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Evolution of Universities and Government Policy: the case of South Korea

Ki-Seok Kwon*

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Abstract This paper investigates the two academic revolutions of the Korean higher education system. Since economic catch-up began in the 1960s, Korea has strongly encouraged the activities of its higher education system to serve industrial development as it has progressed through various developmental stages. At the 'strong regulation' stage, universities focused on the provision of technicians. As the need for higher education grew, the 'massive expansion' stage emerged. Finally, most recently, university research and its direct contribution to the economy have been invigorated by strong governmental support. Possibly, this is due to the fact that the Korean government has strongly controlled not only industry but also academia. As long as other East Asian universities have similar conditions to those of the development of Korean universities, we can generalise this model not only to universities in other East Asian countries, but also to universities in other rapid catch-up countries.

Keyword Academic revolution, universities, government policy, catch-up, South Korea

I. Introduction

Awareness of the importance of academic knowledge for technological innovation is increasing both for policy practitioners and academics. Various policy measures for strengthening university-industry linkages have therefore been implemented not only in developed countries but also in developing countries. However, particularly in developing countries, science policy practitioners are less well-informed as to how best to implement programmes, and how to create legal regulations in order to commercially exploit their academic potential, considering the characteristics of the national innovation system (i.e. universities in those countries have insufficient research resources, and their links to industry are relatively weak).

* Department of Public Policy, Hanbat National University, South Korea; kiseok@hanbat.ac.kr

Within the academic community, the contribution of academic research to industrial innovation has been highlighted within the last few decades. For example, university research is positively related to the R&D intensity of companies (Nelson, 1986), and to firms' invention of new processes and products (Mansfield, 1991, 1998). However, despite some recent attention to the relationship between public science and industrial innovation in developing countries (Nelson, 2004; Mazzoleni, 2003; Albuquerque, 2001; Pavitt, 2001 and 1998), the topic is still relatively unexplored. Furthermore, similar issues, including weak university-industry linkages in developing countries, have only been recently investigated (e.g. Intarakumnerd et al., 2002; Sutz, 2000).

South Korea (hereafter, referred to as Korea) is known as a successful country in terms of its rapid economic catch-up. Several studies have been carried out to explain the process of innovation of Korean firms set against the overall Korean system of innovation (Kim, 1997; Shin, 1996; Amsden, 1989). In contrast, the role of Korean universities in the catch-up process has not been adequately explained, other than some negative comments in the midst of a brief description of the overall Korean innovation system (Kim, 2000; Pack, 2000). Therefore, academics interested in the Korean national innovation system have arrived at the point where they need to focus more closely on subsystems such as universities and publicly funded research institutes.

Thus, in order to clarify the objective of this study, the aforementioned issues will be more intensively examined. The evolution of universities in developing countries has not been sufficiently investigated (Chapman and Austin, 2002). In particular, the evolution of the three main missions (teaching, research and service to society) of universities has rarely been explored in the context of the characteristics of the national innovation system (Hershberg et al., 2007). This study therefore aims to understand the three missions of Korean universities by focusing on the emergence of the second and the third missions as well as the relationship between the two missions, considering the government's policy as well as the idiosyncratic properties of the Korean national innovation system.

In the next two sections, in order to understand the main topic of this research against existing literature, a critical review of previous studies has been attempted, considering the idiosyncratic characteristics of the national innovation system in developing and developed countries. In particular, theoretical issues regarding the emergence of academic research and the entrepreneurial activities of universities are addressed at system level (e.g. the national higher education system).

II. The Emergence of Universities' Research Activities and Contribution to the Economy

The university, as an autonomous community of students and teachers providing education in specific disciplines, is generally regarded as an invention of western society (Charle and Verger, 1989). For a long time, teaching has usually been seen as the main mission of universities since the mediaeval age. Even though scientific research as a profession had been institutionalised outside of universities, it began to be widely formalized as another mission of the universities in the 19th century (Ben-David, 1984). Later, research skills were transferred to students through seminars and training in laboratories rather than through private groups (Charle and Verger, 1989). This change started in Germany with the so-called 'Humboldtian University'. The Humboldtian model can be characterised in terms of the strong autonomy of universities and academics in spite of their dependency on state funding (Martin, 2003; Geuna, 1999).

During the 1980s, many western countries were exposed to a change that influenced the relationship between university and society. Martin (2003) suggests that there were three driving forces for this change: growing competition in global market, tight constraints for government research funding, and the growing importance of science and technology. Therefore, under these conditions, the 'third mission' of universities, that of making a direct socio-economic contribution to society, emerged to become more prominent (Martin and Etzkowitz, 2001). Against this background, in terms of the relationship between universities and society, the Humboldtian social contract has been 'revised'. Guston and Keniston (1994) maintain that under the new social contract, the scientific community is accountable in providing society with a rationale of not only their 'usefulness' but also the 'relevance' of their scientific research for public interests such as national security and the local economy. In this vein, the academic knowledge from university research started to become recognised as an important source for economic growth by public policy makers as well as academics. In order to exploit this academic potential, many industrialised countries have witnessed a policy re-orientation to strengthen the interaction between academic research and its industrial application (Mowery and Sampat, 2005).

