9.39	-	204.20	1,008.10
1961	470.34	449.54	13.66	-	225.88	1,159.43
1962	570.78	418.17	17.63	-	203.36	1,209.92
1963	717.84	432.26	20.54	-	195.02	1,365.64
1964	851.73	444.50	20.27	-	189.58	1,506.08
1965	1,006.78	456.54	20.27	0.08	205.42	1,689.10
1966	1,143.95	475.66	21.12	1.34	209.44	1,851.53
1967	1,380.55	533.22	22.34	1.45	186.30	2,123.86
1968	1,631.21	573.91	24.09	2.40	200.30	2,431.90
1969	1,923.44	615.46	28.47	2.49	205.41	2,775.26
1970	2,298.93	635.71	39.70	10.54	212.20	3,197.08
1971	2,404.97	558.52	40.02	18.02	226.35	3,247.90
1972	2,620.14	558.72	40.29	21.33	229.88	3,470.37
1973	2,982.35	595.87	59.14	21.84	194.89	3,854.09
1974	2,863.02	636.91	76.84	44.32	225.69	3,846.79
1975	2,686.42	599.93	92.31	56.53	227.05	3,662.24
1976	2,873.10	586.42	104.57	76.68	232.55	3,873.33
1977	2,896.79	558.63	138.60	71.23	207.46	3,872.71
1978	2,834.05	513.79	180.12	133.46	203.14	3,864.55
1979	2,939.84	566.77	214.84	158.38	231.56	4,111.39
1980	2,624.36	673.27	241.64	185.83	246.56	3,971.65
1981	2,434.52	704.06	242.59	197.60	242.55	3,821.32
1982	2,253.02	675.38	252.38	230.47	231.60	3,642.86
1983	2,357.69	689.21	289.24	257.15	242.28	3,835.58
1984	2,385.61	757.71	369.62	302.10	216.10	4,031.12
1985	2,280.41	788.10	382.13	359.05	244.32	4,054.01
1986	2,275.41	732.85	395.92	378.69	240.32	4,023.18
1987	2,403.17	761.25	408.61	422.46	228.28	4,223.77
1988	2,554.05	805.39	425.94	401.98	266.30	4,453.66
1989	2,674.40	796.70	461.58	411.46	273.01	4,617.15
1990	2,835.58	807.54	492.84	455.11	272.01	4,863.08
1991	2,785.25	831.88	520.85	480.29	291.38	4,909.65

Source: Agency of Natural Resources and Energy, "Comprehensive Energy Statistics"

Table 6-2-2 Investment in Pollution Control Equipment Broken Down by Industry

(100 million yen)

Year	Investment in pollution control equipment				Total
	Iron & steel	Electric power	Chemicals	Machinery	
1971	690	493	222	176	3,057
1972	859	605	229	207	3,311
1973	1,030	726	725	365	5,147
1974	1,671	1,417	1,600	528	9,170
1975	2,091	1,726	1,443	369	9,645
1976	2,654	2,260	607	330	7,819
1977	812	1,569	257	284	4,055
1978	629	1,375	144	242	3,265
1979	680	1,111	113	185	2,901
1980	321	1,699	84	228	3,128
1981	464	2,435	106	223	4,037
1982	694	2,751	112	230	4,516
1983	416	3,555	77	174	4,540
1984	254	2,439	191	197	3,475
1985	260	2,458	162	236	3,668
1986	178	1,913	132	109	2,672
1987	79	1,871	55	103	2,428
1988	159	2,077	89	189	2,815
1989	232	1,797	107	246	2,766
1990	248	1,962	125	366	3,054

Source: Ministry of International Trade and Industry, "Capital Investment Plans of Major Industries"

Table 6-2-3 Investment in Pollution Control Equipment

Industry	Investment [¥100 mil.]	Percentage [%]	Type of equipment	Investment [¥100 mil.]	Percentage [%]
Electric power	1,962	64.2	Air pollution	1,812	61.9
Machinery	366	12.0	Water pollution	463	15.8
Iron & steel	232	7.6	Noise/vibration	307	10.5
Pulp & paper	143	4.7	Industrial Related facilities	72	2.5
Chemicals	125	4.1		271	9.3
Others	226	7.4	Total	2,925	100
Total	3,054	100			

Source: Ministry of International Trade and Industry, "Capital Investment Plans of Major Industries"



Table 6-2-4 Production of Environmental Equipment

(100 million yen)

Year	Total			
		Private sector	Public sector	Export
1971	302,259	193,553	102,393	6,313
1972	374,646	218,321	151,538	4,787
1973	488,248	312,138	166,034	10,076
1974	677,307	450,623	216,867	9,817
1975	683,082	435,704	238,303	9,075
1976	693,876	377,991	300,680	15,205
1977	581,127	219,851	348,308	12,968
1978	613,316	171,834	413,351	28,131
1979	644,548	161,124	452,195	31,229
1980	655,109	221,310	393,506	40,293
1981	677,928	243,175	398,915	35,838
1982	610,992	195,472	397,478	18,042
1983	651,436	203,895	424,445	23,096
1984	594,788	211,954	365,222	17,612
1985	652,827	202,863	424,349	25,615
1986	668,603	192,396	418,273	57,934
1987	622,916	173,244	413,913	35,759
1988	644,868	159,168	464,767	20,933
1989	*	*	*	*
1990	785,008	206,322	549,578	29,108
1991	956,923	262,361	639,622	54,940
1992	1,124,519	302,633	753,230	68,656

Year	Air pollution control				Water pollution control			
	Total	Private sector	Public sector	Export	Total	Private sector	Public sector	Export
1971	124,651	118,595	3,506	2,550	142,316	70,626	67,927	3,763
1972	132,690	121,827	7,130	3,733	186,513	86,642	98,888	983
1973	209,272	194,149	9,065	6,058	211,890	102,198	105,689	4,003
1974	334,253	318,471	9,820	5,962	265,328	117,517	143,967	3,844
1975	312,464	298,602	10,806	3,056	296,067	125,990	164,296	5,781
1976	280,981	262,134	13,955	4,892	315,841	101,173	204,362	10,306
1977	144,345	127,268	12,677	4,400	324,953	73,790	244,022	7,141
1978	109,758	83,719	10,518	15,521	379,178	65,926	303,418	9,834
1979	112,271	82,407	18,270	11,594	408,223	65,561	323,477	19,185
1980	160,109	122,732	17,216	20,161	352,132	79,081	253,175	19,876
1981	162,846	130,075	11,441	21,330	369,904	87,398	268,605	13,901
1982	141,916	114,060	19,634	8,222	322,981	68,918	244,612	9,451
1983	146,880	119,848	17,411	9,621	337,872	68,791	256,003	13,078
1984	158,323	128,345	20,569	9,409	315,832	73,340	234,606	7,886
1985	147,681	118,301	13,819	15,561	322,458	58,417	255,286	8,755
1986	151,759	118,733	11,956	21,070	335,839	54,177	257,595	24,067
1987	143,232	103,180	13,280	26,772	334,679	51,292	277,274	6,113
1988	104,049	82,139	10,376	11,534	343,868	54,227	283,426	6,215
1989	*	*	*	*	*	*	*	*
1990	154,231	109,265	23,886	21,080	392,075	77,515	309,190	5,370
1991	221,932	160,497	18,649	42,786	412,706	77,644	328,916	6,146
1992	239,212	194,966	20,852	23,394	479,757	79,336	395,763	4,658

Year	Noise pollution/vibration control				Waste disposal			
	Total	Private sector	Public sector	Export	Total	Private sector	Public sector	Export
1971	805	747	58	0	34,487	3,585	30,902	0
1972	1,010	964	45	1	54,433	8,888	45,475	70
1973	1,062	1,007	40	15	66,024	14,784	51,240	0
1974	1,291	1,239	52	0	76,435	13,396	63,028	11
1975	1,541	1,406	134	1	73,010	9,706	63,067	237
1976	2,162	1,598	564	0	94,892	13,086	81,799	7
1977	5,070	3,636	1,025	409	106,759	15,157	90,584	1,018
1978	3,944	2,567	1,201	176	120,436	19,622	98,214	2,600
1979	3,983	2,580	1,313	90	120,071	10,576	109,135	360
1980	6,484	2,947	3,476	61	136,384	16,550	119,639	195
1981	5,746	1,369	4,262	115	139,432	24,333	114,607	492
1982	6,780	4,400	2,213	167	139,315	8,094	131,019	202
1983	4,439	2,232	2,055	152	162,245	13,024	148,976	245
1984	6,672	3,987	2,617	68	113,961	6,282	107,430	249
1985	3,821	2,583	959	279	178,867	23,562	154,285	1,020
1986	3,977	3,213	563	201	177,028	16,273	148,159	12,596
1987	4,857	4,427	370	60	140,148	14,345	122,989	2,814
1988	3,630	2,449	1,162	19	193,321	20,353	169,803	3,165
1989	*	*	*	*	*	*	*	*
1990	6,496	4,809	1,601	86	232,206	14,733	214,901	2,572
1991	10,954	6,953	3,934	67	311,331	17,267	288,123	5,941
1992	8,860	5,828	2,910	122	396,690	22,503	333,705	40,482

Source: Japan Society of Industrial Machinery Manufacturers, "Production of Environmental Equipment"

Table 6-2-5 Installation of Flue-gas Desulphurisation and Denitrification Systems

Year	Desulphurization		Denitrification	
	Number	Capacity (mil. Nm <sup>3</sup> /h)	Number	Capacity (mil. Nm <sup>3</sup> /h)
1970	102	5.4	-	-
1971	183	9.3	-	-
1972	323	18.0	5	0.1
1973	543	28.8	10	0.4
1974	768	42.7	20	1.2
1975	994	79.5	45	4.3
1976	1,134	103.8	71	8.2
1977	1,192	110.5	93	13.7
1978	1,227	114.8	109	22.2
1979	1,266	117.5	122	28.4
1980	1,329	122.0	140	39.1
1981	1,362	126.5	175	63.6
1982	1,366	127.2	188	71.7
1983	1,405	129.1	231	95.1
1984	1,583	133.4	253	103.5
1985	1,741	154.5	305	109.9
1986	1,758	155.0	323	125.9
1987	1,789	169.2	348	138.1
1988	1,810	176.3	379	142.1
1989	1,843	178.8	430	159.1
1990	1,914	193.8	538	200.0
1991	2,014	204.7	715	216.0

Source: Environment Agency, "State of Installation of Smoke Treatment Systems"

Table 6-2-6 SO<sub>x</sub> and NO<sub>x</sub> Emissions in Selected Countries

	Japan	U.S.	Germany	France	U.K.
	[1986]	[1988]	[1989]	[1989]	[1989]
SO <sub>x</sub> [1000t]	835	20,700	1,001	3,699	1,272
NO <sub>x</sub> [1000t]	1,176	19,800	2,707	2,690	1,760
TES [Mtoe]	363.5	1926.0	271.6	211.3	219.0
SO <sub>x</sub> /TES [kg/toe]	2.30	10.75	3.69	17.51	5.81
NO <sub>x</sub> /TES [kg/toe]	3.24	10.28	9.97	12.73	8.04

Note: TES is for Total Energy Supply.

Source: "OECD Environmental Data, Compendium 1991"

Table 6-2-7 SO2 and NO2 Concentrations

(ppm)

Year	SO2	NO2	
	General air pollution monitoring stations	General air pollution monitoring stations	Automobile exhaust gas monitoring stations
1965	0.057	-	-
1966	0.057	-	-
1967	0.059	-	-
1968	0.055	-	-
1969	0.050	-	-
1970	0.043	0.022	-
1971	0.037	0.021	0.032
1972	0.031	0.020	0.034
1973	0.030	0.025	0.037
1974	0.024	0.027	0.040
1975	0.021	0.026	0.040
1976	0.020	0.027	0.042
1977	0.018	0.026	0.042
1978	0.017	0.028	0.043
1979	0.016	0.028	0.042
1980	0.016	0.027	0.043
1981	0.014	0.026	0.042
1982	0.013	0.025	0.042
1983	0.012	0.025	0.040
1984	0.012	0.025	0.038
1985	0.011	0.024	0.037
1986	0.010	0.026	0.039
1987	0.010	0.028	0.041
1988	0.010	0.028	0.042
1989	0.011	0.028	0.041
1990	0.010	0.028	0.041
1991	0.011	0.029	0.042

Source: Environment Agency, "White Paper on the Environment" (1993)

Table 6-2-8 CO2 Emission from Fossil Fuel Consumption in Selected Countries

(100 million tC)

Year	Japan	U.S.	Germany	U.K.	France	Canada	U.S.S.R. (former)	China	OECD	World total
1971	2.2	11.6	2.0	1.8	1.2	1.0	6.1	2.3	23.2	38.3
1973	2.6	12.6	2.2	1.8	1.4	1.0	6.7	2.5	25.5	42.2
1975	2.5	11.9	1.9	1.6	1.2	1.1	7.4	2.9	24.0	42.5
1977	2.6	13.1	2.0	1.7	1.3	1.2	7.9	3.5	26.0	46.5
1979	2.7	13.4	2.2	1.7	1.4	1.2	8.4	3.9	27.0	50.9
1980	2.6	12.9	2.1	1.6	1.3	1.2	8.6	3.9	26.6	49.7
1982	2.4	11.9	1.9	1.5	1.2	1.1	8.8	4.0	24.1	47.9
1983	2.4	11.9	1.9	1.5	1.1	1.1	8.8	4.2	24.0	48.7
1984	2.6	12.4	2.0	1.4	1.1	1.1	8.9	4.6	24.7	52.0
1985	2.6	12.5	1.9	1.5	1.1	1.1	9.1	4.9	24.9	51.2
1986	2.6	12.4	2.0	1.6	1.0	1.1	9.3	5.2	25.0	52.2
1987	2.5	12.9	1.9	1.6	1.1	1.2	9.6	5.4	25.6	53.8
1988	2.8	13.4	1.9	1.6	1.0	1.2	9.8	5.7	26.4	55.6
1989	2.9	13.5	1.9	1.5	1.1	1.3	9.7	6.0	26.8	56.4
1990	3.0	13.2	1.9	1.6	1.1	1.2	9.4	5.9	26.7	55.8

Source: OECD, "Energy Balances of OECD Countries 1987/88,89/90"

OECD, "World Energy Statistics and Balances 1971-87,1985-88,89-90"

Table 6-2-9 Primary Energy Supply in Selected Countries

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(unit: Mtoe)

Year	Japan	U.S.	Germany	U.K.	France	Canada	U.S.S.R. (former)	China	OECD
1971	282.37	1630.28	239.69	211.27	159.00	157.98	777.45	241.45	3188.14
1973	331.19	1754.94	265.97	220.58	182.92	179.39	855.92	270.32	3519.75
1975	318.46	1679.43	240.74	201.58	169.87	188.46	950.58	321.39	3377.42
1977	341.27	1836.48	261.38	209.69	180.52	205.17	1029.07	377.40	3659.37
1979	362.38	1896.00	285.95	219.33	198.21	220.59	1108.35	427.85	3849.77
1980	354.95	1826.06	273.99	200.64	198.19	223.27	1140.15	423.54	3733.56
1982	336.96	1706.84	251.82	192.55	187.38	212.55	1184.80	436.54	3521.69
1983	341.29	1711.76	252.15	192.30	190.30	212.15	1199.44	460.10	3538.47
1984	364.00	1781.99	261.85	191.72	195.37	223.90	1237.53	497.85	3678.39
1985	365.25	1791.79	267.92	202.00	201.39	230.69	1281.33	539.89	3739.59
1986	368.80	1792.81	269.85	205.49	203.87	233.16	1314.27	568.40	3769.34
1987	371.11	1859.46	270.86	208.02	209.69	240.25	1357.12	594.57	3880.48
1988	398.76	1928.36	274.11	208.52	208.90	249.50	1405.72	625.13	4002.96
1989	406.69	1945.45	271.60	210.45	218.14	219.71	1368.93	637.33	3988.70
1990	428.20	1905.77	278.17	210.02	220.76	210.33	1341.68	633.15	3984.22

Source: OECD, "Energy Balances of OECD Countries 1987/88,89/90"

OECD, "World Energy Statistics and Balances 1971-87,1985-88,89-90"

Table 6-2-10 Paper Recycling Rate

(unit: 1000 tons, %)

Year	Fiber material for paper manufacture (A)	Recycled pulp/paper (B)	Paper recycling rate (B)/(A) (%)
1980	18,517	7,765	42.0
1981	17,925	8,129	45.4
1982	18,685	8,714	46.7
1983	19,795	9,341	47.2
1984	20,648	9,882	47.9
1985	21,503	10,663	49.6
1986	22,265	11,049	49.6
1987	23,700	11,815	49.8
1988	25,578	12,628	49.4
1989	27,372	13,771	50.3
1990	28,829	14,886	51.6
1991	29,123	15,226	52.3
1992	28,282	14,879	52.6

Source: Prepared by the Paper Recycling Center based on the Ministry of  
International Trade and Industry Monthly Statistics on Paper and Pulp.

Table 6-2-11 Paper Recycling Rate in Selected Countries

Year	Japan	U.S.	China	Germany	U.K.	France
	Paper recycling rate (%)					
1960	-	-	-	27	28	27
1965	37	-	-	27	29	27
1970	39	-	-	30	29	28
1975	39	15	-	34	28	32
1980	47	26	-	35	34	30
1984	49	27	-	38	29	28
1986	50	28	18	42	30	33
1987	50	28	19	42	30	34
1988	48	30	22	41	30	33
	Paper consumption (1000 tons)					
1988	24,940	77,057	13,200	12,346	9,286	7,934

Note: U.S.A. rate for 1980 is the 1978-80 average; U.K. rate for 1975 is the 1974 rate.  
Source: UNEP, "Environmental Data Report 1991/92"

Table 6-2-12 Cullet Use Rate

Year	Bottle production (1000 tons) (A)	Cullet use (1000 tons) (B)	Cullet use rate (%) (B)/(A)
1983	2,305	952	41.3
1984	2,413	1,023	42.4
1985	2,251	1,062	47.2
1986	2,149	1,186	55.2
1987	2,202	1,197	54.4
1988	2,310	1,136	49.2
1989	2,429	1,155	47.6
1990	2,610	1,251	48.0
1991	2,445	1,266	51.8
1992	2,370	1,332	56.2

Source: Prepared by the Glass Bottle Association from Ministry of International Trade and Industry, "Miscellaneous Statistics"

Table 6-2-13 Steel Can Recycling Rate

Year	Generation of waste cans (1000 tons) (A)	Recycled cans (1000 tons) (B)	Recycling rate (%) (B)/(A)
1985	1,118	409	36.6
1986	1,127	428	38.0
1987	1,207	460	38.1
1988	1,250	509	40.7
1989	1,333	581	43.6
1990	1,459	654	44.8
1991	1,438	721	50.1
1992	1,400	795	56.8

Source: Data from Empty Can Treatment Association

Table 6-2-14 Aluminum Can Recycling Rate

Year	Total consumption (1000 tons) (A)	Recycled cans (1000 tons) (B)	Recycling rate (%) (B)/(A)
1982	40.6	16.0	39.4
1983	45.4	18.3	40.2
1984	53.6	21.8	40.6
1985	60.5	24.5	40.6
1986	70.0	28.8	41.2
1987	109.6	45.5	41.5
1988	149.0	62.2	41.7
1989	147.6	62.8	42.5
1990	161.2	68.6	42.6
1991	180.3	77.7	43.1
1992	197.8	106.5	53.8

Source: Data from Aluminum Can Recycling Association

Table 6-2-15 Aluminum Recycling Rate in Selected Countries

Year	Japan	U.S.	Germany	Italy	France	Canada	U.K.	Netherlands
	Recycling rate (%)							
1972	17	19	27	36	22	11	30	-
1973	14	18	27	37	22	12	27	-
1974	14	20	29	35	22	10	27	-
1975	15	26	30	41	23	13	30	30
1976	16	24	27	37	22	13	30	21
1977	21	25	30	39	24	15	27	26
1978	23	23	33	38	26	20	26	30
1979	21	24	31	35	24	21	29	28
1980	25	27	31	36	23	17	27	31
1981	27	32	33	41	27	16	28	42
1982	25	31	34	35	21	12	24	31
1983	29	29	32	37	23	16	24	38
1984	31	28	32	37	26	16	24	33
1985	31	28	30	36	24	15	23	42
1986	34	28	31	36	23	16	20	45
1987	36	30	31	36	25	14	19	47
1988	35	31	-	36	30	12	15	45
	Consumption (1000 tons)							
1988	3,443	6,758	1,701	1,034	897	691	651	258

Source: UNEP, "Environmental Data Report 1991/92"

Note: The U.S. figure include the consumption of secondary aluminum and direct consumption of scrap by industry.

Table 6-3-1 Approval of New Drugs (New Effective Elements)

Year	Number of newly approved drugs		Breakdown of newly approved drugs	
		Biotechnology applied drugs	Developed in Japan	Developed overseas
1980	33	-	18	15
1981	61	-	24	37
1982	36	-	17	20
1983	33	1	13	20
1984	26	-	9	18
1985	53	2	18	35
1986	33	1	16	17
1987	45	3	22	23
1988	45	3	18	28
1989	29	1	10	19
1990	33	2	12	23
1991	36	8	21	15
1992	31	2	16	15
Total	494	23	214	285

Note 1: Some elements were developed simultaneously in Japan and overseas (included in both "Developed in Japan" and "Developed overseas") in 1982, 1984, 1988 and 1991.

Note 2: In the original source data, the words "domestic-origin" and "overseas-origin" are used.

Source: Ministry of Health and Welfare

Table 6-3-2 Approval of New Drugs by Classification

Type of drug	1983-87	1988-92	1983-92 Total
1 Drugs for circulatory organs	22	42	64
2 Vitamins/Metabolic drugs	15	22	37
3 Antibiotic	24	13	37
4 Drugs for the central nervous system (excl. 6)	14	19	33
5 Biological drugs	16	13	29
6 Drugs to alleviate fever, pain and inflammation	16	6	22
7 Epidermal drugs	14	7	21
8 Drugs for the respiratory organs	11	5	16
9 Drugs for peptic ulcers	11	5	16
10 Anti-cancer drugs	13	3	16
11 Hormone drugs	8	7	15
12 Chemotherapeutic (excl. 3) drugs	7	7	14
13 X-ray contrast media/other diagnostics	5	5	10
14 Radioactive drugs	3	6	9
15 Others	11	14	25
Total	190	174	364

Note 1: Insecticides and xenodiagnostic drugs are excluded.

Note 2: New elements contained in the same combination drug are counted as one drug (cysteine malate, lysine malate and lysine sulfite in 1988).

Source: Five-year total figures are calculated based on data from Ministry of Health and Welfare.



Table 6-3-3 Spread of Major Medical Devices in General Hospitals

		(%)			
Medical devices	Year	1981	1984	1987	1990
Upper alimentary canal fiberscope		65.9	70.5	73.4	76.1
Image diagnosis ultrasound equipment		57.0	67.2	80.6	85.9
Digital radiography		-	2.0	3.4	5.9
Vascular serial radiographic apparatus		-	20.8	23.6	26.9
Cephalic/cranial CT		10.8	13.3	9.9	5.5
Whole body CT		7.9	17.0	34.4	54.4
RI diagnosis equipment		10.2	11.5	12.0	12.3
MRI (NMR-CT)		-	-	1.3	8.1
Microsurgery equipment		7.7	13.5	14.8	15.5
Laser surgical knife		2.8	6.0	7.2	10.7
Extracorporeal shock wave lithotripsy		-	-	-	3.2
Devices to stop atrial fibrillation		28.8	36.7	40.3	47.9
Hyperthermia equipment		-	-	1.4	2.2
Linear accelerator		2.4	3.3	4.0	4.8
Hemodialyzers (dialysis)		15.7	17.2	19.2	21.9

Note 1: 1981, 1984 and 1987 figures for "Upper alimentary canal fiberscope" are for fiber gastroscope.

Note 2: 1981 figures for "Image diagnosis ultrasound equipment" are for ultrasound diagnosis equipment.

Note 3: 1981 figures for "Microsurgery equipment" are for micro-neurosurgery.

Note 4: 1981 figures are as of the end of December. 1984, 1987 and 1990 figures are as of October 1.

Source: Based on the Medical Facilities Survey implemented by the Ministry of Health and Welfare.

(Number of general hospitals having the equipment divided by total number of general hospitals.)

Table 6-3-4 Number of Categories of Highly Advanced Medical Treatment and Hospitals Providing Such Treatment

Year		1985	1986	1987	1988	1989	1990	1991	1992	1993
Types of highly advanced medical treatment (A-B)		17	21	24	21	23	23	26	30	33
Applied to highly advanced medical treatment (A)		17	24	27	30	32	36	39	49	52
Applied to treatment under health insurance (B)		-	3	3	9	9	13	13	19	19
Hospitals providing highly advanced treatment (C-D)		0	117	151	115	138	104	120	104	114
Applied to highly advanced medical treatment (C)		-	132	166	183	206	221	237	264	274
Applied to treatment under health insurance (D)		-	15	15	68	68	117	117	160	160

Note: Figures show totals as of the end of each year, except 1993 for which the figure is as of the end of May.

Source: End-year totals are calculated from data provided by the Ministry of Health and Welfare.

