The Economics of Intellectual Property in the Republic of Korea

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Introduction

This publication aims to promote the development of empirical research on the economics of intellectual property in the Republic of Korea, and endeavors to provide policy makers with research based conclusions in different areas of intellectual property.

The project was initiated by convening a National Roundtable on the Economics of Intellectual Property in the Republic of Korea which took place in the Seoul National University in April 2008.

The roundtable provided an opportunity to Korean economists to discuss potential areas of research in the field of intellectual property, and also discussed the various methodologies and availability of data for conducting the studies. In addition to the national economists, two international economists and a number of national institutions, including the Korea Intellectual Property Office (KIPO) and the Copyright Office participated in the Roundtable.

After the roundtable, the economists and other participants were invited to submit research proposals to WIPO, which were peer-reviewed and selected for funding by WIPO. First drafts of all the papers were also peer reviewed by internationally renowned experts, enabling the authors to improve their papers and incorporate some of the suggestions. The final papers have been included in this publication.

In Chapter 1, Keun Lee provides an overview of the technological and intellectual property developments in the Republic of Korea in the last few decades, which sets the background for the other papers. Analyzing technological developments in Korea, Professor Lee states that when the economy took off in the 1960s, the export basket mainly comprised products assembled or processed from imported parts and raw materials. R&D expenditures never exceeded 0.5 percent of GDP in the 1960s and 70s, and so firms were dependent on foreign technologies. Government policies favored import of technologies that promoted exports, thereby setting the stage for Korean firms to make heavy investments in seeking foreign technologies, to gain market shares in skill-intensive industries. Thereafter, in the period up to the mid-1990s, Korean firms increased their production of knowledge intensive products in the electronics, auto and mechanical engineering industries, increasingly using their own brand names. Firms also started setting up their own R&D centers. The period after the mid-1990s marked the entry of Korea into the OECD, and though the country was affected by the financial crisis. it was able to become a totally ‘open economy’, assisted in part by the post-crisis reform package, launched by the government. However, the author states that the reforms were perceived to have adversely affected the growth process, because, despite a more stable business environment, the macro indicators were not too promising. Businesses embarked on a reform process, and those which demonstrated technological prowess, were the ones which emerged as competitive entities.

On the evolution of the IP System in Korea, Professor Lee traces the history since 1908. The first major wave of legislative changes occurred in the 1960s, when there was a comprehensive amendment of all IP laws. The degree of protection was lower than in the earlier laws, and compulsory licensing was introduced. It was in the 1970s and 80s that Korea signed bilateral treaties with Japan and the United States, and also acceded to the basic conventions administered by WIPO. In the mid-1980, product patents were introduced for pharmaceuticals and computer

software and infringement standards raised. In the mid-1990s, the laws became TRIPS compliant, and in some areas, standards were higher than the global average. Subsequently, with the significant increase in patent filing, measures were initiated to streamline and improve patent administrative systems. Specific steps were also taken to facilitate protection for SMEs, and attention was given to developing synergies between universities and businesses.

Professor Lee also traces the changes in the strategies followed by firms in dealing with the use of technologies, and relates it to the evolution of the IP System. In the initial stages, IP protection was extended to minor inventions, but subsequently raised significantly to conform to technological advancements. The author also analyzes various patenting trends, including the changes in foreign and local ownership patterns; and the emergence of new technological sectors.

In Chapter 2, Yee Kyoung, Keun Lee and Ki-neung Choo examine the interface between IP and innovation in the process of economic development in Korea. The paper examines the role of IPRs from two different perspectives. The first is a look at different types of IPRs, over the process of economic growth, and the second is to specifically examine the role of utility models, in the technological development of Korea. The paper states that Korea is one of the developing countries where utility models have been very extensively used by companies. However, over the years, the number of applications filed has been diminishing, as compared to patent applications. Until the 1990s, the number of utility model applications was more than that for patents, reaching the ratio of 1:6 in 1984, but the levels have declined thereafter. Since the mid-90s, patent applications have exceeded the number of utility model applications, which reflects the change in the economic profile of Korea; from a country with limited technological resources, to one making significant strides in this field.

To examine the issue at greater length, the authors set up three hypotheses. The first hypothesis is that patent protection in the country was positively associated with innovation, only after the country acquired higher technological capabilities. With the help of a time-series analysis, they conclude, based on the Korean case, that the strengthening of patent protection became increasingly relevant to promote innovation as the country became more technologically advanced. Examining the same hypothesis from a firm-level panel analysis, it is concluded that strong IPRs are positively associated with patents, only after a firm becomes technologically advanced. Examining the role of utility models, the second hypothesis is that widespread experiences of producing minor inventions is an important determinant of a firm's technological capability to produce 'inventive innovations'. The authors show that the utility model system can be beneficial to developing countries or technologically poor companies. Therefore, it is important for a country to properly configure its IPR system and tailor it to the technological capabilities of companies in that country. With regard to the specific impact of utility models on firm performance, the third hypothesis is that the growth of the firm is positively associated with its 'minor inventive activity', particularly if it is not significantly advanced, technologically. The authors are able to establish that utility models are likely to be appropriate for domestic companies, which are resource poor, or are below the technological frontier. They conclude that strong patent protection becomes relevant for innovation in a country, only at a later stage of development, and that at the initial stages, utility models may play a greater role. Further, that level of IPR protection in a country should not be set without regard to the level of economic development, as high levels may not be appropriate for firms in countries with less technological capabilities.

In Chapter 3, Kyoo-Ho Park examines the level of effectiveness of patents in Korea, and the major elements influencing patenting activities with regard to innovation strategies. Commenting on the

significant increase in patent filings in Korea, since the late 80s, the author feels that it is important to understand this phenomenon, in order to properly analyze the changes taking place in innovative activities in the recent decades. The questions addressed by him are: what is the level of effectiveness of patents as an appropriation mechanism of innovation output in Korea; and what is the impact of innovation strategy on the use of patents as an appropriation mechanism for technology protection in Korea. In trying to identify the effectiveness of patents, as compared to other appropriation mechanisms, he compares the results of a 2002 survey by the Science and Technology Policy Institute in Korea, with another one done in 2005. He finds that while in 2000-2001, the most favorable appropriation mechanism was market pre-emption for product innovation, secrecy and registration were also important mechanisms. In 2005, while on average secrecy and lead time where seen to be the most effective mechanisms, the gap between these mechanisms and patent protection was not as high as it was in 2001. He presents an empirical model which analyses the determinants of patenting activities in Korea. Using the results of the KIS survey in 2005, which surveyed the importance given to each appropriation mechanism, he says that it is possible to interpret this importance as a proxy measure of perceived effectiveness by individual firms. Furthermore, the possibility of using patents for technology protection, considering their efficacy, is strongly related to the incidence of patenting. After this analysis, the author concludes that even in protecting process innovation, it was found that patents were effective in protecting innovation output. Moreover, firms engaged in cooperative R&D are more likely to show higher patenting activity. Again, firms which target foreign markets and export to other countries are more inclined to use patents as an appropriation mechanism. He also concludes that larger firms have a higher probability of using patents as an appropriation mechanism, as compared to smaller firms. In terms of Korean characteristics of innovation, the author concludes that the size of the firm matters. Korean firms combined product innovation with patenting in order to gain segments successfully.

In Chapter 4, Sung Jin Kang and Hwan Joo Seo look at intellectual property rights, spillovers and innovative activities in Korea. As a background, the authors state that according to conventional economic theories, the protection of patents creates social costs of lower use of the invention in the short term; but provides incentives for greater innovative effort in the long term. The authors refer to recent empirical studies that analyze the dynamic relationship between innovative activities and the strengthening of patent rights and cast doubts on the effectiveness of the patent system in encouraging innovations. Taking the example of Korea, they examine whether the strengthening of patent rights in the past decades, has induced greater innovation and higher number of patent applications. They study the role of the firm or industrial specific factors, in the rise of patents of Korean firms; and also look at the questions whether an increase in patent applications have actually led to higher innovative activities. Examining the data over a period of twenty years, the authors examine the role of ‘internal-firm characteristics’ such as size, debt ratio, capital-labor intensity, human capital and export ratio on innovative activities. The study also tests the effect of knowledge spillovers. The authors conclude that the accumulated stock of ideas leads to higher level of technology, even though the effect diminishes in the long run. Secondly, companies with higher capital-intensity, higher export-ratios and greater investments on human capital tend to increase patent applications. Thirdly, there is an inverted U-relationship between market structure and innovative activities; and lastly, that productivity has a positive relationship with the number of patent applications filed.

Taegi Kim and Keun-Yeob Oh examine the effects of the patent system on innovation and productivity, in Chapter 5, basing their studies on evidence from Korea’s firm level data. The authors state that much of the economic growth that took place in Korea in 1960s can be

attributed to the increase in the stock of labor and capital, rather than productivity growth. The authors determine whether the strengthening of the patent system in Korea induced the increases in R&D expenditures and then go on to determine whether or not this increase resulted in productivity growth in the Korean manufacturing sector. They used data from 216 firms to evaluate the effects of innovation on productivity growth. The authors conclude that the policy reforms that were initiated in Korea asserted a positive effect, which influenced an increase in the R&D expenditure and patent applications, and also that the associated increases in the knowledge stock led to productivity growth in Korean manufacturing firms. The authors also conclude that the intellectual property reforms had a greater impact on high technology firms, than on low technology ones.

In Chapter 6, Boo-Young Eom and Keun Lee examine the case of Korea in finding effective combinations of knowledge transfer modes in public research organizations and firm interactions. The authors examine the impact of different modes of knowledge transfer from public research organizations (PROs), on the performance of firms in Korea. The authors state that the government policy in Korea has gradually been moving towards facilitating patenting while the universities are becoming entrepreneurial institutions like those in Japan. The authors look at diverse information channels and their combinations, and analyze the contributions to industrial innovation measures, in terms of patents and new sales of firms. They point out that in the 1980s, the government prioritized the building of national R&D capacity, with an emphasis on large scale national projects. Since then, industries and universities have been linked through a specific program. In the 1990s, the R&D capacity of universities and industries developed significantly, and the number of scientific papers published also rose sharply. In the empirical analysis, the authors deal with three hypotheses. The first hypothesis is that the joint modes (IP and IP modes; non-IP and IP-modes or non-IP and non-IP modes) of knowledge transfer from PROs, rather than a single mode, may contribute to innovation in Korean firms. The second hypothesis is that the synergy effect of joint transfer modes are significant only in the case of patents filed, but not in sales; and the third hypothesis is that the joint mode of technology transfer from PROs lead to more patents filed and sales by firms in the high-tech industries. The authors come to the conclusion that the joint implementation of knowledge transfer modes from PROs has a synergistic effect on knowledge creation, leading firms to file more patents. Secondly, the joint implementation of knowledge transfer contributes to industrial innovation through patents, though the transfer from universities was still hampered in industrializing knowledge through sales. The third conclusion reached by the authors is that the joint implementation of knowledge transfer modes from PROs, facilitates industrial innovation through patent filings, mainly in high or medium-tech industries, though still facing limitations in industrializing knowledge through sales, even in the previously mentioned industries. The authors also reach the conclusion that the mode of business activity has no significant impact on industrial innovation, suggesting a new policy initiative to facilitate spin-offs, science parks and entrepreneurial universities.

In Chapter 7, Byung-Hee Soh, Jihyang lee and Dong-Uk Kim examine the impact of copyright law on the music industry in Korea. The authors endeavor to ascertain whether any attitudinal changes have taken place, with regard to copyright in the music industry, since the amendment of copyright law in Korea. The attempt was to find out if there was any change in the production of original Korean musicals since the amendment of the copyright law, and also increases in royalty payments for importing copyrighted works. The Copyright Act of Korea, which was enacted in 1957, was amended significantly in 1986 and 2006. While conducting the survey to gauge the impact of the copyright law, the authors also looked at the relative impact on different age groups. They found that the younger generation appeared to be more inclined to abide by the law due to greater

awareness on the issue. The overall conclusion reached by the authors is that the copyright law has broadly had a positive impact on the growth of the music industry in Korea. This has led to import substitution of licensed musicals by domestic creation, and has also enhanced the production quality of Korean musicals. However, the impact of copyright protection on the artist community is not very satisfactory, and the artists are not comfortable seeking protection for their works. Therefore, there is a need to create more awareness among the artists regarding the kind of protection available under copyright law.

In Chapter 8, Nowook Park looks at intellectual property promotion policies and their impact in Korea. The author provides a description of intellectual property promotion policies in Korea; examines their impact on the creation and utilization of intellectual property; and then discusses some of the implications. The policies covered in the paper relate to the creation, utilization and protection of intellectual property. The author acknowledges that the data available is not suitable to undertake a thorough evaluation of the impact of those policies. Nevertheless, certain preliminary conclusions can be reached based on the available data. In the first place, the author concludes that he could not find any significant relationship between the size of the budget and user satisfaction levels. Regarding the impact of the invention class program, the author finds that the class helped the students to determine their career growth and that involvement at a very early stage was effective in promoting IP related activities. With respect to the IP value assessment program, it was found that the policies for promoting the utilization of IP amongst small business enterprises were not working effectively. The author has therefore suggested a few measures to improve the program, which are aimed at promoting the commercialization of intellectual property. He also seeks improvements in data availability, to monitor and evaluate the performance of the program more effectively.

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Contributors

KI-NEUNG CHOO

Kineung Choo is an instructor at the Republic of Korea Naval Academy. He received his Bachelor's degree from the Korea University and completed his Master's and PhD degrees in economics at the Seoul National University. He has also been employed as an associate research fellow at the Korea Institute of Intellectual Property (KIIP).

BOO-YOUNG EOM

Boo-Young Eom is a research fellow at the Korea Institute of Intellectual Property (KIIP). She has served as Second Secretary at the Ministry of Foreign Affairs and Trade and as a senior researcher at the Korea Institute for International Economic Policy. She holds a Master's degree in international trade from the IUHEI at the University of Geneva and a PhD in technology and development from Seoul National University. She has expertise in intellectual property rights (IPRs), trade rules/policies, knowledge transfer mechanisms and Input-output analyses. She is currently engaged in research projects on international comparative study in inter-industry IP relations (Korea, Japan and the US) and IP ODA – modeling and application.

SUNG JIN KANG

Sung Jin Kang is a Professor at the Department of Economics, Korea University. He received a PhD from Stanford University in 1999. His publications relate to Q-convergence with interquartile range in the Journal of Economic Dynamics and Control (2005) and Did Public Transfers Crowd Out Private Transfers in Korea during the Financial Crisis? in the Journal of Development Studies (2009). His current research topics are technology spillovers through FDI and patents and their impact on productivity.

DONG-UK KIM

Dong-Uk Kim is a PhD candidate in economics and a lecturer. He was awarded the Best Teacher Award for general education at Kookmin University in 2008. His current research interest is the musical industry and copyright.

TAEGI KIM

Taegi Kim is a professor of economics at Chonnam National University, Korea. He graduated from Seoul National University with a Bachelor's, a Master's and a PhD in economics. His research interests are international trade, R&D and technology, trade and growth.

YEE KYOUNG KIM

Yee Kyoung Kim is an Associate Research Fellow at the Korea Institute of Intellectual Property (KIIP), Seoul. She completed her PhD in economics at Seoul National University. Her dissertation addressed how the role of knowledge on economic performance differs, depending on the level of economic development. Her works are either currently under review or have been published in academic journals. She has worked for the World Bank and the Korea Intellectual Property Office (KIPO) and she has been a visiting scholar at American University in Washington DC, USA. Her research topics include IPRs, technology transfer, economic catch-up, development economics and institutional economics.

JIHYANG LEE

Jihyang Lee is a producer at the Seoul Metropolitan Musical Theater (SMMT) at Sejong Center. She has been involved in the stage management of several musicals. She holds a PhD in performing arts studies and she studied singing in Italy before she joined the SMMT. She is also a lecturer at Sukmyoung Women's University and Myoungji University.

