RESEARCH MATERIAL No.114

Study on Systematization of the Indicators on Regional S&T Activities toward Innovation

Summary

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Third Policy-Oriented Research Group

National Institute of Science and Technology Policy (NISTEP)

Ministry of Education, Culture, Sports, Science and Technology (MEXT)

1. Study objective and background

Science & Technology Basic Plans have emphasized the promotion of science and technology in regions. The reason for the emphasis lies in relatively slow economic recovery in these areas. Due to the limited financial resources of the local governments, expectations are high that promoting S&T and fostering innovation and entrepreneurship will contribute to creating new industries and jobs.

For more strategic and effective implementation of policy measures to promote regional S&T and innovation, it is necessary to quantitatively estimate the status quo and potential, as well as the progress and outcomes, of these promotional activities in each region, and to continuously monitor how they are positioned in Japan.

From this perspective, the National Institute of Science & Technology Policy (NISTEP) extended its previous studies on "Regional Science and Technology Indicators," which quantitatively measure regional S&T resources and activities, and used the indicators for trial analyses of regional characteristics. NISTEP also constructed the "Composite Indicators on Regional Science and Technology Activities toward Innovation" for a comprehensive understanding of S&T resources and innovation efforts in regions and for deriving implications for the future course and promotion of policy packages.

2. Analysis by regional S&T Indicators

NISTEP conducted in FY 1996 and 1999 basic surveys on the development of "Regional Science and Technology (S&T) Indicators" for the quantitative assessment of regional S&T resources. The results included the concept and structure of the regional S&T indicators and the practical database constructed based on them.[1].

Regional S&T indicators consist of 85 indicators by prefecture. An analysis of the correlation among these sub-indicators revealed that, based on the normalized data, the number of patent attorneys per 100,000 population and the number of certified public accountants per 100,000 population closely correlated with the number of patent applications filed per 100,000 establishments and the number of trademarks filed per 100,000 establishments.

In real numbers, higher correlation was found between the number of joint research projects and the number of papers, the number of joint research projects and the number of inventors for patent applications, and the number of papers and the number of inventors for patent applications. On the other hand, correlation in the normalized numbers was lower between indicators related to the number of joint research projects and papers (joint research projects with industry per university, the number of papers per scientist, the number of papers per research institute [public and academic combined]) and inventor-related indicators (the number of

[1] "Preliminary Study on Regional Science and Technology Indicators," 3rd Policy-Oriented Research Group, National Institute of Science & Technology Policy, Science and Technology Agency (NISTEP Report No. 51, March 1997); "Study on Regional Science and Technology Indicators," 3rd Policy-Oriented Research Group (Yoichi Arafune, Toshihiko Watanabe, Kinji Gonda), National Institute of Science & Technology Policy, Ministry of Education, Culture, Sports, Science and Technology (Research Material 80, December 2001).

inventors per scientist, the number of inventors per research institute [public and academic combined]).

Furthermore, in real numbers, indicators in the sub-category of impact (the number of university-initiated start-ups, the number of certified companies under the Law Concerning the Promotion of Creative Business Activities of Small and Medium Enterprises, the number of newly hired workers, the influx of workers from other prefectures, etc.) sometimes had strong correlation with indicators in the sub-categories of S&T foundations and output. In the normalized numbers, however, few of the indicators showed such a high correlation.

A possible factor behind the lack of significant correlation with these “exit” indicators may be that the regional “flow” of major intellectual outcomes, starting from the research and development foundations and reaching the categories of output and impact, has not fully developed.

3. Development of the “Composite Indicators Measuring S&T Activities toward Innovation”

a). The framework and the characteristic of Composite Indicators Measuring S&T Activities toward Innovation

The advantage of the regional S&T indicators is their extensive coverage of 85 sub-indicators and the resulting inclusion of a massive volume of information. The relative standard of a prefecture can be seen simply by looking at specific data on these indicators. The regional S&T indicators, however, are hardly sufficient for an overall assessment of the efforts that each prefecture has made to promote regional S&T and innovation and what progress has been made through these efforts.