However, the above description on the emergence of the two missions can be criticised for being oversimplified. With regard to the historical development of higher education in industrialised countries, the third mission is not totally new; Moreover, different types of universities have coexisted within one country. For example, in the late 19th century, we can find a type of university that dedicated themselves to the third mission, such as technical universities and Fachhochschulen in Germany, which coexisted with Humboldtian universities (Martin, 2003). Furthermore, the above description could be criticised for overlooking the fact that the two missions of universities vary according to the idiosyncrasies of the role and structure of each national system. At the end of the 18th century, France created the Ecole Polytechnique and similar institutions to provide national military technology. In spite of these counter-examples, the simplified explanations of the sequential emergence of the second and third missions of universities provide us with a starting point for understanding the influence of the introduced mission (direct socio-economic contributions to society) on the pre-existing two missions (teaching and research), as we shall discuss in the next section.

III. Academic Research and Entrepreneurial Activities of Universities in Developing Countries and Catch-Up Countries

Nowadays, it is usual to find various institutional forms of higher education outside of western countries where universities are created. However, the role of higher education in developing countries is quite different from that in industrialised countries. Furthermore, if we consider the universities' public function and close entanglement in the national system, universities in developing countries are likely to show their own characteristics with regard to carrying out their three missions. In order to explore these idiosyncrasies, we need to consider some conceptual modifications to take account of the context in developing countries. Accordingly, the existing literature on teaching, research and economic contribution of universities in developing countries, and particularly the relationship between the second and the third missions, is discussed in what follows.

First of all, teaching has usually been the main mission for universities in developing countries as in industrialised countries. However, the accessibility of higher education is quite different in the two groups of countries. According to Trow's definition, most developing countries still remain in the stage of 'elite education' (less than 15% of students of university age enrolled) rather than achieving 'mass education' (up to 50% enrolment rate), while most of industrialised countries have reached at 'universal education' stage with an enrolment rate more than 55% (World Bank, 2000). In OECD countries, more than 55% of students who enrolled in upper secondary education in 2005 entered tertiary education (OECD, 2007). Regarding the generally low level of accessibility to higher education in developing countries, Chapman and Austin (2002) suggest a higher return of investment in primary and secondary education than higher education in those countries as a possible factor.

However, more recently some developing countries have been facing an increasing need for higher education. This is because they are now producing more potential entrants for tertiary education due to a long period of investment in secondary and primary education, and because they are becoming aware that high-quality labour is an important factor for their economic development (World Bank, 2000). In the case of catch-up countries such as Korea and Taiwan, they have produced a considerable number of graduates (particularly, in the fields of science and engineering) based on a rapidly increasing enrolment rate in higher education from the early catch-up stage (Mazzoleni and Nelson, 2007; Mazzoleni, 2003; Hobday, 1993). In this process, overseas trained and highly qualified scientists returning home has been important for upgrading the technological capabilities for the absorption of international technical knowledge (Albuquerque, 2001). In contrast, from the early period of economic development, universities in Latin America focused on the education of a small number of 'professional elite' (particularly, outside the field directly applicable to industry and agriculture) (Bernasconi, 2008; Ribeiro, 1969). The key difference between the Korean and Latin American cases is the scale of provision of domestically trained engineers during industrialisation.

Secondly, various existing studies in the literature addressing academic research in developing countries suggest three characteristics: backwardness of scientific resources, dependence on overseas academia, and isolation of the academic system from the local communities. Regarding the backwardness of scientific resources for research, the academics in the centre lead the main stream of science based on well-equipped laboratories and attracting the brightest students from all over the world, and they operate prestigious international journals in their mother tongue (Altbach, 1991). In contrast, those in the periphery (at the opposite end) tend to copy existing knowledge and have difficulty in producing creative knowledge due to their unprivileged condition (Hershberg et al., 2007). For example, India has the third biggest university system in the world, but most of the universities are suffering from inadequate financial support, obsolete laboratories and small libraries. Although the situation has begun changing recently, it was very hard to find a university with a 'critical mass' in terms of facilities and researchers a few decades ago (Altbach, 1991). Some universities in less developed countries, especially in the Middle East, are expected to meet the needs of society in regard to agricultural research, commerce, health and so on (Akrawi, 1969). Unfortunately, it is still not unusual to find inadequate research capacity and facilities to solve the practical problems of the local area.

In terms of dependency, Shils (1972) maintains that the academics in major universities in the industrialised world are regarded as being located in centre, while those in developing countries are on the periphery. Based on this idea, Shrum and Shenhav (1995) assert that some researchers in less developed countries have strong connections to the ‘scientific core’ in developed countries, so they can be recognised as competent scholars by addressing research topics evaluated as important in the core. Therefore, academic research in developing countries tends to be mainly focused on the interests of the academics’ own global community rather than local needs.

Isolation from other local actors is another characteristic of academia in developing countries. In other words, the relationship between academia and industry in developing countries does not show strong linkages, and this has largely been the case until today (Crane, 1977; Waissbluth et al., 1988; Sutz, 2000; Intarakumnerd et al., 2002). Therefore, some scholars (e.g. Goontatilake, 1984; Shrum and Shenhav, 1995) maintain that the academic activities in less developed countries tend to be isolated from local needs. For example, Bryant (1969) maintains that in developing countries there is some mismatch between the biomedical technology and the diseases of their countries. Moreover, Latin American universities have focused on basic research that is not directly applicable to industrial innovation (Velho, 2004; Thomas, 1999).