Table 6-3-5 Trends in the Mortality Rate of Major Adult Diseases

Year	Mortality rate	Cancer	Heart disease	cerebral apoplexy
1955	776.8	87.1	60.9	136.1
1960	756.4	100.4	73.2	160.7
1965	712.7	108.4	77.0	175.8
1970	691.4	116.3	86.7	175.8
1975	631.2	122.6	89.2	156.7
1980	621.4	139.1	106.2	139.5
1981	614.5	142.0	107.5	134.3
1982	603.2	144.2	106.7	125.0
1983	623.0	148.3	111.3	122.8
1984	619.3	152.5	113.9	117.2
1985	625.5	156.1	117.3	112.2
1986	620.6	158.5	117.9	106.9
1987	618.1	164.2	118.4	101.7
1988	649.9	168.4	129.4	105.5
1989	644.0	173.6	128.1	98.5
1990	668.4	177.2	134.8	99.4
1991	674.1	181.7	137.2	96.2

Note: Mortality rate shows the number of deaths per 100,000 persons.

Source: Ministry of Health and Welfare, "Vital Statistics"

Table 6-3-6 Trends in the Five-year Cancer Survival Rate

(%)

Year (1st-5th)		1965-70	1970-75	1975-80	1976-81	1977-82	1978-83	1979-84
Total		40.6	44.4	48.5	49.8	51.8	51.8	52.8
M A L E	All cancers	28.7	33.5	36.7	38.2	40.7	41.5	41.9
	Lung cancer	12.7	14.5	16.7	18.3	21.4	24.2	24.3
	Stomach cancer	32.6	43.3	49.0	51.8	55.6	55.9	54.8
	Liver cancer	2.5	5.8	13.3	10.0	10.5	14.9	11.5
	Colon cancer	29.2	46.0	50.2	61.4	60.6	56.9	50.4
	Esophagus cancer	6.5	10.8	14.4	15.6	13.1	14.1	18.8
F E M A L E	All cancers	51.5	54.0	59.8	61.3	62.4	61.8	63.8
	Breast cancer	65.0	65.5	73.3	76.1	77.7	78.2	78.5
	Stomach cancer	36.9	43.0	49.0	50.2	51.8	51.2	52.4
	Cervical cancer	61.9	65.3	71.0	72.0	73.9	70.0	73.1
	Lung cancer	10.2	15.4	22.6	23.1	25.2	21.7	28.4
	Colon cancer	41.8	47.1	59.9	59.5	58.4	58.1	65.3

Year (1st-5th)		1980-85	1981-86	1982-87	1983-88	1984-89	1985-90	1986-91
Total		51.3	51.9	54.4	54.6	55.1	55.2	54.9
M A L E	All cancers	40.8	41.9	43.5	43.7	44.5	45.5	46.6
	Lung cancer	22.8	23.6	25.3	26.6	23.8	25.3	24.8
	Stomach cancer	55.9	57.3	59.9	60.3	60.4	61.1	62.0
	Liver cancer	14.9	16.7	16.1	19.3	27.9	29.2	26.4
	Colon cancer	52.1	53.8	53.1	47.6	55.3	59.1	65.3
	Esophagus cancer	16.4	17.4	17.5	21.7	24.7	18.8	27.1
F E M A L E	All cancers	62.5	62.7	64.5	64.6	64.8	64.2	62.9
	Breast cancer	77.9	89.8	77.5	79.0	79.0	77.3	78.1
	Stomach cancer	52.0	53.4	58.3	57.1	64.5	66.4	63.3
	Cervical cancer	73.1	70.7	72.5	72.2	74.7	74.4	76.6
	Lung cancer	29.5	30.4	32.9	37.0	37.7	32.1	28.7
	Colon cancer	63.2	67.0	67.7	63.3	55.4	55.0	53.1

Note: Five year survival rate of patients hospitalized initially at Central Hospital of National Cancer Center

Source: Data from National Cancer Center

Table 6-3-7 Trends in the one-year Survival Rate for Ischemic Heart Diseases and Cerebrovascular Diseases

(%)

Year of discharge	Male			Female		
	1977-79	1980-82	1983-85	1977-79	1980-82	1983-85
Acute myocardial infarction	87.6	85.3	91.2	86.5	82.6	79.1
Angina pectoris	93.3	97.9	97.9	91.7	97.2	96.8
Subarachnoid bleeding	81.5	75.6	75.5	73.2	70.3	75.2
Cerebral haemorrhage	70.6	81.2	87.0	63.3	85.6	89.9
Cerebral infarction	95.9	93.3	92.4	85.3	88.9	86.9

Source: Prepared from "Registration and Follow-up Survey of Patients with Cardiovascular Diseases" conducted by National Cardiovascular Center

Table 6-3-8 Trends in Wheelchair Manufacture

Year	Number of powered wheelchairs	Number of manual wheelchairs	Ratio (%)
	A	B	A/(A+B)
1981	3,182	52,353	5.7
1982	3,744	58,656	6.0
1983	3,894	61,006	6.0
1984	4,350	68,150	6.0
1985	4,188	65,612	6.0
1986	5,445	102,684	5.0
1987	5,880	103,691	5.4
1988	6,706	106,848	5.9
1989	6,756	113,237	5.6
1990	8,032	130,321	5.8
1991	8,575	133,436	6.0
1992	9,038	150,269	5.7

Source: Data from Japan Association of Wheelchair Manufacturers

Table 6-3-9 Trends in Nursing Bed Manufacture

Year	Number manufactured
1980	42,124
1981	38,656
1982	55,727
1983	67,239
1984	75,510
1985	94,553
1986	118,744
1987	131,960
1988	158,586
1989	169,777
1990	161,836
1992	156,349

Note: The figure uses the number of beds in the category "special nursing beds" in the source data as the number of nursing beds manufactured.

Source: National Association of Bed Manufacturers data

Table 7-2-1 Aspects of Japan in Which You Feel Pride

Year.month	Response (%)				
	Culture and the arts	Natural beauty	Educational standard	Science and technology	Economic prosperity
1980.12	18.4	25.4	17.3	15.4	15.5
1981.12	19.5	27.0	18.6	14.9	17.8
1982.12	18.4	27.7	19.6	15.3	14.1
1983.12	20.1	30.0	22.1	18.7	17.7
1984.12	20.9	29.4	22.6	19.4	19.1
1985.12	19.5	27.2	22.8	18.2	19.3
1986.12	26.3	33.8	25.0	20.1	18.9
1987.12	25.1	34.6	24.5	20.3	20.5
1988.12	25.1	35.8	25.0	20.1	22.4
1989.12	25.7	36.8	27.0	21.9	25.1
1991.12	29.7	34.6	30.8	21.3	27.3
1992.12	27.2	36.5	29.1	18.1	21.3
1993.12	29.4	39.8	29.8	17.6	17.1

Note: No data are available for 1990.12.

Source: Prime Minister's Office, Public Relations Office, "Public Opinion Poll on Social Awareness"

Table 7-2-2 Aspects of Japan in Which You Feel Pride  
(response rate for "high level of science and technology")

Year.month	Response (%)		
	Male	Female	Total
1980.12	19.9	12.0	15.4
1981.12	19.1	11.6	14.9
1982.12	18.8	12.4	15.3
1983.12	23.1	15.3	18.7
1984.12	23.4	16.3	19.4
1985.12	21.9	15.3	18.2
1986.12	24.0	16.9	20.1
1987.12	23.8	17.4	20.3
1988.12	23.5	17.2	20.1
1989.12	26.8	17.9	21.9
1991.12	25.6	17.4	21.3
1992.12	21.1	15.6	18.1
1993.12	20.8	17.6	15.1

Note: No data are available for 1990.12.

Source: Prime Minister's Office, Public Relations Office, "Public Opinion Poll on Social Awareness"

Table 7-2-3 "Is Japan an Advanced Country in Science and Technology?" (Total)

Year.month	Response (%)				
	Definitely believe so	Believe so to some extent	Do not necessarily believe so	Definitely do not believe so	Do not know
1987.12	33.4	50.9	7.6	0.9	7.3
1988.12	32.7	52.1	7.7	0.8	6.7
1989.12	35.6	49.2	6.3	0.8	8.1
1990.12	35.7	48.2	8.7	1.3	6.3
1991.12	47.7	39.6	6.0	1.2	5.2
1992.12	38.9	46.7	7.8	1.0	5.5
1993.12	38.5	45.9	8.2	1.7	5.7

Source: Prime Minister's Office, Public Relations Office, "Public Opinion Poll on Social Awareness

Table 7-2-4 "Is Japan an Advanced Country in Science and Technology?" (Males aged 20-2

Year.month	Response (%)				
	Definitely believe so	Believe so to some extent	Do not necessarily believe so	Definitely do not believe so	Do not know
1987.12	41.0	45.0	8.1	2.5	3.5
1988.12	35.5	53.4	8.0	1.8	1.3
1989.12	41.6	48.8	6.4	1.2	2.0
1990.12	42.7	46.5	6.7	1.8	2.3
1991.12	52.3	39.2	4.8	2.1	1.6
1992.12	51.2	40.0	6.3	0.9	1.8
1993.12	51.7	37.0	7.5	2.2	1.6

Source: Prime Minister's Office, Public Relations Office, "Public Opinion Poll on Social Awareness"

Table 7-2-5 Percentage of Respondents Who "Have an Interest in News or Topics about Science and Technology"

Year.month	Response (%)		
	Male	Female	Total
1981.12	68.3	39.2	52.6
1987. 3	68.1	38.5	52.4
1990. 1	69.5	45.1	55.9
1991.11	69.5	41.2	54.4

Note: Data for 1991.11 are based on a survey conducted by National Institute of Science and Technology Policy.

Source: National Institute of Science and Technology Policy, "Comparative Survey on Public Opinion Regarding Science and Technology in Japan, U.S.A. and Europe", 1992  
Prime Minister's Secretariat, "Public Opinion Poll on Science & Technology and Society"

Table 7-2-6 Percentage of Respondents Who "Have an Interest in News or Topics about Science and Technology"

Year.month	Age 20-29		Age 30-39		Age 40-49		Age 50-59		Age 60-69	
	Highly	Somewhat	Highly	Somewhat	Highly	Somewhat	Highly	Somewhat	Highly	Somewhat
1981.12	11.2	44.1	7.9	45.0	8.5	46.6	7.7	42.2	12.7	40.9
1987. 3	8.4	41.4	9.6	44.6	9.8	48.9	13.6	42.6	8.0	39.1
1990. 1	6.7	44.1	9.4	46.9	13.0	50.9	10.2	48.6	14.0	41.7
1991.11	5.1	36.2	8.7	45.7	7.6	52.3	15.0	48.1	10.0	43.2

Note: Data for 1991.11 are based on a survey conducted by National Institute of Science and Technology Policy.

Source: National Institute of Science and Technology Policy, "Comparative Survey on Public Opinion Regarding Science and Technology in Japan, U.S.A. and Europe", 1992  
Prime Minister's Secretariat, "Public Opinion Poll on Science & Technology and Society"



Table 7-2-7 Concern and Knowledge about Social Issues

(A) Concern about various social issues

	Response (%)	
	Concerned	Have no
Land issues	74.9	25.1
Agricultural issues	59.0	41.0
International problems and diplomacy	60.4	39.6
Educational issues	69.8	30.2
Issues concerning new scientific	50.1	49.9
Economy and business conditions	75.1	24.9
Issues concerning new	54.3	45.7
Energy	66.0	34.0
Issues concerning new medical	74.5	25.5
Issues concerning space probes	41.7	58.3
Environmental issues	84.0	16.0
Problems of the aged	85.5	14.5
Defence and security	62.4	37.6
Tax issues	82.3	17.7

(B) Knowledge about various social issues

	Response (%)	
	Know about	Do not know about
Land issues	57.6	42.4
Agricultural issues	44.5	55.5
International problems and diplomacy	41.5	58.5
Educational issues	54.3	45.7
Issues concerning new scientific	26.3	73.7
Economy and business conditions	53.5	46.5
Issues concerning new		
inventions/technology	24.9	75.1
Energy	41.7	58.3
Issues concerning new medical	37.6	62.4
Issues concerning space probes	18.7	81.3
Environmental issues	60.8	39.2
Problems of the aged	66.3	33.7
Defence and security	36.9	63.1
Tax issues	56.8	43.2

Source: National Institute of Science and Technology Policy, "Comparative Survey on

Table 7-2-8 Source of Information about Science and Technology

Source of information	Response (%)
Television news	82.0
Books	7.6
Television documentaries	27.8
Technical journals	3.5
Television commercials	14.1
Municipal PR	8.0
Newspaper articles	59.6
Exhibitions and museums	5.6
Newspaper advertisements	12.9
Friends	11.1
Articles in magazines and periodicals	18.0
Family members	11.7
Advertisements in magazines and periodicals	8.0
Others	1.3
No particular source	8.9

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Note: The questionnaire is of multile-response type.

Source: National Institute of Science and Technology Policy,  
"Comparative Survey on Public Opinion Regarding Science and

Table 7-2-9 Source of Information about Science and Technology  
(male/female comparison)

Source of information	Response (%)	
	Male	Female
Books	12.4	3.5
Technical journals	6.5	0.9
Articles in magazines and periodicals	24.6	12.2
Family members	6.0	16.6

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Note: Results with large male-female differences are shown.

Source: National Institute of Science and Technology Policy, "Comparative Survey on  
Public Opinion Regarding Science and Technology in Japan, U.S.A. and Europe", 1992

Table 7-2-10 S&amp;T-related Facilities Visited in the Last Year

Facilities	Response (%)					
	Once		At least twice		Did not visit	
	Respondents who are interested in science	Average	Respondents who are interested in science	Average	Respondents who are interested in science	Average
Museums with science & technology displays	10.3	8.0	4.6	3.5	85.1	88.5
Nature museum	13.4	10.4	4.8	4.3	81.8	85.3
Zoo/Botanical gardens	25.9	25.8	22.3	18.1	51.8	56.1
Exhibitions with S&T-related displays	9.5	7.2	3.8	2.7	86.7	90.1
Public library	6.3	6.1	23.6	20.5	70.1	73.4
Art museum	16.8	15.9	15.9	12.7	67.3	71.4
Aquarium	27.4	24.2	8.3	8.0	64.3	67.8

Source: National Institute of Science and Technology Policy, "Comparative Survey on Public Opinion Regarding Science and Technology in Japan, U.S.A. and Europe", 1992

Table 7-2-11 Understanding of Science and Technology Terms

(A) Understanding of science and technology terms (Overall)

	Response (%)			
	Understand the meaning clearly	Understand the meaning to some	Have heard of the term	Do not know at all
DNA	6.5	11.6	26.6	55.3
Acid rain	23.3	42.8	24.8	9.1
Nuclear fusion	10.5	31.0	34.2	24.4
Immunity	26.1	45.0	18.5	10.4
Data base	7.8	16.6	30.1	45.4
VAN	4.1	8.4	17.4	70.1
IC, LSI	10.2	21.9	25.7	42.2
AI	3.5	8.3	17.9	70.3
Optical fiber	14.8	30.6	38.5	16.1
Hole in the ozone layer	13.6	29.9	31.5	25.0

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(B) Understanding of science and technology terms

(Classified by degree of interest in science during primary and junior high school years)

	Response (%)				
	Extremely interested	Interested	Not very interested	Not at all interested	Do not know
DNA	42.7	22.4	10.7	7.6	5.8
Acid rain	87.5	75.6	57.6	44.3	43.0
Nuclear fusion	70.4	51.3	29.3	22.8	24.5
Immunity	90.1	77.6	65.0	55.7	50.0
Data base	48.7	30.0	15.6	7.6	19.7
VAN	28.3	15.5	7.3	2.5	9.3
IC, LSI	57.9	39.6	22.5	13.9	18.7
AI	28.3	14.4	6.6	2.5	9.3
Optical fiber	78.3	54.9	33.4	21.5	27.9
Hole in the ozone layer	72.3	55.0	30.5	24.0	22.1

Note: Figures showing the understanding of science and technology terms in Table (B) are total for respondents who "understand the meaning clearly" and who "understand the meaning to some degree".

Source: National Institute of Science and Technology Policy, "Comparative Survey on Public Opinion Regarding Science and Technology in Japan, U.S.A. and Europe", 1992

Table 7-2-12 Level of Scientific Knowledge

(A) Overall

		Response (%)		
		Correct	Incorrect	Do not know
Human beings evolved from primitive animal life	(CORRECT)	<u>74.3</u>	9.4	16.3
Continents are moving on the earth's surface	(CORRECT)	<u>60.3</u>	15.4	24.2
Laser beams can be obtained by focusing sound waves	INCORRECT	28.3	<u>21.1</u>	50.6
Antibiotics also kill viruses	INCORRECT	50.9	<u>13.1</u>	36.0
Solar rays cause skin cancer	(CORRECT)	<u>77.4</u>	5.6	17.0
All radiation is man-made	INCORRECT	19.1	<u>52.6</u>	28.3
Electrons are smaller than atoms	(CORRECT)	<u>29.3</u>	19.4	51.3

Note: The value shown by the shaded bar is the percentage of correct answers.

(B) Percentage of correct answers by gender

		Correct response (%)	
		Male	Female
Human beings evolved from primitive animal life	(CORRECT)	78.1	71.0
Continents are moving on the earth's surface	(CORRECT)	64.4	56.8
Laser beams can be obtained by focusing sound waves	INCORRECT	30.6	12.7
Antibiotics also kill viruses	INCORRECT	14.4	12.0
Solar rays cause skin cancer	(CORRECT)	78.1	76.7
All radiation is man-made	INCORRECT	62.4	44.1
Electrons are smaller than atoms	(CORRECT)	38.7	21.1

Note: Ratio of respondents who gave correct answers in the survey on "Understanding of science and technology terms".

Source: National Institute of Science and Technology Policy, "Comparative Survey on Public Opinion Regarding Science and Technology in Japan, U.S.A. and Europe", 1992

Table 7-2-13 Understanding about Acid Rain

(A) Causes of acid rain

	Response (%)		
	Correct	Incorrect	Do not know
Acid dust	36.4	36.9	26.7
NOx and SOx	70.1	9.6	20.3
Carbonic acid gas	40.9	26.3	32.8

Note: Percentage of respondents who indicated that they understand the meaning of acid rain.

(B) Effect of acid rain

	Response (%)		
	Correct	Incorrect	Do not know
Global atmospheric temperature will rise	39.1	39.2	21.6
Human health is adversely affected	54.4	25.1	20.5
Plant and animal life is affected	83.9	3.1	13.0

Note: Percentage of respondents who indicated that they understand the meaning of acid rain.

Source: National Institute of Science and Technology Policy, "Comparative Survey on Public Opinion Regarding Science and Technology in Japan, U.S.A. and Europe", 1992  
National Institute of Science and Technology Policy, "Public Opinion Poll on Science and Technology (Preliminary Poll)", January 1991

Table 7-2-14 Understanding about the Hole in the Ozone Layer

(A) Causes of the ozone hole

		Response (%)		
		Correct	Incorrect	Do not know
Increase of carbonic acid gas	(JAN.)	20.7	53.4	25.9
	(NOV.)	16.1	67.0	16.9
Increase of freon gas	(JAN.)	85.2	2.3	12.5
	(NOV.)	94.2	2.2	3.6
Increase of bismuth gas	(JAN.)	5.8	37.2	56.9
Increase of chlorine gas	(NOV.)	7.1	66.7	26.2

Note: "Increase of bismuth gas" was replaced with "Increase of chlorine gas" in the November survey.

Bismuth gas is a rare earth element used in superconductors, and has no bearing on the ozone hole.

Percentage of respondents who indicated that they understand the meaning of the hole in the ozone layer.

(B) Effects of the ozone hole

		Response (%)		
		Correct	Incorrect	Do not know
Rise in the global atmospheric temperature	(JAN.)	56.7	26.9	16.4
	(NOV.)	60.3	28.9	10.9
Interference with radio communication	(JAN.)	19.9	44.2	35.9
	(NOV.)	14.5	54.7	30.8
Harmful to human health	(JAN.)	78.6	4.5	17.0
	(NOV.)	87.7	5.8	6.5

Note: Percentage of respondents who indicated that they understand the meaning of the hole in the ozone layer.

Source: National Institute of Science and Technology Policy, "Comparative Survey on Public Opinion Regarding Science and Technology in Japan, U.S.A. and Europe", 1992

National Institute of Science and Technology Policy, "Public Opinion Poll on Science and Technology (Preliminary Poll)", January 1991

Table 7-2-15 Views and Attitude Regarding Conservation of the Natural Environment

## (A) Overall

	Response (%)				
	I agree totally	I agree	I disagree	I disagree totally	Do not know
Current conservation standards are inadequate	25.5	51.9	17.8	2.9	1.9
A certain amount of destruction cannot be helped	1.2	27.6	56.6	13.0	1.6
Further destruction must be halted	29.6	54.6	11.9	2.3	1.6
It is unreasonable to expect us to lower human living standards	6.3	37.4	47.6	6.5	2.3

## (B) Age ratio of "I agree totally" and "I agree" responses

	Response (%)					
	Age 20-29	Age 30-39	Age 40-49	Age 50-59	Age 60-69	Age 70 and older
Current conservation standards are inadequate	81.2	75.8	78.7	79.4	76.4	68.9
A certain amount of destruction cannot be helped	24.5	26.5	28.4	31.7	32.7	31.1
Further destruction must be halted	83.7	84.5	81.9	84.7	88.6	81.1
It is unreasonable to expect us to lower human living standards	34.7	35.1	40.1	49.9	60.5	49.0

Source: National Institute of Science and Technology Policy, "Comparative Survey on Public Opinion Regarding Science and Technology in Japan, U.S.A. and Europe", 1992

Table 7-2-16 Views about the Provision of Science and Technology Information

	Response (%)	
	"I agree totally" + "I agree"	"I disagree" + "I disagree totally"
Most people can gain an understanding of science and technology if it is explained clearly	63.2	36.5
There are sufficient opportunities to find out what one wants to know or places which provide information about science and technology	23.0	76.1
It is not important to know about science and technology in our daily lives	24.0	75.7

Source: National Institute of Science and Technology Policy, "Comparative Survey on Public Opinion Regarding Science and Technology in Japan, U.S.A. and Europe", 1992



Table 7-2-17 Attitude towards the Social Impact of Science and Technology

	Response (%)				
	I agree totally	I agree	I disagree	I disagree totally	No response
In most cases more jobs will be created	7.9	35.1	48.4	6.2	2.4
Progress in science and technology makes work more	7.1	36.7	47.8	6.2	2.1
Progress in science and technology makes our lives	11.2	45.6	38.2	3.0	2.0
These days people think little of spiritual aspects	17.3	53.3	25.7	1.8	2.0
Science and technology will solve economic and social	2.1	16.1	66.9	12.5	2.5
Scientists work for the benefit of humankind	11.4	62.1	20.5	3.8	2.2

Source: National Institute of Science and Technology Policy, "Comparative Survey on Public Opinion Regarding Science and Technology in Japan, U.S.A. and Europe", 1992

Table 7-2-18 in Science and Advantages or Disadvantages

	Response (%)				
	More advantages	Advantages and disadvantages are about the same	More disadvantages	Cannot say either way	Do not know
November 1991	41.5	50.7	7.8	-	-
January 1990	52.7	30.5	7.3	-	9.6
March 1987	54.3	28.7	8.3	-	8.7
October 1976	24.6	18.6	29.6	16.3	10.9

Note: Data for November 1991 are based on a survey conducted by National Institute of Science and Technology Policy.

Source: National Institute of Science and Technology Policy, "Comparative Survey on Public Opinion Regarding Science and Technology in Japan, U.S.A. and Europe", 1992  
Prime Minister's Secretariat, "Public Opinion Poll on Science & Technology and Society"

Table 7-3-1      Ownership of Personal Computers  
(comparison of Japan, U.S.A. and France)

	Response (%)	
	Have	Do not have
Japan (1991)	11	89
U.S. (1990)	22	78
France (1989)	16	84

Note: Figures for France include people whose family owns a personal computer.  
Source: Japan - National Institute of Science and Technology Policy, "Comparative Survey on Public Opinion Regarding Science and Technology in Japan,  
U.S. - J.D. Miller, "The Public Understanding of Science and Technology in  
France - Daniel Boy, "Attitudes of the French toward Science", 1990

Table 7-3-2 Japan-U.S. Comparison of Interest in Issues Concerning New Scientific Discoveries

	Response (%)				
	Extremely interested	Somewhat interested	Not very interested	Not interested at all	Do not know
Japan (1991)	13.6	36.5	39.7	10.0	0.1
U.S. (1992)	36.1	49.1		14.6	

Note: The U.S. questionnaire has three choices: "Extremely interested", "Somewhat interested", and "Not interested at all".  
Source: Japan - National Institute of Science and Technology Policy, "Comparative Survey on Public Opinion Regarding Science and Technology in Japan, U.S.A. and Europe", 1992  
U.S. - J.D. Miller and L. Pifer, "The Public Understanding of Science and Technology in the United States, 1992", 1993

Table 7-3-3 Japan-U.S. Comparison of Interest in Issues Concerning New Inventions and Technologies

	Response (%)				
	Extremely interested	Somewhat interested	Not very interested	Not interested at all	Do not know
Japan (1991)	16.6	37.7	35.7	9.8	0.1
U.S. (1992)	36.9	53.2		9.7	

Note: The U.S. questionnaire has three choices: "Extremely interested", "Somewhat interested", and "Not interested at all".  
Source: Japan - National Institute of Science and Technology Policy, "Comparative Survey on Public Opinion Regarding Science and Technology in Japan, U.S.A. and Europe", 1992  
U.S. - J.D. Miller and L. Pifer, "The Public Understanding of Science and Technology in the United States, 1992", 1993

Table 7-3-4 Source of Information about Science and Technology (International Comparison)

	Response (%)			
	Television	Radio	Newspaper	Magazines and books
Japan (1991)	82	-	60	29
China (1990)	84	69	-	59
France (1989)	45	5	14	33

Note: The French survey was single response asking respondents to pick "the most important source of information"; all others were multiple response.