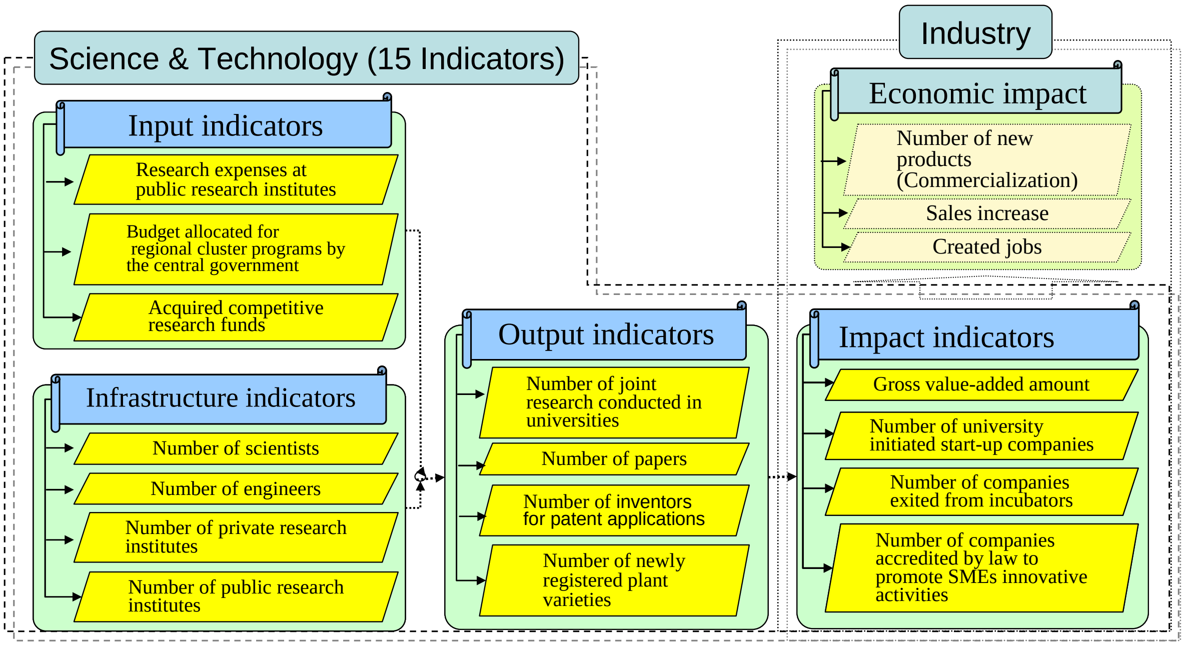
For a comprehensive evaluation of the prefectural activities to facilitate S&T capacity building and innovation, NISTEP developed the “Composite Indicators measuring S&T Activities toward Innovation” (hereinafter “Composite Regional Indicators”).

The aim of developing the Composite Regional Indicators is to draw attention to, in addition to traditional focuses such as metropolitan areas and regions with prestigious universities, regions where there have been steady progress in local efforts to promote innovation as well as industry-academia-government-cooperation in regions. This will derive implications for future government policy packages and for other regions.

The Composite Regional Indicators consist of the select 15 sub-indicators listed in Figure 1, which are of major importance in S&T and are mutually supplementary. They have been selected using as a reference the “Science and Technology Indicators,”[2] which was developed by NISTEP for the quantitative analysis of S&T activities in major countries, considering the flow from R&D input, technology transfer, and commercialization and start-up in regions. These sub-indicators are divided into four categories: input, infrastructure, output, and impact.

[2] “Science and Technology Indicators,” National Institute of Science & Technology Policy (NISTEP Report No. 73, April 2004).

Figure 1 Structure of Composite Indicators Measuring S&T Activities toward Innovation



One characteristic of the Composite Regional Indicators is the adoption of the number of patent inventors as an output indicator.

In Japan, many companies have headquarters in metropolitan areas, and patents are often filed by these headquarters even if they are technologies developed in regional laboratories or divisions. Hence, using the number of applications patented filed as an indicator will highly likely lead to overestimation of metropolitan performance and underestimation of regional performance.

