The Development of Industry-Academia-Government Cooperation and Regional Innovation in Japan

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Abstract

This paper reviews the developments of industry-academia-government cooperation and regional innovation in Japan.

The current situation of industry-academia-government cooperation is characterized by the following three:

A) Increasing number of joint-authored papers by industry and academia,
B) Increasing number of patents after establishments of TLOs,
C) Drastic rise of university-initiated start-ups.

However, comparison with the US and the UK shows that Japan is still lagging behind.

In order to promote regional innovation in Japan, both the central and local governments have implemented policy packages including budget allocations and setting up dedicated offices, conferences, advisory boards, and general principles. A composite indicator system measuring regional S&T activities toward innovation is being developed. We reviewed some of the results by using this indicator to evaluate the current status.

Finally, policy implications derived from the above considerations are also described.

Part 1. Industry-Academia-Government Cooperation in Japan

1- 1 . Introduction of Major Policies & Programs for Facilitating Cooperation : Lagging behind US and UK by "2 laps"

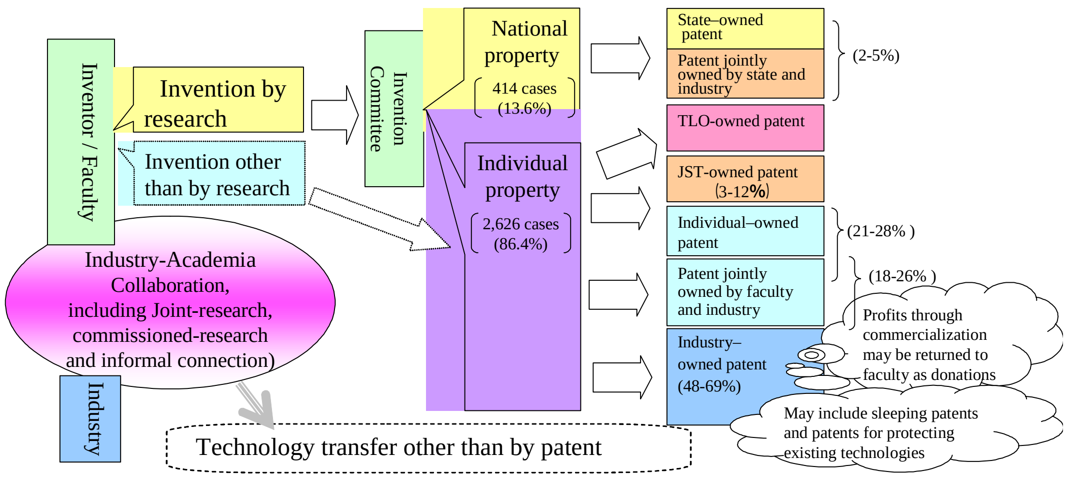
Table 1-1 shows that major policies and programs for facilitating cooperation between industry-academia-government, such as the law for establishing TLOs, and various operational system reforms, have been only initiated in 1998-99 in Japan. That is in fact Japan is lagging behind US and UK by almost '2 laps', where major policies and programs have been introduced already in '70s and '80s, but we are trying to catch up with them.

Table 1-1. Major Policy Initiatives for Promoting Cooperation since '98

-	Law promoting technology transfer from university to industry	....	Establishment and promotion of TLOs: enforced in 1998
-	Development of university IP headquarters	....	43 selected as of July 2003
-	Effective promotion of joint research between industry-academia-government sector	....	Japanese type 'Matching funds' (2002-)
-	Improvement of operational systems	....	Realization of multiple-year contracts capability (2000-), Flexible operation capability by unifying account titles (1998-)

1- 2 . Flow of Patents Invented by National University

Figure1-1 roughly describes typical flow of patents invented by national university, before its reorganization to university corporation in April, 2004.