Source: Japan - National Institute of Science and Technology Policy, "Comparative Survey on

China - Z. Zhang and J. Zhang, "A Survey of Public Scientific Literacy in China", 1993

France - Daniel Boy, "Attitudes of the French toward Science", 1990.

Table 7-3-5 International Comparison of the Percentage of People Who Visited a Nature (Historical) Museum in the Past Year

	Response (%)	
	Visited	Did not visit
Japan (1991)		
Total	14.7	85.4
Male	17.0	82.9
Female	12.4	87.5
U.S. (1992)		
Total	30.6	69.3
Canada (1990)		
Total	28.4	71.6
China (1990)		
Total	22.0	78.0

Note: Museum of nature" in Japan, "Museum of natural history" in U.S. and Canada, and "Museum of science or natural history" in China.

Note: The French survey was single response asking respondents to pick "the most important source of information"; all others were multiple response.

Source: Japan - National Institute of Science and Technology Policy, "Comparative Survey on Public Opinion Regarding Science and Technology in Japan, U.S.A. and Europe", 1992

U.S. - J.D. Miller and L. Pifer, "The Public Understanding of Science and Technology in

Canada - E.F. Einsiedel, "Scientific Literacy - A Survey of Adult Canadians"

China - Z. Zhang and J. Zhang, "A Survey of Public Scientific Literacy in China", 1993

Table 7-3-6 Understanding of Science and Technology Terms (International Comparison)

DNA	Response (%)		
	Understand clearly	Understand to some degree	Do not know
Japan (1991)	7	12	82
U.S. (1990)	22	28	51
China (1990)	6	3	91
U.K. (1988)	13	15	72

Acid rain	Response (%)		
	Understand clearly	Understand to some degree	Do not know
Japan (1991)	23.3	42.8	33.9
U.S. (1990)	27.5	42.4	30.1

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Source: Japan - National Institute of Science and Technology Policy, "Comparative Survey on Public Opinion Regarding Science and Technology in Japan, U.S.A.

U.S. - J.D. Miller, "The Public Understanding of Science and Technology in the United States, 1990", 1991

J.D. Miller and L. Pifer, "The Public Understanding of Science and

Canada - E.F. Einsiedel, "Scientific Literacy - A Survey of Adult Canadians"

China - Z. Zhang and J. Zhang, "A Survey of Public Scientific Literacy in

U.K. - Oxford University, Department for External Studies / Social and

Table 7-3-7 International Comparison of the Level of Scientific Knowledge - Correct Response

	Response (%)			
	Japan (1990)	U.S. (1992)	China (1990)	EU (1992)
Continents are moving	82	79	44	82
Human beings evolved from primitive animal	79	45	73	65
The universe was created by a massive explosion	54	38	16	-
Laser beams can be obtained by focusing sound	14	37	18	36
The earth's core is extremely hot	78	81	45	86
Electrons are smaller than atoms	37	46	36	42
Antibiotics also kill viruses	8	35	13	27

Source: Japan - Prime Minister's Secretariat, "Public Opinion Poll on Science & Technology and Society-January 1990", 1990

U.S. - J.D. Miller and L. Pifer, "The Public Understanding of Science and Technology in the United States, 1992", 1993

China - Z. Zhang and J. Zhang, "A Survey of Public Scientific Literacy in China", 1993

EU - Commission of the European Communities, "Europeans, Science and Technology -Public Understanding and Attitudes-", 1993

Table 7-3-8 Attitude towards the Social Impact of Science and Technology  
(International Comparison)

(A) Science makes our lives healthier, safer and more comfortable

	Response (%)			
	I agree	Cannot say either way	Do not know	I disagree
Japan (1991)	54	8	5	32
U.S. (1992)	84		2	14
U.K. (1988)	73	12	1	14
EU (1989)	73	14	4	9

(B) Science and technology makes our lives more hectic

	Response (%)			
	I agree	Cannot say either way	Do not know	I disagree
Japan (1991)	57		2	41
U.S. (1992)	38		3	60
U.K. (1988)	49	16	3	32
EU (1989)	58	16	5	21

(C) We have come to rely on science and forgotten about our spiritual side

	Response (%)			
	I agree	Cannot say either way	Do not know	I disagree
Japan (1991)	71		2	28
U.S. (1992)	48		5	47
U.K. (1988)	44	19	2	34
EU (1989)	46	20	7	27

(D) Computerization increases work

	Response (%)			
	I agree	Cannot say either way	Do not know	I disagree
Japan (1991)	43	8	2	55
U.S. (1992)	39		6	53
U.K. (1988)	34	12	3	50
EU (1989)	24	17	7	52

(E) I can accept animal testing if it is beneficial to human beings

	Response (%)			
	I agree	Cannot say either way	Do not know	I disagree
Japan (1991)	56		2	42
U.S. (1992)	53		5	42
U.K. (1988)	36	9	2	53

Source: Japan - National Institute of Science and Technology Policy, "Comparative Survey on Public opinion Regarding Science and Technology in Japan, U.S.A. and Europe", 1992  
U.S. - J.D. Miller and L. Pifer, "The Public Understanding of Science and Technology in the United States, 1992", 1993  
U.K. - Oxford University, Department for External Studies / Social and Community Planning Research, "Survey of the public understanding of science in Britain", 1988  
EU - J.R.Durant, et.al., "Europeans, Science and Technology", 1991.

Table 7-3-9 Attitude Regarding Scientists (Japan-U.S. Comparison)

- (A) Scientists carry out their research for the sake of their own curiosity  
(Japan-U.S. comparison)

	Response (%)		
	I agree	Do not know	I disagree
Japan (1991)	31	3	66
U.S. (1988)	34	2	64

- (B) Scientists can pose somewhat of a risk to society because of the  
knowledge they possess (international comparison)

	Response (%)		
	I agree	Do not know	I disagree
Japan (1991)	21	2	77
U.S. (1988)	38	3	59
France (1989)	75	4	20

- (C) Scientists aspire to improve people's lives (international comparison)

	Response (%)		
	I agree	Do not know	I disagree
Japan (1991)	62	3	35
U.S. (1988)	80	3	17
France (1989)	83	2	15

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Source: Japan - National Institute of Science and Technology Policy, "Comparative Survey on Public Opinion Regarding Science and Technology in Japan,

U.S. - NSB, "Science and Engineering Indicators -1989"

France - Daniel Boy, "Attitudes of the French toward Science", 1990

Table 7-3-10 Advantages and Disadvantages of Science and Technology  
(International Comparison)

(%)

	More advantages	Advantages and disadvantages are about the same	More disadvantages
Japan			
(1987)	54	29	8
(1991)	42	51	9
U.S.			
(1972)	54	35	4
(1985)	68	4	19
(1992)	73	6	16
France			
(1972)	56	38	5
(1982)	47	44	6
(1989)	41	52	4

Source: Japan - National Institute of Science and Technology Policy, "Comparative Survey

Prime Minister's Office, "Public Relations Office, Public Opinion Poll on Science

U.S. - J.D. Miller and L. Pifer, "The Public Understanding of Science and

France - Daniel Boy, "Attitudes of the French toward Science", 1990

Table 8-1-1 Trends in the Number of Japanese Researchers and Engineers Departing Japan

(persons)

Year	Total	Scientific research/investigation				
		Total	Asia	Europe	North America	Other regions
1972	10,578	2,682	688	804	1,074	116
1973	14,484	5,218	809	2,156	2,018	235
1974	15,937	5,324	991	1,856	2,191	286
1975	16,420	5,594	937	2,185	2,291	181
1976	18,588	6,634	1,021	2,565	2,785	263
1977	17,788	7,069	1,191	2,662	2,917	299
1978	19,356	7,614	1,375	2,763	3,129	347
1979	23,093	9,386	1,839	3,107	4,012	428
1980	23,149	8,870	1,874	3,043	3,546	407
1981	23,690	9,143	1,998	2,884	3,799	462
1982	25,727	10,518	2,388	3,446	4,170	514
1983	29,057	12,322	3,013	3,978	4,630	701
1984	35,251	14,781	4,336	4,387	5,362	696
1985	41,123	17,293	5,364	5,001	6,149	734
1986	55,869	19,425	6,011	5,623	6,830	961
1987	81,407	23,923	7,722	6,864	8,226	1,111
1988	113,632	28,924	9,411	8,079	10,042	1,392
1989	146,488	33,254	10,200	9,535	12,034	1,485
1990	185,888	64,243	20,669	17,853	22,143	3,578
1991	196,743	76,381	22,833	19,159	30,045	4,344

(persons)

Year	Total	Overseas study, training, technology acquisition				
		Total	Asia	Europe	North America	Other regions
1972	7,896	7,896	854	2,593	4,044	405
1973	9,266	9,266	1,726	2,756	4,543	241
1974	10,613	10,613	1,608	3,185	5,243	577
1975	10,826	10,826	780	3,425	6,285	336
1976	11,954	11,954	1,602	3,232	6,714	406
1977	10,719	10,719	943	3,083	6,395	298
1978	11,742	11,742	707	3,347	7,243	445
1979	13,707	13,707	705	3,592	9,059	351
1980	14,279	14,279	746	3,510	9,715	308
1981	14,547	14,547	816	3,538	9,889	304
1982	15,209	15,209	868	3,479	10,559	303
1983	16,735	16,735	1,068	3,770	11,518	379
1984	20,470	20,470	1,522	4,612	13,798	538
1985	23,830	23,830	2,288	5,696	15,180	666
1986	36,444	36,444	5,228	8,714	21,221	1,281
1987	57,484	57,484	10,116	13,684	31,044	2,640
1988	84,708	84,708	15,560	19,106	46,046	3,996
1989	113,234	113,234	20,025	24,752	62,520	5,937
1990	121,645	121,645	18,426	23,769	73,712	5,738
1991	120,362	120,362	15,484	22,680	76,289	5,909

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



Table 8-1-2 Trends in the Number of Foreign Researchers and Engineers Entering Japan  
(persons)

Year	•@ Total	Breakdown by purpose of entry into Japan				
		Overseas study	Training	Teaching activity (Teaching)	Artistic/academic activity (Research)	Provision of advanced technology (Technology)
1972	4,663	3,839	-	216	577	31
1973	5,525	4,492	-	307	696	30
1974	6,386	5,225	-	389	739	33
1975	6,634	5,461	-	422	722	29
1976	7,164	5,842	-	539	764	19
1977	8,099	6,533	-	598	945	23
1978	8,624	6,782	-	735	1,080	27
1979	9,174	7,234	-	870	1,018	52
1980	10,370	8,275	-	946	1,090	59
1981	11,540	9,271	-	1,031	1,190	48
1982	24,270	10,864	10,328	1,211	1,743	124
1983	28,902	12,999	12,612	1,275	1,950	66
1984	34,184	16,335	14,268	1,513	2,027	41
1985	38,801	19,991	14,809	1,582	2,377	42
1986	43,686	23,927	15,550	1,675	2,499	35
1987	53,103	29,684	18,613	2,009	2,739	58
1988	68,304	37,445	25,274	2,317	3,208	60
1989	84,295	45,424	32,512	2,661	3,633	65
1990	104,572	55,935	41,090	3,101	693	3,753
1991	128,623	64,646	48,868	3,812	2,015	9,282

Year	•@ Total	Breakdown by nationality			
		Asia	Europe	North America	Other regions
1972	4,663	3,079	376	1,062	146
1973	5,525	3,392	517	1,417	199
1974	6,386	4,039	590	1,537	220
1975	6,634	4,292	632	1,463	247
1976	7,164	4,584	757	1,548	275
1977	8,099	5,287	803	1,704	305
1978	8,624	5,717	800	1,788	319
1979	9,174	6,223	952	1,652	347
1980	10,370	7,249	972	1,761	388
1981	11,540	8,028	1,015	2,082	415
1982	24,270	17,167	1,849	2,876	2,378
1983	28,902	21,014	2,101	3,147	2,640
1984	34,184	25,219	2,296	3,717	2,952
1985	38,801	29,369	2,487	3,821	3,124
1986	43,686	33,485	2,796	4,348	3,057
1987	53,103	41,621	3,383	4,814	3,285
1988	68,304	55,617	3,807	5,271	3,609
1989	84,295	67,248	4,640	6,255	6,152
1990	104,572	86,163	5,674	7,612	5,123
1991	128,623	108,650	7,156	8,293	4,524

Note: Purposes in parentheses show requirements for entry provided for in 1990 revised law.

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

Table 8-1-3 Breakdown of Japanese Researchers and Engineers Leaving Japan by Purpose and Re  
(persons)

	Scientific research/investigation	Overseas study, technology acquisition	Total
Asia	22,833	15,484	38,317
China	11,990	6,424	18,414
South Korea	3,566	2,847	6,413
Taiwan	1,798	1,532	3,330
Others	5,479	4,681	10,160
Europe	19,159	22,680	41,839
France	2,832	4,056	6,888
Germany	2,525	2,607	5,132
U.K.	6,162	11,065	17,227
Others	7,640	4,952	12,592
Africa	166	94	260
North America	30,045	76,289	106,334
U.S.	26,879	71,279	98,158
Others	3,166	5,010	8,176
South America	373	306	679
Oceania	3,805	5,509	9,314
Others	0	0	0
Total	76,381	120,362	196,743

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

Table 8-1-4 Breakdown of Foreign Researchers and Engineers Entering Japan by Purpose and Region  
(persons)

		Overseas study	Training	Teaching	Research	Technology	Total
Asia		58,425	42,755	812	889	5,769	108,650
	China	16,447	11,343	244	366	1,992	30,322
	South Korea	21,278	6,233	255	230	1,394	29,390
	Taiwan	14,212	1,883	164	55	637	16,951
	Others	6,488	23,296	149	238	1,746	31,987
Europe		2,076	2,109	962	572	1,437	7,156
	France	231	329	144	72	184	960
	Germany	283	332	173	98	85	971
	U.K.	294	258	404	87	372	1,415
	Others	1,268	1,190	241	315	796	3,810
Africa		227	877	9	29	44	1,186
North America		2,916	1,178	1,871	458	1,870	8,293
	U.S.	2,546	473	1,663	412	1,670	6,764
	Others	370	705	208	46	200	1,529
South America		600	1,602	24	19	59	2,304
Oceania		370	334	134	43	101	982
Other regions		32	13	0	5	2	52
Total		64,646	48,868	3,812	2,015	9,282	128,623

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

Table 8-1-5 Trends in the Number of Foreign Researchers Hosted under an Official Program  
(long-term stay)

Fiscal year		1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
	Number (persons)											
Asia		13	15	18	26	28	34	53	60	60	86	125
Western Europe		31	60	62	63	73	81	147	183	217	205	202
Eastern Europe/ former Soviet		6	7	11	12	11	10	14	18	50	77	92
North America		8	18	18	15	20	24	59	100	124	134	105
Others		3	2	2	5	4	3	13	29	31	31	34
Total		62	104	111	122	137	154	287	394	485	533	560
	Share by region											
Asia		21.0	14.4	16.2	21.3	20.4	22.1	18.5	15.2	12.4	16.1	22.3
Western Europe		50.0	57.7	55.9	51.6	53.3	52.6	51.2	46.4	44.7	38.5	36.1
Eastern Europe/ former Soviet		9.7	6.7	9.9	9.8	8.0	6.5	4.9	4.6	10.3	14.4	16.4
North America		12.9	17.3	16.2	12.3	14.6	15.6	20.6	25.4	25.6	25.1	18.8
Others		4.8	1.9	1.8	4.1	2.9	1.9	4.5	7.4	6.4	5.8	6.1
Total		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Note: The figures show the total number of foreign researchers invited by Japan Society for the Promotion of Science and Science and Technology Agency.

Source: Japan Society for the Promotion of Science, "Outline of Programs"  
Science and Technology Agency, "International Science and Technology Handbook"  
Science and Technology Agency, "Foreign S&T Researcher Invitation System"

Table 8-1-6 Trends in the Number of Foreign Researchers Hosted under an Official Program  
(short- and long-term stay)

Fiscal year		1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
	Number (persons)											
Asia		371	470	565	568	696	666	845	853	891	972	1,004
Western Europe		171	215	221	229	250	294	345	372	408	404	392
Eastern Europe/ former Soviet		50	60	69	65	64	78	86	104	128	132	162
North America		118	136	139	140	142	138	180	205	227	234	221
Others		39	13	26	28	29	34	51	61	63	59	66
Total		749	894	1,020	1,030	1,181	1,210	1,507	1,595	1,717	1,801	1,845
	Share by region											
Asia		49.5	52.6	55.4	55.1	58.9	55.0	56.1	53.5	51.9	54.0	54.4
Western Europe		22.8	24.0	21.7	22.2	21.2	24.3	22.9	23.3	23.8	22.4	21.2
Eastern Europe/ former Soviet		6.7	6.7	6.8	6.3	5.4	6.4	5.7	6.5	7.5	7.3	8.8
North America		15.8	15.2	13.6	13.6	12.0	11.4	11.9	12.9	13.2	13.0	12.0
Others		5.2	1.5	2.5	2.7	2.5	2.8	3.4	3.8	3.7	3.3	3.6
Total		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Note: The figures show the total number of foreign researchers invited by Japan Society for the Promotion of Science and Science and Technology Agency.

Source: Japan Society for the Promotion of Science, "Outline of Programs"  
Science and Technology Agency, "International Science and Technology Handbook"  
Science and Technology Agency, "Foreign S&T Researcher Invitation System"

Table 8-1-7 Trends in the Number of Experts Dispatched in the "Science/Culture" Field

(number of dispatched teams)									
	Fiscal year								
	1983	1984	1985	1986	1987	1988	1989	1990	1991
Asia	27	40	47	49	58	70	105	152	114
Middle and Near East	0	15	18	12	22	22	18	11	22
Africa	0	1	4	12	10	11	3	0	3
Central and South America	3	0	0	3	9	15	4	14	38
Oceania									
Europe	0	0	1	0	0	0	0	0	0
International affairs	1/132	0/106	0/105	0/104	1/119	1/119	0/81	1/125	0/118
Total	31	56	70	76	100	119	130	178	177
Total number of experts dispatched	2,615	2,782	2,838	3,046	3,419	3,763	4,005	3,970	4,023

Source: Japan International Cooperation Agency, "JICA Annual Report"

Table 8-1-8 Trends in the Number of Japan Overseas Cooperation Volunteers Dispatched in the "Science/Culture" Field

		(number of dispatched teams)								
	Fiscal year									
	1983	1984	1985	1986	1987	1988	1989	1990	1991	
Asia		27	29	45	53	54	52	67	79	83
Middle and Near East		1	2	1	2	2	3	6	9	13
Africa		14	18	22	28	30	29	38	39	52
Central and South America		38	49	68	78	90	91	107	110	118
Oceania		2	4	7	10	13	17	17	17	22
International affairs		0/2	0/2	0/2	0/3	0/8	2/19	4/33	4/33	4/39
Total		82	102	143	171	189	194	239	258	292
Total number of volunteers dispatched		1,476	1,742	2,104	2,410	2,654	2,612	2,691	2,681	2,769

Source: Japan International Cooperation Agency, "JICA Annual Report"

Table 8-1-9 "Science/Culture" Share of Total Personnel Dispatched Overseas

									(%)
	Fiscal year								
	1983	1984	1985	1986	1987	1988	1989	1990	1991
Experts	1.2	2.0	2.5	2.5	2.9	3.2	3.2	4.5	4.4
Study groups	0.5	0.1	0.6	0.6	0.7	0.7	0.9	1.7	1.0
Japan Overseas Cooperation Volunteers	5.6	5.9	6.8	7.1	7.1	7.4	8.9	9.6	10.5

Source: Japan International Cooperation Agency, "JICA Annual Report"

Table 8-2-1 Japan's Technology Trade (FY 1993, by major industry)

	(100 million yen)	
	Technology exports	Technology imports
Motor vehicles	1,242	87
Industrial chemicals and chemical fibers	222	187
Drugs and medicines	310	346
Iron and steel manufacturing	133	34
Communication and electronics equipment	807	1,347
Other industries	1,290	1,629
All industries	4,004	3,630

Source: Management & Coordination Agency, "Report on the Survey of Research & Development"

Table 8-2-2 Trends in Japan's Technology Trade (all industries)

Fiscal year	Technology trade (100 million yen)	
	Technology exports	Technology imports
1971.00	271.87	1,345.43
1972.00	421.72	1,739.16
1973.00	508.47	1,733.09
1974.00	571.02	1,598.32
1975.00	665.94	1,691.31
1976.00	834.04	1,773.02
1977.00	933.25	1,900.66
1978.00	1,220.49	1,920.58
1979.00	1,331.45	2,409.84
1980.00	1,596.12	2,395.29
1981.00	1,751.06	2,596.32
1982.00	1,849.21	2,826.13
1983.00	2,408.87	2,792.80
1984.00	2,775.12	2,814.47
1985.00	2,342.20	2,931.73
1986.00	2,240.78	2,605.77
1987.00	2,155.75	2,832.45
1988.00	2,462.55	3,121.95
1989.00	3,293.48	3,299.25
1990.00	3,393.52	3,719.07
1991.00	3,705.52	3,946.61
1992.00	3,776.91	4,139.08
1993.00	4,004.00	3,630.00

Source: Management & Coordination Agency, "Report on the Survey of Research & Development"

Table 8-2-3 Trends in Japan's Technology Trade Balance (all industries and major industries)

Fiscal year	(Export/import)						
	Motor vehicles	Communication and electronics equipment	Industrial chemicals and chemical fibers	Drugs and medicines	Iron and steel manufacturing	Other industries	All industries
1971	0.361	0.136	0.291	0.232	0.746	0.154	0.202
1972	0.291	0.283	0.506	0.104	0.844	0.140	0.242
1973	0.156	0.101	0.988	0.201	0.733	0.230	0.293
1974	0.534	0.178	1.088	0.240	1.233	0.202	0.357
1975	0.308	0.239	1.048	0.230	1.969	0.248	0.394
1976	0.631	0.313	1.243	0.351	1.274	0.300	0.470
1977	0.614	0.371	1.208	0.244	1.937	0.341	0.491
1978	0.778	0.339	1.213	0.478	2.378	0.525	0.635
1979	0.864	0.373	1.390	0.609	3.041	0.365	0.553
1980	0.815	0.378	1.524	0.294	2.226	0.582	0.666
1981	1.178	0.427	1.266	0.747	1.655	0.561	0.674
1982	0.961	0.431	0.792	0.510	3.724	0.551	0.654
1983	1.730	0.371	0.982	0.805	2.284	0.837	0.863
1984	2.642	0.539	1.246	0.992	5.824	0.868	0.986
1985	2.282	0.694	1.459	0.999	5.576	0.565	0.799
1986	3.564	0.594	1.022	1.371	3.727	0.603	0.860
1987	5.471	0.531	1.269	1.181	1.247	0.519	0.761
1988	8.260	0.602	1.321	0.893	1.373	0.502	0.789
1989	11.457	0.636	1.267	0.880	4.517	0.651	0.998
1990	11.759	0.553	1.316	1.109	1.452	0.629	0.912
1991	12.396	0.567	0.989	0.977	1.767	0.679	0.939
1992	6.596	0.334	1.057	0.812	2.539	0.792	0.912
1993	14.276	0.599	1.187	0.896	3.911	0.792	1.103

Source: Management &amp; Coordination Agency, "Report on the Survey of Research &amp; Development"

Table 8-2-4 Trends in Technology Exports by Major Industries

(100 million yen)

Fiscal year	Motor vehicles	Communication and electronics equipment	Industrial chemicals and chemical	Drugs and medicines	Iron and steel manufacturing	Other industries	All industries
1971	15.64	23.07	58.93	6.59	36.79	130.85	271.87
1972	15.08	50.27	153.37	6.44	43.88	152.68	421.72
1973	20.18	21.13	157.14	8.77	40.51	260.74	508.47
1974	31.18	29.37	198.44	12.50	82.55	216.98	571.02
1975	42.53	41.22	179.43	13.28	119.31	270.17	665.94
1976	47.31	60.37	220.69	18.77	137.54	349.36	834.04
1977	51.69	75.95	189.98	15.33	152.48	447.82	933.25
1978	63.56	76.01	177.45	34.09	174.99	694.39	1,220.49
1979	102.05	105.05	287.72	57.28	176.75	602.60	1,331.45
1980	84.42	150.78	253.77	29.86	178.56	898.73	1,596.12
1981	127.88	186.81	186.76	82.65	245.01	921.95	1,751.06
1982	154.69	256.23	180.69	66.38	290.47	900.75	1,849.21
1983	184.10	238.20	172.57	99.48	401.51	1,313.01	2,408.87
1984	271.89	329.60	190.83	136.98	323.95	1,521.87	2,775.12
1985	259.96	417.17	197.84	130.68	261.95	1,074.60	2,342.20
1986	402.38	361.42	152.56	173.15	215.40	935.87	2,240.78
1987	459.67	398.19	189.08	161.01	99.93	847.87	2,155.75
1988	541.87	477.48	270.50	162.97	107.98	901.75	2,462.55
1989	830.42	585.44	294.51	189.04	215.72	1,178.35	3,293.48
1990	889.01	676.67	276.83	249.71	94.24	1,207.06	3,393.52
1991	995.25	734.89	248.50	284.88	105.27	1,336.73	3,705.52
1992	1,134.09	756.76	235.03	278.48	88.02	1,284.53	3,776.91
1993	1,242.00	807.00	222.00	310.00	133.00	1,290.00	4,004.00

