Recent changes to Korea's innovation governance

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Abstract. ***Governments around the world are faced with the challenge of an increasing sophistication of the technological base at home and abroad. How they cope with it is reflected in institutional change. Highlighting Korea's stunning growth in financial inputs to its innovation system since the early 1980s, this paper provides an in-depth and first-hand account of the ongoing changes to South Korea's national innovation system. Emphasis is given to the most recent reform enacted in 2004. It is concluded that Korea's NIS is an important foundation of its economic competitiveness.***

Introduction

The Republic of Korea (South Korea) has witnessed a phenomenal pace of growth since the 1970s, with per capita incomes in real US dollar terms rising seven fold over the past 30 years. Reaching the level of 20,000 USD in per capita GDP is a declared government objective that will probably be met in 2008. From a nation shattered by the upheavals of the Korean War (1950-1953) it has been transformed to the world's tenth largest economy and the third largest in Asia. It is important to note this has been achieved with a minimum of foreign assistance. Commonly touted as one of East Asia's four dragons (alongside Hong Kong, Taiwan and Singapore) Korea today can clearly be counted among the advanced industrialized nations. Though the exact causes and mechanisms of this startling advance are subject to an ongoing academic debate, dwelling in particular on the role of the state in this context (Amsden 1989, Krugman 1994), most scholars would subscribe to the notion that a set of well-defined science, technology and innovation (STI) policies – suited to the specific needs of a late industrializing country - have underpinned that growth in a very significant fashion.[2]

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[2] This interpretation is supported by recent World Bank research which noted Korea's successes in total factor productivity (TFP) in comparison to Mexico. TFP essentially is about the development and successful exploitation of knowledge and innovation.

Driven by external (the rise of China) and internal (ageing population) factors, Korea has embarked on becoming a knowledge society in which traditional factors of production such as capital and labor are progressively superseded by new dimensions such as patents, research and development (R&D) and availability of knowledge workers. A knowledge society is one that "creates, shares and uses knowledge for the prosperity and well-being of its people" (http://www.med.govt.nz/pbt/infotech/digital-strategy/draft/draft-11.html). It was estimated by the OECD that over 50 percent of GDP in the major OECD economies has become knowledge-based. And as much as 70 to 80 percent of economic growth is now said to be due to new and better knowledge (OECD 1996). These insights frame the current debate within Korea about the impending innovation challenge and the proper strategies required to carve out a profitable niche in the sandwich position between high-tech Japan and low-tech China.

These insights immediately invite the question of how the institutional underpinnings of Korea's national innovation system (NIS) look like today, how they evolved over time and to what extent, if any, they could be replicated in other countries. The paper will investigate the hypothesis, that Korea's relative success in S&T owes much to the distinct patterns of up-stream governance of its NIS. In so doing, we will first introduce the theory of national innovation system as it has been developed mainly by Scandinavian scholars from the late 1980s. The following part will entail a summary of Korea's experiences with S&T and dwell on how its NIS has developed over the past fourty years. Next we will shed light on the most recent changes to Korea's upstream innovation governance. The article concludes by a summary of strengths and weaknesses of Korea's NIS.

General picture of S&T in Korea

Under the leadership of President Roh Moo-hyun, elected to office in 2002, the Korean government has made big strides in attempting to foster R&D across the board, both within public research institutes and the private sector which finances 75% of R&D in Korea. This resolve is mirrored in comparative S&T statistics usually placing Korea on par with the advanced countries of North America and Europe, at least as far as financial inputs to R&D are concerned. General expenditure on R&D (GERD), the broadest measure of money flowing to science and research in an economy, peaked at 25 billion US dollars in 2005, the highest figure the country has seen since statistics were first compiled in the early 1960s (Figure 1). Since 1970 GERD has expanded by a compounded annual growth rate (CAGR) of 26.1%. Considering the relative share of GERD in relation to GDP, Korea also compares very favorably with other countries: the ratio of GERD over GDP is at 2.99% (2005), a very healthy figure against Japan's 3.15% (2003), Sweden's 3.98%, Germany's 2.52% and the United States' 2.68% (OECD 2005).[3] This coincided with a considerable improvement in the annual rankings of the World Competitiveness Yearbook by the International Institute for Management Development (IMD). In the field of science competitiveness Korea advanced from 28th (1998) to 12th (2006) position, and from 27th (2003) to 6th (2006) place in technology competitiveness (IMD 2006). These figures are particularly noteworthy as the country's overall ranking has slightly slipped to 38th over the past eight years. So clearly there is a positive momentum in the field of science and technology which is further supported by a host of indicators beyond the IMD league tables such as R&D intensity (R&D as

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(http://info.worldbank.org/etools/docs/library/235384/KoreaKE-Overview.pdf). For an overview of STI policies Teubal (1997).

[3] Government projections in Korea foresee a rise of GERD/ GDP to 5.2% by 2030.

a percentage of GDP), the government R&D budget,[4] the number of researchers and science personnel and the number of publications measured by the Science Citation Index (SCI). All of these show very healthy upward trends. All together Korea has shown a propensity to constant fine-tuning of its innovation governance in synch with a changing technological, social, economic and political environment.

