LOOK OUT TO THE WORLD

THE CHANGING ROLE OF GOVERNMENT RESEARCH INSTITUTES IN INNOVATION SYSTEMS

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Abstract:

Recent years have seen an intensified discussion in many OECD countries about the role and mission of public research in the innovation system. This discussion takes place in quite specific national contexts, but should benefit from international experience. However, whereas voluminous literatures address the changing governance methods, organizational forms and missions of universities[2], much less attention has been devoted to developing a common understanding of the challenges faced by non-university public research institutions[3].

The main goals of this paper is to contribute to clarifying the nature of these challenges, outlines possible policy answers and draws some implications for Korea. In the first section, the paper uses available internationally comparable indicators to review trends in the contribution of government research institutes (GRIs) to R&D and innovation activities. In the second section, the paper identifies the current major changes in the dynamics of innovation that may call for further adjustments in the positioning, organization and steering of public research institutes. Finally, the paper outlines some strategic objectives and orientations for the reform of public research institutes as part of the broader agenda of the Korean innovation strategy.

Keywords*: Public (government) research institutes; Reform; R&D; Innovation; Korea.*

(continue)

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[2] For example, see the OECD Thematic Review of Tertiary Education, 2008.

[3] Efforts to study GRIs have been and remain mainly undertaken at the national or institutional level *(e.g. Gulbrandsen and Nerdrum, 2007; Hyytinen et al 2009)*. Cross-country analyses of GRIs using the same methodology are sparser. One example is the Eurolab project which was carried out in 2002 by an international consortium led by PREST at the University of Manchester *(PREST, 2002)*. In 2003, the OECD published a report on the Governance of Public Research: Toward Better Practices *(OECD, 2003)* which reviewed the changes in the governance of OECD countries' science systems.

4. GRIs in Korea: specific features and outlook[4]

A recent OECD report has analyzed the strengths and weaknesses of the Korean innovation system, and has addressed some of the opportunities and threats that are likely to arise in the coming years *(OECD, 2009).* These are summarized in Table 2. The positioning, organization and research orientations of public research are among problematic areas identified in this SWOT analysis.

By budget expenditure, the GRIs in Korea are the largest performers of research in the public sector, though their leading position is increasingly challenged by universities. They have played a significant part in the technological upgrade of Korean industry over the last four decades, and have shown themselves, in most cases, able to adapt to fast-changing conditions. However, further reform and adaptation of GRIs is on the political agenda and necessitates understanding of their current and potential contribution to the Korean innovation system.

This section starts by describing the different public research organizations operating in Korea, their historical development and their funding. Next, the performance of GRIs is reviewed and the continuing debate over their appropriate role in the wider innovation system is discussed. Finally, some directions for policies to enhance the contribution of GRIs to the transition of the Korean economy towards a more innovation-driven sustainable growth path are suggested.

Table 2. SWOT analysis of the Korean innovation system

Strengths	**Opportunities**
- Strong, mobilizing national vision - High growth rates in GDP - Strong government support for innovation and R&D - Good and improving framework conditions for innovation - High ratio of gross domestic expenditure on R&D (GERD) to business enterprise expenditure on R&D (BERD) - Highly educated workforce - Good supply of human resources for science and technology (HRST)	- Geopolitical positioning in one of the most dynamic region of the world - Free trade agreements - Globalization, including of R&D - Growing Korean S&T diaspora - Developments in S&T (technological change), particularly information technology, nanotechnology, biotechnology and environmental technology - and their possible fusion - Growth of China and other newly industrializing economic, both in the region and worldwide, offering new market for

[4] This section draws heavily on the results of the OECD Review of Innovation Policy (OECD, 2009) which was drafted by Michael Keenan (Country Review Unit, DSTI, OECD) and Ron Johnston (consultant to the OECD, Professor at the University of Sydney), with contributions from and under the supervision of the author, and benefitted from the support of the Korean government and contributions by STEPI researchers, particularly Kong-Rae Lee.

- Ready early adopters of new technologies - Strong ICT infrastructure - Exceptionally fast followers - Strong and internationally competitive firms - Learning society with a capacity to learn from failures and international good practices - Capability to produce world-class talents	Korean export
Weaknesses - Under-developed fundamental research capabilities and weak research capacity in universities - Weak linkages between GRIs and institutions of higher education - In education, rote learning, overemphasis of university entrance exam, and crippling cost of private education - Under-utilization of female labour - Low productivity in the services sector - Relatively weak SME sector - Legacy of dirigisme which hampers the development of a diffusion-oriented innovation policy - Unbalanced international linkages - Uneven development across regions and sectors - Small domestic market (compared to China, Japan, United States) - Policy co-ordination problems between ministries	**Threats** - Low fertility rates and an aging society - Arrival of strong new competitors in fields in which Korea excels, e.g. ICTs, particularly from China - Geopolitical developments in the region -Disruption in the supply of imported natural resources and energy, upon which the Korean economy is highly dependent - Global economic outlook and its consequences for export-oriented economies