Source: Management &amp; Coordination Agency, "Report on the Survey of Research &amp; Development"



Table 8-2-5 Trends in Technology Imports by Major Industries

(100 million yen)

Fiscal year	Motor vehicles	Communication and electronics equipment	Industrial chemicals and	Drugs and medicines	Iron and steel manufacturing	Other industries	All industries
1971	43.35	170.06	202.70	28.35	49.32	851.65	1,345.43
1972	51.83	177.75	302.87	62.20	51.96	1,092.55	1,739.16
1973	129.59	210.18	159.03	43.57	55.29	1,135.43	1,733.09
1974	58.41	165.27	182.31	52.10	66.96	1,073.27	1,598.32
1975	138.02	172.36	171.28	57.70	60.58	1,091.37	1,691.31
1976	74.98	192.91	177.48	53.53	107.94	1,166.18	1,773.02
1977	84.21	204.59	157.32	62.88	78.72	1,312.94	1,900.66
1978	81.70	224.41	146.24	71.28	73.59	1,323.36	1,920.58
1979	118.13	281.34	206.97	94.04	58.13	1,651.23	2,409.84
1980	103.63	398.99	166.56	101.62	80.23	1,544.26	2,395.29
1981	108.55	437.52	147.54	110.67	148.08	1,643.96	2,596.32
1982	160.94	594.75	228.07	130.09	78.00	1,634.28	2,826.13
1983	106.44	641.86	175.75	123.65	175.81	1,569.29	2,792.80
1984	102.90	612.04	153.21	138.09	55.62	1,752.61	2,814.47
1985	113.91	601.34	135.57	130.85	46.98	1,903.08	2,931.73
1986	112.89	608.42	149.25	126.33	57.80	1,551.08	2,605.77
1987	84.02	749.89	149.05	136.38	80.13	1,632.98	2,832.45
1988	65.60	793.11	204.77	182.49	78.67	1,797.31	3,121.95
1989	72.48	920.36	232.42	214.83	47.76	1,811.40	3,299.25
1990	75.60	1,224.42	210.36	225.14	64.89	1,918.66	3,719.07
1991	80.29	1,295.71	251.32	291.61	59.56	1,968.12	3,946.61
1992	171.94	1,366.58	222.26	343.00	34.67	2,000.63	4,139.08
1993	87.00	1,347.00	187.00	346.00	34.00	1,629.00	3,630.00

Source: Management &amp; Coordination Agency, "Report on the Survey of Research &amp; Development"

Table 8-2-6 Trends in Technology Trade (new contracts) (all industries)

Fiscal year	Technology exports (100 million yen)	Technology imports (100 million yen)	Balance (export/import)
1971	111.09	156.42	0.710
1972	182.06	144.62	1.259
1973	247.18	195.22	1.266
1974	201.01	146.35	1.373
1975	188.76	133.00	1.419
1976	270.30	178.60	1.513
1977	362.84	168.88	2.149
1978	471.10	381.83	1.234
1979	520.79	268.08	1.943
1980	742.63	276.80	2.683
1981	707.63	249.11	2.841
1982	633.36	444.39	1.425
1983	748.95	424.35	1.765
1984	909.06	318.41	2.855
1985	733.11	333.47	2.198
1986	518.49	336.36	1.541
1987	447.91	562.06	0.797
1988	473.62	545.72	0.868
1989	666.49	483.53	1.378
1990	585.84	733.88	0.798
1991	702.82	537.41	1.308
1992	576.89	943.96	0.611
1993	628.00	449.00	1.399

Source: Management & Coordination Agency, "Report on the Survey of Research & Development

Table 8-2-7 Breakdown of Japan's Technology Exports by Region and Major Industry (FY 1992)

Technology exports (100 million yen)

Industry	North America	Europe	Southeast Asia	Other regions
All industries	1,260.79	643.91	1,663.67	208.54
Industrial chemicals and chemical fibers	64.66	63.74	96.91	9.72
Drugs and medicines	185.63	89.64	3.03	0.18
Iron and steel manufacturing	15.43	22.98	35.14	14.47
Communication and electronics equipment	150.02	127.54	459.99	19.21
Motor vehicles	517.14	155.61	395.19	66.15
Other industries	327.91	184.40	673.41	98.81

Source: Management & Coordination Agency, "Report on the Survey of Research & Development"

Table 8-2-8 Trends in Japan's Technology Exports by Region (all industries)

Technology exports							(100 million yen)
Fiscal year	World	Asia	West Asia	North America	South America	Europe	Other regions
1972	322.39	153.31	3.74	48.14	21.84	78.23	13.03
1973	415.31	208.09	3.49	58.92	20.72	103.22	20.87
1974	540.69	192.60	31.82	65.11	47.76	168.02	35.34
1975	665.94	261.27	21.66	142.47	58.45	140.36	41.73
1976	834.04	319.73	32.04	128.98	72.36	217.96	62.98
1977	933.25	298.10	68.86	134.39	79.31	246.79	105.80
1978	1,220.49	384.23	125.83	168.33	94.92	187.03	260.15
1979	1,331.45	548.33	99.36	230.21	75.92	221.97	155.66
1980	1,596.12	542.18	244.13	295.01	108.42	290.46	115.91
1981	1,751.06	679.04	101.57	383.26	117.70	321.49	148.00
1982	1,849.21	707.67	56.97	408.19	108.03	389.63	178.72
1983	2,408.87	1,019.20	173.00	600.34	100.68	370.53	145.13
1984	2,775.12	1,125.16	307.83	719.15	36.54	407.07	179.36
1985	2,342.20	875.23	141.13	587.40	87.40	454.61	196.44
1986	2,240.78	864.81	104.85	622.88	51.61	435.98	160.65
1987	2,155.75	864.35	15.88	725.02	44.60	402.61	103.29
1988	2,462.55	1,014.12	22.77	769.76	44.43	492.62	118.84
1989	3,293.48	1,288.62	23.60	1,151.36	45.80	650.67	133.43
1990	3,393.52	1,533.17	19.59	1,081.20	29.49	614.66	115.40
1991	3,705.52	1,705.46	36.69	1,171.47	30.65	670.91	90.35
1992	3,776.91	1,663.67	15.81	1,260.79	42.69	643.91	150.04
1993	4,004.00	1,864.00	18.00	1,288.00	38.00	677.00	119.00

Export share							(%)
Fiscal year	World	Asia	West Asia	North America	South America	Europe	Other regions
1972	100.00	47.55	1.16	14.93	6.77	24.27	4.04
1973	100.00	50.10	0.84	14.19	4.99	24.85	5.03
1974	100.00	35.62	5.89	12.04	8.83	31.08	6.54
1975	100.00	39.23	3.25	21.39	8.78	21.08	6.27
1976	100.00	38.34	3.84	15.46	8.68	26.13	7.55
1977	100.00	31.94	7.38	14.40	8.50	26.44	11.34
1978	100.00	31.48	10.31	13.79	7.78	15.32	21.32
1979	100.00	41.18	7.46	17.29	5.70	16.67	11.69
1980	100.00	33.97	15.30	18.48	6.79	18.20	7.26
1981	100.00	38.78	5.80	21.89	6.72	18.36	8.45
1982	100.00	38.27	3.08	22.07	5.84	21.07	9.66
1983	100.00	42.31	7.18	24.92	4.18	15.38	6.02
1984	100.00	40.54	11.09	25.91	1.32	14.67	6.46
1985	100.00	37.37	X	25.08	3.73	19.41	8.39
1986	100.00	38.59	4.68	27.80	2.30	19.46	7.17
1987	100.00	40.10	0.74	33.63	2.07	18.68	4.79
1988	100.00	41.18	0.92	31.26	1.80	20.00	4.83
1989	100.00	39.13	0.72	34.96	1.39	19.76	4.05
1990	100.00	45.18	0.58	31.86	0.87	18.11	3.40
1991	100.00	46.02	0.99	31.61	0.83	18.11	2.44
1992	100.00	44.05	0.42	33.38	1.13	17.05	3.97
1993	100.00	46.55	0.45	32.17	0.95	16.91	2.97

Source: Management &amp; Coordination Agency, "Report on the Survey of Research &amp; Development"

Table 8-2-9 Breakdown of Japan's Technology Imports by Region and Major Industry  
(FY 1992)

Technology imports (100 million yen)

Industry	North America	Europe	Southeast Asia	Other regions
All industries	2,938.98	1,187.33	5.54	7.23
Industrial chemicals and chemical fibers	108.86	113.16	x	x
Drugs and medicines	184.55	158.45		x
Iron and steel manufacturing	19.47	15.03		x
Communication and electronics equipment	1,112.38	253.79	0.28	0.41
Motor vehicles	115.01	55.10		1.83
Other industries	1,398.71	591.80	5.26	4.99

Note: Technology imports from Southeast Asia is included in those from other regions.

Source: Management & Coordination Agency, "Report on the Survey of Research & Development"

Table 8-2-10 Trends in Japan's Technology Imports by Region (all industries)

Technology imports

(100 million yen)

Fiscal year	World	Asia	West Asia	North America	South America	Europe	Other regions
1972	1,683.69			1,270.86		406.81	3.07
1973	1,685.51			1,060.24		605.29	19.99
1974	1,558.84			1,030.16		503.47	5.21
1975	1,691.31			1,075.11		599.26	16.93
1976	1,773.02			1,175.48		594.30	3.24
1977	1,900.66			1,210.87		679.98	9.82
1978	1,920.58			1,252.43		664.32	3.84
1979	2,409.84			1,560.73		809.63	39.48
1980	2,395.29			1,568.62		821.27	5.40
1981	2,596.32			1,739.01		844.25	13.06
1982	2,826.13			1,885.61		926.62	13.90
1983	2,792.80			1,940.00		844.99	7.81
1984	2,814.47			1,939.89		866.98	7.60
1985	2,931.73		x	2,102.79		815.67	13.27
1986	2,605.77		2.00	1,745.51		851.37	8.88
1987	2,832.45		x	1,792.51		1,034.17	5.78
1988	3,121.95		-	1,981.27		1,136.02	4.65
1989	3,299.25		0.63	2,107.41		1,181.63	10.20
1990	3,719.07		0.97	2,578.71		1,127.62	12.73
1991	3,946.61		0.38	2,751.68		1,186.13	8.79
1992	4,139.08	5.54	0.00	2,938.98	0.00	1,187.33	7.23
1993	3,630.00	12.00	x	2,591.00	x	1,024.00	15.00

Import share

(% )

Fiscal year	World	Asia	West Asia	North America	South America	Europe	Other regions
1972	100.00			75.48		24.16	0.18
1973	100.00			62.90		35.91	1.19
1974	100.00			66.09		32.30	0.33
1975	100.00			63.57		35.43	1.00
1976	100.00			66.30		33.52	0.18
1977	100.00			63.71		35.78	0.52
1978	100.00			65.21		34.59	0.20
1979	100.00			64.76		33.60	1.64
1980	100.00			65.49		34.29	0.23
1981	100.00			66.98		32.52	0.50
1982	100.00			66.72		32.79	0.49
1983	100.00			69.46		30.26	0.28
1984	100.00			68.93		30.80	0.27
1985	100.00		x	71.73		27.82	0.45
1986	100.00		0.08	66.99		32.67	0.34
1987	100.00			63.28		36.51	0.20
1988	100.00			63.46		36.39	0.15
1989	100.00		0.02	63.88		35.82	0.31
1990	100.00		0.03	69.34		30.32	0.34
1991	100.00		0.01	69.72		30.05	0.22
1992	100.00		0.00	71.01		28.69	0.17
1993	100.00		0.33	71.38		28.21	0.41

Source: Management &amp; Coordination Agency, "Report on the Survey of Research &amp; Development"

Table 8-2-11 Trends in Japan's technology trade

## (A) Bank of Japan statistics

Fiscal year	Technology exports		Technology imports		Income/ expenditure ratio (dollar basis)
	Income (mil. dollars)	In yen (100 mil. yen)	Payment (mil. dollars)	In yen (100 mil. yen)	
1971	60	199.7	448	1,624.0	12.3%
1972	74	219.2	572	1,694.5	12.9%
1973	88	240.5	715	1,954.1	12.3%
1974	113	331.8	718	2,108.5	15.7%
1975	161	482.3	712	2,132.8	22.6%
1976	173	504.3	846	2,466.2	20.4%
1977	233	594.2	1,027	2,619.1	22.7%
1978	274	548.4	1,241	2,484.0	22.1%
1979	342	792.4	1,260	2,919.3	27.1%
1980	378	817.3	1,439	3,111.5	26.3%
1981	537	1,229.3	1,711	3,916.8	31.4%
1982	527	1,314.8	1,796	4,480.7	29.3%
1983	624	1,474.6	2,079	4,913.1	30.0%
1984	693	1,692.1	2,317	5,657.4	29.9%
1985	746	1,649.3	2,522	5,575.6	29.6%
1986	1,009	1,612.9	3,375	5,394.9	29.9%
1987	1,385	1,915.6	4,177	5,777.2	33.2%
1988	1,681	2,155.9	5,076	6,510.0	33.1%
1989	2,189	3,127.0	5,455	7,792.5	40.1%
1990	2,582	3,647.3	6,004	8,481.3	43.0%
1991	2,984	3,974.1	6,493	8,647.4	46.0%
1992	3,224	4,023.5	7,128	8,895.7	45.2%

Source: Bank of Japan, International Balance of Payments Statistics

## (B) Management and Coordination Agency statistics

Fiscal year	Technology exports		Technology imports		Income/ expenditure ratio
	Number of transactions	Income (100 million yen)	Number of transactions	Payment (100 million yen)	
1977	2,881	933.3	6,659	1,900.7	49.1%
1978	3,157	1,220.5	6,573	1,920.6	63.5%
1979	3,667	1,331.5	7,012	2,409.8	55.3%
1980	4,103	1,596.1	7,248	2,395.3	66.6%
1981	4,877	1,751.1	7,207	2,596.3	67.4%
1982	4,738	1,849.2	6,936	2,826.1	65.4%
1983	6,403	2,408.9	7,839	2,792.8	86.3%
1984	5,426	2,775.1	7,316	2,814.5	98.6%
1985	5,885	2,342.2	7,679	2,931.7	79.9%
1986	5,469	2,240.8	7,494	2,605.8	86.0%
1987	5,955	2,155.8	7,373	2,832.5	76.1%
1988	6,352	2,462.6	8,356	3,122.0	78.9%
1989	7,559	3,293.5	7,109	3,299.3	99.8%
1990	7,163	3,393.5	8,249	3,719.1	91.2%
1991	8,063	3,705.5	7,409	3,946.6	93.9%
1992	8,201	3,776.9	8,126	4,139.1	91.2%

Source: Management and Coordination Agency, Report on the Survey of Research &amp; Development

Table 8-2-12 Procedure for Correction and Equation for Calculation for Technology Trade Statistics

<Management & Coordination Agency statistics>

- (1) Technology imports in the fields of wholesale, retailing, restaurant management, financing/insurance, real estate, and services.

The ratio of the number of cases of new technology introduction in the above industrial fields to that in all industrial fields, namely 38.0%, is used in the calculations.

The calculations are also based on the amount of technology imports in the industrial fields covered by the Management and Coordination Agency statistics, namely 413.9 billion yen..

$$\text{Equation: } (413.9 \text{ bil. yen}) / (0.62) \times (0.38) = 253.7 \text{ bil. yen}$$

<Bank of Japan statistics>

- (2) Payment for know-how on plant export and instruction in industrial technology

The calculations are based on the assumption that the field of "engineering" accounts for 2.3% of the total contracted amount for plant export.

The plant export statistics are based on the number of contracts, and payments are made about three years later. Thus the 1992 calculations use the amount of technology export three years before, namely 1989,

$$\text{Equation: } (1,810.5 \text{ bil. yen}) \times 0.023 = 41.6 \text{ bil. yen}$$

- (3) Payment for transfer or use of trademark right

The calculations use the average payment per contract (43 million yen/contract) and the number of trademark contracts made (2,750).

$$\text{Equation: } 43 \text{ mil. yen} \times 2,750 = 118.3 \text{ bil. yen}$$

Table 8-2-13 Adjusted Value of Technology Trade

## (A) Trends in technology trade - Bank of Japan statistics

Fiscal year	Technology exports		Technology imports		Income/expenditure ratio	
	Before adjustment (100 mil. yen)	After adjustment (100 mil. yen)	Before adjustment (100 mil. yen)	After adjustment (100 mil. yen)	Before adjustment	After adjustment
1975	482	584	2,133	1,818	0.23	0.32
1976	504	642	2,466	2,081	0.20	0.31
1977	594	855	2,619	2,225	0.23	0.38
1978	548	910	2,484	2,130	0.22	0.43
1979	792	1,329	2,919	2,387	0.27	0.56
1980	817	1,322	3,112	2,600	0.26	0.51
1981	1,229	1,631	3,917	3,243	0.31	0.50
1982	1,315	2,001	4,481	3,852	0.29	0.52
1983	1,475	2,061	4,913	4,081	0.30	0.51
1984	1,692	2,611	5,657	4,678	0.30	0.56
1985	1,649	2,422	5,576	4,691	0.30	0.52
1986	1,613	2,065	5,395	4,520	0.30	0.46
1987	1,916	2,317	5,777	4,753	0.33	0.49
1988	2,156	2,646	6,510	5,445	0.33	0.49
1989	3,127	3,402	7,793	6,835	0.40	0.50
1990	3,647	3,932	8,481	7,537	0.43	0.52
1991	3,974	4,207	8,647	7,564	0.46	0.56
1992	4,023	4,440	8,895	7,713	0.45	0.58

## (B) Trends in technology trade - Management &amp; Coordination Agency statistics

Fiscal year	Technology exports		Technology imports		Income/expenditure ratio	
	Before adjustment (100 mil. yen)	After adjustment (100 mil. yen)	Before adjustment (100 mil. yen)	After adjustment (100 mil. yen)	Before adjustment	After adjustment
1975	666	666	1,691	2,079	0.39	0.32
1976	834	834	1,773	2,216	0.47	0.38
1977	933	933	1,901	2,302	0.49	0.41
1978	1,221	1,221	1,921	2,397	0.64	0.51
1979	1,332	1,332	2,410	2,984	0.55	0.45
1980	1,596	1,596	2,395	3,027	0.67	0.53
1981	1,751	1,751	2,596	3,283	0.67	0.53
1982	1,849	1,849	2,826	3,578	0.65	0.52
1983	2,409	2,409	2,793	3,710	0.86	0.65
1984	2,775	2,775	2,815	3,769	0.99	0.74
1985	2,342	2,342	2,932	3,908	0.80	0.60
1986	2,241	2,241	2,606	3,562	0.86	0.63
1987	2,156	2,156	2,833	3,968	0.76	0.54
1988	2,463	2,463	3,122	4,464	0.79	0.55
1989	3,294	3,294	3,299	4,857	1.00	0.68
1990	3,394	3,394	3,719	5,669	0.91	0.60
1991	3,706	3,706	3,947	6,091	0.94	0.61
1992	3,777	3,777	4,139	6,676	0.91	0.57

n statistics and Management & Coordination Agency statistics.

(Values of Bank of Japan statistics have been converted in terms of exchange rate.)

"After adjustment" refers to preliminary calculations.



Table 8-2-14 Trends in the Number of Foreign Technology Import Contracts

Fiscal year	Contracts	Fiscal year	Contracts
1950	76	1971	2,007
1951	188	1972	2,403
1952	252	1973	2,450
1953	235	1974	2,093
1954	213	1975	1,836
1955	184	1976	1,893
1956	310	1977	1,914
1957	254	1978	2,139
1958	242	1979	2,116
1959	378	1980	2,142
1960	588	1981	2,076
1961	601	1982	2,229
1962	757	1983	2,212
1963	1,137	1984	2,378
1964	1,041	1985	2,436
1965	958	1986	2,361
1966	1,153	1987	2,709
1967	1,295	1988	2,834
1968	1,744	1989	2,898
1969	1,629	1990	3,211
1970	1,768	1991	3,175
		1992	3,224

Source: National Institute of Science and Technology Policy

"Outline of Foreign Technology Imports, 1989"

"Analysis of Trends in Foreign Technology Imports, 1990"

"Analysis of Trends in Foreign Technology Imports, 1991"

"Analysis of Trends in Foreign Technology Imports, 1992"

Table 8-2-15 Breakdown of Foreign Technology Import Contracts by Technological Field

Fiscal year	Number by technological field					Total
	Electric	Machinery	Chemical	Metal	Other fields	
1985	900	457	331	85	663	2,436
1986	934	395	299	66	667	2,361
1987	1,274	386	287	65	697	2,709
1988	1,341	439	313	70	671	2,834
1989	1,604	383	308	60	543	2,898
1990	1,972	367	292	70	510	3,211
1991	1,988	368	274	59	486	3,175
1992	2,132	318	296	47	431	3,224

Fiscal year	Share by technological field (%)					Total
	Electric	Machinery	Chemical	Metal	Other fields	
1985	36.9	18.8	13.6	3.5	27.2	100.0
1986	39.6	16.7	12.7	2.8	28.3	100.0
1987	47.0	14.2	10.6	2.4	25.7	100.0
1988	47.3	15.5	11.0	2.5	23.7	100.0
1989	55.3	13.2	10.6	2.1	18.7	100.0
1990	61.4	11.4	9.1	2.2	15.9	100.0
1991	62.6	11.6	8.6	1.9	15.3	100.0
1992	66.1	9.9	9.2	1.5	13.4	100.0

Source: National Institute of Science and Technology Policy

"Outline of Foreign Technology Imports, 1989"

"Analysis of Trends in Foreign Technology Imports, 1990"

"Analysis of Trends in Foreign Technology Imports, 1991"

"Analysis of Trends in Foreign Technology Imports, 1992"

Table 8-2-16 Number of Software Import Contracts relative to Total Technology Introduction Contracts

Fiscal year	Software import contracts	Other technology introduction contracts	Total technology introduction contracts
1971	39	1,968	2,007
1972	63	2,340	2,403
1973	97	2,353	2,450
1974	127	1,966	2,093
1975	84	1,752	1,836
1976	125	1,768	1,893
1977	83	1,831	1,914
1978	113	2,026	2,139
1979	142	1,974	2,116
1980	156	1,986	2,142
1981	192	1,884	2,076
1982	268	1,961	2,229
1983	409	1,803	2,212
1984	524	1,854	2,378
1985	524	1,912	2,436
1986	597	1,764	2,361
1987	837	1,872	2,709
1988	985	1,849	2,834
1989	1,213	1,685	2,898
1990	1,519	1,692	3,211
1991	1,521	1,654	3,175
1992	1,623	1,601	3,224

Source: National Institute of Science and Technology Policy

Table 9-1-1 Prefectural Population (1992)

Prefecture	Population (persons)	Prefecture	Population (persons)
Hokkaido	5,658,837	Shiga	1,246,267
Aomori	1,471,881	Kyoto	2,606,361
Iwate	1,414,357	Osaka	8,735,141
Miyagi	2,277,429	Hyogo	5,465,580
Akita	1,219,335	Nara	1,401,113
Yamagata	1,254,925	Wakayama	1,077,811
Fukushima	2,115,064	Tottori	614,866
Ibaraki	2,895,200	Shimane	774,891
Tochigi	1,956,871	Okayama	1,932,072
Gumma	1,982,554	Hiroshima	2,866,736
Saitama	6,561,173	Yamaguchi	1,565,303
Chiba	5,672,787	Tokushima	829,591
Tokyo	11,874,161	Kagawa	1,024,272
Kanagawa	8,104,230	Ehime	1,510,735
Niigata	2,475,239	Kochi	817,406
Toyama	1,120,131	Fukuoka	4,852,386
Ishikawa	1,169,016	Saga	877,894
Fukui	824,134	Nagasaki	1,552,111
Yamanashi	861,761	Kumamoto	1,844,623
Nagano	2,165,460	Oita	1,233,319
Gifu	2,079,594	Miyazaki	1,166,891
Shizuoka	3,701,395	Kagoshima	1,786,944
Aichi	6,765,550	Okinawa	1,237,657
Mie	1,810,884	Total	124,451,938

Source: Management & Coordination Agency, "Estimated Population as of October 1, 1992"