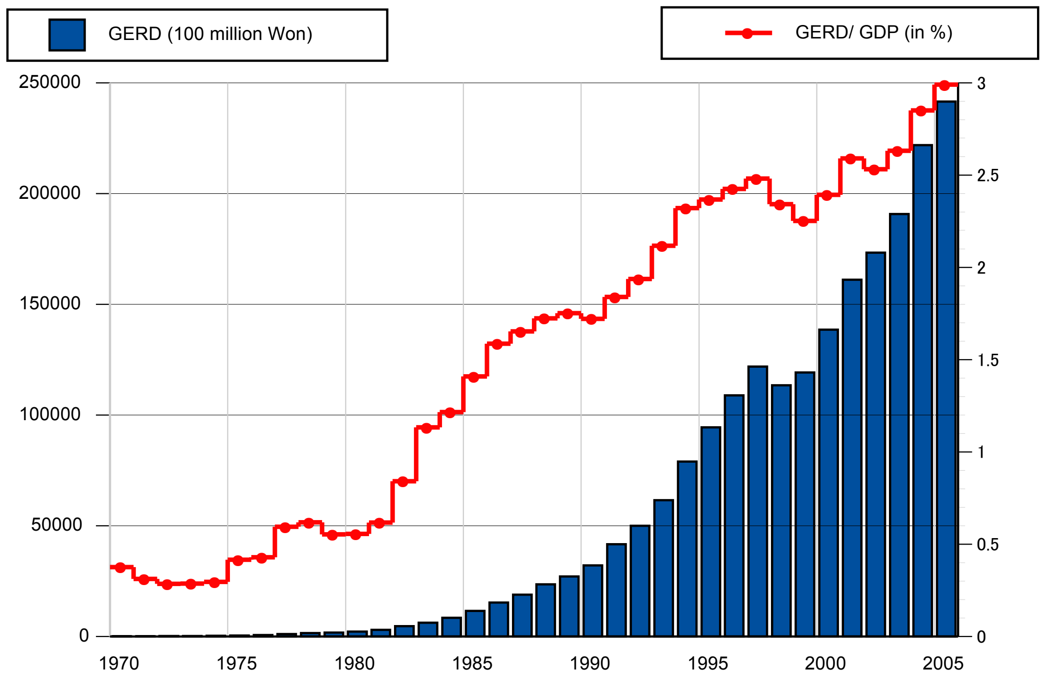

Figure 1: GERD (right scale) and GERD as a percentage of GDP (left scale) in Korea, 1970 to 2005.
Source: MOST S&T database.

National innovation systems

Innovations are the lifeblood of any modern economy, as they propel economic growth by means of technical change (OECD 1992). Yet despite their significance the economic and other sciences are only edging marginally closer to a comprehensive understanding applicable across time and space of how, why and when innovations emerge or not. Innovation is a ubiquitous phenomenon in any modern economy and has, therefore, been studied in a variety of contexts, including in relation to technology, commerce, social systems, economic development, and policy construction. Lundvall who stressed the importance of learning and user-producer interaction in his groundbreaking book on the subject wrote: “In practically all parts of the economy, and at all times, we expect to find ongoing processes of learning, searching and exploring, which result in new products, new techniques, new forms of organization and new markets.” (Lundvall 1992: 8). In the course of this ambitious strand of research that gained substantial pace from the mid 1980s, a near consensus has emerged that “government matters” in fostering innovative processes. As Ahrens (Ahrens 2002 : 10) puts it: “This new line of thinking seeks to bring politics back in and to overcome the apparent dichotomy between the market and the state as two mutually exclusive mechanisms of resource allocation. (…) Thus the pendulum has actually begun to swing back toward redefining the role of the state in economic

[4] The 2007 government R&D budget amounts to 10 billion USD. Until 2010 the R&D budget will grow by 10% annually. This is about one half of Germany’s public R&D budget, and 1/15 of the US.

development.” This forceful logic is equally true for the role of government in the innovation game, where it is now considered a very important player, sitting either at the supplying end (e.g. through providing funding for scientists) or at the receiving end (e.g. through innovation-enhancing public procurement).

This raises two pertinent questions: first about the shape of a limited, but effective government (World Bank 1993: 84) and second about how to best design the innovation governance matrix that procures policy advice and frames interventions, particularly so in rapidly developing countries such as South Korea that have had little time in making the paradigmatic shift in their national innovation systems from imitation to innovation. Adopting third generation innovation policies that anchor science and innovation at the very heart of government action across multiple policy domains remains a prime challenge (OECD 2006). And so does the crafting of proper innovation governance, i.e. the institutional matrix through which policies are fashioned, prioritized and delivered.

