Study for Evaluating the Achievements
of the S&T Basic Plans in Japan

Comparative Analysis on S&T Policies and Their Achievements between Major Countries

- Highlights -

March, 2005

National Institute of Science and Technology Policy (NISTEP)
Ministry of Education, Culture, Sports, Science and Technology

The Japan Research Institute, Limited (JRI)

Summary

This report provides an overview of the results for FY2004 of the "Comparative Analysis on S&T Policies and Their Achievements between Major Countries during the period of the 1st and 2nd Science and Technology Basic Plans," a part of the comprehensive survey; "Study for Evaluating the Achievements of the S&T Basic Plans in Japan," funded by the Special Coordination Funds for Promoting Science and Technology for FY2004 of Ministry of Education, Culture, Sports, Science and Technology.

The analysis for the year under review focused on comparative international analysis for the four following topics.

- Policies for expanding R&D funding and prioritization by the governments
- Budgetary frameworks and research activities of universities
- Introducing new vitality to the science and technology human resource
- Results achieved by industry, academia and government cooperation policies and regional innovation policies

The results of comparative international analysis are summarized in the following sections

(1) Summary of Comparative International Analysis

1) Levels of Government Investment in R&D

Differences in how statistics are kept make it difficult to draw simple comparisons between the levels of government investment in R&D in the major countries. In terms of actual spending figures (taken from budgets), however, comparisons of government investment in R&D reveal the United States to be the clear leader, with spending calculated as ¥16.68 trillion (central government only, approx. 4 times Japanese amount) when converted on the basis of OECD purchasing power parity. Comparison on the basis of percentage of GDP is also consistent with the trend in absolute spending figures, with the U.S. achieving the highest percentage of 1.07%. Again, this rate is sharply higher than the 0.7% figure for Japan (not including regional government investment) and the 0.77% of the 15 EU countries (includes both central and regional government investment (for the higher figures)). (See Chapter 1.)

2) Setting Targets for Investment in R&D

With regard to the setting of quantitative targets for investment in R&D, the EU countries, the United Kingdom and China set specific R&D investment targets as a percentage of GDP. Both the public and private sectors for all countries and regions endeavor to set high targets for R&D investment. This is seen as one indication that the scope of science and technology policies is expanding beyond the realm of simple assistance for R&D activities and now take the form of "innovation policies" that ensure practical application can be made of the R&D results, the results can be further built upon and that they offer benefit to society at large.

Worthy of special note is the fact that, in 2002, the European Council established targets for increasing overall EU investment in R&D to 3% of GDP (with 1% coming from government) by 2010. Further, the United Kingdom announced the new "Science and Innovation Investment Framework 2004-2014" strategy in July 2004. In accordance with this new 10-year strategy, combined public and private sector investment in R&D will be increased to 2.5% of GDP by FY2014 and the OST and Department for Education and Skills, which account for approximately 45 percent of government investment, will increase their R&D budgets by close to 6 percent through FY2007.

These trends indicate the various countries have introduced new policies that place priority on science and technology based on a consensus that research and development will be the source of future innovation. (See Chapter 1.)

3) Prioritization Policies

A look at the prioritization policies of the various countries showed that all countries, including the United States, the United Kingdom, Germany and the EU, as well as Japan, had established prioritization policies in the areas of life sciences, information communications technology (ICT) and the environment. Nanotechnology is an area that became the focus of world attention when it was identified as an area of commitment by then president of the United States Bill Clinton in January 2000. Nanotechnology was also designated a priority field in Japan's 2nd Science and Technology Basic Plan. The National Nanotechnology Initiative (NNI) was established as a key strategic science and technology strategy in the FY2001 United States budget, while nanotechnology was designated a priority field in the EU's 6th Framework Programme in 2002. In other areas, new trends have been discovered. These include the emergence of the "basic technology" theme that encompasses many different fields in the United Kingdom and the "citizens and governance" theme in the EU. (See Chapter 1.)

4) Composition of University Research Funding

Simple comparisons for funding have been made difficult by the fact that funding items are defined differently according to country, as seen with labor costs and other items. That being said, a look at the various types of funding that comprise the overall research funding figures for major countries seems to indicate that, in the U.S., there is a trend toward a comparatively large portion of research funding for universities being comprised of “external and government research funding.” Furthermore, the greater the size of the total university research budget the larger the proportion of external funding. In contrast, research funding at United Kingdom universities is comprised of “dual support,” provided by the government, and a rapidly increasing proportion of external support in the form of funding from charities, the private sector and overseas sources (the EU budget in particular). This enables funding to keep a good balance between maintaining the competitiveness while facilitating diversity. Here in Japan, research funding has become comparatively more dependent on external funding, with the rapid increase in competitive funding and corporate funding. (See Chapter 2.)

5) Developing and Securing the S&T Human Resources with Actual Research Management Capabilities and Their Mobility

The high degree of mobility (across fields, industry sectors and national boundaries) of S&T personnel is underpinned by the mechanisms in place that enable personnel to congregate in areas prioritized for R&D investment, with the resulting strong correlation developing between the “prioritization of R&D investment” and the “securing science and technology personnel (development and mobility)”. The framework of this system makes it possible to develop S&T personnel very capable of applied research, who have the ability and qualifications to function as Principal Investigators (PI) imbued with good research management capabilities, for work with highly project-oriented type research funding. Even in Germany where researcher mobility between the academic and industry sectors is comparatively lower than that of the United States, doctoral recipients are recognized by corporations as “personnel having good research management capabilities” and utilized in ways commensurate with their ability. In contrast, science and technology personnel in Japan find that “graduate school doctorate courses” and “activities conducted in research laboratories” play a key role in their acquiring high levels of knowledge and ability. However, acquiring “research management capabilities” is still quite difficult in “doctorate program” level education today. Therefore, the key challenges for opening up career paths and greater mobility for doctoral recipients will be to enable such personnel to participate in joint industry and academia applied research projects offering positions and responsibilities commensurate with their abilities and increasing the opportunities for accepting corporate internships. (See Chapter 3.)

6) Promoting Regional Innovation Through Industry, Academia and Government Cooperation

The regional innovation policies implemented through industry, academia and government cooperation by the various countries are based on lessons learned from the successful examples of Silicon Valley in the United States and other high-tech regions. These countries also adopt specific policies and tailored to their own national conditions and requirements. For example, innovation policies include establishing networks that will be effective in translating research results produced through university participation into venture businesses and providing the incubator facilities and innovation necessary to promote such businesses. In such cases, the balance of authority and resources between central government and regional governments varies widely according to country, as does the central government support that serves as the "triggering effect at the incipient stages of such innovation policies." From the United States and advanced European countries' examples we can see that periods of between 10 years and several decades from the initial launch were required for the various research and development cluster areas to become independent and self-sustaining. This goes to show how important it is to adopt long-term planning and support policies rather than maintaining unrealistic expectations of quick results. Fostering an R&D cluster region throughout its growth period until it finally become self-sustaining requires that those concerned are mindful of the fact it is necessary to establish a diverse range of ongoing innovation systems (naturally balanced) that are based on the forces of regional competition and cooperation. (See Chapter 4.)

(2) Implications for Japan's Future Policies

1) Establishing Logical Approach to Prioritizing R&D Fields

R&D budget resources in Japan are allocated on a priority basis to the four priority research areas (including life science, ICT, the environment, and nanotechnology and materials), a trend paralleled in the United States and many other technologically advanced nations. However, the current reality is that while there are examples in Europe of prioritizing support for those industry sectors that may be competitive in any of these priority areas, there are no countries, Japan included, that have established clear-cut policies that set out even a basic set of concepts for establishing a basis for prioritizing budgetary resources according to a real vision of how such prioritization should serve the country’s national and societal interests. It will be important for the future for the various countries, including Japan, to establish a more accountable “logical approach to prioritization” in order to clarify the system of priority research areas in accordance with a vision for the nation for the future and current societal needs. (See Chapter 1.)

2) Promoting Policy Coordination and the Central Role of the Council for Science and Technology Policies

It was during the 2nd Basic Plan that the Council for Science and Technology Policies was assigned the role of providing overall coordination of the science and technology policies of the various government ministries as a central command type role. The reality, however, has been that science and technology policy has rarely been drawn up and implemented in proper coordination with other spheres of government policy. The EU, for example, is currently reviewing its immigration and social security policies with an eye to improving the mobility of researchers. This move illustrates the necessity for establishing coordination between science and technology policy and industrial, educational, health, medical, labor, welfare, environmental and national land policies. In this respect, we look forward to the Council for Science and Technology Policies taking on a true central command role during the next Basic Plan implementation stage in order to effectively coordinate science and technology policy with policy in other spheres of government to ensure more effective implementation. The most effective way to implement science and technology policy will be continue beyond the Basic Plan design stage and follow through to the implementation stage, as with the United Kingdom’s "technology foresight programme,” a programme which is market need-driven and based on models of future scenarios.

3) Reforming Education System of a Doctorate Course, etc., in Order to Develop S&T Personnel with Capabilities for Applied Research and Research Management Skills

Special measures implemented during the 1st and 2nd Basic Plans have helped to strengthen the physical resources and infrastructures at domestic universities, however, the educational and research systems required to accommodate emerging trends in new fields of research and societal need are still insufficiently developed. In order to provide researchers with doctor degree with a diverse range of career paths and greater mobility, it will be necessary to strengthen the industry, academia and government cooperation programs and the interfaces available for training system for researchers. Specific policies we would like to see are qualitative improvements to the type of corporate internship system widely in use in major Western countries and implementation of recurrent education for private sector technical personnel at the professional graduate school level. Rather than training researchers that simply work in narrow, highly specialized fields, it would be more suitable to adopt a broadly based, double-track system of researcher development in which researchers are fostered to become "R&D leaders." Policies designed to take advantage of competitive funding type resources through hiring post doctorate level personnel and actively supporting the independent research activities of young researchers with the commensurate ability to take on such responsibility should be studied. (See Chapter 3.)

4) Diversification of the University Funding Framework and Promotion of Dual Support System

When compared with its overseas counterparts, the university funding framework in Japan is said to be characterized by a comparatively low proportion of funding from external sources, particularly the corporate sector, with most funding being provided internally. Although it is difficult to make simple comparisons, as conditions and financial structures vary according to university, it is believed that the current increased availability of competitive research funding and corporate funding is leading Japanese universities to a greater dependency on external funding. The reality is that there is insufficient overhead incidental to external funding being introduced. In an environment where the availability of internal funding is severely restricted, there is simply not enough funding to cover the increased operating expenses incurred when expanding researcher development and research activities. Thus, when it comes to a trade-off between external and internal funding, there is concern over a negative incentive arising whenever acquiring external funding.

For the future, it will be important to maintain an appropriate balance between internal and external funding and to provide specific allowances to cover the various costs incurred when introducing appropriate overhead coverage for external funding. Doing so at universities with high level of research will enhance research environments and systems, which, in turn, will increase competitiveness, which will then serve to increase the level of external funding including offered by corporations. The overall result will be the creation of a 'virtuous circle' that may lead to the creation of self-sustaining funding systems. Another concern is if a single basic approach is used for evaluation when determining budgetary applications for research fields and research subjects for universities, there is the danger the available funding will become concentrated on a small number of leading researchers at leading universities. Such a development would make it difficult to adopt the flexible technology development strategies required to accommodate a diverse range of research and development and the new conditions the future may bring. We should study the “dual support” system in place in the United Kingdom so that we can establish a strong dual support type system for making the most effective use of “administrative costs subsidies” and “competitive research funding” here in Japan. (See Chapter 2.)

5) Make Regional Innovation the Driving Force for “Promoting Development and Innovation in Science and Technology”

It will be necessary to emphasize the important role that promotion of regional innovation should play in the goal of promoting development and innovation in science and technology. It is proposed that “creation of an international level regional cluster” that will serve as part of the national innovation system based on the concept of “selection and concentration” be made the first policy goal and “promotion and support of a science and technology innovation promotion program with local characteristics” capable of ensuring diversity and flexibility required by the nation’s science and technology innovation promotion activities as a whole be made the second policy goal. According, it is desirable that the menu of policies should be drawn up in accordance with the foregoing two proposed directions.

The division of authority and resources between the Japanese central and regional governments differs significantly from that of the Western countries. Whereas Western countries can simply provide follow-up for good practices, Japan must take steps to ensure the continued development of programs implemented for the regional clusters, which are designed to become independent and self-sustaining. It must be done in a way that takes fully into account the division of roles between the central and regional governments. The traditional Japanese keys to success must be applied to ensure success. The heads of local government entities must, for example, provide strong and harmonious leadership in order to establish the broadly based cooperation necessary to provide the required public sector support (including development of research personnel) and reach the point of viability (critical mass) over the long-term. (See Chapter 4.)

6) Reviewing Support for Entrepreneurs - Providing Initial Markets and Expanding Opportunities Through Government Procurement

When setting promotion of healthy support for entrepreneurs based on the "competition and cooperation" mechanism and the promotion of innovation as the goals, it will be important to avoid the temptation to simply provide lock-step support and preferential treatment for the venture corporations. "Initial stage markets" should be provided instead for such research and development based ventures. In other words, Japan should consider the option of "establishing a framework for giving preference in government procurement to venture corporations," as is practiced in many of the world's leading countries. The "Analysis of Socio-Economic Impact of Science and Technology Policy in Japan" conducted as part of the "Study for Evaluating the Achievements of the S&T Basic Plans in Japan" also specified the importance of "policy coordination," citing various practical examples that included government procurement, along with support for basic research and the building of research infrastructures, as effective government support policies.

Considering that there is a huge potential procurement market, as well, in the areas of social welfare, national land maintenance and disaster prevention, areas traditionally not included in policies concerning science and technology, we anticipate that developing these areas will help to expand the sphere of support for entrepreneurs. This can be done by coordinating policies between the various government ministries under the leadership of the Council for Science and Technology Policies (discussed in section 2) above). (Section IV, "Analysis of Socio-Economic Impact of Science and Technology Policy in Japan," NISTEP Report No. 89)

Preface: Purpose of Study and Overview

(1) Purpose of Study

In the ensuing years since the 1st Science and Technology Basic Plan was drawn up in 1996, Japan’s science and technology policies have undergone significant changes, with steady growth in investment in research and development and ongoing reform of the research and development systems currently in place. Systematic analysis and evaluation of the results of the past, success in achievement and the problem points will be essential in order to bring implementation of the 2nd Basic Plan, now in its third year, to completion. It will be crucial to the task of formulating the next Basic Plan. Evaluation of the science and technology Basic Plans are also important in terms of maintaining accountability to the population of Japan concerning the increased investment of public funds in the fields of science and technology.

This report provides an overview of the second-year results for the “Comparative Analysis on S&T Policies and Their Achievements between Major Countries during 1st and 2nd Science and Technology Basic Plans,” a part of the comprehensive survey; “Study for Evaluating the Achievements of the S&T Basic Plans in Japan,” funded by the Special Coordination Funds for Promoting Science and Technology for FY2004 of Ministry of Education, Culture, Sports, Science and Technology.

(2) Overview of Study

a. Criteria for Selecting Countries Covered

The approach to selecting countries covered in the study is basically the same as the one used for the FY2003 report. As shown in Figure 1 below, the main science and technology policies are listed together with the most representative initiatives and examples of success. Countries covered in the report were selected on the basis of countries with policies ((1) to (3)) that promise significant benefits for science and technology development in Japan.

（Figure 1）　Distinctive Trends in Science and Technology Policy and Examples of Application by Various Countries

Science and technology policy trends	Typical Examples from Major Countries
(1) Expansion of government investment in R&D and strategic prioritization	・ United States: Most radical examples of prioritization with doubling of NIH budget and proposing the National Nanotechnology Initiative (NNI) as a joint project with several ministries. ・ United Kingdom: Labor administration doubling of the budget within ten years and deployment of centralized competitive research funding management system. ・ EU: Established target to increase combined public and private sector R&D investment to 3% of GDP. Introduced the FP6 “structuring effect.” ・ South Korea: Implementing the radical top-down science and technology policy, expanded R&D investment. Private sector R&D investment rapidly expanding also.
(2) Training and securing science and technology human resource	・ United States: World’s leading science and technology researcher base, depends heavily on brain gain and immigration policy. ・ China: World’s 3rd largest science and technology researcher base, now implementing strong researcher call back policy. ・ EU: Now implementing strong researcher callback policy and “policy coordination” to improve researcher mobility within region.
(3) Industry, academia and government cooperation in promoting regional innovation	・ Germany: Boasts central government‘s best practice “BioRegio” programme that creates the most biotechnology ventures in Europe. ・ Sweden: Features highest knowledge investment in the world, with R&D investment standing at over 4% of GDP. Built industry, academia and government cooperation system extending beyond its borders. ・ Finland: “Oulu model” designated the best practice in world for regional innovation. Ranked top small or medium sized country in world in terms of IMD international competition and OECD “Growth Project.” ・ China: Promoting radical industry, academia and government promotion project featuring highly diversified and flexible university management. Chunkanson rapidly becoming a world knowledge center.

b. Selection of Countries and Regions Covered

This study has selected the following countries and regions for discussion based on distinctive science and technology policy trends and their examples of application.

- United States
- EU
- United Kingdom
- Germany
- Sweden
- Finland
- China
- Taiwan
- South Korea

c. Study Topics

① Comparative international analysis of government R&D investment expansion policies and prioritization policies
② Comparative international analysis of university budgetary frameworks and research activities
③ Comparative international analysis of efforts to introduce new vitality to pool of science and technology researchers
④ Comparative international analysis of the results of industry, academia and government cooperation on innovation policies

Chapter 1:

Comparative International Analysis of Government R&D Investment Expansion Policies and Prioritization Policies

【Key Points】

- As with actual spending figures, a breakdown of total government R&D investment as a percentage of GDP shows the United States leads with 1.07%. This is sharply higher than the 0.7% figure for Japan (not including regional government investment) and the 0.77% of the 15 EU countries (includes both central and regional government investment (for the higher figures)), however, the differences between countries are not as wide as with actual total R&D spending figures.
- In terms of quantitative targets for government R&D investment, Japan, the EU and the United Kingdom disclose specific R&D investment target figures as a percentage of GDP. With the exception of Japan, the total government R&D investment amounts are growing at higher rates in the post year 2000 period when compared with the latter half of the '90s. In the post year 2000 period, the United States has recorded the highest growth in total government investment in research and development.
- With regard to combined total investment by the public and private sector in R&D, the EU countries, the United Kingdom and China set specific R&D investment targets as a percentage of GDP. All countries and regions endeavor to set high targets for R&D investment. This is seen as one indication that the scope of science and technology policies is expanding beyond the realm of simply providing assistance for R&D activities and now takes the form of "innovation policies" that ensure practical application can be made of the R&D results, the results can be further built upon and that they offer benefit to society at large.
- A look at the prioritization trends of the various countries shows countries including the United States, EU, United Kingdom and Germany, as well as Japan, had established prioritization policies in the areas of life sciences, information communications technology (ICT) and the environment. Almost all countries had recognized the strategic importance of nanotechnology and designated "nanotechnology and materials" as a priority area. The National Nanotechnology Initiative (NNI) was established as a key strategic science and technology strategy in the FY2001 U.S. budget, and was designated a priority field in the EU's 6th Framework Programme in 2002.

1.1 Summary of Comparative International Analysis

Differences in how statistics are kept make it difficult to draw simple comparisons between the levels of government investment in R&D in the major countries. In terms of actual spending figures (taken from budgets), however, comparisons of government investment in R&D reveals the United States to be the clear leader, with spending calculated as \16.68 trillion (central government only, approx. 4 times Japanese amount) when converted on the basis of OECD purchasing power parity. On a by country basis, Japan comes after the United States and is ahead of Germany, the largest of the 15 EU Nations.

Comparison on the basis of percentage of GDP is also consistent with the trend in absolute spending figures, with the United States achieving the highest percentage of 1.07%. Again, this rate is sharply higher than the than the 0.7% figure for Japan (not including regional government investment) and the 0.77% of the 15 EU countries (includes both central and regional government investment (for the higher figures)), however, the differences between countries are not as wide as with actual total R&D spending figures. (See Figure 1-1.)

Regarding disclosure of quantitative targets for government R&D investment, Japan, the EU and the United Kingdom disclose specific R&D investment target figures as a percentage of GDP. The United States does not disclose these investment figures at all. Germany discloses figures concerning the rate of increase in the budgets of research institutions.

With the exception of Japan, the total government R&D investment amounts are growing at higher rates in the post year 2000 period when compared with the latter half of the ‘90s. In the post year 2000 period, the United States has recorded the highest growth in total government investment in research and development.

A look at the prioritization trends of the various countries shows countries including the United States, EU, the United Kingdom and Germany, as well as Japan, have established prioritization policies in the areas of life sciences, information communications technology (ICT) and the environment.

Nanotechnology became the focus of world attention when it was identified as the one of the most promising technology and as an area of government commitment by the president of the United States Bill Clinton, who had been alerted to Japan’s superior standing in the field, in January 2000. Nanotechnology was also designated a priority field in Japan's 2nd Science and Technology Basic Plan. It was during this time that Japan, recognizing the strategic importance of nanotechnology, made "nanotechnology and materials" a priority area. It was also at this time that the United States and the EU made it a priority area. For example, the National Nanotechnology Initiative (NNI) was established as a key strategic science and technology strategy in the FY2001 U.S. budget, while nanotechnology was designated a priority field in the EU's 6th Framework Programme in 2002. In other key areas, this was also the time the "basic technology" theme that encompasses many different fields was adopted in the United Kingdom and the "citizens and governance" theme in the EU.

With regard to the setting of budget-related quantitative targets when selecting priority areas, while the United States and the United Kingdom do set such targets, Japan and the EU do not, reflecting basic differences in the approaches countries take. At the international workshop held as part of this study in September 2004, it was announced that although the United States and European countries do not adopt specific prioritization policies they do exist in the form of budgetary allocations.

With regard to combined total investment by the public and private sector in R&D, the EU countries, the United Kingdom and China set specific R&D investment targets as a percentage of GDP. All countries and regions endeavor to set high targets for R&D investment. This is seen as one indication that the scope of science and technology policies is expanding beyond the realm of simply providing assistance for R&D activities and now takes the form of "innovation policies" that ensure practical application can be made of the R&D results, the results can be further built upon and that they offer benefit to society at large.

Also noteworthy is the fact that, in 2002, the European Council established targets for increasing overall EU investment in R&D to 3% of GDP (with 1% coming from government) by 2010. Further, the United Kingdom announced the new "Science and Innovation Investment Framework 2004-2014" strategy in July 2004. In accordance with this new 10-year strategy, combined public and private sector investment in R&D will be increased to 2.5% of GDP by FY2014 and the Office of Science and Technology (OST) and Department for Education and Skills, which account for approximately 45 percent of government investment, will increase their R&D budgets by close to 6 percent annually through FY2007.