KEUN LEE

Dr. Keun Lee is a professor of economics at the Seoul National University and a Director of the Center for Economic Catch-up. He holds a PhD from the University of California, Berkeley. He has worked as a consultant at the World Bank, a lecturer at the University of Aberdeen, UK and a research fellow at the East West Center, Hawaii. His main area of research is the economics of catch-up with a focus on innovation, corporate organization and growth and industrial policy. He is the editor of the Seoul Journal of Economics and also one of its editors on research policy.

KEUN-YEOB OH

Keun-Yeob Oh is a professor of international economics at Chungnam National University, Korea. He graduated from Seoul National University (BA and MA), and Ohio State University (PhD in economics). Recently, he has been studying the relationship between international trade and intellectual property through time series data analysis.

KYOO-HO PARK

Dr. Kyoo-Ho Park is a professor in the school of industrial management at Korea University of Technology and Education. He holds a PhD from Seoul National University. His publications include "Linking the Technological regime to the Technological Catch-up: Analyzing Korea and Taiwan using the US patent Data" in Industrial and Corporate Change (2006). His main area of research is the differential characteristics of catching-up countries and patent management, especially with the relation with technological innovation.

NOWOOK PARK

Nowook Park received a PhD in economics from the University of Michigan, focusing on the areas of public finance and political economy. He joined the Korea Institute of Public Finance in 2003 as a Fellow and has been conducting extensive research and providing consulting and training services on various issues related to public finance and budgeting. In an effort to improve the performance of spending programs by introducing performance evaluation activities into the government, he established the Center for Performance Evaluation and Management within the Korea Institute of Public Finance and has been conducting an evaluation of government programs. He has served on many evaluation committees in the Government of the Republic of Korea including for the Korea Intellectual Property Office (KIPO). He is also actively involved in international policy exchange and consulting activities through participating in projects of international organizations such as the IDB, the Korea International Cooperation Agency (KOICA), the OECD and the World Bank.

HWAN JOO SEO

Hwan Joo Seo is an associate professor in the Division of Business Administration at Hanyang University. He received his PhD from EHESS in 1998. He has also been a visiting researcher at Nagoya University. His current research interests concern service innovation and the role of IPRs in the innovation process. He has been published in Telecommunication Policy, The Service Industries Journal and Economics of Innovation and New Technology.

BYUNG-HEE SOH

Byung-Hee Soh is a professor of economics at Kookmin University, Seoul, Korea. He is also an adjunct professor of cultural economics at the Graduate School of Culture Technology, Korea Institute of Science and Technology. He is currently on the executive board of the Association for Cultural Economics International. His published works include Arts and Culture Sponsorship and Copyrights (2006); Government Failure (2007); Economics of Art and Culture (2012). He holds a Ph.D. in economics from Northwestern University.

Chapter 1

Intellectual Property and Economic Development in the Republic of Korea: An Introduction

KEUN LEE

ABSTRACT
This paper provides an overview of the evolution of technological and IP development in Korea, which is one of the few countries to have achieved a remarkable transformation from a least developed country (LDC) to a developing or first-world country. Accompanying such economic and income growth, there has been technological development, utilizing diverse learning channels ranging from Original Equipment Manufacturer (OEM), licensing, in-house R&D and public-private consortia to overseas R&D posts and strategic alliances. This paper has shown that such dynamic changes in access modes and learning have been in parallel with the evolution of the Korean IPR systems. During the early stages, IPRs were granted to minor inventions or adaptations by local residents, while later on, with the growth of technological capacity, stronger protection of both domestic and foreign IPRs has been provided. Korea has now attained the most developed level in the scope of the subject matter, including the most recent IPRs, involving inventions in biotechnology and business methods.

1. Introduction

The world economy has undergone rapid change since the end of World War II and has followed a variety of socio-economic trajectories. The Republic of Korea (referred to hereafter as Korea) is one of the few countries worldwide where dramatic economic growth has been sustained for several decades, enabling it to enter the ranks of the richer countries. This achievement has been attributed to different factors such as the unique role of the government and early export- or outward-oriented growth. Attention has been given to the upgrading of technological capabilities (Kim, 1997; OECD, 1996; Lee and Lim, 2001). The view is that without upgrading capabilities, sustaining long-term high-growth rates would not be possible (Lee, 2009; Lee and Mathews, 2009). The effects of technological development can also be derived from diverse sources. While there are more studies focusing on the role of major businesses (such as the so-called chaebols), including Kim (1997) and Lee and Lim (2001), relatively little research has focused on IPRs and the IP regimes in Korea.

This paper seeks to give a brief overview of the evolution of Korean technological and IP development, following the studies of Lee et al. (2003) and Lee and Kim (2010). Reconsidering the Korean experience from the IP perspective is important and timely, given the heated debate on the role of IP protection in economic growth.

Section 2 discusses the literature on the role of intellectual property in economic development, particularly in Korea. Section 3 discusses the dynamic processes of technological development in Korea, while Section 4 reviews the evolution of the IP system in Korea. Section 5 identifies the role of intellectual property in technological development in Korea. Section 6 contains conclusions and remarks.

2. Literature Review

While some evidence of the effects of IPRs on economic growth exist, particularly with regard to patent protection, the debate is far from being settled and the conclusions are mixed. Some studies have emphasized the "incentive" effects of patent rights on the profitability of innovation; others focus on the market power effect of patent rights in limiting the diffusion of new technologies and the ability of innovators to build on existing knowledge capital.

More recently, some studies have dealt with the impact of IPRs contingent on certain conditions or stages of economic development or capabilities. For instance, Gould and Gruben (1996) showed that the strength of IPRs had a greater impact on the countries that are more open to trade. Falvey et al. (2006) observed that the response of economic growth to patent protection varied at different threshold levels. Varsekelis (2001), Kanwar and Evenson (2003) and Chen and Puttitanum (2005) saw that R&D and gross domestic product (GDP) ratios or the filing of US patents were positively related to the strength of patent rights, dependent on other factors. Schneider (2005) found that stronger patent rights had positive effects on US patent filings for developed countries; while for developing countries, patent protection had either a negative or insignificant influence on other variables such as infrastructure and foreign direct investment (FDI).

Although it did not use rigorous econometric tools, the study by Lee et al. (2003) can be considered as one of the most comprehensive studies to focus on the role of intellectual property in the economic development of Korea. The study gives a dynamic perspective, with emphasis on the changing role of intellectual property and the intensity and scope of IP protection throughout the course of Korea's economic development. It argues that the optimum levels of protection for IPRs in "catch-up" economies can be considered from a dynamic perspective. In the very early stages of industrialization, the protection of IPRs was not an important issue. However, as the economy's technological capability grows, there is an increasing need for international technology transfer and growth in the local market for technology. Thus, an adequate level of protection for foreign IPRs should be provided locally. Lee et al. (2003) conducted a survey using the same format as Granstrand (1999) to confirm that enterprises of differing capability levels tend to show varying attitudes and strategies toward IP management and utilization. While there is some degree of overlap with the findings of Lee et al. (2003), a study conducted by Lee and Kim (2010) provided a more updated view on the issue, with additional information about how Korean firms have responded to the increased levels of IPR protection.

In contrast, the studies of Song (2006), Song and Shin (2006) and Mahoney et al. (2005) focused on company case studies on coping with the diverse challenges of IP management and related conflicts. These demonstrate the diverse or heterogeneous challenges and responses by Korean companies of various sizes and levels of capability. On the one hand, IPRs were found to present barriers for the growth of some companies, particularly smaller companies. On the other hand, IPRs provided strong pressures for upgrading large or highly efficient companies belonging to business groups.

More recently, studies using econometric analysis have been carried out. Kim et al. (2009) used the sector-level data to determine that R&D investment and patents seem to have positive effects on increasing the total productivity factor in the Korean economy, and that R&D (including patents) of other companies was more influential than their in-house R&D patents, which is consistent with the study by Lach (1995). Park (2006) sought to identify the context or conditions where protection of IPRs is more effective. He found that in the Korean manufacturing sector, there were relatively

larger companies doing collaborative R&D with other agents that tend to use IPRs effectively in protecting their innovations, particularly those relating to product innovation.

In contrast, there exist quite a few studies on copyright issues related to digitalized contents and the Internet. Soh and Yoo (2002) reviewed the changes in copyright and the system of copyright management in Korea and their linkage to the development of digital technology. In order to effectively protect copyright in the digital environment, the study emphasized the need for developing newer technologies to prevent piracy and to educate the public to better understand and recognize copyrights. Park, Kim, and Lee (2004) investigated the attitude of free movie-content users toward infringement of IPRs and the changes after the initiation of subscription fees, especially in the movie industry. After analyzing the responses from the questionnaires given to college students, they determined that respondents consider free downloading of illegal movies to be a more serious infringement of intellectual property than illegal music downloads.

3. Technological Development in Korea

From the 1960s to the mid-1970s

Economic expansion in Korea began in the 1960s with the dawn of a new political leadership which pursued so-called export-led growth. However, the technological capability of domestic companies was poor and exporting was confined to the assembling or processing of imported parts and raw materials. The level of technological investment was also extremely low; average R&D expenditure from 1965 to 1973 was only 0.34 per cent of GDP, not exceeding 0.5 per cent during the 1960s and 1970s (Table 1). Nevertheless, domestic companies had to make an effort to overcome their poor technological capabilities by investing in learning foreign technology from the more advanced countries. Further learning efforts were concentrated mainly on operational technology through informal channels such as the purchase of capital goods or reverse engineering (Kim, 1997). As shown in Table 2, imports of capital goods amounted to 3,154 million US dollars (relating to two periods, 1962-1966 and 1967-1971) from 1962 to 1971. In contrast, technology imports[1] over the same period were a mere 21.2 million US dollars.

Table 1: Trends in Major Technology and IPR Variables in Korea

	Early Effort 1960-73 Average	Catch-up Began 1974-85 Average	Catch-up Rapid 1986-94 Average	Catch-up Maturing 1995-2005 Average
0) R&D/GDP[a]	0.34	0.72	1.85	2.53
1) Foreign patents [b]	335	3,910	12,171	27,297
Domestic patents [b]	986	1,457	14,542	76,584
Domestic share (%)	*74.6*	*27.1*	*54.4*	*73.27*
2) Utility models[b] [A]	4,100	9,816	26,735	42,451
Invention patents[b] [B]	1,321	5,368	26,713	104,530
Ratio [A]/[B]	*3.1*	*1.83*	*1*	*0.41*
3) Individual (Korean) patents [b]	-	1,256	2,331	15,037
Corporate (Korean) patents [b]	-	581	9,840	61,548
Corporate share (%)	-	*31.63*	*80.85*	*80.37*

Source: a) Ministry of Science and Technology, Report on the Survey of Research and Development in Science and Technology; b) Database of IPRs available at www.kipo.go.kr.

1 Technology imports relate to technology imported with the technological licensing or technical assistance needed to train local engineers to run turnkey plants.

Although technology imports were low, government policies were established to stimulate the import of foreign technology. There were laws in force on the import of capital goods, foreign loans and technology imports, including the Foreign Capital Inducement Act of 1966. For effective technology control, guidelines were issued in 1968 to prioritize technologies that promoted exports, developed intermediate capital goods industries or had an awareness-promoting effect. In 1972, the Technology Development Promotion Act was introduced to stimulate technology imports and, a year later, the Foreign Capital Inducement Act was revised to provide more flexible criteria and to facilitate technology import procedures (OECD, 1996: 87).

Table 2: Changing Modes of Access to Foreign Technology in Korea (in million US dollars)

	Technology imports (licensing payments)		Foreign direct investment (FDI)			Imports of capital goods	
	Payment (US$m)	Cases	Amount (US$m)	Technology transfer	Cases	Amount (US$m)	[E] / Total imports
	[A]	[B]	[C]	[C1]	[D]	[E]	
			Part A: Amounts				
1962-1966	0.8	33	47.4	4.7	39	486	18.9
per year	0.2	6.6	9.5	0.9	7.8	97.2	
1967-1971	20.4	285	218.6	21.9	350	2,668.00	30.8
per year	4.1	57	43.7	4.4	70	533.6	
1972-1976	96.5	434	879.4	87.9	851	81,060	27.3
per year	19.3	86.8	175.9	17.6	170.2	1,621.20	
1977-1981	451.4	1,225.00	720.5	72.1	244	25,685.60	27.7
per year	90.3	245	144.1	14.4	48.8	5,137.10	
1982-1986	1,184.90	2,078.00	1,767.50	176.8	565	46,572.80	32
per year	237	415.6	353.5	35.4	113	9,314.60	
1987-1991	4,359.40	3,471.00	5,634.70	563.5	1,622.00	111,499.40	36.4
per year	871.9	694.2	1,126.90	112.7	324.4	22,299.90	
1992-1993	1,797.00	1,240.00	1,938.80	193.9	506	61,184.30	37
per year	898.5	620	969.4	96.9	253	30,592.20	
Total	7,906.10	8,766.00	11,207.60	1,120.76	4,177.00	256,200.30	33.5

	Part B: Ratios		
	Capital goods / Technology imports (E/A)	Imports of capital goods / FDI (E/C)	Technology imports / (Technology transfer via FDI)
1962-1966	607.5	10.3	0.2
1967-1971	130.8	12.2	0.9
1972-1976	84	9.2	1.1
1977-1981	56.9	35.6	6.3
1982-1986	39.3	26.3	6.7
1987-1991	25.6	19.8	7.7
1992-1993	34	31.6	9.3

Note: Technology transfer through FDI is assumed to be approximately 10 per cent of FDI in comparison with technology imports (payments for licensing).

Sources: Author's adaptation using data from the Bank of Korea, Korea Industrial Technology Association (KITA), as cited in OECD (1996: 83). Taken from Table 3 (Lee 2009).

From the mid-1970s to the mid-1980s

This period was characterized by the active importation of foreign technology by Korean firms for imitative innovation (Kim, 1997). In the mid-1970s, the economy shifted toward heavy and chemical industries, while large companies emerged to form chaebols or business groups. Korean enterprises invested extensively in learning foreign technologies to gain a market share in skill-intensive industries. In order to stimulate the inflow of technology needed to modernize its heavy industries, Korea had to substantially ease import criteria. This was done in 1984 by introducing a reporting system of automatic approval for technology imports, which replaced the earlier pre-approval system (OECD, 1996: 88).

Formal channels of learning and technical licensing were essential for securing access to advanced technology. Table 2 shows that technology imports from 1982 to 1986 equaled 1,184.90 million US dollars, which was about 12 times more than that of the previous 10 years. The share of R&D expenditures in GNP continued to increase, and, since 1983, the R&D ratio has been above 1 per cent.

From the mid-1980s to the mid-1990s.
This period saw a rapid catch-up led by major businesses. Companies were increasing their production of knowledge-intensive products in the major manufacturing industries such as electronics, automobiles and mechanical engineering. Large companies extended outward FDI into cheaper wage areas in Southeast Asia, becoming among the first multinational companies. After accumulating capability for process improvement, companies started to initiate product innovation (OECD, 1996: 82). Goods for export were produced with both the original equipment manufacturer (OEM) labels and personalized brand names: exporting popular brands became more common (ibid. 82).

Since the mid-1980s, Korean companies, realizing the limitations of licensing and embodiment of transferred technology, started to establish their own in-house R&D centers (OECD, 1996). This change was in part attributable to foreign companies which were reluctant to grant technology licenses to Korean enterprises, as the Koreans were attempting to enter the skill-intensive markets dominated by these more advanced countries. R&D expenditures rose rapidly, as indicated in their share of GDP, from 1.4 per cent in 1985 to 2.32 per cent in 1994. In order to encourage R&D activities by private firms, the government relaxed the prior approval criterion needed for R&D institutes and a large number of institutes were established. This strategy provided tax waivers for private research institutes, military service exemption for research personnel and tariff exemption for research equipment (OECD, 1996: 95). Overseas branches of private R&D institutes were also set up in order to enhance access to foreign sources of knowledge and keep up with recent technology developments. By 1994, there were 51 overseas R&D centers (ibid. 97).

