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Adaptive Efficiency: Can it Explain Institutional Change in Korea's Upstream Innovation Governance?

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Curriculum Vitae

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1. Introduction

Institutional dynamics have often been cited in response to the challenging question of why East Asian countries were able to grow so rapidly since the 1960s. While the erroneous neoclassical notion of their governments being hands-off has meanwhile been dispelled, the search for a more general theory of institutional change taking account of the particularities of East Asian countries is still under way. The precise 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] Insights from development economics pointed to a formidable role of government and inspired conjectures to open the black box of policy-making that was hitherto taken as a given (Evans, 1992; World Bank, 1993). Institutional analysis, especially the interplay and effects of formal and informal constraints ("the rules of the game") proposed by Douglas North (North, 1981; North, 1988; North, 1990; North, 1992; North, 1994), lends the right tools to study the policy process and provides promising clues to a better understanding of policy reform processes in the field of science, technology and innovation policies. As Ahrens (Ahrens, 2002a: 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 development."

Although there exist different theories of institutional change, which vary widely regarding their degree of formalization and practical relevance, Douglas North (and his followers) are

[1] Parts of this paper were presented at the 1st Doctoral Colloquium at the Private University of Applied Sciences Goettingen in January 2009. The author would like to thank the workshop organizers and participants for their helpful comments.

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

recognized as being the first to develop a coherent understanding of institutional change grounded in a firm understanding of new institutional economics. In a series of books and articles he set out to explain the performance of economies through time, based on key insights of property rights and transaction cost theories that were applied to the analysis of economic performance. His research was in part motivated by a lack of explanatory power of neoclassical economics that was able to explain economic performance based on differential investments in education, infrastructure and savings, but failed to explain why economies undertake (or do not undertake) those investments in the first place. Institutions determine the payoffs; more broadly institutions are the structure that humans impose on human interaction and therefore define the incentives that (together with the other constraints (budget, technology, etc.)) determine the choices that individuals make that shape the performance of societies and economies over time. While emphasizing the important role of political leadership and ideology, he concluded that institutional change is an endogenous, path-dependent process (North, 1990). Throughout his writings, North argued for a need to relax the strict assumptions of neoclassical economics and called in particular for a (re)-consideration of transaction costs, non-market instruments of resource allocation, and the rationality postulate, and emphasized the constantly changing nature of the environment. These considerations led him to focus on institutional change and the path dependent nature of economic activity from a bird's-eye perspective. However the theory of institutional change can – and should - also be applied more concretely to specific state configurations.

Taking North's theory as a background, this article attempts to shed light on the institutions and organizations that shape and deliver science, technology and innovation (STI) policies in the Republic of Korea (Schlossstein and Park, 2006; Hong, 2005; Kim and Dahlmann, 1992). The country has had little time in making the paradigmatic shift in its national innovation systems from imitation to innovation and adjusting its institutions to the new imperative of so-called third generation innovation policies that anchor science and innovation at the very heart of government action across multiple policy domain (OECD, 2006; Edler et al., 2003). Collectively, the public institutions and organizations that are concerned with fashioning, prioritizing and delivering STI polices in Korea will be referred to as *upstream innovation governance*. Upstream innovation governance is modelled as a subsystem of an overarching national innovation system (Lundvall, 1992). Hence two questions will be fielded: First, who are the players in upstream innovation governance in Korea, and what sort of changes they have been subjected to since the 1960s; second, can their evolution be approximated as "adaptively efficient" according to North and his followers?

In that we argue for the need to distinguish different levels of governance (in addition to the classical separation in public and private). Although questions of governance, both at the corporate and state level, received renewed attention from the early 1990s, the concept has not reached a level of formal clarification or common understanding among economists and political scientists that would make it amenable to a broader application in the context of Korea. It is however important to remember that Korea has grown in large part thanks not only to capital investment, but also thanks to technological change (Kim, 1997). This ascent has fueled a constant redesigning of institutions and organizations governing the delivery of STI policies. The hypothesis of this chapter is that Korea is moving to a governance-mode of policy-making in the field of science, technology and innovation enabled by mechanisms of adaptive efficiency. In short, the country has abandoned its focus on "catch-up" and has instead ushered in new institutions suited to upstream innovation governance. This development was triggered by internal as well as external forces.

2. The big picture of science and technology in Korea

Korea is usually placed 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. 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, 2005b).[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 that time span. 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

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

intensity (R&D as 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. These sizeable improvements in input and output indicators for innovative activity can be explained by a changing technological landscape in surrounding countries and changes in the choice set of available institutions in Korea itself.