(Figure 1-1) R&D Prioritization Policies in Major countries: Reciprocal Comparison

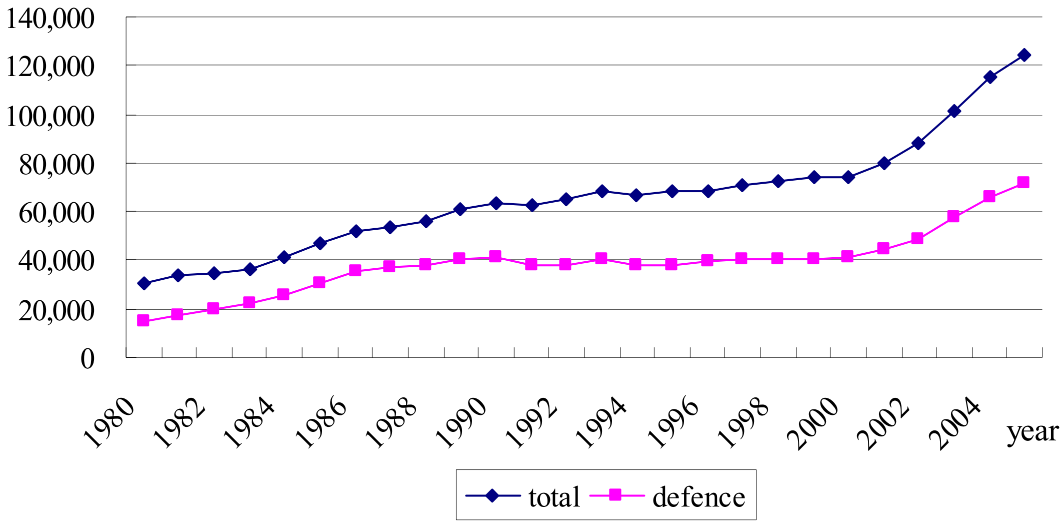
Country	**Japan**	**U.S.**	**EU-15**	**U.K.**	**Germany**
(1) Total of Government R&D investment (S&T budget basis) (PPP)	4.8 trillion yen (FY2004) (including budgets by local governments) 3.6 trillion yen (FY2004) (excluding budgets by local governments)	16.7 trillion yen (2004) (federal budgets only)	11.0 trillion yen (2001) (including budgets by central and local * governments)	1.86 trillion yen (2002) (central government budget only)	2.4 trillion yen (2003) (including budgets by federal and State governments)
(2) % of GDP	0.8% (FY2003) (including budgets by local governments) 0.7%(FY2003) (excluding budgets by local governments)	1.07%(2004) (federal budgets only)	0.77%(2001) (national & regional budgets)	0.79%(2002) (national budgets)	0.80%(2003) (federal & state budgets)
(3) Quantitative targets for Total of Government R&D investment	Total budgets from FY2001 to 2005 equals 24 trillion yen (including regional budgets) 1% of GDP in FY2005	None	3% of European GDP by 2010, including government and private R&D [6th Framework Program: 2002-2006]	Real S&T budget is to be doubled between FY 1997 and 2006. [A policy target by the Labour Party]	Annually increasing budget for research institutes by 3% [Structural reform for labor market and social welfare, “Agenda 2010”] 2003 ~
(4) Prioritized R&D areas	[Second Basic Plan] - Life science - ICT - Environment - Nanotechnology & materials	- Life science (NIH) - Nanotechnology (NNI was set to be a key S&T strategy in FY2001) - Homeland security (DHS) - Networking & information technology - Environment & energy	[6th Framework Program] - Life science - Information society technologies - Nanotechnology & nanoscience (*Specified as a priority area in FP6) - Aeronautics & space - Food quality & Safety - Sustainable Development - Citizens and governance	[Cross-Council Priority Programs in Research Councils] - E-science - Life science (Genome program) - Basic technology - Stem cells - Sustainable energy economy - Rural economy and land use	[Federal government priority areas] - ICT - Biotechnology - Medical care and health - Technology for sustainable development - Materials - Nanotehcnology - Energy - Transportation and mobility - Aviation and Space
(5) Quantitative targets For Prioritized R&D expenditure	None (Doubling the competitive research funds during Second Plan)	Doubling NIH Budget [FY 1998-03: achieved] Doubling NNI Budget [FY 2005-09: Total $3.7 billion]	None	Allocating £650 million to priority areas from FY2001-05, 40% of which will be for life science	None
Reference and data sources	MEXT S&T Policy Bureau, “Budget for S&T in FY2005 and Supplementary Budget in FY2004, (preliminary report.),” Cabinet Office	OECD “Main S&T Indicators” (2004 / 01) [$1=136.2 yen (2004)]	OECD [€1=162.5 yen (2001)] European Commission, *Contributions of local governments budgets are included, if significant.	OECD [£1=231.0 yen (2002)] OST, “SET Statistics” OST, “National Statistics”	OECD [$1=139.7 yen (2003)]

1.2 Trends According to Country

1.2.1 United States

The period recurrent deterioration in financial conditions that occurred after the year 2000 also happened to be a time of significant growth in government investment in R&D. Policy measures to deal with the threat of terrorism led to the establishment of the Department of Homeland Security. Defense and Homeland Security were subsequently designated priority research and development areas.

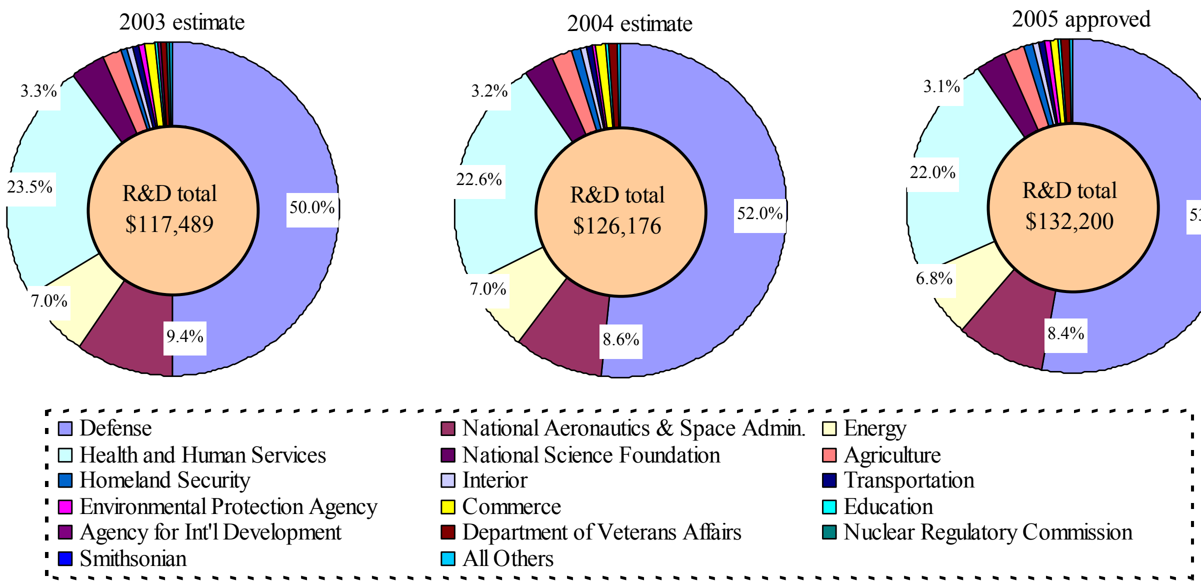
(Figure 1-2) Budgetary Trends for United States Government Research and Development



*estimate in 2004, 2005
(data) Office of Management and Budget (OMB)

The Department of Defense accounts for a large portion of the research and development budget, taking a 52.24% share in 2004. The next largest share of 22.43% went to the Department of Health and Human Services. Most of this department's budget was allocated to the National Institute of Health (NIH). Only the Departments of Defense and Homeland Security recorded growth in their budgetary allocations between 2003 and 2004, while allocations for all other departments declined. This budgetary trend clearly reflects the policy direction of the current administration.

（Figure 1-3） United States Research and Development Budgetary Allocations by Government Department (defense and non-defense)

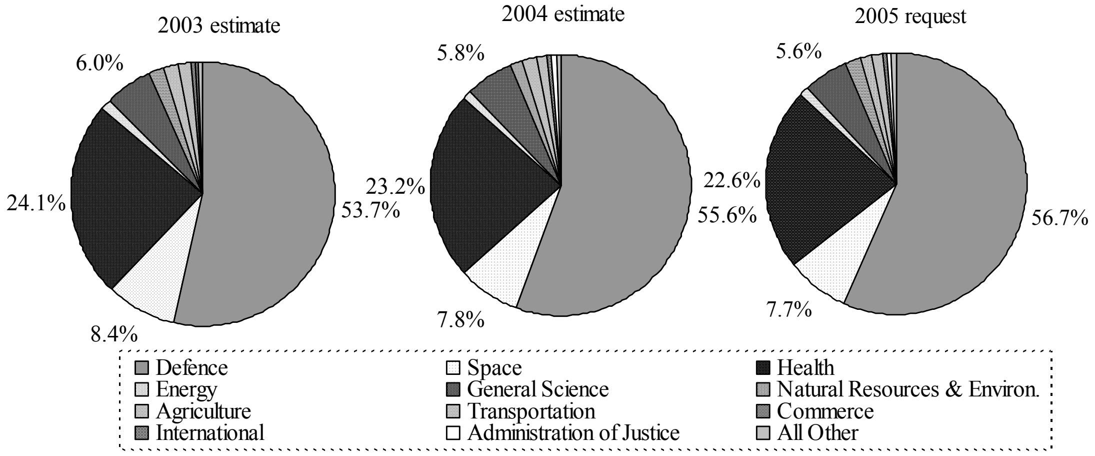


The breakdown of budgetary allocations according to area of expenditure also reveals a huge share going to defense spending. A comparison of the figures for 2003 and 2004 shows significant growth in the share allocated for the area of defense, with the share rising sharply from 53.7% to 59.9%. All other areas of expenditure either stayed the same or declined.

The priority areas within the current budgetary framework are listed below.

- Life sciences
- Nanotechnology (designated a key science and technology strategy in FY2001)
- Homeland Security
- Network and information technology (IT)
- The environment and energy

(Figure 1-4) United States Research and Development to Budgetary Allocations by Area of Expenditure (defense and non-defense)



A look at the proportions of budgetary allocations for basic research and applied research in non-defense related areas shows the two fields of research with a basic 50% each relationship, reflecting the traditional emphasis the United States places on basic research. Where the Department of Health and Human Services shows the typical 50% each relationship between the two research fields, spending at the National Science Foundation (NSF) is almost all allocated to basic research.

(Figure 1-5-1) Research and Development Funding Allocations According to Research Phase for United States Government Bodies (non-defense)

Agency	2004 approved		
	ratio(%)		
	basic	applied	basic+applied
Health and Human Services	26.64	23.63	50.28
National Institute of Health	26.64	21.39	48.03
National Science Foundation	6.43	0.38	6.81
Department of Defence	2.51	8.81	11.32
Department of Energy	4.87	5.18	10.05
National Aeronautics & Space Admin.	4.08	6.20	10.29
Department of Agriculture	1.62	1.65	3.27
Department of Interior	0.07	1.03	1.10
Environmental Protection Agency	0.21	0.76	0.97
Department of Commerce	0.69	1.16	1.85
Department of Transporation	–	0.70	0.70
Department of Veterans Affairs	–	1.40	1.42
Department of Education	–	0.40	0.44
All Others	1.19	0.32	1.51
Total	48.53	51.47	100.00

(Source) American Association for the Advancement of Science (AAAS)

Comparisons of the budgetary allocations for basic research, applied research and development research in areas including defense spending reveals the majority of spending for the Departments of Defense and Homeland Security is for development research.

A look at the breakdown of the budgetary spending for specific areas within the National Science Foundation (NSF) reveals that there are no priority areas selected and no special budgetary strategies in place. While the overall National Science Foundation (NSF) budget is on a declining trend, it seems that decisions concerning budgetary allocations within the Foundation are made on a purely academic basis.

（Figure 1-6） Comparison of Priority Areas
in the National Science Foundation (NSF) Budget

priority fields	Budget ($, million)			
	2001 request	2002 request	2003 request	2004 request
Biocomplexity in the Environment	136.31	58.10	79.20	99.83
Information Technology Research	326.91	272.53	285.83	302.61
Nanoscale Science and Engineering	216.65	173.71	221.25	248.99
Mathematical Sciences	―	―	60.09	89.09
Human and Social Dynamics	―	―	10.00	24.25
Workforce for the 21st Century	157.05	125.51	184.69	8.50
Toal, Above Categories	836.92	629.85	841.06	773.27

（Source） National Science Foundation

In the United States there is a strong correlation between the “prioritization of R&D investment” and the “securing of science and technology personnel (training and mobility)”. More specifically, science and technology policies that “prioritize specific fields and specific areas of research” are designed to utilize the following processes in order to make intensive use of budgetary funds and human resources available.

1) Once a science and technology policy is prioritized, government funding, or more specifically, “external and government research funding,” is provided to the prioritized field in the form of investment.
2) Next, three different groups move into action to obtain this funding. The first is the university group, the second the federal government research laboratory group and the third the corporate sector group (Lockheed Martin, Texas Instruments, etc.)
3) During this phase incentive acts to spur universities and research institutions to

"scout out highly qualified researchers in order to acquire the competitive funding" and "gather highly qualified researchers to form a strong research team capable of maximizing results created with funding."

4) The end result is a pattern that develops in which "research funding is diverted to priority fields" and "researchers converge on these priority fields in search of the invested funding."

1. 2. 2 United Kingdom

The Blair Labour administration that took power in 1997 sharply increased government investment in research and development. In the ten-year period up to then, the level of investment actually remained static when adjusted to the cost-of-living. In the ensuing five-year period from 1998 to 2003, investment increased by approximately 30%. A breakdown of this investment reveals a sharp increase in the research funding for the Research Councils channeled through the Office of Science and Technology (OST) and in the expenditure through the Higher Education Funding Councils, with increases of approximately 54% and 48%, respectively (translates annually to 9.2% and 8.1%).

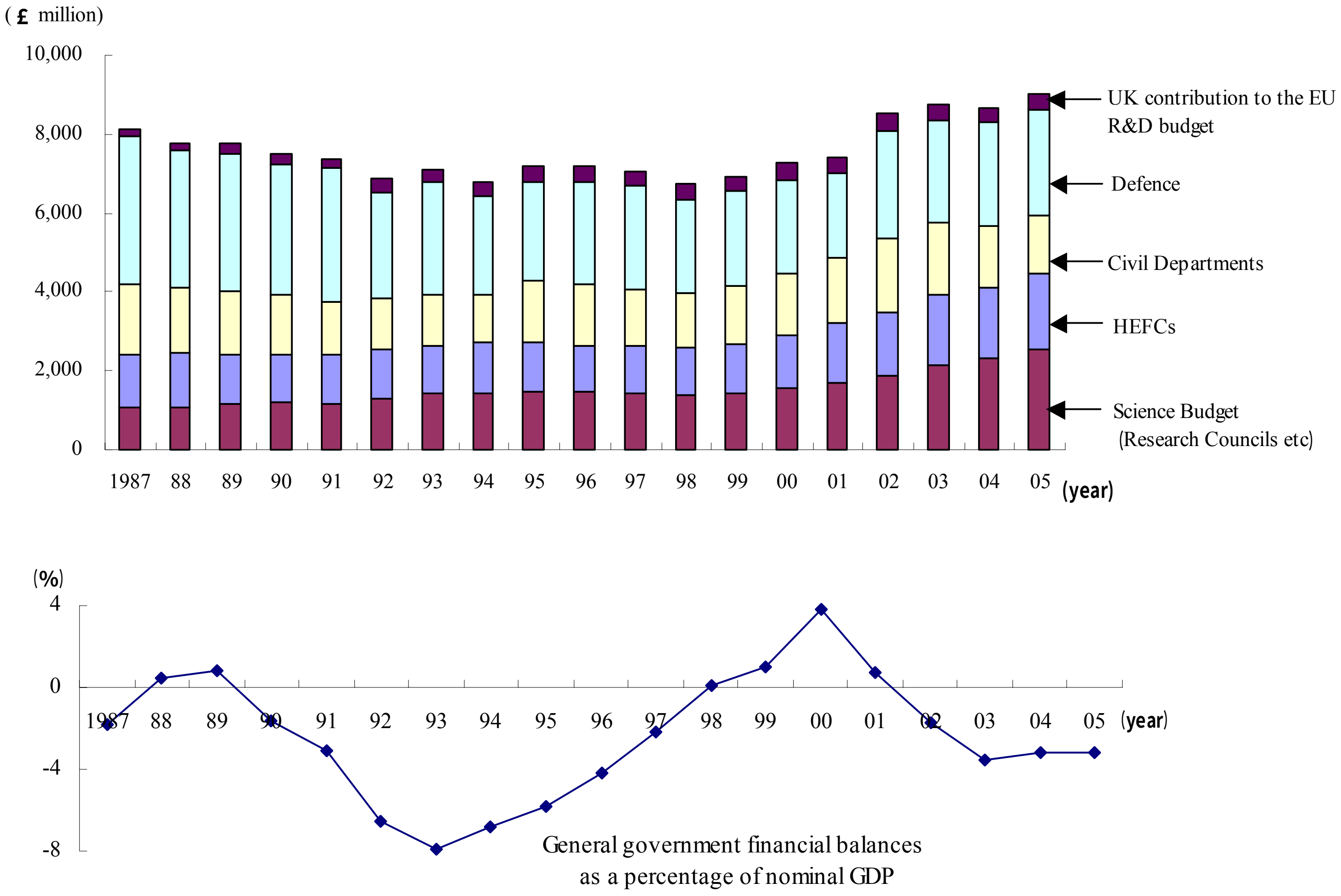
The Science and Technology Innovation Investment Framework 2004-2014, a long-term strategy in the form of a 10-year plan announced by the government in July 2004, will increase research funding through the Office of Science and Technology (OST) and the Department of Education and Skills at an annual rate of 5.7% through FY2007 (Note 1). These two entities account for approximately 45% of government R&D investment (based on FY2003 figures). There is some question, however, over whether these sharp increases in government R&D investment can be maintained in light of the fact that the government budget fell into the red in 2002 and is not expected to recover anytime soon.

Note 1: The long-term strategy manual states that efforts will be made to encourage investment in research and development by the industrial sector, with the ultimate target of increasing investment from the current 1.88% (FY2002) of GDP to 2.5% by FY2014.

The funding provided by the UK government is channeled through the Research Councils and the Higher Education Funding Councils (HEFCs), as well as government ministries, in the form of the "Dual Support System," a special funding distribution body (Note 2). Figure 1-8 shows a long-term perspective of trends in government research and development investment (excluding military investment). As Figure 1-8 indicates, funding provided by the various government bodies (Civil Departments) is on a declining trend, while that provided by programmes (Others, Note 2) under the jurisdiction of the Office of Science and Technology (OST) and the Dual Support System (Research Councils and Higher Education Funding Councils (HEFCs)) is on an increasing trend in its ratio.

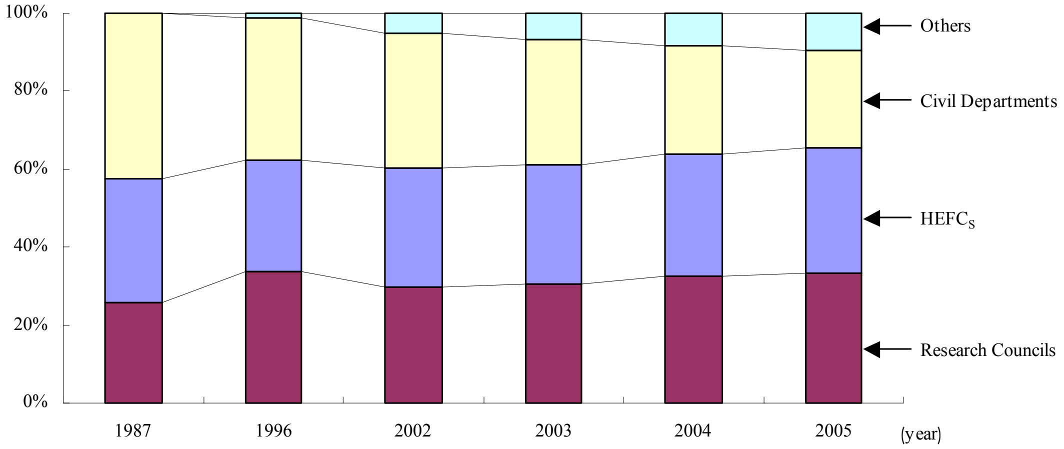
> Note 2: The heading "Others" represents programmes implemented by the Office of Science and Technology (OST) (joint infrastructure funds, science and technology research investment funds and Foresight and Link funding, etc.). Note that FY2005 funding budgeted for Research Councils not yet allocated to a specific Council is recorded under the heading "Others."

（Figure 1-7） Trends in UK Government R&D Investment and Budget Balances



(Source) OST, OECD

（Figure 1-8） Trends in UK Government R&D Expenditure (civilian) by Allocating Institution



(Source) OST "SET Statistics"

Note: The heading "Others" mainly represents programmes implemented by the Office of Science and Technology (OST) (joint infrastructure funds, science and technology research investment funds and Foresight and Link funding, etc.). Note that FY2005 funding for Research Councils not yet allocated to a specific Council is recorded under the heading "Others."

The Research Councils have currently designated six themes as priority programmes in the areas of e-science and genome science in the field of life science. Several councils are performing coordinated research on these themes. The funding provided for each of the research themes in Figure 1-9 shows how, even among priority areas, life science research has special funding preference.

（Figure 1-9） Trends in Priority Areas in the Office of Science and Technology (OST) Budget

	2001	2002	2003	2004	2005	total
e-Science	13.00	29.50	55.50	57.50	57.50	213.00
Post-genomics and Proteomics	15.00	39.50	55.50	61.27	74.73	246.00
Basic Technology	2.00	15.00	27.00	27.30	32.70	104.00
Stem Cells	—	—	0.00	9.25	30.75	40.00
Towards a Sustainable Energy Economy	—	—	2.00	7.62	18.38	28.00
Rural Economy and Land Use	—	—	0.00	4.62	15.38	20.00

(Source) DTI "Science Budget 2003-04 to 2005-06" 2002

Note: The numbers shown in the Figure represent only those research budgetary allocations channeled through the OST. The fact is that it is difficult to gain an overall picture of the research activities being funded by all the other government institutions.