From the mid-1990s to the present
This period marked Korea's entry into the club of developed countries, namely, the Organization of Economic Cooperation and Development (OECD). However, it was also the time when the country suffered from a financial crisis and was faced with comprehensive economic reforms imposed by the International Monetary Fund (IMF). The post-crisis reform package for Korea was one of the most comprehensive and decisively implemented sets of reforms undertaken by any country after a major downturn. Korea became almost a totally open economy in every aspect, including capital market liberalization, FDI and importation of foreign goods.

Ten years on, many observers are currently concerned with the reforms that have jeopardized the long-term sustainability of economic growth as there is an increasing recognition of both the benefits and the costs of the reforms (Lee and Lee, 2008). While the reforms have thrust Korean companies into a more stable and transparent business environment, major economic indicators have been less robust, with a five-percentage point downturn in gross investment rates relative to GDP.

Major companies underwent substantial reform. Radical restructuring was inevitable, with approximately one-third of the top 30 chaebols going bankrupt. According to Choo et al. (2009), lack of investment was a critical factor in the production inefficiency of the 1990s (the pre-crisis period), and the post-crisis turnaround of the surviving chaebols was based on correcting the source of this inefficiency. However, more importantly, this study confirmed that technological

capabilities were essential factors in explaining the post-crisis performance of the surviving chaebols, implying that the only enterprises that succeeded in building a degree of capability survived the crisis. Through post-crisis restructuring, the remaining chaebols re-emerged as attractive, profitable global players with very low debt ratios and substantial foreign shareholdings.

This company-level study is consistent with the aggregate trend of technological capabilities measured according to patent data. First, among Korean patents, the patent share applied by domestic firms rose to 93 per cent, with large companies as the major domestic inventors. This accounted for the rapid accumulation of technological capability, since there were those which had initiated R&D activities during the third catch-up period. For example, in 1999, the top 10 Korean companies in terms of patent registration owned 62.4 per cent of the patents granted in Korea. Korean patents granted to foreigners also increased rapidly, from 5,937 in 1995 to 12,013 in 2000. The most impressive feature of the period was the increase in the number of local entities which were granted patents in Korea, their share increasing from 52.5 per cent in 1995 to 65.6 per cent in 2000. In addition, US patents registered by Koreans increased rapidly: Korea ranked fifth or sixth in terms of patents granted in the US, after the US, Japan, Germany, the UK and Taiwan. This rapid increase in the number of Korean-held patents was mainly due to improved technological capabilities of inventors residing in Korea as a result of R&D activities in the country.

4. Evolution of the IP System in Korea

Industrial property rights' protection in Korea is currently covered by several different laws such as patent law, utility model law, trademark law, design law, unfair competition prevention and trade secret protection law, and semi-conductor integrated circuits lay-out design law. The patent law establishes the basic principles of the patent system and regulates the general procedures. Meanwhile, the enforcement decree and the enforcement regulation on patent law regulate the details of the administrative procedures. The current patent law comprises 12 chapters of 232 Articles and an Addendum.

In Korea, the Patent Law (No. 196), Design Law (No. 197), and Trademark Law (No. 198), which were promulgated on August 12, 1908 and enforced on August 16, 1908, can be considered as the first written laws that protected IPRs in Korea and they are basically the same as the Japanese industrial property laws. These laws were abrogated when Japan annexed Korea in 1910 and, as a consequence, Japanese IP laws were imposed on Korea until 1945, the end of World War II. After 1945, South Korea was governed by a US military administration until 1948, when an independent South Korean Government was established. During this period, the request for IPR protection resulted in the promulgation of the patent law by the US military administration on October 5, 1946, subsequently ratified on October 15, 1946. The 1946 Patent Law, which dealt with utility models and designs in addition to patents, remained in force until 1961. In effect, this 1946 law was the first modern IP law in the Korean Republic. This law, patterned on the US model, adopted the first-to-invent principle and provided patents for plant and other substances (such as pharmaceuticals). The term of a patent was set at 17 years, similar to US law. The evolution of the Korean IPR system, seen in Table 3, will be discussed in detail in the following section.

Table 3: Evolution of the Korean IPR System and Science and Technology Policies

Year	Science and Technology-Related Facts
1908	The first national laws on the protection of patent, design and trademark promulgated (Japanese influence)
1910	Japanese IP law imposed after Japanese occupation
1946	After the liberation, the first modern-type industrial law promulgated (US influence): first-to-invent principle; plant and product patents; 17-year term for patent protection
1949	Patent Bureau as part of the Ministry of Commerce and Industry established
1961	The first revision to the Patent Law: the Utility Model Law, the Design Law, and the Unfair Competition Prevention Law; 12-year term of patent protection; plant patent abolished
1963	Revision of the Trademark Law
1966	Establishment of the Korea Institute of Science and Technology
1967	Establishment of the Bureau of Science and Technology: the Science and Technology Promotion Law enacted
1972	The Technology Development Promotion Act came into force
1973	Korea Patent Association (KPA) established
1974	Treaty on IPRs between Japan and Korea came into force
1977	Korea Industrial Property Office (KIPO) established
1978	Treaty on IPRs between the US and Korea
1979	Joined World Intellectual Property Organization (WIPO)
1980	Joined the Paris Convention for the Protection of Industrial Property
1982	Establishment of the Special National R&D Program. The R&D to GDP ratio exceeded 1 per cent
1984	Joined the Patent Cooperation Treaty (PCT), shift of technology import system from approval system to reporting system
1986	Invention of pharmaceutical products and methods of producing pharmaceuticals; 15-year term of patent protection
1987	Case involving Samsung vs. Texas Instruments
1992	R&D to GDP ratio exceeded 2 per cent
1994	Korea Invention Promotion Association (KIPA) established under the provisions of the Invention Promotion Act
1995	Korea Industrial Property Rights Information Center established. In compliance with the TRIPS Agreement, the scope of patentable subjects increased and the patent term was extended to 20 years
1996	Korea Industrial Property Business Arrangement Center established
1997	IPRs Research Center established
1998	Patent Court opened. KIPO established an on-line application system (KIPOnet). Introduction of the Quick Registration System (QRS) for utility models, Joined the Strasbourg Agreement Concerning the IPC and Nice Agreement Concerning the International Classification of Goods and Services for the Purposes of the Registration of Marks
2000	The Technology Transfer Promotion Law enacted
2002	Joined the Trademark Law Treaty (TLT) and the International Convention for the Protection of New Varieties of Plants (UPOV)
2003	Joined Protocol Relating to the Madrid Agreement Concerning the International Registration of Marks
2004	Joined the WIPO Copyright Treaty (WCT)
2006	QRS abolished and the after-registration system introduced
2008	KIPO introduced customer-tailored three-track IP administration

Source: Lee et al. (2003) and KIPO website (www.kipo.go.kr/en/).

The IP system in the 1960s

The period between 1961 and 1963 was characterized by an overall revision of the laws on patents, utility model, designs and prevention of unfair competition. One of the crucial revisions was the cancellation of the US-style first-to-invent rule and the adoption of the first-to-file (apply) rule. Overall, the degree of protection under the new system in the 1960s was weaker compared with the 1946 Patent Law in terms of scope and length of protection. For example, the term was shortened from 17 years to 12 years and substance patents were excluded from protection. Compulsory licensing was also introduced. A non-resident was required to assign his representative with an address or a business space in Korea before initiating any procedure related to a patent. The laws were updated to meet international standards for novelty criteria in the 1973 revision.

The IP system in the 1970s and early 1980s

Along with the growth of the Korean technology market, the surge of foreign patent applications during this period appeared to be affected to some extent by patent treaties concluded with other developed countries and in turn resulted in the international harmonization of Korean IP laws. In 1974, Korea signed a patent treaty with Japan, the first foreign country to own Korean patents and accordingly to have filed the largest share of foreign-owned patents in that particular year. The

treaty on IPRs between the US and Korea was also signed in 1978. Furthermore, Korea became a member of WIPO in 1979 and acceded to the Paris Convention in 1980 and to the PCT in 1984. Consistent with international standards, the laws extended the term of patent protection from 12 to 15 years.

Changes since the mid-1980s

In the 1980s, the Korean IP system evolved further toward enhancing its compatibility with foreign systems. For example, the revision of the Patent Law between 1986 and 1987 introduced the product patent for pharmaceutical and chemical materials and product patent protection for computer software and materials. Penalties for the infringement of patent rights were made more stringent, thus creating a better environment not only for the importation of high technology, but also for encouraging fair competition (Kim, 2001: 160). Subsequent revisions of the IPR system in 1990, 1993, and 1995 reflected the inclusion of plant materials as patentable subject matter (1990 revision), extending the term of patents to 20 years (WTO/TRIPS-related revision, effective January 1995), and the introduction of an IP Tribunal established in 1998 (1995 revision). As a result, Korea's IPR index became much higher than the global average (Lee and Kim, 2010).

Most Recent Revisions

Given the surge in the number of patents in Korea in this period, the IPR system revision was more focused on facilitating administrative procedures and improving the quality and efficiency of patent examination. For example, KIPO introduced an online application system called KIPOnet in the 1998 amendment, providing an abbreviated patent processing period for patent prosecution, mainly through developing an Internet-based application system in 1999. Recently, with too many utility patents of low importance, the Korean Government switched to the automatic registration system, known as the quick registration system (QRS), which allowed for registration of utility patents without substantive examination. However, the QRS was discarded in 2006 due to an increase in sub-standard utility models.

Since the 1997 financial crisis and in order to revitalize economic development, policy emphasis has shifted to encourage the development of small companies, including enterprises based on new technology, with less reliance on large conglomerates. As a result, a new IPR policy oriented toward small and medium-sized enterprises (SMEs) was introduced. This policy included publicizing the importance of setting up an IPR infrastructure (i.e. on-line access systems), partial funding for applications in foreign countries, reduction of charges in application and examinations and assisting the search for process by distributing patent map reports and PIAS software for patent mapping. Since 2000, collaboration between universities and businesses has been emphasized. Four laws are of particular importance: the Science-Technology Basic Law, the Technology Transfer Promotion Law, the Patent Law and the Law for Boosting Industrial Education Promotion and Collaboration. Article 16 of the Technology Transfer Promotion Law (2000) enables publicly-funded universities to work with businesses and use their technology and knowledge for commercial purposes.

More recent changes in the Korean IPR system have been focused on areas related to non-patent types of IPR, such as signing up to the Trademark Law Treaty (TLT) and the International Convention for the Protection of New Varieties of Plants (UPOV) in 2002, the Protocol Relating to the Madrid Agreement Concerning the International Registration of Marks in 2003 and the WIPO Copyright Treaty (WCT) in 2004.

5. The Role of Intellectual Property and the IP System in Technological Development in Korea

Research has found that there is often a dynamic change in modes of access to foreign knowledge by latecomers and Lee (2005) explained this change in Korea. The first stage in the 1960s and early 1970s involved learning from foreign OEM buyers or through working in FDI companies. By the mid-1970s, when the latecomers recognized the need for more systemic learning and planned technological development, such firms tended to resort to technology licensing and actively sought learning or transfer from their FDI partners. By the mid-1980s the latecomers had established a certain degree of in-house R&D capacity with a clear idea of what should be done, how it should be done, and what resources should be allocated. Finally, with licensing or learning from foreign partners revealing its limits, the latecomers could rely on public-private R&D consortia, government research institutes (GRIs), research in the existing literature, overseas R&D outposts, co-development contracts with foreign specialists in R&D technology and/or international M&A.

Such dynamic change in access modes and learning ran in parallel with the evolution of the Korean IPR systems. During the early stages, IPRs were granted to minor inventions or adaptations by local residents and there was less need for domestic recognition of foreign IPRs (Lee et al., 2003). However, later on and with the growth of technological capacity, the need for international technology transfer and the local market for technology increased. Thus, protection of both domestic and foreign IPRs has now been provided. Since the late 1980s, Korea has substantially increased the level of its IPR protection and expanded the scope of patentable objects (Lee and Kim, 2010). Korea has now reached the highest level of development in the scope of the matters covered, including the most recent IPRs, biotechnological and business method inventions.

Along with the evolution of IP systems in Korea, Lee and Kim (2010) found the trends of several IPR variables over the course of progress in Korea of interest. First, in the early days of catch-up, Koreans filed mostly petty patents (utility models) and a few normal (invention) patents. It was only later that the share of invention patents began to exceed that of petty patents. Second, individual inventors filed more patents with corporations accounting for a small share. Later, the share of corporate patents outnumbered that of individual patents. Third, the relative shares between domestic vs. foreign patents in Korea show more dynamic patterns. In the past, foreigners had no interest in Korean IPRs and thus filed no patents, resulting in the dominance of domestic patents: this situation changed eventually when foreigners began filing most of the patents. With the growth of capabilities of domestic inventors (usually companies), their share of patent filings increased and outnumbered those filed by foreigners. These three trends suggest that the importance of patents and IPRs was not recognized by Korean firms until the mid-1980s. Earlier, Korea had been accumulating its absorptive technological capacity and focusing on utility models. In the mid-1980s, the country began to aggressively invest in its in-house R&D, which led to the rapid build-up of indigenous R&D capabilities.

While recent accounts show that the dynamic pattern in the development of technological capabilities in Korea seems to have flowed very successfully, there have been some critical junctures along the way. Such a period was in the late 1980s when there was a sudden increase in the level and scope of IPR protection. It was only in 1986 that the Korean IPR system first recognized product patents for pharmaceuticals; before then only process patents had been recognized. The origins of the amendment go back to 1981 when the US officially requested Korea to adopt the product patent fearing that Korean chemical producers would imitate US technology in pharmaceutical and agricultural chemicals. Its introduction was strongly opposed by the relevant

industries in Korea, particularly the pharmaceutical industry, over concerns of the increasing burden of royalty payments. This not only applied to pharmaceuticals, but also to other industries such as electronics where the number of international patent right conflicts and tensions was increasing.

A notable example was the case of Samsung Electronics Co. vs. Texas Instruments (TI), which involved 10 US patents on dynamic random access memory (DRAM) owned by TI. This action was one of many patent infringement actions brought by TI against Samsung when the latter refused to renew its patent licensing agreement with TI. After extensive litigation, agreement was reached with Samsung entering into a new patent licensing agreement worth more than 1 billion US dollars with TI. The case became a landmark that encouraged Korean companies to accord importance to inventions and patents. Samsung and other Korean conglomerates began to adopt a strategy for patent protection, including the establishment of a patent division, and encouraging researchers to invent more (Lee and Kim 2010). While major chaebol companies have grown powerful enough to use cross-licensing , the situation with smaller companies is different and often critical.

As explained in Lee and Kim (2010), the cases of the large, medium, and small-sized companies in Korea suggested a diversity of challenges and responses by the latecomers depending on their level of capability. First, medium-sized companies in Korea explored various ways to circumvent the barriers created by the IPRs. Mahoney et al. (2005) examined the role that IP considerations played in the development and commercialization of the recombinant DNA hepatitis B vaccine in Korea. It showed that Korean vaccine manufacturers were not significantly inhibited by existing IPRs in developing their vaccines, as they were able to identify ways to obtain the necessary IP protection through joint ventures. However, the cases of smaller companies showed that the incumbents could cause great damage to the small companies endeavoring to catch up (Lee and Kim, 2010). While some latecomers have been able to overcome that hurdle, some can easily become embroiled in the IPR trap, especially if they lose a court action or have no financial or technical capacities to handle the IPR dispute with the incumbents.