3. Distinguishing institutions and organizations in upstream innovation governance

North has rightly insisted on drawing a clear line between institutions and organizations, and we subscribe to that stream of reasoning. For the sake of clarity, let us now spell out our understanding of institutions and organizations. Institutional thought has dominated economic and political science thinking since the late 19th century. While there is broad agreement among institutional economists that the economy is "instituted" (Polanyi, 1957) over time, the exact mechanisms of institutional change in upstream innovation governance have not yet been established. Institutions play an important role in reducing uncertainty and devising rules for inter-personal exchanges (North, 1990: 3). Every society and economy is governed by institutions to some degree that both shape and frame human interaction, the state and how players in the innovation system relate to each other, i.e. institutions steer human behavior in a certain direction (McKelvey, 1997; Edquist and Johnson, 1997). Institutions are operationalized both formally (e.g. through laws, contracts and codes of conduct) and informally (e.g. through routines, societal conventions and customs). While the latter type of institutions needs an explicit act of creation and is typically subject to enforcement by the public administration (legal system or police), the latter variant simply emerges over time as a result of continuous human interaction and reflective of the fundamental values of a society (Ahrens, 2002b). In his cross-cutting review of institutions, Langerfeld (2003) further refines the Northian approach by introducing different levels of analysis such as self-emergent vs. constructed, fundamental vs. derived and inherently stable vs. those institutions that need constant enforcement in order to be maintained. It is generally assumed that informal institutions show substantial inertia and change only incrementally (Murrell, 1994).

[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.

Understanding institutions and their impact on economic growth requires appreciation of complexity, continuity and evolution across space and time. The question for most NIE scholars is "not how things stabilize themselves in a 'static state', but how they endlessly grow and change" (Hodgson, 1998: 188). At the very basis, this necessitates an enhanced understanding of the differences between institutions and organizations which are often used interchangeably used in non-expert parlance. The NIE refer to institutions as normative rules and addresses questions of how they emerge and prosper or institutions that are applied to understand organizations, especially the firm as an economic institution (Ahrens, 2002a: 50). This study follows the widely agreed conception that institutions are the rules of the game in a society and an economy, "the humanly devised constraints that structure human interaction. They are made up of formal constraints (e.g. rules, laws, constitutions), informal constraints (e.g. norms of behavior, conventions, self-imposed codes of conduct), and their enforcement characteristics. Together they define the incentive structure of societies and specifically economies." (North, 1990: 3).

More concretely, institutions are "sets of working rules that are used to determine who is eligible to make decisions in some arena, what actions are allowed or constrained, what aggregation rules will be used, what procedures must be followed, what information must or must not be provided, and what payoffs will be assigned to individuals dependent on their actions (…). All rules contain prescriptions that forbid, permit or require some action or outcome. Working rules are those actually used, monitored and enforced when individuals make choices about the actions they will take." (Ostrom, 1990: 51).

There is reasonable unanimity among NIE scholars as to the role of institutions which as their most basic characteristic include enforceable norms, rules and behaviors that serve collective purposes and structure and constrain social interaction (Ahrens, 2002a: 51). More broadly, institutions structure inter-relations and exchanges and provide a yardstick to understanding what other people are doing and why. Based on an extensive review of the institutionalist literature, Scott (Scott, 2001: 48) describes institutions and their roles as:

- Social structures that have attained a high degree of resilience;
- Composed of cultural-cognitive, normative, and regulative elements that, together with associated activities and resources, provide stability and meaning to social life;
- Transmitted by various types of carriers, including symbolic systems, relational systems, routines and artefacts;

- Operating at multiple levels of jurisdiction, from the world system to localized interpersonal relationships; and
- Connoting stability but being subject to change processes, both incremental and discontinuous.

Others have suggested that "long-term institutional changes are path dependent, deriving from the specific adjustment path the economy takes towards them" (Setterfield, 1993: 761). The path of institutional evolution "is shaped by (1) the lock-in that comes from the symbiotic relationship between institutions and the organizations that have evolved as a consequence of the incentive structure provided by those institutions and (2) the feedback process by which human beings perceive and react to changes in the opportunity set" (North, 1990: 7).

By contrast organizations embody the personal side of institutions (Schmoller, 1900/1904: 61), they are the "players" as opposed to the "rules of the game". Organizations encompass a group of individuals that is collectively organized and whose interaction is enabled and constrained by a given set of institutions. In upstream innovation governance, organizations refer to the public administrative offices (such as ministries, research institutes, universities), whereas institutions refer to the formal and informal rules, procedures, norms and codes that govern the interaction between these organizations. In this study, organizations are construed to be an embedded part of the larger regulative systems of institutions.