Types and regional distribution of Korean GRIs

GRIs are classified into four categories in Korea, according to their governance and financing arrangements:

- Government-sponsored research institutes (GRIs sticto sensu) - these are semi-autonomous research centres established by the Korean government. There are 100 GRIs in all, 52 of which are associated with the humanities and social sciences. They operate under the provisions of the Law for the Creation and Promotion of the Government Research Institutes (1999). Employees do not have the public servant status. The largest GRIs fall directly or indirectly (through two research councils) under the Ministry of Education, Science and Technology (MEST) and the Ministry of Knowledge Economy (MKE). This section focuses on them;

- National labs - these are fully financed by the central government, which employs the research staff directly. There are currently 53 national labs, many of which are operated by the Ministry for Food, Agriculture, Forestry and Fisheries;
- Local government-sponsored research institutes - these are autonomous organizations financially supported by local governments. The majority are involved in planning and linking local innovation actors to boost technological innovation in regions, and as such do not do scientific research themselves. There are 38 such organizations across Korea.
- Local government labs - these were mostly established several years ago to support local agriculture and fishing, though in recent years, some have been established to support manufacturing or to cultivate emerging industries. They are governed by local governments, and their research staffs are local government officials. Korea has 118 such organizations.

Table 3. Distribution of public research organizations in Korea (2004)

Types of organizations	Natural science & technology	Agriculture and fishery	Humanities and social science	Total
Total number (%)	79(25.6)	131(42.4)	99(32.0)	309
- Central govt. sponsored	46(46)	2(2,0)	52(52.0)	100
- National labs	7(13.2%)	34(64.2)	12(22.6)	53
- Local govt. sponsored	5(13.2)	0(0.0)	33(86.8)	38
- Local govt. labs	21(17.8)	95(80.5)	2(1.7)	118

Table 4 shows the R&D expenditure of GRIs, universities (public and private) and companies in each region as of 2006. As the data shows, the Seoul metropolitan area accounts for around 30% of GRIs' R&D expenditures. Although the government has launched initiatives in other parts of the country, such as the construction of a new government administrative city and "innovation cities" and "enterprise cities", in order to boost development, the lack of innovation resources or assets across Korea, especially in universities and companies, is seen as the greatest barrier to more effective regional economic development through innovation.

Table 4. R&D expenditure and ratio by sector of performance and region (2006)

KRW millions and percentages

Sector of performance / Region	Research institute	Universities and colleges	Companies	Total
Seoul Metropolitan Area	1 098 449	1 495 569	14 746 266	17 340 284
	(31.40)	(54.94)	(69.80)	(63.42)
Busan	68 057	149 764	373 474	591 295
	(1.95)	(5.50)	(1.77)	(2.16)
Daegu	30 278	98 756	183 023	312 057
	(0.87)	(3.63)	(0.87)	(1.13)
Gwangju	30 900	162 473	188 239	381 612
	(0.88)	(5.97)	(0.89)	(1.40)
Daejeon	1 760 100	183 610	1 118 321	3 062 031
	(50.33)	(6.75)	(5.29)	(11.20)
Ulsan	1 975	29 661	507 545	539 181
	(0.06)	(1.09)	(2.40)	(1.97)
Gangwon	31 075	75 278	75 561	181 914
	(0.89)	(2.77)	(0.36)	(0.67)
Chungbuk	75 022	56 498	331 671	463 191
	(2.15)	(2.08)	(1.57)	(1.69)
Chungnam	87 128	74 856	1 003 312	1 165 296
	(2.49)	(2.75)	(4.75)	(4.26)
Chonbuk	50 926	81 728	134 944	267 598
	(1.46)	(3.00)	(0.64)	(0.98)
Chonnam	22 472	39 588	168 352	230 412
	(0.64)	(1.45)	(0.80)	(0.84)
Gyeongbuk	72 380	172 801	1 308 523	1 533 704
	(2.07)	(6.35)	(6.19)	(5.68)
Gyeongnam	154 984	84 719	967 750	1 207 453
	(4.43)	(3.11)	(4.58)	(4.42)
Jeju	13 305	16 573	19 799	49 677
	(0.38)	(0.61)	(0.09)	(0.18)
R&D expenditure by sector	3 497 05	2 721 874	21 126 780	27 345 704

Source: MoST and KISTEP (2007).

Historical development

A short historical account of the development and evolution of GRIs provides insight into many of the challenges that these institutions still face today. In the 1960s, Korea lacked technological capabilities for industrialization and imports of foreign technologies were the immediate solution. The more fundamental solution, however, was the establishment of an industrial R&D institute that would build up endogenous technological capabilities. Accordingly, the Korea Institute of Science and Technology (KIST) was founded in 1966 as an integrated technical centre to meet the country's industrial needs. At that time, KIST relied on recruiting overseas-trained Korean scientists and engineers, and its main purpose was to support industry in its efforts to adopt and adapt foreign technologies. By 1970, the few GRIs that had been established accounted for 84% of the nation's total R&D expenditures and 44% of the nation's pool of researchers *(Kim, 2001)*.