Table 9-1-2 Prefectural Population Trends

Prefecture	Population (x 1000)		Rate of population increase (%) (1980-1990)
	1980	1990	
Hokkaido	5,576	5,644	1.21
Aomori	1,524	1,483	-2.69
Iwate	1,422	1,417	-0.35
Miyagi	2,082	2,249	7.98
Akita	1,257	1,227	-2.33
Yamagata	1,252	1,258	0.52
Fukushima	2,035	2,104	3.38
Ibaraki	2,558	2,845	11.23
Tochigi	1,792	1,935	7.98
Gumma	1,849	1,966	6.37
Saitama	5,420	6,405	18.17
Chiba	4,735	5,555	17.32
Tokyo	11,618	11,856	2.04
Kanagawa	6,924	7,980	15.25
Niigata	2,451	2,475	0.95
Toyama	1,103	1,120	1.51
Ishikawa	1,119	1,165	4.05
Fukui	794	824	3.68
Yamanashi	804	853	6.06
Nagano	2,084	2,157	3.49
Gifu	1,960	2,067	5.43
Shizuoka	3,447	3,671	6.50
Aichi	6,222	6,691	7.54
Mie	1,687	1,793	6.26
Shiga	1,080	1,222	13.20
Kyoto	2,527	2,602	2.97
Osaka	8,473	8,735	3.08
Hyogo	5,145	5,405	5.06
Nara	1,209	1,375	13.74
Wakayama	1,087	1,074	-1.17
Tottori	604	616	1.90
Shimane	785	781	-0.48
Okayama	1,871	1,926	2.93
Hiroshima	2,739	2,850	4.04
Yamaguchi	1,587	1,573	-0.91
Tokushima	825	832	0.77
Kagawa	1,000	1,023	2.36
Ehime	1,507	1,515	0.56
Kochi	831	825	-0.75
Fukuoka	4,553	4,811	5.66
Saga	866	878	1.42
Nagasaki	1,591	1,563	-1.74
Kumamoto	1,790	1,840	2.79
Oita	1,229	1,237	0.65
Miyazaki	1,152	1,169	1.50
Kagoshima	1,785	1,798	0.74
Okinawa	1,107	1,222	10.47
<b>Total</b>	<b>117,060</b>	<b>123,611</b>	<b>5.60</b>

Source: Management &amp; Coordination Agency, "Population Census of Japan"

Table 9-1-3 Prefectural Youth Population (1990)

Prefecture	Population under 15 years (persons)	Percentage to total population (%)
Hokkaido	1,034,251	18.33
Aomori	289,082	19.49
Iwate	269,810	19.04
Miyagi	439,313	19.54
Akita	219,637	17.89
Yamagata	233,824	18.58
Fukushima	422,064	20.06
Ibaraki	559,033	19.65
Tochigi	380,087	19.64
Gumma	368,080	18.72
Saitama	1,196,946	18.69
Chiba	1,034,308	18.62
Tokyo	1,727,479	14.57
Kanagawa	1,375,769	17.24
Niigata	462,559	18.69
Toyama	195,598	17.46
Ishikawa	215,171	18.48
Fukui	155,998	18.94
Yamanashi	155,849	18.27
Nagano	392,889	18.22
Gifu	387,665	18.76
Shizuoka	694,558	18.92
Aichi	1,236,783	18.49
Mie	330,251	18.42
Shiga	249,258	20.39
Kyoto	448,900	17.25
Osaka	1,503,885	17.22
Hyogo	991,045	18.34
Nara	255,863	18.60
Wakayama	192,839	17.95
Tottori	118,201	19.20
Shimane	143,884	18.42
Okayama	353,191	18.34
Hiroshima	525,256	18.43
Yamaguchi	278,562	17.71
Tokushima	149,770	18.01
Kagawa	184,729	18.05
Ehime	280,919	18.54
Kochi	144,276	17.49
Fukuoka	910,356	18.92
Saga	177,614	20.23
Nagasaki	316,761	20.27
Kumamoto	355,634	19.32
Oita	231,265	18.70
Miyazaki	239,738	20.51
Kagoshima	357,453	19.88
Okinawa	299,836	24.53
<b>Total</b>	<b>22,486,239</b>	<b>18.19</b>

Source: Management &amp; Coordination Agency, "Population Census of Japan"

Table 9-1-4 Number of Primary, Junior and Senior High School Students by Prefecture (1992)

Prefecture	Number of students (persons)				Ratio (%)	Percentage of students to population			
	Primary school	Junior high school	Senior high school	Total		Primary school	Junior high school	Senior high school	Total
Hokkaido	413,189	234,433	239,171	886,793	4.62	7.3	4.1	4.2	15.7
Aomori	117,393	65,409	66,520	249,322	1.30	8.0	4.4	4.5	16.9
Iwate	108,592	60,489	61,856	230,937	1.20	7.7	4.3	4.4	16.3
Miyagi	180,113	97,975	93,730	371,818	1.94	7.9	4.3	4.1	16.3
Akita	88,657	50,446	48,995	188,098	0.98	7.3	4.1	4.0	15.4
Yamagata	93,890	51,984	51,137	197,011	1.03	7.5	4.1	4.1	15.7
Fukushima	171,633	92,543	90,588	354,764	1.85	8.1	4.4	4.3	16.8
Ibaraki	227,930	128,882	128,548	485,360	2.53	7.9	4.5	4.4	16.8
Tochigi	153,469	86,164	94,839	334,472	1.74	7.8	4.4	4.8	17.1
Gumma	146,660	83,516	84,641	314,817	1.64	7.4	4.2	4.3	15.9
Saitama	472,065	266,679	254,470	993,214	5.17	7.2	4.1	3.9	15.1
Chiba	413,603	235,190	228,131	876,924	4.57	7.3	4.1	4.0	15.5
Tokyo	668,450	397,289	471,613	1,537,352	8.01	5.6	3.3	4.0	12.9
Kanagawa	534,954	298,087	306,191	1,139,232	5.93	6.6	3.7	3.8	14.1
Niigata	184,304	104,534	105,100	393,938	2.05	7.4	4.2	4.2	15.9
Toyama	76,731	45,383	50,401	172,515	0.90	6.9	4.1	4.5	15.4
Ishikawa	84,576	49,129	52,299	186,004	0.97	7.2	4.2	4.5	15.9
Fukui	61,858	33,986	34,471	130,315	0.68	7.5	4.1	4.2	15.8
Yamanashi	62,827	34,500	39,019	136,346	0.71	7.3	4.0	4.5	15.8
Nagano	155,146	89,450	93,282	337,878	1.76	7.2	4.1	4.3	15.6
Gifu	154,931	88,409	93,295	336,635	1.75	7.5	4.3	4.5	16.2
Shizuoka	276,873	155,377	158,016	590,266	3.07	7.5	4.2	4.3	15.9
Aichi	483,480	270,392	280,234	1,034,106	5.39	7.1	4.0	4.1	15.3
Mie	133,264	74,039	74,445	281,748	1.47	7.4	4.1	4.1	15.6
Shiga	100,449	55,554	53,779	209,782	1.09	8.1	4.5	4.3	16.8
Kyoto	175,394	101,247	113,352	389,993	2.03	6.7	3.9	4.3	15.0
Osaka	579,298	331,051	364,553	1,274,902	6.64	6.6	3.8	4.2	14.6
Hyogo	397,011	220,837	223,721	841,569	4.38	7.3	4.0	4.1	15.4
Nara	103,382	59,448	56,537	219,367	1.14	7.4	4.2	4.0	15.7
Wakayama	78,270	42,942	45,107	166,319	0.87	7.3	4.0	4.2	15.4
Tottori	48,146	26,079	26,787	101,012	0.53	7.8	4.2	4.4	16.4
Shimane	57,715	32,386	33,352	123,453	0.64	7.4	4.2	4.3	15.9
Okayama	141,487	79,124	89,928	310,539	1.62	7.3	4.1	4.7	16.1
Hiroshima	209,325	116,484	124,225	450,034	2.34	7.3	4.1	4.3	15.7
Yamaguchi	111,580	63,767	67,013	242,360	1.26	7.1	4.1	4.3	15.5
Tokushima	61,230	33,385	34,241	128,856	0.67	7.4	4.0	4.1	15.5
Kagawa	73,845	42,234	44,603	160,682	0.84	7.2	4.1	4.4	15.7
Ehime	112,369	63,530	67,133	243,032	1.27	7.4	4.2	4.4	16.1
Kochi	58,187	32,665	33,180	124,032	0.65	7.1	4.0	4.1	15.2
Fukuoka	370,227	204,689	203,888	778,804	4.06	7.6	4.2	4.2	16.0
Saga	72,528	40,104	39,161	151,793	0.79	8.3	4.6	4.5	17.3
Nagasaki	127,593	70,301	71,109	269,003	1.40	8.2	4.5	4.6	17.3
Kumamoto	146,178	78,312	75,700	300,190	1.56	7.9	4.2	4.1	16.3
Oita	92,322	53,280	56,925	202,527	1.05	7.5	4.3	4.6	16.4
Miyazaki	97,226	54,244	54,425	205,895	1.07	8.3	4.6	4.7	17.6
Kagoshima	147,026	78,910	77,481	303,417	1.58	8.2	4.4	4.3	17.0
Okinawa	121,850	61,982	61,305	245,137	1.28	9.8	5.0	5.0	19.8
Total	8,947,226	5,036,840	5,218,497	19,202,563	100.00	7.2	4.0	4.2	15.4

Source: Ministry of Education, "Fundamental School Research"

Table 9-1-5 Number of Primary, Junior and Senior High School Teachers by Prefecture (1992)

Prefecture	Number of teachers (persons)				Ratio (%)	Percentage of teachers to population			
	Primary school	Junior high school	Senior high school	Total		Primary school	Junior high school	Senior high school	Total
Hokkaido	22,348	14,875	14,107	51,330	5.09	0.39	0.26	0.25	0.91
Aomori	6,821	4,088	3,970	14,879	1.48	0.46	0.28	0.27	1.01
Iwate	6,712	4,017	3,893	14,622	1.45	0.47	0.28	0.28	1.03
Miyagi	8,518	5,481	5,113	19,112	1.90	0.37	0.24	0.22	0.84
Akita	5,088	2,960	3,069	11,117	1.10	0.42	0.24	0.25	0.91
Yamagata	5,325	3,114	3,228	11,667	1.16	0.42	0.25	0.26	0.93
Fukushima	8,974	5,394	5,163	19,531	1.94	0.42	0.26	0.24	0.92
Ibaraki	11,065	6,858	6,895	24,818	2.46	0.38	0.24	0.24	0.86
Tochigi	7,744	4,651	4,673	17,068	1.69	0.40	0.24	0.24	0.87
Gumma	7,146	4,711	4,427	16,284	1.62	0.36	0.24	0.22	0.82
Saitama	19,817	13,556	12,672	46,045	4.57	0.30	0.21	0.19	0.70
Chiba	18,238	11,816	11,627	41,681	4.14	0.32	0.21	0.20	0.73
Tokyo	31,518	20,394	22,774	74,686	7.41	0.27	0.17	0.19	0.63
Kanagawa	22,452	15,056	15,392	52,900	5.25	0.28	0.19	0.19	0.65
Niigata	10,191	6,020	5,963	22,174	2.20	0.41	0.24	0.24	0.90
Toyama	4,071	2,479	3,060	9,610	0.95	0.36	0.22	0.27	0.86
Ishikawa	4,451	2,740	3,089	10,280	1.02	0.38	0.23	0.26	0.88
Fukui	3,436	1,995	2,062	7,493	0.74	0.42	0.24	0.25	0.91
Yamanashi	3,425	2,097	2,313	7,835	0.78	0.40	0.24	0.27	0.91
Nagano	7,694	5,321	5,519	18,534	1.84	0.36	0.25	0.25	0.86
Gifu	7,657	4,999	5,127	17,783	1.76	0.37	0.24	0.25	0.86
Shizuoka	12,305	8,042	8,497	28,844	2.86	0.33	0.22	0.23	0.78
Aichi	21,878	13,957	13,911	49,746	4.94	0.32	0.21	0.21	0.74
Mie	7,455	4,452	4,361	16,268	1.61	0.41	0.25	0.24	0.90
Shiga	4,951	3,158	3,072	11,181	1.11	0.40	0.25	0.25	0.90
Kyoto	8,609	5,686	6,103	20,398	2.02	0.33	0.22	0.23	0.78
Osaka	26,132	18,146	18,983	63,261	6.28	0.30	0.21	0.22	0.72
Hyogo	18,210	11,982	11,783	41,975	4.16	0.33	0.22	0.22	0.77
Nara	5,360	3,544	3,304	12,208	1.21	0.38	0.25	0.24	0.87
Wakayama	4,797	3,038	2,765	10,600	1.05	0.45	0.28	0.26	0.98
Tottori	2,782	1,542	1,630	5,954	0.59	0.45	0.25	0.27	0.97
Shimane	3,843	2,308	2,157	8,308	0.82	0.50	0.30	0.28	1.07
Okayama	7,601	4,533	5,014	17,148	1.70	0.39	0.23	0.26	0.89
Hiroshima	11,042	6,726	7,311	25,079	2.49	0.39	0.23	0.26	0.87
Yamaguchi	5,925	4,026	4,012	13,963	1.39	0.38	0.26	0.26	0.89
Tokushima	3,784	2,231	2,229	8,244	0.82	0.46	0.27	0.27	0.99
Kagawa	3,813	2,458	2,737	9,008	0.89	0.37	0.24	0.27	0.88
Ehime	6,080	3,767	3,779	13,626	1.35	0.40	0.25	0.25	0.90
Kochi	4,078	2,698	2,366	9,142	0.91	0.50	0.33	0.29	1.12
Fukuoka	16,769	10,939	10,087	37,795	3.75	0.35	0.23	0.21	0.78
Saga	3,619	2,381	2,390	8,390	0.83	0.41	0.27	0.27	0.96
Nagasaki	6,782	4,335	4,201	15,318	1.52	0.44	0.28	0.27	0.99
Kumamoto	7,915	4,590	4,302	16,807	1.67	0.43	0.25	0.23	0.91
Oita	5,617	3,423	3,486	12,526	1.24	0.46	0.28	0.28	1.02
Miyazaki	4,818	3,252	3,112	11,182	1.11	0.41	0.28	0.27	0.96
Kagoshima	8,332	5,158	4,858	18,348	1.82	0.47	0.29	0.27	1.03
Okinawa	5,581	3,743	3,823	13,147	1.30	0.45	0.30	0.31	1.06
Total	440,769	282,737	284,409	#####	100.00	0.35	0.23	0.23	0.81

Source: Ministry of Education, "Fundamental School Research"



Table 9-1-6 Number of University etc. Students by Prefecture (1992)

Prefecture	Number of students (persons)				Ratio (%)	Percentage of students to population				
	University	Junior college	College of technology	Total		University	Junior college	College of technology	Other than university	Total
Hokkaido	73,775	23,406	3,718	100,899	3.51	1.30	0.41	0.07	0.48	1.78
Aomori	14,108	3,532	814	18,454	0.64	0.96	0.24	0.06	0.30	1.25
Iwate	11,618	1,923	831	14,372	0.50	0.82	0.14	0.06	0.19	1.02
Miyagi	45,590	5,820	1,650	53,060	1.85	2.00	0.26	0.07	0.33	2.33
Akita	7,060	2,132	828	10,020	0.35	0.58	0.17	0.07	0.24	0.82
Yamagata	8,839	2,675	797	12,311	0.43	0.70	0.21	0.06	0.28	0.98
Fukushima	14,963	4,732	823	20,518	0.71	0.71	0.22	0.04	0.26	0.97
Ibaraki	28,213	6,490	1,005	35,708	1.24	0.97	0.22	0.03	0.26	1.23
Tochigi	14,986	5,842	1,021	21,849	0.76	0.77	0.30	0.05	0.35	1.12
Gumma	14,374	6,863	1,028	22,265	0.78	0.73	0.35	0.05	0.40	1.12
Saitama	93,227	21,455	0	114,682	3.99	1.42	0.33	0.00	0.33	1.75
Chiba	89,890	17,600	960	108,450	3.78	1.58	0.31	0.02	0.33	1.91
Tokyo	606,605	83,637	4,164	694,406	24.17	5.11	0.70	0.04	0.74	5.85
Kanagawa	167,608	23,568	0	191,176	6.66	2.07	0.29	0.00	0.29	2.36
Niigata	17,843	3,918	1,062	22,823	0.79	0.72	0.16	0.04	0.20	0.92
Toyama	10,827	2,261	1,456	14,544	0.51	0.97	0.20	0.13	0.33	1.30
Ishikawa	23,631	5,949	1,819	31,399	1.09	2.02	0.51	0.16	0.66	2.69
Fukui	9,111	2,113	1,024	12,248	0.43	1.11	0.26	0.12	0.38	1.49
Yamanashi	12,505	3,381	0	15,886	0.55	1.45	0.39	0.00	0.39	1.84
Nagano	12,740	6,416	984	20,140	0.70	0.59	0.30	0.05	0.34	0.93
Gifu	19,241	12,263	984	32,488	1.13	0.93	0.59	0.05	0.64	1.56
Shizuoka	21,047	11,092	1,055	33,194	1.16	0.57	0.30	0.03	0.33	0.90
Aichi	138,490	42,441	1,093	182,024	6.34	2.05	0.63	0.02	0.64	2.69
Mie	13,219	4,014	2,720	19,953	0.69	0.73	0.22	0.15	0.37	1.10
Shiga	7,033	3,890	0	10,923	0.38	0.56	0.31	0.00	0.31	0.88
Kyoto	133,235	20,513	785	154,533	5.38	5.11	0.79	0.03	0.82	5.93
Osaka	195,298	53,634	1,025	249,957	8.70	2.24	0.61	0.01	0.63	2.86
Hyogo	95,378	33,688	1,992	131,058	4.56	1.75	0.62	0.04	0.65	2.40
Nara	21,034	8,329	1,022	30,385	1.06	1.50	0.59	0.07	0.67	2.17
Wakayama	5,057	1,153	794	7,004	0.24	0.47	0.11	0.07	0.18	0.65
Tottori	5,466	1,080	1,010	7,556	0.26	0.89	0.18	0.16	0.34	1.23
Shimane	5,543	461	847	6,851	0.24	0.72	0.06	0.11	0.17	0.88
Okayama	30,785	10,415	815	42,015	1.46	1.59	0.54	0.04	0.58	2.17
Hiroshima	46,517	11,603	1,428	59,548	2.07	1.62	0.40	0.05	0.45	2.08
Yamaguchi	17,813	7,069	2,124	27,006	0.94	1.14	0.45	0.14	0.59	1.73
Tokushima	10,265	5,431	807	16,503	0.57	1.24	0.65	0.10	0.75	1.99
Kagawa	9,972	4,572	1,631	16,175	0.56	0.97	0.45	0.16	0.61	1.58
Ehime	16,398	3,871	1,592	21,861	0.76	1.09	0.26	0.11	0.36	1.45
Kochi	6,042	1,287	787	8,116	0.28	0.74	0.16	0.10	0.25	0.99
Fukuoka	118,890	25,223	3,104	147,217	5.12	2.45	0.52	0.06	0.58	3.03
Saga	7,295	2,337	0	9,632	0.34	0.83	0.27	0.00	0.27	1.10
Nagasaki	12,213	6,779	818	19,810	0.69	0.79	0.44	0.05	0.49	1.28
Kumamoto	25,052	5,300	1,661	32,013	1.11	1.36	0.29	0.09	0.38	1.74
Oita	12,837	2,774	806	16,417	0.57	1.04	0.22	0.07	0.29	1.33
Miyazaki	8,410	1,844	825	11,079	0.39	0.72	0.16	0.07	0.23	0.95
Kagoshima	19,921	5,524	1,030	26,475	0.92	1.11	0.31	0.06	0.37	1.48
Okinawa	13,305	4,238	0	17,543	0.61	1.08	0.34	0.00	0.34	1.42
Total	2,293,269	524,538	54,739	#####	100.00	1.84	0.42	0.04	0.47	2.31

Source: Ministry of Education, "Fundamental School Research"

Table 9-1-7 Student Movement among Prefectures When Advancing to University (1992)

Prefecture	Number of students enrolled in university		Enrolled in university in the same prefecture (A)	Outflow of students to other prefectures (B)	Inflow of students from other prefectures (C)	Inflow/outflow (C)/(B)
	By location of university	By location of high school				
Hokkaido	16,752	15,532	10,670	4,862	6,082	1.25
Aomori	3,131	4,260	1,100	3,160	2,031	0.64
Iwate	2,364	4,159	862	3,297	1,502	0.46
Miyagi	10,300	7,324	3,839	3,485	6,461	1.85
Akita	1,509	3,239	725	2,514	784	0.31
Yamagata	2,239	3,828	682	3,146	1,557	0.49
Fukushima	3,695	6,236	1,087	5,149	2,608	0.51
Ibaraki	6,232	10,786	1,577	9,209	4,655	0.51
Tochigi	3,687	8,163	1,214	6,949	2,473	0.36
Gumma	3,509	7,573	963	6,610	2,546	0.39
Saitama	31,414	24,866	6,408	18,458	25,006	1.35
Chiba	24,900	25,060	6,439	18,621	18,461	0.99
Tokyo	120,725	63,758	36,524	27,234	84,201	3.09
Kanagawa	48,196	37,788	13,486	24,302	34,710	1.43
Niigata	3,446	7,681	1,457	6,224	1,989	0.32
Toyama	2,472	5,801	1,051	4,750	1,421	0.30
Ishikawa	5,785	5,983	1,833	4,150	3,952	0.95
Fukui	2,283	3,885	879	3,006	1,404	0.47
Yamanashi	3,645	3,777	610	3,167	3,035	0.96
Nagano	2,575	7,565	442	7,123	2,133	0.30
Gifu	4,726	9,224	1,321	7,903	3,405	0.43
Shizuoka	5,394	15,558	1,878	13,680	3,516	0.26
Aichi	33,300	33,322	18,751	14,571	14,549	1.00
Mie	3,351	7,717	1,231	6,486	2,120	0.33
Shiga	1,683	5,299	282	5,017	1,401	0.28
Kyoto	31,184	13,993	6,469	7,524	24,715	3.28
Osaka	48,487	42,984	20,396	22,588	28,091	1.24
Hyogo	24,117	28,195	9,939	18,256	14,178	0.78
Nara	5,723	7,367	1,067	6,300	4,656	0.74
Wakayama	1,027	4,024	198	3,826	829	0.22
Tottori	1,100	2,221	320	1,901	780	0.41
Shimane	1,205	2,931	372	2,559	833	0.33
Okayama	7,127	9,686	2,585	7,101	4,542	0.64
Hiroshima	11,116	14,041	5,077	8,964	6,039	0.67
Yamaguchi	4,454	6,528	1,039	5,489	3,415	0.62
Tokushima	2,084	3,447	779	2,668	1,305	0.49
Kagawa	2,618	4,950	772	4,178	1,846	0.44
Ehime	3,855	7,397	2,066	5,331	1,789	0.34
Kochi	1,326	2,509	320	2,189	1,006	0.46
Fukuoka	26,232	20,817	12,465	8,352	13,767	1.65
Saga	1,644	3,338	405	2,933	1,239	0.42
Nagasaki	2,724	6,232	1,173	5,059	1,551	0.31
Kumamoto	6,164	6,562	2,786	3,776	3,378	0.89
Oita	2,928	4,971	687	4,284	2,241	0.52
Miyazaki	2,394	4,355	862	3,493	1,532	0.44
Kagoshima	3,893	5,798	1,889	3,909	2,004	0.51
Okinawa	2,889	3,567	2,129	1,438	760	0.53
Others	-	7,307	-	-	-	-
Total	541,604	541,604	189,106	345,191	352,498	1.02

Source: Ministry of Education, "Fundamental School Research"

Table 9-1-8 Working Population by Prefecture (1992)

Prefecture	Working population (1000 persons)			Percentage of working population to total population		
	Total	Mfg. industries	Non-mfg. industries	Total	Mfg. industries	Non-mfg. industries
Hokkaido	2,850	338	2,512	50.4	6.0	44.4
Aomori	750	109	641	51.0	7.4	43.5
Iwate	761	156	605	53.8	11.0	42.8
Miyagi	1,160	209	951	50.9	9.2	41.8
Akita	631	147	484	51.7	12.1	39.7
Yamagata	675	187	488	53.8	14.9	38.9
Fukushima	1,114	296	818	52.7	14.0	38.7
Ibaraki	1,543	427	1,116	53.3	14.7	38.5
Tochigi	1,071	320	751	54.7	16.4	38.4
Gumma	1,088	335	753	54.9	16.9	38.0
Saitama	3,516	911	2,605	53.6	13.9	39.7
Chiba	3,057	610	2,447	53.9	10.8	43.1
Tokyo	6,635	1,313	5,322	55.9	11.1	44.8
Kanagawa	4,354	1,093	3,261	53.7	13.5	40.2
Niigata	1,328	345	983	53.7	13.9	39.7
Toyama	627	186	441	56.0	16.6	39.4
Ishikawa	634	164	470	54.2	14.0	40.2
Fukui	461	136	325	55.9	16.5	39.4
Yamanashi	472	118	354	54.8	13.7	41.1
Nagano	1,232	329	903	56.9	15.2	41.7
Gifu	1,153	397	756	55.4	19.1	36.4
Shizuoka	2,094	648	1,446	56.6	17.5	39.1
Aichi	3,792	1,243	2,549	56.0	18.4	37.7
Mie	983	298	685	54.3	16.5	37.8
Shiga	652	233	419	52.3	18.7	33.6
Kyoto	1,355	352	1,003	52.0	13.5	38.5
Osaka	4,537	1,171	3,366	51.9	13.4	38.5
Hyogo	2,752	733	2,019	50.4	13.4	36.9
Nara	686	175	511	49.0	12.5	36.5
Wakayama	544	116	428	50.5	10.8	39.7
Tottori	332	76	256	54.0	12.4	41.6
Shimane	408	88	320	52.7	11.4	41.3
Okayama	1,024	267	757	53.0	13.8	39.2
Hiroshima	1,504	377	1,127	52.5	13.2	39.3
Yamaguchi	803	163	640	51.3	10.4	40.9
Tokushima	424	90	334	51.1	10.8	40.3
Kagawa	545	118	427	53.2	11.5	41.7
Ehime	759	164	595	50.2	10.9	39.4
Kochi	422	53	369	51.6	6.5	45.1
Fukuoka	2,342	417	1,925	48.3	8.6	39.7
Saga	443	90	353	50.5	10.3	40.2
Nagasaki	726	104	622	46.8	6.7	40.1
Kumamoto	920	152	768	49.9	8.2	41.6
Oita	600	100	500	48.6	8.1	40.5
Miyazaki	596	94	502	51.1	8.1	43.0
Kagoshima	853	126	727	47.7	7.1	40.7
Okinawa	548	36	512	44.3	2.9	41.4
Total	65,756	15,610	50,146	52.8	12.5	40.3

Note: Data are as of October 1, 1992.