Early explanations of innovative activity focused exclusively on inputs (financial and human resources) being utilized in a linear model of innovation stretching seamlessly from basic research to commercialization. New technology was assumed to start with basic research and move through applied research, invention, commercial market testing, and ultimately to diffusion. Innovations were considered the result of a linear process made up of different stages that take place in a sequential, hierarchical and one-way order. The adoption of this linear concept of innovation could lead to the conclusion that high investments in R&D would have positive consequences on productivity and growth. However, during the 1970s and 1980s the emergence of new and important technologies was followed by a reduction of productivity in the majority of the OECD countries (OECD 1991). The apparent contradiction between these facts was known as the productivity paradox. The Green Book on Innovation (European Commission 1995) also highlighted this paradox in relation to European countries. The pitfalls of the linear model of innovation became increasingly evident, in that it ignores the importance and influence of institutions (North 1990) and other market and non-market factors which in various and complex ways impinge upon the emergence of new products and services (OECD 1992). In the light of these new findings, the basic assumptions behind the linear model lost much of their explanatory power and appeal to policy makers. The new focus on the economic importance of knowledge and its properties helped a radically different perspective on innovative activity to thrive: national innovations systems.

The theory of national innovation systems was first conceived in the second half of the 1980s to provide a broad-based account and add analytical rigor to the understanding of innovative activity in a given economy (Lundvall 1985), (Freeman 1987), (Lundvall 1988), (Nelson 1993), (Lundvall 1992), (Edquist 1997), (Edquist 2001), (Chaminade and Edquist 2006). NIS theory frames innovation not as a linear process, but as a complex interaction between various institutions, in particular governments, universities, private and public research institutes and private firms. The point of departure is the existence and reproduction of entities in biology or, if translated to the economic world, a certain configuration of technologies and organizational forms. There are mechanisms that create diversity (i.e. innovations) in the system and there are selection mechanisms (i.e. nature or the market) that reduce diversity by increasing or decreasing the relative importance of elements through a “filtering system” (Edquist 1997: 6). This filter ensures that only entities survive that adapt with a tolerable fit (Hodgson 1993). Through that lens technological change is a path-dependent and open-ended process where a system never reaches an equilibrium state because technologies are only superior in a relative, not an absolute sense. National innovation systems are open systems (as opposed to closed systems) with an often discontinuous transition to states characterized by greater complexity, path-dependency, multi-stability and heterogeneity of agents. Their openness implies a limited degree of determinism making it hard to foresee or predict outcomes (Nicolis and Prigogine 1989, Saviotti 1997: 182). NIS are highly knowledge intensive which is generated through search activities in individual and collective learning processes.

Evolutionary theories as the basis of national innovation systems theory share three characteristics, hailing from biological evolution but adapted to socio-economic evolution (Nelson and Winter 1982). 1) retention and transmission of knowledge; 2) generation and novelty leading to diversity; 3) selection among alternatives. These three principles are underpinned by the assumption that explanations of why an evolutionary pattern of change occurred must be identified in the decisions and actions of various economic agents, implying that the evolutionary logic can be leveled to describe innovation systems at different levels, such as national, regional or sectoral (McKelvey 1997:202). Rather than focusing on the individual and isolated units within the economy (firms, consumers) NIS flag the collective underpinnings of innovation and address the overall system that creates and distributes knowledge. In doing so innovation is construed as an outcome of evolutionary processes within these systems, and unlike in neoclassic theory information asymmetries are not considered a market failure but essential stepping stones of variety and novelty.

How players in the NIS interact and share knowledge in a productive way has captured the attention of policy makers and academics for the past decade and continues to pose a considerable research challenge. What has emerged thus far is a prevailing consensus that a systems approach to understand the dynamics of innovation is more realistic and provides a more useful yardstick to policy making than does the linear model of innovation. Edquist (Edquist 1997: 14) defines innovation systems as "all important economic, social, political, organizational, institutional, and other factors that influence the development, diffusion, and use of innovations". Nelson (1993) expresses similar views in defining NIS as "the elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge…and are either located within or rooted inside the borders of a nation state". Depending on the objective and the level of analysis, innovation systems can be supranational, national, regional or sectoral. The NIS approach reckons that successful innovations depend on long-term relationships and close interaction between the innovative organisation and external organisations and institutions. Moreover, this systemic approach to innovation considers that innovative activity and interactions between innovative agents are strongly influenced by the institutional environment. Institutions can be described as "sets of common habits, routines, established practices, rules, or laws that regulate the relations and interactions between individuals, groups and organizations" (Edquist and Johnson 1997). "Institutions are the rules of the game", according to North (North 1990: 3), and their main function is to "reduce uncertainty by establishing a stable (but not necessary efficient) structure to human interaction" (Ibidem: 6). Because institutions influence the way individuals, firms and organisations behave, relate to each other, learn and use their knowledge, they affect the emergence of innovations. Institutions have been rightly termed the "missing link" in the study of economic, political and social systems. The NIS approach thus highlights that actors do not innovate in isolation but within continuous interactions with other organizations in the system (at regional, national and supranational level). Their coordination of innovative activities involves two dual and concomitant processes, i.e. flows of economic resources in transaction and production processes as well as transformation and transmittal of information that shape coordination and behaviour (Norgren and Hauknes 2000: 6). Though a more nuanced understanding of these flows has emerged over the last ten years, their detailed understanding still poses considerable challenges to researchers and policy-makers. What appears certain however is that in evolutionary economic perspective on qualitative technological change and innovation is regarded the most important driver of economic growth.