In the 1970s, a number of specialised research institutes were established to keep pace with the rise in industrial sophistication and diversity. Each institute aimed to develop capabilities in strategic areas such as shipbuilding, geo-science, electronics, telecommunications, energy, machinery, chemicals, etc., in order to serve the growing needs of the private sector.

However, by the 1980s, Korean firms were criticizing the research support being provided by GRIs as failing to meet their needs. At the same time, the government believed that many "specialized satellite institutes" under related ministries were too small to achieve economies of scale and that this resulted in overlap and frequent duplication of research efforts *(Yim and Kim, 2005)*. The government therefore consolidated 15 GRIs under various ministries into nine large research institutes under MoST.

The Korean government was also keen for industry to perform a greater share of R&D so as to develop its own technological capacity. Thus, in addition to consolidating the number of GRIs, the government initiated national R&D programs (NRDP) in 1982 to provide funding for GRIs to collaborate with industry on areas of strategic research and technological development. This extra funding helped GRIs to increase their research activities, but throughout the 1980s and 1990s, their performance continued to be criticized by government and business alike. Criticisms centred upon apparent duplication of research domains, poor R&D project management, and perceived low R&D productivity levels. To boost research efficacy and productivity, from 1991, GRIs were subject to regular evaluations of their performance, and in 1996 a contractual project-based management system (PBS) was introduced to replace the lump-sum system then in operation.

During the 1980s and 1990s, the number of GRIs continued to grow and there was further reorganization through mergers and break-ups. Nevertheless, GRIs began to lose their once-dominant role, with industry quickly becoming the largest R&D funder and performer by the mid-1980s, and with the universities also gradually catching up over time.

In 1998-99, a committee drew up proposals for the most fundamental reform of GRIs in almost two decades. It proposed separating GRIs from their host ministries (several ministries besides MoST had again acquired their own research institutes after the move to consolidate GRIs in the early 1980s) and placing them under five newly established research councils located in the Office of the Prime Minister. The intention was to improve their performance by giving them greater autonomy from ministerial interference - in a sense, to separate bureaucratic and research cultures. The suggested reform was carried out, but only in part, as the research councils had no budgets of their own to distribute to the GRIs and the latter were therefore still dependent upon the ministries for their funding.

The system underwent further change in 2004, when the then new government moved the three science and technology-based research councils from the Office of the Prime Minister to MoST. This move was part of a broader set of measures to strengthen a revamped MoST and saw the biggest GRIs come under MoST's jurisdiction. In mid-2008 the number of research councils was reduced from five to three, with two remaining in the S&T area: the Research Council for Fundamental S&T under the supervision of MEST and the Research Council for Industrial S&T under the supervision of MKE. Both research councils supervise 13 GRIs each.

Funding of GRIs

The proportion of government support in total R&D expenditure differs by type of research field, research institute and historical dependency. Roughly speaking, around half of the GRIs' budget comes from a government core grant (Table 5), while the other half comes from contract research for various organizations, including a range of central government ministries (the main purchasers of research), local governments and private companies. GRIs have benefited from the smallest increases in R&D spending over the last decade or so, with universities and firms accounting for an ever-increasing share of Korean R&D.

Table 5. Government core grant to GRIs under the three S&T research councils

Name of councils and their member institutes	2006	2007	Growth rate (%)
Korea Research Council of Fundamental Science & Technology (KRCF)	8229	13761	67.2
Korea Institute of Science and Technology (KIST)	84134	85908	2.1
Korea research Institute of Bioscience and Biotechnology (KRIBB)	45458	50832	11.8
Korea Basic Science Institute (KBSI)	35417	39647	11.9
Korea Astronomy and Space Science Institute (KASI)	16323	18357	12.5
Korea Institute of Oriental Medicine (KIOM)	12875	17316	34.5
National Fusion Research Centre (NFRC)	11114	20371	83.3
National Institute for Mathematical Sciences (NIMS)	1000	2105	110.5
Korea University of Science & Technology (UST)	2059	2949	43.2
Subtotal	**216606**	**251246**	**16.0**
Korea Research Council of Industrial Science & Technology (KOCI)	10509	10478	-0.3
Korea Institute of Industrial Technology (KITECH)	59363	56147	-5.4
Electronics and Telecommunications Research Institute (ETRI)	20204	21246	5.2
Korea Food Research Institute (KFRI)	15354	16654	8.5
Korea Institute of Machinery and Materials (KIMM)	39830	45780	14.9
Korea Electro-technology Research Institute (KERI)	32657	35124	7.6
Korea Research Institute of Chemical Technology (KRICT)	35152	39463	12.3
National Security Research Institute (NSRI)	31788	35182	10.7
Korea Institute of Toxicology (KITOX)	13341	26342	97.5
Subtotal	**258198**	**284416**	**10.9**
Korea Research Council of Public Science & Technology (KORP)	11245	11334	0.8
Korea Institute of Science and Technology (KISTI)	55038	63843	16.0
Korea Institute of Construction Technology (KICT)	24609	23622	-4.0
Korea Railroad Research Institute (KRRI)	16238	20053	23.5
Korea Research Institute of Standards and Science (KRISS)	53748	56030	4.2
Korea Ocean Research & Development Institute (KORDI)	39929	47119	18.0
Korea Institute of Geoscience and Mineral Resources (KIGAM)	35557	39056	9.8
Korea Aerospace Research Institute (KARI)	25769	26791	4.0
Korea Institute of Energy Research (KIER)	31092	38779	24.7
Korea Atomic Energy Research Institute (KAERI)	52567	58340	11.0
Subtotal	**345792**	**384967**	**11.6**

