Recent Developments in Research and Innovation Policy in Japan

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1. Introduction

Japanese science and technology system is in a process of drastic reformation. In addition, the Japanese government sets policies for promoting innovation in industry as a high priority. Since the second Science and Technology Basic Plan was published in 2000, the Japanese government has started to use systemic approach to reforming national innovation system of Japan. That is, reformation of science and technology system is geared toward reinforcing policies to stimulate innovation in corporate sectors. In this paper, a big picture on policy initiatives for reforming Japanese innovation system is provided, to evaluate policy developments so far from a viewpoint of systemic changes of firm's innovation incentive structure.

This paper consists of four parts, as follows: In order to provide an overview of recent developments in research and innovation (R&I) policies in Japan, the first part is devoted to describing recent reforms of the government structure and R&I policy management system in Japan. Under this evolution of institutional arrangements, the second part focuses on policies for private R&D promotion and the targeting strategy for government-funded R&D programs. The third part describes public research infrastructure, including the recent reorganization of public research institutions and policies to promote industrial use of scientific outcomes from public research institutions. The renovation of the Japanese national innovation system is the subject of

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this section. Finally, this paper concludes with an overall assessment of these R&I policy developments.

2. Institutional framework behind recent developments in R&I policies

2.1 First Science and Technology Basic Plan: 1995 to 2000

In 1995, the Science and Technology Basic Law was enacted in Japan. At that time, the Japanese economy was in a sharp downturn after the burst of the "bubble economy" in the beginning of the 1990s. In order to keep the long-term competitiveness of the Japanese economy, the government showed its commitment to policies for boosting up private R&D and facilitating stronger science and industry linkage to improve innovation productivity in the private sector.

The task of improving the S&T system and promoting private R&D is a long-term one, and it is important to set some policy goals and plans on implementation of R&I policies to achieve the goals. In order to facilitate this policy planning process, the Science and Technology Law obliges the government to come up with the Science and Technology Basic Plan. In addition, the law states that this Plan should be drafted by the Council of Science and Technology Policy (CSTP), which was chaired by the prime minister with members comprising ministers in charge of R&I policies and representatives from the scientific community and industry.

The first Science and Technology Basic Plan, drafted by the CSTP, was approved by a Cabinet meeting of the Japanese Government in 1996. This plan designates the basic strategy of R&I policies in Japan covering the period from 1996 to 2001. It works as a guideline for each ministry in charge of R&I policies to implement actual policies in order to meet the goals, which are also designated in this plan. Some important points in the plan are as follows:

- Private R&D promotion to match social and economic needs, such as new industry creation in the high-tech area and technologies to cope with environmental problems and natural resource constraints

- Promotion of basic research for scientific contribution to international society

- Innovation system reform for building a creative research environment, such as introducing a competitive environment among public research institutions, and a more flexible employment system for researchers

- Facilitating stronger linkage between industry and public research institutions to improve the private sector innovative output productivity
- Strengthening the evaluation system for public research organizations and government-funded R&D programs

In this Science and Technology Basic Plan, it should be noted that some quantitative targets for policy actions during the period from 1996 to 2000 are designated. The most important one concerns the budget for R&I policies, which is 17 billion yen over the period from 1996 to 2000, as compared to the 1995 budget of about 2.5 trillion yen. This is a clear sign of the higher priority put on R&I promotion by the government than on various other kinds of policy objectives. It should be noted that this decision by the Japanese government is to commit to fiscal expenses over five years, even though there is an annual budgetary process, which needs approval from the Diet. Within the government, the Ministry of Finance expressed a strong objection to this plan, but it finally agreed to it, based on the understanding that this figure is just a target and not a decisive commitment.

The Science and Technology Basic Plan is important in that it shows commitment to R&I policies by a Cabinet meeting, consisting of all ministers in the Japanese government. This importance comes from the decentralized system of Japanese R&I policy administration, which is divided into various ministries by sector. For example, METI (Ministry of Economy, Trade and Industry) is in charge of R&D promotion scheme for industry, which includes SME innovation policy, regional innovation clusters, R&D tax credit, etc. In addition, R&D promotion policies for agriculture, transport, telecommunications, construction, etc. are managed separately by the ministry in charge of each respective area. Before national government reform took place in 2001, the Science and Technology Agency (STA) was in charge of general coordination. However, its role was quite limited. STA served as the secretariat for the Science and Technology Council, but important decisions, such as setting the public R&D spending target, were in fact negotiated between major ministries and the Ministry of Finance.

2.2 National Government Reform in 2001

The structure of the Japanese national government changed drastically in 2001, in the course of administrative reform initiated by former Prime Minister Hashimoto. In this process, the structure of the ministries in charge of R&I policy has been reorganized as well. The STA has been merged with the Ministry of Education, creating a new ministry called MEXT, the Ministry of Education, Culture, Sports, Science and Technology.

In addition, a new section to coordinate R&I policies by various ministries has been created inside the Cabinet Office of the Prime Minister, called the Bureau of Science and Technology Policy. This bureau, with about 100 staff members comprised of government officials from ministries, and scientists from academia and the private sector, is expected to act more strongly in coordinating R&I policies.

Furthermore, most national research institutes, once sections of the national government, have changed their status to Independent Administrative Institutions (IAIs), which are independently managed bodies that determine their own budgets and personnel for research activities. This will be discussed in more detail in Section 4.2.