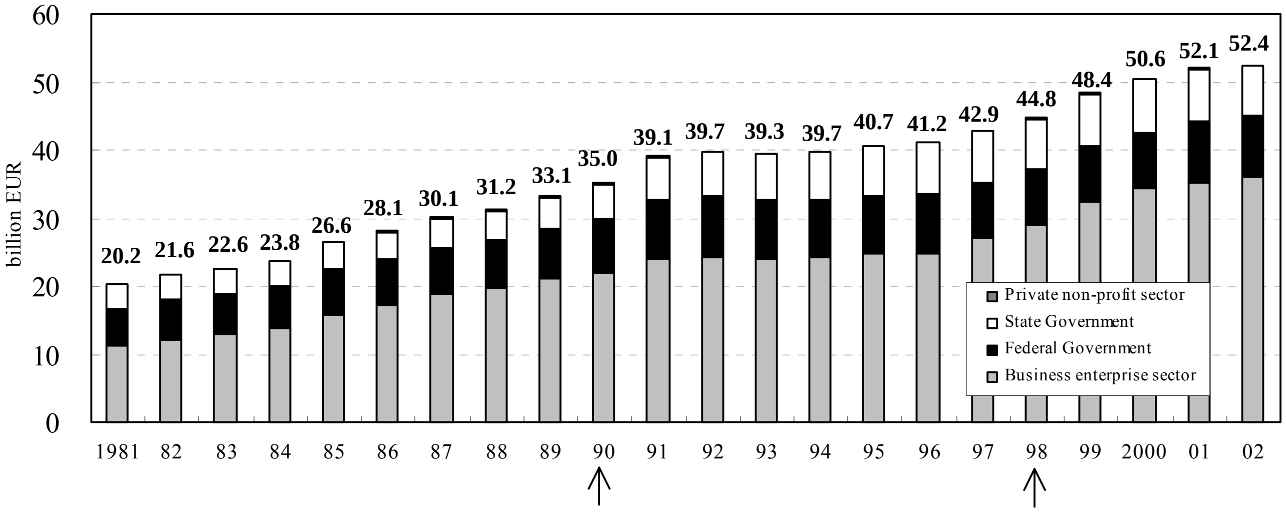
1. 2. 3 Germany

The total amount spent on research and development in Germany has been increasing since the 1980s, coming to €52.4 billion (6.5 trillion yen) by 2002. Private sector corporations take a leading role in research activities in Germany. State (Lander) governments in Germany also have strong influence over research activities, as they invest an amount equivalent to that of the federal government in research activities.

The current economic downturn in Germany is attributed to the effects of German reunification and Germany's late entry into such new industries as computers, electronics and biotechnology. Beginning in the latter part of the Kohl administration (up to 1998), Germany has been taking steps to increase grants (subsidies) for research in such new industries as biotechnology, energy and information communications technology (ICT). The current second coalition government (formed by Schr0der’s SPD and the green party) led by German President Gerhard Schr0der announced policies during 1998 German general election that included “creating future employment by building economic strength based on sustained growth and innovation” and “creating employment through innovation based on research and development.” Research and development funding by the federal government has increased significantly since 1998, with the budget for the Federal Ministry for Education and Research (German abbreviation, BMBF), which plays a central role in science and technology policy, growing by 34% between 1998 and 2004.

On March 14, 2003, German President Gerhard Schr0der announced the “Agenda 2010” reform package designed to restructure both the labor market and the social security system in order to create economic growth. President Schr0der declared “Implementing a programme of strong investment in the fields of education and research during this time of difficult economic conditions will make it possible to maintain a high standard of living. Therefore the government should continue to expand budgets available for research institutions by 3% per year.” On January 6, 2004, President Schr0der announced the government would be focusing on the second phase of “Agenda 2010.” The President pointed out that the second phase will “focus on an offensive approach to innovation in the areas of the research, education and vocational training,” with the aim of developing “elite research universities.”

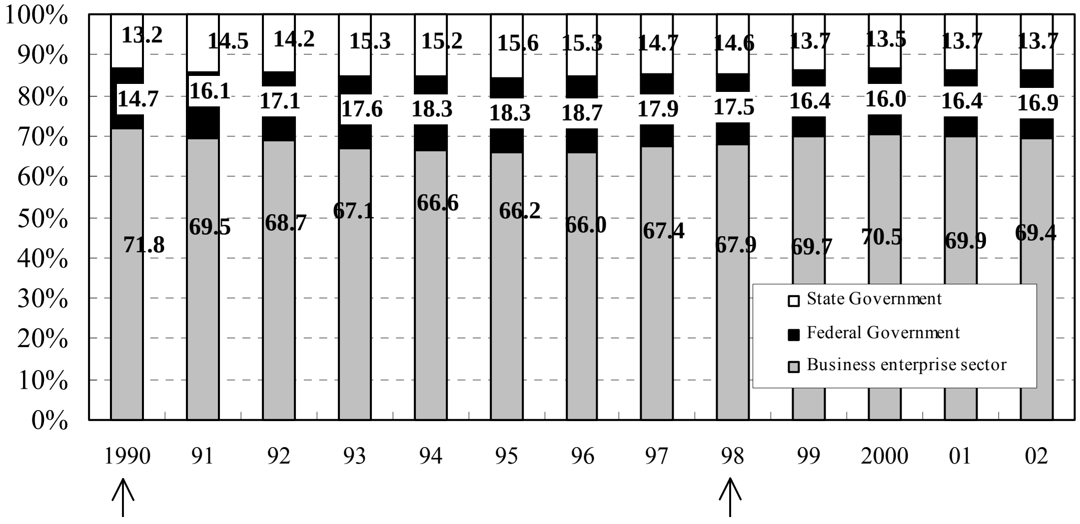
（Figure 1-10） Trends in Total Amounts Spent on Research and Development Funding in Germany



German Unification

Schr0der Administration ~

（Figure 1-11） Trends in Use of Research and Development Funding by Specific Field in Germany



German Unification

Schr0der Administration ~

(Source) Bundesministerium für Bilding und Forshung (BMBF)
"Bundesbericht Forschung 2004", 2004
(Federal Ministry of Education and Research (BMBF)
"Report of the Federal Government on Research")

The following nine areas have been designated as areas of priority for German research and development.

① Information communications technology (ICT)
② Biotechnology
③ Medical and health
④ Technology designed to enable environmentally sustainable development
⑤ Materials
⑥ Nanotechnology
⑦ Energy
⑧ Transport and mobility
⑨ Aerospace technology

Germany's prioritization strategy incorporates the following two key features.

I. Research for Human being
II. Innovation for New Jobs

The Federal Ministry for Education and Research (German abbreviation, BMBF), which plays a leading role in science and technology policy, has declared its intention to work offensively to promote “Agenda 2010.” The main fields of science and technology given priority by the Federal Ministry for Education and Research (BMBF) are described in Figure 1-1. Note that nanotechnology is a field of special focus.

1.2.4 Other Countries

(1) EU:

Increasing the Focus on Life Sciences and Development of Research Personnel

The EU spends a comparatively small amount on its research and development budget that comes to only about 5% of the total spent by governments of EU member nations. Nevertheless, joint research and development conducted at the EU level is designed to serve as a catalyst to stimulate the research and development conducted by individual countries. In this sense it plays a key development role. A look at the budgetary trends over the long term for the Framework Programme, which serves as the framework for research and development conducted by the EU, reveals considerable changes in areas of priority over the past 20 years or so.

EU science and technology policy is regarded as the driving force behind implementing the Lisbon Strategy (Note), which designates creation of the European Research Agency (ERA) as one of its top priorities. The EU's 6th Framework Programme is being used as a policy promotion tool for creating the European Research Agency (ERA).

The 4-year budget for the EU's 6th Framework Programme comes to €17.5 billion, an increase of 17% over the 5th Framework Programme. Figure 1-13 shows the budget divided into four main projects. Of these, the seven priority areas for Project 1 alone accounted for approximately 70% of the budget allocation of €16.27 billion (not including atomic energy).

Comparison of the content of the budget for the EU's 6th Framework Programme with that of its predecessor FP5 (1998 to 2002) reveals no significant changes in areas of priority. However, there are significant differences in terms of priority for budgetary allocations within specific fields over the long-term (see Figure 1-14). For example, the field of energy accounted for approximately 50 percent of the budget in the EU's 1st Framework Programme (1984 to 87). As allocations for energy declined in subsequent budgets, the emphasis on information communications technology (ICT) and industrial materials technology grew. Life sciences and the development of research personnel became areas of main focus with FP5.

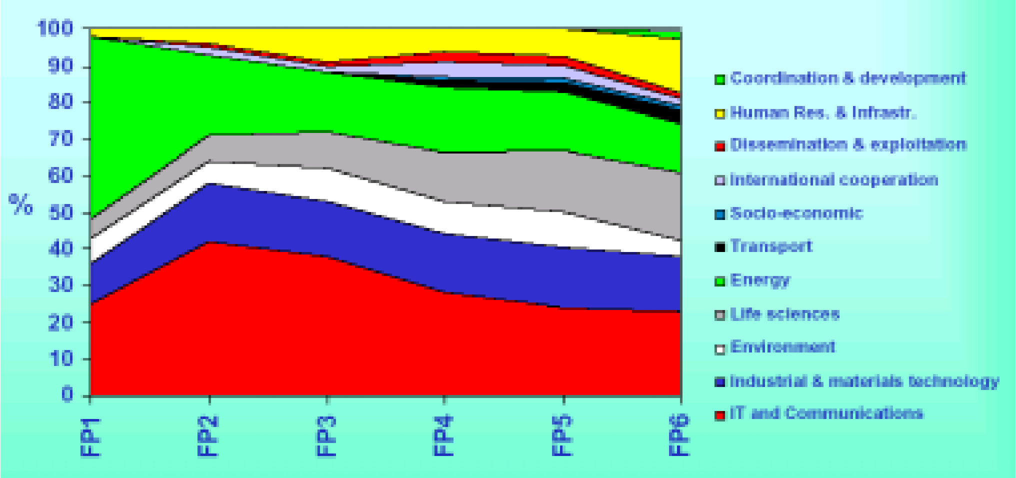
（Figure 1-13） Content of EU 6th Framework Programme Budget

(unit: million €)

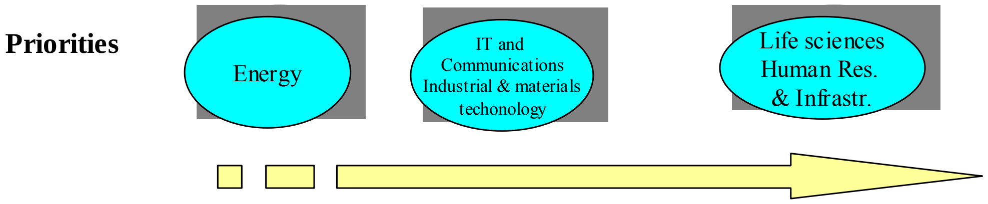
1. FOCUSING AND INTEGRATING COMMUNITY RESEARCH	13,345
(1) Thematic priorities	11,285
① Life science: genomics and biotechnology for health	2,255
② Information society technologies	3,625
③ Nanotechnologies and nanosciences, knowledge-based multifunctional materials and new production processes and devices	1,300
④ Aeronautics and space	1,075
⑤ Food quality and safety	685
⑥ Sustainable development global change and ecosystems	2,120
⑦ Citizens and governance in a knowledgy-based society	225
(2) Specific activities covering a wider field of research	1,300
2. STRUCTURING THE EUROPEAN RESEARCH AREA	2,605
(1) Research and innovation	290
(2) Human resources and mobility	1,580
(3) Research infrastructures	655
(4) Science and society	80
3. STRENGTHENING THE FOUNDATIONS OF THE EUROPEAN RESEARCH AREA	320
(1) Support for the coordination of activities	270
(2) Support for the coherent development of R&I policies	50
4. EURATOM PRIORITIES	1,230
Total	17,500

(Source) European Commission “Participating in European Research Sixth Framework Programme” 2002

(Figure 1-14)　Trends in Framework Programme Budget Allocations by Field



(Source)"The Role of FP6 in building ERA" , Marco Malacarne, DG Research, June 2003



(2) Finland: Emphasizing Competitive Environment over Selection of Priority Areas

Finland experienced a sharp economic downturn during the early 1990s in the aftermath of the collapse of both the bubble economy and the Eastern European and Soviet regimes of the time. Even paring down investment in other field, the Finnish government at that time took steps to increase in research and development. This aggressive approach to investment in research and development paid dividends with rapid economic recovery by the mid 1990s being enabled by developments in the field of information technology (IT). The recovery continues to this day.

Finland's approach is to focus on creating a competitive environment rather than prioritizing specific fields. As an historic background, Finland found inspiration in the industrial technology policies of Japan in the 1980s and adopted the "identify and support potential winners" policy in which the government provides support for key industries of the future. This approach was based on the premise that the government possessed the requisite high degree of knowledge that qualified it to identity and select the key industries and technological fields of the future.

However, the government discovered in the 1990s how difficult it was to anticipate the growth industries of the future and made policy changes accordingly. The government then adopted the new policy of “creating a competitive environment.” Specifically, the policy aimed at correcting mistakes identified in the market in order to promote competitiveness and create a more normal environment conducive to economics rather than directly intervening in markets.

We were able to interview a key personality in Finland over the course of the current study. This individual voiced the opinions that “Finland does not take the approach of selecting priority areas and providing research and development grants on a preferential basis. Instead, it is to grant assistance only to those areas identified as capable of standing up to the stiff international competition. Accordingly, grants increased to strengthen the field of information technology (IT) have provided benefits in the long run.”

(3) China: Emphasizing the Establishment of Strong Fields and Applying High-tech Research Results to Industry

The principal aim of China’s current science and technology policy is one of playing catch-up to the industrially advanced nations. The government is investing heavily in fields where China is internationally competitive. It is also establishing strong science and technology fields and placing emphasis on applying the results of high-tech research to industry.

＜Overview and Target for Development of Science and Technology Policy in the 10th Five-Year Plan (2001 to 2005)＞

● Overview

- Given limitations on national science and technology resources, priority to resource allocation is given to the most advanced fields while the lowest fields are unallocated.
- Progress towards international standards is maintained for all fields of science and technology while research and development efforts focus on the key fields.
- Work continues on progress in high-tech fields and industrial application of research results.
- Measures are taken to strengthen the nation's innovative capabilities while rapid progress is made in technology.

● Targets for Development

- Bring technical levels and competitiveness of Chinese corporations in the main sectors (agriculture, industry and services) to the mid 1990s level of advanced nations. Make parallel efforts to bring certain areas up to current level of advanced nations.
- Raise the levels of basic and high-tech research to the most advanced international standards by 2005 and achieve major international breakthroughs in certain fields.
- Apply science and technology resources to solving population, natural resources and environmental issues.
- Expand research and development expenditures to 1.5% of GDP and raise corporate share of investment in research and development to 50 percent by 2005.
- Development of science and technology human resource pool of 900,000 by 2005.
- Continue work on building science and technology infrastructures.

(Source) China Science and Technology Department and the Overview of Science and Technology Management in China.

In addition, the following specific targets have been set for the duration of the plan (2001 to 2005) in order to achieve the "Development in Science and Technology Policy in the 10th Five-Year Plan (2001 to 2005)."

- Expand investment in research and development (increase spending from 1% of GDP in 2000 (at 1.31% in 2002) to 1.5% in 2005).
- Expand the science and technology human resource pool to 900,000.

The following four main tasks have, for the interim, been designated as necessary for meeting the targets and policies of the 10th Five-Year Plan (2001 to 2005).

① Strengthen research and development for generic technologies in order to transform the nation's economic structure and support sustained development.
② Strengthen capability for sustained innovation in science and technology to achieve significant advances in development.
③ Apply China's unique science and technology innovation capabilities to the area of defense in order to maintain national security.
④ Achieve greater depth through rebuilding science and technology systems in order to create a national technology innovation system.

(4) Taiwan: Focusing Major Budgetary Resources on Nanotechnology

In 1998, the Taiwanese government established the "National Science and Technology Program" (see Figure 1-17) as part of an integrated program designed to promote societal and economic development in accordance with its science and technology development plan. A key feature of this plan is that it allocates major budgetary resources to the field of nanotechnology. The government is also increasing investment for research and development for disaster prevention due, no doubt, to the fact that Taiwan is in a region highly susceptible to earthquakes.

（Figure 1-17） Duration and Budgetary Breakdown of Taiwan's National Science and Technology Program

Program	**Duration**	**Total Budget （TWD$1.0 billion）※**	**Related Government Agencies**
Hazard Mitigation （ disaster prevention technology ）	1998 to 2001 2002 to 2006	1.0 3.1	Economic Department, Agricultural Committee, Internal Affairs Department, National Science Committee, Sanitation Department, Environmental Protection Agency, Traffic Department, Finance Department, Public Works Committee, Education Department, Others
Telecommunications	1998 to 2003	12.8	Economic Department, Traffic Department, Education Department, National Science Committee
Agriculture and biotechnology	1998 to 2001 2002 to 2004	0.8 2.0	Agricultural Committee, Academic Sinica, National Science Committee, Economic Department
Biomedicine	2000 to 2002	1.1	Sanitation Department, National Science Committee, Economic Department,
Genome drug discovery	2002 to 2004	7.5	Academic Sinica、Cultural Committee, Sanitation Department, National Science Committee
Digital archiving	2002 to 2006	2.8	Academic Sinica、Cultural Committee, Others
Systems on chip	2002 to 2005	7.7	Economic Department, Education Department, National Science Committee
Nanotechnology	2003 to 2008	23.2	Economic Department, Academic Sinica, Education Department, National Science Committee
e-learning	2003 to 2007	4.0	Economic Department, Education Department, Labor Committee, Cultural Committee, Sanitation Department, National Science Committee, others

※TWD$1 Taiwan dollar （NT$） ¥3.5

(Source) Executive Branch National Science Committee and Chinese Science and Technology Yearbook (2002 Edition)

(5) South Korea: 6T Technology Designated a Key National Science and Technology Strategy

The South Korea Science and Technology Basic Plan was established to help the nation achieve the number ten ranking in the world in terms of science and technology competitiveness by 2006, and thereby “achieve economic growth capable of raising average per capita income to $15,000 and establish a welfare society.” This strategy illustrates how South Korea links science and technology policy very closely to industrial and economic policy, a trend also seen in China including Taiwan.

In order to achieve this goal, South Korea has designated development of a promising new technology, known as “6T technology,” as a key element of its national science and technology strategy. Intensive research and development efforts are currently underway.

（Figure 1-18） Overview of "6T Technology" Included in the South Korea Science and Technology Basic Plan

Category	Full Name	Outline
IT	Information Technology	All technology required for information distribution, including creating, deriving, processing, transmitting and storing information.
BT	Biotechnology	Technology capable of using living organisms or matter derived thereof or biological systems that are capable of triggering biological phenomena usable in manufacturing commercial liable products or technology used in improving such processes.
NT	Nanotechnology	Science and technology techniques that can be used to manipulate, analyze and control matter at the atomic and molecular levels.
ST	Aerospace Technology	Technology for developing aircraft, satellites and rockets and related technology.
ET	Environmental and Energy Technology	Technology for preventing, reducing or recovering from environmental contamination, and environmental, purification, energy and marine environment technology.
CT	Culture Technology	Digital media technology used for developing advanced cultural and artistic industries.

(Source) South Korea’s “Science and Technology Basic Plan”

In accordance with the plan, targets have been set to increase various science and technology related indices in order to expand research and development funding from the figure of KRW15.8116 trillion (approx. $1.5 trillion) in 2001 to KRW2.4 trillion (approx. $2.4 trillion) in five years. The indices targets include increasing the number of domestically filed patents from 43,314 in 1999 to 130,000 in 2006 and overseas filed patents from 6,642 in 1998 to 18,000 in 2006. The ultimate goal after achieving these targets is to increase per capita income from $9,675 to $15,000. Refer to figure 1-19 below for a detailed list of these targets.

（Figure 1-19） Current Science and Technology Indices and Future Targets in Accordance with the "South Korea Basic Science and Technology Plan"

Category			**2001**	**2006**
Charge	Investment	Total R&D Investment	KRW15.8116 trillion	KRTW2.4 trillion
		R&D investment budgeted by government	4.3%	Increase government R&D investment over next five years by factor exceeding rate of total government budget increase.
		Proportion of basic research in government R&D	17.8%	20% or more
	Manpower	No. of researchers	159,900（2000）	200,000
		No. of researchers per 10,000 of population	33.8（2000）	40
Output	Patent	Domestic patents (filed by Koreans)	43,314（1999）	130,000
		Overseas Patents	6,642（1998）	18,000
	Paper	SCI (science citation index) format	12,232（2000）	30,000
		Order	No. 16（2000）	No.10 or higher
		No. of cases cited over 5 years	No. 60（2000）	No. 40
	Science and technology indicators		0.07（1999）	0.3
Result	Competitiveness in science and technology （IMD）		No. 21	No. 10
	World competitiveness （IMD）		No. 28	No.15
	Per Capita GDP		$9,675（2000）	$15,000

(Source) "South Korea's Science and Technology Basic Plan" (2002-2006)

Chapter 2:
Comparative International Analysis of University Budgetary Frameworks and Research Activities

【 Key Points 】

- Simple comparisons for funding have been made difficult by the fact that funding items are defined differently according to country, as seen with labor costs and other items. That being said, a look at the various types of funding that comprise the overall research funding figures for major countries seems to indicate that, in the U.S., there is a trend toward a comparatively large portion of research funding for universities being comprised of “external and government research funding.” Furthermore, the greater the size of the total university research budget the larger the proportion of external funding.
- With universities in the United States, the greater the size of the total university research budget the larger the proportion of external funding. Public universities (state universities) receive a higher proportion of internal funding for their research budgets when compared with private universities. This is believed due to public universities receiving funding from state and local governments in the form of something similar to the operating subsidies that Japanese universities receive.
- United Kingdom universities receive funding in three forms. These include 1) the Dual Support System (which provides research funding via the Ministry of Education and Skills and the Research Councils of the Office of Science and Technology (OST) (thus dual support)), 2) research funding distributed by the Research Councils and 3) and funding from charities provided on a long-term basis. This system of funding is unique in the fact it combines the “competitive” aspect with “diversity.”
- State (Lander) universities make up approximately 70 percent sign of the German institutions of higher learning (general universities and universities for applied sciences (“Fachhochschulen”)). Tuition is normally free and the “basic funding” is provided by a combination of the federal government and the State (Lander) government. “Research funding” is provided in the form of “internal research funding” diverted from the school’s “basic funding” and “external funding” provided by research support institutions, corporations and foundations. Approximately 85% of “research funding” comes from government/public sectors, 10 percent from private sector corporations and the rest from a combination of foundations and overseas sources.