1. In mid-2008, the number of research councils was reduced from three to two.

Source: MoST.

GRIs Performance

Under the research councils, GRIs have recently improved their performance in terms of publications and patent applications *(Lee, Chul-Won, 2007)*. For example, SCI publications per researcher increased from 0.407 in 2003 to 0.465 in 2004 and to 0.489 in 2005, a significant rise in a short space of time. As Figure 14 shows, these numbers are higher than those of the Fraunhofer Society's institutes in Germany (although the latter conduct more applied research and may be less active in academic publishing than institutes engaged in more fundamental research), though considerably lower than those of the Lawrence Berkeley National Laboratory (LBNL) in the United States and the National Institute of

Advanced Industrial Science and Technology (AIST) in Japan. The results are similar when using SCI publications per KRW 100 million spent.

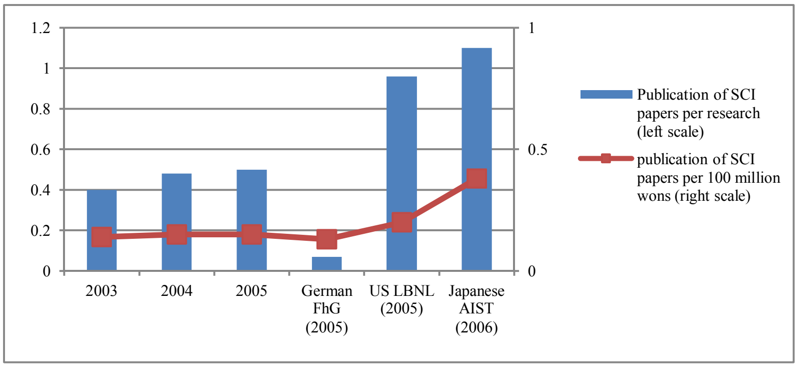

Figure 14. SCI publications by GRIs (2003-2005) and international benchmarks

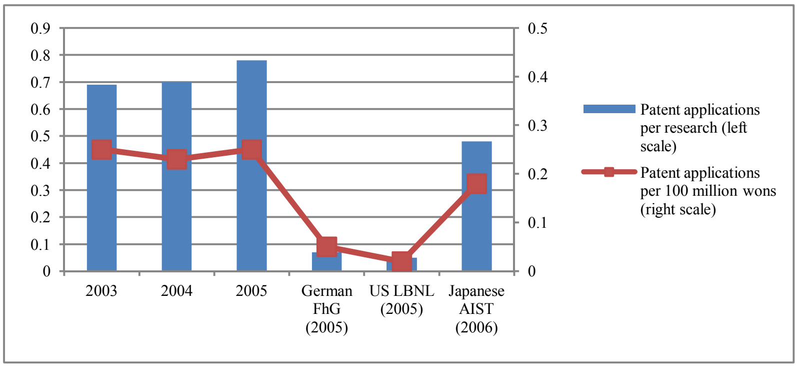

Figure 15. Patent applications of GRIs (2003-2005) and international benchmarks

In terms of patent applications, the performance of Korean GRIs appears very good by international standards. As shown in Figure 15, patent applications per researcher increased from 0.6754 in 2003 to 0.765 in 2005, figures that are much higher than those of the Fraunhofer institutes, the LBNL or AIST (as the LBNL undertakes largely fundamental research, its relatively low performance on this measure is not unexpected). A comparison based on patent applications per KRW 100 mil-lion shows a similar trend. Furthermore, GRIs made 3 158 patent applications in 2006 (Table 6), significantly more than US GRIs and Canadian government research institutes including universities.

In terms of technology transfer rates, Table 6 shows that Korea underperforms the United States and Canada but seems to do better than Japan. Around 30% of Korean GRI patents were transferred in 2006, compared to 37.5% in US GRIs. Korean GRIs performed considerably better than Korean universities, which saw only 13.6% of their technologies transferred. Overall, these figures indicate that Korean GRIs have more difficulty commercializing their R&D than their counterparts in North America.