However, some studies refuting the ‘linear centre-periphery’ relationship in global knowledge production have emerged. In her case study of the research collaboration between Iceland and Canada, Thorsteinsdóttir (1998) maintains that scientists in a ‘scientific periphery’ or in a ‘small science system’ can carry out their own research in certain disciplines based on exploiting their local advantages. This study shows the possibility that academic research closely related to local demand and industrial development in the periphery can be carried out. Furthermore, concerning the development of science and universities in catch-up countries such as Korea, Taiwan, Singapore and Malaysia, Altbach (1998) stresses the importance of infrastructure (e.g. laboratories and libraries) and the sharing of scientific findings (e.g. through domestic journals and scientific societies) in order to create a domestic scientific system.

Thirdly, in terms of the third mission of universities, the contribution to the local economy through academic research is difficult due to the inadequate research capacity as shown above. In the case of East Asian catch-up countries, it is very difficult to find evidence that university research itself directly contributed to their economic catch-up (Altbach, 1989). Mazzoleni and Nelson (2007) also maintain that the important contribution to catch-up has been the result of the application of knowledge or skills of technical labour in the field of engineering and applied research rather than directly from basic academic research. In a similar vein, Mazzoleni (2003) maintains that in the process of catch-up, the education system is important, because education enables countries to absorb external knowledge and to diffuse knowledge through the national system. He also adds that, in the case of Korea and Taiwan, the exploitation of human resources trained overseas is positively related to the national absorptive capacity.

Recently, developing countries as well as developed countries have witnessed a policy orientation towards strengthening the interaction between academic research and industrial application (Etzkowitz et al., 2000; Sutz, 2000; Dagnino and Velho, 1998). As the economy becomes more knowledge-based, universities' economic contribution to society through the transfer of academic knowledge through formal and informal channels (i.e. human resource training and contracted research) has begun to be emphasised in developing countries as well as in catch-up countries (Altbach, 2004). For example, some public Brazilian universities are increasing their production of patents (Etzkowitz et al., 2005); Furthermore, 1,500 companies have been spun-off from Brazilian universities in the last two decades (Anprotec, 2007). Catch-up countries in Asia such as Singapore and Korea have recently started to commercialise academic research (Hershberg et al., 2007). As a distinctive example, the Singaporean case shows recent efforts to create a strong interaction between the universities' activities and local economic development. In order to support 'strategic' sectors such as biotechnology, medical and financial services, the Singaporean government expanded university enrolment in these disciplines and permitted the establishment of private universities for the first time (Tan, 2004). Furthermore, in the late 1990s, the National University of Singapore (NUS) launched a series of initiatives, including reorganisation of its technology transfer offices to be more 'inventor oriented', creation of a Venture Support unit and provision of seed funding, which encouraged NUS researchers to begin spin-off activities (Wong et al., 2007).

Based on the literature and its discussion above, we can summarise the emergence of academic research and the economic contribution of universities in developing countries and the relationship between the two missions. From this summary, we can put forward a few propositions to help us understand universities and their role in catch-up countries. Firstly, teaching is one of the main missions of universities in both developing and developed countries. In the initial stage, the investment in primary and secondary education provides developing economies with industrial labourers who are literate and have modest skills. However, during the process of the catch-up, the enrolment rates of catch-up countries in higher education (particularly, in science and engineering disciplines) are distinctively higher than those in developing countries. This may be partly due to the catch-up industry's increasing need for technical labour and to the increased income level of households that allows payment of university fees.

Secondly, research as well as the economic contribution of universities in developing countries tends to be limited due to the 'vicious circle' existing in the national innovation system. With regard to supply-side factors, a scarcity of highly qualified researchers and adequate equipment means that universities do not attract industry's attention as collaborators. In terms of demand-side factors, mismatched demand from industry and weak linkages between university, industry and government tend to fail to stimulate the production of application-oriented research to meet local requirements. However, East Asian catch-up countries such as Korea and Taiwan, as well as other developing countries, are more likely to be dependent upon public institutes in the early stage of economic development. As both the global and local economy becomes knowledge-based, scientific knowledge produced by the universities becomes more important than before. Responding to this, governments have been trying to strengthen and harmonise the relationship between university and industry through various policy measures such as laws and public R&D expenditure. For example, in the opto-electronics sector, Taiwanese universities provide expertise in chemicals and materials to the private sector (Mathews and Hu, 2007).

Thirdly, the active role of governments is one of the most influential factors in explaining the relationship between university and industry and between academic research and the economic contribution of universities in catch-up countries (particularly in Asia) (Cummings, 1997). In the initial stage of catch-up, the government often has a strong emphasis on economic development, seeing industry and universities as means to achieve their policy goal (Song, 2002). The government may have chosen several industrial sectors to be supported strategically, and may have encouraged the immediate provision of human resources (particularly in the strategically chosen field of science and engineering) by academia. As academic research capacity increases, public R&D funds are invested in the 'strategic' research areas. For example, in the case of Singapore, the government identified several areas such as biotechnology, electrical engineering, computer science and financial management to be supported for its survival, and invested heavily on research in these areas as well as on the training of human resources (Altbach, 1989).

IV. Korean Universities and National Innovation System

During the last half-century, Korean universities have experienced tremendous changes, both quantitatively and qualitatively. The number of universities, academic faculties, and students increased at a rapid rate compared to other developing countries as well as developed countries. For example, according to the rate of enrolments of each stage, Trow (1974) suggested three stages of development of higher education: elite (less than

15%), mass (between 15% and 50%) and universal education (more than 55%). Based on his definition, Korean higher education has moved from the 'elite phase' to the 'universal phase' within only three decades.