One of the earliest explicit contributions to NIS theory can be found in Freeman (Freeman 1987) who studied major elements of the Japanese system and thus became the first to use the term 'national innovation system' in published form. In his words a national innovation system is "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies" (Freeman 1987: 1). In the second groundbreaking book on the subject, Lundvall (Lundvall 1992) explained his radical departure from neoclassical economics and the resulting motivation by way of two assumptions: "First, it is assumed that the most fundamental resource in the modern economy is knowledge and, accordingly, that the most important process is learning. (…) Second, it is assumed that learning is predominantly an interactive and, therefore, a socially embedded process which cannot be understood without taking into consideration its institutional and cultural context." (Lundvall 1992: 1). Lundvall identifies NIS as complex, dynamic and social systems "constituted by elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge (…) either located within or rooted inside the borders of a nation state." (Lundvall 1992: 2). This suggests that innovation is no longer an extraordinary event entering from outside and temporarily disturbing the general equilibrium but rather a pervasive, all-around phenomenon of modern capitalism. In all visible essentials, innovation now appears to be a process of interactive learning, not a single discreet event (Lundvall 1992: 8-9). It follows from what has been said that a useful distinction between national innovation systems in a broad sense (encompassing all parts and aspects of the economic structure and the institutional set-up) and a narrow sense (entailing only organizations and institutions involved in searching and exploring, i.e. firm R&D departments, universities) can be made (Lundvall 1992: 12). Lundvall himself suggests that the boundaries of a national innovation system cannot be sharply determined, but seems to prefer the delimiter of national boundaries in contrast to global, regional or sectoral innovation systems.

The next prominent scholar on NIS theory is Nelson (Nelson 1993) who introduces no explicit definition of an innovation system but, unlike Lundvall whose analysis was mainly theoretically informed, Nelson provides 15 case studies from a variety of countries, sandwiched in between a general opening and closing chapter. While venturing discontent with the somewhat abstract and broad concept of national innovation systems, Nelson and Rosenberg sum up their research approach as follows: "the orientation of this project has been to carefully describe and compare, and try to understand, rather than theorize first and then attempt to prove or calibrate the theory" (Nelson and Rosenberg 1993: 4). These three books together are considered the classic foundation of NIS theory, where a lot of the later works are built on.

Other major publications concerned about national innovation systems are summarized in the following portion. Patel and Pavitt (Patel and Pavitt 1994) in an overview article welcome NIS as a serious attempt to define and describe the metrics of intangible investments made by countries and companies and to account for the important differences between countries in the levels of these investments. National innovation systems are defined as "the national institutions, their incentive structures and their competencies, that determine the rate and direction of technological learning (or the volume and composition of change-generating activities in a country." (Patel and Pavitt 1994: 12). Within this approach, and in line with earlier work, the public sector is identified as an important player in systems research about innovative activity. The article concludes with a call for more and better data related to innovation and for more in-depth scholarship on the differing institutional competencies across countries that underpin the economic benefits of learning activities (Patel and Pavitt 1994: 27).

In another seminal contribution to NIS theory, Edquist (Edquist 1997) sums up the basic ingredients of national innovation systems: "Innovation processes are influenced by many factors; they occur in interaction between institutional and organizational elements which together may be called 'systems of innovation'." (Edquist 1997: preface). He also reported that the theoretical foundation of innovation systems research is rather patchy. Conceding that NIS is highly relevant from a policy-making point of view, Edquist points out the lack of conceptual rigour inherent to any new theory such as a systems theory of national innovation systems. In this environment innovation processes occur over time and are characterized by feedback loops, frequent inter- and intra organizational interaction and shaped by institutions. Edquist (Edquist 1997: 14) defines innovation system as "all important economic, social, political, organizational, institutional, and other factors that influence the development, diffusion, and use of innovations". Thus he cautions against an ex-ante inclusion of certain elements of a system. Edquist's work is important in that it complements nicely earlier writings by Freeman, Lundvall and Nelson.

More recent work of Niosi defined NIS as "the system of interacting private and public firms (either large or small), universities, and government agencies aiming at the production of science and technology within national borders. Interactions among these units may be technical, commercial, legal social, and financial, in as much as the goal of the interaction is the development, protection, financing or regulation of new science and technology" (Niosi et al. 1993: 212). Niosi borrowed the terminology of "x-efficiency" (Leibenstein 1976) and concluded in an analogy to firms that national innovation systems are not operating optimally but exhibit a variable level of efficiency, depending on their internal organization and accumulated knowledge.