Table 6. International comparison of technology transfer among public sector research performers (2006)

Performance indicators	Korea			United States			Japan (Univ. + GRIs)	Canada (Univ. + GRIs)
	Univ	GRIs	Total	Univ	GRIs	Total		
Number of technologies patented (2006)	4,616	3,158	7,774	15,002	1,790	16,792	8,725	1,307
Number of technologies patented (2006)	629	951	1,580	4,087	671	4,758	1,171	544
Ratio of technology trans-fers (%)	13.6	30.1	20.3	27.2	37.5	28.3	13.4	41.6
Yearly royalty income (USD millions)	3.2	53.3	56.5	1088	346	1435	n/a	43.3
Yearly R&D expenditure (USD millions)	2200	2964	5164	37162	4082	41244	47200	3127
Number of employees per commercialisation unit	4.8	3.6	4.2	8.65	6.1	8.2	14.3	8.3

Source: Lee (2007).

Royalty income figures provide one indicator of the “quality” of technology transfer. As Table 6 shows, Korea again underperforms the United States and Canada (figures for Japan are not available). The picture is even worse for Korean universities.

Figure 16 shows that the Korean situation is gradually improving. The royalty ratio as a percentage of R&D expenditure has shown a similar trend over the same period. This performance is comparable to that of the LBNL in the United and far exceeds the performance of AIST in Japan. But GRIs have some way to go to catch up with the German Fraunhofer institutes, which earn the equivalent of almost 20% of their total R&D expenditure in royalty income (on the basis of a fraction of the patent applications made by Korean institutes).

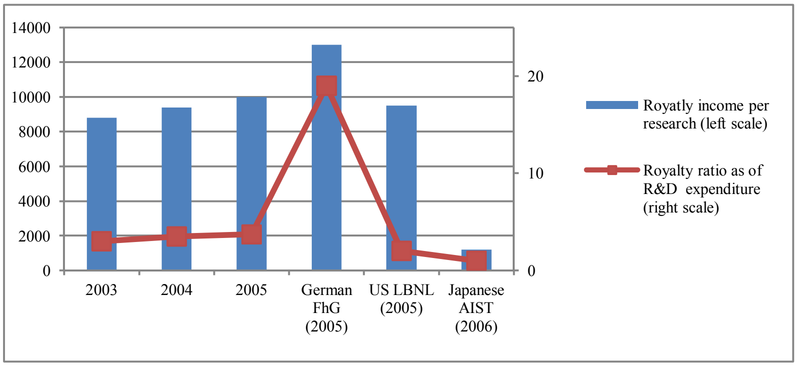

Figure 16. Royalty income of GRIs (2003-2005) and international benchmarks

To summarize, Korean GRIs have improved their performance in recent years, in terms both of number of publications and returns from commercialization of their R&D efforts. However, given the level of patenting activity, they should be doing much better. There are several possible explanations for this relatively disappointing performance:

- *First,* technology markets are less developed in Korea than in North America, owing to their relatively weak institutionalization.
- *Second*, compared to North America, there is relatively weak interest on the part of local firms in adopting new technologies from GRIs, particularly among SMEs. Even among larger firms, there appears to be a growing preference to conduct research in house and to reduce reliance on the GRIs for fear of "knowledge leakage".
- A *third* explanation may lie in the GRIs and universities themselves, as they may be insufficiently geared to offer their R&D for exploitation. However, the Korean government has placed much emphasis on the commercialization of R&D and the channels for transferring public research results are various, such as technology transfer agreements, direct creation of venture firms, technical consulting and training of engineers and technicians. Most GRIs have set up commercialization units, but these remain comparatively small. As Table 6 indicates they employ on average 3.6 persons, fewer than Korean universities (4.8) and considerably fewer than in Japan, Canada and the United States.
- *Finally*, it seems certain that Korean GRIs and universities are patenting

excessively, as evidenced by the very rapid rise of Korea in the patent rankings over the last decade. The government has set very ambitious performance targets, including publication and patenting, for the public sector re-search base. As researchers have struggled to meet these targets, they have tended to patent discoveries that might not otherwise have been patented. As a result, Korean institutes hold a large body of patents, many of which are unlikely ever to be exploited.

What role for GRIs?

In spite of successive reforms of recent decades, the role GRIs should play in the Korean innovation system is still widely discussed. There remains a sense that they are not as effective and efficient as they could be. Indeed, according to the opening lines of the page devoted to GRIs on the MoST/ MEST website[5], "there have been grave concerns regarding research effectiveness and operational efficiency of the GRIs' R&D activities". It is clear that for many, these concerns remain, but the extent to which they are justified is open to question.

The main problem - stretching back perhaps 30 years - has been a lack of consensus on the role-that the GRIs should play in the innovation system. Korea is hardly alone in this uncertainty, as the role of GRIs has been called into question across the OECD area in recent decades. Yet, GRIs remain extremely important players in national research systems, and especially in Korea where university research still remains relatively weak. Because they have been poorly studied, GRIs have often been victims of stereotypes and of policy fashions *(Laredo, 2008)*. In fact, GRIs vary widely, with different types of organizations facing different issues that require different policy responses. This observation also applies to Korean GRIs, and due attention should be paid to this sort of differentiation.