Table 1 Characteristics of Korean universities in three main periods

	Strong Regulation (1960 - mid-1970s)	Massive Expansion (late 1970s - 1980s)	Academic revolutions (1990s - present)
Major policy orientation	- Strong regulation over numbers - Medium-skilled labour - Focus on vocational education	- Policy to meet the needs of the masses - Establishment of research infrastructure	- Deregulation and diversity are strengthened - Encouragement of research and its economic usefulness
Universities' responses	- Limited access to universities - Focus on teaching - Research as an individual activity	- Expansion of higher education system - Open universities and junior colleges	- On-line universities, Credit bank system etc. - Invigoration of research and cooperation with industry

From the early stage of catch-up, the Korean government has been a dominant factor influencing the growth of the university system as well as industry. Particularly through the provision of technically skilled labour as well as qualified scientists and engineers, Korean universities have been continually encouraged to play a role as a human resource supplier for economic growth up to now. In the 1990s, the government adopted a series of policies for strengthening universities' research activities, and recently Korean universities began to be recognized as one of the direct contributors to local economic development.

In this vein, this section suggests a categorisation based on the development of Korean firms as encouraged by the government's industrial policy. The various responses of universities according to their different policy environments as well as the evolving stages of the Korean national innovation system are discussed in this section as summarised in Table 1.

1. Strong Regulation (1960s-Mid 1970s)

In the aftermath of Park Chung-Hee's military coup in 1961, strong regulation over the national system as well as the education sector characterises the 1960s and 1970s (Lee et al., 1998). In this period, acting as a supplier of technical labour was regarded as a main role of the secondary and tertiary education system, especially through vocational education and training, while access to universities was limited (Kim and Lee, 2006; Lee et al., 1998). In particular, in addition to encouraging an increase in the supply of human resources in the field of science and engineering to industry, overall governmental control over public universities as well as private universities was based on strong policy measures such as fixed numbers of students.

After the liberation in 1945 and the Korean War between 1950 and 1953, the reestablishment of the Korean higher education system continued until the '60s as described in Section 3.1. A 5-year economic development plan drafted by the government in 1962 was implemented through various policy measures. At the same time, the government recognised certain problems arising from the '50s 'laissez-faire' education policy, in particular: the heavy concentration of students in the Seoul area, 4-year universities, private universities and the disciplines such as humanities and social sciences (Umakoshi, 1997). To address these problems, the 5-year Education Reconstruction Plan and the Act of Advancement of Industrial Education were drawn up in 1962 and in 1963 respectively. In 1966, the 5-year Plan for the Advancement of Science and Technology was drafted. Based on this plan, the Office of Science Education was established in the Ministry of Education.

The implementation of these plans and laws launched an era of strong government control of the education system. Particularly, according to the Presidential Order no. 2332 in 1965, the fixed number of the students enrolling in tertiary education institutions was to be determined by the Ministry of Education. Based on this order, the government could control the number of graduates not only in a given university but also in specific disciplines of the university; therefore, the university system could be easily mobilised to provide increasing human resources in science and engineering, with decreasing numbers of students in humanities and social science.

Based on the fixed number policy, large national universities in the regions were strongly supported. As mentioned above, the government regarded the imbalanced development between the capital area and other regions as a serious problem stemming from the '50s policies with regard to the economy and education. Therefore, by increasing the quota for enrolled students at regional universities, the government aimed both to reduce the concentration of students in the capital area and to attract them to regional universities. For example, between 1968 and 1978, while the quota of the capital area increased 1.4 times, that of the other regions increased 2.8 times. Moreover, this increase was concentrated in the fields of science and engineering in order to meet the needs of regional industry. This concentration coincided with support for strategic local industry in the third 5-year Economic Plan (1972-1976) (Umakoshi, 1997).

Table 2 Number of students going abroad by discipline and country

Periods	1953 - 1960 (%)	1961 - 1973 (%)
Humanities/Social Science	2,183 (44.7)	3,588 (47.9)
Natural Science/Engineering	1,614 (33.0)	3,177 (42.4)
Medical/Pharmaceutical Science	651 (13.3)	247 (3.3)
Agricultural/ Maritime	124 (2.6)	127 (1.7)
Education, Etc.	312 (6.4)	347 (4.7)
The United States	4,391 (89.9)	6,398 (85.5)
Germany	160 (3.3)	246 (3.3)
The others	333 (6.8)	842 (11.2)
Total	4,884 (100.0)	7,486 (100.0)

Source: MOE (1974), report on students studying abroad, ministry of education

In terms of highly qualified scientists and engineers, the strong dependence on overseas institutions started during this period. In 1950s, the government began to encourage overseas training supported by foreign scholarships and initiated an official supporting programme for students to study abroad in 1954. These initiatives were possible due to U.S aid just after the Korean War. In the 1960s and 1970s, the training of highly qualified scientists and engineers was motivated by both the government initiatives and by individual demand for higher education at overseas institutions (Kim, 1997). Half of these students were in the field of science and engineering, and most students went to the institutions in the US, as shown in Table 2.