For the purpose of this study the definition of Metcalfe (Metcalfe 1995) is particularly insightful because he expressively re-affirms government's position at the nexus of policy development and implementation. For him a "system of innovation is that set of distinct institutions which jointly and individually contributes to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artefacts which define new technologies." (Metcalfe 1995: 462-463). Taken together these definitions vary in detail but are broadly informed by three principles. 1) Organizations do not innovate in isolation but in close collaboration with various subsystems the quality and efficacy of which define the overall outcomes of the innovation system (Freeman 1987, Smits 2002). 2). More and very heterogeneous actors are involved in the management of innovation processes (Grimmer et al. 1999). 3) National innovation systems are path-dependent. This "memory" should be taken into account in the course of any analysis (Rosenberg

1976, Hollingsworth and Boyer 1997). And these trends collectively urge government to take the leading role as innovation system builder and facilitator (Smits and Kuhlmann 2002: 12). As such the NIS approach has a systemic perspective on innovation which is mainly the result of various agents' actions and mutual relations/ interactions. This approach reckons that successful innovations depend on long-term relationships and close interaction between the innovative organisation and external organisations and institutions. Moreover, this systemic approach to innovation considers that innovative activities and interactions between innovative agents are strongly influenced by the institutional environment.

Ultimately, governments around the world are faced with the challenge of an increasing sophistication of the technological base at home and abroad. Science is infinitely a more complex thing than policy makers would generally admit. This transformation has led to an upgrading of the means and instruments of S&T policy making itself, and a detailed study covering the governance of the upstream S&T system in Korea will therefore be meaningful to reveal sources of economic competitiveness.

Korea's innovation governance past and present

Economics borrowed the term "governance" from political science, where it used to connote "structures and practices of coordination and control without a sovereign power" (Benz 2007: 1). Governance structures underlying the process of policymaking craft institutions which provide individuals with specific (dis)incentives for their action and thus affect political and economic outcomes (North 1990). Hence, governance is not a synonym for government; the former rather highlights the importance of state capacity and institutional variety (Ebner 2005). More recently, governance was defined as "the capacity of the institutional matrix (in which individual actors, organizations and policymakers interact) to implement public policies, enforce rules and regulations, and to improve private sector coordination" (Ahrens 2002). And de la Mothe aptly characterized governance as "the handling of complexity and the management of dynamic flows. It is fundamentally about interdependence, linkages, networks, partnerships, co-evolution and mutual adjustment" (de la Mothe 2001).

This paper is chiefly concerned about the emerging reference frame of upstream innovation governance. It is argued that there is a) a need for distinguishing different levels of governance (in addition to the classical separation in public and private) and b) a growing academic interest to characterize how STI policies are framed and implemented within countries and regions. Therefore, upstream innovation governance refers to the formal and informal rules, incentives and constraints which shape the interaction of high-level state actors in national systems of innovation. In that it specifically addresses the instruments and mechanisms of priority-setting[5], policy coherence[6] and institutional learning. This is applied to the case of Korea, a country that over the past four decades has experienced distinctive phases in its upstream innovation governance. Throughout the various stages of development, Korea's innovation governance has evolved and improved in lockstep with changes in the external environment and internal needs (Figure 2)

[5] Schlossstein (2007b), Schlossstein and Park (2006)
[6] Schlossstein (2007a)

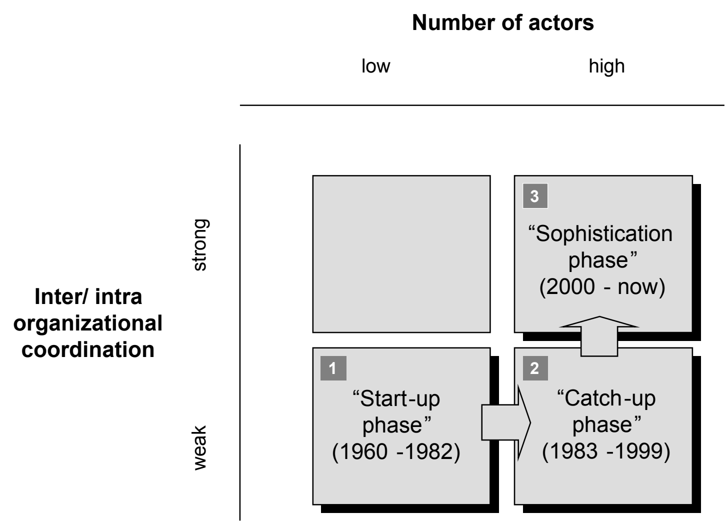

Figure 2: Adaptive evolution of Korea's innovation governance.

At the very beginning, the "Division of Technology Management" in the Economics Planning Board (EPB) was charged with S&T policy making.[7] Under the heavy-handed leadership of President Park Chung-hee the country switched to an export promotion strategy in 1964, after US support was withdrawn, affording Korean companies a chance to upgrade their technological capabilities via exposure to foreign markets and better capitalize on imports that included technology in some form. The choice of appropriate technology and its adaptation required a minimum of indigenous R&D capability. Coinciding with the first five year economic development plan, a full Ministry of Science and Technology (MOST) and the Science and Technology Promotion Law were established, both in 1967. This earned Korea a reputation for being the first developing country with a ministry-level organization for S&T. In addition to trade, science education in secondary schools and universities was initiated. With the basic infrastructure in place, the 1970s can be construed as the growth stage of Korean S&T with the focus shifting to capital and technology intensive industries, heavy and chemical industries, and emphasis on the education of qualified scientists and engineers. In 1973 a Council for Science and Technology (CST), chaired by the Prime Minister, was established and tasked with overall planning of the science system. However, this group was largely ineffective as it met only four times in a decade (Lim 2000).[8] In the second half of the 1970s a number of government-supported research institutes (GRI) were created which for many years formed the backbone of scientific research in Korea.[9]