Thus, in the context of a rapidly evolving innovation system and industry's development of its own R&D capabilities, the purpose of Korean GRIs is not as clear-cut as it once was. At the same time, the Korean government has begun to favor the strengthening of R&D capabilities in universi-ties, which are considered the "natural" sites of skills development and knowledge transfer. Pressure to reform GRIs has resulted in a succession of changes in their governance systems, creating a near-permanent sense of uncertainty and even crisis in many institutes. This has served to undermine the stability required for conducting long -term fundamental research, something that governments have often failed to take into account *(Lee, Kong-Rae, 2007*).

[5] MEST website (http://english.mest.go.kr), accessed August 2008

Clearly, GRIs are in a difficult position. They were the main recipients of public R&D funding when universities conducted relatively little R&D. However, as the R&D capabilities of universities and firms have increased, some convergence has begun, with all actors conducting similar sorts of research. Accordingly, many in industry argue that the GRIs should now focus primarily on fundamental research. Yet, many university researchers argue that the GRIs should return to their original purpose of supporting technology adoption and adaptation by Korean firms. Whether GRIs face such a stark choice is an open question, and there are few reasons to believe that they should focus on just one type of activity at the expense of others. Moreover, as highlighted above, the GRIs are not identical and each institute has its own history and accumulated competencies. Sensitivity to these is required in any future reforms.

Nevertheless, the GRIs would appear to be squeezed between two constituencies with a strong sense of their identity. Before exploring the positioning issue further, however, it is worth reviewing the direction in types of research performed by the GRIs. As Table 7 shows, the trend has been away from basic research towards more experimental development, while the proportion of R&D expenditures for applied research has remained largely unchanged, at approximately one third. Most of this shift occurred in the first few years after the Asian financial crisis and the current picture stabilized in 2003 (in fact, the current proportion of basic research stabilised in 2001). These figures seem to suggest that GRIs are primarily positioning themselves to develop new technologies.

Table 7. R&D expenditure by research stage in research institutes

KRW millions and %

	Total R&D expenditure	Basic research		Applied research		Experimental development	
1998	2 099 470	561 521	26.7	741 199	35.3	796 750	38.0
1999	1 979 174	494 138	25.0	756 409	38.2	728 627	36.8
2000	2 031 981	454 443	22.4	672 213	33.1	905 325	44.6
2001	2 160 166	438 260	20.3	894 403	41.4	827 503	38.3
2002	2 552 632	526 182	20.6	1 015 664	39.8	1 010 786	39.6
2003	2 626 356	525 515	20.0	972 984	37.0	1 127 856	42.9
2004	2 964 646	616 140	20.8	1 151 992	38.9	1 196 514	40.4
2005	3 192 887	684 540	21.4	1 158 356	36.3	1 349 991	42.3
2006	3 497 050	716 725	20.5	1 252 430	35.8	1 527 896	43.7

Source: MoST and KISTEP (2007).

Although GRIs seem to have greater potential than universities to contribute to the diversification of the economy away from the ICT sector (Table 8), there are questions concerning whether GRIs are best placed to bring technologies to the market; it is widely believed that this is best done by the private sector.

Table 8. Association of R&D expenditure's to "6T" (2006)

(in %)

	GRIs	Universities	Companies	Total
ICT (Information technology)	19.4	25.7	39.5	35.6
BT (Biotechnology)	12.7	24.2	3.3	6.6
NT (Nanotechnology)	4.8	9.7	15.3	13.4
ST (Space technology)	9.2	2.0	0.6	1.8
ET (Environment technology)	13.1	8.6	5.0	6.4
CT (Culture technology)	0.0	2.7	1.2	1.2
Other	40.8	27.2	35.1	35.0
Total	**100.0**	**100.0**	**100.0**	**100.0**

Source: MoST and KISTEP (2007).

Another issue to take into account is the fact that GRIs conduct much of the "big science" carried out by the public sector and universities cannot match their facilities. This is not unusual, and international experience suggests that GRIs often carry out fundamental research that would be impossible to conduct in universities. However, if GRIs are to conduct more fundamental research, it is likely that the current project-based system will need to be revised. Originally introduced in 1996 to improve the efficiency and performance of GRIs, the project-based management system (PBS) has improved R&D management through the use of competitive tendering. However, there have also been some less desirable effects:

- *First*, PBS has been detrimental to the stability needed to foster more fundamental research (since many projects are more mission-oriented and relatively short-term)[6];
- *Second*, it has encouraged GRIs to apply for a wide spectrum of projects as they compete for funding. The loss of focus has contributed in part to the identity crisis in many GRIs;
- *Finally*, it has seen a vast expansion in the use of temporary contract

[6] On the other hand, GRIs are major players in some of the government's more long-term, strategic research programmes, including the 21st Century Frontiers programme.

labour (for example, at the Korean Research Institute for Bioscience and Biotechnology [KRIBB], special service interns outnumbered regular employees by almost 2:1 in 2006). Although the use of temporary contracts gives GRIs some flexibility, it also makes them less attractive destinations for researchers (see below).