To eliminate the output-indicator bias arising from the common geographical disparity between the corporate R&D centers and headquarters, and to accurately locate the corporate sources of output, this study has adopted the regional number of inventors of patent applications rather than the number of patents filed. This is expected to allow the indicators to express more accurately each region’s distinctive efforts toward the invention of new technologies.

In the future, adding the industrial indicators of economic impacts, such as the development of new products, sales growth, and job creation, to the Composite Regional Indicators should be considered. It would be still too early for these industrial indicators to be reflected in the impact of policy measures, however, because measures and programs to promote regional S&T and innovation have just started recently. This study thus focused on the indicators related to S&T only, to evaluate activities toward regional innovation promotion.

b). Reviewing progress in regional S&T and innovation

This study placed particular emphasis on analyzing the impact of efforts to foster regional innovation under the 1st and 2nd S&T Basic Plans and reviews time-series data between fiscal year 1990, which is five years before the start of the First Basic Plan, and the latest available year.

From this perspective, the target period has been divided into four terms in reference to the effective periods of the Basic Plans: “before pre-first” (FY 1990), “pre-first” (FY 1991-1995), “first” (FY 1996-2000), and “second” (FY 2001-2003). (Although the Second S&T Basic Plan covers the FY 2001-2005 period, the data available for preparing this report were up to FY 2003.)

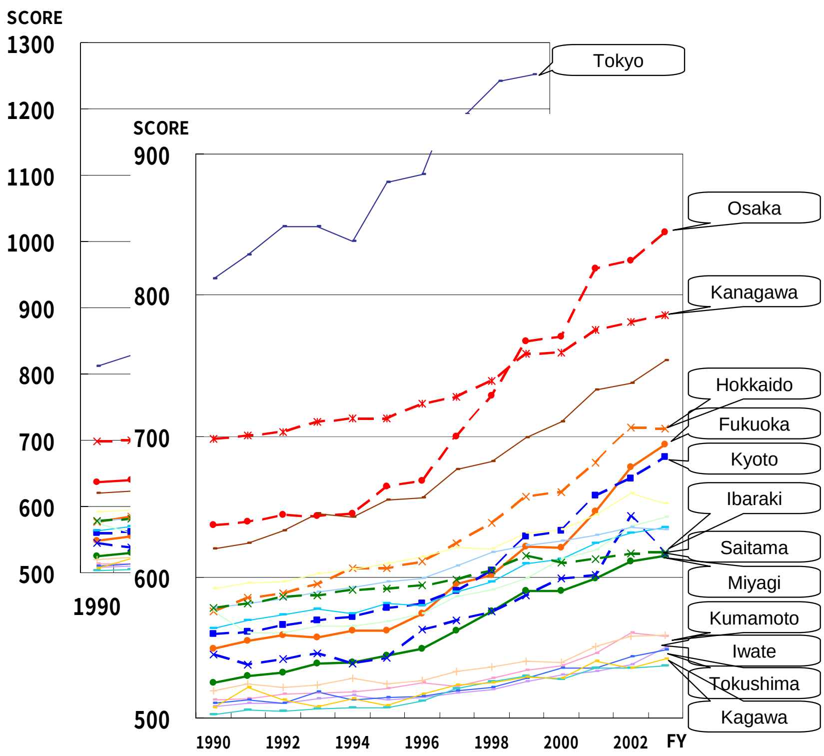
The principal component analysis was used to generalize the 15 sub-indicators. The resulting first principal component was found from its eigenvalue to account for about 50% of all the indicators discussed in this study and to have a positive weight. It was therefore defined as the “general indicator” of prefectural S&T and innovation activities as a whole.

This indicator was used to assess and analyze how each prefecture’s efforts to promote S&T and innovation have grown relative to those of other prefectures during the target period and why they have shown major or minor growth.

Figure 2 shows the top 20 prefectures in terms of growth between FY 1990 and FY 2003. Tokyo dominated, and other metropolitan areas ranked higher in the total score. A comparison of the total scores and the growth rankings showed that certain pairs of prefectures—Osaka and Kanagawa, Kyoto and Ibaraki, and Miyagi and Saitama—earned similar total scores but ranked very differently in growth.