2. Massive Expansion (Late 1970s-1980s)

In the aftermath of the coup in 1980, General Chun Doo-Hwan succeeded Park Chung-Hee. In the light of the vulnerable political legitimacy of the government, a series of distinctive reformations of the education system as well as in the other areas were implemented (Lee et al., 1998). The most significant characteristics of this period are the massive expansion and the relaxation of previous strong regulation of the university system in order to meet the explosive demand for higher education (Kim and Lee, 2006). However, the expansion occurred mainly in terms of the number of students in non-technological disciplines such as humanities and social science, whereas in the previous period, vocational training in the fields of science and engineering was stressed (Cho et al., 2002).

Around the end of 1970s, the strong regulation policy based on fixed numbers of students faced a few challenges due to the explosion in demand for higher education. For a long time, personal education had been considered as a significant factor for the success of members of Korean society, something that can be traced back to Confucianism (Lee, 2006). Furthermore, as the national economy grew, households accumulated enough wealth to pay for tuition fees, and industry came to need more qualified human resources. More directly, the sudden increase of potential entrants (i.e. graduates from secondary education) in the previous period also contributed to the explosive demand for tertiary education. Therefore, the demand for higher education increased throughout the society (Lee et al., 1998). Responding to these increasing demands, the quota or fixed number of students in higher education institutions was increased from 78,615 in 1978 to 185,065 in 1979, a 250% increase (Kim and Lee, 2002). Considering the much smaller increase from 45,000 in 1969 to 66,000 in 1977, this was a remarkable increase. During the 1980s, the number of students enrolled in higher education institutions increased from 0.57 million to 1.49 million, and 10 new universities were established. Moreover, the form of control policy focused on fixed numbers shifted from the number of entrants to the number of graduates in 1981, allowing the number of freshmen for each university to increase.

Table 3 Increase of number of postgraduate students

Year	Master program	Doctoral program	Total
1970	6,112	518	6,640
1975	12,351	1,519	13,870
1980	29,901	4,038	33,939
1985	57,698	10,480	68,178
1990	72,417	14,494	86,911
1995	93,993	18,735	112,728
2000	197,436	32,001	229,437
2005	238,753	43,472	282,225
2010	263,100	53,533	316,633
2014	260,897	69,975	330,872

Source: Korean educational statistics service (http://kess.kedi.re.kr/)

With the increase in the number of students and institutions, structural changes in the university system became possible. In the 1980s and 1990s, new forms of higher education institutions were created, whereas in the 1970s, the need for higher education was met mainly through increasing the size of existing institutions. For example, the 2-year air and correspondence colleges and 2-year teacher-training colleges were upgraded to 4-year national universities. The specialised higher schools aiming to provide qualified industrial labour, which had been established around 1970, were upgraded to formal short-term higher education institutions in order to meet the demand from both citizens and industry (Umakoshi, 1997). New forms of institutions such as open universities were introduced in 1982 and various bachelor degrees were launched for students opting for a self-study route.

Around the late 1970s, certain conspicuous changes started to emerge with regard to graduate education (Woo, 2002). The number of graduate students was abruptly expanded, as shown in Table 3. In 1970, the number of students enrolled in graduate schools was only 6,640, which amounted to 3.7% of all students in higher education institutions. However, in the 1980s, the increase of postgraduate students in domestic institutions was faster than that of undergraduate students, whereas in the 1970s, most doctoral degrees had been earned abroad except for medical doctors (Umakoshi, 1997). Furthermore, certain changes in military service speeded up these trends. For example, shorter military service as an officer for graduates of master's programmes was introduced in 1981, and highly qualified scientists and engineers were exempted from the military service in the same year. As a result, the proportion of postgraduate students in higher education institutions increased to 6.6% in 1993. This formed part of the background of the 1990s' invigoration of academic research in Korean universities.

3. Research and Economic Contribution (The 1990s-Present)

Research invigoration: 'the first Korean academic revolution' in the 1990s

Research had begun to be stressed as one of the main missions of universities since the early 1990s by the science and technology policy community, which consists of public officials, scientists and academics related to the field. Accordingly, the government began to establish policy measures encouraging universities to provide innovative knowledge in order to raise the technological capacity of Korean industry. Simultaneously, the main role of public research institutes was re-oriented to 'future-oriented large complex advanced technology development' (Yim and Kim, 2006). Furthermore, national R&D programmes were diversified and expanded by individual ministries without strong coordination among the ministries (Song, 2002). This section summarises various policy measures to support research activities in universities, including various laws, R&D programmes, and other institutional changes.

