# Adapting Public Research Institutes to New Dynamics of Innovation†

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## Abstract

*Governments around the world place great hopes in innovation in their search for new sources of growth and for responses to grand challenges, such as climate change, new or re-emerging infectious diseases, accelerating urbanisation, ageing, food security, and availability of clean water. However they must devise their relevant support policies -- including through sponsored research within public research institutes -- taking into account that innovation processes are currently undergoing a major transformation.*

*New innovation patterns include a broadening scope of relevant activities, a growing importance but changing nature of scientific roots of technological development, a stronger demand-pull, the emergence of new local and national STI powerhouses, and the rise of more open and globalised innovation networks. They translate into new opportunities but also constraints for policies to enhance the contribution of public research institutes to national innovation performance. The article derives the main policy implications regarding the desirable evolution of the mission, research focus, as well as the funding and steering of public research institutes, with a special reference to Korea.*

KEYWORDS: innovation, public research, public research institutes, R&D, Korean innovation system, global challenges

## 1. INTRODUCTION

During the last decade high-income countries have suffered from reduced potential output growth, with daunting cascading consequences of financial disequilibria, soaring public debt, social tensions regarding income distribution and rising unemployment. This economic challenge coincides with the urgent need to address a series of grand challenges, such as climate change, health, food security, or access to potable water (OECD, 2010a).

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Innovation is called to the rescue; however, is the current innovation paradigm part of the solution or part of the problem? This article starts with the assumption that the answer is both. Only "knowledge capital deepening" can significantly quantitatively and qualitatively improve growth prospects. This involves restoring a better balance between efforts to derive further benefits from the existing stock of knowledge through diffusion and more creative use and efforts to replenish this stock, drawing on science fields with novel characteristics (Box 1).

- Broad-based technological and softer innovations by the business sector will be the main drivers of sustainable growth to provide the main sources of progress in productivity and contribute to other quality of life improvements.
- Non-Malthusian responses to major challenges (e.g. improving the well being of a fast growing world population while making a more sober use of natural resources) will require a new wave of radical innovations based on discoveries by both natural sciences (e.g. new energy technologies) and social sciences (e.g. sustainable urbanization).
- Public research will continue to provide a vital springboard for successful innovation strategies by other actors, with Government Research Institutes (GRIs) maintaining a distinct role.

GRIs will experience mounting pressures to adjust their operation, research focus, and institutional positioning as new innovation dynamics take a firmer shape in an increasingly competitive environment for access to key resources (creative people, fertile ideas, patient money, and lucrative markets

## 2. NEW INNOVATION DYNAMICS

### 2.1. Driving forces

Innovation dynamics are shaped by partly autonomous and partly interrelated profound changes that arise in societal, economic and cognitive spaces.

In the societal sphere (and with forms of cultural expression that vary slightly depending on individual countries) new social attitudes, behaviours and other phenomena create new a demand for innovation as well as new constraints and opportunities for the deployment of innovation processes.

More educated, IT-connected, urban, mobile, but ageing populations, exhibit evolving consumption patterns with a premium attached to green and safe products. They have higher expectations regarding the quality of some public goods (education, security, prevention of technological risk, and health care), and are becoming more aware of the dependency of their wealth on global disorders that first affect more disadvantaged populations (global warming, new or re-emerging infectious diseases, shortage of water, and the depletion of non-renewable resources).

BOX 1. Back to fundamentals? – A short American tale

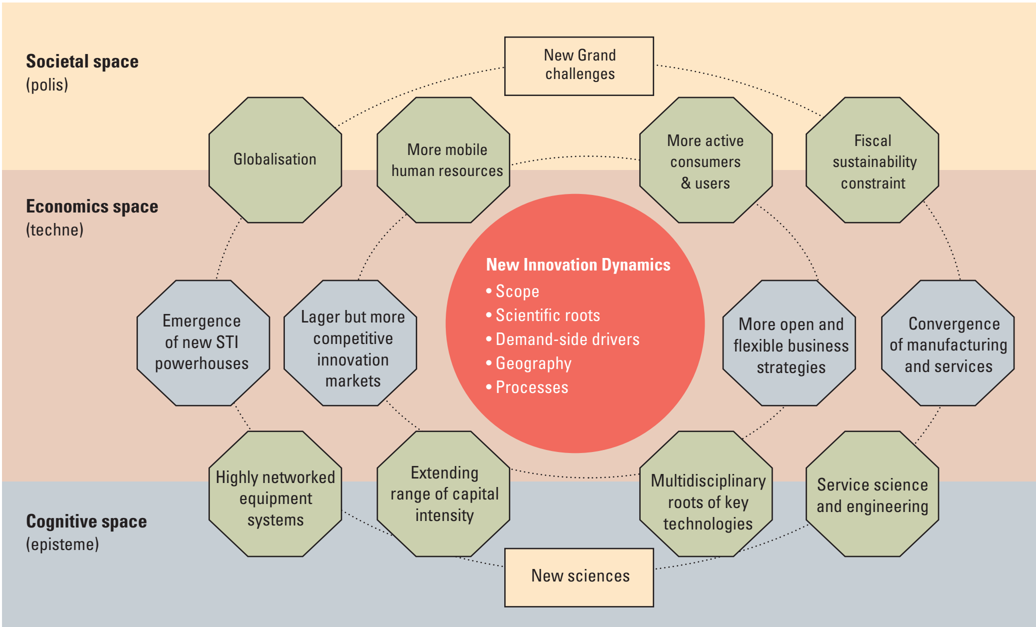
| | Trigger / Context | Concern / Answer | Underlying concept |
|---|---|---|---|
| • "Advances in science when put to practical use mean more jobs, higher wages, shorter hours, more abundant crops, more leisure for recreation, for study ... Advances in science will also … lead to the prevention or cure of diseases … (and) promote conservation of our limited national resources." Vannevar Bush, July 1945 | World War II has changed science-government relations. Strong political will to build on this new momentum in peacetime. | More Federal funding for basic research; creation of the NSF. | **Linear model (unmanaged spillovers from university research + mission-oriented research in large-scale programs implemented by dedicated agencies)** |
| • "We choose to go to the moon." President Kennedy, September 1961 | The Soviet challenge. | More support for mission-oriented research. | |
| • "What sense does it make to spend billions of dollars each year on government-supported research and then prevent new developments from benefiting the American people because of … red tape?" Birch Bayh, 1980 | 1979 energy crisis (President Carter "malaise" speech). | Bayh-Dole Act, to remove regulatory disincentives to the commercialization of publicly funded research. | Distinction between basic and applied research becomes less relevant for university research in some fields. |
| • "The rapid growth of technical competence beyond U.S. borders has made it increasingly difficult for US-based companies to derive sustained competitive advantages from superior research-capabilities alone." US National Academy of Engineering, 1991 | The Japanese challenge ("the Japanese arrived on Wall Street", 1986) | **NSF launches the ERCs and the S&TCs (1985-87); but attention focuses mainly on strategic trade policy issues and the reinforcement of the corporate, entrepreneurial side of the innovation eco-system(s)** | **Interactive model of knowledge production, diffusion and use, including elements of Mode 2 and Pasteur's quadrant.** |
| • The nation that fosters an infrastructure of linkages among and between firms, universities and government gains competitive advance. US Council on Competitiveness, 1998 | The flourishing 'Silicon Valley' and 'Biotech research triangle" models | | |
| • "We need a commitment to innovation that we haven't seen since President Kennedy challenged us to go to the moon. This is our generation's Sputnik moment" President Obama, December 2010 | In search of new sources of growth Global challenges The Chinese factor | Have we for too long over-emphasized commercialization to the detriment of the replenishment of the sources of radical innovations? | |