One of the central propositions of the new institutional economics is that rational agents have self-interest in building and sustaining efficient institutions in order to govern their strategic interactions (Williamson, 1985). These distinctly crafted institutions, which have attracted the attention of economists for the past 20 years or so, then shape individual behaviour. Applied to the context of development and transition countries, we can observe a growing concern about *governance* (as opposed to government) as a major factor in explaining why some economies do not narrow the gap between their actual and potential rate of development. The process of economic development necessitates an institutional structure that designs and implements science and technology policies.

4. Measuring change in upstream innovation governance

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. Hence, governance is not a synonym for government; the former rather highlights the importance of state capacity and institutional variety (Ebner, 2005). The concept of governance has been discussed under many facets and became fashionable in many scientific disciplines, including but not limited to political science, economics, and information technology. Sloat (2002) noted that governance is currently applied to "everything from corporations to rural society" and the academic literature on the subject is relatively disjointed although the reconnection in the 1990s of the studies on networks in policy-making with works on national innovation systems has spurred a rethinking of governance in network terms and its ramifications for the joined-up government debate (de la Mothe, 2001; Edler et al., 2003). From a bird's eye perspective, its practical value rests in providing a framework to fathom the changing processes of governing, and the ensuing incidents of adaptation, learning and experimenting with the state acting as a moderator (Stoker, 1998). For purposes of clarity, we draw a clear distinction between public governance (related to the institutions and organizations of a state apparatus) and corporate governance (related to the decision-making mechanisms within private corporations). We focus exclusively on the former. The renewed interest in national innovation systems from the 1980s has quickly fielded the question of the role of the state in constructing and perfecting NIS, as far as they lend themselves to purposeful interventions (Bach and Matt, 2005). Though governance has only recently been explicitly evoked in the context of national innovation systems, it is evident the concept holds great promise in furthering our understanding of upstream innovation governance (OECD, 2005a; Boeckholt, 2004).

It was in fact the World Bank (World Bank, 1993) which helped the term 'governance' to become prominent and has since been regarded as a powerful approach in theory and practice to overcome the minimal-state doctrine of the 1980s and to integrate non-economic stumbling blocks on the road to economic development in the overall challenge of how to frame issues of state capacity and capability related to policy reform. However as governance became more prominent, it also became conceptually blurred. In a recent study Ahrens (2002a: 120) found a "confusing variety of definitions which greatly differ with respect to issues, problems, or objectives". It is therefore save to assume that there has not yet been any universally accepted definition put forward, even though there is a growing awareness that the quality of a country's governance – and particularly its innovation governance – is a key determinant of economic growth and sustainable development (Hjelt et al., 2008; Fagerberg and Srholec,

2008). There are at least three basic approaches that are helpful to approach the term governance from a conceptual perspective (see also (Ahrens, 2002a: 121-128)):

a) One stream of literature views democratic government as an unalterable pre-condition for successful policy reform. Proponents often resort to the notion of "good governance" as a shortcut label for state representatives who are elected in free and fair contests and countries that are more or less abiding by the principles of human rights, fair justice and low levels of corruption. This way of conceptualizing governance however is empirically not well supported, may lead to unnecessary political references and reduces the debate to "small versus big government" when in fact the *quality of government* is the focal issue. Again Korea is a point in case: the country has experienced two totally different forms of government, an authoritarian from 1962-1987 and a democratic one after 1987. Throughout those years, its upstream innovation governance has developed and perfected itself without being really influenced by the transition from autocracy to democracy. So there is a need for a debate about governance that goes beyond the broad dimensions of democracy and autocracy and focuses on development and innovation-specific challenges, resources and capabilities that shape a country's transition pathway. What is needed is an approach that zeroes in on the specific characteristics of the government apparatus such as rationality, efficiency, and technocratic capability which insulates public policy making from excessively strong business interests (rent-seeking).

b) A second approach to governance is based on informal institutions shaping individual behavior and providing incentives/ disincentives for action. Adherents to this school have stressed the impact of culture, habits and traditions on the outcome of policy processes and governance configurations while recognizing the role of trust and personalistic relationships in economic and political transactions (Granovetter, 1985). With reference to Korea, authors have at various occasions dwelled on those basic characteristics of Korean individuals that they perceived as differentiating this group from others: a work ethic that stresses dedication and perseverance, a determination to overcome challenges, and a constant benchmarking of foreign countries leading to improved outcomes at home (Yun, 2007; Kim, 1997). Though it is next to impossible to quantify the precise effects of cultural traits on the development of upstream innovation governance, they could play a role in so far as they represent a society's

commitment to learning and progress and a fertile ground for government to place demands on its own people in the early stages of economic growth.