The Bureau of Science and Technology Policy (BSTP) serves as secretariat of the new Council of Science and Technology Policy Council (CSTP), which is assigned more important missions than the old CSTP was. The mission of the new CSTP is investigating and discussing not only basic strategy for R&I policies, but also resource allocation. Centralization of the decision-making system was one of the major features of the national government reform of 2001, and the Cabinet Office now plays a more important role in policy-making. This is the case for S&T policy, and the CSTP, backed by the BSTP inside the Cabinet Office, has become more influential in facilitating inter-ministerial budgets and human resource allocation in the R&I area.[2] Within the government, budgetary allocation is managed by the Ministry of Finance. Under this new system, the CSTP has discussed each ministry's budget proposal on S&T policies, made suggestions to the Ministry of Finance who is supposed to examine each ministry's S&T budget proposal in the process of compiling whole government budget proposal to present to the Diet.[3]

Due to the expiration of the first Plan in 2000, the new CSTP had to develop the second Science and Technology Basic Plan, covering the period from 2001 to 2005. In the process of drafting the second Plan, the CSTP began by evaluating how far the first Plan

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2 Annex 1 shows the current government structure for S&T policy formulation in Japan.

3 An actual process of CSTP's S&T budget recommendation differs year by year. In case of 2003 budget preparation process, all important S&T programs were presented at CSTP for it to make recommendation with grading out of S, A, B and C. This recommendation is transferred to Ministry of Finance for it to use reference in its examination process.

had been implemented. The quantitative target of government-funded R&D of 17 trillion yen was achieved, even though the government faced severe budgetary constraints due to the sluggish economy and the tax revenue downturn. In addition, the government succeeded in putting together some important legislative arrangements for science and industry, such as the law facilitating the establishment of technology licensing offices in universities. However, in some areas such as relaxing employment regulations for researchers in national laboratories and setting up an effective evaluation system of public research institutions, our evaluation is that policy actions were insufficient.

The main points of the second Plan are as follows:

- Strategic targeting in publicly funded research projects. The second Plan lists (1) life science, (2) information and communication technology, (3) environment technology, and (4) materials and nanotechnology as targeted fields where government resources should be allocated with higher priority.
- Renovation of the research and development system in public research institutions and universities to facilitate more competition among institutions and a flexible and innovation environment for researchers
- Strengthening an effective and transparent evaluation system
- Further industry and science linkage to improve industrial competitiveness by innovation in private sectors
- Reform of the education system for long-term S&T human resource development
- Target of R&I policy budget from 2001 to 2006: 24 trillion yen, roughly 1% of the GDP

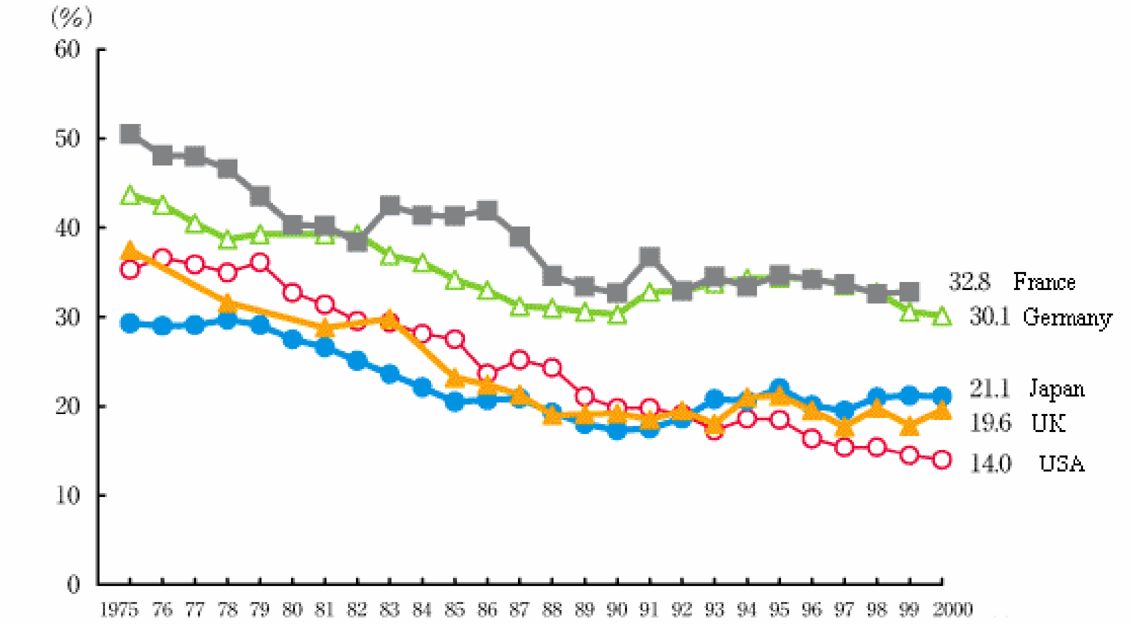
We would like to point out two major changes from the first Plan. One is that targeted technology areas are clearly expressed. The intention is resource reallocation of the R&D budget toward important technology areas. This process is managed by a competition process among PRIs and researchers through increasing the share of competitive funding. Thus setting up an effective and transparent evaluation system becomes very important. The other difference from the first Plan, related to the first point, is that the importance of research output is stressed. Regardless of the type of research activity, whether it be curiosity-driven basic research or applied research for industry, research output from government funding is expected to be maximized. Some kinds of output, such as scientific papers and patents, will become more and more useful in the evaluation process. One and a half years have passed since the new system was introduced, and Japanese R&I policies are still in the process of transition, as will be discussed in detail in later sections.