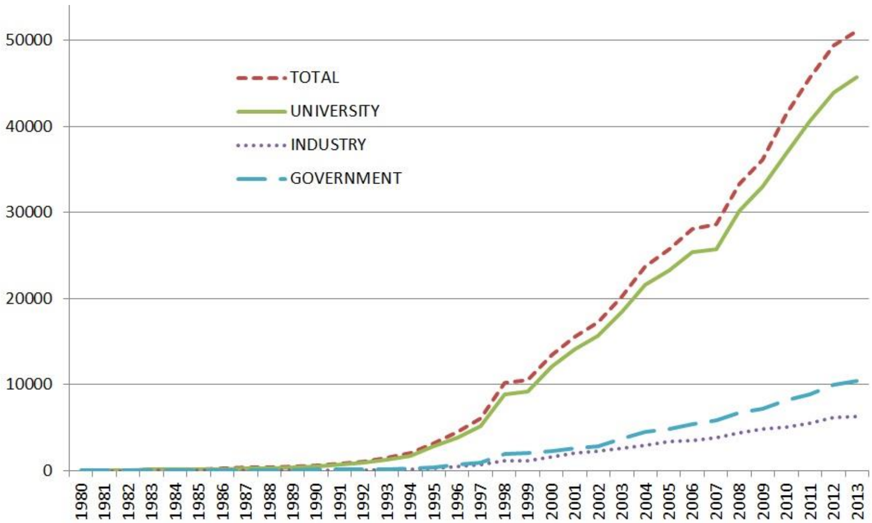
Firstly, in order to establish an infrastructure for basic research, the government enacted 'the Basic Science Advancement Law' in 1989. According to this law, 'the master plan for advancement of basic research' was drafted. On the other hand, in its final report to the President, PACST (the Presidential Advisory Council on Science and Technology) maintained that national science policy goals needed to be re-oriented to invigorate basic research capabilities (PACST, 1990). This led to the creation of 'the Implementation Plan for Innovation in Science and Technology' in 1991, which suggested various policy measures, such as fostering excellent research groups and establishing university laboratories.

Secondly, in addition to the establishment of the infrastructure mentioned above, the research activity of academics was strongly supported through various programmes implemented by KOSEF (the Korea Science and Engineering Foundation). Some of the most successful programmes to support academic research were: SRCs (Science Research Centers) / ERCs (Engineering Research Centers) and RRCs (Regional Research Centers) created in universities by KOSEF and MOST (the Ministry of Science and Technology). On the other hand, the creation of university laboratories was encouraged by MOE (the Ministry of Education) through financial support, and MOIC (the Ministry of Industry and Commerce) established TICs (the Technology Innovation Centers).

Furthermore, as briefly mentioned in the previous subsection, the massive increase in postgraduate students is another characteristic of this period. The 'Brain Korea 21' programme (hereafter referred to as BK 21) was launched based on 'performance contracts' in order to support university researchers, particularly postgraduate students.

Thirdly, in order to support various R&D programmes, huge amounts of funding have been invested in the university system through national R&D programmes operated by the ministries. In other words, most of the source of university R&D expenditure has been dependent on the government. Furthermore, the way of allocating the funding of these programmes has changed since the 1990s. University researchers have to compete not only with their colleagues in academia but also with researchers in governmental institutes to obtain the funds and to carry out the research proposed by government, whereas in the previous period research funds were allocated based on the number of academics in each university (Cho et al., 2002).

In terms of the number of publications in SCI (Science Citation Index) journals, a sharp increase can be observed after the early 1990s, as shown in Figure 1. This change is likely to be closely related to the policy measures regarding Korean universities as one of the main actors providing knowledge in the national innovation system as presented. Accordingly, the 1990s is a period of the first academic revolution in the Korean academic system.



Source: Data based on KRF (2014) and Park (2001)

Figure 1 The number of publications on SCI journals by sectors

Stress on direct contributions to the economy: the 'second Korean academic revolution' in the 2000s

There have been a large number of policy measures supporting cooperation between universities and industry including various government programmes and laws since the 1960s. However, the policy measures before 2000 were mainly focused on the training of industry-oriented human resources and were based on government-initiated R&D programmes (Park et al., 2007). Around 2000, as the research capacity of universities increased, various governmental and university efforts particularly focused on the exploitation of academic research potential have been implemented. Against this background, this subsection examines the efforts of both government and university authorities to invigorate university-industry linkages. These efforts can be categorised into several areas: enactment of laws, national R&D programmes, national plans, and the other institutional changes including those to the university system.

First of all, the government created new laws and amended existing laws in order to encourage the exploitation of academic potential. The specific laws invigorating university-industry cooperation are as follows: the Promotion of Industrial Education and the University-Industry Cooperation act (1963), the Promotion of Technology Transfer Act (2000) and the Promotion of Invention Act (1994). Including these, eight ministries have enacted or partially amended a total of eleven laws since 2000.

Based on the amendment of the 'Promotion of Industrial Education and

University- Industry Cooperation Act (1963)’ in 2003, legally autonomous organisations such as university-industry cooperation foundations have been established on university campuses since 2003; as a result, Korean universities have been permitted to create for-profit companies based on academics’ inventions. Moreover, a Korean version of the US Bayh-Dole Act, the ‘Promotion of Technology Transfer Act’ was enacted in 2000. This Act enforces public research institutes to create technology licensing offices. Moreover, in 2001, the range of this enforcement was extended to forty-six public universities. The ‘Promotion of Invention Act’ was enacted in 1994, and subsequently revised to set out the jurisdiction of intellectual property rights (IPR) of academics in public universities in 2001; as a consequence, the agencies affiliated to universities can manage their IPR and the transfer of university inventions.

Secondly, the government implemented a series of R&D programmes to stimulate the commercial exploitation of academic research as well as to strengthen university-industry linkages. According to Sohn et al. (2006), the level of funding for university-industry cooperation programmes consists of 25% (1.8124 trillion won) of all national R&D projects (7.2283 trillion won) in 2006. Moreover, most of them have been started since 2000, and from around 2004 they have been implemented actively (Park et al., 2007). In terms of size and importance, there are four major programmes of particular importance: the second phase BK21 project, the NURI (New University for Regional Innovation) project, the CK (Connect Korea) project and the HUNIC (Hub University for Industrial Collaboration) project. In addition to these, eleven ministries were operating 50 similar projects in 2006 (KRF, 2006).