2.1 Summary of Comparative International Analysis

2.1.1 Types of Research Funds Comprising Overall University Research Budgets in Major Countries

Figure 2-1 shows the various types of research funds that make up the total research budgets for universities in the major countries. Simple comparisons for funding have been made difficult by the fact that funding items are defined differently according to country, as seen with labor costs and other items. That being said, a look at the various types of funding that comprise the overall research funding figures for major countries seems to indicate that, in the United States, there is a trend toward a comparatively large portion of research funding for universities being comprised of “external and government research funding.” “Internal research funding” comprises 24.8% of budgets of public universities and 9.7% of private universities. Internal research funding comprises 31.2% of budgets at United Kingdom universities. It comprises 83.1% of funding at Japan’s national universities and 89.9% at private universities (Case 1: includes labor costs, etc.). “Internal research funding” comprises a comparatively high 61.3% of the total funding at German universities. The figures clearly reveal that Japanese and German universities rely on internal funding for a comparatively large portion of their research budgets.

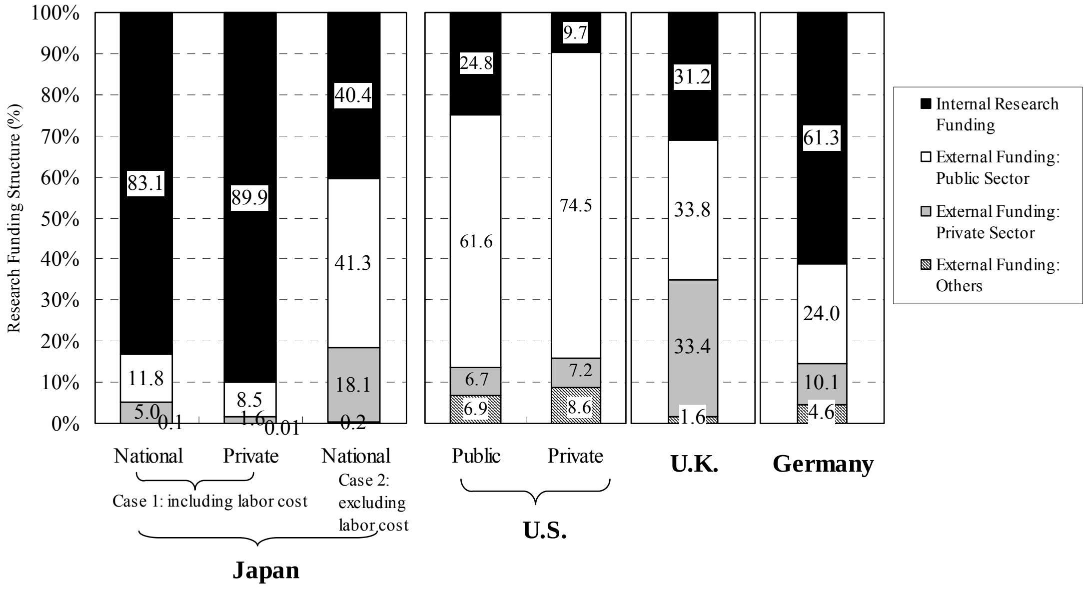
With regard to “external and private sector research funding,” national universities in Japan receive 5.0% and private universities 1.6% of their total funding budgets from these sources.

The “external and private sector research funding” accounts for 6.7% of the total research budget for public universities and 7.2% of private universities in the United States. In the United Kingdom it accounts for approximately 33% of the university research funding budget, however, it is a figure that also includes funding from charities (approximately 17%) and from overseas sources (approximately 9%). Calculated on the basis of funding from domestic corporations only the figure would come to a mere 7%.

According to Japanese Ministry of Internal Affairs and Communications statistic keeping practice, the funding for educational research and incidental labor costs are an inseparable part of the internal research funding that takes the form of “the research funding for internal use by Japanese universities.” According to the United States’

National Science Foundation (NSF) statistics, the internal funding proportion of the “American university research funding budget” does not include educational research funding as an inseparable cost and only includes research funding that comes accounted for separately. To compensate this discrepancy, we can apply the Case 2 calculation technique which subtracts labor costs from the “internal research funding” figure for Japan. By during a rough calculation on this basis we can surmise that Japanese universities receive about the same amount of “external funding” as United Kingdom universities

(Figure 2-1) Rough Calculations of the Composition of Research Funding for Universities of Various Countries (2002)



(Source) Taken from the following reports.

Japan; Case 1: labor costs included

Taken from Department of Statistics, Ministry of Internal Affairs and Communications Report: “Report on Survey of Research and Development for 2003” (Summary, Figure 3).

- Internal Research Funding: “Funding Supplied from the University’s own financial resources”
- External Funding: - Public Research Funding:

“National and regional government bodies” + “special organizations and independent organizations”

- Private Sector Funding: “Funding from the Private Sector”
- Others: “Funding from Overseas Sources”

Case 2: labor costs not included

With regard to Case 1 statistics, it is assumed that “internal research funding” is comprised of “basic materials costs” + “other incidental costs” and “external funding” is used for “basic materials costs” + “other incidental costs.” The portion of the research funding for “internal use” to the funding supplied from the university's own financial resources was calculated by subtracting “external funding” from “basic materials costs” + “other incidental costs” in science and technology field.

2.1.2 Trends in Higher Education Funding As a Percentage of GDP (1995 to 2001)

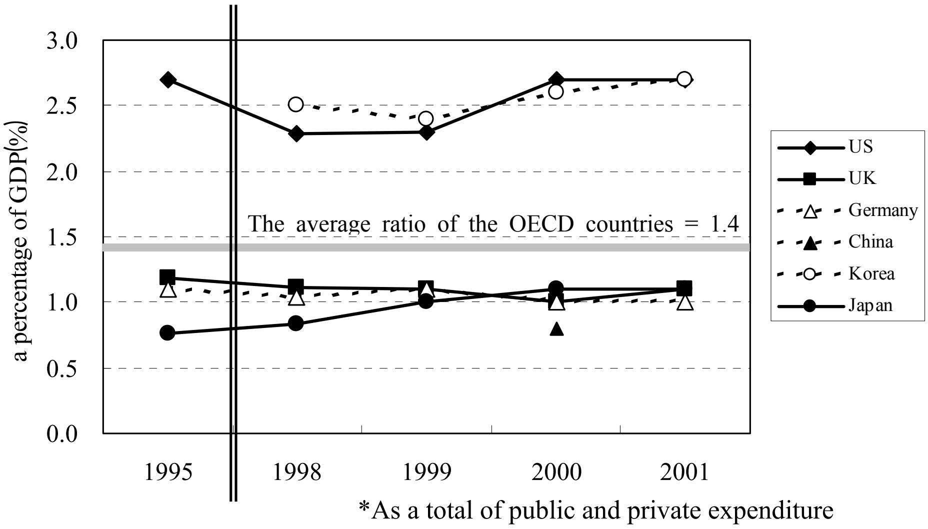
Figure 2-6 shows the trends in higher Education funding as a percentage of GDP. The percentages of higher Education funding in relation to GDP for the six countries covered under this comparison can be roughly divided into two groups.

The United States and South Korea fall into the comparatively higher 2.5% group. In the other group are Japan, the United Kingdom, Germany and China, which with a GDP percentage of roughly 1.0% are more in line with the OECD member country average of 1.4%. (Information on trends in China is inconclusive as only data for the year 2000 is available.)

OECD member countries not shown in Figure 2-6 that exceed the 1.4% average include the five nations of Canada (2.5%), Denmark (1.8%), Sweden (1.7%), Finland (1.7%) and Australia (1.5%).

The percentage of GDP used for higher Education funding in Japan certainly cannot be said to be very high on the international ranking scale.

〔Figure 2-6〕 Trends in Higher Education Funding As a Percentage of GDP



*As a total of public and private expenditure

	1995	1998	1999	2000	2001
US	2.7	2.3	2.3	2.7	2.7 (0.9)
UK	1.2	1.1	1.1	1.0	1.1 (0.8)
Germany	1.1	1.0	1.1	1.0	1.0 (1.0)
China	n.a.	n.a.	n.a.	0.8	n.a.
Korea	n.a.	2.5	2.4	2.6	2.7 (0.4)
Japan	0.8	0.8	1.0	1.1	1.1 (0.5)
<the avarage ratio of the OECD countries>					1.4

Note: The figures in ( ) represent the public higher Education Funding Ratio.

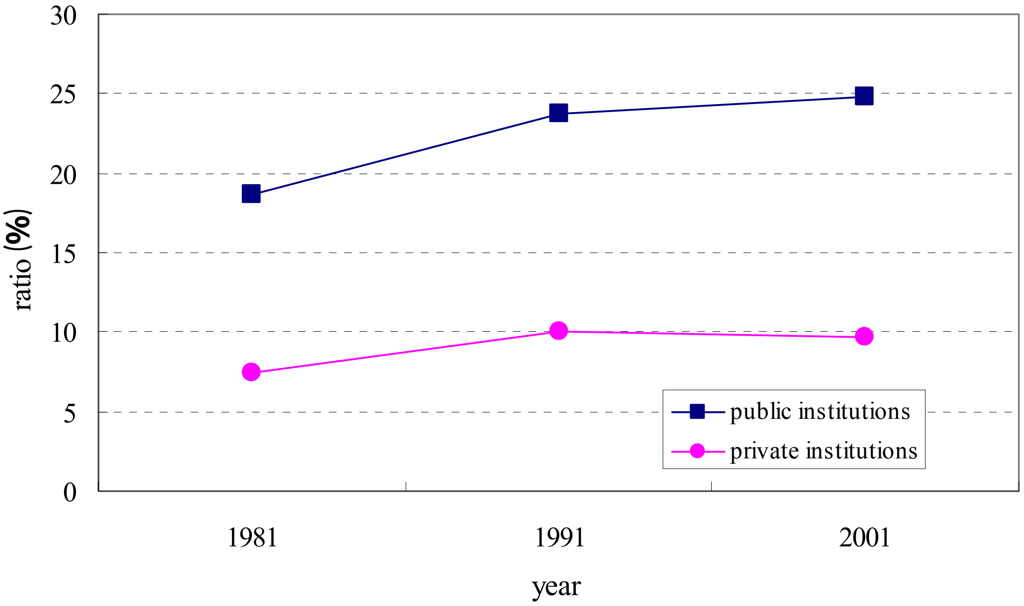
2.2 Trends According to Country

2.2.1 United States

Figure 2-7 shows the percentages of “internal funding” that comprise research funding. A look at the trends for the period 1981 to 2001 shows that the percentages range from 18.7% to 24.8% for public universities (state universities). In contrast, the figure for private universities is in the 7.4% to 10.0%. The public universities (state universities) clearly use a far more “internal funding” for their research funding.

According to analysis conducted by the National Science Foundation (NSF), it is believed that the key factor in this phenomenon is the fact that the operating subsidies provided to public universities by state and local governments are primarily allocated to research funding. (For detailed information, refer to the section “State and Local Government Funds”, p5-10, Science and Engineering Indicator 2002, NSF.)

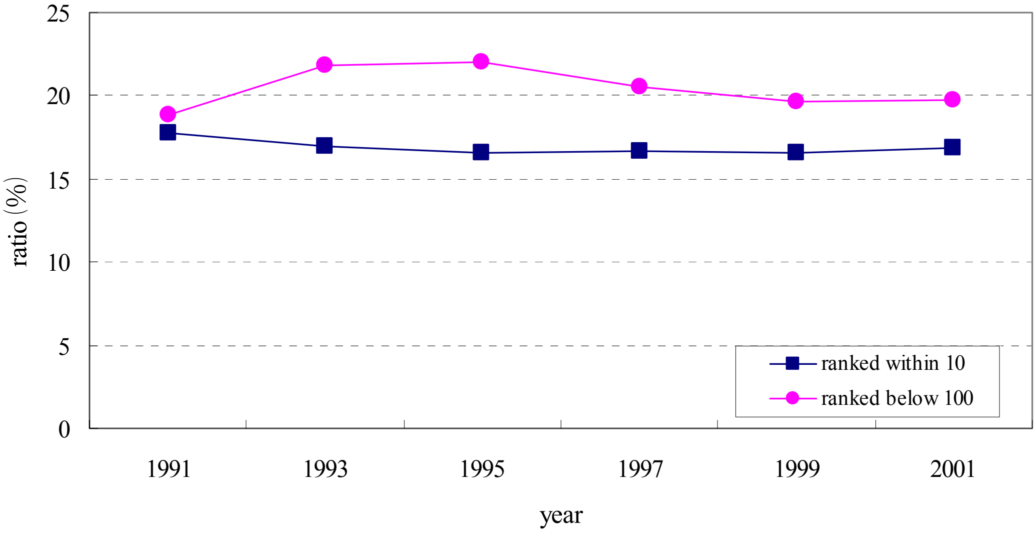
〔Figure 2-7〕 Proportion of “Internal Funding” Comprising University Research Funding in the United States



(Source) Taken from “Science and Engineering Indicator-2004” Appendix table 5-3, National Science Foundation (NSF).

Figure 2-8 shows how university research funding is allocated. The “the total research funding for universities ranking in the top 10 in terms of level of acquisition of research funding” and the “total research funding for universities ranking 101 and lower,” as recorded in National Science Foundation (NSF) statistics, showed the following trends. The allocation percentage, which stood at approximately 20% of total research funding for the top 10 universities in 1985, declined to about 17% as they entered the 1990s. The trend was the opposite for universities ranking 101 and lower, as they went from approximately 17% in 1985 up to approximately 20% as they entered the 1990s. The data on a whole shows greater dispersal of the research funding being provided to universities. (“Emphasis on Research at Universities and Colleges”, p5-14, Science and Engineering Indicator 2002, NSF.)

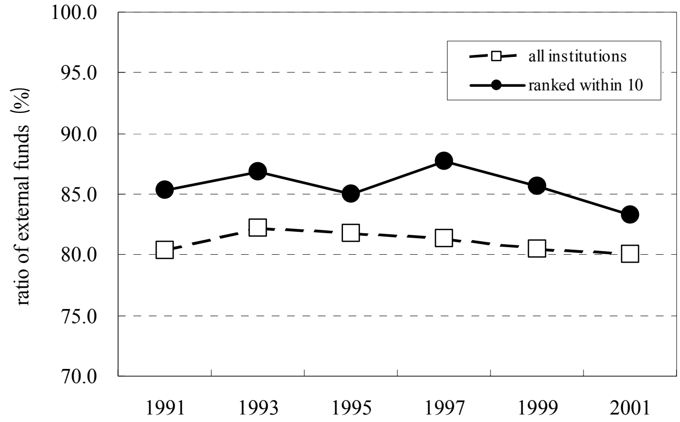
(Figure 2-8) Allocation of Research Funding to United States Universities: Percentages for “Top 10” and “101 and Lower” Universities



(Source) Taken from “Academic Research and Development Expenditures”, Division of Science Resources Statistics, National Science Foundation.

A look at the trends in “proportion of external funding comprising University Research and Development expenditures” for the FY1991 to FY2001 period prevails that the average calculated for all American universities fell within the 80.0% to 82.2% range. Looking only at the top 10 ranking universities (UCLA first in FY2001) in terms of research and development, the average fell within the 83.3% to 86.8% range. The difference is accounted for by the fact that the top 10 universities in the United States received between 3.3% and 6.4% more “external funding” (Figure 2-9).

(Figure 2-9) Trends in Proportion of External Funding Comprising Research Funding at Universities (Public and Private) in the United States

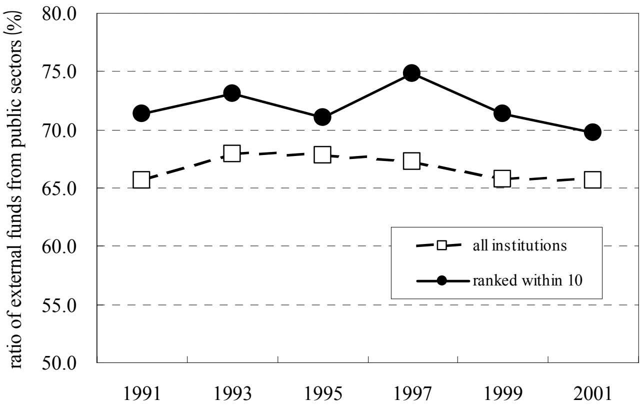


(Source): See below.

- Calculated by subtracting the costs item "Academic institutions" from the total research funding.
- The fiscal year starts from the beginning of October the preceding year and ends the end of September the current year.

The proportion of research funding comprised by "external funding from public sector" calculated for all American universities (Public and Private) for 2001 showed an average of 65.7%. In contrast, the average for the top 10 universities came to 69.7% (Figure 2-11).

(Figure 2-11) Trends in Proportion of External Funding by Public Sector Comprising Research Funding at Universities (Public and Private) in the United States



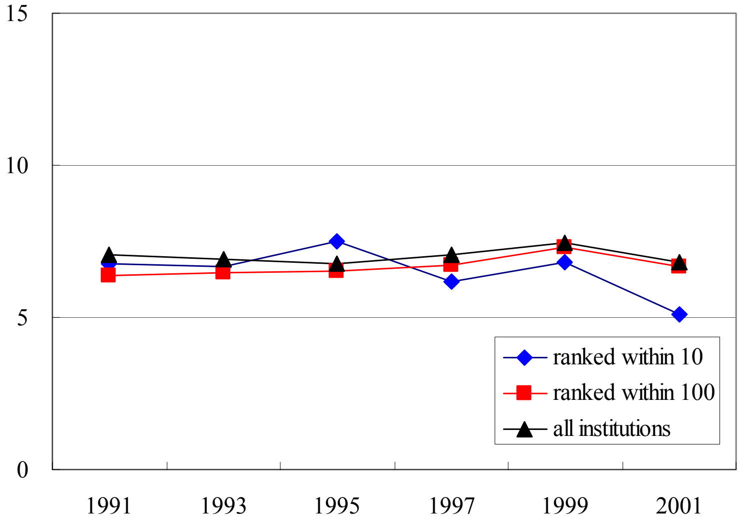
(Source) See below.

- Taken from "Academic Research and Development Expenditures", Division of Science Resources Statistics, National Science Foundation (NSF).
- Expense categories: "Federal government" and "State and local government" statistics used as "Funding by Public Sector."
- The fiscal year starts from the beginning of October the preceding year and ends the end of September the current year.

The “proportion of research funding comprised by funding from industry” calculated for all American universities (public and Private) for the FY1991 to FY2001 period showed an average in the 6.8% to 7.5% range. In contrast, the average for the top 10 universities was in the 5.1% to 7.5% range.

There was no significant difference between the averages of for all American universities and the top 10 universities in relation to “funding from industry” (Figure 2-12).

(Figure 2-12) Trends in Proportion of Funding From Industry Comprising Research Funding at Universities (Public and Private) in the United States



(Source) See below.

- Taken from “Academic Research and Development Expenditures”, Division of Science Resources Statistics, National Science Foundation (NSF).
- Expense categories: “Industry” statistics used as “Funding from Industry.”
- The fiscal year starts from the beginning of October the preceding year and ends the end of September the current year.

The breakdown of “external research funding from private sector” revealed the "donations" made up to major proportion. For example, the funding acquired from industry as part of the revenue for Stanford University for 1999 came to approximately $172 million. About $64 million (or approximately 37%) of this was in the form of donations. (Taken from “A report on its history, financial conditions, and success stories”, March 2002, prepared for The Japan Research Institute, Limited, Jon Sandelin; Senior Associate; Stanford University Office of Technology Licensing)

2.2.2 United Kingdom

Research funding for the United Kingdom universities come primarily from the following three sources.

① The Dual Support System (which provides research funding via the Ministry of Education and Skills and the Research Councils of the Office of Science and Technology (OST) (thus dual support))
② Research funding distributed by the Research Councils
③ Funding from charities provided on a long-term basis.

This system of funding is unique in the fact it combines the “competitive” aspect with “diversity.” When compared with the increase in the number of students, the increase in the UK university income has tapered off.

A close look at real income on a cost-of-living adjusted basis reveals university income increased by approximately 23% between FY1995 and FY2002. During the same period, however, the number of students going on to university increased by approximately 26%, resulting in a 3% reduction in real university income per student (see Figure 2-13).

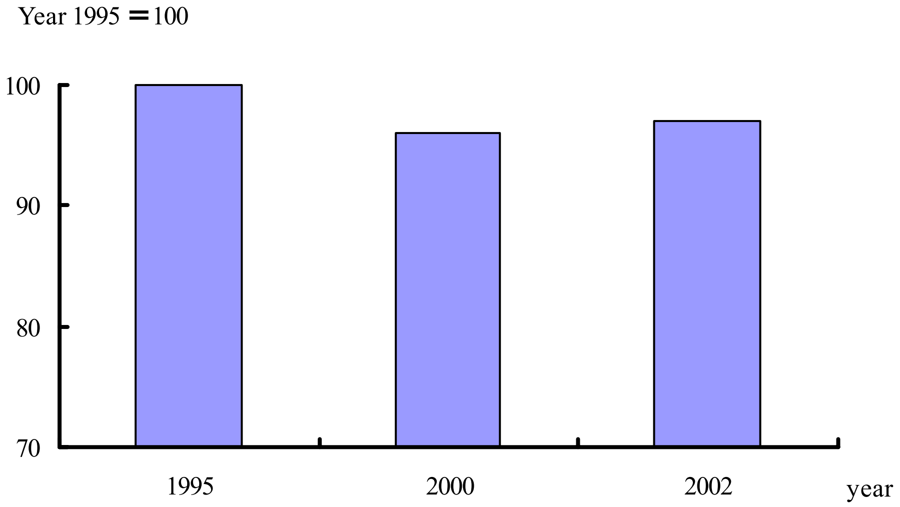
Trends in allocation of “block grants”, the major source of income provided by the government in block, reveal an approximate 9% decline in income per student in real terms (Figure 2-14). This rate of decline significantly outstrips the rate of decline in all of university income.

In other words, despite efforts on the part of universities to make up for the shortfall in “government block grant funding” (adjusted in real terms on a per student basis) to UK universities, they have failed to make up the full amount.

It is because of these developments that the tuition fee system for the United Kingdom universities is scheduled to change from a fixed tuition system (annual fees of £1,125) to a discretionary system, in which schools can set tuition fees according to department up to a maximum of £ 3,000 in FY2006. All universities will be responsible for taking steps to secure the financial resources they require to charging tuition fees.

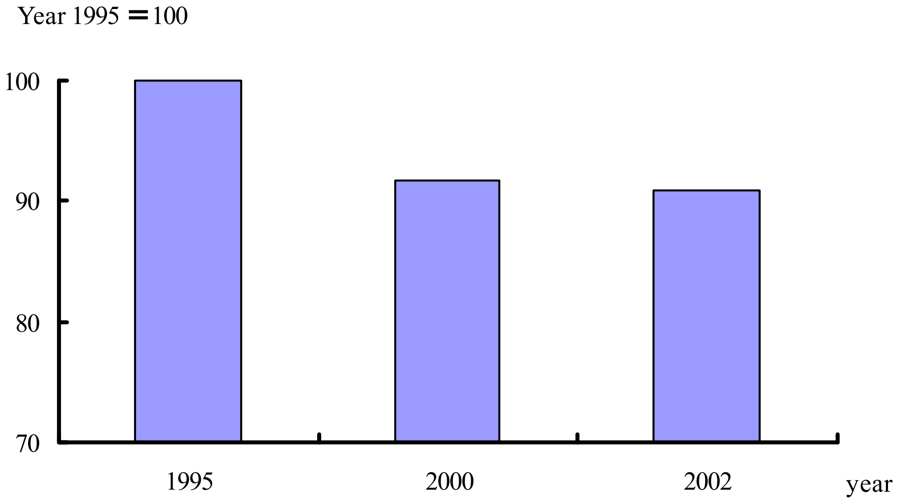
(Students were not originally required to pay tuition fees as part of the system of government funding provided for United Kingdom universities. The current system of uniform tuition fees was introduced in 1988 to provide a new source of funding for the then expanding field of higher education. However, there is a fee adjustable system still in place that adjusts tuition fees according to a student’s income.)