6. Conclusions

This paper's aim has been to provide an overview of the evolution of technological and IP development in Korea which is one of the few countries to have achieved a remarkable transformation from an LDC to a newly developed or first-world country. This economic and income growth has been accompanied by technological development, utilizing diverse learning channels ranging from OEM, licensing, in-house R&D, public-private consortia to oversee R&D posts and strategic alliances. This paper has shown that such dynamic changes in access modes and learning have run in parallel with the evolution of the Korean IPR system. In the early stages, IPRs were granted for minor inventions or adaptations by local residents while later on, with the growth of technological capacity, protection of both domestic and foreign IPRs has been provided. Korea has now attained the most-developed level in the scope of the matters covered, including the most recent IPRs: biotechnological and business method inventions. The evolution of the technology and IPR systems in tandem is interesting and indicates a need to conduct more in-depth studies based on reliable data and methodologies.

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Chapter 2

Intellectual Property Rights and Innovation in Economic Development in Korea

YEE KYOUNG KIM, KEUN LEE and KI-NEUNG CHOO,

ABSTRACT
This paper uses a dynamic perspective to analyze the changing role of IPRs through the course of economic growth, focusing on the changing roles of normal patent and utility models (petty patents). Our major findings were as follows. First, strong conventional patent protection measured by the patent rights index leads to the generation of more patents only at a later stage of development. Second, utility models have a positive impact on patent generation but their impact decreases with the enhancement of technological capabilities. Third, firms with utility models were associated with better performance during the early stages of economic development, although this impact decreases over time. Overall, these empirical findings imply that strengthening only the level of IPR protection regardless of the level of economic development may not be appropriate for developing countries with fewer technological capabilities.

1. Introduction

While Korea's rapid economic growth has often been associated with the role of government, another stream of research has focused on the role of upgrading technological capability in the course of economic development (L. Kim, 1997). After the 1980s, Korea became one of the world's leading patenting nations; US patents owned by Koreans rose from 14 in 1982 to 8,762 in 2009, and the Koreans' share in US patents rose from 0.01 per cent to 5.2 per cent over the same period (US Patent and Trademark Office (USPTO), 2009). In 2009, Korea ranked fourth in terms of patents granted in the US, after the US, Japan and Germany. What drove such a rapid increase in the development of technological capability in Korea? This paper aims to address this issue by investigating the role of IPRs. While a WIPO report by Lee at al. (2003) pursued a similar issue through a survey and qualitative analysis using descriptive data, this paper will conduct an econometric analysis using both time series and firm-level data.

It analyzes the role of IPRs from two different perspectives. First, we take a dynamic perspective to analyze their changing role throughout the course of economic growth. At an earlier stage in economic growth, catch-up economies tend to pursue an imitation-oriented technology strategy and are passive in protecting intellectual property or negligent in utilizing it as a tool for their catch-up strategy. However, in the later stages as their technological capabilities grow, they feel an increasing need to use the IP system. With this in mind, we will use both time series and panel data, and the index of patent rights to analyze the dynamic role of patent rights in technological development.

Second, we will examine the role of utility models (or petty patents) in Korea's technological development, as utility models might be important in the early days of its development. Due to the

lack of local technological capability before the 1980s, Korea depended heavily on reverse engineering and importing equipment and machinery from abroad (Lee et al., 2003). Thus, minor inventions that modified imported products were qualified for utility model protection rather than conventional patents. The number of utility model applications was higher than that for traditional patent inventions up to the late 1980s (Lee et al., 2003; Lee and Kim, 2010). Korean inventors were very active in filing utility model protection; thus, the role of utility models as a stepping stone to real innovation over the course of Korea's catch-up process is worthy of analysis. Nevertheless, few addressed the role of utility models in Korea's economic growth and firm performance, with the possible exception of Kim et al. (2012). This study aims to contribute by highlighting the important role of the utility model system in Korea's technological progress by analyzing extensive firm-level data covering the period 1970 to 1995.

In sum, this paper focuses on two issues. First, it empirically analyzes how IPR protection in Korea has affected innovation, addressing the role of IPR protection at each stage of economic development. For the analysis, both time series analyses using aggregate data and firm-level panel data from 1970 to 1995 are used. Second, it empirically analyzes how utility models in Korea have affected innovation/firm growth at the stage of imitation or innovation.

2. IPR Protection and Innovation in Korea

Can strong IPR protection generally stimulate more innovation regardless of the stage of economic development? Current academic and policy debates have focused on the effects of strong IPR protection in general, on raising developing country standards to developed country levels and on restricting imitations, piracy and infringement in developing countries. However, the possibility that stronger and different types of IPRs could have differential effects on countries at different stages of economic development has been acknowledged in the literature. There are theoretical models that explicitly consider the stage of economic development in determining the effect of stronger IPRs. For example, Eicher and Penalosa (2008) developed a theoretical model in which the size of the market must reach a certain minimum level for stronger IPRs to stimulate innovation and economic growth. The idea is that the value of innovation should be sufficiently high to make it economically worthwhile to create and invest in IPR institutions. Alternatively, it is possible for IPRs to have a negative effect on innovation for a country below critical market size. Grossman and Lai (2004) showed that the optimal level of IPRs depends on an economy's market size and innovative capacity. The smaller the market, the weaker the innovative capacity, the lower the optimal strength of IPRs should be. The feeling is that the deadweight losses of IPRs are greater if innovative capacity is too weak to compensate. Furthermore, the marginal benefits of stronger IPRs are greater if the market size is greater. As developing countries have both smaller markets and lower innovative capacity, balancing marginal costs and marginal benefits of IPRs occurs at a lower level than in developed countries. Hence, obliging less-developed economies to adopt standards of IPRs applying to developed countries would result in the economies of the former reaching a level of IP protection that exceeds their optimal level. Innovation in developing countries can therefore be adversely affected if their IPRs are raised above a level suitable to their environment of adaptive, incremental R&D and smaller market size.

There is empirical evidence on the differential impact of IPRs on both economic growth and innovation at different income levels. Falvey et al. (2006) used threshold regression analysis on panel data relating to 79 countries from 1975 to 1995. Controlling for country and time effects, they found that the response of economic growth to IPRs varies at different income thresholds. Empirical evidence on the effects of utility models on innovation and growth is based largely on

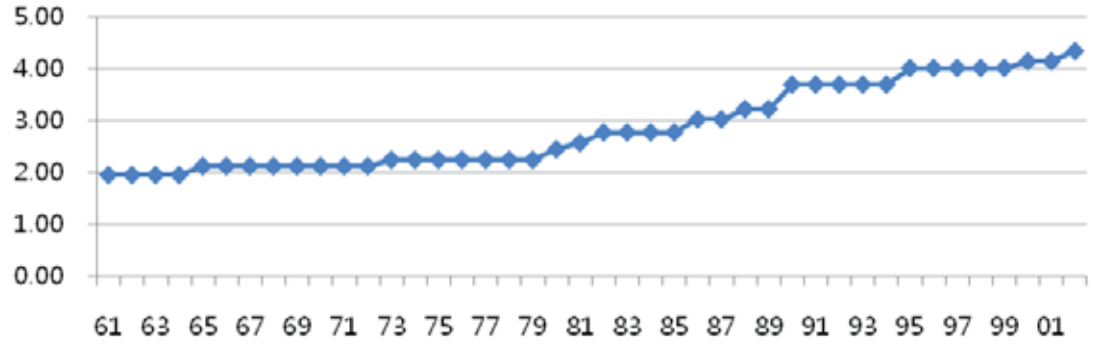
anecdotal evidence. Kumar (2002) argued that in East Asia, utility models help initiate a culture of patenting and innovation, and, in contrast, India does not provide utility model protection. Kumar (2002) also suggested that this may have adversely affected local engineering industries. The World Bank (2002) documented case studies in the farm machinery sector in Brazil and the rice sector in the Philippines where utility models allow domestic producers to adapt foreign innovations to local needs and conditions. Econometric evidence is provided in Maskus and McDaniel (1999), which found that such protection has, on balance, a positive impact on the growth of total productivity in Japan. Some development economists have paid close attention to the role of utility models.

In sum, our study built on previous empirical studies in the following ways: (1) we examined both patent rights protection and utility models as potential determinants of innovation and economic growth; (2) we controlled for the technological capabilities or the economic development status of Korea; (3) we utilized both time-series data and firm-level panel data in analyzing the impact of patent protection: previous econometric work had largely treated the country as the unit of analysis. We began with a time-series analysis and then examined the experience of Korean companies in order to illustrate how patent protection and utility models affect firm growth or innovation at different phases of technological development.

2.1. The IPR System in Korea

While Lee et al. (2003) elaborated on the institutional changes regarding the IPR regimes in Korea, the study did not try to measure the level of IPR protection. This paper provides a Korean patent rights index by adopting the methodology of Ginarte and Park (1997). For this purpose, we thoroughly reviewed the Korean patent laws. The patent rights index was originally constructed by Ginarte and Park (1997) for 110 countries quinquennially from 1960 to 1990, based on each country's national patent laws and was later revised (Park, 2008). Five categories of patent laws were examined: (1) extent of coverage; (2) membership of international patent agreements; (3) provisions for loss of protection; (4) enforcement mechanisms; (5) duration of protection. A value ranging from 0 to 1 was given to each of these categories (per country, per period). The unweighted sum of these five values constitutes the overall value of the patent rights index. The index, therefore, ranges in value from 0 to 5; higher values indicate stronger levels of protection. Except for duration (explained in the following section), each category consists of several conditions which, if satisfied, indicate a strong level of protection in that category. Each condition is of a binary character; indicated with a "yes" if it is satisfied or a "no" if it is not. For example, if a country satisfies all three conditions required for strong enforcement, it scores 3 out of 3 and earns a value of 1 for enforcement; if it satisfies only one condition, it receives a score of 1/3 for enforcement; our research team thus created a patent rights series shown in Figure 1, further details of which are presented in the Appendix.

Figure 1: Patent Rights Index in Korea (1961-2002)



Note: Revision of Choi and Lee (2005), following Ginarte and Park (1997) and Park (2008).

Figure 1 shows the major changes in Korea's IP system. It was initially established in the early 1960s by adopting the first-to-file (apply) rule and a 12-year term of protection and compulsory licensing and it substantially changed in the 1980s by joining international patent treaties, which is shown as major increases in Figure 1. For example, Korea signed up to the WIPO Convention in 1979 and acceded to both the Paris Convention for the Protection of Industrial Property in 1980 and the Patent Cooperation Treaty (PCT) in 1984.

Consistent with international standards, the laws extended the patent protection term from 12 to 15 years. Nevertheless, up to the early 1980s, the IPR system in Korea was relatively weak compared with other advanced countries: the average patent rights index of high-income countries in 1985 was 2.89, which is higher than 2.77 (of Korea) in 1985. However, revisions of the Patent Law in 1986 and 1987 introduced the substance patent for pharmaceutical and chemical materials and product patent protection for computer software and materials respectively. Subsequent revisions of the IPR system in 1990, 1993 and 1995 included the patentability of plants (1990 revision), the Agreement on Trade-Related Aspects of Intellectual Property Rights (WTO/TRIPS)-related revision effective from January 1995, which extended the term of patents to 20 years, and established the IP Tribunal in 1998 (1995 revision). This pattern was reversed in the 1990s and in 1990, the average patent rights index of high-income countries was 3.08, whereas that of Korea was 3.69. Thus, 1986 marked an important period in Korean patent law history (Lee and Kim, 2010).

2.2. Utility Model System in Korea

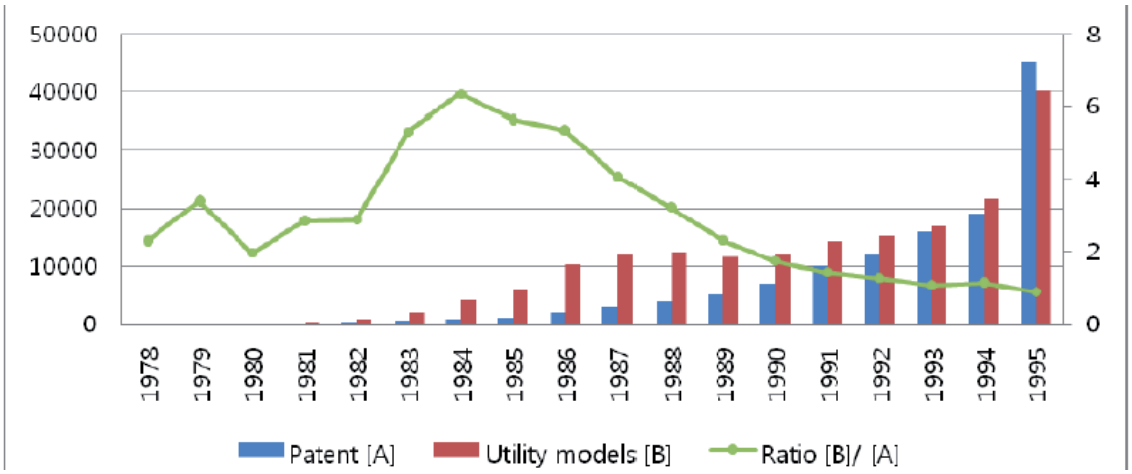
Utility models concern second-tier protection for minor inventions, such as devices, tools and implements, particularly in the mechanical, optical and electronic fields. Processes or methods of production are excluded (Kim et al., 2012). The duration of protection is typically six to 10 years, and technical details must be disclosed. Applications for utility models are generally less expensive and do not require substantive examination. While the inventive step required is low, the invention must exhibit a practical or functional advantage over existing prior art (Beneito, 2006). For example, utility model status is granted to devices embodying a creative idea applicable to the shape, structure or other technological aspects of a product. In sum, utility models and patents differ in that they protect different types of innovations. In other words, patents protect innovations with a relatively high degree of inventiveness, while utility models protect innovations with a relatively low degree of inventiveness. Thus, utility model protection is easier to obtain, particularly for smaller inventions, although requirements can vary within and between countries.

The Law of Utility Models in Korea was enacted in 1961 and has been revised several times. Initially, utility models were subject to substantive examination, and conversion between patents

and utility models was allowed. However, to facilitate the application process for utility models, KIPO adopted its Quick Registration System (QRS) in 1999. Under this system, utility models could be registered immediately after completing a form and fulfilling the basic requirements, but they were not submitted to substantive examination; the latter only in case of an infringement of utility model rights. This system was adopted to offer earlier protection than was required for utility models due to a shorter life cycle of the products that incorporated them. Under this system, dual application instead of modification of application was adopted. However, the system was abandoned in 2006 due to the surge in utility models which did not qualify, although consequently, the substantive examination was reintroduced. For filings in Korea after July 1, 1999, the term of protection was limited to 10 years from the date of filing for utility models, which is shorter than the 20 years required for patents. Furthermore, Korea does not allow for the renewal of utility model protection, whereas Thailand provides for a maximum of four years (i.e. two renewals for a period of two years each).

Korea is one of the developing countries where utility models have been intensively exploited. As the technological capabilities of Korean companies lagged during the 1960s and 1970s and as they did not possess the resources to conduct highly innovative R&D, they relied heavily on imported technologies and on reverse engineering, adapting them for local needs (L. Kim, 1997; Lee et al., 2003). Due to poor technological capabilities in Korea in the early stages of development, the number of utility model applications exceeded those for traditional patents up to the early 1990s (see Figure 2). In the 1970s and the early 1980s, the ratio of utility models to patents was nearly two to three. This ratio began to decline after 1984, the year when it peaked at more than six. Although levels of patent and utility model applications were both rising, the pattern began to shift and by 1995, patent applications exceeded the number of utility model applications. These trends corresponded to the transformation of Korea from a nation with limited technological resources and capabilities to one of the leading patenting nations.