c) Another perspective evokes the replacement of traditional "powers over" with contextual "powers to" (Pierre and Peters, 2000), implying a shift from the top-down legislature approach which attempted to regulate individual and organizational behavior in a detailed way to 'governance', which attempts to set the parameters for people and institutions that are following self-imposed rules to achieve desired outcomes. This stance is prevalent in the debate about the modernization of policy systems "from government to governance" which often implies a switch from constraining to enabling factors. This can also be seen as a characteristic feature of upstream innovation governance, where government and its agencies interact in a joined-up mode with blurred boundaries, a multitude of actors and a focus on process rather than on output. Bache (2003) found that governance is generally implying an increasingly complex set of state-society relationships mediated by networks rather than hierarchies in the policy-making process. He concluded that in this situation the government's role is increasingly modified to become one of co-ordination and steering. Korea is a good example for that shift. A major reason for that shift may be the fact that in an increasingly complex and multifaceted world, no single actor has the necessary knowledge and resources to address problems unilaterally and independently (Kooiman, 1993). In summary, this perspective focuses on how to co-ordinate multiple, state and non-state actors and organizations in an environment where the powers of government are no longer clearly distributed but result from intelligent sharing of responsibilities and co-ordination.

As we have seen, theories of governance are intellectually rooted in a range of disciplinary perspectives and operate at multiple levels. No single definition that would fit all facets of the 'governance problem' can be put forward at this point in time. Governance is therefore a term that takes different meanings in the hands of different authors. Stoker (1998) suggests that governance refers to the blurring of boundaries between and within public and private sectors. He further offers five propositions related to governance which are also cornerstones of our analysis: (1) Governance refers to a set of institutions and actors that are drawn from but also outside government; (2) Governance identifies the blurring of boundaries and responsibilities for tackling social and economic issues; (3) Governance identifies the power dependency involved in relationships between institutions involved in collective action; (4) Governance is

about autonomous self-governing networks of actors; (5) Governance recognises a capacity to get things done that does not rest on the power of government to command or use its authority. It sees government as able to use new tools and techniques to steer and guide. All this means that government loses it "power monopoly" and will have to rely on informed inputs to the policy process from various purpose-built organizations, i.e. government research institutes in the field of STI policies.

In a recent white paper, the European Commission used the following definition for the term governance: "'Governance' means rules, processes and behavior that affect the way in which powers are exercised at European level, particularly as regards, openness, participation, accountability, effectiveness and coherence." (Commission of the European Communities, 2001: 8) It can be deduced from this definition that the concept of governance allows for a larger community of actor to have influence on the outcome of strategy formulation processes and the allocation of budgets and tasks. In that vein, Pollit and Bouckaert conclude that as governance becomes more widespread, "the boundaries between individual institutions become less significant than the question of how the whole ensemble dances (or fails to dance) together." (Pollitt and Bouckaert, 2000). The 'ensemble' can be re-interpreted as upstream innovation governance, where the actors represent organizations and their links and relationship are called institutions. Thus in upstream innovation governance policy per se is not the major analytical concern, it is rather the interplay of various actors that together determine the strategies, activities and outcomes of innovative processes. Like any other policy, STI policies need an institutional and organizational underpinning supporting their design and delivery. We shall therefore define upstream innovation governance as the capacity of a country's institutional matrix (in which national and sub-national ministries, public research institutes, science councils, research funding agencies and policy makers interact with each other) to prioritize, devise and implement science, technology and innovation policies and improve public-sector co-ordination (Figure 1).

Figure 1: Korea's upstream innovation governance (framework based on Boekhold 2004). Note: Organizations marked in grey were added in the course of institutional change since the 1960s.