(Figure 2-13) University Income on a Student Per Capita Basis (in real terms) in the United Kingdom



(Source) Taken from “Main Economic Indicators,” OECD, and “Resources of higher Education Institutions,” Higher Education Statistics Agency.

(Figure 2-14) University Government Block Grant Funding on a Student Per Capita Basis (in real terms) in the United Kingdom

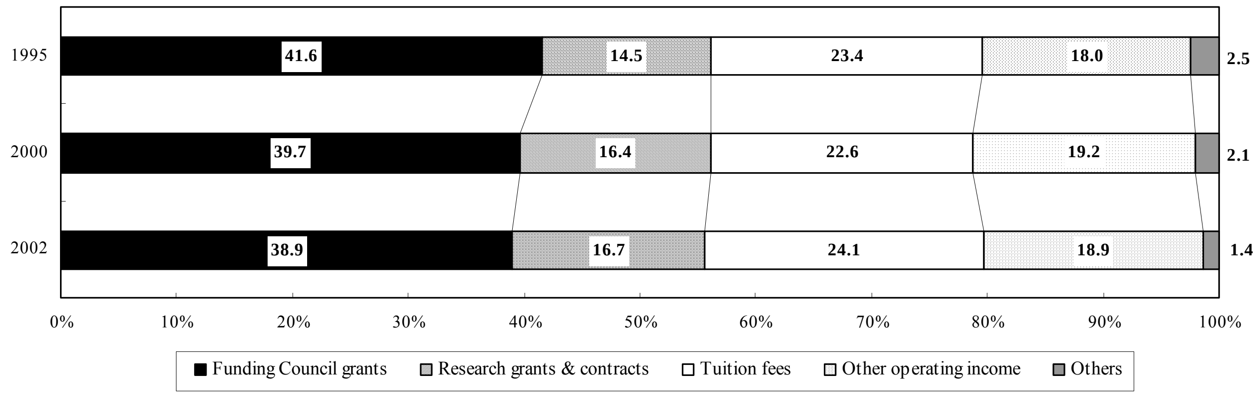


(Source) Taken from “Main Economic Indicators,” OECD, and “Resources of higher Education Institutions”, Higher Education Statistics Agency.

A look at trends in sources of the United Kingdom University income (Figure 2-15) shows (1) government block grant funding with the largest share, followed in order by (2) tuition fees, (3) income from business activities and (4) external research funding (Note 1). Although "government block grants" comprise the largest share of income at the overall periods, their share of overall university income is on a declining trend. "External research funding," however, is on an increasing trend, while income from "tuition fees" and "business activities" has leveled off. As the share of "government block grants" declines, the share of individual sources of university income (Note 2) is on the increase.

Note 1: This comprises "government block grant funding", excluding the amount provided for "research funding".
Note 2: This comprises income excluding the "government block grants."

(Figure 2-15) Trends in Sources of Income for Universities (Overall)
in the United Kingdom



(Source) Taken from "Resources of higher Education Institutions", Higher Education Statistics Agency

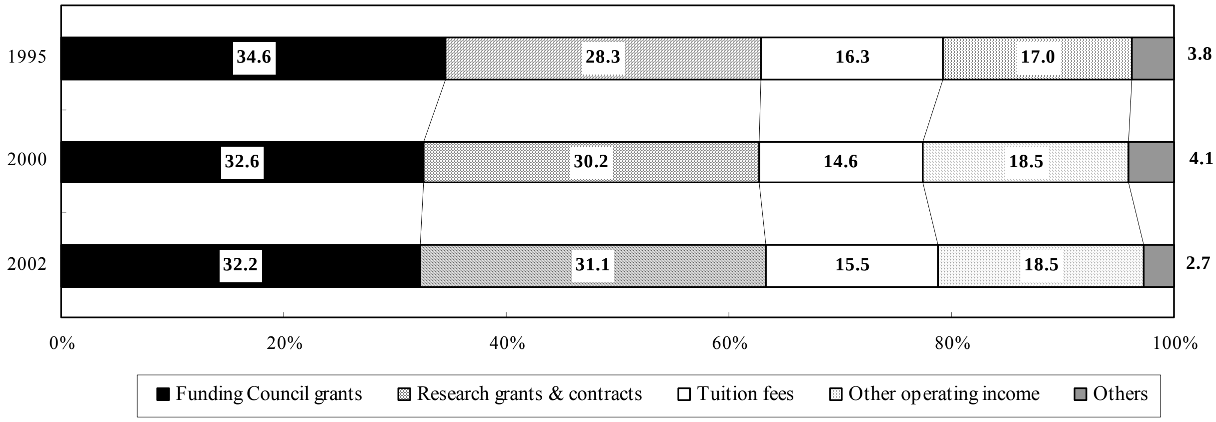
The trends in sources of income of universities most active in research ranking in the top 10 of recipients of external research funding (Figure 2-16) are shown in Figure 2-17. The largest share is (1) government block grant funding, followed in order by (2) external research funding, (3) income from business activities and (4) tuition fees. Compared with the overall average for universities, universities in this group receive a very large share of income from “external research funding”, with shares coming from “government block grants” and “tuition fees” being comparatively smaller.

（Figure 2-16） Top Ten Universities in Acquisition of External Research Funding (for FY2002)

Rank	Name	Research grants and contracts （1,000 £）
1	Imperial College of Science, Technology & Medicine	**167,157**
2	The University of Oxford	**162,894**
3	The University of Cambridge	**162,278**
4	University College London	**159,779**
5	The University of Edinburgh	**96,861**
6	King's College London	**93,376**
7	University of Manchester	**80,803**
8	The University of Glasgow	**80,383**
9	The University of Southampton	**71,265**
10	The University of Leeds	**70,808**

As with the United Kingdom universities overall, “government block grant funding” makes up the largest share of university income for the top 10 group at the overall periods, but is, again, on a declining trend. The “external research funding”, on the other hand, is on an increasing trend and as of FY2002 was almost equivalent to the share of income from “block grant funding.” Income from “tuition fees” and “business activities” has leveled off. As the share of “government block grants” declines the share of individual sources of university income is on the increase.

(Figure 2-17) Trends in the Breakdown of Sources of Income for the United Kingdom Universities (most active in research)



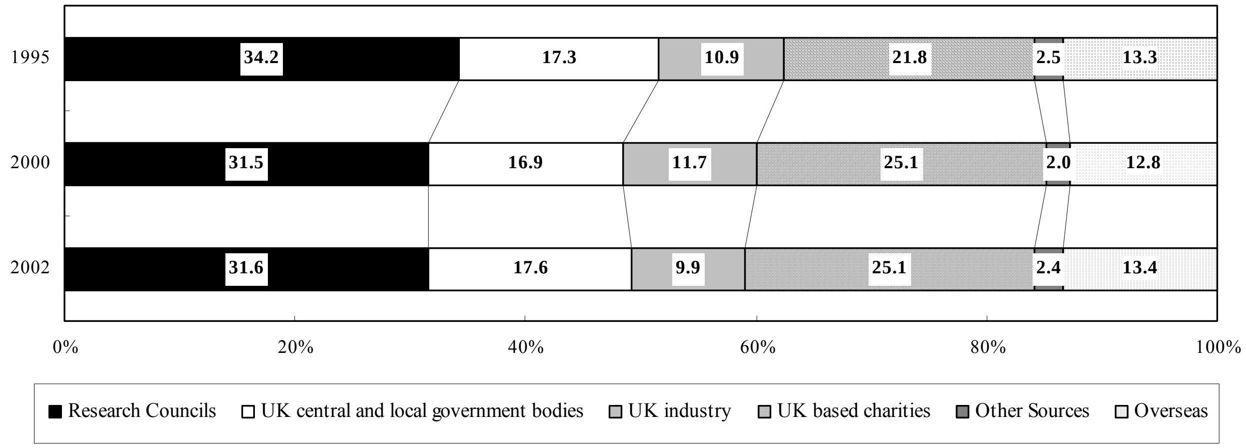
(Source) Taken from “Resources of higher Education Institutions”,
Higher Education Statistics Agency

The future of “government block grant funding” for higher education will continue as an important source of funding within the framework of the “Dual Support System” included in the “Science & Innovation Investment Framework 2004-2014”, the long-term, 10-year strategy announced by the government in July 2004. This strategy has been praised for introducing a new flexibility that enables “government block grant funding” to be applied to development of new areas, thus giving universities of stronger footing for making strategic decisions on their own.

A breakdown of sources of “external research funding,” excluding overseas and other special sources, shows (1) Research Councils with the largest share, followed in order by (2) charities, (3) government bodies, and (4) industry. Although the Research Councils are the largest source of funding at the overall periods, the share of funding is now on a slight declining trend. Funding by charities, on the other hand, is increasing, while that provided by the government bodies and industry is leveling off (Figure 2-18).

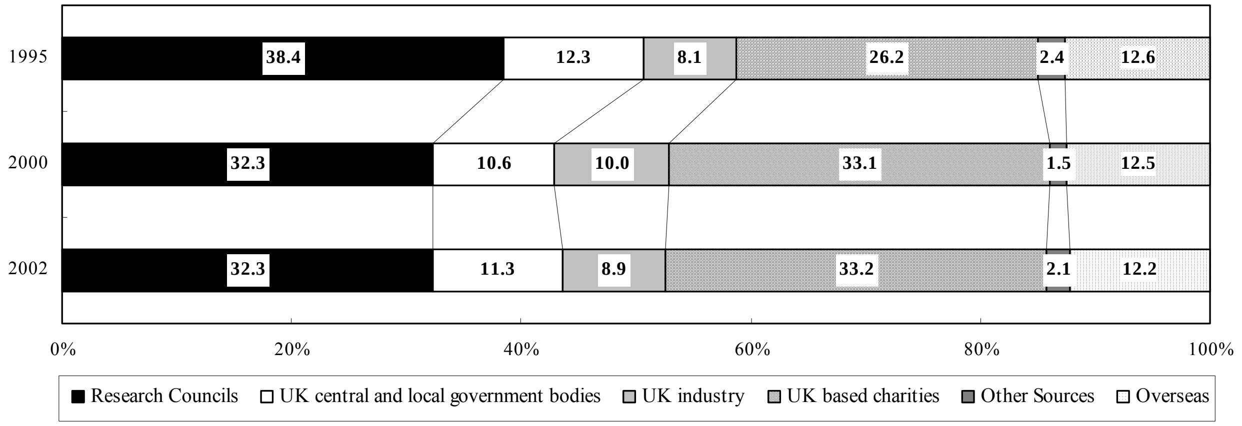
Since the FY2000, charities have been the largest source of funding, followed in order by the Research Councils, government bodies and industry (Figure 2-19). While the increase in share of funding from charities and the decline in share from Research Councils reflects the trend for universities overall, it is far more pronounced in the case of the universities most active in research.

(Figure 2-18) Trends in Sources of External Research Funding for the United Kingdom Universities (Overall)



(Source) Taken from "Resources of higher Education Institutions,"
Higher Education Statistics Agency

(Figure 2-19) Trends in Sources of External Research Funding for the United Kingdom Universities (most active in research)



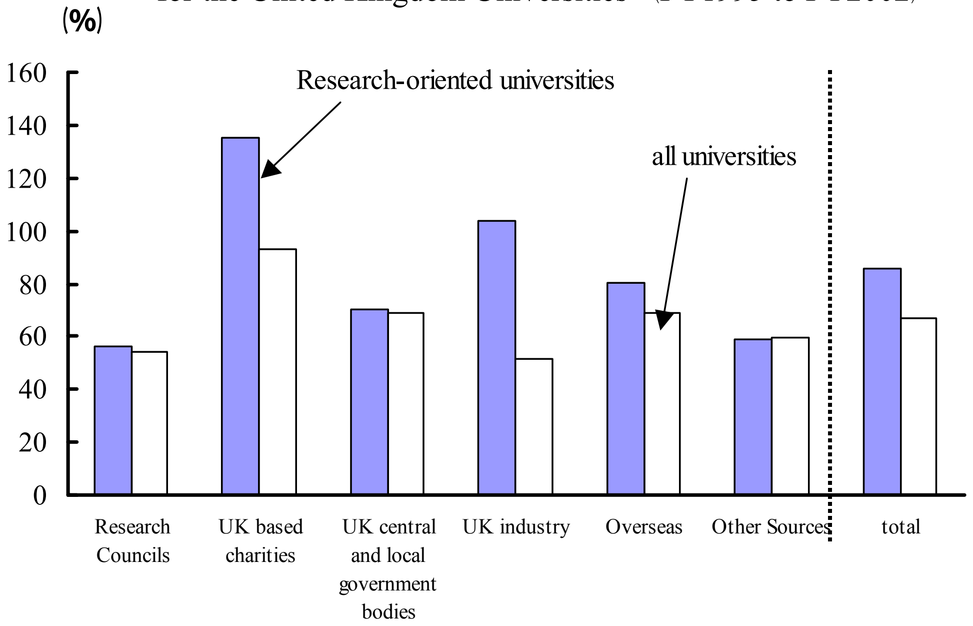
(Source) Taken from "Resources of higher Education Institutions,"
Higher Education Statistics Agency

Comparison of the rate of increase (according to source) in the portion of external research funding since FY1995 for universities overall and universities most active in research reveals that the universities most active in research have a far larger share of funding from charities and industry. With regard to funding from the Research Councils and government bodies, there is no significant difference between the universities most active in research and universities overall (Figure 2-20). These trends reveal that the funding provided by charities and industry tends to favor the universities most active in research. The funding provided by the Research Councils and government bodies is distributed evenly among all universities. As a result, the universities ranking in the top 10 of recipients of "external funding" grew in share from 40.4% in FY1995 to 44.1% in FY2002 (Figure 2-21).

In terms of "external funding" received from charities alone, the top 10 universities most active in research increased their acquisition of "external research funding" from £164 million in FY1995 to £381 million in FY2002 and their corresponding shares from 48.5% to 58.3%. The Joint Infrastructure Fund (JIF, Note:), which combined funding from government and charity sources, existed during this period. It is possible that the charity funding made available to the top ten universities was done so as part of government research support policy of the time.

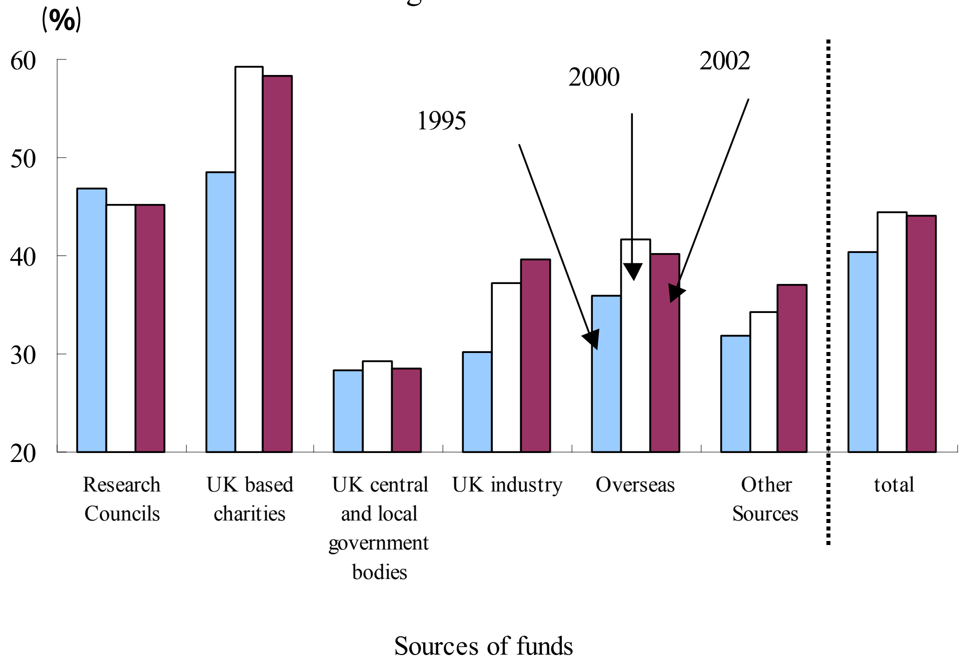
Note: Funding was mainly used for maintenance of university buildings and the construction of large facilities. The JIF budget for the FY1999 to FY2001 three-year period was in the order of £750 million pounds. Of this, £300 million was provided by the Office of Science and Technology (OST), £300 million by the Wellcome Trust and £150 million by the Higher Education Funding Council.

（Figure 2-20） Trends in Increases of External Research Funding by Source for the United Kingdom Universities （FY1995 to FY2002）



(Source) Taken from "Resources of higher Education Institutions", Higher Education Statistics Agency

（Figure 2-21） Trends in Shares of External Research Funding for the Top 10 Funded United Kingdom Universities



(Source) Taken from "Resources of higher Education Institutions," Higher Education Statistics Agency

2.2.3 Germany

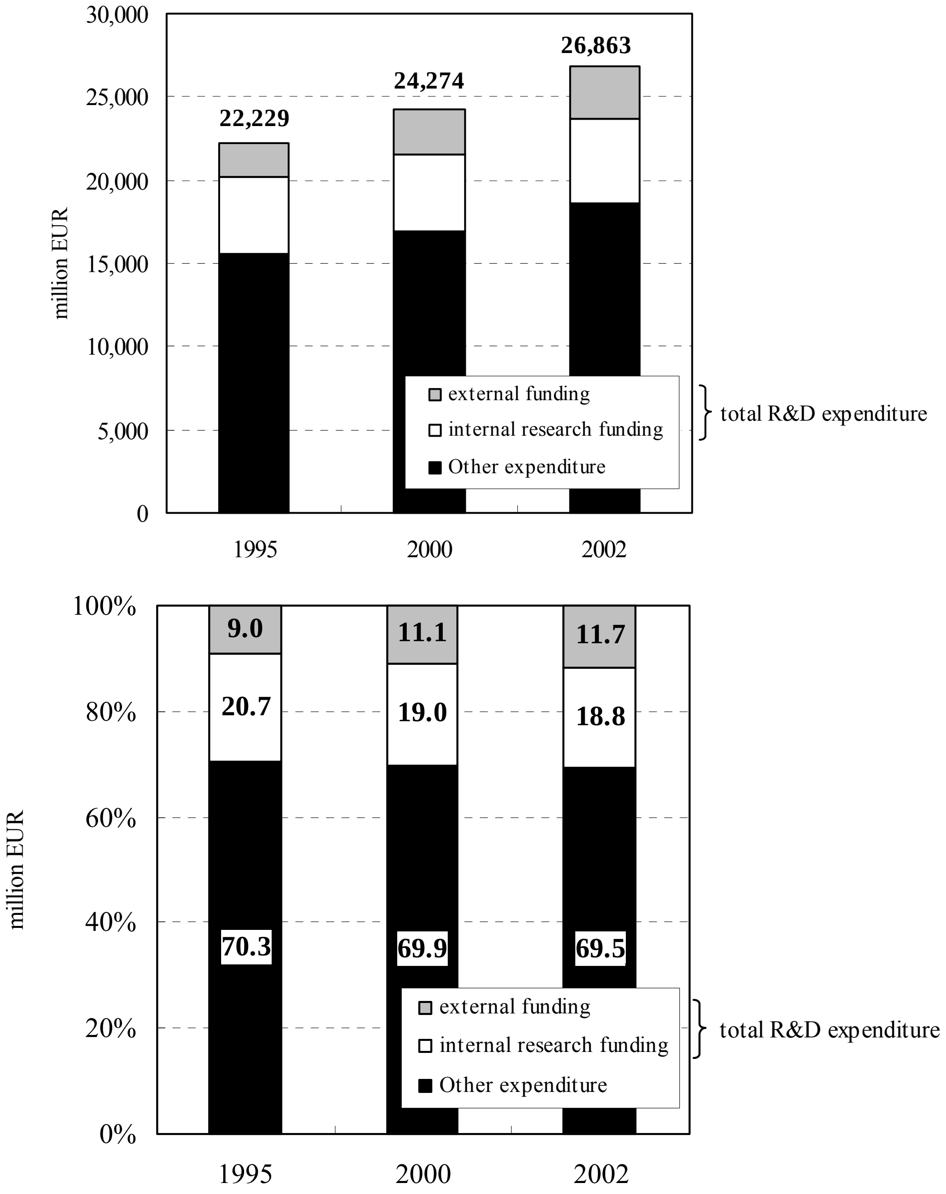
⑴ Composition of Funding Budgets for State (Lander) Universities

State (Länder) universities in Germany make up approximately 70% of institutions of higher education (universities and universities of applied sciences (Fachhochshulen)) and play a central role in research and development activities. These universities are basically tuition free, as “basic funding” is provided by the combination of federal and State (Länder) government sources, with the federal and state (Länder) governments funding on a 1:9 ratio. “Research funding” is comprised mainly “internal research funding,” drawn from the university’s “basic funding,” and the “external funding” coming from external research organizations, private sector corporations and foundations. Note that “internal research funding” includes labor costs. How much of the “basic funding” is used as “internal research funding” is left up to each educational institution.

The “external funding” provided to universities is referred to in Germany as “Drittmittel” (third-party funding). This is in contrast to the primary “basic funding (internal funding)” provided by the federal government and the secondary “basic funding” provided by the state (Länder) governments. Federal Statistical Office of Germany maintains annual records available to the public concerning the “per capita professor Drittmittel (third-party funding),” which is used as an index to identify those universities considered to be “strong in research and thereby trustworthy.” “External funding” which is also referred to as “Drittmittel (third-party funding)” is comprised of project funding provided by the federal and state (Länder) governments, state (Länder) government-related research funding obtained from other research institutions and funding received on a commissioned or joint research basis from private enterprises.

The trends in composition of State (Länder) university budgets (1995 to 2002) are shown below.