Source: NISTEP Report No. 78, 2004

Figure 1-1. Flow of Patents Invented by National University

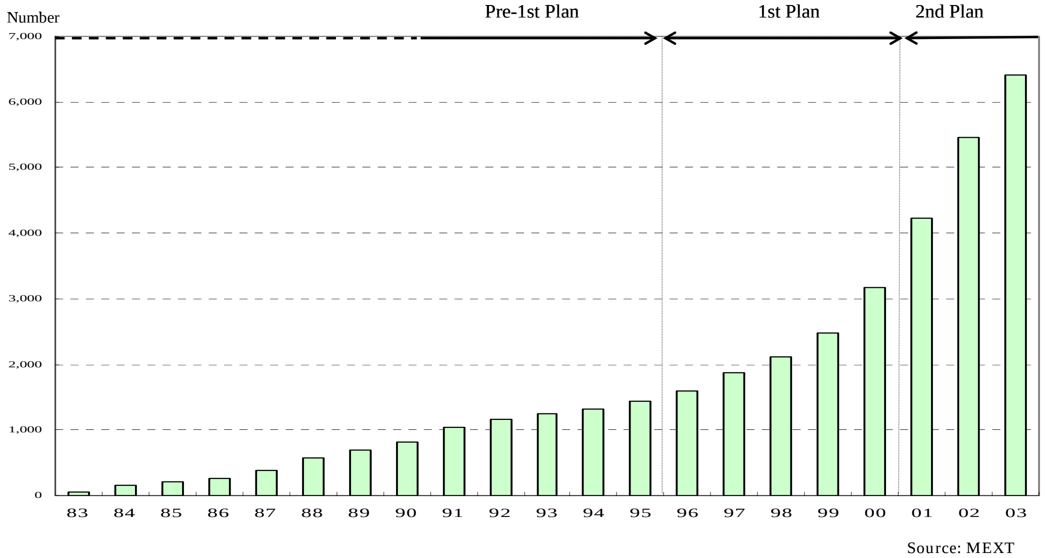


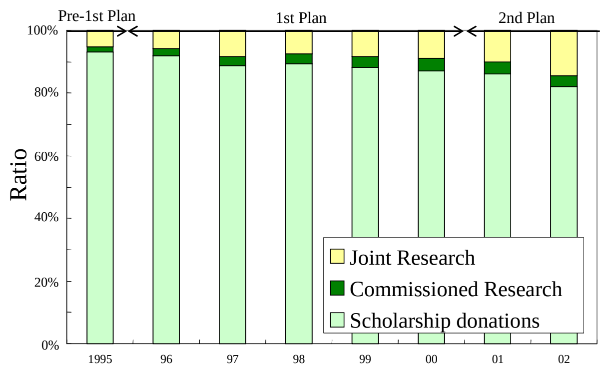
Figure 1-2. Number of Joint Research between University and Industry

It shows that patents owned by individuals and / or industry account for more than 80% of all, but that still include many so-called ‘sleeping patents’ and those applied only for the purpose of protecting existing technologies, which may be one cause of Japan’s low efficiency of converting intellectual assets to real fruits, which will be discussed later in this paper.

1- 3 . Joint and Commissioned Research between University and Industry

Figure1-2 shows the dramatic increase of joint research between national university and domestic industry, and it actually shows that only during the first three years in the 2nd Basic Plan period (2001-03), total number of joint research has been more than doubled.

Figure 1-3 shows the continued shift from classical ‘informal cooperation’ with small-amount of donations to more sophisticated ‘targeted cooperation’ by contract-base arrangements. While the total revenues from the industry to national universities have been steadily increasing,



Total revenues (100 million yen)	523	526	524	522	522	571	641	705

*: based on data from MEXT and NISTEP.

Figure 1-3. Share of Joint & Commissioned Research

the ratio of scholarship donations continues to decline and the share of joint and commissioned research has been increasing.

Table 1-2 describes some cases of typical comprehensive collaboration between university and domestic industry, which is also expected to facilitate deepening of inter-industry cooperation, such as a vertical integration of different companies from materials to manufacturing observed in the case of the collaboration recently initiated between Kyoto University and 5 major companies. Inter-academia cooperation is also expected to be triggered by this kind of comprehensive collaboration, such as seen in the case of bottom-up type of collaboration between Hokkaido University and Hitachi, Ltd.

Table 1-2. Classification of Comprehensive Collaboration

Type	Cases	Major characteristics
Vertical integration	Kyoto University - ROHM Co., Ltd. - NTT Corp. - Hitachi, Ltd. - Pioneer Corp. - Mitsubishi Chemical Corp.	Jointly developing organic electronics and devices.
Bottom-up	Hokkaido University - Hitachi, Ltd.	Joint-collaboration in nano-science area further developed to comprehensive collaboration, aiming at synergy effects in relevant areas within university.
Top-down	Osaka University - Mitsubishi Heavy Industries, Ltd. (MHI)	Collaboration not in a specific area, rather in all the areas MHI deals.

1- 4 . Increasing Ratio of Joint-authored Papers

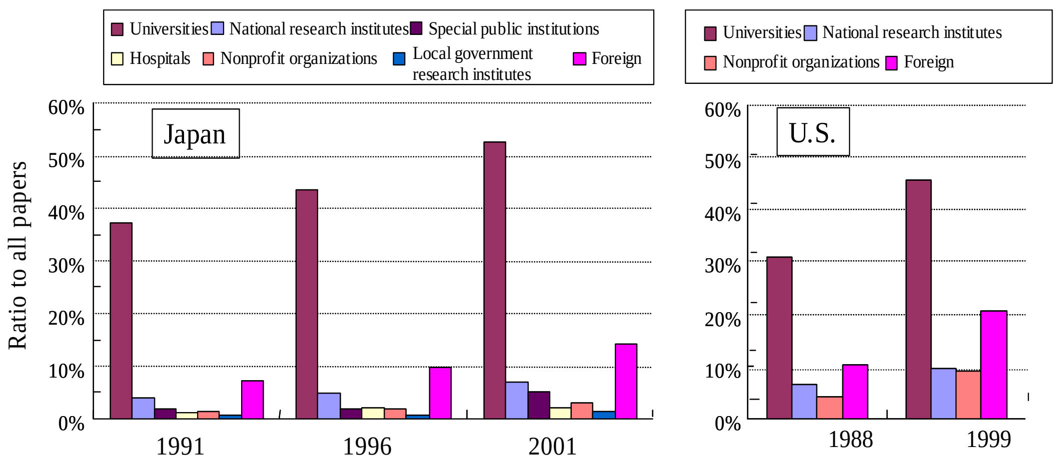
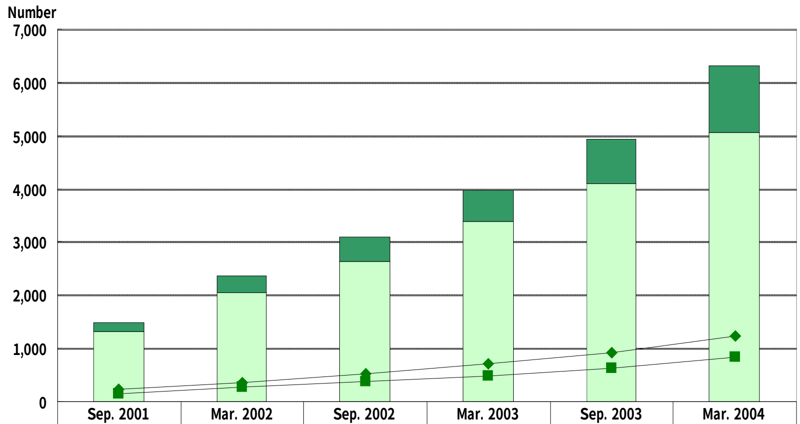