*Source: The author*

More active individual or organised consumers (and other interest groups) can support or even take part in innovation, but can also oppose (for ethical or other reasons) effectively some of its directions.

The cognitive space is currently undergoing a turbulent endogenous transformation, with the emergence of new sciences and greater interaction between traditional sciences enabled by the use of common IT-based research tools. Scientific coalitions around themes that are prioritised by public funding are further encouraged in periods of budget restraint. In the economic space, the pursued globalisation of markets for goods, services, and production factors leads to increased competition in a larger spectrum of activities. Innovators can recoup their costs on larger markets and have a larger choice of possible locations for their R&D activities; however, the novelty is short lived. Speed and costly complementary investment in IP protection and marketing are more than ever

FIGURE 1. New Innovation Dynamics: Drivers and Directions




*Source: The author*

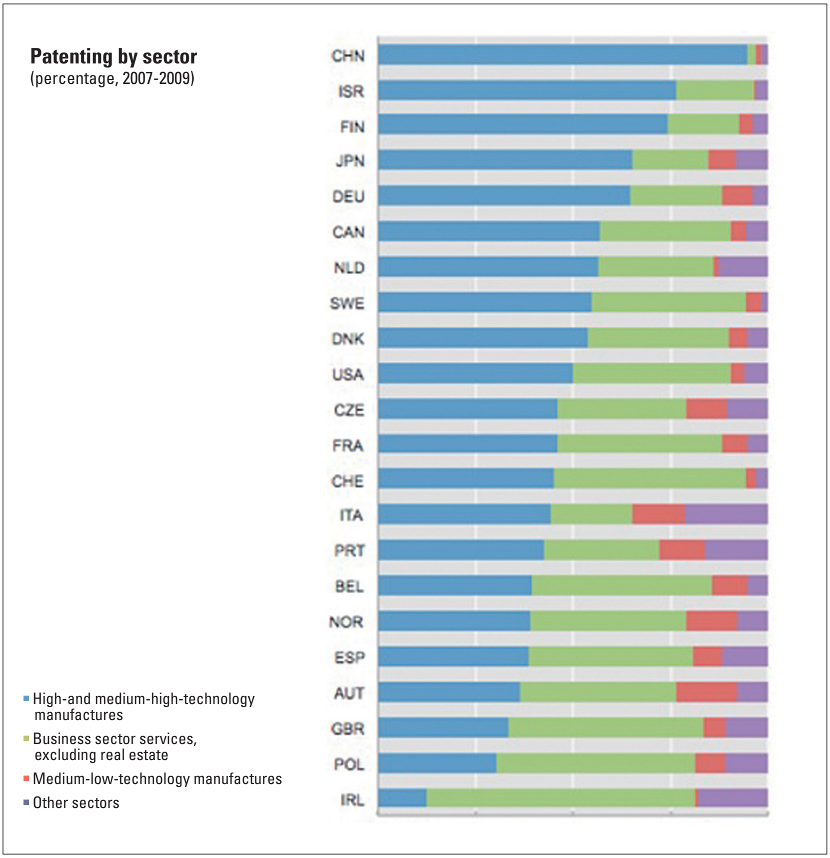
critical for success. The convergence between manufacturing and services increasingly challenge traditional business practices and public policies beyond what would suggest a simplistic hardware versus software metaphor. The concept of "service science and engineering" emphasises the need of a systematic approach to the importance of engineering knowledge nurtured in the manufacturing sector for innovation in the service sector (Spohrer, 2007). Reciprocally, knowledge-intensive services help the manufacturing sector design new products that have the functionalities required by users acting in a more personalised service-intensive environment. In a macroeconomic context that imposes more fiscal stringency, governments must themselves become more innovative in their answers to evolving social expectations and their management of relevant public policies and services.

## 2.2. New Innovation Patterns

### *2.2.1 Broadening scope*

An innovation is any organised process that stimulates creativity and channels it so that it serves a socially useful purpose; however, for too long the analytical and policy focus has mainly been on R&D-based development of new products and processes in manufacturing. Increasingly market conditions and other factors (e.g. demonstration effect, capability, and motivation of the new generation of human resources) induce more firms in all sectors, that include services (Figure 2), to create value through a wide range of complementary technological and non-technological changes and innovations (NESTA, 2008; Miles, 2006).

FIGURE 2. Patented Innovations by the Business Services Sector



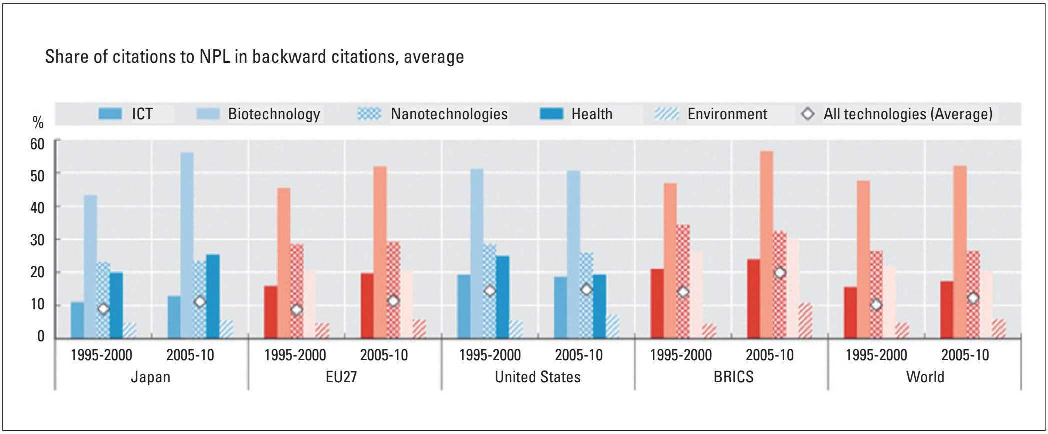

*Source: OECD*

Outside the market sphere (and consequently responding to a very different set of pressures, interests, restrictions, and demands) innovation in government now attracts considerable attention. It mainly concerns the content and delivery of public services; in addition, it also extends to other government functions that include the 'clever' procurement of products and services used in the accomplishment of sovereign government missions. (see www.oecd.org/governance/publicsectorinnovation).