(Figure 2-22)　Trends in Composition of State (Länder) University Budgets in Germany



(Source of statistics)　Federal Statistical Office of Germany

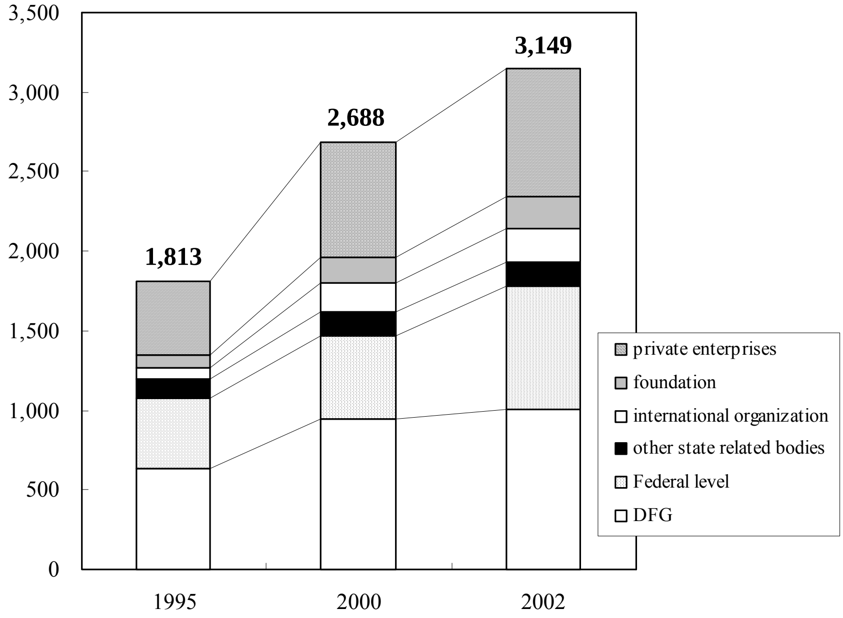
The slight decline in “internal research funding” is believed to be inserting serious pressure on university finances.

There is now a serious move towards “introducing a tuition fee system” for education in Germany which has so far been free. The Federal Court of Constitution has declared Article 27 of the Higher Education Law, which forbids the charging a tuition fees for education, “unconstitutional.” State (Länder) governments are now announcing new policies to charge €500 to €2000 for academic term for university education.

The reality in the aftermath of the reunification of East and West Germany in the 1990s has been the need to provide long-term financial support to the former Eastern region. This coupled with the economic downturn has led to the need to reduce financial assistance provided to the universities, leading to a reduction in faculties and teaching personnel. The policy of “charging tuition for university education” has been proposed by university chancellors since the mid for 1990s as a defensive measure to stop the “decline in the quality of research and education.” The current Schr0der administration responded to this proposal in 2002 by declaring “Article 27 of the Higher Education Law guarantees tuition free university education up to the completion of the first degree,” however, the Federal Court of Constitution declared this to be a “the violation of the authority of the state (Länder) over educational administration.” Nevertheless, Minister of Education Edelgard Bulmahn has declared that introducing tuition fees for higher education will take educational opportunities away from poorer students and foreign students from developing countries.

The figures below show trends in “external funding” used as part of university research funding.

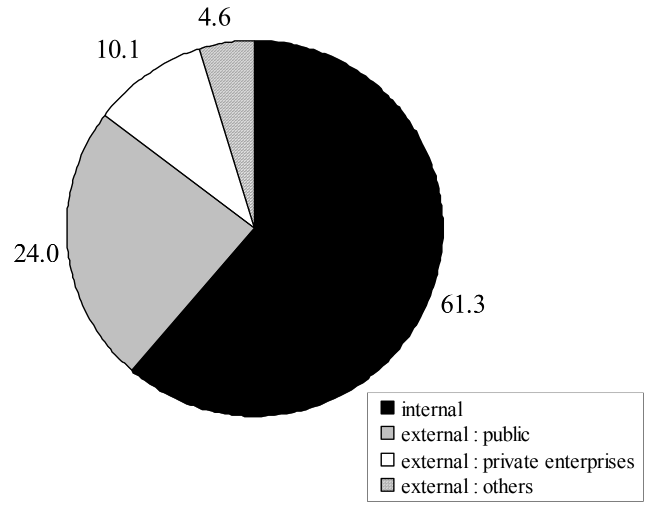
(Figure 2-23) Trends in External Funding Provided to State (Länder) Universities in Germany



million EUR	1995		2000		2002	
	amount	**ratio**	**amount**	**ratio**	**amount**	**ratio**
Deutsche Forschungsgemeinschaft(DFG)	633	35%	949	35%	1,009	32%
Federal level	447	25%	523	20%	776	25%
other state related bodies	120	7%	144	5%	147	5%
international organization	67	4%	185	7%	207	6%
foundation	83	5%	158	6%	206	6%
private enterprises	463	26%	729	27%	804	26%
(total)	1,813	100%	2,688	100%	3,149	100%

(Source of statistics) Federal Statistical Office of Germany

(Figure 2-24) Composition of Research Funding for State (Länder) Universities in Germany (2002)



(Source of statistics) Federal Statistical Office of Germany

The research funding used by Germany's State (Länder) universities is approximately 85% from government sources, with private sector corporations providing about 10%, and the is from foundations and overseas sources. This is because the majority of research funding comes from "internal research funding". Moreover, a high proportion of "external funding" comes from Deutsche Forschungsgemeinschaft (DFG), which is managed by the government sources, and the public funding provided by the federal government such as "project funding" (other than that from "basic funding").

Approximately 60% of research funding for State (Länder) universities comes from "internal funding" and the remaining 40% from "external funding". While the "internal research funding" is on a slight declining trend, it is anticipated that dependence on "external funding" will continue to grow.

Chapter 3:
Comparative International Analysis of the Abilities and Activities Conducted by Doctoral Recipients

【Key Points】

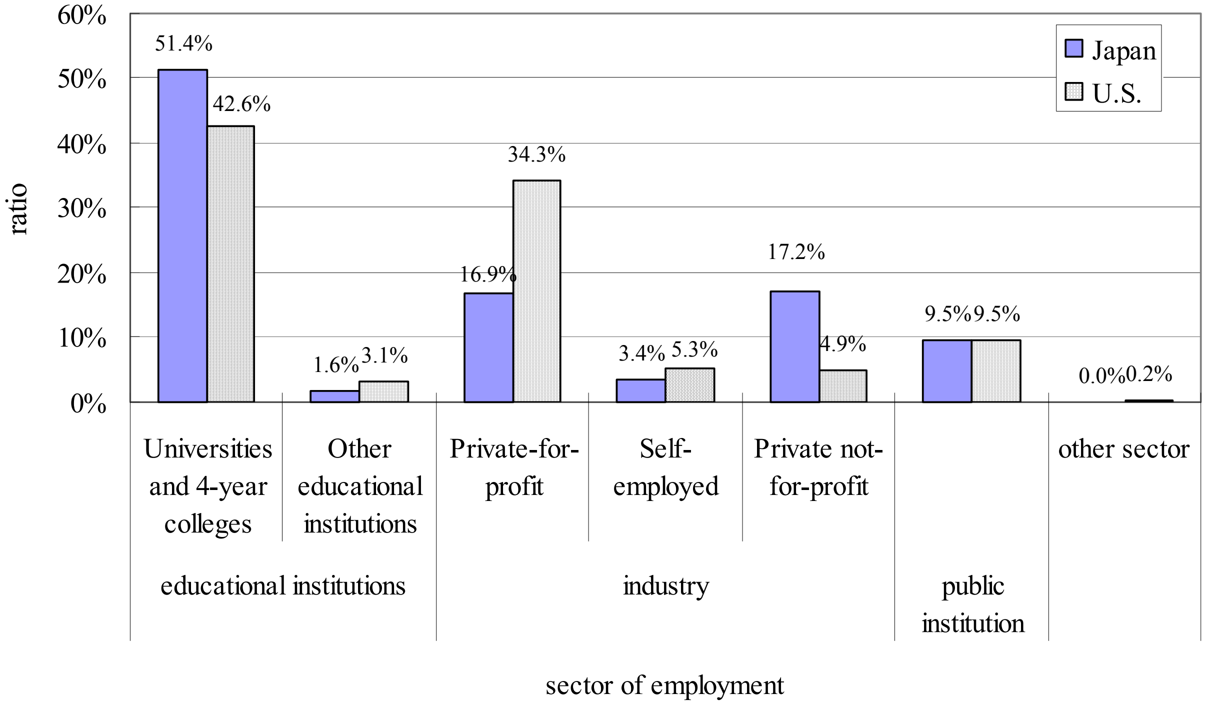
- In order to develop policies designed to make effective use in various fields of the highly specialized knowledge of personnel with doctorate level qualifications in Japan, we conducted a comparative analysis between Japan and the United States the U.S. practice of using such personnel as R&D leaders in various areas of society. (For detailed description of analysis results, refer to the separate "Comparative Analysis on Abilities and Careers of HRST (Human Resources in Science & Technology) between Japan and the U.S. - Career Paths for Doctoral Recipients –," Study for Evaluating the Achievements of the S&T Basic Plans in Japan, NISTEP REPORT No.92)
- The key points of information obtained through questionnaires and by conducting hearings are described below.
  - The most significant difference between Japanese and American doctoral recipients through comparative analysis was that the rate of their employment in profit-generating companies in Japan was very low.
  - Corporations in the United States regard doctoral recipients as having the ability or the potential ability to supervise research in the most advanced fields and serve as leaders capable of coordinating and supervising research-related communication both within the company and with external associates and institutions, and manage entire research projects.
  - Japanese corporations also require the services of highly qualified doctoral recipients with good communication and management capabilities that can serve as research leaders.
  - However, the reality is that Japanese corporations internally lack sufficient general awareness of the fact that "doctoral recipients possess the abilities described above."

3.1 Summary of Comparative Analysis Results
(Comparing Japan with the United States)

Information concerning differences in employment conditions for doctoral recipients according to employment category obtained from the "Study of Activities Conducted by Doctoral Recipients in Japan and United States," commissioned to the Japan Research Institute (March 2004) by the Ministry of Education, Culture, Sports, Science and Technology, are described below.

A look at employment conditions according to employment category for doctoral recipients revealed a gap of nine points between Japan and the United States in the area of "four-year universities", 17 points for "profit-generating corporations" and 12 points for "non-profit institutions" (Figure 1). Note that the wide gap in the "non-profit institutions" category is believed due to a difference in classification of statistics, as "all health services personnel employed in industry are included in the non-profit institutions category." When health services personnel are subtracted from the non-profit institutions category (13.4%), the employment percentage gap closes, with 3.8% for Japan and 4.9% for the United States.

Figure 1: Distribution of Doctoral Recipients According to Employment Category in Japan and the United States
Japan: Responses = 4,611, United States: Responses = 553,400



Note: Individuals engaged in heath services are all included in the "non-profit institutions" category, even those who indicated they are employed at "profit-generating corporations" or are "self-employed."

(Source) "Study of Activities Conducted by Doctoral Recipients in Japan and United States," commissioned to the Japan Research Institute (March 2004) by the Ministry of Education, Culture, Sports, Science and Technology.

Comparisons of differences in employment conditions according to employment category between doctoral recipients in Japan and the United States revealed the trends described below. It is important to be mindful, however, of certain differences between the two countries in the way of survey statistics are categorized.

(1) Comparison according to employment category (4-year universities, profit-generating companies, non-profit institutions and public institutions) shows that Japanese doctoral recipients employed at 4-year universities are 9 points higher while those employed in the profit-generating company category are 17 points lower.
(2) It is clear that a significantly lower percentage of Japanese doctoral recipients are employed in profit-generating companies.

The following two factors were suggested as the reasons why U.S. corporations hire more doctoral recipients.

(1) Corporations in the United States regard doctoral recipients as having the ability or the potential ability to supervise research in the most advanced fields and serve as leaders capable of coordinating and supervising research-related communication, both within the company and with external associates and institutions, and manage entire research projects.
(2) For these reasons, doctoral recipients are given preference over bachelors or masters by the research divisions of the U.S. corporations.

In contrast with the attitudes of U.S. corporations towards doctoral recipients, it is believed Japanese corporations evaluate the abilities of doctoral recipients in the following ways.

(1) Like their U.S. counterparts Japanese corporations require the services of doctoral recipients who possess highly specialized technical expertise, communicative powers and management capabilities to serve as leaders in research operations.
(2) However, the reality is that Japanese corporations internally lack sufficient general awareness of the fact that “doctoral recipients possess the abilities described above.”

3.2 Trends By Country

3.2.1 Germany

Interviews conducted with private sector corporations, research support institutions and so on in Germany revealed “private sector corporations looked to doctoral recipients to serve as managers of research and development in the advanced fields of science and technology. This is very similar to the research and development supervisor or “Principal Investigator” type career path available for doctoral recipients in the United States.”

The following two opinions were voiced concerning possible drawbacks in Germany facing the hiring of doctoral recipients for science and technology work.

① The average age of doctoral recipients tends to be quite high due to the lengthy educational program in Germany.
② Such personnel are lacking in the necessary management skills and broad perspective required to serve as “research and development managers in the most advanced fields.”

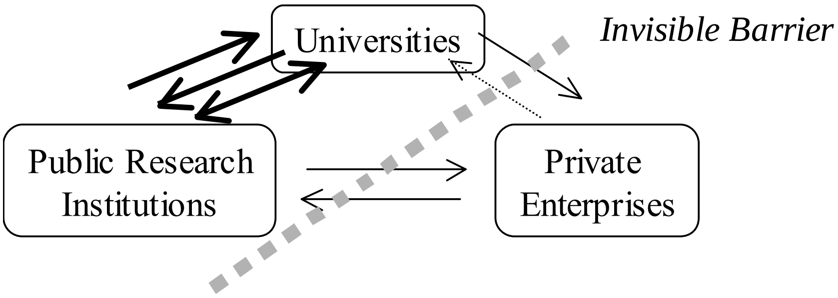
While opinions may diverge on these issues, measures are already being taken in some sectors to deal with these potential problems.

Although precise statistics are not available, most institutions are of the view that the career paths for doctoral recipients are divided fairly evenly between academia and industry. A much higher percentage of doctoral recipients in Germany proceed to careers in industry, as compared with Japan. The following possible reasons were given for this trend. Two schools of thought are presented concerning mobility of doctoral recipients.

a. Mobility of Personnel in the Industrial, Academic and Public Sectors in Germany

One key characteristics of the German situation is that public sector employment offers much better tax and pension benefits than the private sector, a factor that creates a significant barrier to mobility between the public and private sectors. More than the simple mobility of individual personnel, the key factor at work here is that the private sector and universities have established good relations and a feeling of trust that has led to strong cooperation between industry, academia and the public sector. Almost all universities in Germany are state (Länder) universities, which places them in the public sector. This, in effect, can create the sort of "Invisible Barrier" to mobility shown in the following figure.

Conceptual View of Mobility of Personnel
Between Industry, Academia and Public Sector



b. Mobility of Personnel at The International Level

The three key aspects of "mobility of researchers including doctoral recipients at the international level" are "the fostering of researchers capable of serving at the international level," "the inflow of highly qualified researchers" and "the shortage of researchers within Germany itself."

i) Inflow of Highly Qualified Researchers: The "Brain Gain" Effect

- During 2003, researchers affiliated with overseas research institutions were hired as "junior professors" in German universities, filling 12% of the available positions. Thirty per cent of these were foreign nationals, pointing to Germany's success in attracting highly qualified overseas researchers.
- Germany also has program for attracting young overseas researchers, and providing support for their doctorate and post doctorate education with the aim of eventually allowing them to return to their countries of origin. This is regarded as a win-win system as Germany is able to benefit from their achievements while they are there.

ii) Developing Researchers With an International Perspective: "International Brain Circulation"

- The "Emmy Noether Programme" of Deutsche Forschungsgemeinschaft (DFG) (a public institution for research funding), is a highly advanced system under which support is provided for researchers working overseas on the condition that they eventually return to Germany. The government's desire is that researchers gain experience and grow in their work overseas and then come back to Germany.

iii) Overcoming Serious Shortage of Researchers by Accepting Researchers from Overseas

- There is now serious concern over the shortage of researchers in Germany.
- Germany is making up for the shortfall in researchers by hiring personnel from Poland, Russia, the Eastern European countries and India. Characteristic of these researchers is that they do not demand high salaries and extensive benefits and are highly qualified, valuable human resources. Their presence and superior ability creates opportunities for previously unemployed Germans to work under them and thereby help to lower the unemployment rate.

3.2.2 China

(1) Human Resource Development Issues and “the 10th Five-Year Plan”

“The 10th Five-Year Plan” (2001 to 2005) includes a section on “science and technology, education and human resources” which establishes policy targets for “attracting highly qualified personnel from overseas.” Further, there is a policy for “making effect use of overseas study opportunities to expand the avenues for fostering highly qualified individuals”. A key human resource development policy is to encourage personnel to study at overseas institutions to develop skills as well as simply inviting highly qualified personnel from overseas. (See Figure 3-3)

(Figure 3-3) Human Resource Development Policies in “the 10th Five-Year Plan”

“Science and Technology, Education and Human Resources,”
Section 3 of “the10th Five-Year Plan”

① Developing Pool of Highly Qualified Personnel With Practical Experience

- This includes personnel with science and technology backgrounds capable of contributing to the development of society and the economy, with special emphasis on academic leaders capable at the most advanced international levels.
- Entrepreneurs capable of competing in the global arena.
- Civil service personnel with highly specialized knowledge.
- Highly technically qualified, mature and skilled workers and personnel capable of establishing agricultural business operations and conducting science and technology research.

② Establishing Overseas Links

- Attracting highly qualified personnel from overseas.
- Making effective use of overseas educational opportunities to expand the avenues for developing highly qualified personnel.

③ Establishing Frameworks for Educating Personnel

- Strengthening the framework for basic education, especially with regard to making compulsory nine-year education more widely available and promoting high school education.
- Continuing implementation of the 211 Project (designed to give priority to 100 universities and one group of selected field of studies from across the country for 21st century level development)

(Source) Osamu Tanaka, “China’s 10th Five-Year Plan,” Sososha (2001)

(2) Program for Attracting Highly Qualified Personnel

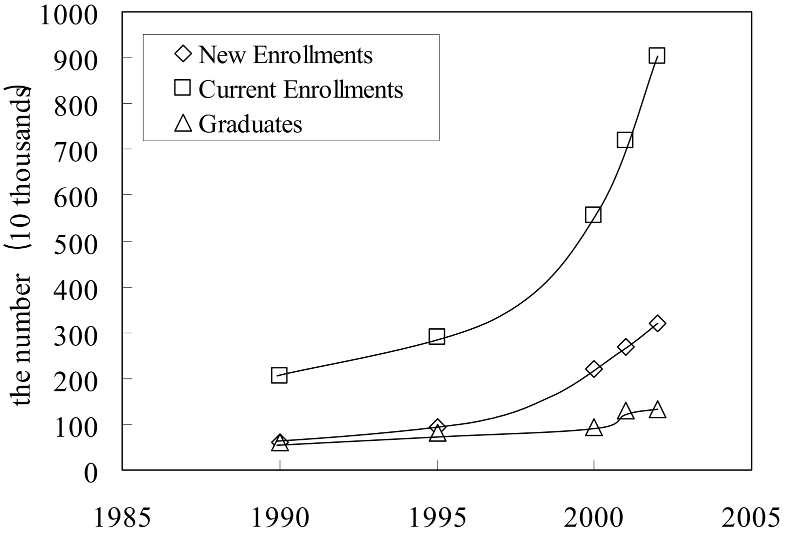
China is undergoing rapid development in science and technology and is currently implementing the “overseas personnel call-back policy” in order to attract highly qualified research and development personnel from overseas locations, as part of its effort to catch up to the technologically advanced nations. Previous plans designed to attract highly qualified personnel to China include the Department of Education Chunhui Plan, and the Academy of Science Hundred Researchers Plan.

(3) Developing Qualified Science and Technology Personnel and Providing Working Environments

a. Raising Levels of Education in China

The percentage of students continuing on to university level education in China has increased rapidly in recent years. Figure 3-5 shows that where 0.609 million students went on to higher education in 1990 a total of 3.205 million progressed to higher institutions of learning in 2002, more than a fivefold increase.

（Figure 3-5） Statistics for New Enrollments, Current Enrollments and Graduates of Higher Education in China



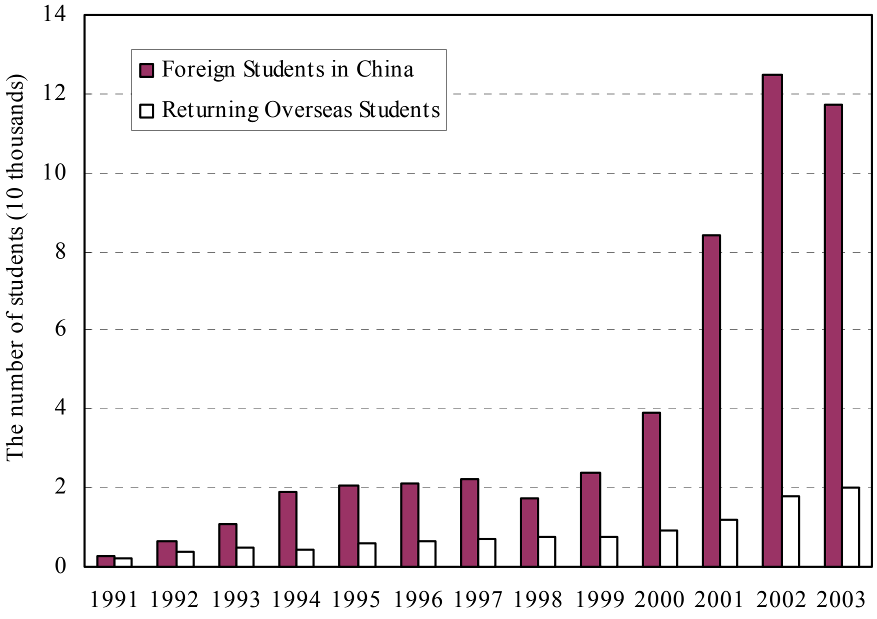
(10 thousands)	1990	1995	2000	2001	2002
New Enrollments	60.9	92.6	220.6	268.3	320.5
Current Enrollments	206.3	290.6	556.1	719.1	903.4
Graduates	61.4	80.5	95	130.6	133.7

(Source) “China Statistical Yearbook”, China Statistics Press

b. Promoting Mobility of Personnel at the International Level

Government policies to attract overseas technical personnel, combined with the high rate of economic growth, has led to a situation where the numbers of Chinese students studying overseas, as well as Chinese students returning from overseas study, is on the increase. Chinese students returning from overseas study exceeded 10,000 in 2001, while the number of students studying overseas exceeded 80,000. This has led to increased mobility of technical personnel at the international level (Figure 3-6).