The development of technological capabilities in the private sector was the policy thrust of the 1980s. A rapid increase in real wages and labor disputes forced firms to firmly embrace technological development. Led by the government, this was achieved in two ways. First, through a reform of tax incentives for private sector R&D,

[7] EPB is a government body credited with engineering Korea's economic growth from the 1960s to the 1980s. It was merged with the Ministry of Finance in 1995.
[8] Later attempts, such as the PCPST, were similarly ineffective. This situation was only remedied with the establishment of the National Science and Technology Council in 1999, under the direction of the president (and no longer the prime minister).
[9] In the early days, GRI employees had the status of civil servants. After 1982, when MOST took control of GRIs, the employees' status changed to researchers.

and second through a national R&D program by MOST in 1982 and by the Ministry of Commerce, Industry and Energy in 1987 which both aimed at the deployment of indigenous R&D capabilities. These new government programs came at a time when the private sector already spent as much on R&D as government and heralded the advent of the "select and concentrate" principle which basically stipulates that government should only act as catalyst for private investment, and not as its replacement ("crowding out"). Major industries of the 1980s included semiconductors, steel, automobiles and shipbuilding which continue to account for much of Korea's competitiveness in the global marketplace.

By the 1990s S&T activity on the government and private levels were greatly expanded as evidenced by the fact that 75% of Korea's cumulative R&D investment was allocated past 1990. Starting with the Highly Advanced National (HAN) Projects in 1992, the first government R&D program in Korean history to be crafted through inter-ministerial consensus-building, the decade saw a three-fold rise in GERD and the emergence of an institutional framework needed to steer the proliferation of science and technology across the board. The focus was firmly on reinforcing high-tech industries, in particular information technologies and semiconductors (Figure 3).

Along with a proliferation of stakeholders, in particular ministries, the "coordinating function" became seemingly weak and ministries continued to push their own vested projects. The Prime Minister, entrusted with overall R&D management, could not effectively remedy this trend, since most of the decision power is in the hands of the president of Korea; S&T statistics and indicators were underdeveloped and government officials lacked crucial knowledge about S&T policies (Hwang and Kim 2000).

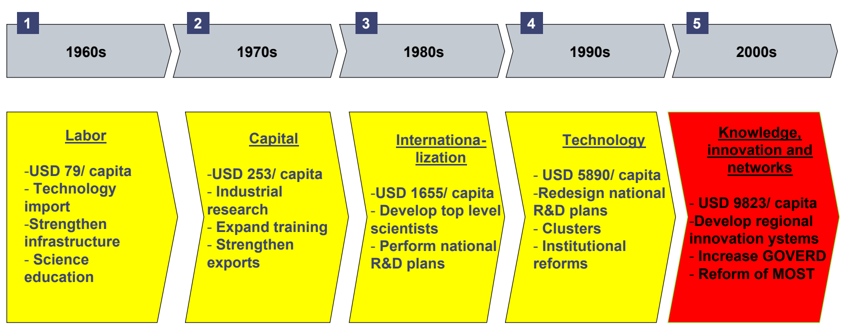

Figure 3: Major development stages of S&T in Korea since the 1960s.
Source: Author.

Although being regarded as a successful model of technological catch-up, Korea is presented with the challenge of transitioning from a catch-up innovation system to a system that truly supports the build-up of an indigenous knowledge base. This can only be achieved through deep institutional reforms that go much beyond funding considerations and ultimately cure the shortcomings of the Korean NIS, i.e. a lack of comprehensive coordination, weak linkages between S&T policies and government budget, excessive competition among ministries, weak evaluation and some overlaps in the missions of the GRIs (Hong 2005). To counter these perceived problems, the Korean government since 1999 has enacted a series of cross-cutting organizational reforms aimed at strengthening coordination among ministries and R&D agencies as well as improving harmony among different policy measures. With the need for horizontal STI policies becoming more obvious, the government in 2004 created a new governance structure build around the hallmarks of integration and coherence (Figure 4). As it entails some elements that have drawn international attention, this new governance structure deserves closer attention.

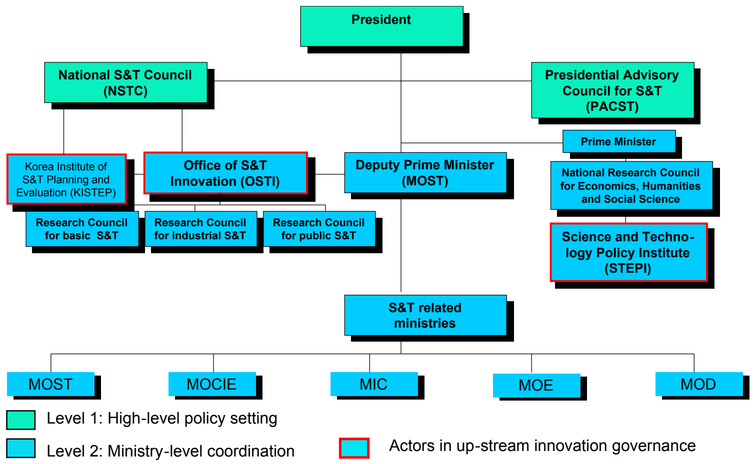

Figure 4: Korea's national innovation system after the 2004 reform (MOST – Ministry of Science and Technology, MOCIE – Ministry of Commerce, Industry and Energy, MIC – Ministry of Communication, MOE – Ministry of Education, MOD – Ministry of Defence).
Source: Author.