### *2.2.2. Scientific roots -- growing importance and changing nature*

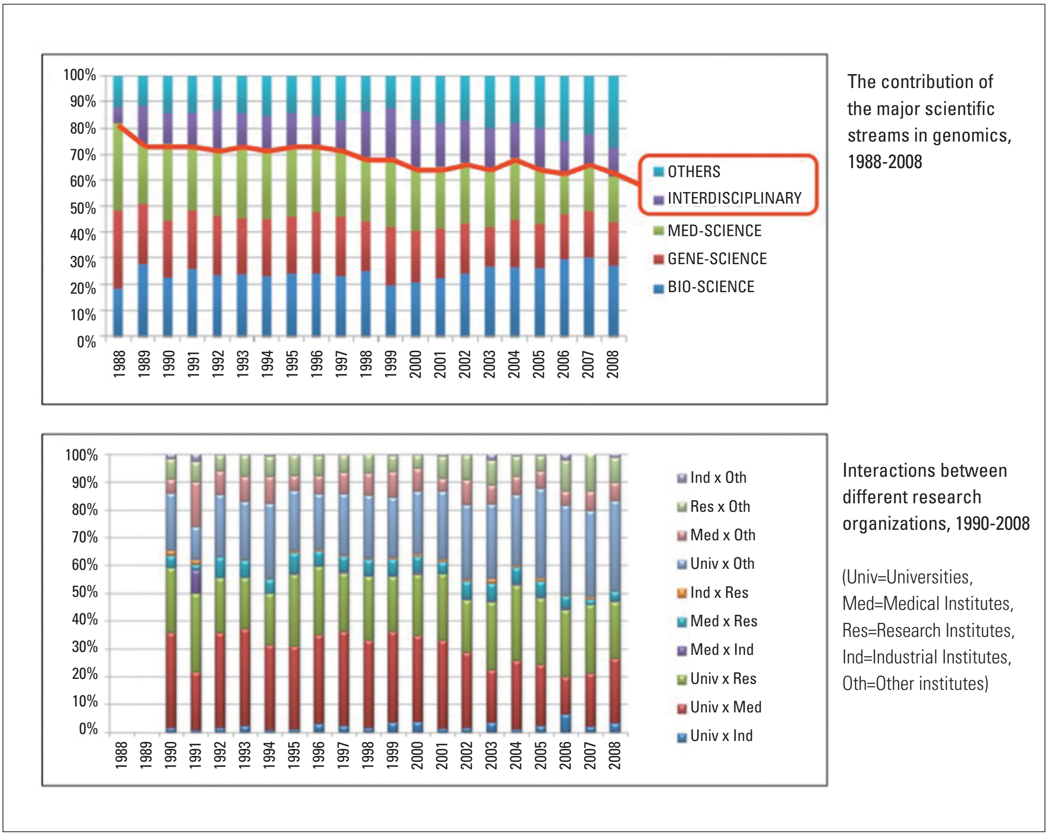
Almost all hard or soft innovations draw directly or indirectly on more or less recent advancements in the understanding of natural or social phenomena gained through science-based research. In important areas such as ICT, biotechnology, and green technologies, the direct scientific content of innovation is increasing significantly with one indicator being the citation of scientific literature in industrial patents (Figure 3).

FIGURE 3. Patents Citing Non-Patent Literature (NPL), selected technologies, 1995-2000 and 2005-2010




*Source: OECD (2011a)*

FIGURE 4. Interdisciplinarity and Inter-Organisational Research Interaction: The Example of Genomics

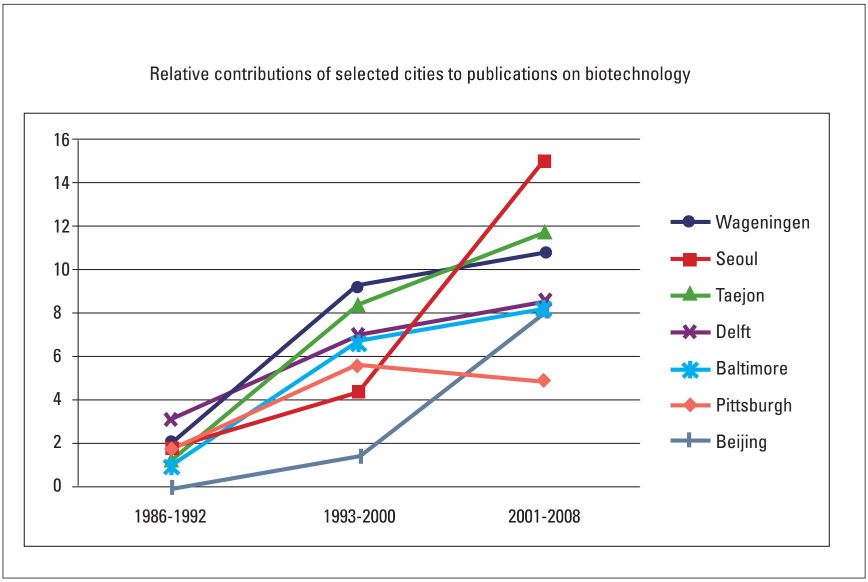



*Source: Ventura da Silva (2011)*

Science shows two contrasting evolutions (Georghiou, 2011): on the one hand, the huge progress by scientific instruments leads to a dramatic fall in the cost of achieving a given effect (e.g. resolution), while automation allows a rapid increase in labour productivity; on the other, sophistication and higher capital intensity entail rising costs to remain at the forefront of science in face of tighter budgetary constraints.

Capital intensity that used to characterise some areas of physics and chemistry is extending to life sciences, environmental sciences, and engineering. This is accompanied by the convergence in disciplinary requirements around interdisciplinary collaborations in the use of some techniques and related equipment (e.g. imaging). In some cases, this gives rise to the development of highly networked equipment systems unfixed to a single location.

FIGURE 5. New Geographical Hotspots of Innovations




Another new feature of importance for innovation and the management of public research organisations is the emergence of new sciences (e.g. life and environmental sciences) that exhibit distinct knowledge dynamics and respond differently to government interventions (Heimeriks, 2009). New sciences are intrinsically multidisciplinary, develop more than others through interaction between different types of research organisations that include GRIs (Figure 4), and gives rise to new geographical hotspots of innovation (Figure 5) (Heimeriks et al., 2011, Ventura da Silva, 2011; Bonaccorsi, 2008). This raises a new challenge for the public management of the science system such as budget allocation between scientific disciplines.