Source: Management &amp; Coordination Agency, "Basic Survey on Employment Structure"

Table 9-1-9 Number of Regular Workers and Newly Employed Workers by Prefecture (1992)  
(1000 persons)

Prefecture	Regular workers	Newly employed			Other than newly employed
		Total	New graduates	Other than new graduates	
Hokkaido	1,203.2	286.5	29.1	257.4	916.7
Aomori	417.2	55.8	13.3	42.5	361.4
Iwate	472.2	63.9	8.3	55.6	408.3
Miyagi	830.5	174.3	26.6	147.7	656.2
Akita	566.8	65.9	12.2	53.7	500.9
Yamagata	421.8	57.1	10.2	46.9	364.7
Fukushima	752.9	105.6	19.0	86.6	647.3
Ibaraki	1,094.9	132.7	32.6	100.1	962.2
Tochigi	640.3	111.3	21.7	89.6	529.0
Gumma	721.8	135.4	38.6	96.8	586.4
Saitama	1,069.4	135.5	19.2	116.3	933.9
Chiba	985.5	239.1	24.9	214.2	746.4
Tokyo	5339.3	804.0	225.8	578.2	4,535.3
Kanagawa	1,754.8	256.3	55.7	200.6	1,498.5
Niigata	805.5	129.5	23.5	106.0	676.0
Toyama	520.7	87.6	17.1	70.5	433.1
Ishikawa	389.4	68.4	12.7	55.7	321.0
Fukui	339.5	40.8	4.5	36.3	298.7
Yamanashi	245.9	29.8	10.3	19.5	216.1
Nagano	747.7	113.6	18.3	95.3	634.1
Gifu	856.5	131.0	35.0	96.0	725.5
Shizuoka	1,141.4	180.2	28.6	151.6	961.2
Aichi	2,166.7	284.5	83.9	200.6	1,882.2
Mie	517.2	63.7	12.1	51.6	453.5
Shiga	441.3	52.2	8.4	43.8	389.1
Kyoto	754.3	87.4	20.5	66.9	666.9
Osaka	2,715.0	388.1	94.9	293.2	2,326.9
Hyogo	1,303.5	196.7	47.9	148.8	1,106.8
Nara	251.8	32.4	6.9	25.5	219.4
Wakayama	222.7	42.1	6.9	35.2	180.6
Tottori	259.1	35.1	5.8	29.3	224.0
Shimane	310.6	59.9	5.7	180.6	250.7
Okayama	646.3	116.9	15.8	101.1	529.4
Hiroshima	863.7	116.1	27.1	89.0	747.6
Yamaguchi	557.0	86.1	7.6	78.5	470.9
Tokushima	350.9	67.6	9.4	58.2	283.3
Kagawa	467.9	131.2	25.8	105.4	336.7
Ehime	565.6	95.5	15.5	80.0	470.1
Kochi	268.9	35.4	12.0	23.4	233.5
Fukuoka	1,404.4	217.1	41.8	175.3	1,187.3
Saga	278.7	41.8	7.9	33.9	236.9
Nagasaki	395.4	93.1	6.7	86.4	302.3
Kumamoto	573.0	71.9	12.5	59.4	501.1
Oita	411.7	63.5	11.0	52.5	348.2
Miyazaki	325.4	79.4	15.5	63.9	246.0
Kagoshima	535.6	121.7	17.3	104.4	413.9
Okinawa	355.4	71.3	14.2	57.1	284.1
Total	38,259.2	6,055.0	1,220.3	4,834.7	32,204.2

Note: Number of workers newly employed during January-December 1992.  
Source: Ministry of Labour, "Report on the Survey on Employment Trends"

Table 9-1-10 Movement among Prefectures by Newly Employed Workers: Inflow from and Outflow to Other Prefectures (1992)

(thousand persons)

Prefecture	Newly employed workers	Inflow			Outflow		
			New graduates	Others		New graduates	Others
Hokkaido	286.5	7.7	0.5	7.2	26.0	7.9	18.1
Aomori	55.8	6.7	2.7	4	22.6	3.1	19.5
Iwate	63.9	9.2	2.8	6.4	12.0	5.6	6.4
Miyagi	174.3	21.6	3.2	18.4	18.7	5.6	13.1
Akita	65.9	13.5	1.4	12.1	9.8	2.6	7.2
Yamagata	57.1	5.1	0.8	4.3	16.1	2.9	13.2
Fukushima	105.6	11.5	1.2	10.3	20.1	3.1	17
Ibaraki	132.7	24.3	6.2	18.1	21.6	5.6	16
Tochigi	111.3	22.5	3.3	19.2	15.2	5.1	10.1
Gumma	135.4	21.9	9.2	12.7	5.4	1.6	3.8
Saitama	135.5	33.1	4.6	28.5	117.0	27.1	89.9
Chiba	239.1	91.5	12.8	78.7	70.6	27.6	43
Tokyo	804.0	299.0	109.6	189.4	150.9	34.5	116.4
Kanagawa	256.3	57.6	18.8	38.8	107.2	28.5	78.7
Niigata	129.5	14.4	1.4	13	7.1	2.3	4.8
Toyama	87.6	7.8	2.5	5.3	6.3	3.2	3.1
Ishikawa	68.4	4.7	2.1	2.6	8.1	2.6	5.5
Fukui	40.8	3.9	0.6	3.3	5.9	1.2	4.7
Yamanashi	29.8	4.6	1.8	2.8	5.4	1.1	4.3
Nagano	113.6	23.2	6.4	16.8	7.5	3.5	4
Gifu	131.0	14.8	2.9	11.9	19.0	7.2	11.8
Shizuoka	180.2	26.7	5.5	21.2	14.7	4.7	10
Aichi	284.5	73.7	31.7	42	32.8	8.9	23.9
Mie	63.7	12.7	3.5	9.2	13.4	3.2	10.2
Shiga	52.2	15.5	3.4	12.1	6.8	3.1	3.7
Kyoto	87.4	24.5		18.6	32.1	10.5	21.6
Osaka	388.1	88.6	35.7	52.9	70.8	17.4	53.4
Hyogo	196.7	39.0	13.1	5.9	49.6	12.1	37.5
Nara	32.4	4.8	2.7	2.1	24.2	12.5	11.7
Wakayama	42.1	6.2	0.5	5.7	4.6	2.3	2.3
Tottori	35.1	5.4	2.0	3.4	2.4	1.2	1.2
Shimane	59.9	5.2	1.0	4.2	4.5	1.9	2.6
Okayama	116.9	10.7	1.6	9.1	14.3	5.1	9.2
Hiroshima	116.1	16.8	8.1	8.7	21.6	5.1	16.5
Yamaguchi	86.1	10.1	1.4	8.7	9.2	5.5	3.7
Tokushima	67.6	3.5	0.8	2.7	6.1	2.4	3.7
Kagawa	131.2	23.1	4.0	19.1	6.2	1.7	4.5
Ehime	95.5	7.2	1.0	6.2	11.9	1.5	10.4
Kochi	35.4	2.9	0.5	2.4	3.6	1.3	2.3
Fukuoka	217.1	37.6	8.7	28.9	33.1	13.1	20
Saga	41.8	7.9	1.6	6.3	14.0	6.5	7.5
Nagasaki	93.1	4.5	1.7	2.8	12.0	5.8	6.2
Kumamoto	71.9	9.0	2.3	6.7	17.9	7.2	10.7
Oita	63.5	9.4	0.7	8.7	7.5	2.9	4.6
Miyazaki	79.4	10.2	5.1	5.1	9.1	4.0	5.1
Kagoshima	121.7	13.6	1.6	12	11.5	5.6	5.9
Okinawa	71.3	4.8	0.3	4.5	7.8	2.7	5.1
Total	6,055.0	1,172.2	339.0	833.2	1,114.3	330.0	784.3

Note: Number of workers newly employed during January-December 1992.

Source: Ministry of Labour, "Report on the Survey on Employment Trends"

Table 9-1-11 Government S&T-related Disbursements to Local Governments  
(FY 1992 budget)  
(subsidies etc. to prefectures and municipalities from 1992 government's  
S&T-related disbursements)

(million yen)

Office	To prefectures		To municipalities		Total	
	Subsidies etc. (mil. yen)	Ratio (%)	Subsidies etc. million yen)	Ratio (%)	Subsidies etc. (mil. yen)	Ratio (%)
Ministry of Health and Welfare	20,104	44.5	570	9.2	20,674	40.2
Science and Technology Agency	13,955	30.9	3373	54.3	17,328	33.7
Ministry of Agriculture, Forestry and Fisheries	3,884	8.6	0	0.0	3,884	7.6
Ministry of International Trade and Industry	3,666	8.1	0	0.0	3,666	7.1
Ministry of Education	3,165	7.0	1263	20.3	4,428	8.6
Environment Agency	450	1.0	0	0.0	450	0.9
Total	45,224	100.0	6,207	100.0	51,431	100.0

Item	Amount	
	(mill. yen)	Ratio (%)
Government S&T-related expenditure	2,134,700	100.00%
Subsidies to prefectures	45,200	2.12%
Subsidies to municipalities	6,200	0.29%
Total grants to local governments	51,400	2.41%

Note: "Subsidies etc." include commissions, grants and burden charges in addition to subsidies.

Source: Calculated from 1992 draft budget in S&T-related fields (Science and Technology Agency), List of  
"Subsidies" (Finance Investigation Association) and interview surveys.

Table 9-1-12 S&amp;T-related Expenditure by Prefecture (fiscal 1992)

Prefecture & designated cities	S&T-related expenditure (x 1000 yen)		Population (persons) (1992)(C)	Per capita (yen/person)	
	Total (A)	Ordinary expenditure (B)		(A/C)	(B/C)
Hokkaido	24,084,232	23,974,433	5,658,837	4,256	4,237
Aomori	10,348,194	10,250,141	1,471,881	7,031	6,964
Iwate	11,687,190	5,231,265	1,414,357	8,263	3,699
Miyagi	10,561,957	9,846,568	2,277,429	4,638	4,324
Akita	13,974,108	12,479,153	1,219,335	11,460	10,234
Yamagata	13,146,092	9,414,345	1,254,925	10,476	7,502
Fukushima	33,027,892	8,262,667	2,115,064	15,616	3,907
Ibaraki	13,010,188	9,659,249	2,895,200	4,494	3,336
Tochigi	7,069,726	6,071,990	1,956,871	3,613	3,103
Gumma	5,904,486	5,275,765	1,982,554	2,978	2,661
Saitama	7,973,700	7,451,969	6,561,173	1,215	1,136
Chiba	21,327,102	19,580,346	5,672,787	3,760	3,452
Tokyo	35,412,058	31,179,273	11,874,161	2,982	2,626
Kanagawa	37,221,105	22,445,203	8,104,230	4,593	2,770
Niigata	7,968,045	7,662,707	2,475,239	3,219	3,096
Toyama	8,668,923	4,914,442	1,120,131	7,739	4,387
Ishikawa	7,794,944	6,803,650	1,169,016	6,668	5,820
Fukui	17,411,823	9,896,196	824,134	21,127	12,008
Yamanashi	4,354,704	3,383,199	861,761	5,053	3,926
Nagano	7,678,849	5,920,538	2,165,460	3,546	2,734
Gifu	4,161,107	4,161,107	2,079,594	2,001	2,001
Shizuoka	13,655,820	11,042,298	3,701,395	3,689	2,983
Aichi	14,266,863	13,936,321	6,765,550	2,109	2,060
Mie	7,839,811	7,324,254	1,810,884	4,329	4,045
Shiga	10,285,423	8,668,173	1,246,267	8,253	6,955
Kyoto	17,732,367	4,777,389	2,606,361	6,803	1,833
Osaka	38,950,252	21,813,486	8,735,141	4,459	2,497
Hyogo	20,470,440	14,083,550	5,465,580	3,745	2,577
Nara	9,888,049	2,997,042	1,401,113	7,057	2,139
Wakayama	8,548,543	4,959,764	1,077,811	7,931	4,602
Tottori	3,008,626	3,008,126	614,866	4,893	4,892
Shimane	4,777,948	4,777,948	774,891	6,166	6,166
Okayama	9,747,223	4,995,993	1,932,072	5,045	2,586
Hiroshima	12,798,802	9,289,973	2,866,736	4,465	3,241
Yamaguchi	6,985,216	6,985,216	1,565,303	4,463	4,463
Tokushima	4,826,957	4,493,739	829,591	5,818	5,417
Kagawa	4,535,544	4,272,358	1,024,272	4,428	4,171
Ehime	8,973,034	8,110,460	1,510,735	5,940	5,369
Kochi	3,926,005	3,908,243	817,406	4,803	4,781
Fukuoka	15,954,704	9,582,489	4,852,386	3,288	1,975
Saga	6,361,233	6,361,233	877,894	7,246	7,246
Nagasaki	5,372,657	5,349,741	1,552,111	3,462	3,447
Kumamoto	12,621,542	11,004,847	1,844,623	6,842	5,966
Oita	9,994,317	6,053,295	1,233,319	8,104	4,908
Miyazaki	5,588,687	5,118,137	1,166,891	4,789	4,386
Kagoshima	9,719,847	8,884,475	1,786,944	5,439	4,972
Okinawa	5,446,036	5,438,867	1,237,657	4,400	4,394
Total	575,062,371	421,101,623	124,451,938	4,621	3,384
Sapporo	72,331	72,331	-	-	-
Sendai	1,126,959	1,126,959	-	-	-
Chiba	658	658	-	-	-
Yokohama	10,148,130	1,665,942	-	-	-
Kawasaki	934,850	924,850	-	-	-
Nagoya	1,820,305	1,820,305	-	-	-
Kyoto	1,544,719	1,465,630	-	-	-
Osaka	16,323,005	4,480,423	-	-	-
Kobe	3,673,369	1,314,334	-	-	-
Hiroshima	1,853,061	1,853,061	-	-	-
Kitakyushu	1,388,497	1,388,497	-	-	-
Fukuoka	27,884	27,884	-	-	-
Total	38,913,768	16,140,874	-	-	-
Hokkaido(*)	24,156,563	24,046,764	5,658,837	4,269	4,249
Miyagi(*)	11,688,916	10,973,527	2,277,429	5,133	4,818
Chiba(*)	21,327,760	19,581,004	5,672,787	3,760	3,452
Kanagawa(*)	48,304,085	25,035,995	8,104,230	5,960	3,089
Aichi(*)	16,087,168	15,756,626	6,765,550	2,378	2,329
Kyoto(*)	19,277,086	6,243,019	2,606,361	7,396	2,395
Osaka(*)	55,273,257	26,293,909	8,735,141	6,328	3,010
Hyogo(*)	24,143,809	15,397,884	5,465,580	4,417	2,817
Hiroshima(*)	14,651,863	11,143,034	2,866,736	5,111	3,887
Fukuoka(*)	17,371,085	10,998,870	4,852,386	3,580	2,267
Total	613,976,139	437,242,497	124,451,938	-	-

Note: Includes S&amp;T-related expenditure by designated cities.

Source: National Institute of Science and Technology Policy,

**Research on the Promotion of Regional Science and Technology**

(NISTEP Report No.39), 1995

Table 9-2-1 Number of National Experiment and Research Institutions and R&D Scientists and Engineers by Prefecture (1993)

Prefecture	R&D scientists/ Institutions engineers (persons)	
	Institutions	engineers (persons)
Hokkaido	4	389
Aomori	1	9
Iwate	1	168
Miyagi	2	77
Akita	0	0
Yamagata	0	0
Fukushima	0	0
Ibaraki	31	5,647
Tochigi	1	114
Gumma	1	86
Saitama	2	479
Chiba	2	240
Tokyo	36	5,739
Kanagawa	4	323
Niigata	2	97
Toyama	0	0
Ishikawa	0	0
Fukui	0	0
Yamanashi	0	0
Nagano	0	0
Gifu	0	0
Shizuoka	1	56
Aichi	1	180
Mie	2	220
Shiga	0	0
Kyoto	0	0
Osaka	2	271
Hyogo	0	0
Nara	1	61
Wakayama	0	0
Tottori	0	0
Shimane	0	0
Okayama	0	0
Hiroshima	3	193
Yamaguchi	0	0
Tokushima	0	0
Kagawa	2	102
Ehime	0	0
Kochi	0	0
Fukuoka	0	0
Saga	1	70
Nagasaki	1	40
Kumamoto	2	174
Oita	0	0
Miyazaki	0	0
Kagoshima	0	0
Okinawa	0	0
Total	103	14,735

Source: Science and Technology Agency, "Handbook on Science and Technology"



Table 9-2-2 Number of Public Experiment and Research Institutions and R&D Scientists and Engineers and Research Expenditure by Prefecture (FY 1993(\*))

Prefecture	Institutions (A)	R&D scientists/ engineers (persons) (B)	Expenditure (*) (mil. yen) (C)	Expenditure per institution (mil. yen) (C)/(A)	R&D scientists/ engineers per institution (persons) (B)/(A)	Expenditure per R&D scientist/ engineer (mil. yen) (C)/(B)
Hokkaido	32	1,006	19,538	611	31	19.4
Aomori	16	351	8,845	553	22	25.2
Iwate	11	218	4,044	368	20	18.6
Miyagi	15	236	3,964	264	16	16.8
Akita	13	318	6,233	479	24	19.6
Yamagata	14	263	4,214	301	19	16.0
Fukushima	16	286	5,112	320	18	17.9
Ibaraki	19	239	5,017	264	13	21.0
Tochigi	16	260	4,239	265	16	16.3
Gumma	11	260	4,354	396	24	16.7
Saitama	19	399	5,717	301	21	14.3
Chiba	22	434	10,342	470	20	23.8
Tokyo	21	785	19,071	908	37	24.3
Kanagawa	24	608	11,768	490	25	19.4
Niigata	14	281	5,275	377	20	18.8
Toyama	10	333	5,089	509	33	15.3
Ishikawa	16	247	4,773	298	15	19.3
Fukui	12	297	6,576	548	25	22.1
Yamanashi	11	202	2,925	266	18	14.5
Nagano	18	354	4,944	275	20	14.0
Gifu	23	280	4,398	191	12	15.7
Shizuoka	14	442	8,259	590	32	18.7
Aichi	20	688	13,484	674	34	19.6
Mie	10	252	4,578	458	25	18.2
Shiga	12	193	3,522	294	16	18.2
Kyoto	17	273	4,946	291	16	18.1
Osaka	11	728	10,148	923	66	13.9
Hyogo	13	346	8,279	637	27	23.9
Nara	7	226	7,345	1,049	32	32.5
Wakayama	13	198	5,231	402	15	26.4
Tottori	10	173	3,106	311	17	18.0
Shimane	10	213	4,373	437	21	20.5
Okayama	10	218	3,518	352	22	16.1
Hiroshima	11	317	5,401	491	29	17.0
Yamaguchi	8	198	3,975	497	25	20.1
Tokushima	11	183	3,444	313	17	18.8
Kagawa	10	181	2,900	290	18	16.0
Ehime	15	248	3,711	247	17	15.0
Kochi	14	195	2,951	211	14	15.1
Fukuoka	14	450	8,048	575	32	17.9
Saga	13	194	3,115	240	15	16.1
Nagasaki	8	224	6,131	766	28	27.4
Kumamoto	8	245	5,132	642	31	20.9
Oita	15	240	5,129	342	16	21.4
Miyazaki	8	210	4,208	526	26	20.0
Kagoshima	12	333	7,159	597	28	21.5
Okinawa	9	223	4,100	456	25	18.4
Total	656	15,048	288,631	440	23	19.2

Note: Figures show 1992 expenditures.

Source: Management & Coordination Agency, "Report on the Survey of Research & Development"

Table 9-2-3 Number of Universities by Prefecture (FY 1993)

Prefecture	Total	National universities	Public universities	Private universities
Hokkaido	24	7	2	15
Aomori	6	1	-	5
Iwate	4	1	-	3
Miyagi	10	2	-	8
Akita	2	1	-	1
Yamagata	2	1	-	1
Fukushima	5	1	1	3
Ibaraki	6	3	-	3
Tochigi	6	1	-	5
Gumma	5	1	2	2
Saitama	15	1	-	14
Chiba	21	1	-	20
Tokyo	106	12	2	92
Kanagawa	22	2	1	19
Niigata	7	3	-	4
Toyama	5	2	1	2
Ishikawa	8	2	1	5
Fukui	4	2	1	1
Yamanashi	5	2	1	2
Nagano	3	1	-	2
Gifu	7	1	1	5
Shizuoka	7	2	1	4
Aichi	34	4	3	27
Mie	5	1	-	4
Shiga	2	2	-	-
Kyoto	25	3	3	19
Osaka	35	3	3	29
Hyogo	29	3	3	23
Nara	9	3	2	4
Wakayama	3	1	1	1
Tottori	1	1	-	-
Shimane	2	2	-	-
Okayama	10	1	-	9
Hiroshima	12	1	2	9
Yamaguchi	6	1	2	3
Tokushima	4	2	-	2
Kagawa	3	2	-	1
Ehime	4	1	-	3
Kochi	3	2	1	-
Fukuoka	26	4	4	18
Saga	3	2	-	1
Nagasaki	4	1	1	2
Kumamoto	6	1	1	4
Oita	4	2	-	2
Miyazaki	4	2	-	2
Kagoshima	5	2	-	3
Okinawa	4	1	1	2
Total	523	98	41	384

Source: Ministry of Education, "Fundamental School Research"

Table 9-2-4 Number of University etc. Teachers (FY 1993)

Prefecture	Number of teachers (persons)			Total	Ratio (%)	Number of teachers per 10,000 persons				Total
	University	Junior college	College of technology			University	Junior college	College of technology	Other than university	
Hokkaido	4,989	903	300	6,192	4.01	8.82	1.60	0.53	2.13	10.94
Aomori	851	224	63	1,138	0.74	5.78	1.52	0.43	1.95	7.73
Iwate	1,018	159	62	1,239	0.80	7.20	1.12	0.44	1.56	8.76
Miyagi	3,429	300	123	3,852	2.50	15.06	1.32	0.54	1.86	16.91
Akita	547	166	63	776	0.50	4.49	1.36	0.52	1.88	6.36
Yamagata	792	128	61	981	0.64	6.31	1.02	0.49	1.51	7.82
Fukushima	790	232	62	1,084	0.70	3.74	1.10	0.29	1.39	5.13
Ibaraki	2,304	383	72	2,759	1.79	7.96	1.32	0.25	1.57	9.53
Tochigi	1,893	245	77	2,215	1.44	9.67	1.25	0.39	1.65	11.32
Gumma	874	325	77	1,276	0.83	4.41	1.64	0.39	2.03	6.44
Saitama	2,658	797		3,455	2.24	4.05	1.21	0.00	1.21	5.27
Chiba	2,802	648	70	3,520	2.28	4.94	1.14	0.12	1.27	6.21
Tokyo	38,232	3,046	293	41,571	26.94	32.20	2.57	0.25	2.81	35.01
Kanagawa	3,927	860		4,787	3.10	4.85	1.06	0.00	1.06	5.91
Niigata	1,568	210	74	1,852	1.20	6.33	0.85	0.30	1.15	7.48
Toyama	932	169	115	1,216	0.79	8.32	1.51	1.03	2.54	10.86
Ishikawa	1,864	305	122	2,291	1.48	15.95	2.61	1.04	3.65	19.60
Fukui	761	130	75	966	0.63	9.23	1.58	0.91	2.49	11.72
Yamanashi	768	160		928	0.60	8.91	1.86	0.00	1.86	10.77
Nagano	1,124	334	71	1,529	0.99	5.19	1.54	0.33	1.87	7.06
Gifu	1,277	509	75	1,861	1.21	6.14	2.45	0.36	2.81	8.95
Shizuoka	1,286	381	76	1,743	1.13	3.47	1.03	0.21	1.23	4.71
Aichi	6,943	1,547	74	8,564	5.55	10.26	2.29	0.11	2.40	12.66
Mie	917	221	186	1,324	0.86	5.06	1.22	1.03	2.25	7.31
Shiga	446	196		642	0.42	3.58	1.57	0.00	1.57	5.15
Kyoto	6,243	723	59	7,025	4.55	23.95	2.77	0.23	3.00	26.95
Osaka	9,943	1,623	98	11,664	7.56	11.38	1.86	0.11	1.97	13.35
Hyogo	4,287	1,245	151	5,683	3.68	7.84	2.28	0.28	2.55	10.40
Nara	1,080	266	73	1,419	0.92	7.71	1.90	0.52	2.42	10.13
Wakayama	492	55	63	610	0.40	4.56	0.51	0.58	1.09	5.66
Tottori	622	73	74	769	0.50	10.12	1.19	1.20	2.39	12.51
Shimane	604	46	62	712	0.46	7.79	0.59	0.80	1.39	9.19
Okayama	2,306	633	61	3,000	1.94	11.94	3.28	0.32	3.59	15.53
Hiroshima	2,631	469	114	3,214	2.08	9.18	1.64	0.40	2.03	11.21
Yamaguchi	1,110	371	183	1,664	1.08	7.09	2.37	1.17	3.54	10.63
Tokushima	1,231	261	60	1,552	1.01	14.84	3.15	0.72	3.87	18.71
Kagawa	640	171	120	931	0.60	6.25	1.67	1.17	2.84	9.09
Ehime	988	235	131	1,354	0.88	6.54	1.56	0.87	2.42	8.96
Kochi	652	69	63	784	0.51	7.98	0.84	0.77	1.61	9.59
Fukuoka	6,453	977	223	7,653	4.96	13.30	2.01	0.46	2.47	15.77
Saga	652	127		779	0.50	7.43	1.45	0.00	1.45	8.87
Nagasaki	1,047	346	65	1,458	0.94	6.75	2.23	0.42	2.65	9.39
Kumamoto	1,406	235	132	1,773	1.15	7.62	1.27	0.72	1.99	9.61
Oita	679	163	63	905	0.59	5.51	1.32	0.51	1.83	7.34
Miyazaki	701	85	63	849	0.55	6.01	0.73	0.54	1.27	7.28
Kagoshima	1,325	308	77	1,710	1.11	7.41	1.72	0.43	2.15	9.57
Okinawa	940	111		1,051	0.68	7.59	0.90	0.00	0.90	8.49
Total	129,024	21,170	4,126	154,320	100.00	10.37	1.70	0.33	2.03	12.40