Figure 1-4. Ratio of Joint-authored Papers by Companies and Other Sectors

As another evidence of gaining links between industry and universities, Figure 1-4 shows the increased ratio of joint-authored scientific papers between companies and universities. Surprisingly, ratio of joint-authored papers by domestic companies and universities in Japan accounted as far as 53% in 2001, which is almost close to that in the US, where this kind of collaboration between universities and industries seems to be most advanced in the world.

1-5. Trend of Patents granted through TLOs

Figure 1-5 shows the dramatic increase of patent application and licensing through the activities of TLOs, after major policy initiatives introduced in late 1990s. It can be observed that not only the total number of application and licensing is rapidly increasing, but also the rate of patents granted against the number of application is also improving steadily, which may show the gaining 'productivity' of technology transfer activities in Japan, although it is still far lower than those in US and UK, as described afterwards.



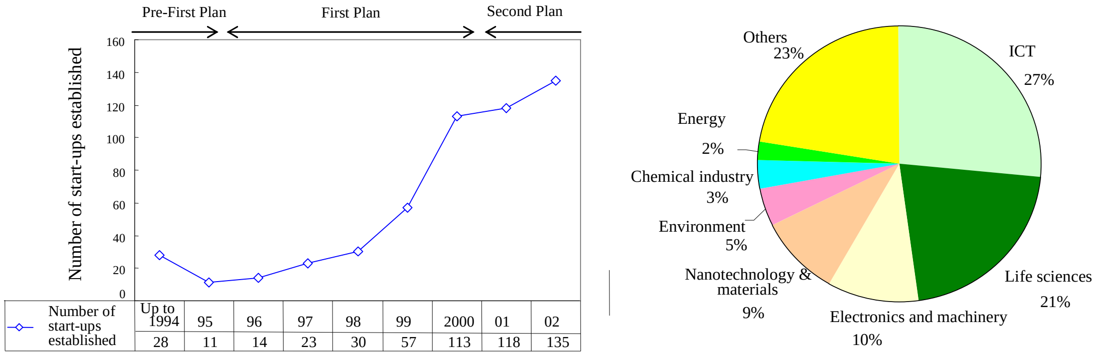
	Sep. 2001	Mar. 2002	Sep. 2002	Mar. 2003	Sep. 2003	Mar. 2004
Number of Patent Applications in other Countries	179	318	475	602	843	1,256
Number of Patent Applications in Japan	1,306	2,043	2,625	3,378	4,088	5,058
Number of Patents with Royalty Income	155	262	371	479	619	833
Number of Patents Granted	223	356	517	705	920	1,237
Rate of Patents Granted	17.1%	17.4%	19.7%	20.9%	22.5%	24.5%

Source: METI website

Figure 1-5. Number of Patent Applications and Patents with Royalty

1-6. Significant Increase of University-Initiated Start-ups

As another form of commercialization of intellectual assets from university, Figure 1-6 shows the significant increase in the number of university-initiated start-ups, which already exceeded 600 in total. This entrepreneurial boom is occurring mainly in four priority R&D areas designated in 2nd Basic Plan (ICT, Life sciences, Environment,



	Up to 1994	95	96	97	98	99	2000	01	02
Number of start-ups established	28	11	14	23	30	57	113	118	135

*: Breakdown of 614 companies as of August, 2003

Source: Calculated by NISTEP based on "Research Results of University-Initiated Start-Ups", FY2003 (Univ. of Tsukuba, January 2004)