### *2.2.3. A stronger demand-pull*

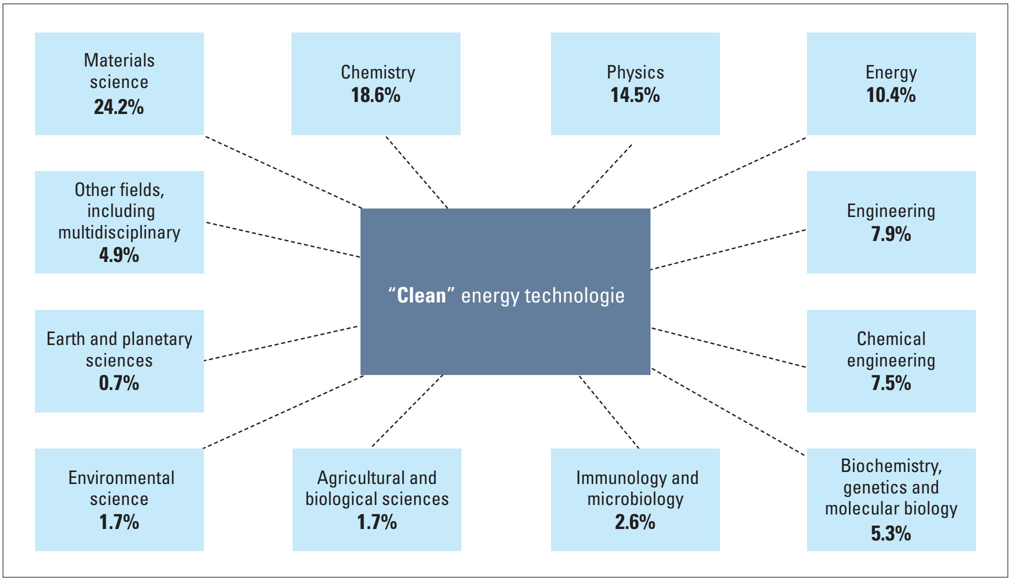
Two main forces are gaining in importance on the demand-side of innovation processes. First, the role of users has currently become pervasive in a wider range of technological and non-technological innovations (Figure 6). This trend is well-understood (Flowers et al., 2010) and documented in research-intensive industries, e.g. pharmaceuticals (Smits et al., 2008), as well in other sectors, e.g. sports equipment (Bråtå et al., 2009). Communities of users can become a real social phenomena (e.g. Apple), and their professional core represents an integral part of corporate innovation networks. Public research organisations must leverage and take part in these emerging turbulent innovative communities.

FIGURE 6. User Innovation Activities by Sector (% of total number of respondents in each sector)

| | |
|---|---|
| Software and IT services | 50% |
| Mining and quarrying | 33.3% |
| Other Creative Activities | 24.7% |
| Other manufacturing | 23.2% |
| Aerospace and automotive | 20% |
| Financial services | 18.5% |
| Other business services | 17% |
| Wholesale trade | 16.7% |
| Legal, consultancy and accounting services | 15.4% |
| Agriculture and fishing | 14.3% |
| Retail trade and personal services | 8.30% |
| Transport and communication | 7.4% |
| Hotels and restaurants | 6.3% |
| Construction | 5.8% |
| Energy production | 0% |

*Source: NESTA (2008)*

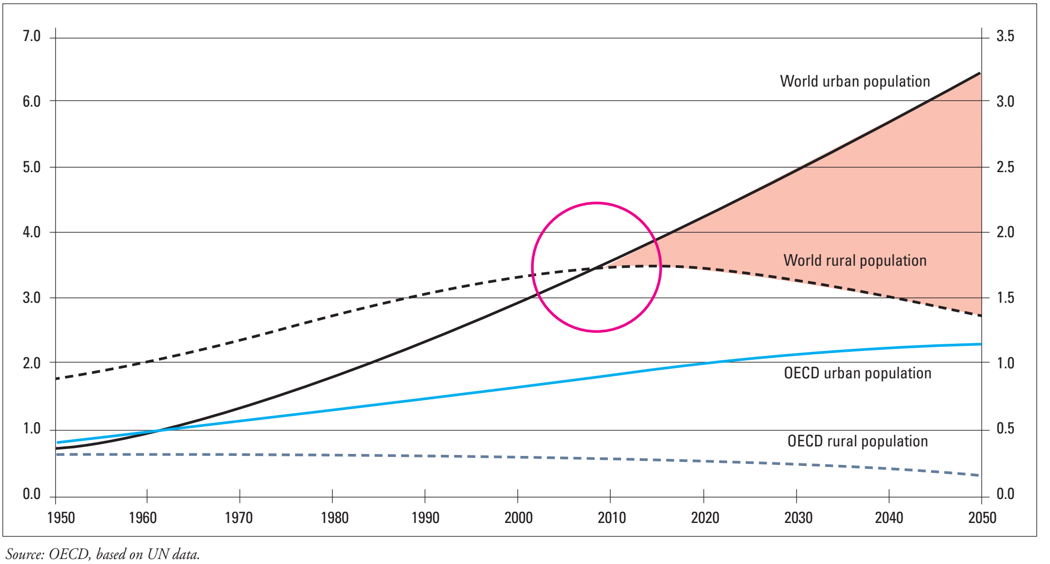
FIGURE 7. Share of Scientific Fields Cited in Patents for Clean Energy Technologies, 2000-09




*Source: OECD*

Second, another strong demand-pull with even deeper implications is exerted by social expectations regarding the contribution of science and technology to meeting grand challenges. Climate change is probably the biggest of them and motivates a substantial part of the green growth agenda. Decoupling $CO_2$ production from economic growth entails a radical transformation of the energy system, from extraction to multiple end-use technologies and social practices. Changes in economic incentives (through price and regulatory mechanisms) and social behaviour will not be sufficient; scientific and technological advances and breakthroughs that draw upon a multidisciplinary knowledge base (Figure 7) will also be required (IEA, 2011).