Source: Ministry of Education, "Fundamental School Research"  
Management & Coordination Agency, "Population Estimates"

Table 9-2-5 Number of Postgraduate Students by Prefecture (FY 1993)

Prefecture	Number of postgraduate students (persons)	Number of postgraduate students per 100,000 persons
Hokkaido	3,868	68
Aomori	401	27
Iwate	523	37
Miyagi	3,338	147
Akita	402	33
Yamagata	514	41
Fukushima	303	14
Ibaraki	3,600	124
Tochigi	591	30
Gumma	592	30
Saitama	1,537	23
Chiba	2,930	52
Tokyo	31,477	265
Kanagawa	6,295	78
Niigata	2,380	96
Toyama	464	41
Ishikawa	1,672	143
Fukui	440	53
Yamanashi	393	46
Nagano	1,003	46
Gifu	823	40
Shizuoka	1,166	32
Aichi	6,391	94
Mie	702	39
Shiga	269	22
Kyoto	7,689	295
Osaka	7,776	89
Hyogo	3,696	68
Nara	514	37
Wakayama	81	8
Tottori	541	88
Shimane	319	41
Okayama	1,925	100
Hiroshima	2,496	87
Yamaguchi	765	49
Tokushima	1,040	125
Kagawa	268	26
Ehime	678	45
Kochi	238	29
Fukuoka	5,036	104
Saga	382	44
Nagasaki	625	40
Kumamoto	1,161	63
Oita	359	29
Miyazaki	280	24
Kagoshima	719	40
Okinawa	446	36
Total	109,108	88

Source: Ministry of Education, "Fundamental School Research"

Table 9-2-6 Trends in the Number of Cases of Joint Research between National Universities and Private Companies

Number of cases of joint research with private companies				Ratio (%)		
Fiscal year	Tokyo	Other than Tokyo	Total	Tokyo	Other than Tokyo	Total
1983	13	23	36	36.1	63.9	100.0
1984	32	106	138	23.2	76.8	100.0
1985	42	144	186	22.6	77.4	100.0
1986	43	183	226	19.0	81.0	100.0
1987	60	286	346	17.3	82.7	100.0
1988	69	464	533	12.9	87.1	100.0
1989	70	572	642	10.9	89.1	100.0
1990	89	703	792	11.2	88.8	100.0
1991	111	936	1,047	10.6	89.4	100.0
Total	529	3,417	3,946	13.4	86.6	100.0

Source: Based on Ministry of Education, "The State of Joint Research with the Private Sector etc. in Fiscal 1991"

Table 9-2-7 Number of Research Institutions (Divisions) in Private Companies  
by Prefecture (1993)

Prefecture	Number of research institutions	Number of research institutions per million persons
Hokkaido	30	5.3
Aomori	2	1.4
Iwate	5	3.5
Miyagi	24	10.5
Akita	3	2.5
Yamagata	9	7.2
Fukushima	21	9.9
Ibaraki	132	45.6
Tochigi	55	28.1
Gumma	50	25.2
Saitama	212	32.3
Chiba	151	26.6
Tokyo	814	68.6
Kanagawa	465	57.4
Niigata	34	13.7
Toyama	33	29.5
Ishikawa	21	18.0
Fukui	19	23.1
Yamanashi	14	16.2
Nagano	50	23.1
Gifu	39	18.8
Shizuoka	125	33.8
Aichi	196	29.0
Mie	45	24.8
Shiga	63	50.6
Kyoto	92	35.3
Osaka	480	55.0
Hyogo	200	36.6
Nara	13	9.3
Wakayama	10	9.3
Tottori	5	8.1
Shimane	2	2.6
Okayama	37	19.2
Hiroshima	54	18.8
Yamaguchi	49	31.3
Tokushima	22	26.5
Kagawa	16	15.6
Ehime	14	9.3
Kochi	6	7.3
Fukuoka	66	13.6
Saga	12	13.7
Nagasaki	6	3.9
Kumamoto	6	3.3
Oita	6	4.9
Miyazaki	3	2.6
Kagoshima	8	4.5
Okinawa	3	2.4
Total	3,722	29.9

Source: Latis Co. Ltd., "Directory of National Experiment and Research Institutions", 1992

Table 9-2-8 Number of Private Company Research Institutions (Divisions) by Prefecture and Industrial Character (1993)

Prefecture	Total	Manufacturing				Non-mfg.
		Processing and assembly	Basic materials	Life-related	Subtotal	
Hokkaido	30	3	12	6	21	9
Aomori	2	0	0	1	1	1
Iwate	5	1	2	1	4	1
Miyagi	24	6	12	0	18	6
Akita	3	0	3	0	3	0
Yamagata	9	4	3	2	9	0
Fukushima	21	5	15	0	20	1
Ibaraki	132	32	82	5	119	13
Tochigi	55	18	25	5	48	7
Gumma	212	65	98	22	185	27
Saitama	50	18	22	8	48	2
Chiba	151	24	85	15	124	27
Tokyo	814	223	298	54	575	239
Kanagawa	465	199	175	39	413	52
Niigata	34	13	13	3	29	5
Toyama	33	9	20	0	29	4
Ishikawa	21	6	10	1	17	4
Fukui	19	5	14	0	19	0
Yamanashi	14	7	5	2	14	0
Nagano	50	23	15	7	45	5
Gifu	39	13	22	3	38	1
Shizuoka	125	40	65	13	118	7
Aichi	196	64	84	26	174	22
Mie	45	10	27	8	45	0
Shiga	63	15	41	5	61	2
Kyoto	92	40	40	7	87	5
Osaka	480	139	261	33	433	47
Hyogo	200	51	116	23	190	10
Nara	13	4	7	1	12	1
Wakayama	10	0	8	2	10	0
Tottori	5	4	0	1	5	0
Shimane	2	1	1	0	2	0
Okayama	37	6	21	2	29	8
Hiroshima	54	16	24	7	47	7
Yamaguchi	49	4	41	3	48	1
Tokushima	22	2	19	1	22	0
Kagawa	16	7	4	1	12	4
Ehime	14	3	10	1	14	0
Kochi	6	1	3	1	5	1
Fukuoka	66	14	29	10	53	13
Saga	12	5	7	0	12	0
Nagasaki	6	5	1	0	6	0
Kumamoto	6	1	5	0	6	0
Oita	6	1	2	1	4	2
Miyazaki	3	0	2	1	3	0
Kagoshima	8	1	3	4	8	0
Okinawa	3	0	0	2	2	1
Total	3,722	1,108	1,752	327	3,187	535

Source: Latis Co. Ltd., "Directory of National Experiment and Research Institutions", 1992

Table 9-2-9 Regional Distribution of Private Company Research Institutions (Divisions):  
by Industrial Character (1993)

	Number of private company research institutions (divisions)					Ratio of private company research institutions (divisions) (%)				
	Processi ng and assembl	Basic material s	Life- related	Non- mfg.	Total	Processi ng and assembl	Basic material s	Life- related	Non- mfg.	Total
Total	1,108	1,752	327	535	3,722	29.8	47.1	8.8	14.4	100.0
Hokkaido	3	12	6	9	30	10.0	40.0	20.0	30.0	100.0
Tohoku	16	35	4	9	64	25.0	54.7	6.3	14.1	100.0
Northern Kanto	68	129	18	22	237	28.7	54.4	7.6	9.3	100.0
Southern Kanto	511	656	130	345	1,642	31.1	40.0	7.9	21.0	100.0
Hokuriku	63	77	13	18	171	36.8	45.0	7.6	10.5	100.0
Tokai	127	198	50	30	405	31.4	48.9	12.3	7.4	100.0
Eastern Kinki	19	56	8	3	86	22.1	65.1	9.3	3.5	100.0
Western Kinki	230	417	63	62	772	29.8	54.0	8.2	8.0	100.0
Chugoku	31	87	13	16	147	21.1	59.2	8.8	10.9	100.0
Shikoku	13	36	4	5	58	22.4	62.1	6.9	8.6	100.0
Kyushu	27	49	18	16	110	24.5	44.5	16.4	14.5	100.0

Source: Latis Co. Ltd., "Directory of National Experiment and Research Institutions", 1992



Table 9-3-1 Product Consignment Amount by Prefecture (1993)

Prefecture	Product consignment amount (million yen)			Number of employee (persons)	Amount per employee (x 1000 yen)
	Small and medium sized companies	Large companies	Total		
Hokkaido	4,645,590	1,286,905	5,932,495	240,362	24,682
Aomori	946,456	325,163	1,271,619	83,110	15,300
Iwate	1,271,913	732,103	2,004,016	123,021	16,290
Miyagi	2,340,186	1,392,839	3,733,025	165,469	22,560
Akita	1,039,512	462,835	1,502,347	115,913	12,961
Yamagata	1,683,506	804,485	2,487,991	154,369	16,117
Fukushima	2,874,222	1,941,613	4,815,835	242,409	19,867
Ibaraki	4,969,553	5,818,633	10,788,186	319,467	33,769
Tochigi	3,744,139	4,400,887	8,145,026	255,196	31,917
Gumma	3,936,336	4,170,264	8,106,600	266,439	30,426
Saitama	10,022,846	6,974,769	16,997,615	594,603	28,586
Chiba	5,992,765	6,194,396	12,187,161	304,480	40,026
Tokyo	12,433,493	10,412,767	22,846,260	784,862	29,109
Kanagawa	9,453,246	18,591,590	28,044,836	701,778	39,963
Niigata	3,451,259	1,385,514	4,836,773	274,224	17,638
Toyama	2,134,632	1,614,121	3,748,753	152,683	24,553
Ishikawa	1,702,553	775,982	2,478,535	124,494	19,909
Fukui	1,363,759	595,063	1,958,822	101,187	19,358
Yamanashi	1,376,592	1,014,126	2,390,718	92,463	25,856
Nagano	3,829,016	2,716,696	6,545,712	284,854	22,979
Gifu	4,002,979	1,624,252	5,627,231	259,952	21,647
Shizuoka	7,920,323	8,344,899	16,265,222	523,810	31,052
Aichi	13,818,788	22,800,755	36,619,543	956,749	38,275
Mie	3,321,425	4,174,738	7,496,163	228,487	32,808
Shiga	2,894,786	3,105,593	6,000,379	163,822	36,627
Kyoto	3,421,854	2,867,242	6,289,096	222,245	28,298
Osaka	16,009,185	8,543,508	24,552,693	862,840	28,456
Hyogo	8,257,611	7,166,624	15,424,235	500,627	30,810
Nara	1,513,421	976,910	2,490,331	90,702	27,456
Wakayama	1,349,499	1,151,856	2,501,355	75,013	33,346
Tottori	606,653	404,121	1,010,774	57,291	17,643
Shimane	632,311	336,005	968,316	68,344	14,168
Okayama	3,190,381	3,677,884	6,868,265	204,070	33,656
Hiroshima	4,048,595	4,882,777	8,931,372	278,081	32,118
Yamaguchi	1,683,871	3,278,617	4,962,488	130,555	38,011
Tokushima	915,849	539,472	1,455,321	71,841	20,258
Kagawa	1,532,490	893,482	2,425,972	95,054	25,522
Ehime	1,971,327	1,335,612	3,306,939	126,153	26,214
Kochi	-	-	578,360	39,659	14,583
Fukuoka	3,876,870	3,833,866	7,710,736	291,386	26,462
Saga	1,026,674	377,007	1,403,681	70,853	19,811
Nagasaki	715,437	627,147	1,342,584	81,074	16,560
Kumamoto	1,404,237	868,865	2,273,102	117,212	19,393
Oita	1,016,477	1,570,995	2,587,472	78,952	32,773
Miyazaki	861,905	418,766	1,280,671	76,237	16,799
Kagoshima	1,231,505	407,212	1,638,717	95,234	17,207
Okinawa	-	-	539,259	25,203	21,397
Total	167,410,272	155,962,331	323,372,603	11,172,829	28,843

Note: Small and medium sized companies and large companies are defined as those with less than 300 employees and 300 or more employees, respectively.

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

Table 9-3-2 Rate of Increase of Product Consignment Amount by Prefecture (1980 - 1990)

(%)

Prefecture	Total	Small and medium-sized companies	Large companies
Hokkaido	17.1	24.4	-7.3
Aomori	49.8	31.7	18.1
Iwate	88.0	50.2	37.8
Miyagi	67.5	46.6	20.8
Akita	61.9	40.0	21.9
Yamagata	101.1	63.9	37.3
Fukushima	98.0	54.2	43.8
Ibaraki	70.7	35.5	35.3
Tochigi	77.2	34.3	42.9
Gumma	112.6	46.4	66.3
Saitama	80.3	43.7	36.6
Chiba	23.6	21.4	2.2
Tokyo	35.5	14.2	21.4
Kanagawa	38.6	14.8	23.8
Niigata	44.6	32.7	11.9
Toyama	45.1	29.1	16.0
Ishikawa	84.8	53.1	31.7
Fukui	71.8	41.6	30.2
Yamanashi	153.7	71.7	82.1
Nagano	96.7	49.1	47.6
Gifu	75.6	52.2	23.4
Shizuoka	73.2	32.1	41.2
Aichi	79.7	25.0	54.7
Mie	67.6	28.6	39.0
Shiga	105.7	42.4	63.3
Kyoto	65.7	28.0	37.7
Osaka	30.9	23.4	7.5
Hyogo	38.9	28.2	10.7
Nara	82.4	42.9	39.5
Wakayama	-2.5	19.3	-21.8
Tottori	83.7	38.3	45.4
Shimane	56.1	34.5	21.6
Okayama	19.9	17.0	2.9
Hiroshima	49.7	27.3	22.4
Yamaguchi	14.4	11.5	2.8
Tokushima	60.5	40.7	19.8
Kagawa	25.4	27.9	-2.5
Ehime	21.8	19.7	2.1
Kochi	14.7	0.0	0.0
Fukuoka	33.2	16.5	16.7
Saga	62.0	48.5	13.6
Nagasaki	63.4	29.5	33.9
Kumamoto	76.5	44.0	32.6
Oita	23.5	14.8	8.6
Miyazaki	52.3	37.3	15.0
Kagoshima	59.1	38.4	20.8
Okinawa	-8.3	0.0	0.0
Total	51.9	27.0	24.9

Note: Small and medium sized companies and large companies are defined as those with less than 300 employees and 300 or more employees, respectively.

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

Table 9-3-3 Number of Applications for Industrial Rights by Prefecture (1992)

Prefecture	Patents	Utility models	Designs	Trademarks	Total
Hokkaido	822	665	215	3,727	5,429
Aomori	42	98	28	493	661
Iwate	239	176	33	530	978
Miyagi	948	529	142	1,264	2,883
Akita	50	112	10	304	476
Yamagata	622	167	104	1,248	2,141
Fukushima	355	244	53	1,183	1,835
Ibaraki	668	316	71	1,136	2,191
Tochigi	487	411	100	1,128	2,126
Gumma	1,501	1,044	234	2,325	5,104
Saitama	2,434	2,824	772	4,331	10,361
Chiba	1,345	1,211	303	2,788	5,647
Tokyo	168,765	36,522	13,579	134,757	353,623
Kanagawa	39,406	6,982	3,042	9,516	58,946
Niigata	762	881	597	2,126	4,366
Toyama	557	418	391	1,777	3,143
Ishikawa	1,074	381	111	1,308	2,874
Fukui	393	387	441	845	2,066
Yamanashi	844	220	64	697	1,825
Nagano	1,720	1,320	241	2,212	5,493
Gifu	1,114	751	727	2,565	5,157
Shizuoka	5,487	1,985	690	6,386	14,548
Aichi	16,149	6,011	1,804	15,276	39,240
Mie	518	500	175	1,710	2,903
Shiga	756	275	55	865	1,951
Kyoto	9,269	3,276	757	6,907	20,209
Osaka	59,361	14,923	8,633	45,735	128,652
Hyogo	9,343	3,297	1,225	11,296	25,161
Nara	429	397	240	1,239	2,305
Wakayama	260	147	96	764	1,267
Tottori	123	95	12	273	503
Shimane	202	483	44	280	1,009
Okayama	1,336	791	143	2,815	5,085
Hiroshima	3,075	1,621	357	2,850	7,903
Yamaguchi	2,101	333	63	1,192	3,689
Tokushima	304	189	40	682	1,215
Kagawa	412	270	599	1,311	2,592
Ehime	1,260	463	248	1,370	3,341
Kochi	114	116	19	300	549
Fukuoka	1,882	1,381	809	5,399	9,471
Saga	160	111	41	519	831
Nagasaki	118	129	166	940	1,353
Kumamoto	423	198	49	775	1,445
Oita	124	141	55	710	1,030
Miyazaki	193	129	28	467	817
Kagoshima	196	167	35	797	1,195
Okinawa	72	114	23	1,141	1,350
Overseas	2	0	2	81	85
Others	202	116	12	17	347
Total	338,019	93,317	37,678	288,357	757,371

Prefecture	Share of applications (%) :the top seven prefectures				
	Patents	Utility models	Designs	Trademarks	Total
Tokyo	49.9	39.1	36.0	46.7	46.7
Osaka	17.6	16.0	22.9	15.9	17.0
Kanagawa	11.7	7.5	8.1	3.3	7.8
Aichi	4.8	6.4	4.8	5.3	5.2
Hyogo	2.8	3.5	3.3	3.9	3.3
Kyoto	2.7	3.5	2.0	2.4	2.7
Shizuoka	1.6	2.1	1.8	2.2	1.9
Others	8.9	21.8	21.1	20.3	15.4
Total	100.0	100.0	100.0	100.0	100.0

Source: Patent Office, "Patent Office Annual Report"

Table 9-3-4 Number of Venture Companies, R&D Scientists and Engineers and patents held by prefecture (1992)  
Patents Held by Prefecture (1992)

Prefecture	Number of venture companies	Number of patents held	Number of R&D scientists/ engineers  (persons)	Per million persons			Per company	
				Companies	Scientists/ engineers	Patents held	Scientists/ engineers	Patents
Hokkaido	41	252	179	7.2	44.5	31.6	4	6
Aomori	8	38	37	5.4	25.8	25.1	5	5
Iwate	7	128	37	4.9	90.5	26.2	5	18
Miyagi	10	30	56	4.4	13.2	24.6	6	3
Akita	6	18	23	4.9	14.8	18.9	4	3
Yamagata	10	685	146	8.0	545.8	116.3	15	69
Fukushima	8	43	90	3.8	20.3	42.6	11	5
Ibaraki	10	49	83	3.5	16.9	28.7	8	5
Tochigi	15	341	84	7.7	174.3	42.9	6	23
Gumma	17	40	111	8.6	20.2	56.0	7	2
Saitama	30	519	361	4.6	79.1	55.0	12	17
Chiba	47	594	539	8.3	104.7	95.0	11	13
Tokyo	529	10,622	7,633	44.6	894.5	642.8	14	20
Kanagawa	124	2,227	1,383	15.3	274.8	170.7	11	18
Niigata	22	90	225	8.9	36.4	90.9	10	4
Toyama	20	298	243	17.9	266.0	216.9	12	15
Ishikawa	15	171	157	12.8	146.3	134.3	10	11
Fukui	19	249	442	23.1	302.1	536.3	23	13
Yamanashi	5	1	28	5.8	1.2	32.5	6	0
Nagano	36	614	563	16.6	283.5	260.0	16	17
Gifu	33	611	353	15.9	293.8	169.7	11	19
Shizuoka	82	1,063	940	22.2	287.2	254.0	11	13
Aichi	114	3,022	1,591	16.9	446.7	235.2	14	27
Mie	25	311	205	13.8	171.7	113.2	8	12
Shiga	16	139	168	12.8	111.5	134.8	11	9
Kyoto	63	728	1,158	24.2	279.3	444.3	18	12
Osaka	217	5,460	2,673	24.8	625.1	306.0	12	25
Hyogo	75	2,440	1,312	13.7	446.4	240.0	17	33
Nara	3	53	24	2.1	37.8	17.1	8	18
Wakayama	19	1,874	204	17.6	1738.7	189.3	11	99
Tottori	6	4	26	9.8	6.5	42.3	4	1
Shimane	9	18	50	11.6	23.2	64.5	6	2
Okayama	20	4,611	530	10.4	2386.6	274.3	27	231
Hiroshima	54	541	557	18.8	188.7	194.3	10	10
Yamaguchi	15	70	188	9.6	44.7	120.1	13	5
Tokushima	15	188	94	18.1	226.6	113.3	6	13
Kagawa	19	1,250	300	18.5	1220.4	292.9	16	66
Ehime	16	425	269	10.6	281.3	178.1	17	27
Kochi	6	47	21	7.3	57.5	25.7	4	8
Fukuoka	52	389	584	10.7	80.2	120.4	11	7
Saga	8	27	51	9.1	30.8	58.1	6	3
Nagasaki	13	26	158	8.4	16.8	101.8	12	2
Kumamoto	6	653	87	3.3	354.0	47.2	15	109
Oita	15	57	94	12.2	46.2	76.2	6	4
Miyazaki	13	233	357	11.1	199.7	305.9	27	18
Kagoshima	9	7	67	5.0	3.9	37.5	7	1
Okinawa	5	9	13	4.0	7.3	10.5	3	2
Total	1,907	41,265	24,494	15.3	331.6	196.8	13	22

Source: Nihon Keizai Shimbun, "Nikkei Venture Company Yearbook"

Table 9-3-5 Gross Prefectural Product (1990)

(million yen)

Prefecture	Amount	Secondary industry	Non-secondary industries
Hokkaido	16,635,184	4,256,338	12,378,846
Aomori	3,696,775	858,913	2,837,862
Iwate	3,670,159	1,172,741	2,497,418
Miyagi	7,153,840	2,201,277	4,952,563
Akita	3,239,931	1,020,354	2,219,577
Yamagata	3,494,756	1,342,171	2,152,585
Fukushima	6,785,810	2,682,290	4,103,520
Ibaraki	9,511,900	4,725,060	4,786,840
Tochigi	7,357,396	3,596,605	3,760,791
Gumma	6,699,276	3,396,112	3,303,164
Saitama	17,094,966	7,600,164	9,494,802
Chiba	16,036,851	5,977,536	10,059,315
Tokyo	83,245,571	22,795,330	60,450,241
Kanagawa	28,326,947	13,084,046	15,242,901
Niigata	7,758,972	2,878,783	4,880,189
Toyama	4,016,222	1,775,047	2,241,175
Ishikawa	3,887,763	1,366,894	2,520,869
Fukui	2,709,049	923,781	1,785,268
Yamanashi	2,728,096	1,175,209	1,552,887
Nagano	6,941,090	3,136,244	3,804,846
Gifu	6,415,655	2,848,317	3,567,338
Shizuoka	14,009,533	6,559,365	7,450,168
Aichi	28,978,223	13,907,580	15,070,643
Mie	5,843,932	2,600,377	3,243,555
Shiga	4,726,610	2,754,049	1,972,561
Kyoto	8,371,508	3,072,332	5,299,176
Osaka	37,422,165	13,144,075	24,278,090
Hyogo	18,378,327	7,659,845	10,718,482
Nara	3,065,879	1,274,693	1,791,186
Wakayama	2,872,251	1,123,864	1,748,387
Tottori	1,837,625	611,055	1,226,570
Shimane	2,095,286	660,407	1,434,879
Okayama	6,823,445	3,134,037	3,689,408
Hiroshima	10,260,135	3,784,659	6,475,476
Yamaguchi	5,000,813	2,056,638	2,944,175
Tokushima	2,239,752	821,629	1,418,123
Kagawa	3,263,865	1,110,965	2,152,900
Ehime	4,119,727	1,549,493	2,570,234
Kochi	2,079,556	514,954	1,564,602
Fukuoka	15,763,688	4,510,091	11,253,597
Saga	2,250,938	786,041	1,464,897
Nagasaki	3,898,920	913,093	2,985,827
Kumamoto	5,091,115	1,489,541	3,601,574
Oita	3,628,018	1,434,545	2,193,473
Miyazaki	2,879,764	747,847	2,131,917
Kagoshima	4,514,518	1,086,852	3,427,666
Okinawa	2,828,792	608,541	2,220,251
Total	449,650,594	166,729,780	282,920,814