The BK21 project in its second phase (2006-2012) is focused on university-industry collaborative research, while the first phase (1999-2005) was concerned with the overall research capability and the training of students at universities (KRF, 2006). In order to contribute to balanced regional growth across the country, the NURI project (2004-2008) encourages universities located outside the Seoul metropolitan area to achieve three goals: enhancing the disciplinary specialisation of regional universities, providing regional human resources, and ‘establishing’ the regional innovation system. In order to ‘connect’ the demand side (industry) and supply side (university), the CK project (2006-2010) has focused on invigorating technology transfer to industry by strengthening the TLO (Technology Licensing Office) capacity. The HUNIC project (2004-2011) and Human Resource Development Centre for Economic Region Leading Industry Project (2009-2011) are aiming to strengthen the R&D activities of existing industrial clusters by encouraging regional universities to cooperate with industries nearby through various channels, such as cooperative research, training human resources and sharing research infrastructure. In 2012, HUNIC project has been integrated into the

LINC (Leaders in Industry-university Cooperation) project.

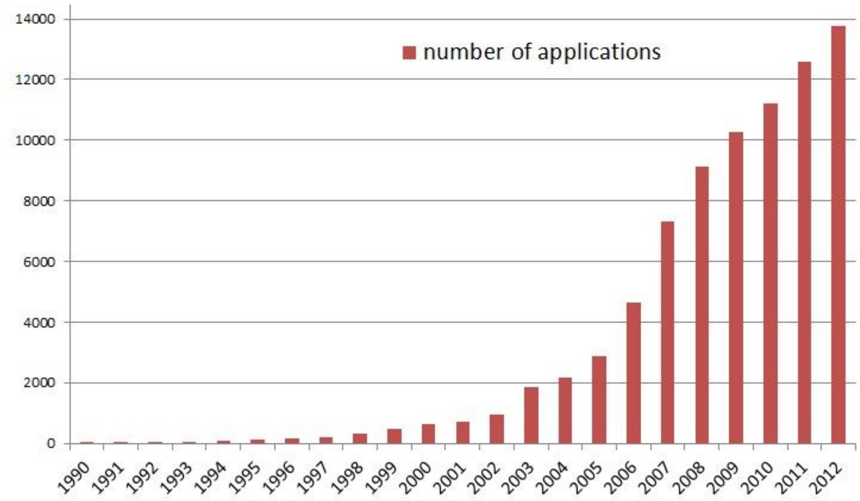
Table 4 Major national R&D projects on university-industry cooperation

Ministries	Supporting agency	Projects	Period	Budget (Mil. US$)
Ministry of Education	KRF (Korea Research Foundation)	The second phase brain Korea 21	2006 -2012	2,030
		New university for regional innovation (NURI)	2004 -2008	1,240
		Connect Korea project (university TLO supporting project)	2006 -2010	30
Ministry of Ind & com and Ministry of Education	KOTEF (Korea Industrial Technology Foundation) & KRF	Hub university for industrial collaboration (HUNIC) project	2004 -2011	304
		Human resource development centre for economic region leading industry project	2009 -2011	302

Source: Revised from KRF (2006), pp. 399-436 and MOE (2014), p.8

Thirdly, the government has drafted several national plans embracing the university-industry cooperation strategy, such as the ‘Plan for University-Industry Cooperation to Establish the National Innovation System (Feb., 2002)’, the ‘Vision and Strategy for New University-Industry Cooperation (Sep., 2003)’ and the ‘Plan for the Expansion of University-Industry Cooperation under the MOE, MOIC and MOL (May, 2005)’. In 2002, the ‘Plan for University-Industry-Government Cooperation to Establish the National Innovation System’ has been jointly drafted by 15 ministries including MOE in order to coordinate ministries’ university-industry-government cooperation projects. According to this plan, an associated body for coordinating each ministry’s projects has been created, and the incentive system for participants such as professors and researchers in the projects has been strengthened.

In response to the government’s strong emphasis on invigorating university-industry cooperation, university authorities have not only established an incentive system benefiting the professors involved in entrepreneurial activities by modifying performance evaluation indicators, but they have also implemented various programmes such as the operation of incubation centres, commissioned training for industrial labour, internships in companies and consultancy for regional industry. According to a survey of 26 Korean universities on changes in the performance indicators for university-industry cooperation (Park et al., 2006), all of them reported that patent performance has been considered, and 16 universities (62%) had adopted this indicator by 2000. Moreover, 35% of universities were using the number of technology-transfer agreements as a performance indicator, and recently the proportion has grown rapidly. Another similar survey (KRF, 2007) reported that 100 out of 129 universities were reflecting industrial collaboration activities in their performance evaluation, and 99 universities weighted an international patent as 16% of a SCI paper.