FIGURE 8. Urban and Rural Population in the World and the OECD (1950-2050, billions)




*Source: OECD, based on UN data.*

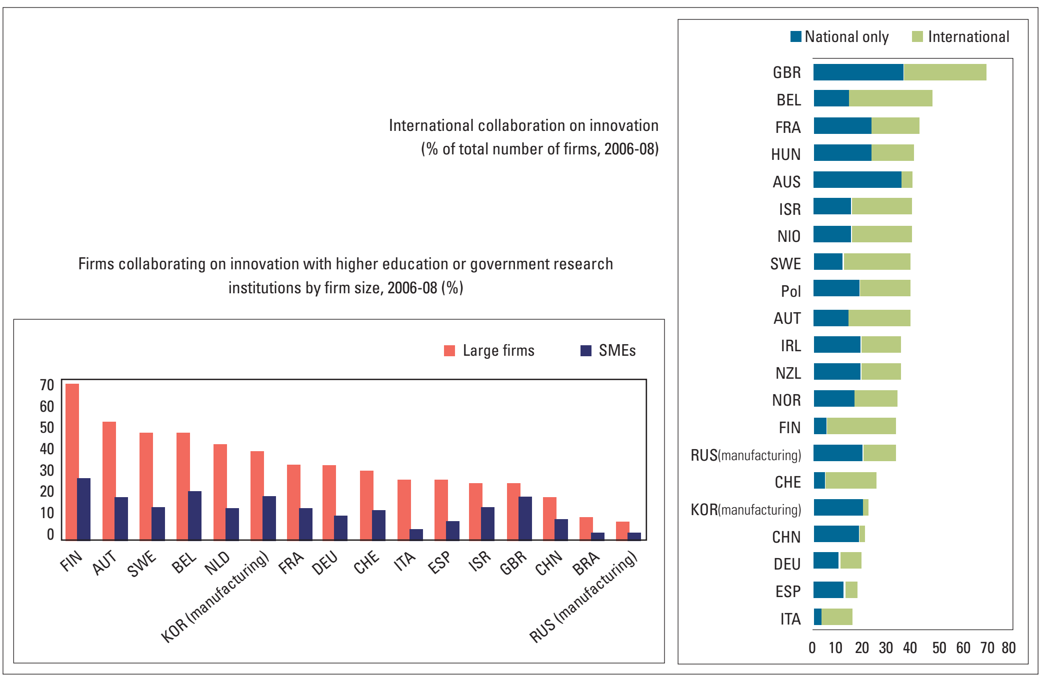
Other big problems such as urbanisation and ageing call for imaginative solutions by the world research community. From this year the world urban population will exceed the rural population. This continuing trend (Figure 8) will raise a number of new issues for urban planning and management such as how to contain the costs of congestion while enhancing the benefits of agglomeration (creative versus entropic cities)? An aging population is currently only a concern of rich countries; however, it will become a global problem in the coming decades (Lutz et al., 2008; UN, 2002). An aging population may undermine global financial stability and thus reduces the affordability of public investment, including on R&D. It will have an ambivalent impact on innovation dynamics: changing consumption patterns, changing social attitudes regarding STI, growing markets, and especially health-related new products and services.

### *2.2.4. Geography - New STI Powerhouses and Active spots*

Foreign direct investment (FDI) flows are an indicator of the changing world landscape of economic activities. They are also an important carrier of new technologies and generate knowledge spillovers for domestic firms and additional investment in R&D for recipient countries. Global FDI flows have tripled over the last 15 years and their geographical patterns have profoundly changed. The United States remains the biggest recipient and investor, but China is set to become the second largest FDI recipient (OECD, 2011a).

Matched by greater domestic R&D efforts these new FDI patterns promote new STI powerhouses, especially in Asia. China has become the second largest R&D investor. However, these aggregated data hide complex changes at the regional, local, and microeconomic levels. More global innovation network structures around leading firms, other key knowledge institutions, and advanced regional eco-systems exist to the benefit of some public research organisations and the detriment of others. It becomes increasingly perilous for GRIs to ignore the need to engage in the most dynamic transborder and transcontinental networks. Dedicated internationalisation strategies are in order (Loikkanen, 2010; Jonkers, 2010); however, this confronts governments with new issues in regards to the evaluation of the costs/benefits of financing GRIs in the presence of significant global spillovers.

FIGURE 9. Collaboration on Innovation




*Source: OECD; EUROSTAD*

### *2.2.5. Processes – Open Innovation and Value Networks*

Confronted with the shortening of product cycles and increasing cost and risk of some forms of differentiation strategies (notably corporate R&D) firms react by the reconfiguration of content-wise and location-wise value chains and the development of value networks created through multi-partner collaboration (Figure 9) (Guinet et Meissner, 2012; Flowers, 2010). These more open business innovation strategies allow firms to customize early new product and service development through greater involvement in the innovation process of prospective users/consumers and gain privileged access to external competencies that include those of public research organisations.

More open/collaborative business strategies to cope with cost pressures and the increased complexity and risk of technological development have paradoxical implications for GRIs. To some extent many firms endure some of the effects of increased competition by devising cooperative arrangements that transfer part of the competitive pressure on partners. GRIs are consequently provided with greater opportunities for research partnerships and contracts, but at the price of going through a more competitive process to harness them.

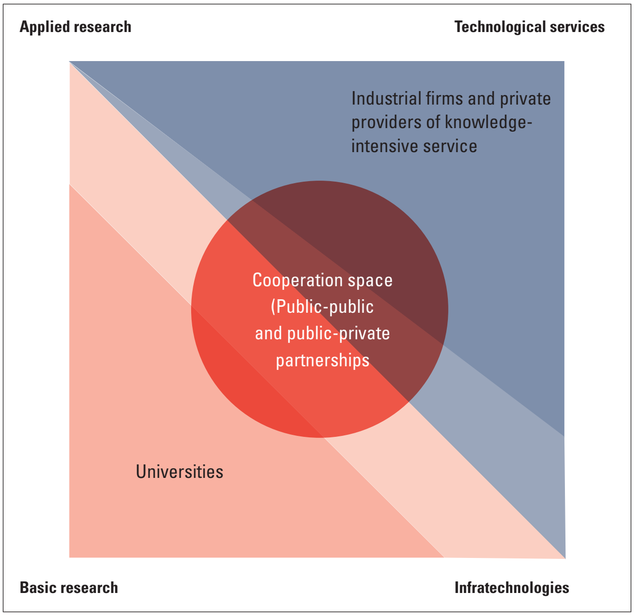
## 3. IMPLICATIONS FOR GRIs

### 3.1. Changing balance between main missions

The new dynamics of innovation do not change a key feature of GRIs, their sheer heterogeneity in terms of size, organisational features, main functions, research portfolio, and disciplinary or sectoral focus. In addition, it hardly attenuates the considerable cross-country variability of the role of GRIs in the innovation system (relative to the two other main actors, firms and universities) since this variability reflects enduring differences such as industrial and technological specialisation, the importance of military research, or historical legacy regarding institutional arrangements in the public sector (Guinet, 2010). This will continue to limit the conclusions one can draw from international comparisons of aggregated statistics on GRIs funding and performance.

The new dynamics of innovation have important consequences in regards to the desirable balance in each country between the main roles of national GRIs. These include conducting strategic and pre-competitive research, technological support for business, public policy support, and providing infratechnologies (measurement, technical norms and standards) as well as the construction, operation, and maintenance of key facilities. They also require changes in the way GRIs perform each of their main functions and compete (or cooperate) with the other main actors of innovation (Figure 10). The capability of existing steering and funding mechanisms to induce these changes is currently questionable (Link et al., 2011).