The revised five year (2003-2007) S&T basic plan, which was re-edited after the inauguration of the new government in February 2003, proposed the reinstatement of Korea as an S&T nation and it was declared as a major policy goal that Korea's global competitiveness in S&T would reach the 8th place in the world by 2007. Ranked no 6 in technological infrastructure and no 12 in scientific infrastructure by the IMD World Competitiveness Yearbook 2006, Korea is en route to achieving the stated objectives. The basic policy directions of the revised S&T basic plan are advancing the national S&T governance system, select and focus on strategic future S&T areas, strengthen future growth engines (a new government R&D program), strengthen regional innovation systems, create new jobs matching the demands of a knowledge-based society and expand people's participation and spread a general S&T culture. What is new about the revised basic plan is that it defined S&T as being the foundation of society, economy and culture and that it derived concrete policy measures from this point of departure.

Korea's S&T governance is now led by the President who is head of the National Science and Technology Council (NSTC) which was created in 1999 and acts as the highest decision-making body for S&T in Korea. NSTC is tasked with the following mission:

- Formulation and co-ordination of major policy and planning for S&T.
- Allocation and co-ordination of the national R&D budget reflecting the result of the NSTC's review.
- Planning of the mid- and long-range national R&D program, including the New Growth Engines.
- Measures for developing GRIs

While having no standing staff, it is composed of three subcommittees, the Steering Committee, the Special Committee on National Technology Innovation and the Special Committee on Next Generation Growth Engines. Regular meetings are held three times a year and prepared by the Office of Science and Technology Innovation (OSTI), a unit within with MOST serving as a secretariat to the NSTC. Headed by a Vice Minister, OSTI employs 100 staff members drawn from MOST

(50%), from other government ministries (25%) and from the private sector (25%). It is hoped that this unique combination of skills will provide rich perspectives on the future development of STI policies in Korea, but some early pitfalls came to light as some junior officials lacked a proper understanding of the nature of the innovation process (from discussions with MOST staff). OSTI was created on 25 October 2004. OSTI's policy intelligence mainly flows from KISTEP, a government research institute which works almost exclusively for OSTI. Individuals in the two organizations have day-to-day interaction, and KISTEP is regarded as an important repository of knowledge, in particular as regards statistics, for the government. Under OSTI, there are also three research councils for basic, industrial and public S&T which group around ten GRIs each under their leadership and try to evaluate their member institutes as well as avoid duplication of work between them. They command however no real budgeting power. In the words of one council chairman, research councils can only use "name and shame" tactics to expose member institutes weaknesses. The real budgeting power lies with the Budget Office instead.

As a result of this reform, MOST had to transfer the management of all programs concerned with applied R&D or R&D commercialization to relevant ministries. For example machinery, electronics and aero-technology R&D were transferred to MOCIE. However, MOST retained big science, fusion technology and science communication programs in its portfolio. In September 2004, the Minister of Science and Technology was elevated to the position of Deputy Prime Minister, on par with the Ministers of Education and Finance. This underscores yet again the high value which is accorded to science in Korea and more importantly, allows him to effectively coordinate the other 20 ministries with a share in the government R&D budget. This used to be a weak link in the Korean system which has now been cured by the elevation which marks the first such incident of its kind in the world, according to the OECD.

Since 75% of GERD is financed and performed by private firms (one of the highest levels in the world after Luxemburg and Japan) government is concentrating its efforts on support to basic science and on how to best complement business R&D through the deployment of an efficient institutional framework in which different S&T actors collaborate and share knowledgeKorea's. To underscore its commitment to science as an important driver of economic change government increased its S&T budget appropriations by double digit figures each year since 2001, to eventually reach 9.5 billion US dollars in 2007 (Table 1). This budget is allocated to 18 ministries.