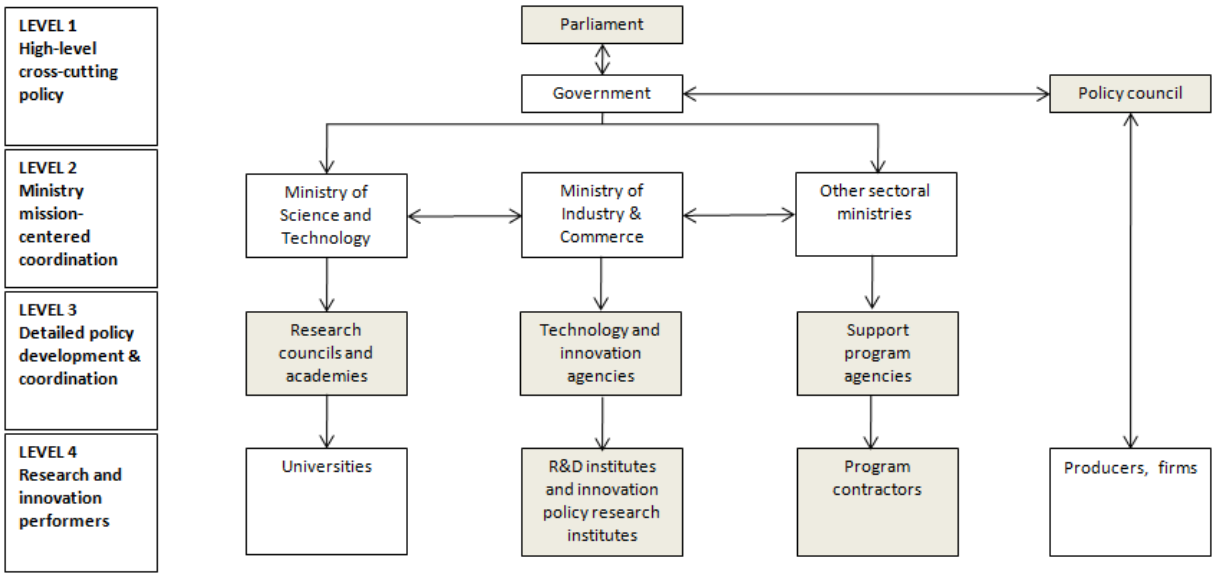


Figure 1 presents a dynamic perspective on the evolution of organizations (the "players") in the upstream innovation governance of Korea. Two major trends can be discerned: a) the number of organizations (ministries, research councils, STI policy research institutes etc.) has greatly increased over the course of time. Owning to institutional inertia, the early-day organizations from the 1960s are largely still in place today, although of course they have been greatly remodeled and complemented through other organizations on a horizontal or vertical level; b) the institutional linkages between the players became more complex, owing in large part to a changing set of challenges to which Korea was subjected as a nation. While change in organizations is relatively easy to observe and interpret, North and others reminded us of the importance of institutions that shape human interaction and provide the rational for organizations to come into being.

To approximate institutional change, we will apply a framework drawn up by Feron and Crowley (2003) who suggested a multidimensional approach in studying the changing challenges and properties of STI policies. Though the choice of dimensions inevitably involves some judgmental biases, the two authors offer five criteria to measure the development of a governance-style polity.

a) *Priority setting*: the process through which priority goals for state action are defined should be autonomous at least theoretically and be responsive to public debates and internal state issues.

b) *Funding*: government should engage in basic funding (to maintain the operation of public research institutes and universities), competitive funding (to identify centers of excellence) and partnerships between the private and public sector, e.g. privatizations, to limit state meddling with research actors through co-funding from the business side.

c) *Recruitment* should be on a fixed-term basis or regulated by internal competition informed by a broad market perspective.

d) *Evaluations* of research should be performed by members of the research sector but must be formally and institutionally be located external. For example, evaluations should be conducted not by colleagues but by peers, including peers of another nationality.

e) *Internationalization* is regarded as a "lever" of state activity especially in the fields of promotion and funding.

On each of these dimensions, we can discern visible progress in Korea since the foundation of its upstream innovation governance in the mid-1960s.