FIGURE 10. Zones of Competition and Cooperation between GRIs and Other Innovation Actors




*Source: The author*

### 3.2. Co-opetition rather than overlaps with universities

GRIs and universities are complements not substitutes, having different skills and core capabilities (Arnold, 2007). GRIs are the only feasible forms to carry-out some mission-oriented R&D (most obviously but not only defence); however, for the business sector, they have several comparative advantages vis-à-vis universities, e.g.:

- More structured and quasi-industrial approaches, with more disciplined project management.
- More experienced researchers, notably in areas where accumulated tacit knowledge is of key importance (e.g. scaling up new techniques to a point where they are industrially useful).
- Exclusive equipment for testing and measurement and sometimes a pilot plant not readily available elsewhere.
- Better routines for the confidential treatment of proprietary knowledge.

Winning models of public research are different in regards to the respective weight of GRIs and universities; however, they are alike in their recognition of a customer perspective. However, the use of GRIs and universities by companies is distinct. The motive to secure a future supply of needed human resources is dominant for interaction with universities; the problem-solving capability and knowledge with a practical application are the most valued contribution expected from GRIs. Another commonality is the effort to cautiously manage the convergence of part of university and GRIs missions through an appropriate mix of cooperative and cooperative arrangements.

Competitive funding is the privileged tool for basic research activities, cooperative programmes (such as public-private partnerships) tend to become the rule for more applied but fundamental pre-competitive research; knowledge markets are entrusted with the regulatory role for IP-based commercialisation.

In Korea, the reinforcement of university research is a clever move to develop national basic research capabilities and to enhance training for research and training by research that benefits the whole national innovation system. However, this should be pursued without the hollowing out of GRIs in their fundamental research capabilities or the distortion of technological service markets. The use of a full economic cost modelling system in the public research system is a good way to avoid this risk.

### 3.3. Adapting to business needs – a moving target

Innovative firms in some sectors still need the help of GRIs to identify and adopt/adapt the best national or foreign R&D and production practices; however, GRIs must focus in areas where they have a real (i.e. not primarily based on subsidised prices) comparative advantage over private providers of similar services. In addition, some of them should not only provide technological services to manufacturing as follow-up or complement to business R&D but also more upstream contributions to innovation in the service sector itself.

The most advanced firms have different requirements. GRIs can help them mainly as partners in pre-competitive R&D and sources of generic or specific infratechnologies needed during the course of in-house R&D.

In Korea, GRIs have successfully played an important role in the initial phase of accelerated industrialisation. According to the terminology of Choi, during this period of “collective learning” they effectively helped “problem solving for imitation based on imported technologies”. They already experienced difficulties to manage the transition towards « collective recombination » when they had the less central (but more tricky task) to “help problem-solving for innovation based on foreign concepts” (Choi, 2010). Now they face the even more difficult challenge to support the increasing number of companies that can have the ambition to build a sustainable global technological leadership based on unique and broad-based innovative capabilities.

## 4. REFORMING GRIs

### 4.1. Steering and funding - guiding principles

Over the last two decades, GRIs reforms have been widespread and almost continuous throughout the OECD (OECD, 2011b). New Public Management (NPM) has provided the main inspiration (Box 2).

BOX 2. NPM Principles

- A stress on cost-cutting and efficiency, "doing more with less"
- An emphasis on hands-on autonomous professional management
- Explicit standards and measures of performance through the clarification of goals, targets, and indicators of success
- A shift from the use of input controls and bureaucratic procedures, to rules that rely on output controls measured by quantitative performance indicators
- A shift from unified management systems to the decentralization of units in the public sector
- An introduction of greater competition in the public sector through term contracts and competitive funding
- Greater accountability as a counterpart of greater autonomy through (for example) performance agreements

*Source: Yamamoto (2003).*

Only in a handful of countries have these principles been strictly implemented to reform public research, mainly the United Kingdom and New Zealand. In other countries, a more pragmatic approach has borrowed from NPM mainly the idea of 'agencification' (separation of policy and implementation functions) and of the need to increase the share of competitive funding; the experience has been mixed.

Greater autonomy of PRIs has led to improved performance. Increased competition within the public research sector has reduced inefficiency beyond what could have been achieved by any conceivable improvement in discretionary public management. A larger share of "contestable" (competitive or otherwise) funding has increased the responsiveness of research organisations, research teams, and individual researchers to changing needs of stakeholders.

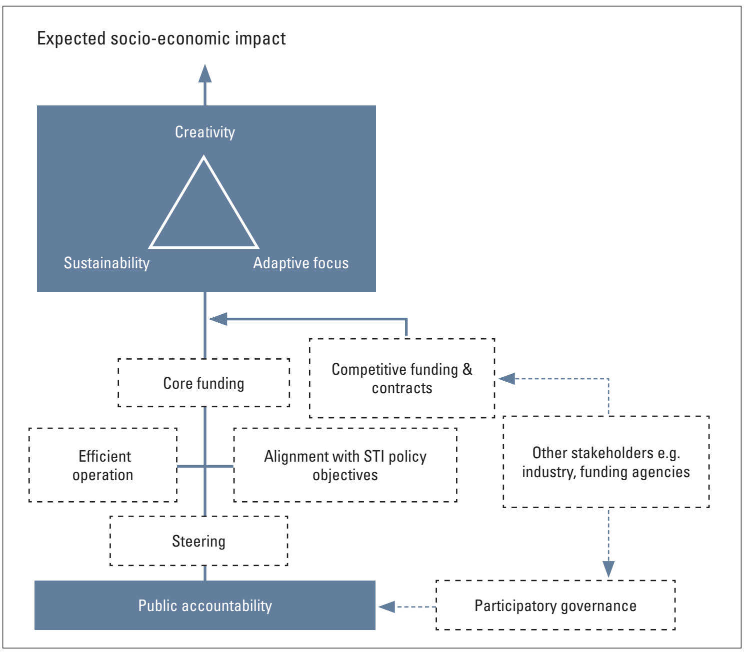
Experience has also demonstrated the limits of NPM principles when applied too bluntly to public research. The lack of core funding has often distorted the research portfolio of GRIs to the detriment of public interest. For example, New Zealand has stepped back recently to rebalance funding structures to secure more stability. Another undesirable effect has been the under-financing of research infrastructures in the absence of counterweights such as dedicated federal funds or a special levy on competitive funding. Another perverse effect arose from the contradiction between a policy to push some GRIs towards self-sustainability and a broader reform of funding that encouraged others to enter the same markets for contract research and technological services. More generally (but also subtly), some undermining of ethical and other values in public service might have happened in some places and countries.