Figure 2: Patent and Utility Model Applications of Korean Firms



Source: data are complied by the authors using KIPRIS (Korean Intellectual Property Rights Information Service) data downloadable from KIPRIS website. Taken from Kim et al.(2012)

3. Growth of Technological Capabilities in Korea

The mid-1980s proved to be a turning point for Korea, dividing its economic development into two time periods. Before this time, Korea was relatively resource-poor and technologically lagging, whereas from the mid-1980s, its indigenous R&D capabilities began to grow markedly as did its expertise in technology. As evidence of this, we can cite a large increase of both in-house R&D activities in the private sector and corporate R&D centers in Korea in the mid-1980s.

Korea has since built up its technological capabilities by emphasizing in-house R&D in the private sector and increasing the aggregate R&D/GDP ratio beyond 1 per cent to reach 2.5 per cent or more. Along the path of development, latecomers eventually reached the stage where in-house R&D was the main form of technology acquisition. In the case of Korea, the motivation for transition from licensing in of technology to in-house R&D was three-fold (OECD, 1996, pp.91-92). First, foreign companies became more reluctant to provide core technology. Second, after the early 1980s, Korea lost its comparative advantages of cheap skilled labor; as a result, Korean companies recognized the need to develop their own technological capabilities. Third, government policy also changed to support private R&D. For example, the Korean Government enacted the Technology Development Promotion Act in 1972. The share of R&D in sales in private firms was around 0.5 per cent in 1982, and it reached 1 per cent by the mid-1980s, rising to 2 per cent by the early 1990s (OECD, 1996). While not comparable with corporate R&D in the 1970s, the size of private sector R&D reached the same level by the mid-1980s, and it has accounted for more than 80 per cent of the total R&D in Korea since the early 1990s, as shown in Table 1.

Table 1: Composition of R&D Expenditure in Korea

	Total		Government Sector			Non-Government/Private Sector		
Year	Amount	Percentage change	Amount	Percentage change	Share (%)	Amount	Percentage change	Share (%)
1978	1,836		1,056		57.52	780		42.48
1979	2,986	62.6	2,194	107.8	73.48	792	1.5	26.52
1980	2,825	-5.4	1,800	-18	63.72	1,025	29.4	36.28
1981	3,668	29.8	2,016	12	54.96	1,652	61.2	45.04
1982	5,331	45.3	2,643	31.1	49.58	2,688	62.7	50.42
1983	6,822	28	2,312	-12.5	33.89	4,510	67.8	66.11
1984	9,072	33	2,515	8.8	27.72	6,557	45.4	72.28
1985	12,371	36.4	3,068	22	24.8	9,303	41.9	75.2
1986	16,069	29.9	3,743	22	23.29	12,326	32.5	76.71
1987	19,852	23.5	4,902	31	24.69	14,950	21.3	75.31
1988	24,542	23.6	5,230	6.7	21.31	19,312	29.2	78.69
1989	28,173	14.8	5,750	9.9	20.41	22,423	16.1	79.59
1990	33,499	18.9	6,510	13.2	19.43	26,989	20.4	80.57
1991	41,584	24.1	8,158	25.3	19.62	33,426	23.9	80.38
1992	49,890	20	8,785	7.7	17.61	41,105	23	82.39
1993	61,530	23.3	10,390	18.3	16.89	51,140	24.4	83.11
1994	78,947	28.3	12,602	21.3	15.96	66,345	29.7	84.04
1995	94,406	19.6	17,809	41.3	18.86	76,597	15.5	81.14
1996	108,780	15.2	24,113	35.4	22.17	84,667	10.5	77.83
1997	121,858	12	28,625	18.7	23.49	93,233	10.1	76.51

Source: Science and Technology Annual 1999 available from the Korea Industrial Technology Association website (www.koita.or.kr). Unit: 100 million Korean Won (the foreign sector is not included).

The number of corporate R&D centers in Korea also began to increase substantially after the mid-1980s. Since large Korean firms opened R&D laboratories in major industries in the late 1960s (Amsden, 1989), the number of corporate centers rose from three in 1967 to 14 in 1976 (Amsden, 1989). As shown in Table 2, there were 45 such centers in 1981. By 1986, a mere five years later, the number had increased more than fivefold. In particular, in 1986, the number of R&D institutes

established each year sharply increased by more than 100 per cent, and, in 1986, the number of corporate R&D centers was over 200. They amounted to more than 500 in 1988 and finally to 1,000 in 1991, as shown in Table 2. The rise in the number of corporate R&D centers indicates that more Korean companies were able to fund their own internal R&D activities. The primary purpose of such laboratories originally lay in facilitating the transfer of designs and production processes from overseas. However, their roles later began to be focused more on new product development (Amsden, 1989).

Table 2: The Establishment of Corporate R&D Centers by Year

Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
New establishment	45	26	31	31	39	89	145	146	110	121
Accumulated no.	45	71	102	133	172	261	406	552	662	783
Year	1991	1992	1993	1994	1995	1996	1997	1998 Total (as of 1998)		
New establishment	179	200	238	263	313	394	556	834		3,760
Accumulated no.	962	1,162	1,400	1,663	1,976	2,370	2,926	3,760		

Source: Korea Industrial Technology Association available at www.koita.or.kr.

Overall, Korea's indigenous R&D capabilities began to grow markedly from the mid-1980s; the growth rate of utility model filings began to decline, and the number of patent applications began to rise. In addition, patent protection began to increase relatively strongly with major reforms in patent law from the mid-1980s. Thus, the question is whether all these events are connected: did patent protection or utility model protection provide incentives to innovate and help pave the way for increased technological development?

4. Hypothesis and Empirical Results

4.1. Patent Protection and Innovations

Based on the foregoing, we set up a hypothesis to examine how IPR protection has affected innovation through the stages of economic development in Korea. As a developing country with low innovative capacity, a relatively lower level of IPR protection might have been more suitable for incremental or adaptive innovations. It would have permitted Korea to imitate the technology of advanced countries, leading to its eventual rapid progress in technological capability. However, once Korea's technological capacity grew, it needed to establish a stronger IP system to protect its innovations. This hypothesis will be tested in both time-series analysis and firm-level panel analysis.

Hypothesis I:
In Korea, patent protection has been positively associated with innovation only since Korea acquired greater technological capability.

For Hypothesis I to test the linkage between IPRs and innovation, both time-series analysis and panel-data analysis have been carried out. The dynamic effect of IPRs can be captured by time-series data, but we have reinforced our analysis with firm-level panel analysis, which has many advantages over time-series analysis. First, panel data can control for individual heterogeneity. Second, panel data with a large number of data points improves the efficiency of econometric estimates by increasing the degree of freedom and reducing the collinearity among explanatory variables (see Hsiao, 2003).

4.1.1. Time-Series Analysis

For the time-series analysis, annual data from 1965 to 2001 acquired from the Korea Institute of Patent Information and the Bank of Korea were used. The variables were first-differenced to resolve the non-stationary problem. The dependent variable is the growth rate of the total number of patents in Korea (Δ(log of no. of patent application)). The main explanatory variable, the patent rights index, was reconstructed as annual time-series data for Korea, following the method of Ginarte and Park (1997) and Park(2008)[2]. To control for other factors that could influence the growth of patent applications, we included two control variables such as R&D expenditure (Δ(log of RD)) and GDP (Δ(log of GDP)). The former is the input of innovation, while the latter is to control for the high propensity of generating innovation in an economy which is becoming more advanced and knowledge-based. To estimate the effect of patent rights protection, which can differ period by period, we examined the regression using IPR dummy variables. Model (1) uses the dummy variables dividing the entire 36 years into six sub-periods in which the level of patent rights protection remains constant. Model (2) uses a high-IPR dummy that divides the entire period into two high/low patent rights protection periods. The threshold year is 1986, when Korea's technological capacity began to increase. The models are specified as follows.

Time-Series Model

$$(1)\ \Delta(\log \text{ of no. of patent application})_t = \alpha_1 + \alpha_2(\Delta(\log \text{ of } RD)_t + \alpha_3(\Delta(\log \text{ of } GDP)_t + \alpha_4 \cdot IPR \text{ dummy}2_t + \alpha_4 \cdot IPR \text{ dummy}3_t + \cdots + \alpha_6 \cdot IPR \text{ dummy}6_t + e_t$$

$$(2)\ \Delta(\log \text{ of no. of patent application})_t = \alpha_1' + \alpha_2'(\Delta(\log \text{ of } RD)_t + \alpha_3'(\Delta(\log \text{ of } GDP)_t + \alpha_4' \cdot High\ IPR\ Dummy_t + e_t$$

Models (1) and (2) aim to test whether the impact of the patent rights index on the growth of patent applications differ by period.

The regression results in Table 3 show that the impacts of IPR dummy variables were insignificant during the early stage of development, while the positive impacts of IPR dummy variables on the technology changes began to be significant from 1986 as shown in model (1). However, the IPR dummy 6 was found to be insignificant, which may suggest that over-strong protection would reinforce the patent holder's monopoly and discourage potential innovators. Nevertheless, overall, strong patent protection was found to be positively associated with innovation once Korea began to engage in in-house R&D activities in 1986. Model (2) supports this hypothesis; it uses a high IPR dummy variable to compare its impact before and after 1985 (high IPR dummy for 1965 to 1985 = 0, high IPR dummy for 1986 to 2001 = 1). The dummy variable has a positive and significant coefficient, indicating that patent rights protection began to be a critical key determinant of innovations only after 1986 when Korea started to engage in in-house R&D activities. These results suggest that the policy to strengthen patent protection is more appropriate for countries that have acquired a certain level of technological capability than those whose technologies are relatively undeveloped. Thus, the phase of technological development needs to be considered when designing a patent protection policy.

2 Park (2008) added new categories such as patentability of software, TRIPS and the Budapest Treaty.

Table 3: Impact of Patent Rights Index on the Changes in Patent Applications

Dependent Variable: Δ(log of no. of patent application)		
	(1)	(2)
Δ (log of RD)$_t$	0.494 (1.93)*	0.543 (2.26)**
Δ (log of GDP)$_t$	1.034 (1.13)	0.216 (0.38)
IPR dummy 2 (1973-1979)	-0.093 (-0.89)	
IPR dummy 3 (1980-1985)	0.076 (0.72)	
IPR dummy 4 (1986-1989)	0.209 (2.51)**	
IPR dummy 5 (1990-1994)	0.141 (1.78)*	
IPR dummy 6 (1995-2001)	0.241 (1.59)	
High IPR dummy (1986-2001)		0.132 (2.22)**
Constant	-0.271 (-1.37)	-0.106 (-1.09)
Adjusted R^2	0.184	0.224
F value	2.194	4.562
Observations	36	36

Note: *** p<0.01, ** p<0.05, * p<0.1, t-statistics are in parentheses. White-Sandwich standard errors were used.

4.1.2. Firm-Level Panel Analysis

While we took Korea as the unit of analysis in the previous section, the dynamic perspective of IPRs on innovations can also be analyzed using firm-level panel data. This type of analysis can provide a better understanding at the micro-level on how Korean companies changed their innovative activities under the different patent protection regimes. Korean firm-level data cover the period 1970-1995 and this specific period should suffice for our analysis as it covers Korea's transition from a low- or middle-income country to a high-income, industrialized country.

We compiled a detailed database of firm-level patents and utility models and matched it to standard company financial data. Patent and utility model data were downloaded from the Korea Intellectual Property Rights Information System (KIPRIS), and standard financial data from Lee et al. (2007, 2008) . These data were the most extensive firm-level data available for Korea. From a total of 17,165 companies in the dataset, we identified 3,635, the selection criterion being that a company should have applied for at least one utility model or patent. We limited the analysis to this data subset, as our goal was to understand the impact of utility models on firm performance as well as the direct impact of utility models and patent rights protection on patenting.

To test the impact of patent rights protection on innovations, knowledge production function (e.g., Pakes and Griliches, 1980, Hausman; Hall and Griliches, 1984) was augmented by adding the relevant interested variable of the patent-rights index. In other words, this examined its impact, after controlling for the input of R&D expenditure. We used contemporaneous R&D following the extensive volume of literature (e.g. Hall et al., 1986). Evidence suggests that R&D activities and innovation occur somewhat simultaneously. Moreover, if a firm attempts to patent an innovation, it files the application while the innovation is being developed or very shortly afterwards (Hall et al., 1986). The one-period lagged patent rights index was used to control for potential endogeneity between IPR protection and innovation. In this specification, we used a negative binomial model as the number of patents applied for by a company in a given year was a non-negative count variable with a high number of zeros.

3 Lee et al. (2007, 2008) constructed their data mainly from the firm-level database of the Korea Information Service (KIS) as well as other sources.

To control for business fluctuation, all variables were five-year averaged. For other control variables, firm size helped us to control for economies of scale in generating patents due to the fixed costs of maintaining a legal department handling IP matters (Lerner, 1995; Lanjouw and Lerner, 1996). The age of a firm helped control for increased efficiency due to entrepreneurs honing their abilities over time (Jovanovic, 1982; Evans, 1987). Further, other control variables include time trend and industry dummy variables. Time trend controls for the general economic conditions and market environments that are subject to change over time. Further, firms may vary in their propensity to innovate. The model specification is as follows.

Firm-level Panel Data Model

$$(3)\ \left(No.\ of\ patent_{it}\right) = exp\begin{pmatrix} \gamma_0 + \gamma_1\left(log\ of\ R\&D\ expenditure_{it}\right) + \gamma_2\left(\ log\ of\ \text{patent rights index}_{t-1}\right) \\ +\gamma_3\ firm\ age_{it} + \gamma_4\ firm\ size_{it} + \gamma_5\left(\ log\ of\ \text{patent rights index}_{t-1}\right) * time\ \text{trend} \\ +\gamma_6\ time\ trend_t + \gamma_7\ industry\ dummies_j \end{pmatrix}$$

where i = firm, j = industry, t = period

Table 4 presents the firm-level results of Hypothesis I regarding the impact of the patent rights index on knowledge generation. Both pooled negative binomial and random effect negative binomial methods were adopted. However, the firm-specific random effect negative binomial model is preferable given that the likelihood ratio test, which compares the panel estimator with the pooled estimator, is statistically significant $\bar{\chi}^2$((01)=1093.09, p-value=0.00 for model (3) and $\bar{\chi}^2$(01)=1091.78, p-value=0.00 for model (4); thus, the interpretation was based on models (3) and (4). In (3), R&D expenditure was found to be positively significant, whereas the patent rights index was found to be negative but insignificant. Overall, this indicates that strong patent rights protection does not spur innovation, but higher R&D input increases the probability of patent generation.

However, the impact of patent rights protection on patent generation could differ as technological capabilities grow. To capture how the impact of patent rights protection changes, an interactive term of patent rights index with time trend is included. The result of model (4) with the interactive term with time trend supports Hypothesis I as it finds the interaction term to be significantly positive even after controlling for R&D expenditure. This supports the proposition that strong IPR is positively associated with patents only after companies have become technologically advanced. We noted that larger firms (higher numbers of employees) tended to produce more patentable innovations, which is a feature of Schumpeterian-type models, while the age of a firm had an insignificant and negative association with patent generation.

$\bar{\chi}^2$

Table 4: Relationship between Innovation and IPRs

Dependent Variable: No. of Patent Applications by Firms				
	(1) Pooled	(2) Pooled	(3) RE	(4) RE
Log of R&D expenditure $_{t}$	0.105***	0.105***	0.0815***	0.0830***
	(8.327)	(7.940)	(8.120)	(8.282)
Log of patent rights index $_{t-1}$	-0.29	-8.317*	-1.985	-6.589**
	(-0.0671)	(-1.684)	(-0.642)	(-2.060)
Time* (Log of patent rights index) $_{t-1}$		1.999***		1.305***
		(2.583)		(2.886)
Time	1.246**	-0.407	1.551***	0.329
	(2.061)	(-0.501)	(3.612)	(0.607)
Firm age $_{t}$	-0.0117**	-0.0124***	-0.005	-0.005
	(-2.492)	(-2.602)	(-1.014)	(-1.051)
(Log of employees) $_{t}$	1.180***	1.189***	0.725***	0.720***
	(21.000)	(21.020)	(16.060)	(16.040)
Constant	-15.06***	-6.724*	-10.54***	-5.081**
	(-7.793)	(-1.767)	(-6.625)	(-2.090)
Industry dummy	Yes	Yes	Yes	Yes
Observations	4516.000	4516.000	4516.000	4516.000
Log likelihood	-2883.740	-2878.480	-2804.190	-2800.010
Wald chi2	4045.586	3901.300	1452.238	1568.567
Prob>chi2	0.000	0.000	0.000	0.000
Number of firms	2093	2093	2093	2093

Note: All data are five-year averaged. *** p<0.01, ** p<0.05, * p<0.1, t-statistics are in parentheses; 21 industry dummies are included, White-Sandwich standard errors are used for pooled regression.