3. Stimulating of private investment in R&D

3.1 Trends in policies to promote private investment in R&D

As shown in Fig. 1, recently the share of government funding in the total R&D expenditure is increasing (in contrast to Germany and the US, which are showing downward trends), because the Japanese government has allocated a bigger budget for R&I policies, following the target set by the Science and Technology Basic Plan.

Fig. 1 Share of government funding in total R&D expenditure
(excluding defense R&D and including social science)



Source: White Paper on Science and Technology, 2001, MEXT, Japan

As explained in the previous section, the motivation to increase the R&D budget is that stimulating private R&D could improve the long-term competitiveness of the Japanese economy. The Japanese economy in the 1990s shows a strong contrast to that of the 1980s. The rate of GDP growth fell from the 4.1% of the 1980s to 1.4% for the 1990s. Although the economic downturn in the 1990s is not perceived as a cyclical event, there must be some structural factors behind this long-term economic slowdown. Some politicians are concerned about the loss of industrial competitiveness in the Japanese manufacturing sector, reflected in the loss of export competitiveness, particularly in the electronics industry. Therefore, stimulating innovation for industrial competitiveness is now a policy focus, and there is strong support from politicians for government R&D spending.

In addition to increasing government-funded R&D, stimulating private R&D by tax incentives is also important. The general direction of corporate tax reform in Japan is to lower the corporate tax rate, by slashing special tax measures for particular activities. In Japan, there are various kinds of tax measures such as accelerated depreciation measures for environment protection equipment, energy-saving machinery and special high-tech equipment. These special taxation measures are now under strict scrutiny by the Ministry of Finance. However, taxation measures to promote private R&D are an exception. In 1999, restrictions on applying R&D to tax credits were relaxed, and this system became more powerful. Japanese R&D tax credit used to be applied for firms spending their largest ever amount on R&D. However, due to sluggish macro-economic conditions, this condition became too severe. Therefore, the new system applies when a firm spends more on R&D than the average amount of the three highest equivalent figures of the previous five years. In 2003, R&D tax incentive was further strengthened. Under the new system, a firm can obtain tax credit from 8 to 12 % of total R&D investment, instead of incremental amount as compared to part R&D investments.

In addition, under the R&D tax credit scheme, the following activities are particularly promoted by provision of special treatments such as expansion of the maximum amount of credit.

- R&D for energy-saving and recycling resources
- Joint research with national research institutes
- Joint research with foreign research institutes
- Joint research with universities
- Special credit rate for small and medium sized enterprises

3.2 Innovation promotion policy for SMEs

SME innovation promotion policy is managed by the Small and Medium Enterprise Agency inside METI (Ministry of Economy, Trade and Industry). To understand recent developments in SME innovation policy, it is important to be aware of the fundamental revision of the SME policy framework that occurred in 1999, along with the revision of the SME Basic Law. Before this revision, SMEs had been treated as ‘weak enterprises’ in the economy, and the SME policy goal was to improve the level of SMEs as a whole so as to be able to compete with large firms. The main point of revision of the SME Basic Law is to throw out this social policy-type SME policy and to treat SMEs as the source of entrepreneurship, innovation and job creation. Now SME innovation policy has moved up to the top priority, replacing policies for SMEs to be insulated from competition from large firms. There are various kinds of policy schemes to promote innovative SMEs, such as special R&D grants, greater tax incentives than for large firms, and special debt guarantee insurance for innovative activities.

One example of an SME innovation promotion scheme is the Japanese SBIR (Small Business Innovation Research), named after the SBIR in the United States. This system was established in 1999 to activate SMEs with technology development capability and to support their creative business activities. Specifically, ministries in charge of R&D grants and non-profit special corporations, such as the Small and Medium Enterprise Corporation, a non-profit funding agency for SMEs, are to designate their R&D grant systems designed for SMEs, as “designated subsidies”. The goal for the total amount of designated subsidies is published annually, and was 18 billion yen in FY 2001. The ministries and non-profit special corporations coordinate to raise the designated subsidy amount every year.

In addition, there are special measures for the commercialization of R&D results from designated subsidies, as follows:

- Expansion of debt guarantee lines by the special debt insurance for SMEs
- Expansion of debt size by the Law on Subsidy for Facility Introduction Funds for Small-Scale Enterprises
- Special loan system of the Japan Finance Corporation for Small Business

3.3 Target setting in R&D program

In the process of drafting the second Science and Technology Basic Plan, there was intensive and extensive discussion on how to allocate these research funds. It is important not only to increase public spending on R&D, but also to maximize its effect. The CSTP has reached the conclusion that priority areas for public spending should be designated by technology field in the Science and Technology Basic Plan, in order to guide each ministry in charge of the actual formulation of R&D-granting scheme to prioritize its areas of spending.

First of all, the CSTP discussed the criteria in selecting priority technology fields, and came up with the following three points.