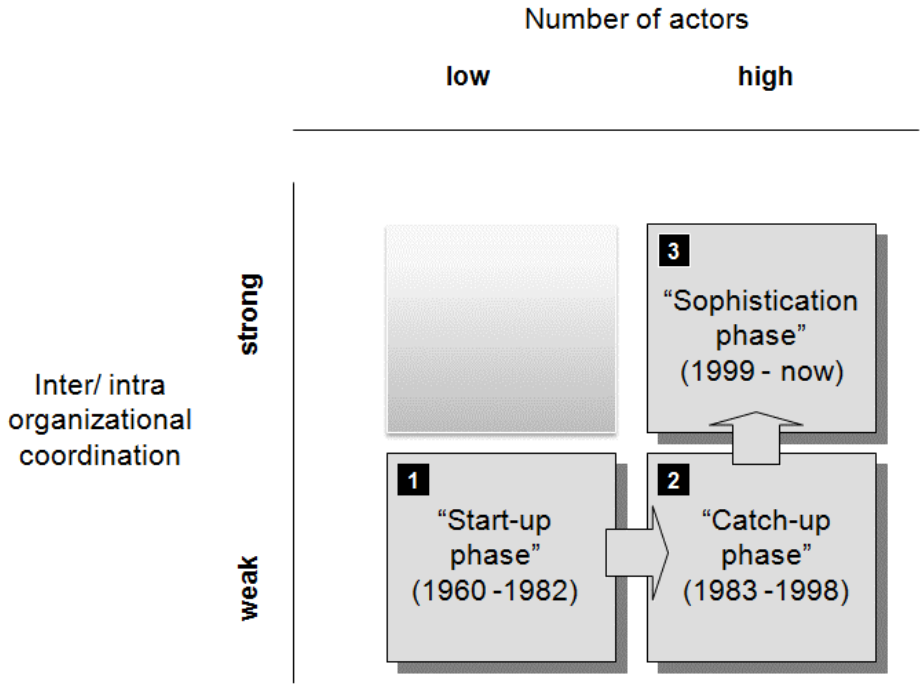
Table 1: Evolution of Korea's upstream innovation governance using the metrics developed by Feron and Crowley (2003). Source: Author.

Dimensions	**Early procedures and mechanisms (1960-1980s)**	**Current mechanisms and procedures (since 1990s)**
Priority setting	Ad-hoc and driven by external challenges	Increasingly driven by internal needs: foresight studies since 1993[5]
Funding	Heavy reliance on direct public funding of research	Trend towards partial public funding
Recruitment	Researchers in national institutes were lifetime public officials until the early 1980s	Researchers in national institutes are appointed on merit with labor contract extension subject to research performance; universities becoming much more rigorous in their selection of tenured professors
Evaluations	Not usually performed	Performed annually by the science councils with a "name and shame" tactic, individual researchers are expected to publish SSCI-grade papers, every research institute organizes an internal research rating system (a five point scale)
Internationalization	Low number of international conferences held in Korea, very few SSCI papers with Korean (co)authors, few international scholars doing research in Korea	Internationalization and openness of Korea's scientific communities have greatly improved, evidenced by a rapidly growing number of SSCI publications

[5] On foresight studies in Korea see Schlossstein 2007b, Schlossstein and Park 2006.

Korea's evolution of upstream innovation governance can therefore be re-interpreted as a three-part narrative along two axes, i.e. the number of actors ("organizations") and their degree of inter- and intraorganizational coordination ("institutions"). See Figure 2.

Figure 2: Three stage narrative of Korea's upstream innovation governance. Source: Author.



The 50 years of history condensed in figure 2 clearly highlight the process of co-evolution between institutions and organizations. So what then happened in Korea? At the very beginning, the "Division of Technology Management" in the Economics Planning Board (EPB) was charged with S&T policy making. Under 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.[6] 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

[6] The Ministry of Science and Technology gained full cabinet-level status only in 1998.

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). 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.

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, 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 (Chung, 1999). 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. The year 1982 marks a turning point in several respects: first the majority of public research institutes were re-organized as sub-entities under their respective ministries and the second researchers were no longer contracted as public officials. Interestingly, the shift to democracy in 1987 under General-turned-President Roh Tae-Woo did not prompt any discernible changes in upstream innovation governance lending further support to the argument that 'governance' has nothing to do with the style of government (i.e. democratic or autocratic).

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 (Schlossstein, 2007a). 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 and aided by technology foresight techniques, the decade saw a three-fold rise in GERD and the emergence of an elaborate 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. It was mainly through the rapid growth of the private sector that the upstream innovation

governance had become the object of discussion. Among the reasons cited in favor of a system-wide re-shuffle was a proliferation of stakeholders, in particular ministries that resulted in weak coordination since ministries were primarily pushing their own vested projects. The prime minister (who is tasked with day-to-day running of government affairs in Korea) was entrusted with overall R&D management, but 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). 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. As it entails some elements that have drawn international attention, this new governance structure deserves closer attention.