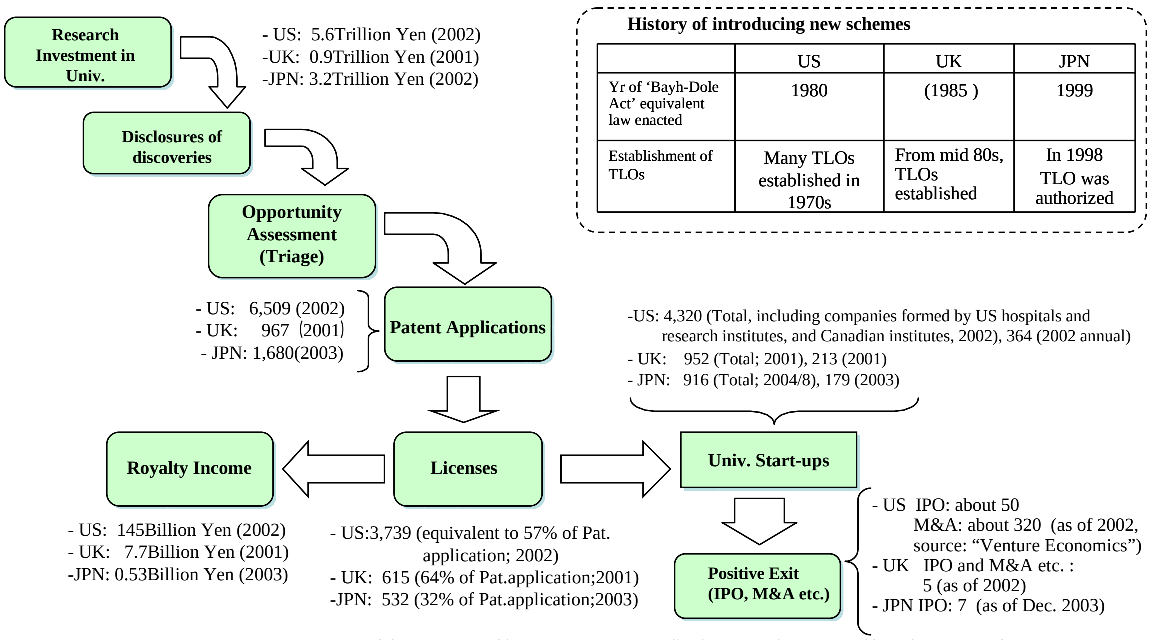
Figure 1-6. Trends in Numbers of University-Initiated Start-ups and its Breakdown Income

Nanotech & materials), with the share of over 60%. In particular, concentration to the fields of ICT and life sciences can be observed.

1-7. International Comparison of Technology Transfer Process and its Fruits

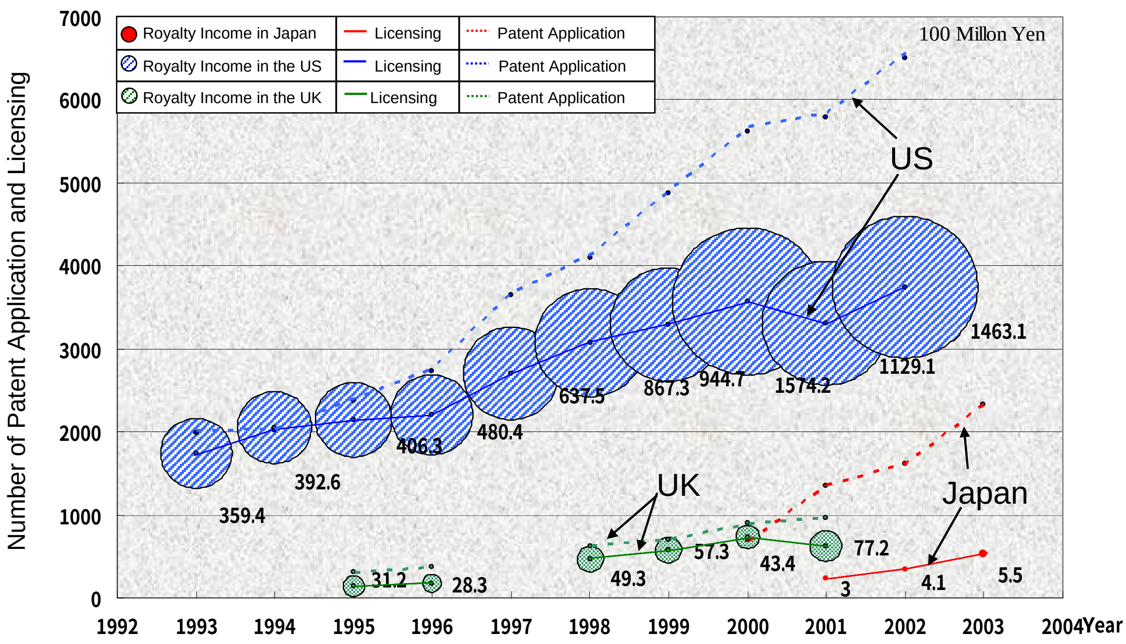
Looking at Japan's recent situation from a more global perspective, Figure 1-7 shows the comparison of technology transfer productivity in Japan with US and UK. While the level of input to the university sector and that of patent application in Japan well compete with the UK levels and are chasing the US, number of licenses and the amount of royalty income are lagging far behind those of US and UK, mainly due to the '2 laps behind' situation of introducing new schemes of technology transfer, as described in 1-1. But larger fruits of commercialization are expected in Japan, as has already been partially observed in good number of university start-ups and their positive exits.

Figure 1-8 is another description of time -series analysis of the productivity of technology transfer from university. In US and UK, continued efforts for 10-20 years have resulted in larger fruits, while in Japan those efforts recently initiated have not fully converted into cash so far, which may be a strong supporting evidence that we should not only ask for a short-term profit by these activities.