Although some research collaboration occurs already (see Box 3), there is no doubt that there is much greater scope for such co-operation between GRIs and universities. This is hampered by the mutual distrust of the two sectors: the universities view themselves as more academically valid and the GRIs see themselves as the public sector's main source of research with the necessary experience, competencies, equipment and relevance. This distrust and lack of understanding and respect creates problems for developing closer and mutually beneficial linkages.

In a further twist to the trend towards convergence between research performers, GRIs have also come together to found a university - the University of Science and Technology (UST) - which focuses upon hands-on multidisciplinary training, a missing gap in much Korean higher education (see Box 4).

The capability to attract young talents to combat aging of their staff and boost creativity is vital for GRIs. A common complaint among GRI researchers is their relatively poor employment conditions. Although they tend to be paid more than their counterparts in universities, they have been forced to retire at 61 (the retirement age in universities is 65) without a pension. Because of this and the lack of institutional stability, many GRI researchers tend to seek alternative appointments in universities and the private sector before they reach their mid-40s.

In the last three or four years, however, the GRIs have enjoyed a modicum of stability as they have focused their attention on a set of core research areas (for example, through the Top Brand Project initiative, in which GRIs identify a small number of fields in which they aim to achieve leadership positions in the short to medium term). The PBS continues to be improved and it has recently been announced that GRIs will benefit from more core funding in the future, with as much as 70% of staff costs being met in this way by 2012, as compared to 40% or so in 2007. Finally, the new government has also announced that it intends to set aside KRW 200 billion by 2013 to cover the pensions of GRI researchers[7]. In parallel to these developments in GRIs, the universities are becoming less comfortable places to work, as professors are increasingly expected to meet

[7] As reported in The Korea Times, 20th March 2008.

performance targets and in some institutions (*e.g.* KAIST) to teach in English. Therefore, some convergence in working conditions between GRIs and universities appears likely, which could make the GRIs, once again, relatively attractive places in which to work.

Box 3. The KIST-Academia Collaborative Education Program

KIST has set up graduate collaboration programs with nine Korean universities in which students complete a basic curriculum at the university in which they are enrolled and then participate in a KIST research project. While they are working on KIST research, students write the thesis required for their degree, and KIST and university faculty members act as co -advisors. Collaboration is seen as beneficial for all: students gain a combination of theoretical and practical knowledge that should stand them in good stead in future employment in industry and KIST can employ the graduates directly after they complete their studies. More indirectly, it is claimed that students act as conduits for the transfer and distribution of KIST's research products to industry

Source: KIST (2007)

Box 4. The University of Science and Technology

Inaugurated in 2004, the University of Science and Technology (UST) operates as a graduate school affiliated with 22 GRIs and specializes in the training of research students in interdisciplinary R&D fields (in contrast to most national and private universities, which have a strong disciplinary academic culture). The UST aims to exploit the synergy effects of conducting education and research together and seeks to capitalize on the facilities, equipment, manpower and experience available in GRIs. Students learn through participation in research projects in GRIs, with minimal lecture-based education.

GRIs cover all major fields and the UST's interdisciplinary approach allows it to offer a differentiated curriculum that meets the growing need for training and education in multidisciplinary fusion technologies. This differentiation is achieved, in part, through a system of lab rotation, whereby students participate in the projects of other research institutes and private corporations, in addition to their advisors' research projects, thereby gaining experience in various research environments. It is also mandatory for students to study a selection of general courses, covering topics such as technology management, research management and planning, venture business studies, and technical writing. Taken together, the training and hands-on practical experience that students gain meets the needs of research and industry and reduces the need for re-education.

Current annual admissions rates are rising though still modest, with 115 admissions divided among masters and doctoral programs in 2007. However, the government has significantly increased UST's budget since its inauguration and there are plans to continue the university's expansion.

Source: UST website

The future role and Governance of GRIs - Policy options

To better contribute to the overall coherence and the adaptive efficiency of the Korean innovation system GRIs may have to adjust their missions. This has implications for the way they are institutionalized and governed. Missions on which more emphasis should be put in the future include the following (somewhat overlapping):

- *Servicing SMEs*. Korea is often compared to Chinese Taipei, where GRIs have played important roles in the development of technologically strong and innovative SMEs. A similar role is often proposed for Korean GRIs. But the situation in Korea is very different, with relatively weak SMEs that are mostly unfit for the sorts of research collaboration that would interest most GRIs. Although this picture might now be changing owing to the recent growth of high-technology start-ups.
- *Moving away from industrially oriented R&D towards public and welfare research*. With the chaebol largely self-sufficient in terms of R&D, and doubts about whether GRIs should be involved in developing commercial technologies or collaborating with SMEs, GRIs might be better off leading a shift towards more public and welfare-oriented R&D around important national challenges. In fact, several institutes already have an explicit public-welfare focus, but others might seek to reorient their research portfolios in similar directions.
- *Concentrating on platform technologies*. If GRIs are still to contribute to industrial innovation, they should focus upon pre-competitive, so-called platform technologies. Several institutes are already working on such technologies, often in co-operation with industry, but this could be further expanded and become the main rationale for several institutes.
- *Leading Korea's shift to more fundamental research*. GRIs have facilities superior to those of universities and greater research experience, which makes them obvious candidates to lead Korea's shift towards more fundamental research. However, recent relative declines in basic research, together with the government's intent to strengthen research in universities, are likely to undermine GRIs' claim to this role. Moreover, if GRIs were to conduct more fundamental research, the current project-based system (PBS) would need to be revised, since it has been detrimental to the stability necessary for fundamental research.
- *Working in areas of interdisciplinary and "fusion" research*. Disciplinary structures in universities are known to inhibit interdisciplinary work, while the scale requirements of "fusion" research often require dedicated research centres and research infrastructures that are not commonly found in Korean universities. GRIs could occupy this territory, but would themselves need to break down cultural and epistemic barriers between institutions.