The election of President Kim Dae-Jung from the Democratic Party in 1998 helped to spur needed change in upstream innovation governance that was further facilitated by the Asian financial crisis which alerted many Koreans to the importance of knowledge about financial systems and brought into the limelight the failures of their own government in preparing to whither off the crisis. This reform was much more encompassing than previous ones: not only did it relegated responsibility for S&T policies back to the president but it also ushered in new organizations, chief among them the National Science and Technology Council (NSTC). The NSTC 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 government research institutes

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 with considerable participation of the private sector which makes up to 50% or committee members. This system was further refined in 2004, helped by the new "people's government" agenda of President Roh Moo-Hyun who had succeeded Kim Dae-Jung in January 2003 (Seong and Song, 2008; Schlossstein, 2008). In the course of 2004, the minister of science and technology was elevated to the position of deputy prime minister. This underscores yet again the high value which is accorded to science in Korea and more importantly, and allowed 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 of the ministerial rank. His ministry, the MOST, was effectively divided in two parts. The new unit, called Office of Science and Technology Innovation (OSTI), was staffed with 100 employees drawn from MOST (50%), from other government ministries (25%) and from the private sector (25%). It was 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[7]. OSTI's major work consisted in supporting the NSTC's work and preparing its decision-making. It also controlled three of the five (later reduced to four) science councils of Korea. OSTI's policy intelligence mainly flows from the Korea Institute of Science & Technology Evaluation and Planning (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. The councils on their part had around ten research institutes under their supervision without however wielding the power to make budget adjustments based on the numerous evaluations they carried out. In the words of one council chairman, research councils can only use "name and shame" tactics to expose member institutes. Budget decisions remain a preserve of the Budget Office. 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.

[7] This insight comes from a personal conversation with a senior official in MOST.

Since 75% of GERD is financed and performed by private firms (one of the highest levels in the world after Luxemburg and Japan, (OECD, 2006)) 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 knowledge. 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 9.8 trillion Won in 2007[8]. (see Table 2) 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 that have started to also attract government's attention.

Table 2: Development of goverment budget for research and development in Korea, 2003-2007. Source: Ministry of Science and Technology, calculations by author.

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%

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

[8] About a quarter of that amount is earmarked for basic research.

and no 12 in scientific infrastructure by the IMD World Competitiveness Yearbook 2006, Korea is en route to achieving the stated objectives (IMD, 2006). 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 (Schlossstein, 2008).

5. Indicators for "adaptive efficiency" of Korea's upstream innovation governance

The next section will investigate the question whether these changes in upstream innovation governance can be regarded as "adaptively efficient", a new analytical perspective that helps to gauge mainly qualitative changes in governance systems. This analysis will rest on Douglas North's concept of "*adaptive efficiency*", that he mentioned throughout his works, hinting that it should guide policy making without however introducing precise clues or indicators to measure the (non)existence of adaptive efficiency. As a point of departure, economic efficiency is conventionally taken to be *allocative efficiency* (e.g., Pareto, Kaldor-Hicks). That perspective pertains to situations of relative stability where efficiency can be measured at a moment in time. Allocative efficiency is what markets and interest groups do best. North broadens economic efficiency to include *adaptive efficiency* or problem-solving through time: "In allocative efficiency, the standard neoclassical Pareto conditions obtain. Adaptive efficiency, on the other hand, is concerned with the kind of rules that shape the way an economy evolves through time. It is also concerned with the willingness of a society to acquire knowledge and learning, to induce innovation, to undertake risk and creative activity of all sorts, as well as to resolve problems and bottlenecks of the society through time (North, 1990: 80-81). Owing to the rapid economic and institutional advance of Korea, the notion of adaptive efficiency (understood as a set of institutions facilitating change and adaptation) is analytically superior to allocative efficiency which usually is the result of well-established routines and standardization (for example in manufacturing processes on the firm-level). Allocative efficiency is primarily concerned with redistributive activities, whereas adaptive efficiency focuses on productive activities. North recommends that adaptive efficiency should guide public policy (North, 1994).

Developing indicators to measure at least qualitatively "adaptive efficiency" is challenging, but nevertheless worthwhile since it might yield novel insights into the overarching question of why and how Korea was able to put up such an astonishing growth that started from a level below that of many African countries (see Table 3).

Table 3: Criteria to measure adaptive efficiency in Korea's upstream innovation governance, based on North (1990).