Moreover, some small to medium prefectures, such as Kumamoto, which ranked 20th in total score, as well as Iwate, Kagawa, and Tokushima, which ranked below 20th place, appeared among the top 20 in growth. These prefectures are noted for particular advantages such as locally rooted industry-academia collaboration and networks, and the extensive utilization of unique intellectual achievements and resources of the region, which has probably contributed to their top 20 positions in growth.

Figure 2 The 20 most rapidly growing prefectures in principal component scores (FY 1990-2003)



Ranking by Increase 1990-2003		Ranking by Total Score in FY2003
1	Tokyo	(1)
2	Osaka	(2)
3	Fukuoka	(6)
4	Kyoto	(7)
5	Hokkaido	(5)
6	Aichi	(4)
7	Miyagi	(14)
8	Hiroshima	(13)
9	Hyogo	(10)
10	Kanagawa	(3)
11	Shizuoka	(9)
12	Ibaraki	(8)
13	Chiba	(11)
14	Ishikawa	(19)
15	Kumamoto	(20)
16	Gunma	(18)
17	Iwate	(21)
18	Kagawa	(30)
19	Saitama	(12)
20	Tokushima	(26)

c). Comparison of top 10 prefectures in principal component scores

Figure 3 compared Kyoto and Ibaraki, which are both known as world-class centers of knowledge and have been earning similar total scores since FY 1990.

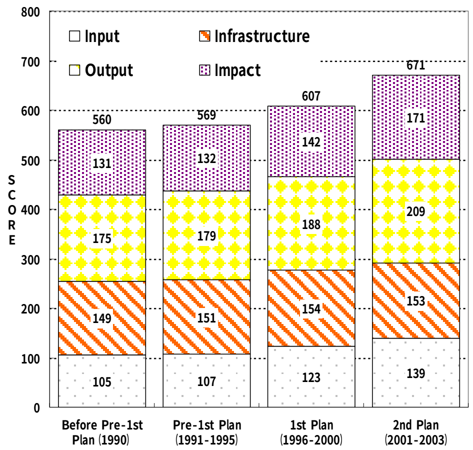
In Kyoto, innovations actively fostered by local companies and advances in well-organized industry-academia collaboration resulted in steady growth of input and output indicators during the first and second terms. In addition, the impact indicators showed a major increase during the second term. Consequently, in FY 2003, Kyoto ranked the seventh in principal component scores and the fourth in growth since FY 1990.

Ibaraki, with its extensive infrastructure of public research institutes, most notably Tsukuba Science City, has increased its output indicators as steadily as Kyoto. Unlike Kyoto, however, Ibaraki has been slow to increase its impact indicators because of the lack of cooperation between these public research institutes and local industries, and a relative delay in government initiative in facilitating “intellectual utilization.” This placed Ibaraki behind Kyoto during the second term even in total score; in FY 2003, Ibaraki ranked the eighth in principal component scores and the 12th in growth since FY 1990.

Figure 3 Comparison of top 10 prefectures in principal component scores (1)

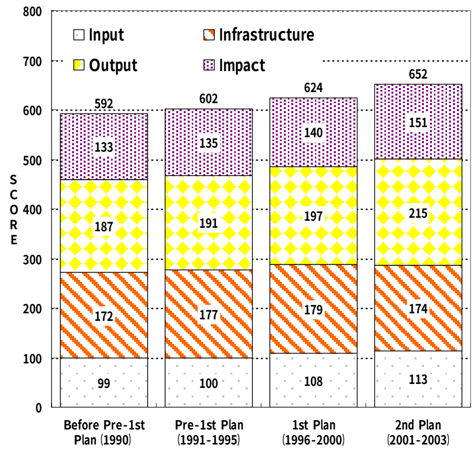
- world-class Agglomerations of intelligence

Kyoto (Total score: 7th, Growth: 4th)