4.2. Utility Models and Innovations/Firm Performances

As shown in the previous section, a strong patent rights index was not a determinant in spurring patent applications when Korea was technologically underdeveloped. Rather, weak patent protection could have encouraged Korean companies to acquire advanced technologies from abroad. Indeed, some scholars (e.g. Hanson, 2008) pointed out that the Korean Government tried "to minimize patent rights protection to help domestic firms use foreign intellectual property during its manufacturing 'imitation' stage, and laws and regulations were formulated in such a way to meet minimal international standards". However, it is hard to believe that rapid accumulation of technological capability would automatically have been achieved with only minimal patent protection. For example, in contrast to Korea, India's weak patent protection did not spur much economic or technological growth. Thus, it seems unreasonable to attribute Korea's rapid success uniquely to weak patent rights protection.

Instead, this paper focuses on a second-tier form of IP protection, i.e. utility models as a useful stimulus to a developing country's technological capacity. Rather than a traditional patent, innovations produced may merit second-tier IPRs. Thus, institutions to protect incremental innovative activities rather than radical innovations would be more effective in encouraging these activities and hence economic growth. The utility model system is potentially considered such an institution (Evenson and Westphal, 1995). Kumar (2002) suggests that in Korea's unprecedented rapid catch-up experience, imitative innovation protected by utility models can be a stepping stone to building the capability to generate future patentable inventions. Through adaptation, imitation and incremental innovation, companies in developing countries acquire knowledge and enjoy learning-by-doing (Suthersanen, 2006). While Korea's patent rights protection deserves credit for innovations at the later stage of technological development, it was the availability of utility models that provided incentives to inventors with fewer resources or limited technological capabilities. This enabled them to acquire and accumulate knowledge through learning-by-doing and provided them with a stepping stone for further technological progress.

4.2.1. Utility Models Leading to Regular Patents

We aimed to test whether a utility model system could eventually stimulate regular inventions. This hypothesis is in contrast to the view that underplays the value of technological imitation. Rather, imitation and diffusion of technologies must be seen as a continuation of the innovative process (Silverberg, 1990). Therefore, to some extent, creativity is needed to copy technology developed abroad. Cimoli and Dosi (1995) pointed out that the sequences linking copy to creativity are two sides of the same coin. Thus, we tested the hypothesis that experience in producing minor inventions (i.e. utility models) is an important determinant of a company's technological capacity to produce inventive innovations (i.e. patents). This proposition concerning the learning effect of utility models was tested using Equation (4).

Hypothesis II:

Experience in producing minor inventions is an important determinant of a company's technological capability to produce major innovations.

$$(4)\ \left(No.\ of\ patent_{it}\right) = exp\begin{pmatrix} \lambda_0 + \lambda_1\left(log\ of\ R\&D\ expenditure_{it}\right) + \lambda_2\left(utility\ \bmod el_{it-1}\right) \\ +\lambda_3\left(utility\ \bmod el_{it-1}\right) * time\ trend_t + \lambda_4\ firm\ age_{it} + \lambda_5\ firm\ size_i \\ +\lambda_6\ time\ trend_t + \lambda_6\ industry\ dummies_j \end{pmatrix}$$

$$\text{where i} = \text{firm},\ \text{j} = \text{industry},\ \text{t} = \text{period}$$

The model for Hypothesis II includes utility models and R&D expenditure to measure the amount of available knowledge within a company. The key variable is the utility model, which has a binary value. It is equal to 1 if the firm applied for more than one utility model in a particular year; otherwise, it is 0. Thus, the utility model variable may vary between 0 and 1 within a firm depending on the year. To test whether knowledge acquired through past utility models provides a stepping stone for further technological progress, we included lagged utility models (i.e. one period is equivalent to a five-year lag) in the model. The logic behind learning-by-doing is that in generating minor inventions, companies acquire knowledge by gaining access to or learning from existing advanced technologies. However, accumulating knowledge that allows them to generate future new patentable inventions is an incremental process and therefore takes time. For this reason, we modeled and examined relatively long time-lags (e.g. five years; a one-period lag means taking values from the previous five years). As for the control variables, firm size helped to control for economies of scale due to the fixed costs of maintaining a legal department handling IP matters (Lerner, 1995; Lanjouw and Lerner, 1996).

Table 5: Impact of Utility Models on New Knowledge Generation

Dependent Variable: No. of Patent Applications				
	(1) Pooled	(2) Pooled	(3) RE	(4) RE
(Log of R&D expenditure)$_t$	0.150***	0.150***	0.107***	0.105***
	(11.130)	(10.630)	(11.200)	(10.810)
Firm age$_t$	0.00715	0.00697	0.00194	0.00233
	(1.157)	(1.054)	(0.415)	(0.498)
Firm size dummy (50-300 employees)	-0.120	0.201	0.215	0.230
	(-0.859)	(0.840)	(0.884)	(0.943)
Firm size dummy (300-1,000 employees)	0.624***	1.156***	0.933***	0.966***
	(2.895)	(4.038)	(3.540)	(3.657)
Firm size dummy (more than employees)	2.657***	3.376***	2.207***	2.248***
	(9.963)	(9.770)	(7.938)	(8.043)
Time	0.953***	1.344***	1.214***	1.327***
	(12.680)	(11.950)	(21.670)	(16.780)
(Utility model)$_{t-1}$	1.038***	3.045***	0.461***	1.170***
	(7.971)	(5.323)	(4.916)	(3.365)
(Utility model)$_{t-1}$* time		-0.577***		-0.207**
		(-3.642)		(-2.116)
Constant	-7.809***	-10.19***	-7.775***	-8.332***
	(-11.55)	(-11.26)	(-9.079)	(-9.256)
Observations	8372.000	8372.000	8372.000	8372.000
Log likelihood	-3835.83	-3097.09	-2948.94	-2946.67
prob>chi2	0.00	0.00	0.00	0.00
Wald chi2	1572.864	4389.655	1613.697	1492.969
Number of firms	2093	2093	2093	2093

Note: All data are five-year averaged. *** p<0.01, ** p<0.05, * p<0.1, t-statistics are in parentheses; 21 industry dummies are included; White-Sandwich standard errors are used for pooled regression.

Table 5 shows the results of Hypothesis II in testing whether utility models tend to stimulate innovative inventions at later stages. As the likelihood ratio test prefers the random effect negative binomial models to the pooled negative binomial model (X^2((01)=1233.08, p-value=0.00 for model (3) and X^2(01)=1195.25, p-value=0.00 for model (4), the interpretation will be based on models (3) and (4).

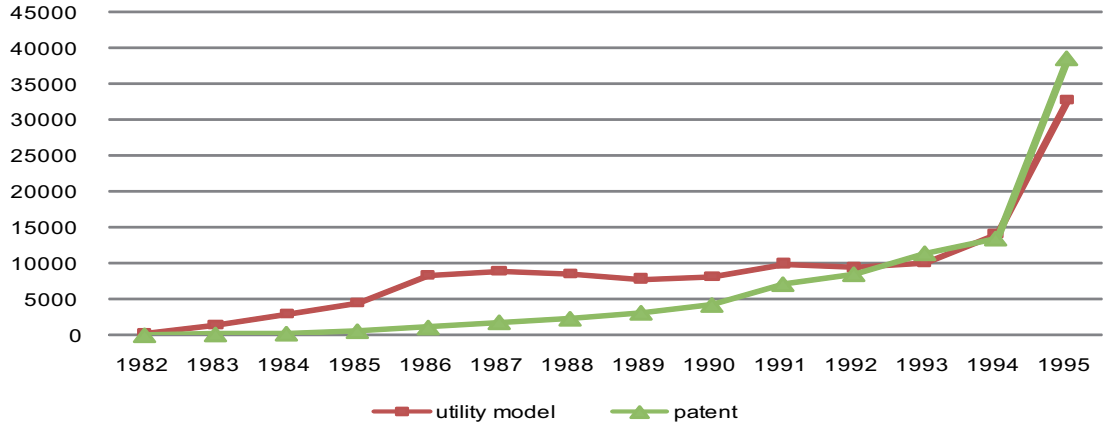
Model (3) in Table 5 indicates that firms with utility models have a higher probability of applying for the new patent even after controlling for R&D expenditure. Empirically, utility models are found to be beneficial in enhancing their technological capabilities. That is, new patentable innovations of firms build upon the knowledge acquired through utility models as well as on enhanced R&D activity. The results support the hypothesis that through adaptation, imitation and incremental innovation, firms can acquire learning-by-doing (Suthersanen, 2006).

However, the relative importance of utility models is reduced as technological capabilities grow to enable companies to conduct R&D activities targeting higher levels of innovation. Model (4) tests whether the impact of utility model on the flow of new patents differs as companies develop their technology over time. Such an impact is captured by the interactive term of utility model and time trend. The result in model (4) indicates that utility model increases the probability of patent applications, whereas its impact as the knowledge source for patent generation diminishes as Korea's technological capabilities rise. The same result holds when we add both a variable for time trend and a full set of dummy variables for each year.[4] This result therefore supports the hypothesis that the utility model system is beneficial to developing countries or technologically poor companies.

4 The results are available upon request.

Further, the diminishing impact of utility models implies that Korea's current technological capabilities are the outcome of both adaptive innovation efforts (utility models) during the early stages of development and real innovative activities, encouraged by strong patent rights protection during the later stage of development; in other words, lack of either may not guarantee technological development. Thus, the proper design and strength of an IPR system tailored to indigenous technological capacities is required to achieve successful industrial dynamics in countries such as Korea.

Figure 3: Trend of Utility Models vs. Patents of Top 10 Patent Applicants (as of 1995)



Source: KIPRIS data compiled by the authors.

Data presented in Figure 3 show that the top 10 patent applicants in Korea tended to apply for more utility models than in the early 1990s, thus supporting the role of the learning mechanism of utility models. The top 10 patent applicants included Samsung Electronics, LG Electronics, Daewoo Electronics, Hyundai Automotives, etc. In sum, Korea's experience suggests that the design and strength of IPR systems should be tailored to the indigenous technological capacities of developing countries to provide the appropriate incentives for innovation.

4.2.2. The Impact of Utility Models on Firm Performance

A key function of a patent is to help a firm achieve sufficient returns on its investment when commercializing new technology through better positioning in the market (Geroski et al., 1993; Geroski and Machin, 1993; Granstrand, 1999). Thus, if this function is fulfilled, the result of the innovative process may be associated with superior performance. Previous empirical findings show a positive association between patents and corporate performance at the firm level. However, several limiting factors make it difficult to profit from innovations, such as the inability to prevent other firms from copying the technology; the high cost of or limited access to capital or related technology; the challenge of putting a product into production in time and the high cost of marketing, as shown by a survey in Lee et al. (2003). Thus, firms at an early stage in their development and with poor resources may find incremental innovation important in helping to position themselves in existing markets at minimal cost. Consequently, utility models, which represent incremental innovations, are expected to be positively associated with the performance of firms at an early stage in their growth.

Therefore, the hypothesis can be set up as follows:

Hypothesis III
Firm growth is positively associated with minor inventive activity, particularly if a firm is technologically lagging.

$$(5)\ \left(Sales\ \text{Growth}_{it}\right)=\begin{pmatrix}\delta_0+\delta_1\left(log\ of\ R\&D\ \text{intensity}_{i,t-1}\right)+\delta_2\left(utility\ \text{mod}el_{it}\right)\\+\delta_3\left(utility\ \text{mod}el_{it}\right)*time\ trend_t+\delta_4(\log\ \text{of investment}_{it})\\+\delta_5(\log\ \text{of}\ firm\ age_{it})+\delta_6(\log\ \text{of employees}_{it})+\delta_7 time\ trend_t\\+\delta_8\ industry\ dummies_j+\delta_i+\upsilon_{it}\end{pmatrix}$$

$$\text{where i = firm, j = industry, t = period}$$

Hypothesis III was tested using the sales growth equation with a variable for utility model application after controlling for R&D intensity (i.e. the ratio of R&D expenditure to sales), investment, number of employees and the age of a firm. R&D intensity was lagged in this model, taking account of the time lag between R&D activities and product manufacture. Investment and employment variables were used to control for the effects of factor inputs. The age of a firm helps control for growth in efficiency due to entrepreneurs learning about their abilities over time (Jovanovic, 1982; Evans, 1987). Table 6 presents the results of regression analysis for Hypothesis III. Here, performance is assessed using a firm's five-year average sales growth. Firm heterogeneity is controlled with fixed effect estimation. As the Hausman test rejected the null hypothesis that the coefficients estimated by the efficient random effects estimator are the same as the ones estimated by the consistent fixed effects estimator, we reported the fixed effect results ((X^2 (06)=43.98, p-value=0.00 for model (3) and (X^2(07)=46.43, p-value=0.00 for model (4).

Model (3) in Table 6 suggests that firms with utility models were not associated with better firm performance for the entire period. However, the impact of utility models changed by period. When utility models interacted with the time trend as in (4), the coefficient of the utility model dummy was found to be significant and positive, although this positive impact decreased with time; the negative and significant coefficient of the interaction term of the utility model and time trend indicating that the importance of utility models decreased as Korea began to acquire greater technological and R&D capabilities. The same results held when we tried the system of generalized method of moments (GMM) estimation, not with a dummy for utility models but with a variable showing the number of utility applications.[5]

The implication is that utility models are likely to be appropriate for companies that are resource-poor or are below the technological frontier. R&D intensity, investment, and labor control variables all have significant positive associations with sales growth, while the age of a firm has a significant negative association (i.e. newer firms generally show faster growth in sales). These results are consistent with Jovanovic (1982) and Evans (1987).

5 The results with the number of utility applications are not reported here but in Kim et al. (2012) where internal innovative knowledge was measured by patents instead of R&D intensity.

Table 6: Impact of Utility Models on the Sales Growth of Companies

Dependent Variable: Five-year Average Sales Growth Rate				
	(1) OLS	(2) OLS	(3) Fixed Effect	(4) Fixed Effect
(Log of R&D intensity) $_{t-1}$	0.0718***	0.0719***	0.0345***	0.0356***
	(5.999)	(6.009)	(2.859)	(2.954)
(Log of Investment) $_{t}$	0.244***	0.244***	0.132***	0.132***
	(8.228)	(8.226)	(3.880)	(3.898)
Utility model $_{t}$	0.0127	0.205	-0.0172	0.478*
	(0.411)	(0.858)	(-0.345)	(1.918)
Utility model $_{t}$ * time		-0.0424		-0.114**
		(-0.814)		(-2.028)
(Log of firm age) $_{t}$	-0.362***	-0.362***	-0.693***	-0.683***
	(-7.660)	(-7.657)	(-3.870)	(-3.822)
(Log of employees) $_{t}$	0.0787***	0.0782***	0.355***	0.361***
	(5.486)	(5.442)	(6.160)	(6.275)
Time	-0.0108	0.0132	-0.00825	0.0563
	(-0.390)	(0.321)	(-0.151)	(0.893)
Constant	1.275***	1.172***	0.509	0.167
	(6.290)	(4.839)	(1.173)	(0.360)
Observations	1668	1668	1668	1668
R-squared	0.32	0.32	0.215	0.22
F-stat	18	17.5	27.81	24.55
Prob	0.00	0.00	0.00	0.00
Number of firms	1051	1051	1051	1051

Note: All data are five-year averaged. *** p<0.01, ** p<0.05, * p<0.1, t-statistics are in parentheses; 21 industry dummies are included, investment rates are investment ratio to assets, White-Sandwich standard errors have been used.