- Creating knowledge that engenders new developments (enhancement of intellectual assets)
- Promoting sustainable growth in world markets, improving industrial technologies, and creating new industries and employment (economic effects)
- Improving people's health and quality of life, enhancing national security, disaster prevention, etc. (social effects)

Accordingly, the following four fields were selected as 'priority fields':

1. Life sciences—whichwill help resolve food shortages and prevent/treat disease in Japan's aging and low-birth-rate society
2. Information and communication technologies—which are advancing rapidly and are vital to the building of an advanced IT network society and the fostering of IT and other high-tech industries
3. Environmental sciences—which are indispensable for human health care and conservation of the living environment, as well as sustaining the foundations of human existence
4. Nanotechnology and materials—which disseminate into a broad range of fields and help Japan maintain its technological edge

In each field there are many subcategories, and the goals of each field are stated in the Science and Technology Basic Plan. In the process of selecting these fields, substantial studies on the economic impact of technological development have been conducted. Examples are forecasting technological trends by scientific disciplines, and economic impact in terms of the size of new industries and job creation. However, since the selecting criteria include not only economic impact, but also social benefits such as improving the quality of life, the selection has not been made based solely on quantitative assessment, but also by taking into account qualitative factors.

4. Reform of Public Research Infrastructure

4.1 New form of national research institute: IAIs

In the course of the national government reform in 2001, most national research institutes, which used to be part of the national government, have become independently administrative institutions (IAIs). Since awareness of this important institutional change is essential in understanding recent developments in public research infrastructure management, an explanation of IAIs is provided first.[4]

In the administrative reform in 2001, not only the reorganization of central government structure, but also a whole range of reforms to achieve efficiency in public adminis-tration, have been made. Accordingly, IAIs were designed to make certain units of the government independent in order to introduce an efficient management system. An independent body has more incentive to improve efficiency, and is also allowed to have more flexibility in its management style so as to increase productivity.

The way that IAI works is that the ministry in charge of each IAI has to provide a mid-term objective over three to five years, and the IAI has to draft a mid-term plan based on the objective. This plan is evaluated by an evaluation committee with external members, and must be authorized by the ministry. In addition, the IAI has to delineate its planning and checking process in an annual plan and an annual report, both of which are reviewed by the evaluation committee. An annual budget will be provided to each IAI based on the results of the mid-term plan evaluation as well as the annual planning and checking process.

At the same time, an IAI is given freedom in its management of financial and human resource allocation. In terms of financial management, corporate accounting rules are applied, which allows it to carry over an annual surplus to the next year, in contrast to the government budget rule in which such carry-over is strictly regulated. In addition, it does not have to comply with the seniority-based pay scale of government officials, making it possible to hire outstanding scientists with exceptional salaries.

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[4] The definition of "public research institute" is broad, and includes national and regional public research institutes as well as higher educational sector members such as universities. It should be noted that the system of IAIs has been introduced to national research institutes. In Japan there are public research institutes attached to local governments as well. Regarding the higher education sector, reform of national universities is now under discussion. National universities are planned be converted to independent institutions in 2004.

Fifty-nine IAIs have been registered since April 2001, and about 30 of them are so-called national research and testing institutes. As of September 2002, all IAIs have just finished evaluation on the first annual report of 2001 FY by their evaluation committees.

4.2 Competitive funding for PRIs

The competitive funds are selectively allocated to research issues that have been chosen by prior evaluation. For this reason, this fund is an important means of utilizing limited funds efficiently and effectively. Also, it is a fair, merit-based system to provide young researchers with research opportunities. Therefore, the general direction of financing public research institutes is towards increasing the share of competitive funds and decreasing the institutional funds. This direction is clearly expressed in the Science and Technology Basic Plan.

The share of competitive funds has been increasing steadily since the first Science and Technology Basic Plan was approved in 1996. From 1997 to 2001, the amount of competitive funds was amplified about 2.4 times, from 6.5% (fiscal 1997) to 9.4% (fiscal 2001), of science and technology-related expenditures (Table 1). Increasing competitive funds is important in motivating young researchers' research incentives. The Second-term Science and Technology Basic Plan provides that, in the course of doubling the competitive funds, the research expenses for young researchers should be increased, and aggressive applications by young researchers for competitive funds in general should also be encouraged.

Table 1: Changes in competitive funds and total S&T budget

(billion yen)

	1997FY	1998FY	1999FY	2000FY	2001FY
Competitive funding	194.1	217.1	237.8	296.8	326.5
Total S&T budget	3002.6	3032.2	3156.7	3286.0	3468.5
% of Competitive F.	6.5%	7.2%	7.5%	9.0%	9.4%

(source) White Paper on Science and Technology (MEXT)

Regarding the extent of Japan's competitive environment, the ratio of adoption of issues is about 20% for new issues under the grant-in-aid for the scientific research system, and less than 10% on average under the basic research promotion system by non-profit funding corporations. Therefore, we can conclude that the environment for the competitive fund is truly “competitive”.

Overheads associated with competitive funding also comprise an important issue. An overhead refers to an indirect cost allowed for expenses necessary for management in research institutes to ensure an appropriate environment for researchers. The expense is allocated, at a certain ratio of research expenses, to the research institutes to which the researchers who have obtained competitive funds belong. It is expected that an overhead will prompt competitive principles among research institutes and create research environments that are attractive to researchers. In Japan the introduction of an overhead into research expenses is rather unusual. Therefore, the Second-term Science and Technology Basic Plan suggests covering around 30% of overheads in competitive funding programs.

Regarding problems in executing research budgets, especially at national universities and national research institutes, administrative procedures tend to be very complicated and inflexible, due to budgetary regulations. However, there has been some progress on flexible treatment of national research funds, such as inter-account transfer and carry-over of expenses over fiscal periods.