Different options for the institutionalisation of GRIs are also regularly discussed. These range from merging and breaking up institutes to revising their ministerial location - options that have been used many times in the past. More radical proposals are also sometimes discussed, including privatization and mergers with universities. Of course, GRIs vary widely; they have different types of organization and face different issues that require different policy responses. The government should be sensitive to this differentiation when formulating policy and should consider the future of each institute on a case-by-case basis. Furthermore, GRIs should be expected to play a number of roles and no institute should be pigeonholed into performing a single function, even if this gives the appearance of administrative untidiness.

As for the governance of GRIs, an additional institutional layer, in the shape of five research councils, was established in the late 1990s between the ministries and their funding agencies and GRIs. Inspired by similar structures in the United Kingdom and Germany, the rationale for the research councils was to give GRIs a certain degree of autonomy from political interference by supervisory ministries, in the hope that this would enhance their R&D performance and efficiency. However, in contrast to their European counterparts, Korean research councils have no funding power and have only an administrative relationship with GRIs.

The research councils were originally placed under the Prime Minister's Office, but those specifically dedicated to S&T, i.e. the Korea Research Council of Fundamental Sciences & Technology (KRCF), the Korea Research Council for Industrial Science & Technology (KOCI), and the Korea Research Council of Public Science & Technology (KORP), were transferred to MoST as part of the 2004 reform package to enhance the latter's co-ordinating position. The other two research councils, which were dedicated to the social sciences and humanities, were merged into the single National Research Council for Economics, Humanities and Social Science (NRCS) and remained under the supervision of the Prime Minister's Office.

The research councils are quite similar in terms of function, internal governance and number of staff. Each has a Board of Trustees composed of vice ministers from relevant ministries, and experts invited from universities, private firms, GRIs and the mass media. Research councils appoint the presidents of the GRIs and operate planning and evaluation committees. They also operate management advisory committees and have small secretariats that carry out policy research, planning and evaluation. Each function has few administrative staff. The GRIs report their research and management plans to their research councils annually. In recent years, the results of the evaluation by an appointed expert committee have exerted significant influence on the budget allocation to GRIs by the Ministry of Planning and Budget.

- On the positive side, the research council system has secured a more autonomous research environment for GRIs, as intended. The research councils have also been able to carry much of the bureaucratic load associated with liaising with ministries and the National Assembly, thereby allowing GRIs to get on with their R&D work. Furthermore, the evaluation committees of each research council have included an examination of the organizational structure of GRIs and their operations every year. This has allowed them to guide GRIs in their management reform activities.

However, some issues need to be resolved:

- *First*, since the research councils lack the financial capacity to support GRIs, regular evaluations and requests to provide management information are often regarded by GRIs as interference by a higher administration body. Some GRIs also find yearly evaluations unnecessary and the source of a heavy burden of administrative work. They also criticize the standardized evaluation criteria used as failing to take sufficient account of the differences between institutes.
- *Second*, the names of the research councils - referring to fundamental, industrial and public S&T - do not necessarily reflect the orientation of GRIs assigned to them, as GRIs typically conduct a broad array of R&D. Indeed, to an outsider, the allocation of GRIs to the research councils seems somewhat arbitrary. By contrast, in other countries, structures like the research councils are often discipline-based.
- *Third*, even though the research councils are not discipline-based, a certain rigidity acts as a barrier to interdisciplinary research co-operation by GRIs located in different research councils.
- *Finally*, each research council has a very small administrative staff. If the roles of the research councils do not increase markedly, it might be better to amalgamate them to create a single organization with greater critical mass. In fact, given that standardized evaluation arrangements are used - and evaluation is perhaps the research councils' main role at present - such amalgamation would create relatively little disruption for GRIs and would achieve scale efficiencies. It could also promote greater interdisciplinary research co-operation.

Some reforms of the research councils have been introduced by the new administration. The main change is a reduction in number of research councils from five to three, with two remaining in the S&T area: the Research Council for Fundamental S&T under the supervision of MEST and the Re-search Council for Industrial S&T under the supervision of MKE. Both research councils supervise 13 GRIs each. Whether these new institutions will play an enhanced role in steering the GRIs remain to be seen./.

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