5. Conclusions

Among the diverse factors associated with Korea's rapid technological development, this paper has focused on the role of the IPR system. In particular, two aspects of the system were considered: the conventional patent protection system measured by the patent rights index and the second-tier protection system for minor adaptive inventions, i.e. the utility model system. We adopted a dynamic perspective to analyze the changing role of IPRs through the course of economic growth and examined the role of utility models (or petty patents) in the country's technological development, particularly in the early days.

Our main findings were as follows. First, strong conventional patent protection measured by the patent rights index only induces more patent generation at a later stage of development in Korea. Second, utility models have a positive impact on patent generation, but their impact decreases if technological capacity is enhanced. Third, companies with utility models show better performance levels during the early stages of economic development, although such impact decreases over time. Overall, these empirical findings on Korean firm-level data as well as the time-series data imply that strengthening only the level of IPR protection without regard to the level of economic development may not be appropriate for developing countries with lower technological capabilities

Rather, Korea's experience suggests that the design and strength of IPR systems should be tailored to the level of the local technological capabilities of a country to provide appropriate incentives for incremental or adaptive innovation. In particular, the utility model system (second-tier IPR) is the correct device for developing countries to encourage incremental innovation, which may be more suitable for local needs and provide a stepping stone to further technological progress. Only after technological capabilities have reached a certain level would the policy to strengthen patent rights protection to encourage more R&D investment become more valid and effective. Nevertheless, current academic and policy debates have focused on the effects of strong IPRs in general and on raising developing country standards to those of developed countries. Accordingly, less attention has been given to the effects of intermediate levels or different types of IPRs. This is one of the aspects in this field of research to which this paper contributes.

However, some limitations remain. First, it would be better if a patent rights index were constructed with possible data availability, reflecting not only the laws and regulations but also actual enforcement of the laws. It would be useful to investigate the issues sector by sector to see if any difference across sectors, for example, in agriculture, electronics and machinery, could be found.

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APPENDIX: DESCRIPTIVE STATISTICS AND CORRELATION

Table A: Summary Statistics of Time Series

Variable	Mean	Standard Deviation
Δ (log of no. of patent application)	0.13	0.17
Δ (log of RD)	0.25	0.18
Δ (log of GDP)	0.18	0.08
Patent rights index	2.92	0.76

Table B: Correlation Matrix of Time Serie

	Δ (log of no. of patent application)	Δ (log of RD)	Δ (log of GDP)	Patent Rights Index
Δ (log of no. of patent application)	1.000			
Δ (log of RD)	0.433	1.000		
Δ (log of GDP)	0.152	0.583	1.000	
Patent Rights Index	0.048	-0.446	-0.801	1.000

Table C: Descriptive Statistics of Firm-Level Panel Data

Variable	Mean	Std. Dev.
R&D expenditure	42272.6	1978668
Patent rights index	2.81	0.61
Firm age	8.98	10.96
Employees	1140.74	7083.49
R&D intensity	0.02	0.97
Patent	1.33	61.83
Investment	5.1	14.12
5-year average sales growth	0.56	0.75
Utility model	0.02	0.13

Note: Unit for R&D expenditure: 1,000 Korean Won; R&D expenditure is deflated with industry-level GDP deflator.

Table D: Correlation of Firm-level Panel Data

	R&D Expenditure	Patent Rights Index	Firm Age	Employees	R&D Intensity	Patent	Investment	Five-Year Average Sale: Growth	Utility Model
R&D expenditure	1								
Patent rights index	0.04	1							
Firm age	0.04	-0.03	1						
Employees	0.55	-0.12	0.14	1					
R&D intensity	0.19	0.1	-0.05	0.06	1				
Patent	0.75	0.04	0.03	0.4	0.1	1			
Investment	0.04	-0.04	-0.02	0.05	0.06	0.03	1		
Five-year average sales growth	0.03	-0.09	-0.26	0.04	0.09	0.02	0.2	1	
Utility model	0.14	0.02	0.01	0.21	0.07	0.1	0.05	0.07	1

Table E: Patent Rights Index (1961-2002)

	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81
1) Coverage																					
Patentability of pharmaceuticals																					
Patentability of chemicals																					
Patentability of food																					
Patentability of plant and animal varieties													1	1	1	1	1	1	1	1	1
Patentability of surgical products	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Patentability of microorganisms																					1
Patentability of utility models	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Patentability of software																					
	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.5
2) Membership in International Treaties																					
Paris Convention and revisions																				1	1
PCT																					
UPOV																					
TRIPS																					
Budapest Treaty																					
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0.2
3) Loss of Protection Measures against Losses																					
Working requirements																					
Compulsory licensing					0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Revocation of patents																					
	0	0	0	0	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
4) Enforcement																					
Preliminary injunctions	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Contributory infringement	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Burden-of-proof reversal	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5) Duration																					
Grant-based standard	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
App-based standard																					
Patent Rights Index	1.96	1.96	1.96	1.96	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.45	2.57
	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	0	1	2
1) Coverage																					
Patentability of pharmaceuticals					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Patentability of chemicals					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Patentability of food									1	1	1	1	1	1	1	1	1	1	1	1	1
Patentability of plant and animal varieties	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Patentability of surgical products	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Patentability of microorganisms	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Patentability of utility models	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Patentability of software																			1	1	1
	0.5	0.5	0.5	0.5	0.75	0.75	0.75	0.75	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	1	1	1
2) Membership in International Treaties																					
Paris Convention and revisions	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
PCT	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
UPOV																					1
TRIPS														1	1	1	1	1	1	1	1
Budapest Treaty							1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	0.4	0.4	0.4	0.4	0.4	0.4	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.8	0.8	0.8	0.8	0.8	0.8	0.8	1
3) Loss of Protection																					
Working requirements									0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Compulsory licensing	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Revocation of patents					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
4) Enforcement																					
Preliminary injunctions	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Contributory infringement	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Burden-of-proof reversal	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5) Duration																					
Grant-based standard	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.88	0.88	0.88	0.88	0.88								
App-based standard														1	1	1	1	1	1	1	1
Patent Rights Index	2.77	2.77	2.77	2.77	3.02	3.02	3.22	3.22	3.69	3.69	3.69	3.69	3.69	4.01	4.01	4.01	4.01	4.01	4.13	4.13	4.33

Note: Revised from Choi and Lee (2005).

Chapter 3

The Effectiveness of Patents and the Determinants of Patenting Activities in Korea

KYOO-HO PARK[6]

1. Introduction

Along with the worldwide surge in patenting activities, Korea has experienced a dramatic increase in those activities since the late 1980s, and has reached the rank of third or fourth in the world. Understanding this phenomenon is crucial in making an objective analysis of the characteristics of Korean innovative activities and their changes in recent decades as it may provide pointers to the changing environment for effective technological innovation.

Korea is well-known for its degree of concentration in terms of the composition of patenting. Large IT corporations, such as Samsung Electronics and LG Electronics, have shown aggressive application and registration of patents and are the majority patent holders in Korea. However, at the same time, there were around 8,500 Korean companies who sought patents in 2005 according to a survey carried out by KIPO. The dramatic increase in patenting accompanied an increase in the number of companies who have sought patents in Korea.

There may be multiple reasons for this, such as an increase in innovative activities leading to a higher propensity to patent; the increase of innovative activities in themselves and the increasing profile of patents as an appropriation mechanism. Taking account of these possibilites, it is traditional to approach the matter in terms of the effectiveness of patents as an appropriation mechanism for innovation output. This approach can explain the meaning of patenting activities with relation to other appropriation mechanisms in less technically developed countries.

As expected, previous studies have dealt mainly with developed countries; their principal argument being that patenting is not an effective appropriation mechanism, compared with other appropriation mechanisms (Levin et al., 1987; Cohen et al., 2000). If so, what are the determinants of patenting activities or the crucial factors influencing the propensity to patent? Although much research has been carried out and diverse arguments have been raised, it seems plausible to analyze it from the perspective of a company's internal factors, particularly its innovative strategy (Brouwer and Kleinknecht, 1999; Arundel, 2001; Peeters and Potterie, 2006; Hanel, 2008). The fact that patenting activities are strategic in nature from a business perspective and the methods of utilizing patents have expanded beyond traditional areas now makes this approach much more important.

Therefore, it is necessary to analyze the level of effectiveness of patenting and to identify the major elements influencing patenting activities in terms of innovation strategies, in order to enhance our understanding of this phenomenon and the characteristics of those activities in Korea.

6 I am grateful for the insightful comments made on earlier drafts by anonymous scholars. Any remaining errors are my personal responsibility.

Based on the information given above, we concentrated on the following questions:

- What is the level of effectiveness of patents as an appropriation mechanism of innovation output in Korea?

This question has two meanings. First, even in the traditional meaning of appropriation, there has been no systematic measuring of the level of effectiveness of patents in Korea. This makes it hard to understand Korean patenting activities. Second, we have tried to extend the meaning of appropriation from the role of patents. There are diverse reasons for obtaining patents, such as protection from imitation, through incentives for employees to bargaining chips (Blind et al., 2006). In this regard, appropriation can encompass the whole gamut of obtaining returns in a broad sense such as direct appropriation of utilizing patented technology and indirect appropriation through using patents as a tool for negotiating with other companies. This results in the possibility to apply for more patents than in the past, with differing rates of patenting according to each industry sector.

- What is the impact of an innovation strategy on the use of patents as an appropriation mechanism or for technology protection in Korea?

This question is on the relationship between patents and the internal innovation strategy of companies as mentioned earlier. We have tried to uncover evidence on this question using the Korea Innovation Survey (KIS) carried out by the Korean Science and Technology Policy Institute (STEPI). The definition and methodology of the survey is based on the revised edition of the Oslo Manual (OECD).

Previous research dealing with patents using survey data will be reviewed and the hypothesis will be developed in the next section. Section 3 tries to analyze the characteristics reflected in the result of the KIS and compare the 2002 results with those of 2005. Based on this, we will present estimated results along with the methodology and data in the following two sections.

2. Previous Literature

Previous literature can be summarized into two trends, the first relatively early, compared with the second group. The authors tried to understand the effectiveness of patents as an appropriation mechanism and under what conditions patenting is effective (Levin et al., 1987; Cohen et al, 2000). Through their results, we saw that patents are neither an effective appropriation mechanism nor a major tool even in large corporations who actively patent. In addition, we know that the utilization of patents has gone beyond the traditional incentive role of forestalling competitors and avoiding being sued to become bargaining chips. The role of patents varies according to each industry's requirements; typically between discrete product industries such as chemicals and complex product industries such as electronics.

It has been recognized that patenting activities are strategic in nature from a business perspective and the method of utilization has expanded beyond the traditional areas, generating a secondary group. This group's research focuses on the determinants of patenting activities or factors influencing patenting activities. These factors can be external or internal. External factors are the different technological opportunities in each sector (Brouwer and Kleinknecht, 1999), the difference between the national system and practice (Cohen et al., 2002) and the characteristics of the patent system and the technological competence of competitors (Harabi, 1995). Internal factors are company size, innovation strategy and method of innovating (Brouwer and Kleinknecht, 1999; Arundel, 2001; Peeters and Potterie, 2006).

Previous literature has shown certain limitations in that the authors have mainly concentrated on industrialized countries with a long history of patent systems and innovative activities and has not considered less-advanced countries with a recent history of industrialization. Taking account of previous literature and its limitations, this paper has tried to analyze the effectiveness of patents as an appropriation mechanism and the important determinants of patenting activities in Korea in terms of companies' innovative strategies.

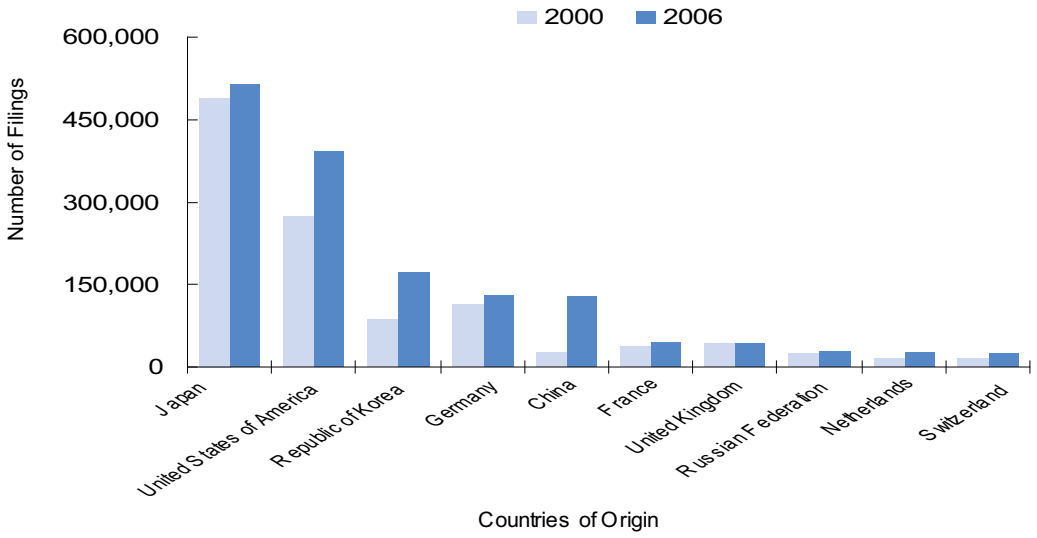
Considering the case of Korea, innovative strategies by companies can be categorized as targeting a particular type of market, type of innovation and method. The distance from lead-user markets, which are typically located in developed countries and the distance from leading sources of technology, which are usually located in universities or public research institutes in developed countries, can be pointed out as a characteristic of less technically-advanced countries. The markets which companies in less-advanced countries aim to enter are very important as regards technological innovation. Furthermore, Korean companies have grown through their export-oriented strategy and their success in foreign markets. Therefore, it is necessary to add the dimension of type of market in addition to traditional strategies comprising types and methods of innovation in terms of innovative strategies employed by firms.

When we take these characteristics into consideration, it is plausible for the three-dimensional innovative strategies to have an important influence on patenting activities in Korean companies. Specifically, the hypotheses can be put forward as follows. First, targeting foreign markets enhances the utilization of patents; second, the type of product innovation can impact on patenting activities; third, the method of innovation can influence those activities.

3. Patenting Activities in Korea

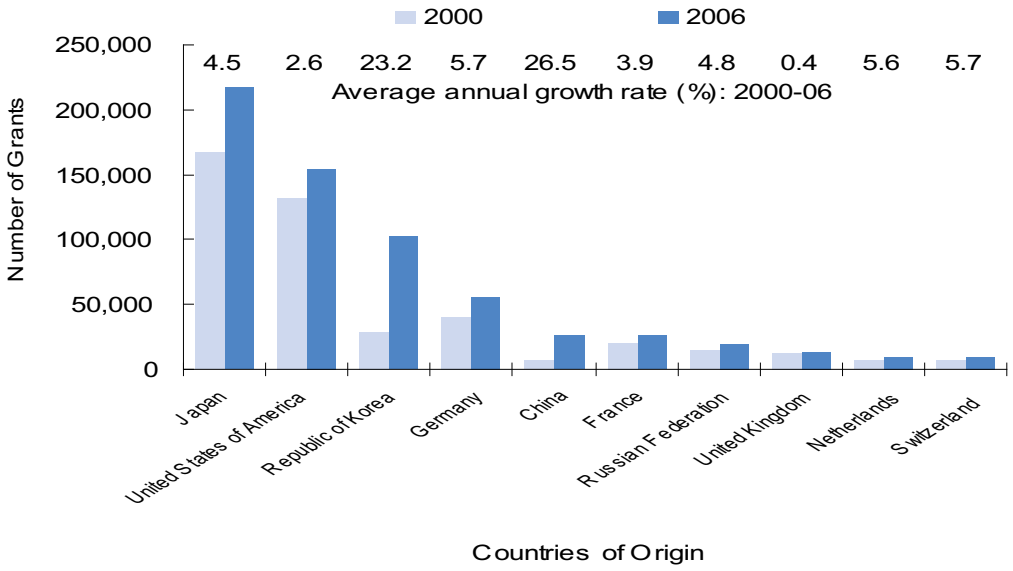
Korea has registered a dramatic increase in patenting activities compared with other countries. This can be seen just by reviewing the patent statistics by country of origin. In addition to considering patent quality, we refer to the statistics of triadic patent families.