-Steady increase of input & output indicators through 1st Plan, followed by rapid increase of impact indicators in 2nd Plan
・Systemic development of knowledge utilization in progress through univ.-industry cooperation

Ibaraki (Total: 8th, Growth: 12th)



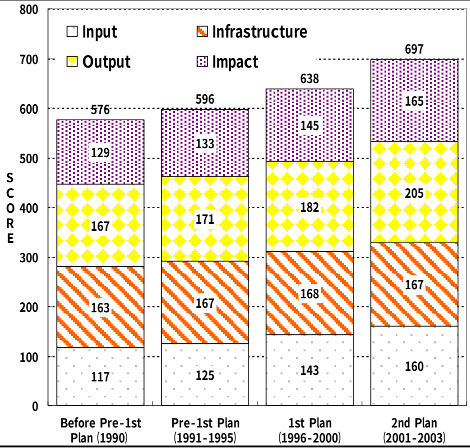
- Impact indicators, leveling off, compared to steady increase of output indicators
・Few cooperation between public research institutes and local industries
・Inactive initiatives by local governments

Another comparison was conducted for Hokkaido and Fukuoka, which both demonstrated relatively high performance during the target period. Hokkaido and Fukuoka ranked notably high—fifth and sixth, respectively, in principal component scores and fifth and third, respectively, in growth. When compared with each other, Fukuoka's impact indicators showed a greater increase between the first and second terms, which contributed largely to the prefecture's leap from 12th place in FY 1990 to sixth in FY 2002, while the same indicators of Hokkaido did not grow as much. This disparity in performance between the two prefectures can be attributed to the regional presence of large companies and municipal government leadership in promoting regional innovation.

Figure 4 Comparison of top 10 prefectures in principal component scores (2)

- Major Cities in Region

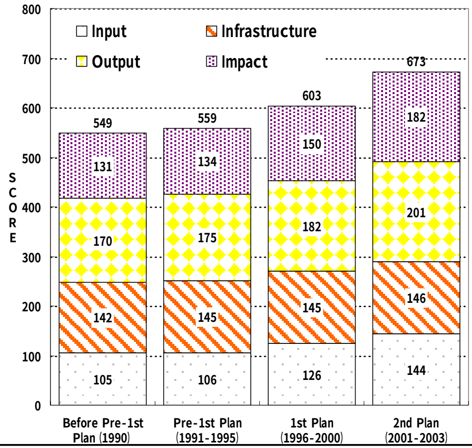
Hokkaido (Total score: 5th, Growth: 5th)



- Satisfactory increases supported by inputs as well as outputs and impacts.
- Outputs indicators have been steadily increasing due to rich infrastructures in agricultural field.

The input indicators is relatively lower than in Fukuoka, because of lack of large companies.

Fukuoka (Total: 6th, Growth: 3th)