Setting up a system for fair and transparent assessment and evaluation is very important to facilitate healthy competition among researchers by increasing the share of competitive funds. The strong push for a competitive environment for researchers in PRIs was made by the first Science and Technology Basic Plan in late 1990. Although its introduction into Japan is rather recent, the majority of researchers now have positive opinions about this trend. However, many researchers are pointing out the need to clarify evaluation criteria and to establish objective standards of evaluation, based on the survey by MEXT in 2000. Assessment of the competition process of R&D funds is conducted by an external evaluation committee. However, the evaluation results are said to depend heavily on the specific members of the evaluation committee. Due to the slow pace of personnel turnover in the Japanese scientific community, there are close networks of researchers in this community, which makes it difficult to set up a truly external committee.

The fundamental principle of evaluation systems is common across countries. In Japan as well as in European and North American countries, peer review (cross-evaluation by counterpart researchers in the same field) is used for evaluation. However, the problem with Japan is its lack of full-time human resources for evaluation, both qualitatively and quantitatively (Annex 2). Therefore, entire evaluation systems must be strengthened by allocating more financial resources for evaluation work, and reinforcing evaluation units by securing research-experienced human recources at home and abroad. It is also important to construct a database of evaluation results which can be referred to by evaluators.

4.3 Evaluation system for PRIs

The importance of program evaluation was pointed out by the first Science and Technology Basic Plan, and the National Guideline on the Method of Evaluation for Public R&D was created in 1997. This guideline covers all layers of evaluation for public spending on R&D, that is, evaluation at the level of overall national R&D policy, systematic evaluation of the PRIs, and evaluation of each R&D program. It suggests checkpoints in the course of evaluation, such as the importance of publicizing evaluation results and of accepting comments from outside. Each ministry, public research organization and non-profit funding agency must follow this guideline and conduct fair and objective evaluation for the effective use of taxes.

In the Second-term Science and Technology Basic Plan, with the goal of achieving competitive public research infrastructure and effective and efficient resource allocation, it is suggested that this guideline should be revised, focusing on (1) securing fairness and transparency, (2) reflecting evaluation results in resource allocation, and (3) securing the resources necessary for evaluation. Based on this recommendation, the guideline was revised and approved in a Cabinet meeting in November 2001.

The gist of this revision of the guideline is to stress the importance of the feedback loop from evaluation results to resource allocation. In addition, in order to ensure fairness of evaluation, it is suggested that quantitative criteria be used as much as possible in evaluation. Furthermore, the guideline recommends that curiosity-driven basic research and market-oriented applied research should be separately evaluated. That is, the former type of research is evaluated by “peer review” by well-qualified international researchers, while the latter is assessed by its initial objectives, from either a scientific/technological or an economic/social viewpoint.

In terms of evaluation of PRIs, it is better to separate them into three categories, i.e., independent administrative institutions (IAIs), national research institutes, and universities. As for IAIs, the evaluation mechanism is institutionalized as is shown in Section 4.1. Each IAI has an external evaluation committee for planning and checking systems mid-term and annual plans/reports. Budget allocation is supposed to be based on this evaluation, but since the system has just started, details of its actual implementation are still unclear. But, one can at least say that after becoming an IAI, each institute is under more pressure to improve its efficiency, since all evaluation reports from the committee are published, and it is easy to compare evaluation results across institutions.

Some national institutes which are in charge of research for particular policy objectives, such as national health institutes, remain part of the national government. In addition, there are some public research institutions attached to local governments. For these institutes, evaluation should be done based on the objectives of each institute as set by the government.

Finally, for public universities, which are funded by either national or local governments, external evaluation has not yet been introduced. Each national university has an internal evaluation committee, following the first guideline on evaluation. However, it has been decided that national universities, now part of the government organization, will be converted to independent institutes in 2004. These new institutes will be similar to IAIs, in that they will have to go through planning and checking processes by an external evaluation committee.

4.4 Commercialization of research findings from PRIs

Commercialization of research findings from PRIs has been strongly promoted by various kinds of policy initiatives under the guideline of the Science and Technology Basic Plans. The mechanism of the commercialization can take various forms. It could be licensing of patents of PRIs or the "spinning out" of researchers to set up new companies. In addition, collaboration of PRIs and industry for research is also encouraged, to increase the probability of commercialization of the research results. Furthermore, such collaboration will also induce knowledge spill-over from PRIs to industry, which eventually enhances industrial innovation.

At the institution level, Law for Promotion of University-Industry Technology Transfer plays an important role. This law was enacted in 1996 to support technology licensing offices (TLOs) at PRIs. Under this law, the registered TLOs can receive financial support for their activities, and other special treatment such as reduced patent application fees. The number of patent applications made between the end of 1998 and the end of December 2000 exceeded 700, which were administered by registered TLOs. (There were 26 TLOs as of January 2002).

In addition, joint research centers have been established at universities since fiscal 1987 as the footholds for the promotion of industry-academia cooperation. These centers provides physical places to conduct collaborative research projects between university and private firms, as well as an inside-university focal point of interaction with industry representatives. There are 61 centers as of the end of March 2002. At national universities, the number of joint research projects has increased 4.4-fold, and the number of researchers for those projects has increased 2.7-fold during the last 10 years.

As for national research institutes, most of which are now operating as independent administrative institutes (IAIs), commercialization of research and collaboration with industry are on the top agenda for their mid-term plan. As discussed in Section 4.3, the overall activities of IAIs are evaluated by each institute’s evaluation committee, and the national guideline on research evaluation states that an evaluation should be based on quantitative criteria as far as possible. Therefore, the quantitative indicators for research output such as the number of patents and papers become important for PRIs. In addition, IAIs are encouraged to attract external research funding, including not only project-based grants from the government, but also research funds from private firms for contracted research and joint research projects.