(Figure 3-6) Trends in Foreign Students in China and Returning Overseas Students

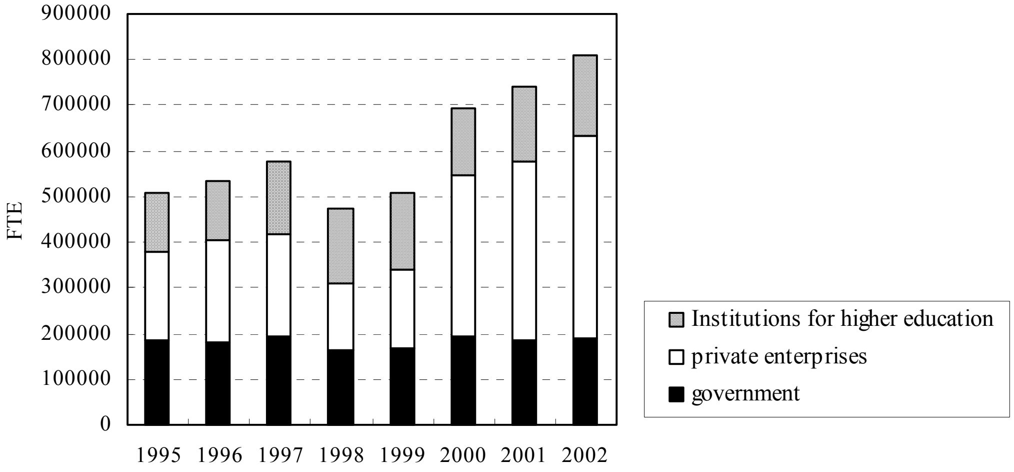


(Source) “China Statistical Yearbook”, China Statistics Press

c. Growing Number of Science and Technology Personnel

The number of science and technology personnel in China is growing, with the number of science and technology personnel employed at corporations showing especially rapid growth since 1998. （See Figure 3-7.）

（Figure 3-7） Numbers of R&D Personnel by Institution （FTE）



Note: Statistics for the 1995 to 1999 period are based on estimates.

(Source) OECD “Main Science and Technology Indicators 2003/1, 2004/1”

Chapter 4:
Comparative International Analysis of Cooperation by Industry, Academia and Government and Regional Innovation Policies

【Key Points】

- The following three points are key to drawing comparisons with the "results of cooperation policies between industry, academia and government" of different countries.
  - While Japan does not lag far behind the United States in terms of patent applications, the number of patent licenses it obtains is on the order of only one-tenth and even two or three decimal points less in terms of income from patent royalties, IPOs and mergers and acquisitions (M&A). This is seen as a result of the Bayh-Dole act introduced in the U.S. in 1980 to promote technology transfer policy.
  - Although the United Kingdom introduced technology licensing organizations (TLOs) ten years earlier than Japan, there is very little difference between the two countries in terms of patent applications and IPOs. The United Kingdom ranks midway between Japan and the United States.
  - Only three or four years have passed since TLOs were launched in Japan, so we are still waiting to see concrete results.
- The regional innovation policies and industry, academia and government cooperation policies by the various countries are based on lessons learned from the successful examples of Silicon Valley in the United States and other high-tech regions but adjusted to suit the individual requirements of each country.
- The balance of authority and resources between central government and regional governments varies widely according to country, as does the central government support that serves as the "triggering effect at the incipient stages of such innovation policies."
- From the examples of the United States and Europe, we can see that periods of between 10 years and several decades from the initial launch were required for the various research and development cluster areas to become independent and self-sustaining, so it is important not to expect quick results.
- The main features of the regional high-tech clusters created by various countries are described below.
  - United States: Silicon Valley is still the leading high-tech cluster in the world. A traditional leader in semiconductors (from its namesake, "silicon") and information technology (IT), it is now showing signs of growth in the area of biotechnology.
  - Germany: The central government employs a "development fostering contest" (a two-stage selection system) in which the various regions within the country are encouraged to compete for funding provided under government regional innovation policy. Under the aegis of the "BioRegio" regional innovation program, Munich has developed into the top biotechnology cluster in Europe.
  - Sweden: The VINNVÄXT regional innovation program is designed to provide

a long ten-year program of support to areas selected for development. The funding provided by the central government is designed to serve as a “catalyst” for industry, academia and government cooperation.

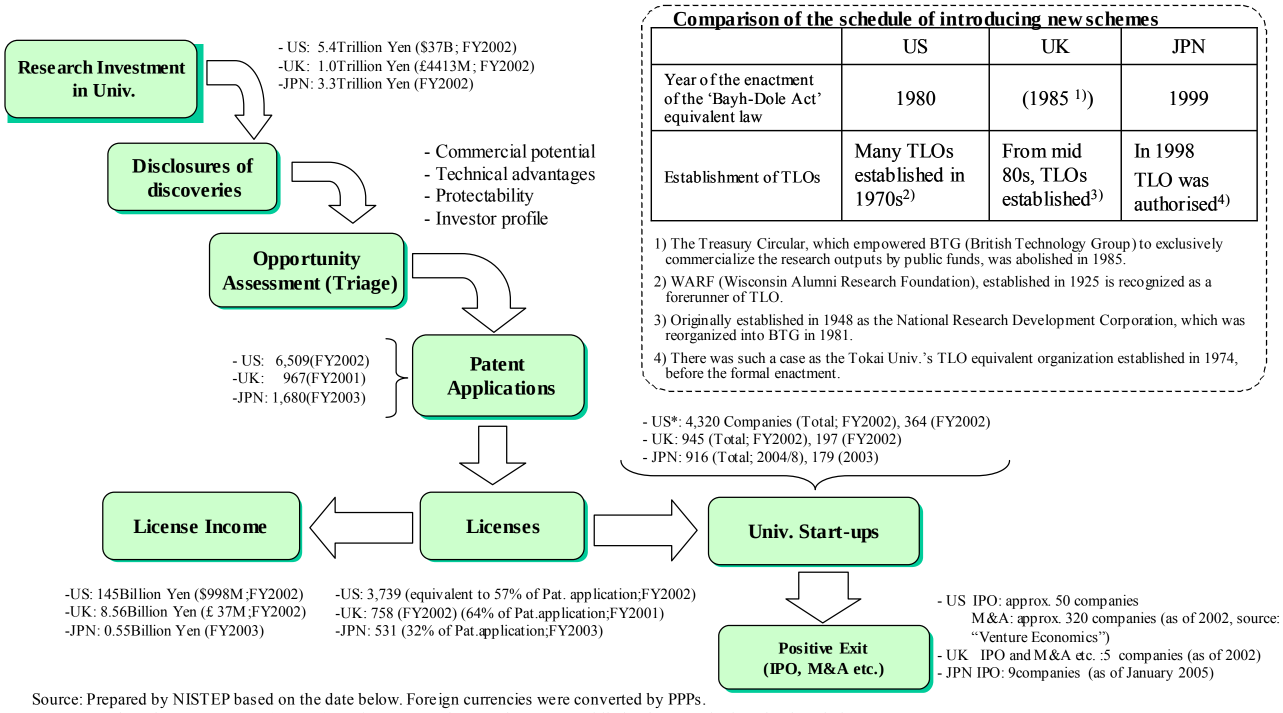
- Finland: The city and University of Oulu joined hands to create “Technopolis,” the first science park in Scandinavia as part of an economic regeneration policy to deal with the decline in traditional industries. The Finnish government implemented in the CoE regional innovation policy to coincide with this project.
- South Korea: In line with its policy to decentralize the heavy concentration of business and industry in Seoul, the government has moved research facilities and government capital functions to the city of DaeJeon where it has established the “Daedeok Science Town.” The government is planning to develop the area into an independent high-tech cluster through the establishment of its “special R&D system.”
- China: The government is building high-tech parks (beginning with “Chunkanson”) in a total of 53 regions nationwide, as part of its “science and technology nation building” policy.

4.1 Summary of Comparative Analysis Results

4.1.1 Results Produced by Industry, Academia and Government Cooperation Policies in Various Countries

Figure 4-1 shows international comparisons of results of technology transfers involved for making commercial application of university research results. This information was used for comparative analysis of the results produced through cooperation between industry, academia and government in three countries that included in Japan, the United States and the United Kingdom.

(Figure 4-1) International Comparisons of the Technology Transfer of University Research Results



Comparison of the schedule of introducing new schemes

	US	UK	JPN
Year of the enactment of the 'Bayh-Dole Act' equivalent law	1980	(1985 1))	1999
Establishment of TLOs	Many TLOs established in 1970s2)	From mid 80s, TLOs established3)	In 1998 TLO was authorised4)

1) The Treasury Circular, which empowered BTG (British Technology Group) to exclusively commercialize the research outputs by public funds, was abolished in 1985.

2) WARF (Wisconsin Alumni Research Foundation), established in 1925 is recognized as a forerunner of TLO.

3) Originally established in 1948 as the National Research Development Corporation, which was reorganized into BTG in 1981.

4) There was such a case as the Tokai Univ.'s TLO equivalent organization established in 1974, before the formal enactment.

Source: Prepared by NISTEP based on the date below. Foreign currencies were converted by PPPs.
- US: Licensing Survey 2002 (AUTM) etc[*: US+Canada, covering HEIs, Public institutes and Education hospitals]
- UK: Higher education-business and community interaction survey 2002-03 (HEFCs), Gross Domestic Expenditure on Research and Development (ONS)
- JPN: MEXT, METI [Patent & licensing data: those managed only through TLO, excluding state patent]

Regarding comparison of R&D expenditures, note that handling of labor costs differs among Japan, US and UK.

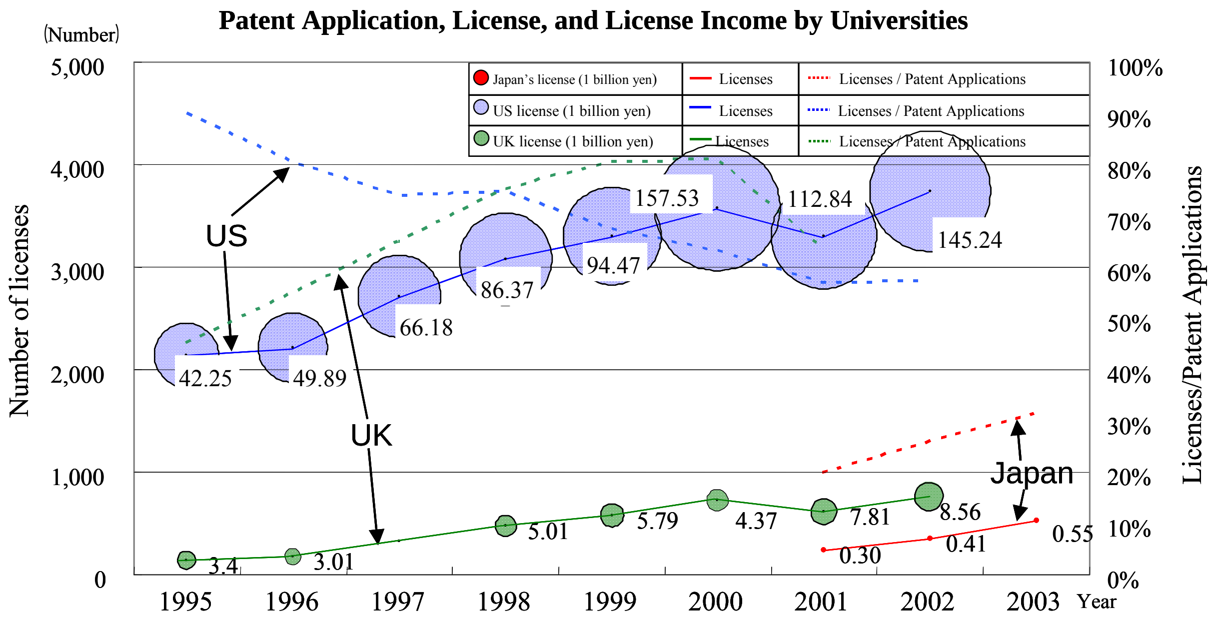
Note: It is important to be mindful of differences in how the labor costs are accounted for in research funding and so on between Japan, the United States and the United Kingdom.

While Japan does not lag far behind the United States in terms of patent applications, the number of patent licenses it obtains is on the order of only one-tenth and even two or three decimal points less in terms of income from patent royalties, IPOs and mergers and acquisitions (M&A). This is the result of several factors; the first being that the US has enjoyed a highly active period of technology transfers from university to business in the twenty-five years since introduction of the Bayh-Dole act in 1980. Japan has yet to see tangible results, as only five years have passed since it introduced technology licensing organizations (TLOs) and its own version of the Bayh-Dole act. A considerable time lag also occurs when making commercial application of university research results. Finally, there was a problem with traditional Japanese rights to intellectual property produced by university research. The rights belonged inherently to the individual, so time was required to sort out how to devise the revenue structure for commercial application.

A comparison of the principal differences between Japan and the United Kingdom revealed that the UK began using TLOs in earnest for transferring technology to the private sector ten years earlier than Japan. There is very little difference between the two countries in terms of performance with patent applications and IPOs. The United Kingdom ranks midway between Japan and United States in terms of number of patent licenses and royalty income. The patent licensing rate serves as an important index for assessing potential revenue from royalties, venture start-ups and stable transfer of technology via the TLOs. The rapid progress made in the area of TLOs in Japan in the past two or three year period indicates that we can achieve the level of income from royalties, for example, of the United Kingdom within the not too distant future.

To facilitate comparison between Japan, the US and the UK with regard to technology transfer of university research results, Figure 4-2 shows trends in numbers of patent licenses issued and ratios of patent applications in relation to licenses over a several-year period. The solid line in the graph represents the number of patent licenses obtained by universities, the size of the circle plot the level of royalty revenues and the dotted line the ratio in relation to number of patent applications. Royalty income in Japan currently stands at ¥550 million per annum.

(Figure 4-2) Comparative International Analysis of Transfers of University Research Results



Note: License incomes in the US and the UK were converted by PPPs into JPY.

Source: <Japan>: METI, <US>: "AUTM Licensing Survey,"
<UK>: "Higher education-business and community interaction survey 2002-03," "Science & innovation investment framework 2004-2014"

The United States and the United Kingdom already have between 15 and 20 years experience fully utilizing TLOs to transfer technology. It is in the past almost ten-year period that this experience has begun to produce results and they are now achieving results that are 10 to 25 times higher than those of Japan. Obviously, Japan has not been able to produce results yet, as full use of TLOs have only been made for three or four years.

While there is the problem of the time lag involved in applying results, there is also the patent licensing rate, which is calculated by the number of licenses issued in relation to the number of patent applications. The United States and the United Kingdom have already saturated in its ratio. Japan's licensing rate is still growing and has increased by 1.5 times in just the past two years. Incorporation of Japan's national universities has enabled intellectual property rights to be managed effectively on institutional basis. The resulting increase in efficiency of application of such rights is expected to increase the number of licenses and royalty revenue in future.

4.1.2 Regional Innovation Promotion Programs by Central Government

① Germany: BioRegio, InnoRegio and EXIST
② Sweden: VINNVÄXT
③ Finland: Centre of Expertise
④ China: Torch Programme
⑤ Japan: “Intellectual Cluster Creation Project” and “Industry Cluster Plan”

Figure 4-3 shows a comparison of the central Government regional innovation promotion programs of the various countries.

（Figure 4-3） Regional Innovation Promotion Programs of the Various Countries

Country		Germany			Sweden	Finland	China	Japan	
Central and regional government spending shares (central: regional)		Science and technology outlay 2：3 R&D outlay 1：1			R&D spending 60：1 （1999）	Most gov't R&D from central gov't	Nat. gov't spending 1：2.3 （2003）	Science and Technology Funding 7.7：1 （FY2003）	
Program Name		BioRegio	InnoRegio	EXIST	VINNVÄXT	Centre of Expertise	The Torch Programme	Intellectual Cluster Creation Project	Industry Cluster Plan
Subsidizing entity		Federal Ministry for Education and Research (BMBF)	Federal Ministry for Education and Research (BMBF)	Federal Ministry for Education and Research (BMBF)	Swedish Agency for Innovation Systems （VINNOVA）	Ministry of the Interior	State Council	MEXT	METI （Business and Industry Agencies）
Start-up date		1996-2000	1999-2006	1998-2004	2003-	1994-	1988-	FY2002-	FY2001-
Target fields		Biotechnology	ー（No specific field）	ー（No specific field）	Biomaterials, foods, robot engineering	ー（No specific field）	High-tech industries	4 Main areas (IT, biotechnology, nanotechnology, environment)	4 Main areas (IT, biotechnology, nanotechnology, environment) and manufacturing.
Overview and targets		・ Bio-cluster creation program. ・ Develop global competitiveness in lagging bio industry.	・ Cluster creation program to foster industry in former East Germany. ・ Build network with unique approach of encouraging competition between regions without identifying specific field.	・ Build regional network supporting university-based venture startups.	・ Support research environment. ・ Raise levels of specific fields. ・ Serve as catalyst for encouraging industry-academia cooperation.	Utilize leading intellectual and specialized capabilities of each region as industry resources.	・ Build national high-tech park. ・ Aim for development of high-tech industries.	Select regions with unique fields of R&D that have high potential for cooperation between industry, academia and government, aiming at creation of "Intellectual Cluster".	Provide comprehensive and effective implementation of regional policies for companies aiming for world markets. Aim for "industrial cluster" creation through extensive mobility of personnel between industry, academia and government.
Regions		Three regions (Munich, Rhineland, Rhein-Neckar) ・ Focus resources on three most advanced regions. ・ Provide some support to unselected 14 regions.	Implement 560 projects in 23 regions.	5 regions	Three regions ・ Applications from 159 regions ・ Subsidies to 25 regions at planning stage. ・ Draft plans presented by 51 regions in implementation stage. Provide some support to remaining 7 regions.	1st Stage: 8 regions 2nd Stage:14 regions （6 regions added） 3rd Stage: 18 regions （4 regions added）	53 locations nationwide （Beijing, Chunkanson, Dalien and Hangzhou, etc., as of 2003）	・ FY2002： 12 regions ・ FY2003： 15 regions （3 regions added） ・ FY2004： 18 regions （3 regions added）	9 blocks nationwide with 19 projects underway.
Support	Support Figures	Approx. ¥3.2 billion per region (*1: 50 million marks) / 5 years	Total amount ¥32 billion (* 2: €255.6 million)	Approx. ¥1.9 billion for 5 regions (*1: 30 million marks)/ 1 year	Central gov't approx. ¥8.2 billion (*3: 600 million SEK)/ 10 years ・ Central gov't max. support ¥136 million per region (*3: 10 million SEK)/ 1 year ・ Regions provide same or larger amount as central gov't.	・ Central gov't approx ¥2.5 billion (*2: €20 million) ・ Regions approx. ¥41.3 million (*2: €330 million)	・ 1996 to 1999 approx. ¥730 million (*4: 51 million yuan) / 1 year ・ 2000 to 2002 approx. ¥710 million (*4: 50 million yuan) / 1 year	Approx. ¥500 million per year per region (total ¥2.5 billion for 5 years)	・ Amount for FY2001 to FY2003: total over ¥65 billion ・ FY2004 budget: ¥49 billion

	Period of Support	5 years	7 years as basic	6 years	10 years（with 3 midterm evaluations）	・ 1st Stage: 5 years ・ 2nd Stage: 3 years ・ 3rd Stage: 3 years	Ongoing support for specified regions; time limit unspecified.	5 years	Differs according to policy.
No. of ventures and related companies		Rapid increase in biotechnology companies ・ 1995 (prior to start): 75 ・ 1999: 279 (No. 1 in Europe)		150 company start-ups in five regions in only first-year.	- (Just started, so no statistics)	Starting up high-technology companies ・ 2nd Stage: 316	Number of high-tech companies in target regions ・ 2001：24,293 ・ 2002：28,338 ・ 2003：32,857	・ No. of university started ventures (cumulative): Tsukuba university study 1999：62 2000：127 （128） 2001：152 （251） 2002：159 （424） 2003：179 （614） End Aug. 2004：115 （916）	
Other benefits for regions (employment, etc.)			Examples of job creation ・ Musicon Valley: approx. 260 ・ MAHREG Automotive: approx. 3,000 in parts industry.		- (Just started, so no statistics)	2nd Stage: ・ Skilled jobs created: 5,700 ・ New innovations: 1,400	Employment levels for high-tech firms in target regions ・ 2001：2.76 million ・ 2002：3.49 million ・ 2003：3.95 million	Results for FY2002 to FY2003 ・ Patents: 489 in Japan, 41 overseas ・ Tech papers: 1,167 ・ Product application, venture start-ups, company start-ups: 87 ・ Income from above results: approx. ¥100 million	–
Benefits to non-targets regions		The “development-fostering contest” resulted in the biotechnology base being built in non-selected Berlin.	–	Successful EXIST knowhow used to implement various programs for supporting other regions. ・ EXIST-Transfer （10 regions） ・ EXIST-Partner （10 not qualifying for final round ） (2002-)	Regional accomplishments shared as case studies. ・ Results of mid-term and final evaluations scheduled for use in case studies in analysis and research.	–	Beijing and Chunkanmura science parks built using “The Torch Programme” to be reproduced across the country.	–	–
Key points and important features		・ Key point is the strong discretionary powers of regional governments, enabling central governments to start key programs and provide a follow-up system. ・ Success achieved by organically linking domestic bases with very high research and development potential to create formidable competitive edge. ・ The “development-fostering contest " is a two-stage selection system.			・ Structure of screening process (Meticulous evaluation performed during planning and implementation stages. Regions failing at planning stage can reapply for implementation stage.)	・ Format for providing government funding (which is only pump priming as regional institutions basically provide funding.)	・ Growing in environment seen as potential market by the entire world due to effect of the “innovation liberation policy.”	・ Changing from old central government led regional policy to regionally developed unique Policies. ・ This comprises a move away from traditional hierarchically structured administration (by establishing "Regional Cluster Promotion Councils" by cooperation of MEXT, METI, local governments and regional institutions).	

（Source）

Main reference is “Study for Evaluating the Achievements of the S&T Basic Plans in Japan: Comparative Analysis on S&T Policies and Their Achievements between Major Countries,” issued by National Institute of Science and Technology Policy (NISTEP) (NISTEP Report No. 81, May 2004).

Additional source material listed below.

- China: Information provided in the “Support” section for China was taken from the “China Science and Technology Statistics Yearbook 2003,” Science and Technology Department Edition, issued by the National Statistics Bureau and published by the China Statistics Publishing Company.
- China: Information for the “Number ventures and related companies” and “Other benefits for regions” sections was taken from the “China Statistics Yearbook 2004,” People’s Republic Of China National Statistics Edition, published by the China Statistics Publishing Company.
- Japan: Information on Japan was taken from the “Project for Creation of Knowledge Clusters” pamphlet, “Industrial Cluster Plan” Pamphlet, “Industrial Cluster Plan” page on METI web site and “A Study on Successful Factors of Regional Innovation and Promotion Policy (Interim report)—September 2004 Edition--” from the Science and Technology Policy Bureau.