Source: Research investment – White Paper on S&T 2003 (foreign currencies converted based on PPP rate)
Other data: - US: Licensing Survey 2002(AUTM) etc- UK: Higher education-business interaction survey 2000-01 etc.
- JPN: MEXT, METI [Pat.& licensing data: those managed through TLO]

Figure 1-7. Comparison of Technology Transfer Processes in Japan, US and UK



Source: US: "AUTM Survey," UK: "Science & innovation investment framework 2004-2014," Japan: METI

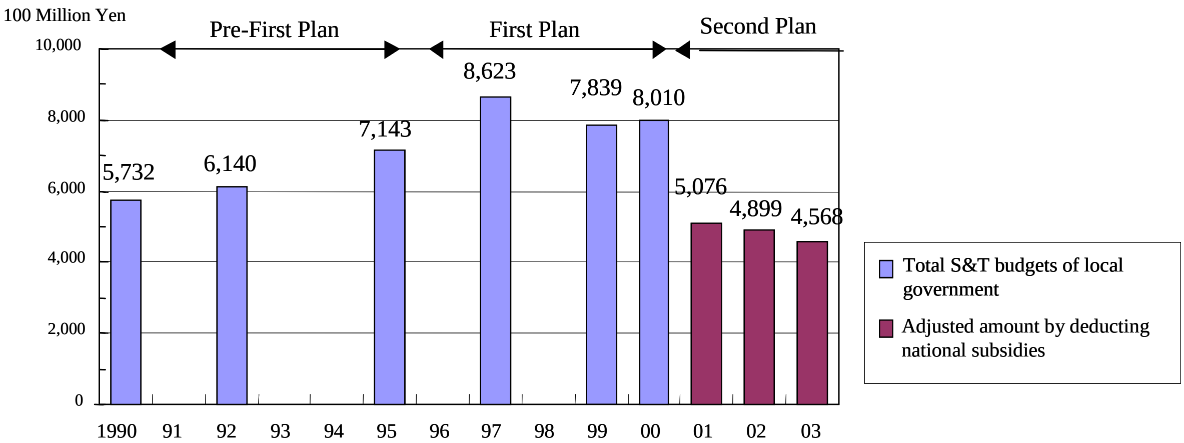
Note: Royalty incomes in the US and the UK were converted by PPP into JPY.

Figure 1-8. Time-series Analysis of Patent Application, Licensing, and Royalty Income by Universities in Japan, US and UK

Part 2. Development of Regional Innovation in Japan

2- 1 . Trends in S&T Budgets by Local Governments

Turning into the aspects of regional innovation which has also been put a high priority among various policy agenda, Figure 2-1 shows the trends in S&T budgets by local governments in Japan. Budgets spent by local governments only account for one seventh of that of central government, and during the 2nd Basic Plan period further decrease has been observed mainly due to the slow economic recovery in regions. That also represents the obvious lack of locally available resources and power for regional innovation.



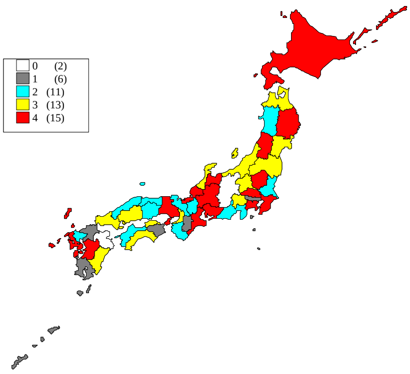
Source: NISTEP(-2001), JAREC: Japan Association for the Advancement of Research Cooperation (2001-03)
*Note: Budgets of 47 prefectures and 12 ordinance-designated cities counted. Figures after 2001 exclude national subsidies. (Coverage of NISTEP survey and JAREC survey substantially differs.)

Figure 2-1. Trends in S&T Budgets by Local Governments

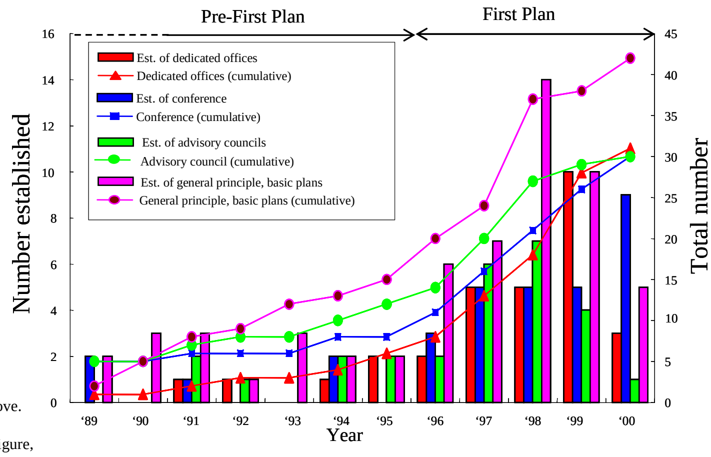
2- 2 . Development of Regional S&T Promotion by Central and Local Governments

Concerning the development of promoting bodies for regional innovation, local governments are doing fairly good, and now there is no single prefecture which does not have any of dedicated office, advisory body, or general principles for regional S&T and innovation policy, as shown in Figure 2-2.

Figure 2-3 shows the brief history of policy implementation by the central government for regional S&T promotion. As the budget for these items dramatically expanded through the 1st and the 2nd Basic Plans, each Ministry has developed relevant policies and programs for regional innovation, which have then provided a significant basis for the following initiatives by local communities.



*: Figures from 0 to 4 show the number of items a local government has undertaken out of the establishments of 4 items (1)-(4) describe above. Figures in parentheses are the number of local governments.
*: Nagano and Oita, two prefectures with no promotion activities on the figure, have already developed promotion guidelines afterwards.