These policy initiatives for commercialization of research findings of PRIs and collaboration with industry have started to work. According to a survey conducted by MEXT in 2000, the share of firms that responded with “increase” in joint research with universities during the last five years is 21.8%, as compared to 9.2% reporting a “decrease”. As for national research institutes, the share of firms with increases in joint research is 13.7% compared to 11.5% which report a “decrease”. In addition, there are other signs, such as increases in the number of joint papers between PRIs and industry and in the number of patent application and licensing revenues of universities.

However, the policy push for commercialization of research findings of PRIs started recently, and there are many things to be developed on the PRI side. Other statistics show that R&D expenses for joint research with domestic PRIs do not increases, in contrast to the upward trend of R&D expenses with foreign PRIs. (Fig. 5) According to an opinion survey of managers of Japanese firms, it is difficult to gain attractive research output in PRIs. In addition, compared to international PRIs Japanese PRIs lack experienced staff in charge of dealing with contracts.

As for researchers at PRIs, incentives for commercializing their research outputs are not so strong. However, becoming involved in research projects with industry is encouraged. Under the new management style of IAIs, each researcher has stronger incentives to collect external funding and to work together with industry as well as with other research institutes. In addition, the government prepares R&D program funding, granted only for joint research team consisting of researchers from both PRIs and private firms, to promote collaboration between PRIs and private firms.

The turnover of researchers among institutions is important in order to facilitate the collaboration of industry and science, and enhances knowledge spill-over embodied in human capital. In connection with the human interchange at public research institutes, during off-duty hours, part-time work to conduct R&D or give technical guidance at businesses has been allowed since 1996 for national research institutes, and since 1997 for national universities. Also, in 2000, dual assignment of university teachers to the TLOs and to the directorship of businesses that use research output was approved.

In addition, introducing the system of IAI to national research institute gives more flexibility in human resource management. National research institutes had to comply with regulations for government employees, such as seniority-based promotion and wage systems. However, after being converted to an IAI, an institute introduce its own human resource strategy, and now it sometimes happens that mid-career university professors are hired as a director or team leader in a PRI.

To facilitate discussions about researchers' incentives for commercializing research results, the system of intellectual property rights is also important. MEXT has a guideline on the IPR ownership for inside-national university research. It states that the ownership of a right is attributed to the Japanese Government when the research concerned is for the specific development of an application, but otherwise the ownership of a right is attributed to the individual researcher. In the case of research projects conducted inside national universities, the majority are curiosity-driven basic research, for which rights are attributed to researchers. However, actual patent application has occurred only rarely, due to the heavy financial burden of applying for and maintaining the right.

For national research institutes there has been no such guideline, but an IPR is attributed to either an individual researcher or the government. University research faces the same problem as does individual holding of IPRs, and in the case of a government holding, effective utilization of the IPRs is not possible, due to the complex procedures for the disposition of national property.

The treatment of IPRs in PRIs is now in the process of reform, and the general policy direction is that they should be attributed to IPRs, instead of to individual researchers. In the case of IAIs, there is no problem associated with national property, since IAIs are no longer part of the Japanese government. In addition, a TLO attached to each PRI can effectively conduct the maintaining and licensing of IPRs. National universities will be converted to IAI-type independent institutes in 2005. Then effective management of IPRs can be conducted by each institute.

As for researchers' incentives, it is important to set rules for remuneration for inventors. Under the patent law in Japan, ownership of a patent in the course of work in private firms belongs to the employee, but the firm can obtain the right according to the employer-employee contract by paying a "reasonable amount of remuneration". Since this language of the patent law is too vague, currently there is heated discussion on this clause. Whether or not a different clause for a patent registered by PRIs is needed is also under debate. Nothing has been decided yet. However, there is general agreement that it is necessary to have some rules to stipulate more details in the amount of remuneration.

4.5 Industry and science collaboration in education

Reform of the higher education system has been discussed in the Council on the Higher Education System, whose members include industry representatives, and higher education to meet the needs of industry is one suggestion made by the Council.

One of the policy schemes to facilitate industry and science collaboration in higher education is the system of joint graduate schools of universities, national research institutes and private firms. Under this system, research activities in public or private research institutes within a group of joint graduate schools are counted as course work toward a doctoral degree at a university of this group. At the end of 2000, about 100 schools had been set up in public and private universities.

However, higher education is still dominated by universities. Under the joint graduate school, the university in the group takes responsibility for the final degree, so that the operation of the whole program, from entrance examination to dissertation evaluation, is managed by the university. It is true that there is some concern from the industry side that some universities' curricula are outdated. In addition, there are some movements to develop curricula of education on science and engineering by scientific associations.

Nevertheless, it is universities that implement actual education to students, and the actual curriculum is written by the professor in charge of each course.