Source: Economic Planning Agency, "Annual Report on Prefectural Economies"

Table 9-3-6 Growth Rate of Gross Prefectural Product (1980 - 1990)

Prefecture	Growth Rate (%)		
	Total	Secondary industry	Non-secondary industries
Hokkaido	54.1	11.2	42.8
Aomori	55.1	12.3	42.8
Iwate	64.5	23.1	41.4
Miyagi	81.9	27.1	54.8
Akita	54.8	19.3	35.5
Yamagata	63.9	30.0	33.9
Fukushima	82.0	34.5	47.5
Ibaraki	94.8	49.6	45.2
Tochigi	78.8	36.3	42.5
Gumma	90.5	50.0	40.4
Saitama	100.9	42.1	58.8
Chiba	101.7	37.4	64.3
Tokyo	107.8	24.2	83.6
Kanagawa	93.3	39.6	53.7
Niigata	68.0	21.8	46.2
Toyama	68.9	33.0	35.8
Ishikawa	72.4	27.5	44.9
Fukui	70.9	23.3	47.5
Yamanashi	97.9	49.8	48.1
Nagano	79.0	38.6	40.4
Gifu	75.4	34.2	41.2
Shizuoka	94.3	45.7	48.6
Aichi	88.4	45.5	42.9
Mie	76.1	33.8	42.3
Shiga	113.4	72.4	41.0
Kyoto	64.1	22.5	41.5
Osaka	72.1	23.8	48.3
Hyogo	69.8	28.5	41.3
Nara	83.4	36.3	47.1
Wakayama	48.8	18.2	30.6
Tottori	71.9	26.1	45.9
Shimane	62.6	18.6	44.0
Okayama	77.2	38.3	38.9
Hiroshima	69.8	26.3	43.5
Yamaguchi	63.6	28.0	35.5
Tokushima	66.3	27.2	39.1
Kagawa	63.2	19.0	44.2
Ehime	57.7	19.5	38.2
Kochi	54.8	15.9	38.8
Fukuoka	66.9	15.5	51.4
Saga	54.1	19.1	35.0
Nagasaki	62.8	12.2	50.6
Kumamoto	72.0	24.0	47.9
Oita	60.2	25.6	34.6
Miyazaki	63.2	15.3	47.9
Kagoshima	67.9	15.4	52.4
Okinawa	89.8	19.2	70.6
Total	81.9	29.5	52.4

Source: Economic Planning Agency, "Annual Report on Prefectural Economies"

Table 9-3-7 Trends in Per Capita Income by Prefecture

Prefecture	Per capita income by prefecture (million y)				Percent ratio to nationwide average			
	1975	1980	1985	1990	1975	1980	1985	1990
Hokkaido	1,058	1,660	1,921	2,512	104	106	97	95
Aomori	868	1,307	1,630	2,160	85	83	82	82
Iwate	848	1,333	1,684	2,197	83	85	85	83
Miyagi	1,018	1,544	1,988	2,533	100	98	100	96
Akita	955	1,441	1,727	2,299	94	92	87	87
Yamagata	935	1,409	1,766	2,349	92	90	89	89
Fukushima	941	1,483	1,894	2,572	92	95	95	98
Ibaraki	1,042	1,598	2,062	2,812	102	102	104	107
Tochigi	1,055	1,682	2,150	2,955	103	107	108	112
Gumma	972	1,567	2,104	2,800	95	100	106	106
Saitama	1,118	1,699	2,227	3,009	110	108	112	114
Chiba	1,118	1,700	2,192	3,084	110	108	110	117
Tokyo	1,567	2,339	3,219	4,467	154	149	162	170
Kanagawa	1,231	1,893	2,391	3,190	121	121	120	121
Niigata	1,014	1,522	1,945	2,558	99	97	98	97
Toyama	1,110	1,705	2,093	2,790	109	109	105	106
Ishikawa	1,091	1,676	2,029	2,756	107	107	102	105
Fukui	1,005	1,590	1,992	2,579	99	101	100	98
Yamanashi	925	1,499	2,112	2,706	91	96	106	103
Nagano	1,033	1,607	2,079	2,801	101	102	105	106
Gifu	1,004	1,579	1,986	2,710	98	101	100	103
Shizuoka	1,079	1,683	2,185	3,046	106	107	110	116
Aichi	1,197	1,867	2,437	3,242	117	119	123	123
Mie	1,074	1,638	2,062	2,784	105	104	104	106
Shiga	1,041	1,671	2,252	2,930	102	107	113	111
Kyoto	1,083	1,732	2,177	2,794	106	110	110	106
Osaka	1,272	1,943	2,587	3,348	125	124	130	127
Hyogo	1,160	1,746	2,156	2,811	114	111	109	107
Nara	1,003	1,533	1,875	2,451	98	98	94	93
Wakayama	877	1,327	1,762	2,239	86	85	89	85
Tottori	952	1,423	1,751	2,335	93	91	88	89
Shimane	889	1,353	1,710	2,202	87	86	86	84
Okayama	1,075	1,584	2,061	2,689	105	101	104	102
Hiroshima	1,204	1,770	2,121	2,901	118	113	107	110
Yamaguchi	1,015	1,464	1,887	2,441	100	93	95	93
Tokushima	946	1,417	1,759	2,449	93	90	89	93
Kagawa	1,067	1,620	1,946	2,686	105	103	98	102
Ehime	989	1,436	1,695	2,256	97	92	85	86
Kochi	917	1,457	1,726	2,166	90	93	87	82
Fukuoka	1,092	1,657	2,033	2,658	107	106	102	101
Saga	915	1,461	1,732	2,246	90	93	87	85
Nagasaki	856	1,319	1,646	2,164	84	84	83	82
Kumamoto	941	1,470	1,873	2,446	92	94	94	93
Oita	873	1,419	1,752	2,349	86	91	88	89
Miyazaki	866	1,382	1,698	2,198	85	88	86	83
Kagoshima	811	1,289	1,650	2,153	80	82	83	82
Okinawa	826	1,199	1,573	2,001	81	76	79	76
Total	1,020	1,568	1,985	2,635	100	100	100	100

Source: Economic Planning Agency, "Annual Report on Prefectural Economies"

Table 10-1 Analysis Data: Factor Analysis by Relative Value

	Number of bachelors of science  (/population)	Number of bachelors of engineering  (/population)	R&D expenditure  (/GNP)	Technology imports  (/GNP)	Number of R&D scientists/ engineers  (/population)	Number of scientific papers  (/scientists, engineers)	Number of scientific paper citations  (/scientists, engineers)	Number of domestic patents  (/scientists, engineers)	Number of external patents  (/scientists, engineers)	Number of patent citations  (/scientists, engineers)	Technology exports  (/GNP)	Product output  (/GNP)	High-tech product output  (/GNP)
U.S.													
1981	0.0523	0.0278	0.0235	0.0212	0.2969	0.2175	0.3832	0.0574	0.0706	0.2355	0.2377	0.5150	0.1064
1982	0.0530	0.0292	0.0252	0.0194	0.3061	0.2125	0.3725	0.0476	0.0766	0.1949	0.1628	0.4941	0.1108
1983	0.0535	0.0311	0.0260	0.0211	0.3201	0.2029	0.3617	0.0437	0.0657	0.1793	0.1536	0.4957	0.1136
1984	0.0553	0.0323	0.0266	0.0251	0.3365	0.1927	0.3436	0.0481	0.0683	0.1980	0.1481	0.5146	0.1263
1985	0.0578	0.0325	0.0281	0.0220	0.3516	0.1947	0.3462	0.0470	0.0735	0.1915	0.1479	0.5108	0.1283
1986	0.0575	0.0319	0.0279	0.0248	0.3652	0.1918	0.3421	0.0432	0.0785	0.1781	0.1696	0.4929	0.1332
1987	0.0553	0.0306	0.0276	0.0312	0.3731	0.1857	0.3348	0.0478	0.0687	0.1981	0.1994	0.5164	0.1439
1988	0.0510	0.0286	0.0272	0.0433	0.3854	0.1850	0.3328	0.0426	0.0669	0.1761	0.2210	0.5221	0.1497
Japan													
1981	0.0199	0.0649	0.0230	0.1450	0.3225	0.0707	0.0689	0.1109	0.0513	0.1002	0.0408	0.8395	0.1521
1982	0.0192	0.0631	0.0240	0.1598	0.3315	0.0711	0.0721	0.1075	0.0608	0.0935	0.0509	0.8386	0.1573
1983	0.0188	0.0594	0.0262	0.1646	0.3405	0.0721	0.0720	0.1122	0.0629	0.0987	0.0472	0.8648	0.1773
1984	0.0195	0.0597	0.0261	0.1767	0.3627	0.0695	0.0708	0.1187	0.0670	0.1145	0.0540	0.8856	0.2154
1985	0.0196	0.0601	0.0277	0.1679	0.3708	0.0752	0.0743	0.0945	0.0859	0.1339	0.0514	0.8932	0.2200
1986	0.0196	0.0613	0.0275	0.1606	0.3896	0.0748	0.0780	0.1083	0.0855	0.1303	0.0450	0.8734	0.2302
1987	0.0202	0.0631	0.0280	0.1548	0.3995	0.0731	0.0755	0.1109	0.0856	0.1602	0.0525	0.8712	0.2566
1988	0.0196	0.0632	0.0285	0.1695	0.4186	0.0778	0.0833	0.0933	0.0846	0.1494	0.0553	0.8528	0.2806
1989	0.0191	0.0625	0.0297	0.1810	0.4345	0.0772	0.0844	0.1018	0.0950	0.1768	0.0686	0.9032	0.3113
France													
1981	0.0150	0.0217	0.0197	0.1617	0.1578	0.2672	0.2657	0.0802	0.1314	0.0812	0.0844	0.6196	0.0903
1982	0.0154	0.0223	0.0206	0.1636	0.1653	0.2581	0.2642	0.0862	0.1465	0.0723	0.0682	0.6262	0.0919
1983	0.0159	0.0231	0.0212	0.1745	0.1693	0.2507	0.2619	0.0790	0.1374	0.0696	0.1127	0.6336	0.0946
1984	0.0171	0.0231	0.0222	0.1776	0.1787	0.2355	0.2532	0.0779	0.1504	0.0721	0.0866	0.6536	0.1009
1985	0.0181	0.0248	0.0227	0.1881	0.1853	0.2416	0.2661	0.0962	0.1930	0.0715	0.0979	0.7071	0.1109
1986	0.0206	0.0248	0.0224	0.1689	0.1895	0.2550	0.2810	0.0892	0.2126	0.0704	0.0937	0.6891	0.1093
1987	0.0217	0.0262	0.0229	0.1794	0.1966	0.2448	0.2755	0.0779	0.1970	0.0784	0.1008	0.6758	0.1088
1988	0.0222	0.0268	0.0230	0.2321	0.2061	0.2420	0.2765	0.0766	0.1970	0.0669	0.1188	0.6798	0.1101
1989	0.0235	0.0295	0.0235	0.1863	0.2138	0.2442	0.2772	0.0688	0.2005	0.0718	0.1076	0.6880	0.1148
Germany													
1981	0.0145	0.0091	0.0249	0.1392	0.2021	0.2242	0.2386	0.0510	0.2428	0.1653	0.0712	0.9639	0.1650
1982	0.0134	0.0098	0.0254	0.1384	0.2072	0.2237	0.2466	0.0648	0.2712	0.1366	0.0751	0.8831	0.1555
1983	0.0165	0.0105	0.0255	0.1481	0.2130	0.2172	0.2489	0.0818	0.2574	0.1308	0.0783	0.8952	0.1676
1984	0.0177	0.0112	0.0264	0.1469	0.2241	0.2053	0.2316	0.0832	0.2534	0.1416	0.0835	0.9384	0.1830
1985	0.0189	0.0110	0.0277	0.1596	0.2354	0.2180	0.2490	0.0920	0.3326	0.1459	0.0875	1.0103	0.2063
1986	0.0203	0.0118	0.0278	0.1745	0.2401	0.2164	0.2538	0.1047	0.3435	0.1388	0.0873	0.9891	0.2054
1987	0.0212	0.0119	0.0288	0.1687	0.2712	0.1945	0.2368	0.0978	0.2826	0.1371	0.0834	0.9635	0.2016
U.K.													
1985	0.0319	0.0184	0.0221	0.2012	0.2125	0.3351	0.4679	0.0506	0.1213	0.0719	0.2264	0.7096	0.1801
1986	0.0308	0.0181	0.0226	0.2239	0.2174	0.3355	0.4739	0.0438	0.1342	0.0688	0.2138	0.6767	0.1786
1987	0.0293	0.0169	0.0222	0.2426	0.2168	0.3359	0.4668	0.0374	0.1232	0.0743	0.2227	0.6897	0.1906
1988	0.0288	0.0174	0.0219	0.2443	0.2197	0.3340	0.4587	0.0355	0.1252	0.0675	0.2240	0.7258	0.2010



Table 10-2 Factor Load

	Variables	Factor 1	Factor 2
1	Number of B.Sc./population	0.639	-0.779
2	Number of B.Eng./population	-0.640	-0.474
3	R&D expenditure/GNP	-0.412	-0.597
4	Technology imports/GNP	-0.324	0.760
5	Number of R&D scientists and engineers/population	-0.432	-0.897
6	Number of scientific papers/scientists and engineers	0.831	0.546
7	Number of scientific paper citations/scientists and engineers	0.961	0.099
8	Number of domestic patents/scientists and engineers	-0.881	0.194
9	Number of external patents/scientists and engineers	-0.023	0.599
10	Number of patent citations/scientists and engineers	0.043	-0.776
11	Technology exports/GNP	0.832	-0.209
12	Product output/GNP	-0.744	0.365
13	High-tech product output/GNP	-0.597	-0.167
	Contribution	5.275	4.080
	Contribution rate	56.4%	43.6%
	Variation	40.6%	31.4%

Note: Above figures are results of Varimax rotation.

Table 10-3 Factor Points

	Year	Factor 1	Factor 2
U.S.			
	1981	1.413	-1.392
	1982	1.198	-1.336
	1983	1.110	-1.405
	1984	0.955	-1.570
	1985	0.934	-1.701
	1986	0.998	-1.697
	1987	0.970	-1.765
	1988	0.996	-1.621
Japan			
	1981	-1.280	-0.179
	1982	-1.284	-0.172
	1983	-1.441	-0.273
	1984	-1.591	-0.367
	1985	-1.478	-0.585
	1986	-1.598	-0.621
	1987	-1.669	-0.851
	1988	-1.613	-0.896
	1989	-1.794	-1.035
France			
	1981	0.469	1.160
	1982	0.320	1.166
	1983	0.422	1.069
	1984	0.259	1.002
	1985	0.092	1.107
	1986	0.237	1.067
	1987	0.290	0.913
	1988	0.267	1.044
	1989	0.300	0.819
Germany			
	1981	-0.027	0.680
	1982	-0.050	0.796
	1983	-0.195	0.779
	1984	-0.333	0.621
	1985	-0.500	0.731
	1986	-0.577	0.793
	1987	-0.615	0.466
U.K.			
	1985	1.211	0.738
	1986	1.214	0.795
	1987	1.224	0.835
	1988	1.166	0.886

Table 10-4 Analysis Data: Analysis of Main Elements

Country	Year	Input variables of science and technology					Output variables of science and technology							
		Number of bachelors of science (persons)	Number of bachelors of engineering (persons)	R&D expenditure ('100 mil. yen)	Technology imports ('100 mil. yen)	Number of R&D scientists/engineers (persons)	Number of scientific papers (papers)	Number of scientific paper citations (times)	Number of domestic patents (patents)	Number of external patents (patents)	Number of patent citations (times)	Technology exports ('100 mil. yen)	Product output ('100 mil. yen)	High-tech product output ('100 mil. yen)
U.S.	1981	120,387	64,068	177,509	1,605	683,300	148,627	261,842	39,225	48,213	160,888	17,991	3,760,554	776,654
	1982	123,346	67,791	187,299	1,456	711,800	151,292	265,132	33,896	54,526	138,738	12,218	3,521,670	790,106
	1983	125,712	72,954	200,744	1,663	751,600	152,494	271,823	32,872	49,391	134,763	12,135	3,667,780	840,370
	1984	131,163	76,531	220,034	2,149	797,600	153,730	274,023	38,364	54,460	157,919	12,665	4,042,036	991,846
	1985	138,275	77,871	239,221	1,978	841,200	163,778	291,192	39,544	61,869	161,073	13,309	4,124,344	1,035,655
	1986	138,993	77,061	247,493	2,346	882,300	169,242	301,813	38,124	69,265	157,121	16,031	4,091,623	1,105,590
	1987	134,984	74,705	253,006	3,031	910,200	168,999	304,696	43,518	62,530	180,267	19,389	4,414,988	1,230,420
	1988	125,531	70,406	261,058	4,420	949,300	175,644	315,955	40,479	63,488	167,202	22,560	4,636,795	1,329,071
Japan	1981	23,358	76,370	59,824	3,775	379,405	26,828	26,133	42,080	19,468	38,031	1,063	2,133,953	386,738
	1982	22,771	74,774	65,287	4,369	392,625	27,901	28,317	42,223	23,860	36,698	1,392	2,208,932	414,306
	1983	22,381	70,824	71,808	4,707	406,042	29,256	29,252	45,578	25,522	40,082	1,351	2,345,584	480,746
	1984	23,423	71,640	78,939	5,401	435,340	30,256	30,803	51,690	29,170	49,847	1,651	2,509,182	610,211
	1985	23,626	72,560	88,903	5,631	447,719	33,667	33,245	42,323	38,450	59,942	1,724	2,734,670	673,599
	1986	23,805	74,516	91,929	5,454	473,296	35,413	36,939	51,276	40,476	61,687	1,527	2,668,756	703,258
	1987	24,655	77,077	98,366	5,515	487,779	35,634	36,829	54,087	41,751	78,137	1,870	2,792,071	822,460
	1988	23,972	77,503	106,276	6,429	513,267	39,924	42,735	47,912	43,426	76,666	2,098	2,897,018	953,083
	1989	23,547	77,009	118,155	7,347	535,008	41,318	45,155	54,473	50,824	94,597	2,782	3,209,455	1,106,206
France	1981	8,126	11,754	25,301	2,080	85,500	22,843	22,718	6,855	11,236	6,944	1,085	821,582	119,794
	1982	8,415	12,156	27,614	2,191	90,076	23,250	23,796	7,764	13,200	6,511	913	847,172	124,324
	1983	8,715	12,650	28,619	2,356	92,682	23,240	24,273	7,323	12,738	6,449	1,522	860,777	128,537
	1984	9,406	12,670	30,687	2,458	98,210	23,125	24,868	7,651	14,770	7,078	1,198	898,555	138,716
	1985	10,009	13,659	32,305	2,682	102,253	24,703	27,211	9,835	19,736	7,306	1,396	990,004	155,293
	1986	11,391	13,722	33,525	2,517	104,953	26,762	29,490	9,362	22,313	7,385	1,397	989,584	156,977
	1987	12,068	14,576	34,831	2,732	109,359	26,773	30,125	8,523	21,540	8,575	1,535	993,459	159,980
	1988	12,391	14,998	36,410	3,694	115,163	27,868	31,846	8,822	22,690	7,707	1,891	1,042,228	168,854
	1989	13,270	16,658	38,775	3,128	120,659	29,461	33,451	8,301	24,193	8,663	1,806	1,094,673	182,596
Germany	1981	8,939	5,639	36,632	2,051	124,678	27,947	29,749	6,357	30,269	20,609	1,048	1,349,738	231,016
	1982	8,266	6,023	37,781	2,053	127,700	28,566	31,494	8,279	34,634	17,448	1,114	1,364,955	240,395
	1983	10,124	6,469	38,824	2,255	130,843	28,414	32,571	10,709	33,676	17,117	1,193	1,407,991	263,543
	1984	10,802	6,826	42,252	2,342	137,100	28,146	31,749	11,402	34,744	19,410	1,331	1,522,369	296,828
	1985	11,507	6,734	45,529	2,621	143,627	31,306	35,759	13,215	47,766	20,961	1,437	1,668,371	340,749
	1986	12,419	7,216	48,072	2,987	146,600	31,729	37,207	15,347	50,356	20,348	1,494	1,668,974	346,519
	1987	12,925	7,246	49,912	2,916	165,614	32,220	39,213	16,194	46,804	22,705	1,441	1,649,314	345,159
U.K.	1985	18,060	10,438	32,874	2,811	120,300	40,310	56,285	6,087	14,596	8,650	3,163	921,071	233,814
	1986	17,471	10,300	35,337	3,310	123,400	41,406	58,482	5,403	16,555	8,487	3,161	915,250	241,580
	1987	16,663	9,618	35,619	3,733	123,400	41,446	57,598	4,609	15,201	9,163	3,427	973,320	268,901
	1988	16,434	9,932	36,664	3,920	125,400	41,880	57,517	4,447	15,695	8,469	3,595	1,065,360	295,075

Note: OECD's purchasing power parities are used for conversion from foreign currencies into yen (see Chap.4).

Table 10-5 Principal Component Analysis Points (primary component)

	Year	Input index	Output index
U.S.			
	1981	4.713	7.559
	1982	4.912	7.093
	1983	5.185	7.070
	1984	5.528	7.727
	1985	5.827	8.151
	1986	5.969	8.548
	1987	6.007	9.076
	1988	6.024	9.402
Japan			
	1981	2.595	2.676
	1982	2.648	2.844
	1983	2.669	3.071
	1984	2.819	3.514
	1985	2.934	3.801
	1986	3.026	4.010
	1987	3.145	4.367
	1988	3.278	4.527
	1989	3.420	5.206
France			
	1981	0.659	1.054
	1982	0.696	1.114
	1983	0.724	1.143
	1984	0.760	1.198
	1985	0.807	1.409
	1986	0.829	1.479
	1987	0.873	1.473
	1988	0.938	1.554
	1989	0.978	1.625
Germany			
	1981	0.729	1.861
	1982	0.741	1.986
	1983	0.787	2.045
	1984	0.837	2.165
	1985	0.887	2.600
	1986	0.939	2.698
	1987	0.990	2.654
U.K.			
	1985	0.885	1.624
	1986	0.917	1.673
	1987	0.915	1.697
	1988	0.935	1.768

Note: A constant was added to principal component points so that the origin for principal component points coincides with the zero point for raw data.

Table 10-6 Weight Coefficient for Principal Component Analysis

Variables		Primary component	Secondary component
1	Number of bachelors of science	0.297	-0.208
2	Number of bachelors of engineering	0.253	0.346
3	R&D expenditure	0.312	-0.061
4	Technology imports	0.012	0.636
5	Number of R&D scientists/engineers	0.311	0.074
6	Number of scientific papers	0.292	-0.242
7	Number of patent citations	0.288	-0.262
8	Domestic patents	0.226	0.444
9	External patents	0.270	0.002
10	Scientific paper citations	0.313	-0.026
11	Technology exports	0.282	-0.239
12	Product output	0.309	0.100
13	High-tech product output	0.298	0.175
Eigenvalue		10.104	2.191
Ratio		0.777	0.169
Accumulative ratio		0.777	0.946

Table 10-7 Primary Component Points: Composition of All Variables

Year	Primary component points	Primary component points (origin=0)
U.S.		
1981	4.604	8.868
1982	4.343	8.607
1983	4.483	8.747
1984	5.213	9.477
1985	5.734	9.998
1986	6.130	10.394
1987	6.577	10.841
1988	6.832	11.096
Japan		
1981	-0.632	3.631
1982	-0.472	3.791
1983	-0.277	3.987
1984	0.164	4.428
1985	0.454	4.717
1986	0.682	4.946
1987	1.042	5.305
1988	1.235	5.499
1989	1.859	6.123
France		
1981	-3.052	1.212
1982	-2.983	1.281
1983	-2.945	1.318
1984	-2.881	1.382
1985	-2.686	1.577
1986	-2.616	1.648
1987	-2.598	1.666
1988	-2.507	1.757
1989	-2.420	1.843
Germany		
1981	-2.360	1.904
1982	-2.252	2.011
1983	-2.178	2.085
1984	-2.052	2.212
1985	-1.677	2.586
1986	-1.572	2.692
1987	-1.575	2.689
U.K.		
1985	-2.467	1.797
1986	-2.415	1.849
1987	-2.401	1.863
1988	-2.335	1.929
Average		
	0.000	4.264