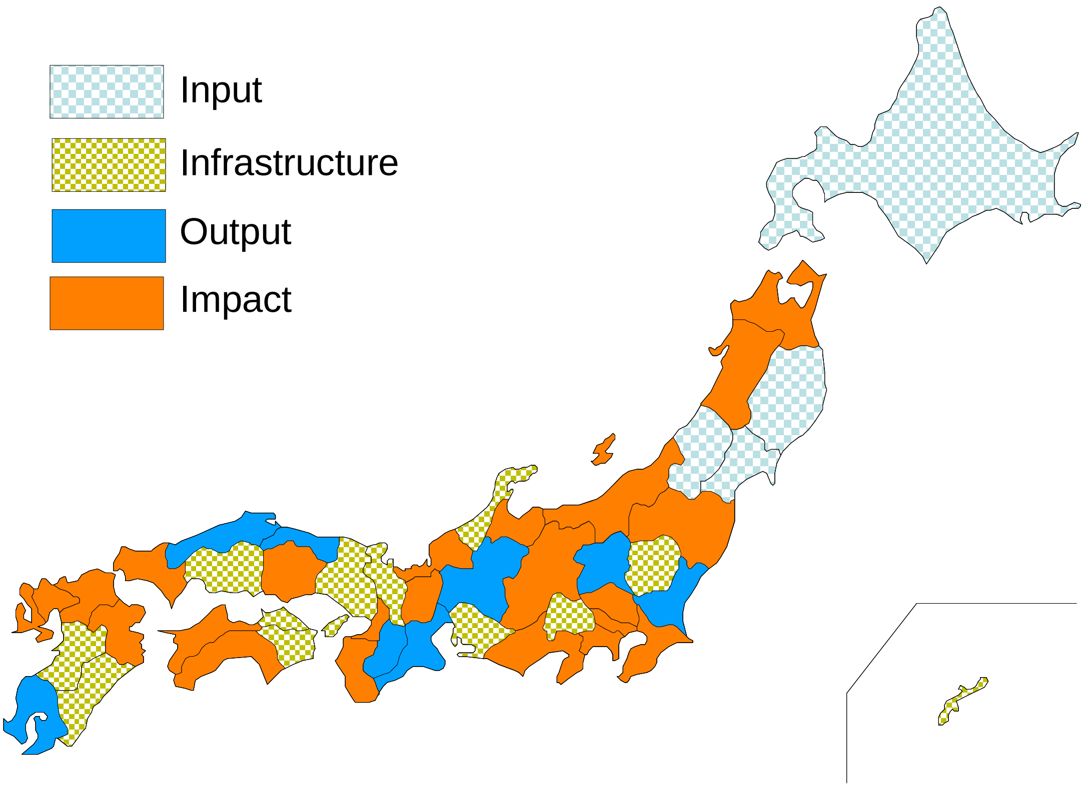
- High increase in impacts especially between 1st and 2nd Plan periods.
- Positive initiatives by leaderships of local governments have resulted in high growth from inputs, infrastructures, and outputs.

d). Identifying prefectural strengths

The indicator category in which a prefecture has shown the greatest growth among the four categories may be assumed to be the relative strength of the prefecture.

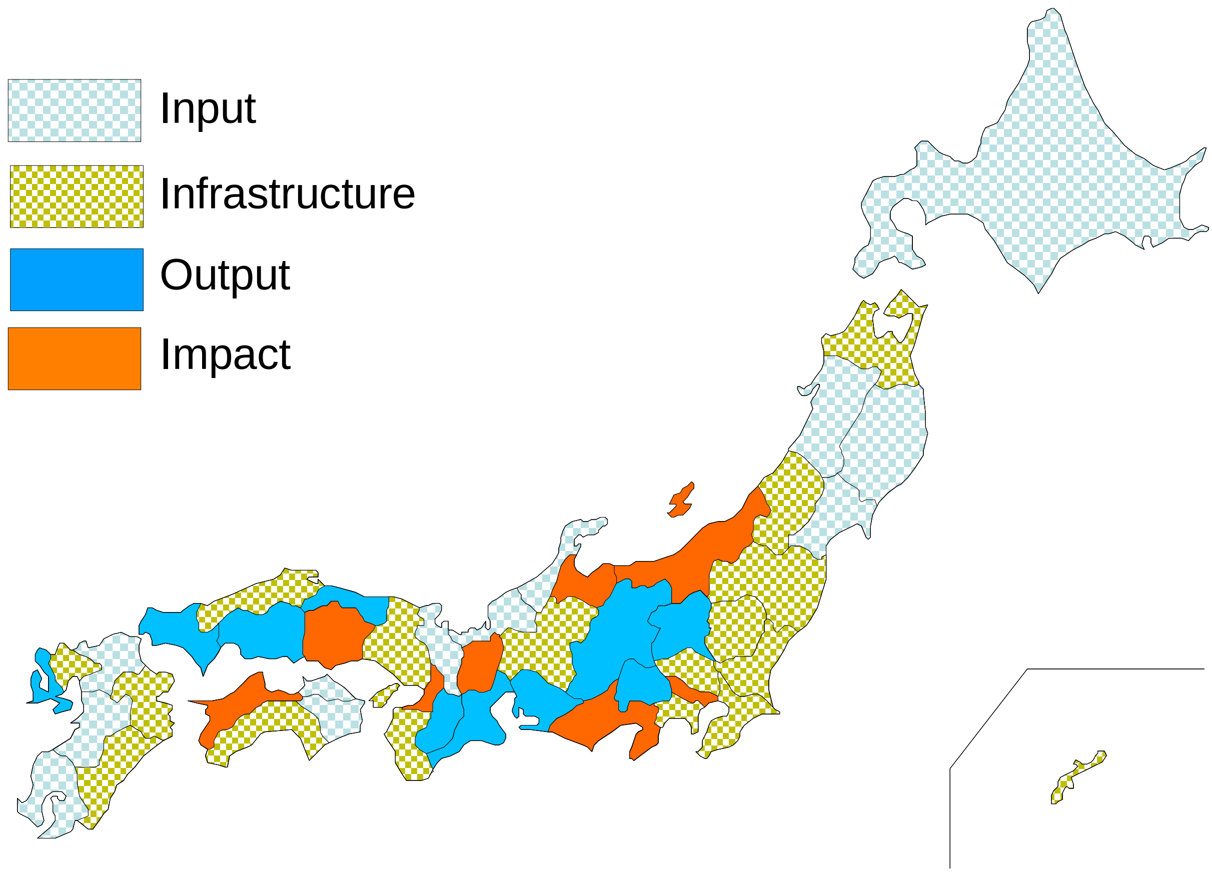
As Figure 5 shows, of the 14 prefectures showing strength in the input indicator category, 11 ranked among the top 20 in growth. These results obviously suggest that the key to fostering regional S&T and innovation is the initial trigger and input supported by government programs. A good example is Hiroshima, whose indicators grew significantly as a whole. The major factors behind this growth were the continuous implementation of intellectual cluster creation projects and other regional programs, and active local government support for public research institutes. Similarly, Ishikawa’s rapid growth in recent years is primarily due to it serving as a science and technology center where prestigious universities with high capacity to attract human and financial resources concentrate, in addition to its efforts to actively push ahead with Knowledge Cluster Initiative and other regional programs.