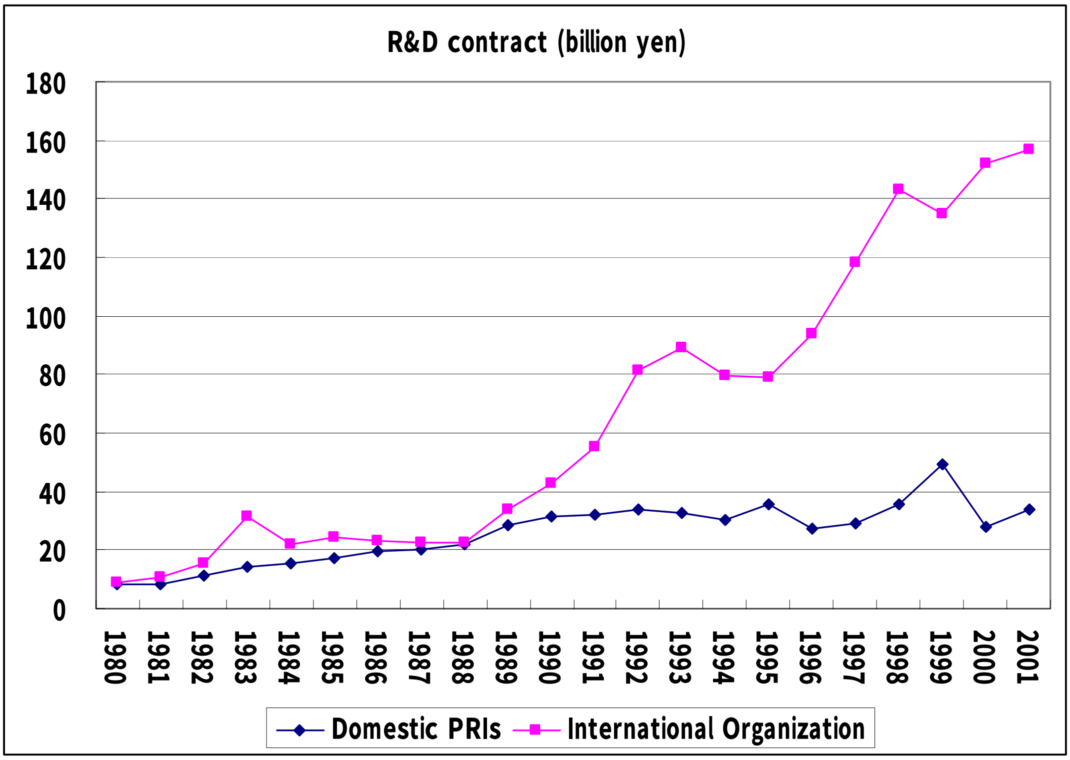
Professional schools for students who have some work experience are becoming common in Japan. There are more than 10 business schools for MBAs in Japan, and there are also some courses focusing on technology management (MOT: Management of Technology). Due to the recent decrease in the average number of children, Japanese universities are keen to establish new courses for mid-career students.

5. Conclusion: what have been achieved and what have not

In this paper, an overview of Japanese R&I policy developments since the late 1990's is provided. Several policy initiatives can be observed in these years. However, the objectives are rather simple, (1) efficient government resource allocation in policies for stimulating private innovation activities and (2) management innovations for public research institutions under market base competition system. In addition, all of these policy changes are intended to foster S&T system to stimulate innovation in industry. Japanese national innovation system can be characterized as 'compartment system by large companies', where industrial innovation is obtained mainly by large companies without strong linkage of S&T systems. However, with an advance of science driven industries, such as IT industry using applied physics and pharmaceutical industry using biotechnology, science and industry linkage becomes a key to stimulate innovation in these high-tech industries of OECD economics.

In this context, recent policy initiatives to activate S&T system to foster linkages with industry are in a right direction. However, at the same time, it should be noted that these changes should take a long time. The reform of national research institutes took place in 2001, and the university reform will come in 2004. The share of competitive funding to total S&T budget is still less than 10% as compared to 30% in the U.S. As is shown in Fig 2, the amount of firm's R&D contract with domestic PRIs is stagnant, although that with international organizations are growing. In this sense, it is fair to say that the effect of this policy change cannot be seen yet.