Note: Exchange rates based purchasing power parity (PPP) as of end of 2002. → *1: German Mark (DEM) = JPY75.2, *2: Euro (Germany) = JPY147.0, *3: ISEK = JPY15.1, *4: Euro (Finland) = JPY144.1, *5: China (Renminbi) = JPY87.3

(1) Features Common to Various Programs

- Aiming to use the “knowledge” produced by universities and research institutions to create “business” such as establishment of venture start-ups.
- In accordance with policies to promote creation of “business,” emphasis is placed on “building regional networks” and “cooperation of academia and industry.”
- The period of support is in the 5 to 10 year range.

(2) Features of “Policies Aimed at Supporting Advanced Fields of Research”

The investment of government funding designed to support advanced research (regions) places emphasis on “creating the opportunities to build research clusters.” They limit the number of target cluster areas to ensure policies are most effective.

- Germany’s “BioRegio” program: This program is designed to focus entire support on three advanced regions with the aim of developing Germany’s biotechnology industry into one of the most advanced in the world.
- Sweden’s “VINNVÄXT” program: This program conducted using a very strict mid-term evaluation process that selected only three areas from among the 159 that submitted applications.

(3) Features of “Policies Designed to Promote Development of the Nation as a Whole”

Government funding for regional innovation policies designed to promote development throughout the country is provided to many different regions.

- Germany’s “InnoRegio” program: Characteristic of this program is that it is designed to promote industrial development in the former East Germany region. It is a broad-ranging program that implements 560 projects across 23 regions.
- Finland’s “Centre of Expertise” program: This program aims to follow on the success of Nokia by searching out and supporting the development of potential second and third Nokia.
- China’s “Torch Programme”: This program is designed to build high-tech science parks throughout China as part of the “science and technology nation building” policy. It was launched in Beijing and covers not only coastal area but regions extending throughout Western China. The “Torch Programme” currently focuses on 53 regions nationwide.

(4) Involvement of Central Governments

< Examples of Strong Involvement >

- The central governments of China and South Korea have played an aggressive role in the regional innovation policies. Specifically, the central government takes the leading role in creating opportunities for building research and development bases, building local infrastructures and securing the services of research personnel. This strong central role is mainly due to being quite far behind other nations in research in development and accumulation of knowledge. There are also many examples of continued central government involvement in the subsequent stages of fostering industries.
- The motivation of the central government to assist the country in helping "foster international competitiveness in biotechnology," an area in which the country has been lagging, is behind Germany's "BioRegio" program. This helped the Munich region to develop into one of the world's top biotechnology research clusters.

< Examples of Less Involvement by Central Government >

- In the advanced nations, central government involvement in regional innovation programs is normally limited to providing the funding for "creating the initial opportunity" or "the initial pump priming measures." The regions are then expected to promote any further development on their own. The central government funding for Finland's "Centre of Expertise" program and Sweden's "VINNVÄXT" program is designed to serve merely as a "pump priming measure."
- In the case of Silicon Valley in the United States, there was almost no central government involvement in its cluster formation process.

(5) Useful Examples of Program Frameworks

< Germany's "Development Fostering Contest Format" (a two-stage selection) >

- The "BioRegio" program conducted a preliminary selection phase that chose 17 regions, which were then provided with the funding necessary to draw up development plan proposals. A second selection phase was conducted to narrow the focus down to three regions. In the final selection phase Munich was selected as the location. Interestingly enough, a biotechnology research base is being built in Berlin, which did not pass the final selection phase. It is through this process that the "BioRegio" program helped to spur development of Germany's biotechnology industry. An important feature of the “development fostering contest format” with a two-stage selection system is that it allows “candidate regions that failed initial selection to be grown up as research base.”

< Three-Phase Evaluation Process of Sweden’s “VINNVÄXT” Program >

- Being that “VINNVÄXT” is a 10-year program, it employs a detailed evaluation process used at the initial planning stage and during the implementation stages. Regions that failed to pass the initial planning stage are still able to apply once more during the implementation phase.
- Each research cluster submits progress reports once every three years, with funding for the next three and a half year period provided only after the report has been examined.

4.1.3 Key Overseas Research Clusters and Their Implications for Japan

The following section conducts comparisons of key overseas research clusters in the fields of information technology (IT) and biotechnology. Comparisons are provided in Figure 4-4 and Figure 4-5.

（Figure 4-4） Key Overseas Research Clusters: Information Technology (IT)

Country		United States	Finland	South Korea	China	Japan
Name and Region		Silicon Valley （Palo Alto Region of California）	Oulu City	Daedeok Valley （Greater DaeJeon City area）	Chunkanson, Beijing * Region covered by "The Torch Programme".	Kita Kyushu * "Intellectual Cluster Creation Project" and "Industry Cluster Plan"
Key industries		Semiconductor industry	IT industry, medicine and the environment	IT industry	IT industry	Environment and IT industry
Principal existing industries		None (mainly agriculture)	Tar, Paper and Chemical Industries	None	None	Steel industry
Overview		Regional cluster formed through venture startups created by graduates of Stanford University.	Achieved rapid cluster development through effective cooperation between regional universities, research institutes, and the private sector in combination with government regional innovation programs.	Research cluster built as a science town through government leadership and modeled on Japan's Tsukuba Science City.	・ The first of the science parks that are being built across China. ・ Designed to develop high-tech industries.	Successful example of regional regeneration that converted a former steel industry town to an environmental town through the leadership of the town Mayor and use of local resources.
Providing cluster creation opportunities		・ Created in the 1930s out of concern that graduates of Stanford University (by Professor Terman, later called the "father of Silicon Valley") were all moving the to the Eastern Seaboard of the United States in order to find employment. ・ Professor Terman encouraged graduates of Stanford University to start up their own businesses in the local area. ・ Beginning with the start-up of Hewlett-Packard in 1937, Silicon Valley has given birth to countless business ventures. (Was named "Silicon Valley" in 1971.)	・ Alarm over the decline of traditional industries led Oulu City and Oulu University to devise a new policy for using local resources to regenerate the area. ・ The city and university of Oulu provided joint funding in 1982 to create "Technopolis," the first science Park in Scandinavia. ・ In 1984, Oulu City was declared the "City of Technology."	・ Coming up against the limits of how much can be done by simply emulating the research and development of advanced nations, steps were taken to change over to science and technology innovation based on the nations on strengths. ・ In 1973, "Daedeok science town" modeled on Japan's Tsukuba Science City was created to serve as a research and knowledge cluster for national research institutes and universities. ・ In 1978, government sponsored research institutes began moving over.	・ In 1980, Dr. Chen Chunxian of the China Academy of Sciences Physical Research Institute was inspired by what he saw in Silicon Valley in the United States to create the first incubation program linking industry and academia in China ・ In 1988, this became a target region for "The Torch Programme" designed to promote high-tech industries.	・ The sense of crisis over the decline of the steel industry (employment declined to one-quarter) in 1985 following the Plaza Accord. ・ The "Kita Kyushu Renaissance" concept proposed by Mayor Sueyoshi.
Main organizations involved in cluster formation		・ Stanford University	・ Oulu City Government Regional Board ・ University: Oulu University ・ National Research Institute: VTT ・ Corporations: Nokia, others	・ University：KAIST ・ Government sponsored research institutions	・ Research institutions of the China Academy of Sciences ・ University：Beijing University, Tsing Hua University, etc. ・ Incubator facilities ・ Location of overseas corporations	・ University: Kyushu Institute of Technology, Waseda University, University of Kitakyushu, Kyushu University ・ Government Body: Kita Kyushu City
Support	Government	1950s: Major corporations participate in response to implementation of "defense program projects concerning electronics, aerospace and space technology."	・ Oulu City: Builds science park in 1982 ・ Ministry of Interior: Implements Centre of Expertise（CoE） regional innovation program (1994 on)	・ Governments (Science and Technology Institute and Daedeok Science Town Administration Office) develop Daedeok Science Town. Based on the central government policy, research institutes and government bodies move in. Benefits from extensive deregulation. ・ Regional governments provide support for venture businesses beginning in the 1990s. ・ The Daedeok Science Park Special Law is enacted in 2004. Central government provides support for commercialization of research and development results, company startups, company activities, enhancement of research and development capabilities, fostering of clusters along lines of individual core fields, establishment of international research and development base and innovation support systems.	・ Construction of science Park ・ Building of transportation and other infrastructures ・ Establishment of legal frameworks	・ Up to 1980s: Building of transportation infrastructure for transporting coal etc. ・ 1997: Eco-town activities approved. ・ 2001: Becomes target region for "Industrial Cluster Plan". ・ 2002: Becomes target region for "Intellectual Cluster Creation Project."
	Others	1930s: Stanford University provides young entrepreneurs with free use of research laboratories and funds for research materials. Becomes the first University in the United States to build an industrial park.	・ Oulu University: Builds science Park in 1982 ・ Private sector companies play key role.			
Crisis over declining clusters		・ 1980s: Sharp decline in semiconductor industry due to Japanese companies	–	・ 1997: IMF currency crisis occurs → The number of research institutions and	–	–

Country	United States	Finland	South Korea	China	Japan
Name and Region	Silicon Valley (Palo Alto Region of California)	Oulu City	Daedeok Valley (Greater DaeJeon City area)	Chunkanson, Beijing * Region covered by "The Torch Programme".	Kita Kyushu * "Intellectual Cluster Creation Project" and "Industry Cluster Plan"
	catching up. ・ Late '80s to early '90s: Competition from other regions, such as Texas. → Development of open systems by Sun Microsystems and Cisco (established in early 1980s) provides strong impetus for recovery. ・ Latter 1990s: IT bubble collapses.		university based venture start-ups increase rapidly from 1999 in response to government "venture promotion policy" (almost 800 new ventures in 2 to 3-year period)		
No. of venture corporations/leading corporations	・ Many including Hewlett-Packard, Apple and Intel. ・ Total of 14,000 high-tech corporations in the year 2000.	Technopolis Corporate Population: over 500	No. of venture operations ・ 1995：approx. 40 ・ 2003：850	No. high-tech corporations Beijing ・ 2001：7,911 ・ 2002：9,567 ・ 2003：12,030	・ No. of product commercialization, practical applications & Co. start-ups (FY2002 to FY2003): 3
Other benefits for regions	・ Silicon Valley expands into surrounding regions, including San Francisco Bay to the northeast, Santa Cruz Mountains to the West and Coast Range Mountains to the southeast. ・ Becomes the world center of high-tech industry.	Employment Oulu City ・ 1993：46 million ・ 2001：65 million		・ The science Park originally built in the Haidian Science Park of Chunkanson now affects the entire Beijing area.	・ In cooperation with Fukuoka City, implements various policies centered on the field of system LSI technology based on the "Silicon Sea Belt Fukuoka concept."
Success factors and points to learn from	・ Stanford University Support ・ Achieving ongoing innovation and the human resource and support network to support it.	・ High quality cooperation and strategies of regional universities. ・ Utilization of local information communications related resources (research facilities of Nokia and VTT).		・ Innovation liberation policy and huge market garnering the attention of the world. ・ Effective utilization of university research facilities.	・ Selection of fields based on taking advantage of regional resources (steel industry, transportation infrastructure and success in overcoming pollution). ・ Top leadership

（Figure 4-5） Key Overseas Research Clusters:Biotechnology

Country		United States	Germany	Sweden	China	Japan
Name and Region		Research Triangle Park (NC)	Munich biotechnology cluster （Munich, Bavaria） * BioRegio target region	Medicon Valley （Oresund region, near the border of Danish and Sweden）	Shanghai * Region covered by "The Torch Programme"	Osaka （Saito） * "Project for "Creation of Knowledge Clusters" and "Industrial Cluster Plan"
Key industries		Pharmaceutical and biological products	Biotechnology industry	Biotechnology industry	Biotechnology industry and information technology (IT)	Biotechnology industry
Principal existing industries		Textiles, tabaccos, cotton, furnitures	Electrical equipment, information technology (IT, mainly Siemens)	Biotechnology industry	None	Pharmaceuticals, etc.
Overview		Opportunity for creating pharmaceutical and biotechnology cluster was created when state government built science park because of concern over downturn in state economy.	Federal government's BioRegio program provided opportunity to create biotechnology cluster.	Life sciences cluster based on accumulated biotechnology and pharmaceutical research resources created at Lund and Copenhagen Universities.	Shanghai was designated the center of "reform and liberalization" program in the 1990s. The Pudong development is the largest project in China.	Biomedical cluster designed to combine accumulated knowledge from universities and institutions with Japan's leading pharmaceutical companies to create a base for making pharmaceuticals.
Providing cluster creation opportunities		・ Sense of crisis over the brain drain of graduates from state universities, the low per capita income (ranked 47 out of 48 states in 1950) and a state economy lacking diversity. ・ In 1959, the state government led a project to build a research park (establishing the Research Triangle Institute and Research Triangle Foundation). ・ In 1965, IBM and the National Institute of Environmental Health Sciences (NIEHS) moved in, creating inflow of new companies.	・ Central government alarm over Germany falling behind the United States and the United Kingdom in biotechnology was a key factor. ・ The BioRegio program was launched in 1996 to create a biotechnology cluster, which has now become a fully developed biotechnology cluster.	・ 1992： Oresund council is established. ・ 1994： Universities, industry and hospitals cooperate in establishing the Medicon Valley Academy. ・ 2000： The opening of the Oresund bridge linking the city of Sweden (Malmo) with the capital of Denmark (Copenhagen) led to the movement to create an economic community at the regional level. ・ The cumulative biomedical research of Lund and Copenhagen Universities.	・ Pudong region was developed through the "reform liberation" policies in the 1990s. ・ From 1992: Zhangjiang Science Park is built.	・ 1970s: Movement begins to turn the Senri site left over from Osaka Expo 70 into a life sciences zone. ・ 1970: National Cardiovascular Center is established. ・ 1986: Osaka City "Basic Concept of International Cultural City "
Main organizations cluster formation		・ Universities: North Carolina State University, Duke University and North Carolina University. ・ Research institutes: National Institute of Environmental Health Sciences and RTI International. ・ Corporations: Mainly overseas corporations.	・ Bio-M AG： Combination incubation center and venture capital. ・ Universities and research institutes: Munich University of Technology, Ludwig Maximilian University, and homes of Max Planck Institute and Fraunhofer Institute.	・ Oresund Regional Council （32 council members） ・ University ： Lund University and Copenhagen University ・ Regional Governments： Copenhagen City and Skane	・ Various institutions of the China Academy of Sciences. ・ Universities ： Shanghai Jiao Tong University and Fudan University ・ Incubator facilities ・ Overseas corporations	・ University：Osaka University, etc. ・ Corporations: Local pharmaceutical companies and biotechnology ventures, etc. ・ Research institutions: National Cardiovascular Center and Osaka Medical Center for Cancer and Cardiovascular Diseases
Support	Government	・ Around 1994-: State government builds incubator and biotechnology facilities. ・ Steps are taken to attract overseas companies and large corporations.	・ Central Government: BioRegio program (Approx. ¥3.3 billion over five years) ・ State Government ① Center of excellence policy used to provide approximately ¥80 billion in support to high-tech field in 7 key regions. Provides ¥30 billion in support to research projects in various regions. ② Is largest shareholder in Bio-M AG. ③ Establishes finance support company.	・ 1995: Acquires certification from INTERREGⅢA, a community cooperation support program of EC. (No central government investment)	・ Building of various infrastructure facilities, including bridges, roads, ports and power generation. ・ Building of Zhangjiang Science Park. ・ Providing supported based on various science and technology programs (863,973 plans, etc.) and offering all types of administrative services.	＜Regional Policies＞ ・ Osaka Government: Various venture support policies ＜Central Government Policies＞ ・ Targeting region for urban renewal projects. ・ 2001: Targeting region for "Industrial Cluster Plan" (Kinki region biotechnology industry projects) ・ 2002: Targeting region for "Knowledge Cluster Creation". ・ Targeting region for special reform district (biomedical cluster creation district).
	Others		・ Banks, VCs and pharmaceutical companies become shareholders of Bio-M AG. ・ Of a total of 35 VCs, over half interest in biotechnology.	・ University provides approximately $50,000 when Medicon Valley Academy is established. ・ Major pharmaceutical companies provide human and monetary resources to venture corporations.	・ Investment received from various overseas corporations.	・ Osaka University: The university plays a major role behind the scenes in government activities, such as attracting the National Cardiovascular Center, to help grow the cluster.
Crisis over declining clusters		–	・ Collapse of the IT bubble and closing of the Neuer Markt (stock market for the venture businesses): - The number of VCs in the state	–	–	–

Country	United States	Germany	Sweden	China	Japan
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		declined from 70 in 2001 to 40 in 2003. - Biotechnology start-ups began to decline in 2001, with the number of startups and closings resulting in zero growth in 2002. → The state government designated the situation a “basic structural crisis” and took steps to study the problem points (highly qualified researchers monopolized, outflow of young researchers, shortage of technical and management capable personnel) and devise countermeasures.			
No. of venture corporations/leading corporations	・ Approximately 70 resident companies as of 2001. ・ About half are overseas corporations (including Japanese companies).	No. of biotechnology companies: ・ 1996：34 ・ 2001：115 Total of 5 companies make IPOs between 1998 and 2000.	No. of biotechnology companies: ・ 2002：115 (approx, double 1997 number)	No. of biotechnology companies in Shanghai: ・ 2001：405 ・ 2002：536 ・ 2003：550	・ Influx of AnGes MG, Inc. and other biotechnology ventures. ・ No. of product commercializations, practical applications & company start-ups (FY2002 to FY2003): 9
Other benefits for regions			・ Medicon Valley shows significant growth, with 60 percent of the life science sector in the Scandinavian Peninsula becoming residents. ・ Although smaller than the Munich biotechnology cluster (in Germany), it has 1.6 times the number of pharmaceuticals under development (as of 2002).		・ FY2004: Cooperation established with Translational Research in Kobe in the areas of regenerative medicine and drug discovery research. ・ Aims to become an international life Sciences center as the “Greater Kansai Area Cluster.”
Success factors and points to learn from	・ Linking university research, human resource development and corporate functions.	Ability to make effective use of the extensive knowledge resources of universities and research institutes in combination with the foundation of regional “corporate industrial base.”	・ The presence of strong leaders. ・ Combination of self-motivated efforts by regional players and network creation.	・ Reform and liberalization policy and huge market garnering the attention of the world.	・ Utilization of the resource base of pharmaceutical companies.

（Source）
Main reference is “Study for Evaluating the Achievements of the S&T Basic Plans in Japan: Comparative Analysis on S&T Policies and Their Achievements Between Major Countries,” issued by National Institute of Science and Technology Policy (NISTEP) (NISTEP REPORT No. 81, May 2004).
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(1) Overview of Regional Clusters in Various Countries

--- Key Considerations at the Developing Stages of Clusters ---

1) Key Considerations at the Initial Stage of Cluster Development

The important elements of cluster creation at the initial stage are the “knowledge base” and the “sense of regional community,” as well as the ability to convey to “a sense of vision.” Elements essential to the initial stage of cluster creation are the levels of technology and expertise, as represented by the “knowledge base” that universities, research institutions and the corporate base can provide. The successful regional clusters we see in the world today were made possible by the close cooperation of each region’s corporate community. Key elements including, “a sense of urgency” and “effective leadership,” help to create such essential conditions are “a strong sense of regional community,” which convey to local stakeholders “a strong sense of vision” which, in turn, creates an atmosphere of harmony and cooperation.

2) Key Considerations during the Cluster Growth Stage

The following elements are considered essential for assisting clusters in achieving self-sustainable growth.

- Access to Markets. Markets that expanded on a global scale with the IT boom were a key factor in the growth of IT clusters. An important element helping to sustain growth of the biotechnology sector clusters was their close proximity to the huge potential markets in the United States and Europe.
- Availability of personnel highly qualified in business and technology.
- A look at Chunkanson in China, and various other clusters in Asia, reveals that many have a good connection, in terms of the human resource network, with Silicon Valley, enabling the transfer of expertise.
- Importance of financial assistance, for example, in the form of venture capitals.

3) Key Considerations for Sustaining Viability of Clusters

A prerequisite for regional clusters in attaining self-sustaining growth lies in “establishing diversity” that sustains true innovation.

Even Silicon Valley, the most successful regional cluster in the world, was driven to a state decline by the sudden rise of Japan’s semiconductor industry, during the 1980s. However, Silicon Valley was able to recover from this crisis by turning its focus to a new industry referred to as “open systems.” What buoyed Silicon Valley through this difficult period was the ability to “sustain innovation” by drawing on the strengths of the regional framework founded on the principles of “competition and cooperation.”

Most recently, the world’s leading IT clusters, such as Silicon Valley and Oulu in Finland, have found themselves in saturated markets looking at potential new fields of technology, such as biotechnology. We believe that the same company-startup infrastructure and human resource network used for developing the IT cluster can be used, as is, for developing new biotechnology clusters. The ability to “establish strong diversity” within the cluster will be the key that enables the cluster to adapt flexibly to changes occurring within and without the country of and intensifying competition.

⑵ Implications for Japan

1) Importance of Long-Term Planning and the Support System

Past examples of regional innovation in North America and Europe reveal that regional innovation projects rarely proceed without hindrance. Industry is frequently beset with difficulties, challenges and major changes in economic and market conditions that can spell failure for projects. An area in which Japan is weak is the systems of support required to foster cluster growth, once plan implementation has started. It is especially important to implement long-term planning that avoids the temptation to achieve “quick results” and, instead, takes careful steps to “establish diversity (of technology, R&D and management, etc.) in human resource development” when attempting to develop self-sustaining clusters. The effective support systems will also be necessary.

2) Enhancing Self-Sustaining Regional Innovation Capability and Wide-Ranging International Cooperation

The role played by central government in regional innovation in advanced nations is simply to “create the opportunity or conditions” to get projects started the regions in question. Regions are then expected to provide the guidance and systems support for maintaining growth of their clusters on their own. Here in Japan, it is necessary to provide guidance and support and continue to foster regional innovation projects, even after the initial stage, in order to ensure success. For the most part, this will involve local government entities and those involved in the innovation projects, rather than central government, itself. This makes it important to strengthen the innovation capabilities of the region in question. Specifically, this means improving capabilities for fostering human resources, developing technology and expanding the base of expertise required for creating company start-ups. Local government entities, universities and research institutions in the local region must play crucial roles in this process.

3) Strengthening Competition and the Selection Process

Elements needed at the initial stage to ensure the success of regional innovation projects are “attractive planning” and the “common vision” that it will convey. Additional requirements include the establishment of “a diversified innovation program” that draws extensively on the regional knowledge and industrial base. Doing this will require a “process of competition and selection,” in which the region in question takes the initiative and develops a suitable regional innovation program, rather using “regional handout” style support policies.

In this context, establishing “world-class regional innovation clusters” that serve as key elements of the innovation framework representative of the nation, itself, will require initiating a process in which the various domestic regions compete with each other, so that the most capable can be chosen. The German “development fostering contest format” with a two-stage selection process and Sweden’s “three-phase evaluation” format will serve as useful reference for establishing such a process.