Figure 5 Prefectural strengths based on growth since FY 1990



Using another approach, Figure 6 shows color-coded prefectural strengths identified by comparison with the national average. Eight prefectures demonstrated strength in impact. All of them are among the 24 prefectures indicating strong growth in impact in Figure 5. Figure 6 highlights that all the prefectures surrounding Tokyo have strength in infrastructure, suggesting their role in supporting “exit” activities that have exerted impact on Tokyo. By contrast, Osaka is surrounded by prefectures that have strength in input, infrastructure, and output, respectively. This combination of different strengths in the Kansai region is inferred to be responsible for the notable growth of Osaka’s indicators in FY 1999, which has been described earlier in this report.

Figure 6 Prefectural strengths based on comparison with the national average



e). Cross analysis of ongoing regional innovation policy measures and general regional indicators

Considering that the target period of this study includes the effective periods of the First and Second S&T Basic Plans, this section focused on analyzing the relationships between the Composite Regional Indicators and major government measures that have come into effect during these terms to promote regional S&T and innovation.

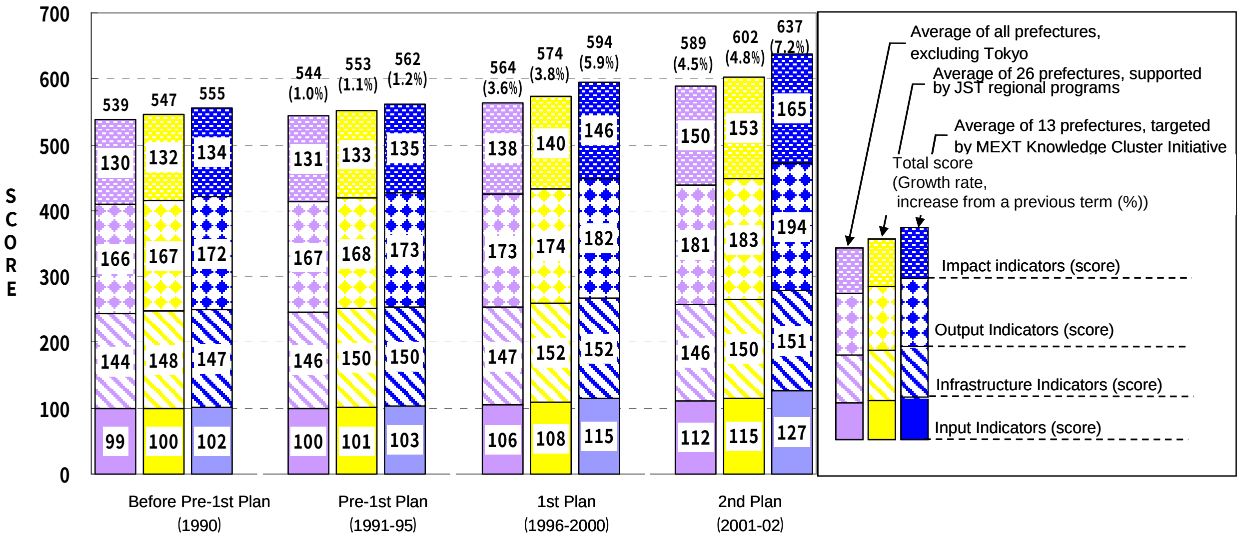
The analysis covered the prefectures participating in the two regional development programs administered by the Japan Science and Technology Agency (JST), namely Collaboration of Regional Entities for the Advancement of Technological Excellence and the Regional Science Promotion (RSP) Program, and those participating in Knowledg Cluster Initiative, which is led by the Ministry of Education, Culture, Sports, Science and Technology, and compared their total growth score with the national average.

As Figure 7 shows, statistically significant differences in growth were found between the participants and non-participants of either JST's regional programs or of the MEXT Knowledge Cluster Initiative in both the 1st and 2nd terms.

Considering that JST's regional programs were launched at full scale during the first term and that participating regions showed a steady increase in both total score and growth rate in the second term, the programs must have had a positive effect.

On the other hand, the Knowledge Cluster Initiative essentially started in FY 2002. This implied that although the input indicators in the second term may have reflected funding from the Project, the output and impact indicators have yet to represent the direct impact of the policy measure. Nevertheless, significant differences in growth were found between the participants and non-participants of the Intellectual Cluster Creation Project, probably because the prefectures selected as participants already had high performance and potential in local-based S&T and innovation. These analysis results, in light of the Project's intention and aims, confirmed the validity of the selection of participants.

Figure 7 Cross analysis of ongoing regional innovation policy measures and Composite Regional Indicators



Note: JST regional program participants refer to prefectures that have embarked on a project under the Collaboration of Regional Entities for the Advancement of Technological Excellence program or that have completed a project under the Regional Science Promotion (network construction type) program and launched another under a different area of the RSP program (research incubation type).

4. Future challenges: potential applications of Composite Regional ndicators

Along with the progress of the S&T Basic Plans, regional frameworks for cooperation among industry, academia, and government have been steadily formed, and policy measures, programs, and schemes to promote regional innovation have been developed. The overall growth of the principal component scores of the Composite Regional Indicators during the 1st and 2nd terms is a sign of solid progress in the general activities toward fostering regional S&T and innovation and in measurable outcomes deriving from them.

Although there have been attempts to analyze the total regional capacity by focusing on intellectual, financial, and other specific aspects of regional innovation, none of them have covered indicators as extensive as in this study, whose indicators range from input to impact. This study has presented a method of identifying and analyzing activities and results across individual municipalities, using a relatively manageable set of indicators. This will be a useful tool especially in analyzing the effectiveness of the Knowledge Cluster Initiative that has been intensively implemented as policy measures under the Second Basic Plan.

This study has collected and analyzed as much available data representing geographical distribution and temporal change as possible. In future, their possible applications should be explored in areas such as prediction and analysis of wide-area collaboration beyond municipal boundaries, comparison of Japanese municipalities where regional clusters exist with those of other countries, and analysis of performance by S&T field.