Source: NISTEP, "Study on Regional Science and Technology Promotion Policies (5th Survey) " (2001)

Figure 2-2. Development of Promoting Bodies in Local Governments for Regional Innovation

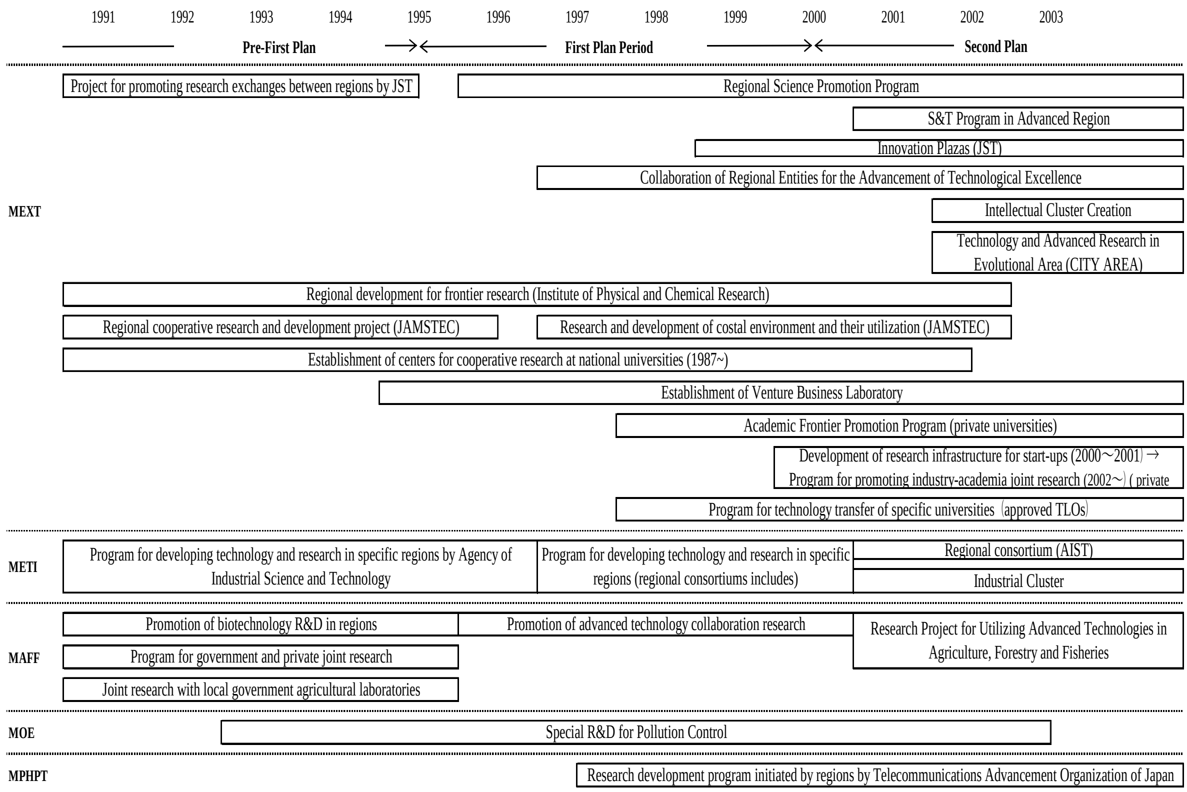


Figure 2-3. History of Budgets and Policy Implementation for Regional S&T Promotion by Central Government

2- 3 . Development of 'Composite Indicators' Measuring Regional S&T Activities toward Innovation

Now, necessary policy frameworks and respective measures being provided, the next question for us is how we can measure the actual progress made by these governmental initiatives. We have developed a composite indicator system measuring regional S&T activities toward innovation, by integrating the element indicators for input, infrastructure, output and impact on a prefecture basis, as shown in Figure 2-4, using the statistical approach of principal component analysis.