Finally, NPM principles do not seem to help solve some problems of growing importance in the context of new innovation dynamics. For example, priority setting and funding R&D to address "big and complex problems" raise still unresolved issues (Georghiou, 2011). In addition, the alignment of participants in multidisciplinary research that involves multiple and more autonomous organisations cannot be ensured by simply implementing standard NPN performance criteria.

## 4.2. Steering and funding – the key dimensions and balancing acts

GRIs are accountable to society for their use of tax payer money; however, they must be given the proper capability and incentives to accomplish their public mission, taking into account that the ultimate outcomes (socio-economic impact) depend on joint or follow-up action by other stakeholders such as industry. Critical capability presents three main attributes: sustainability (sufficient stability and continuity for developing competencies through learning), creativity (eagerness to explore new solutions to standard problems and imagination in mobilising existing knowledge to address new issues), and adaptive focus (flexibility to capture unexpected opportunities and responses to changing demand) (Figure 11). Steering (definition of mission, evaluation, and performance contracts) and funding are the key mechanisms to enforce the contract between society/government and GRIs in a way that stimulates their creativity, ensures sustainability, and allows some flexibility in their research focus.

FIGURE 11. Steering and Funding GRIs – the Key Dimensions




*Source: The author*

### *4.2.1. Reconciling public accountability with creativity*

In this context, the first balancing act is to reconcile public accountability with creativity. It is important to recognise that even in the best conceivable GRIs projects, individuals or teams would distribute in some form of Gaussian curve if they were ranked at any point of time in accordance with their quality/creativity. A rigid and too bureaucratic or dogmatic enforcement of accountability will cut the two tails for the least quality projects as well as the more creative ones in the distribution.

A more pragmatic and advanced approach will preserve a space for the most creative individuals, teams and projects. In this respect, the experience of OECD countries suggests the importance of the following:

- Large autonomy in human resource management by individual GRIs.
- Flexibility in the evaluation of research outcomes, to account for unexpected mix and unusual sequencing of research outputs.
- Systematic use of international benchmarks and reviewers in evaluation.
- Active partnerships with universities, other GRIs, and industry for the valorisation of results at the borderline of core business.

The enhancement of GRIs creativity in the Korean context could specifically require: less reporting burden and more active evaluation closer to operation, relaxing the constraints on recruitment policy within budget limits, more individualized rewards (at the level of researchers or research teams), more part-time research positions at GRIs for university professors, and more part-time professor-researchers positions for GRIs staff.

#### *4.2.2. Funding for sustainability through excellence and social relevance*

The second important balancing act concerns what should be the appropriate funding mix (relative shares of competitive funding, earmarked block funding, and untied block funding) to allow GRIs to secure their sustainability by attracting and retaining talented people working with up-to-date equipment on good projects.

Too much block funding favours incumbents and subsequently reduces performance incentives and agility; however, too much competitive funding prevents institutions or research teams from developing strategies, impairs the renewal of infrastructure, increases reliance on short-term recruitment of cheap researchers, leads to mission creep, and is not a good substitute for privatisation or outright closure in extreme cases.

The current debate is about how block funding should be delivered to provide stability; however, not at the expense of excellence and the social relevance of the research output. How core funding can be delivered in different forms, with different degrees of conditionality, is a crucial issue to be considered in that respect. Core funding earmarked for capacity building is a common practice. Core funding for venture funding is an interesting option in consideration of the need to support novel and unproven approaches; in addition, research organisations must lead funding agencies that are understandably more cautious (US National Academies, 2004).

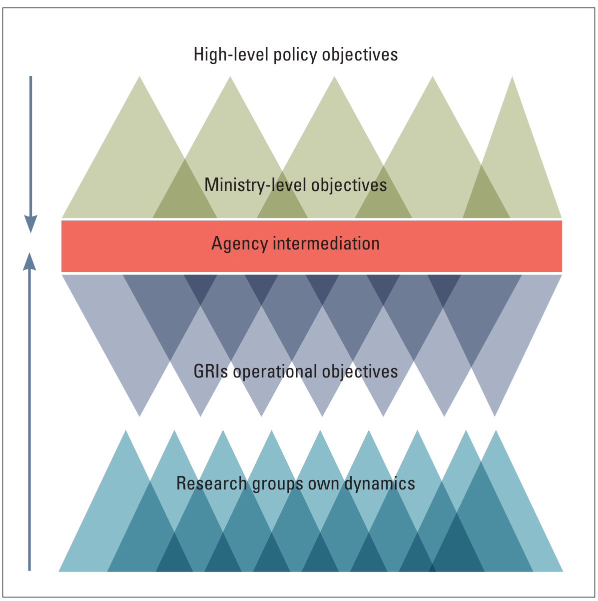
In Korea, there is a large consensus that the project-based funding approach (PBS) has demonstrated its limits. The need to increase the share of core funding, except when this would aggravate the crowding out of private initiative, is generally recognised. A significant part of core funding should to be secured beyond the annual budget cycle, if GRIs are expected to contribute more to fundamental pre-competitive research. Any future GRIs reform will have to decide on how the distinction between non-earmarked and earmarked core funding for capacity building should be implemented in practice for different types of GRIs.

### *4.2.3. Alignment of creative research with STI policy objectives*

Priority setting cannot be a pure top-down process in an area where the asymmetry of information between actors is important and where the implementation of agreed objectives is subject to uncertainties inherent to research activities, especially in turbulent, multidisciplinary, and fast developing disciplines. Setting policy priorities and aligning actors throughout the governance pyramid is a more appropriate approach than attempting to disaggregate policy priorities up to the level of an individual laboratory or research team (Figure 12).

In this process of prioritisation/alignment, one stage of governance plays a vital role: the Agency (which can take different forms in different countries) that, at the confluence of top-down and bottom-up processes, compensate for the asymmetry of information between the policy community and the research community, translate policy objectives into GRIs research objectives, and monitor alignment during implementation. The main causes of misalignment are:

FIGURE 12. Prioritisation: Alignment with STI Policy Objectives




*Source: The author.*

- Failure to translate overriding policy goals into a set of more detailed actionable objectives.
- Actionable objectives do not fit research capabilities.
- Operational management at GRI remains disciplinary or project-based.
- Evaluation criteria are not consistent with funding criteria.