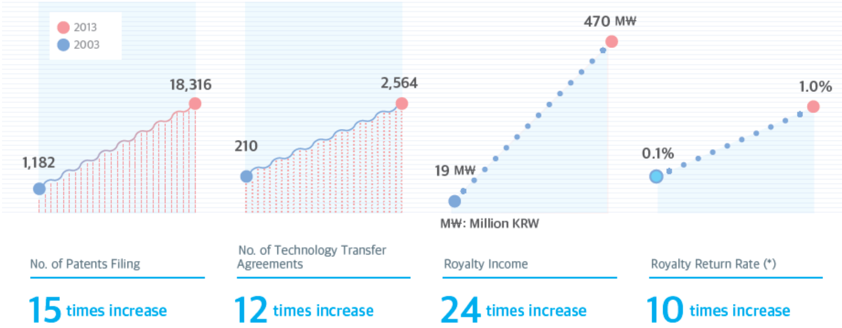
Source: Data based on appendix tables in KIPO (2013)

Figure 2 Domestic patents applications by universities

As shown in Figure 2, the number of domestic patent applications and its ratio to total applications have increased very considerably since the early 2000s. The timing of the abrupt increase coincided with the government policy change to strengthen universities' linkages to industry, as explained.

During the last decade, regarding the third mission of Korean universities, not only the number of patents applications, but also number of technology transfer agreements, royalty income, and royalty return rate have increased remarkably. According to Figure 3, from 2003 to 2013, more than 10 times expansion of the third stream activities of Korean universities is observable.

To sum up, in terms of the government's efforts with regard to university-industry linkages, most of the laws were created and revised after 2000, and the R&D and supporting programmes started between 2002 and 2004, while the major plans were published after 2002. Furthermore, the universities strongly adopted government policy after 2000. Therefore, we may conclude that the 2000s is a period of invigoration of university-industry cooperation in the Korean academic system.



Note: Royalty return rate (total technology royalty) / (total R&D expenditure)
Source: MOE (2014), p.12, 1US dollar is about 1000KRW during the period

Figure 3 Third stream activities of Korean universities during the last decade

V. Conclusion

Since its economic catch-up, the Korean higher education system has developed with a close interaction between government and industry in three different stages. Firstly, at the 'strong regulation' stage, the government encouraged the universities to focus on vocational training in science and engineering in order to provide standardised labour to industry. Meanwhile the R&D mission to support infant industry by adapting internationally-proven technology was given to public research institutes. Secondly, the 'massive expansion' stage is characterised by an eruption of the need for higher education. This is related not only to the overall enhancement of the economy but also to the intensive investment in primary and secondary education in the previous period. In order to meet this demand, the government increased the number of student places and allowed the creation of new (particularly private) universities. Finally, at the 'academic revolution' stage, the government invigorated university research and stressed its direct contribution to the economy. Accordingly, in order to encourage the second and third missions of the universities, the government exerted various efforts such as the creation of laws, the establishment of supporting organisations, and an increase in R&D investment.`

During the last half-century, Korean universities have experienced a remarkable growth in their three main activities. In terms of teaching, the enrolments rate for higher education increased from 5.4% in 1970 to 65.6% in 2005. Research activity and the amount of funding have dramatically increased since the 1990s, while the source of R&D expenditure is primarily the government. Most recently, the mechanism of industrial collaboration was adopted by the universities for making a direct contribution to the economy, with the result that patenting, technology licensing and spin-off activities have all been intensified since the beginning of the millennium.

In this regard, during the emergence of academic research and its direct contribution to the society as well as the co-evolution of industry and academia, the government's role can be evaluated as one of the most critical factors. Furthermore, the strong governmental involvement in the exploitation of academic potential has influenced the relationship between the second and third mission. Considering the existing literature and the evolutionary explanation of the universities in South Korea, we need to discuss the generalisability of the Korean case as well as its implications.

Firstly, the emergence of academic research and its direct contribution of the Korean universities can be compared to that of developed countries. The research and third-stream activities of Korean universities were mostly invigorated by financial and institutional support from the government in the 1990s, while the universities in developed countries began to participate in entrepreneurial activities in the 1980s after the establishment of the fully-fledged scientific community in the late 19th century. In other words, the 'two Korean academic revolutions' occurred nearly at the same time. However, the revolutions are not so 'revolutionary' in the sense that the 'two Korean academic revolutions' were strongly controlled in a 'top-down reformation' by the government rather than a 'bottom-up revolution' by academia.

Secondly, as mentioned above, one of the most influential factors in the relationship between the universities' second and third missions in catch-up countries is the existence of strong government control over academia as well as industry. Accordingly, academia in Korea has developed as a subsystem serving economic goals set by the government, rather than independent communities operating under their own norms as found in western countries. In this regard, the 'triple helix' approach provides a better perspective to understand the relationship between the two missions than the 'open science' approach. Due to the government's efforts to harmonise the two missions, as well as the two actors (i.e. university and industry), Korean science has developed under a strong interaction between science and technology.

Finally, historically, the state has been regarded as a central resource provider as well as the most influential stakeholder, so higher education institutions have been supported mainly by the government over a long period of time. In this regard, at the initial stage, Korean universities are also somewhat similar to the Humboldtian model. As the economic catch-up started, in terms of their immediate response to the practical needs of the society, they were perhaps closer to the technical university, i.e. to Fachhochschulen in Germany and to land grant universities in the US. Recently, the government's higher education policy has tended to encourage Korean universities to become ‘entrepreneurial universities’, while the ‘entrepreneurial’ activities have been more in response to government guidelines than the needs of the market and industry. In addition, due to the limited national supply and the explosive demand during the last century, private higher education institutions have made up the majority of Korean universities. They are under strong government control too, although government support has focused more on public universities.

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