Unit: 100 million KRW	2003	2004	2005	2006	2007	CAGR 2003-2007 in %
Grand total	65,154	70,827	77,996	89,096	97,629	8.42%
R&D budget	55,768	60,995	67,368	72,283	81,396	7.86%
general accounting	52,678	57,418	56,612	61,094	65,907	4.58%
special accounting	3,090	3,577	10,756	11,189	15,489	38.04%
Funds	9,386	9,832	10,628	16,813	16,233	11.58%
Ministry of Science and Technolgy	13,143	14,427	19,609	21,691	23,460	12.29%
Ministry of Commerce, Industry and Energy	12,510	13,903	17,673	19,956	21,836	11.78%
Ministry of National Defence	7,693	7,757	9,087	10,618	12,584	10.34%
Ministry of Education	6,878	7,715	8,778	9,672	10,323	8.46%
Ministry of Information and Communication	6,775	6,643	6,972	8,028	7,833	2.94%
Ministry of Agriculture	2,547	2,787	3,044	3,361	3,674	7.60%
Small and Medium Business Administration	1,765	2,120	2,317	2,679	3,600	15.32%
Ministry of Construction	885	913	1,519	2,620	3,278	29.94%
Ministry of Welfare	1,354	1,537	1,657	1,969;	1,808	5.95%
Ministry of Maritime Affairs and Fishing	1,152	1,249	1,406	1,719	1,789	9.20%
Ministry of Environment	1,111	1,264	1,340	1,458	1,678	8.60%
Other	17,055	18,245	13,680	5,013	5,766	-19.50%

Table 1: Development of government R&D budget in Korea, 2003-2007. Source: MOST, calculations by author.

Summarizing the major effects of the 2004 reform to Korea's S&T governance, we conclude that it represents a definite improvement over the status quo ante, especially as concerns the realignment and clarification of policy jurisdictions between ministries (MOST, MOCIE and MIC) and the strengthened coordination function of the NSTC. On the other hand, we have to remain mindful of other problems such as weak university research and underdeveloped ties between private firms and university research labs.

Future challenges for Korea's innovation governance

The world's S&T landscape is developing rapidly, and certainly Korea's neighbours account for a large share of that advance. From today's vantage point upstream innovation governance is challenged from three angles, i.e. effectiveness, efficiency and efficacy.

a) *Effectiveness* concerns the effects of STI policies on growth and employment. Korea will harness full effectiveness only if its innovation governance is constantly fine-tuned and upgraded to reflect the growing interdisciplinary nature of science. The key word in this context used by the OECD is "horizontalization", i.e. the ability of governments to leverage and manage third-generation innovation policies as a cross-cutting, inter-departmental affair. Also due regard has to be given to the shrinking importance of government if it comes to innovation financing (25% public vs. 75% industry financed). Here government needs to assume an "enabling role" complementing private research efforts.
b) *Efficiency* concerns the inner workings of ongoing R&D programs which are numerous in Korea. 21 Future Promising Technologies, Creative Manpower Initiative, 6T Technologies, Next Generation Growth Engines, 839 IT strategy and others. They are typically run by R&D management organizations (such as KOSEF or IITA) that work under the control of specific ministries. Whether this unleashes the full potential for cooperation across scientific domains and across science-related organizations is a much debated question in Korea. It is however safe to say that the rapid proliferation of programs raise the danger of duplication.

c) *Efficacy* (the ability to produce a desired amount of a desired effect) concerns the degree of policy learning and organizational adjustments. For instance, the newly created Office of Science and Technology Innovation (OSTI) is staffed in a unique way (see above). And younger policy-makers increasingly see themselves as adaptive agents. Very recently, a North-East Asia S&T Roundtable was launched, a trilateral forum where Japan, China and Korea discuss S&T matters.

Conclusion

This paper investigated the hypothesis that Korea's economic competitiveness developed in large part thanks to the upstream governance of its national innovation system. We found evidence of institutional learning and organizational improvement over the past 40 years and ongoing. Though Korea in the past relied on an imitation strategy, it would be a mistake to suggest the country would not have needed any NIS. This is a misunderstanding of the NIS concept. Korea climbed from pure imitation over catch up to technology leadership in certain areas (most notably microchips, TFT screens, collaborative online games, cargo shipbuilding). The impending challenge is in the transition to a creative innovation system. In closing let me summarize the strong and weak aspects of Korea's current NIS.

- The 2004 NIS reform is working, but policy horizontalization among ministries could still greatly be improved.
- Strong growth in public R&D budget, but lingering questions about the efficiency of spending
- Number of SCI publications growing rapidly, but their impact factor remains low
- Government keen on promoting science, but number of science students shrinking
- "Hwanggate" (alleged academic misconduct of Hwang Woo-sok) was cleared up with resolve, but cases of plagiarism and idea theft are still reported elsewhere.[10]
- Regional innovation systems are emerging (particularly in Gyeonggi Province around Seoul), but central government accounts for 97% of all R&D spending
- Public research institutes have been greatly reformed in recent years, but the role of the four Research Councils in managing GRIs is still weak (in particular they have no budgeting power).
- In the past the most important research happened in public sector institutes; as a consequence the quality of university research in Korea is rather low (but catching up).
- The Roh Moo-hyun government has called for a more visible role of Korea in world politics, but bilateral or multilateral government science cooperation in North East Asia is not yet properly developed.

This summary is mixed, since every strong point is (partly) neutralized by a weak one. However this reflects well the current state of affairs in Korea, where the transition from "imitation to innovation", a favourite government catchphrase, is well under way. Korea's upstream innovation governance has shown signs of "adaptive

[10] In March, the President of Korea University had to step down after an academic inquiry found him guilty of scientific misconduct.

efficiency" (North 1990) in that it has responded well to external and internal change imperatives.

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