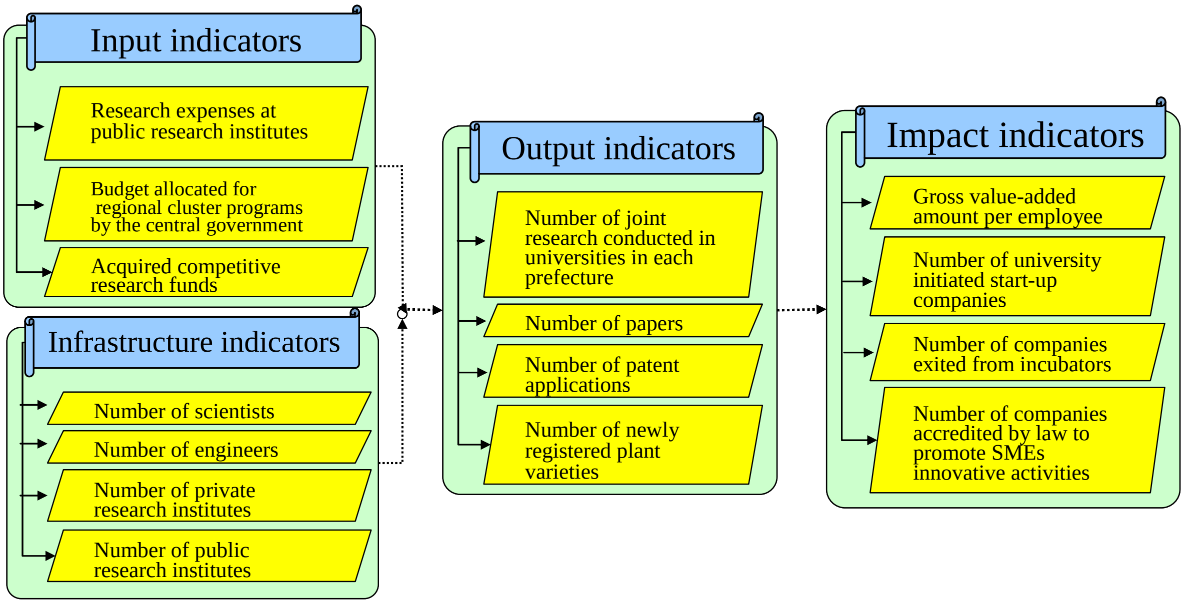


Figure 2-4. Contents of 'Composite Indicators' Measuring Regional S&T Activities toward Innovation

2- 4 . Analyses by Composite Indicators – Case Studies and Cross-Analysis

Using this indicator system, it is expected that we can review the achievements in output and impact, and can analyze the effect of relevant policy initiatives. Table 2-1 shows a quick overview of the rankings of top prefectures in total score and increase rate during the past decade. Tokyo is ranked as an outstanding No.1 and is still rapidly growing, but in the remaining regions there can be observed a clear contrast between those with strong growth and those stagnated due to the difference in the performance of regional innovation in each prefecture.

Table 2-1. Ranking by the Increase of Composite Indicators

Ranking by Increase	Prefecture	Ranking by Total Score in 2002	Increase				
			1990-2002	1995-2002		2000-2002	
1	Tokyo	(1)	66.1%	51.5%	(1)	12.1%	(2)
2	Osaka	(2)	40.5%	33.3%	(2)	10.4%	(3)
3	Fukuoka	(6)	30.1%	26.5%	(3)	12.6%	(1)
4	Hokkaido	(5)	25.8%	19.6%	(6)	8.6%	(5)
5	Kyoto	(7)	24.5%	19.6%	(5)	7.1%	(6)
6	Aichi	(4)	23.0%	15.6%	(7)	4.8%	(11)
7	Hiroshima	(9)	22.6%	22.5%	(4)	9.0%	(4)
8	Miyagi	(13)	18.1%	13.1%	(9)	5.1%	(9)
9	Kanagawa	(3)	17.9%	14.3%	(8)	3.2%	(17)
10	Hyogo	(11)	16.9%	12.3%	(10)	5.3%	(8)
11	Ibaraki	(8)	15.1%	11.2%	(12)	5.0%	(10)
12	Ishikawa	(16)	13.1%	11.1%	(13)	6.9%	(7)
13	Chiba	(10)	13.1%	9.3%	(15)	2.9%	(18)
14	Shizuoka	(12)	10.7%	11.6%	(11)	4.0%	(14)
15	Fukui	(17)	10.2%	10.8%	(14)	2.1%	(27)
16	Gunma	(18)	9.5%	8.3%	(16)	4.4%	(13)
17	Iwate	(24)	8.7%	7.4%	(18)	1.8%	(30)
18	Kagawa	(30)	8.3%	6.9%	(20)	3.2%	(16)
19	Kumamoto	(27)	8.3%	6.7%	(21)	1.6%	(32)
20	Nagano	(15)	8.2%	7.8%	(17)	4.4%	(12)
21	Tokushima	(28)	8.0%	7.2%	(19)	2.3%	(24)
22	Saitama	(14)	7.9%	4.9%	(28)	0.6%	(41)
23	Okayama	(21)	7.7%	5.3%	(25)	2.4%	(22)
24	Yamaguchi	(20)	7.4%	6.1%	(23)	2.5%	(21)
25	Gifu	(19)	7.2%	6.2%	(22)	2.2%	(25)

Figure 2-5 shows a sample comparison of indicators between Kyoto and Ibaraki prefectures. Both have strong scientific base and infrastructure within the region, but the extent of linkage between intellectual assets and local industries has made the difference. In Ibaraki prefecture, which is the home to Tsukuba Science City, impact indicators seem to be leveling off, while output indicators steadily increasing. This should be mainly due to relatively few cooperation between public research institutes and local industries in this region, and to inactive initiatives by local governments.

On the other hand, in Kyoto steady increase of input and output indicators is observed through the 1st Basic Plan, which is followed by rapid increase of impact indicators in the 2nd Basic Plan. This may be mainly thanks to the systematic development of “knowledge utilization" through the full-scale university-industry cooperation in this region. As a result, Kyoto has grown far better than Ibaraki particularly during the 2nd Plan period.