These issues are magnified when prioritising for grand challenges:

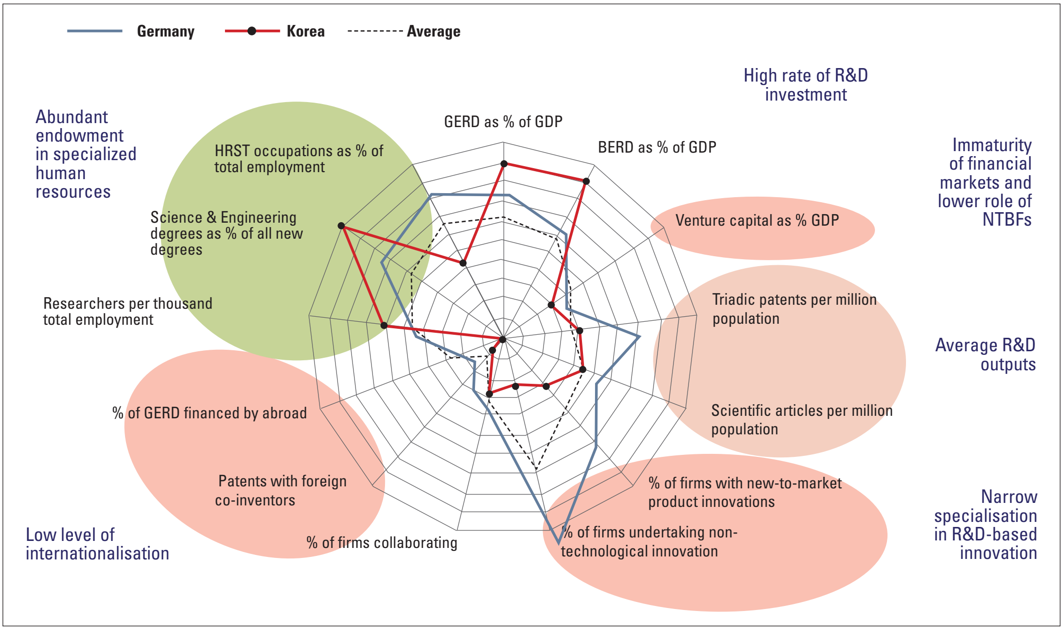
• Public recognition of a grand challenge is usually at the highest level of aggregation.
• The first step, to articulate the challenge into its key components, is particularly demanding for complex problems.
• Failure to do so opens the risk of rhetorical prioritisation with no real impact and/or of opportunistic behaviour within the research community.

Korea is a leading OECD country in regards to the importance attached to and sophistication of techniques employed for STI policy prioritisation (Oh, 2008). However, the efficiency of prioritisation could be enhanced by the reinforcement of one STI governance function, the agency intermediation. A reform of Research Foundations would provide a salient opportunity to address this issue.

## 5. CONCLUDING REMARKS

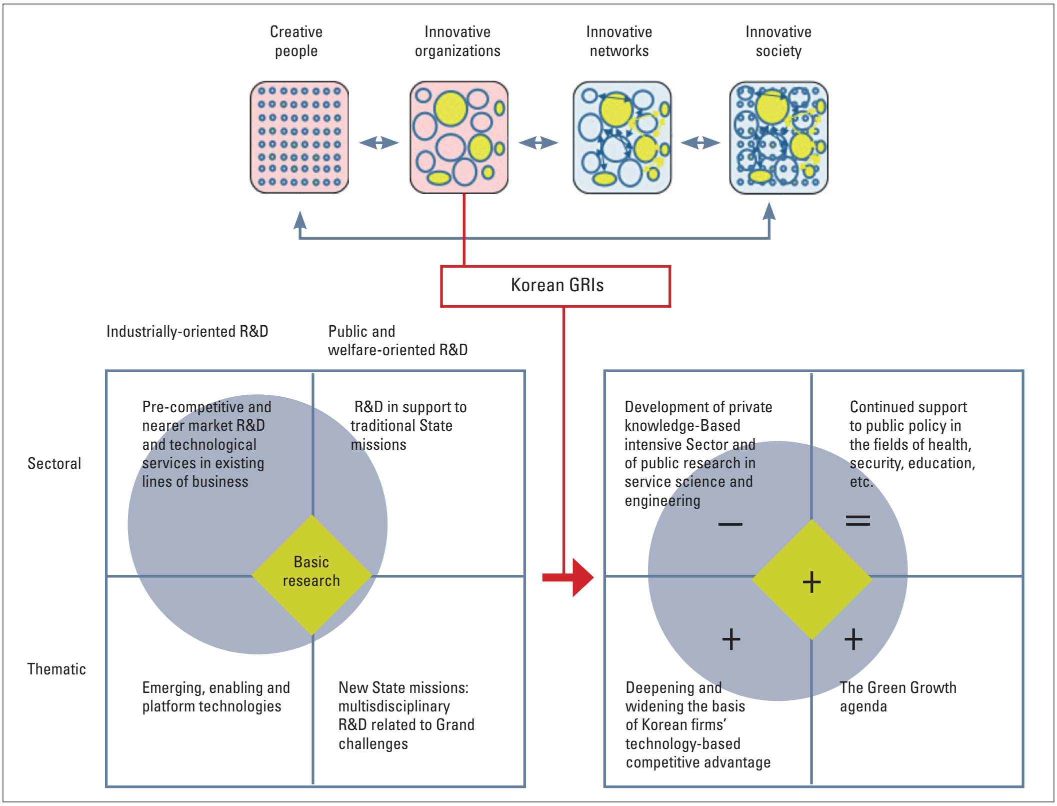
Recent international quantitative benchmarking and more thorough assessments of Korean innovation performance have noted that Korea's exceptionally high rate of R&D investment and abundant endowment in highly qualified human resources translate into only average R&D and innovation outputs (Figure 13) (OECD, 2010b; OECD, 2009).

FIGURE 13. Korean Innovation Systems in a Simple International Comparison




*Source: OECD*

FIGURE 14. Re-focusing the Korean GRIs Research Portfolio




*Source: The author.*

Despite the impressive successes of Korean firms in global markets, the current technological specialisation of the country is still quite narrow and too shallow in regards to its innovation-related roots. This makes the country overly dependent on the continued success of large firms in a relatively limited range of products that are subsequently vulnerable to competitive shocks from emerging economies that target the same fields. Unleashing the creativity of its abundantly skilled human resources, and mobilising social capital and business skills for a broader-based innovation strategy is one of the commendable goals of the national green growth agenda. All organisations in the Korean economy and society have a contribution to make to the current national effort to promote creative approaches to solving problems or capturing opportunities. Figure 14 broadly shows what this might entail in regards to the research focus of GRIs.

The enhancement of GRIs contributions to the upgrading of the Korean innovation system might involve:

- Sustained investment in public research.
- Shifting focus towards more basic and fundamental research in support to innovation in man-

ufacturing as well as services that include multidisciplinary R&D for "new" State missions.

- Raising the attractiveness for young talented researchers that include individualised incentives and increased space for interaction with universities and innovative firms.
- Better recognition of creativity and contributions to collaborative research in evaluation and funding.
- Providing GRIs with more stable funding, for capacity building and the quasi-venture financing of creative but risky undertakings.
- Renewed efforts to better link GRIs to global knowledge networks.
- Adapting overall governance through a more matricial (rather than disciplinary or functional) approach to steering and funding.

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