Criteria for adaptive efficiency according to North An institutional matrix is adaptively efficient if it….	**Enablers of adaptive efficiency in Korea's upstream innovation governance**[9]
…provides individual actors and organizations with incentives to engage in learning and innovation	*Credible commitment* Early and sustained investment in education, continuously growing S&T budget, S&T budget set until 2012 already, further general planning until 2030
…provides individual actors and organizations with incentives to pursue trial-and-error searches to be made under uncertainty and the elimination of organizational errors	*Accountability* Annual published evaluations pointed to best-practice models, systemic analysis of international trends and their adaptation to Korean reality; heads of government research institutes are newly appointed every two years bringing novel perspectives (and are hence not too concerned about unintended side-effects of their policies)
…ensures feedback mechanisms that aid in identifying relatively inefficient prior action	*Transparency* Even though government is traditionally strong in Korea, it is assisted by purpose-driven policy research institutes that perform important advisory roles and dispatch staff as ministerial advisors; private-sector participation in decision-making at a high-level; connectedness of government and research ('joint-up policy making'); reports of multilateral organizations (OECD, World Bank) on science and technology in Korea were explicitly sponsored by the government.
…encourages the development of decentralized decision-making processes	*Participation* Private sector participation in high-level policy advisory bodies; several "citizen consensus conferences" on the risks of science and technology held during the tenure of Roh Moo Hyun; increasing focus on empowering regional innovation actors
…safeguards the principles of competition	*Predictability* Competitive funding for public research projects; research institutes are expected to cover a certain percentage of their budget through private-sector projects; several ministries are sharing responsibility for science and technology

[9] For a detailed discussion of the dimensions 'credible commitment', 'transparency', 'participation', 'accountability', and 'predictability' see Ahrens (2002a).

6. The changing shape of science, technology and innovation policies in Korea

There has been a process of evolution in the way practitioners and academics have approached and modelled science, technology and innovation policies (STI). Science policy in the Western world was established in the immediate aftermath of World War II, with the main area of intervention and action being just science. In the late 1960s, technology emerged more clearly as an area of concern; and governments sought to ameliorate the impact of technological change on the overall economy and society. From the 1980s onwards, there has been a shift in government policy agencies to a focus on innovation policy. Freeman defined three distinctive periods:

- 1940s and 50s supply-side policies: focused on strengthening S&T capabilities, especially science;
- 1960s and 70s demand-side policies: aiming at creating market needs for technology;
- 1980s onwards: policies designed to provide effective linkages between supply and demand, and to respond to a new technological paradigm based on information and communication technologies.

According to Metcalfe, technology involves much more than science, and innovation involves much more than technology (Metcalfe, 1995). Technology by itself is of no significance unless it is translated into innovation.[10] Broadly speaking STI policies can be defined as a set of mostly government-led instruments and institutions which aid in the domestic generation of technology by systematically stimulating technical progress and enhancing skills and procedures applied in the production of goods and services (Ahrens, 2002b: 445; Manil, 2002: 3). More elegantly Dodgson and Bessant wrote: "Innovation policies aim at improving the capacity to innovate of firms, networks, industries and entire economies. Innovation is a process which involves flows of technology and information between multiple agents, including firms of all sizes and public and private research institutes. Innovation policy's principal aim is to facilitate the interaction and communication among these various actors. (…) Innovation policy is therefore different from science policy, which is concerned with the development of science and the training of scientists, and from technology policy, which has as its aims the support, enhancement and development of technology".

Applying these theoretical considerations to Korea yields an interesting result: Korea is a clear counterexample to the "linear model of innovation" which stipulates a well-defined

[10] Dodgson and Bessant (1996) argue: "It is inadequate to think of innovation in 'technological' terms alone. The process of innovation involves consideration of finance, marketing, organization, training, relationships with customers and suppliers, competitive positioning, as well as relationships between products and processes."

sequence from basic research over to developmental and applied research which seemed to be the only feasible route for early scholars of science and innovation (Bush, 1945). Korea developed differently: from developmental to basic research. Despite the deviations from a prescient theoretical model 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 – a long time government objective – has meanwhile been reached. 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.

7. Conclusion

While putting a premium on institutional effectiveness upstream innovation governance is essentially about state capacity and the resulting quality of government intervention in the supply of innovation (Feeny, 1993). This reframes the debate away from a binary Yes-No-approach to government intervention towards novel perspectives on the quality of intervention (Ahrens, 2002a: 10). While at a lot of academic work targeted the private sector as the main engine of innovation (with a typical focus on aggregate outcomes), the interfaces that link knowledge producers and knowledge users in the *public domain* often remain unclear, partly because data is scarce and access more difficult.

For the Korean case, we can conclude that its upstream innovation governance has been steadily refined in a process of co-evolution of institutions and organizations concerned with STI policy delivery, and we have developed suggestive clues as to why these changes may be in synch with North's postulate of adaptive efficiency. Most of the lasting changes to the system were brought through reform coalitions that resulted from a change in the elected leadership, i.e. the president, through external pressures (such as OECD membership which introduced new accounting and reporting techniques for Korea's S&T investments or the Asian financial crisis), or a combination of both. Reforms that were enacted were mainly in line with the basic principles of governance.

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