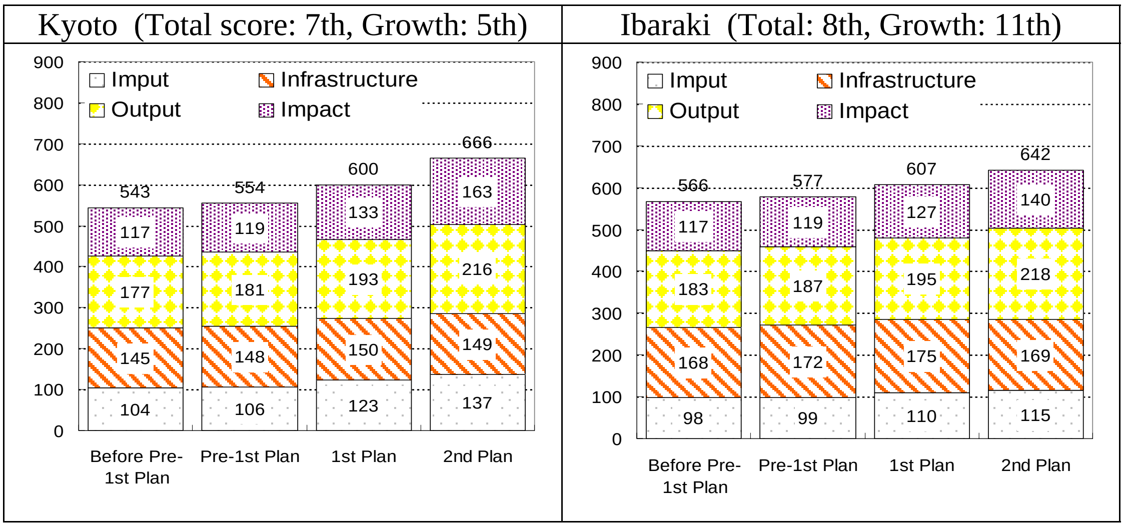


Figure 2-5. Comparison of Composite Indicators in Kyoto and Ibaraki

Figure 2-6 shows a cross analysis of relevant policy developments and composite indicators. It shows that substantial difference can be observed between those regions supported by relevant regional programs of Japan S&T Agency (JST), and those regions being targeted by MEXT Knowledge Cluster Initiative, and the national average (excluding Tokyo). However, the issue of time-lag between input, output and impact should be considered, and in that context cause and effect relationships between public investments and growth in regional innovation should be carefully examined. For instance, MEXT Knowledge Cluster Initiative has been only initiated in 2002, thus the direct contribution by this program can be merely observed in input indicators in the 2nd Plan period.

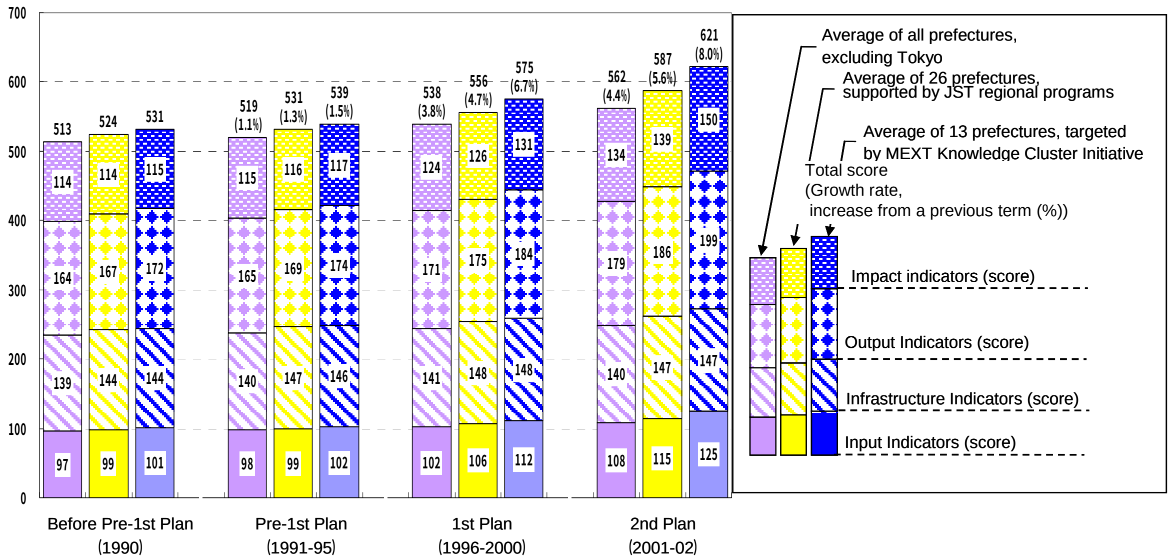


Figure 2-6. Cross Analysis of Regional Innovation Programs and Composite Indicators

Part 3. Implications and Issues for Further Policy Development

Through the analyses described in Part 1, possible implications obtained for industry-academia-government cooperation may include:

- Securing resources and systems such as coordinators and planners, training programs for practical skills of researchers, networking functions;
- Overcoming structural issues such as rules for IP management, securing confidentiality, cooperation with foreign companies with the concern of brain drain and offshore manufacturing;
- Giving incentives for external funds as an issue of 'Additionality' of input and output.

Possible policy implications extracted from our study described in Part 2 may include:

- Dividing roles between the central government and regions, with the central government to take the "first step", while concentrating and delegating authority and resources to regions; and identifying the role and status of eminent regional clusters in NIS (National Innovation System);
- Securing sustainability of funds, technologies, and human resources in the region, with recognizing role and function of network systems driven by local governments;
- Identifying roles of universities and public research institutes for assisting sustainable regional innovation systems;
- Advancing cross-border cooperation including inter-industry, inter-disciplinary, inter-department, international, inter-regions cooperation.

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