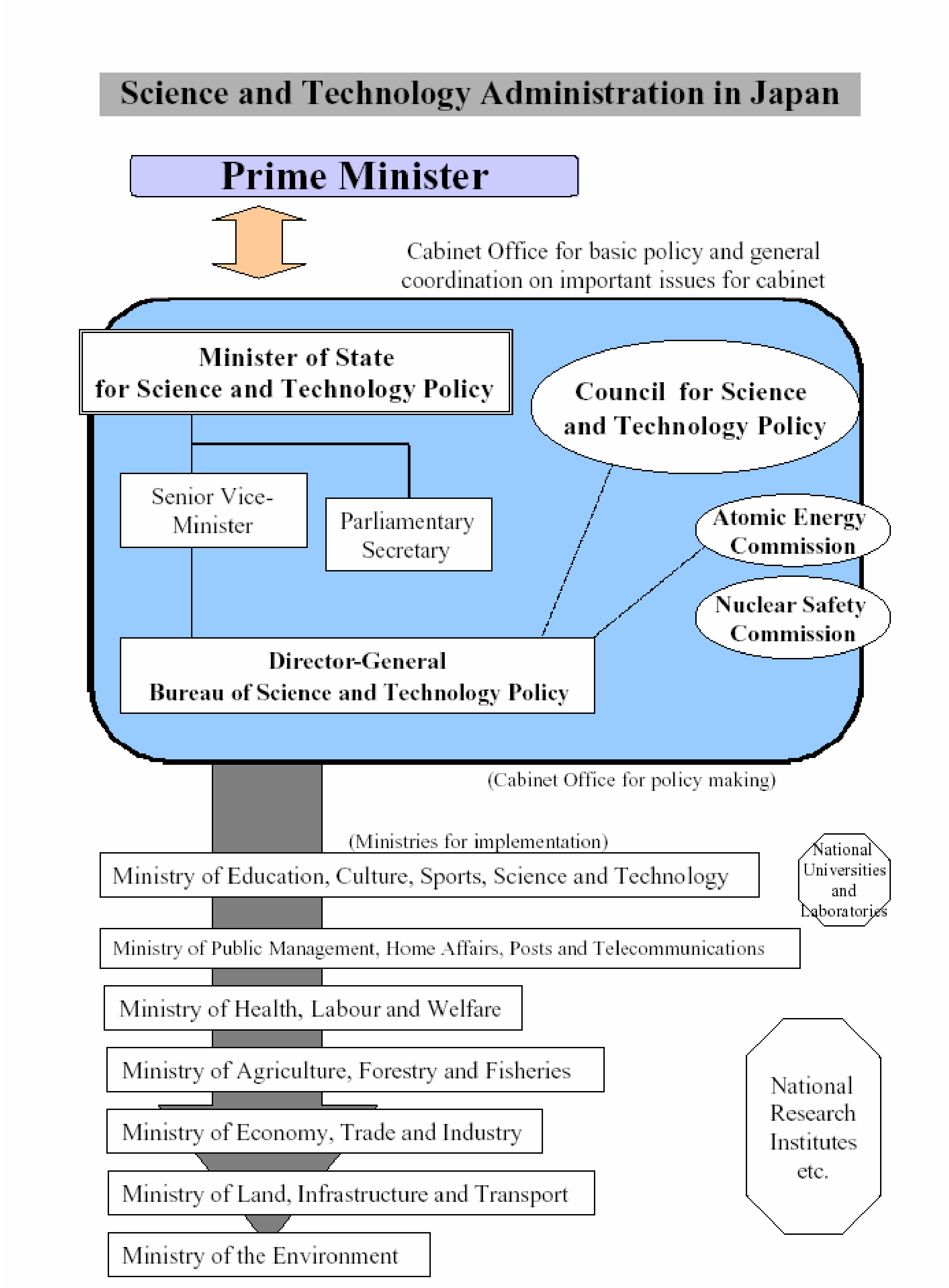
Fig 2. R&D contract of firms with domestic PRIs and international organizations



The government R&D support program should be complement to this reform of science and technology system. The new CSTP was created in 2001, and under the second Basic Science and Technology Plan, four priority fields are identified. The new CSTP is endowed more power in coordination of S&T policies managed by various ministries, as compared to the old one. The most important instrument is a right to submit recommendations on S&T budgets of various ministries to the ministry of finance. However, this system has just started, and a significant amount of budget re-allocation among ministries cannot be observed yet.

The problem associated with compartment system inside the government is also found in managing new national research institutes. Even though the national research institutes were transformed to IAIs with more flexible management style, each IAI is regulated by its home ministry. In an absence of coordination between ministries, there may be duplications in research projects, and horizontal cooperation among related IAIs may be difficult to be achieved. Whole process of changing national innovation system of Japan should be evaluated carefully in a long term. But policy coordination among ministries can be achieved more quickly with strong leadership by politicians.

Annex 1 : Structure of Japanese Government for S&T policy



Annex 2. International Comparison of Evaluation Structure for Competitive Funds

International Comparison of Evaluation Structure on Competitive Funds

Names of country	U.S.		U.K.	Japan		
Names of subsidized foundation	National Institute of Health	National Science Foundation	Engineering and Physical Sciences Research Councils	Ministry of Education, Culture, Sports, Science and Technology (Grant-in-Aid Scientific Research)	Ministry of Education, Culture, Sports, Science and Technology (Special Coordination Funds for Promoting Science and Technology)	Japan Science and Technology Corp. (Core Research Evolutional Science and Technology)
Funds in total	1,780.6 billion yen (1999)	About 420.1 billion yen (2000)	About 77.3 billion yen (1999)	141.9 billion yen (Fiscal 2000)	32.4 billion yen (Fiscal 2000)	29.8 billion yen (Fiscal 2000)
Number of examination per annum	About 30,000 cases	About 30,000 cases	About 5,000 cases	About 100 thousand cases	About 1,000 cases	About 700 cases
Administrative parties of evaluation	First examination: Scientific Review Administrator (about 1,100 persons) Second examination: each research institute	Program directors (about 400 persons)	Program managers (about 300 staff)	Chairman of each evaluation committee (about 90 persons)	Chairman of each evaluation committee (20 persons)	Entrusting outside parties for Research Area Supervisor (10 persons)
Evaluation committees	First examination: 120 study sections (about 1,600 persons) Second examination: 21 advisory council of research institute (about 480 persons)	Evaluators by mail (about 30,000 persons) Panel evaluators (about 8,000 persons)	First examination: referees (3 persons each) Second examination: committee for each of 17 specialized field (evaluators about 1,800 persons)	Science Council -Subcommittee on Grants-in-Aid for Scientific Research (about 500 persons) Japan Society for Promotion of Science -Committee on Grants-in-Aid for Scientific Research (about 5,700 persons)	Evaluation committee for each of 11 systems (about 180 persons)	Committee for each of 10 areas (about 80 persons)

Notes: The IMF exchange rate was used for converting the U.S. and British currencies into Japanese yen.
Source: Surveys by Ministry of Education, Culture, Sports, Science and Technology

Adopted from White Paper on Science and Technology, 2001 (MEXT)