Figure 1: Increase in Patent Applications in Korea



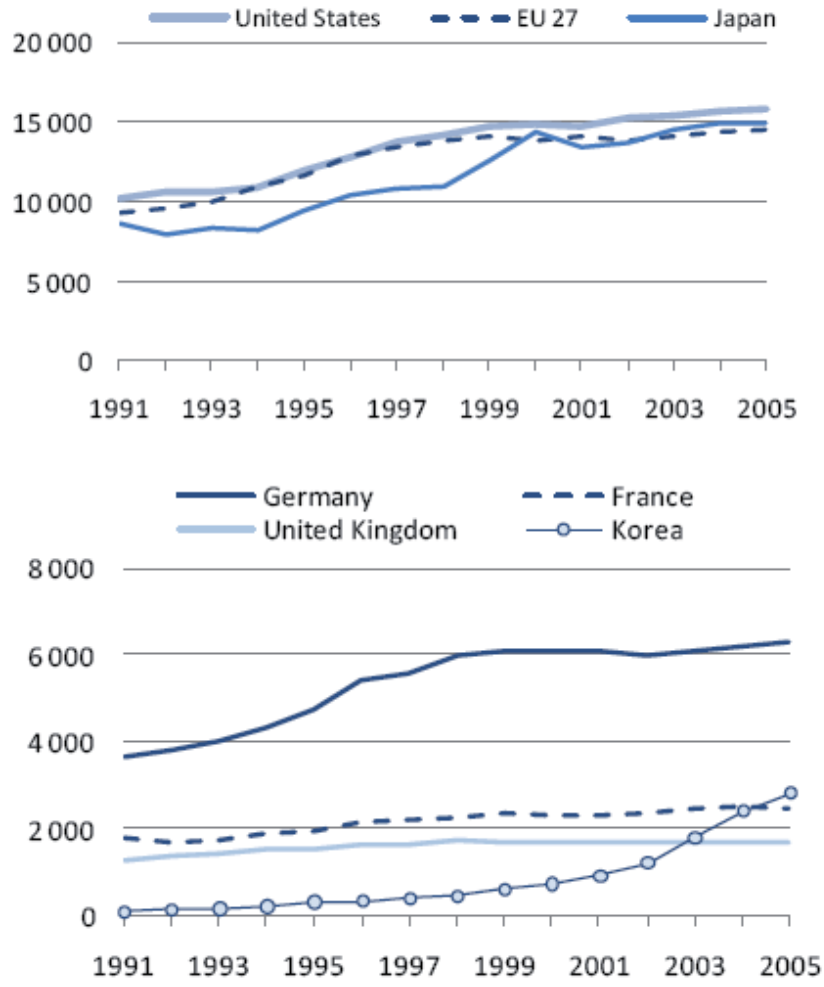
Source: WIPO.

Figure 2: Increase in Patent Registrations in Korea



Source: WIPO.

Figure 3 Increase in Triadic Patent Families in Korea



Source: OECD, Compendium of Patent Statistics 2008

These statistics confirm the striking increase in patenting activities in Korea. Although it is known that this phenomenon has been led by major corporations, in particular in the area of ICT, it has also been accompanied by an increase in the number of patenting entities and the increasing recognition given to patenting activities.

We approached this process from the perspective of effectiveness of appropriation mechanisms. Appropriation is essential for companies trying to generate a sustainable competitive advantage through technological innovation and, as we know, there are various mechanisms for appropriation; patenting is just one which can be utilized to appropriate the innovative output. In the case of Korean firms, we refer to the findings of KIS.

We have tried to identify the effectiveness of patents recognized by companies, compared with other appropriation mechanisms. In addition, we can compare the results of the 2002 survey with those of 2005, in order to observe the changes that have taken place.

In 2000-2001, the most favorable appropriation mechanism was market preemption for product innovation, related to new product innovation and improved products. Next in order of importance are secrecy and IP registration. However, at the same time, the most important mechanisms are IP registration and market preemption. In the case of process innovation, as expected, secrecy is the most effective mechanism. However, as in product innovation, the highest importance given to each mechanism shows that IP registration is no lower on the scale than secrecy. This may imply that even though ineffective overall, there could be a tendency to regard patents as important mechanisms for protecting innovation.

Table 1: Appropriation Mechanisms 2000-2001

2002 Product Innovation							
	0	1	2	3	4	5	sum
IP registration	38.22%	1.55%	4.64%	10.54%	15.53%	29.51%	100.00%
Secrecy	33.83%	2.40%	5.04%	17.69%	19.29%	21.75%	100.00%
Complex design	47.53%	5.28%	10.33%	19.00%	10.62%	7.23%	100.00%
Market preemption	28.78%	2.40%	3.55%	13.22%	22.37%	29.69%	100.00%

2002 Process Innovation							
	0	1	2	3	4	5	sum
IP registration	56.55%	1.85%	4.96%	9.46%	10.39%	16.79%	100.00%
Secrecy	44.41%	1.84%	4.67%	15.55%	16.24%	17.28%	100.00%
Complex design	58.20%	4.10%	8.49%	15.07%	8.37%	5.77%	100.00%
Market preemption	47.61%	2.65%	3.69%	13.14%	14.93%	17.98%	100.00%

The KIS 2005 covering the period 2002-2004 disaggregates intellectual property into each right, so it has been impossible to compare both results directly. On average, secrecy and lead time show the mechanism at its most effective, although the gap between these mechanisms and patents is not as high as in the period 2000-2001, where the most important patent mechanism is selected. These characteristics are shown under process innovation.

Table 2: Appropriation Mechanisms 2002-2004

2005 Product Innovation							
	0	1	2	3	4	5	sum
Patents	42.39%	3.36%	2.13%	12.00%	16.39%	23.73%	100.00%
Utility models	47.92%	3.12%	3.61%	11.58%	17.96%	15.81%	100.00%
Design	59.89%	4.16%	4.93%	10.90%	11.17%	8.95%	100.00%
Trademarks	56.66%	4.65%	3.54%	11.51%	12.97%	10.68%	100.00%
IP (average)	51.71%	3.82%	3.55%	11.50%	14.62%	14.79%	100.00%
Secrecy	41.03%	3.53%	6.51%	17.60%	16.22%	15.11%	100.00%
Complex design	63.94%	7.91%	10.61%	10.89%	4.72%	1.94%	100.00%
Lead time	41.37%	2.01%	5.68%	15.94%	19.47%	15.52%	100.00%

2005 Process Innovation							
	0	1	2	3	4	5	sum
Patents	67.66%	3.98%	3.06%	6.65%	8.87%	9.79%	100.00%
Utility models	71.17%	4.04%	4.04%	7.55%	8.09%	5.11%	100.00%
Design	75.44%	4.81%	4.35%	7.40%	4.73%	3.28%	100.00%
Trademarks	74.35%	4.50%	4.66%	7.40%	5.57%	3.51%	100.00%
IP (average)	72.15%	4.33%	4.03%	7.25%	6.81%	5.42%	100.00%
Secrecy	53.17%	3.28%	6.56%	14.11%	13.20%	9.69%	100.00%
Complex design	72.67%	6.11%	6.87%	9.54%	3.89%	0.92%	100.00%
Lead time	57.86%	2.60%	5.04%	13.21%	12.37%	8.93%	100.00%

4. Methodology and Data

Here we present the empirical model which analyzes the determinants of patenting activities in Korea. Specifically, we will try to perform an econometric analysis in order to determine the impact of innovation strategy on the likelihood of using patents for technology protection. We have made a detailed analysis as to whether and at what level using patents is effective in terms of an innovation strategy, utilizing a probit model and an ordered probit model.

4.1. Econometric Model

We have assumed that perception of the effectiveness of patents demonstrates a company's incentive to patent. We can separate whether using patents is effective as an appropriation mechanism from the level at which using patents is effective as an appropriation mechanism.. The former can be estimated using a probit model and the second using an ordered probit model.

As we know, a probit model can be utilized when the dependent variable is binary. The expected effectiveness of patents is taken to be a function of a set of independent variables. In this setting it is assumed to be a function of innovation strategy and company- and industry-specific exogenous variables.

An ordered probit model can be used when the dependent variable is categoric with the same interval of order. It has also been assumed that the expected level of effectiveness of patent is taken as a function of an innovation strategy and company- and industry-specific exogenous variables as in the probit model.

4.2. Data

We have tried to measure the level of effectiveness of patenting using the results of the Korean Innovation Survey (KIS) carried out in 2005 by the Korean Science and Technology Policy Institute. The Survey was approved by the Korea National Statistical Office as Designated Statistics under the Statistics Law and aimed at analyzing the technological innovation of manufacturing firms. The

definition and methodology of the Survey was based on the revised edition of the Oslo Manual (OECD). This Manual defines innovation in a broad manner, where organizational and marketing innovation as well as technological innovation are included. However, the Survey mainly focuses on technological innovation, although it also covers issues related to organizational and marketing innovation (STEPI, 2006, Report on the Korean Innovation Survey 2005: Manufacturing Sector).

KIS seems to be similar to the previous so-called Yale or Carnegie Mellon Survey utilized by Levin et al. (1987) and Cohen et al. (2000) in terms of the effectiveness of patents recognized by companies, although there are some differences between them in that KIS comprises various issues related to innovation and makes it possible to analyze the underlying factors influencing the effectiveness of patent and patenting activities. This Survey comprises non-patenting companies, but even these share in the recognition and perception of the effectiveness of patents.

KIS surveyed the importance given to each appropriation mechanism such as patents, secrecy, lead time, etc. It is possible to interpret this importance as a proxy measure of effectiveness assessed by individual companies and, accordingly, the possibility of using patents for technology protection, considering that its efficacy has a strong correlation with the propensity to patent (Baldwin et al., 2000). We can analyze this importance by diverse classifications such as company size, industry sector, types of technological innovation, etc.

4.3. Variables

4.3.1. Dependent Variables

KIS asked: “During the period 2002-2004, did your firm make use of any of these methods to protect inventions or innovations developed in your firm? Please evaluate the importance of each method”.[7] The answer is ‘not applicable’ or ‘applicable’, and if a company selected ‘applicable’ it could select the degree of importance from very low to very high (5 point Likert scale) for each method, such as patents, utility models, industrial designs, trademarks, secrecy, complexity of design and lead-time advantage on competitors. The effectiveness of patents could be captured by a dichotomous variable that measured whether or not companies perceived patents as effective and whether they felt it worthwhile to apply for them. However, this variable does not include the level of effectiveness of patents. It is possible to capture the level of effectiveness of patents with the degree of importance given by companies and it represents the strength of protection offered by patents.

These two variables are set as dependent variables. Independent variables including control variables are as follows:

4.3.2. Innovation Strategies

Traditional corporate innovation strategies can be accessed from three dimensions (Peeters, 2006). The first dimension is related to basic versus applied. Corporate R&D may focus on basic research with the aim of cultivating broad areas of technology and diverse applications. The desire for immediate use may lead companies to concentrate on applied R&D. Therefore, it is necessary to refer to the relative importance of basic research or applied R&D in the overall R&D activities carried out. The second dimension concerns the type of technological innovation, such as product or process innovation. This may influence how innovative activities should be done, although constrained by the nature of technology and the selection of appropriation methods. The last dimension related to the mode of innovative activities, i.e. the so-called closed mode versus the open mode. To be specific, this can be measured by whether companies cooperate with other

7 This question does not distinguish between the domestic and the general context and it is impossible to know which markets the respondents had in mind.

companies or institutions in their R&D activities. Arundel (2001) captured corporate innovation strategy as R&D intensity and the share of R&D expenditure targeting product innovation or process innovation, and he regarded cooperative R&D agreements as an information strategy.

From the perspective of less-technically advanced countries, the type of market is important for technological innovation and innovative strategies. This necessitates different ways of responding to the different nature of market demand and requirements, and therefore impacts on how technological innovation should be done. Even roughly, the type of market can be divided into domestic and foreign. Although the domestic market has been globalized, the way of addressing demands from the domestic market is still very different from that for foreign markets from the perspective of companies in developing countries. Whether companies export to other countries or not is an indication of this.

In this paper, we took R&D intensity reflecting the effort to innovate, product innovation, process innovation, interaction between product innovation and process innovation, cooperative R&D, and export as independent variables. In our view, the traditional first dimension is unimportant for Korean companies, considering the fact that average to large Korean corporations usually concentrate on applied R&D.

All of the independent variables can be set using the result of KIS. Intensity of R&D is calculated by average R&D expenditure divided by average sales for each company. The type of innovation, cooperative R&D and export are measured as dichotomy variables and are set as dummy variables.

4.3.3. Firm-Specific Factors

Company size is included to see whether there are inherent advantages associated with size which are independent of other variables (Hanel, 2008). In relation to this, there are two conflicting possibilities (Blind et al., 2006). First, smaller firms may utilize patents much more than larger firms, because the former lack alternative protection mechanisms and have weak appropriation methods, so patenting is more important for them. Second, it is plausible that larger companies patent more, because their resources permit setting-up a dedicated patenting department providing an incentive to patent. In this paper, size is measured by the average sales figures for each firm.

4.3.4. Industry-Specific Factors

Industry can be influential in terms of its importance in the external environment. This influence can be through the nature of technology and demand and the behavior of competitors and users. A set of industry dummy variables has been included for 22 manufacturing industry groups.

For product innovation, it has been shown that the patent mechanism is relatively effective in the IT and electronics, chemical and metal industries. These industries include manufacture of coke, refined petroleum products and nuclear fuels; chemicals and chemical products; basic metals; other machinery and equipment; computers and office machines; electrical machinery and apparatuses, n.e.c.; electronic components, radio, television and communications equipment and apparatus; medical, precision and optical instruments; watches and clocks. However, patents are not effective in the manufacture of textiles with the exception of sewn wearing apparel; the manufacture of such apparel and fur articles; leather tanning and dressing and the manufacture of luggage and footwear.

In the case of process innovation, whereas patent is effective in the manufacture of coke, refined petroleum products and nuclear fuels, it is ineffective in the manufacture of textiles with the exception of sewn wearing apparel and fur articles as is the case of product innovations.

Table 3: The Differential Effectiveness of Patents by Industry

Product Innovation							
Industry	0	1	2	3	4	5	Sum
15	51.82%	4.55%	2.73%	11.82%	13.64%	15.45%	100.00%
17	71.88%	4.69%	3.13%	4.69%	1.56%	14.06%	100.00%
18	77.78%	0.00%	0.00%	5.56%	16.67%	0.00%	100.00%
19	76.47%	0.00%	11.76%	0.00%	11.76%	0.00%	100.00%
20	33.33%	0.00%	0.00%	33.33%	0.00%	33.33%	100.00%
21	66.67%	3.33%	0.00%	10.00%	6.67%	13.33%	100.00%
22	79.31%	3.45%	0.00%	6.90%	6.90%	3.45%	100.00%
23	40.00%	5.00%	5.00%	15.00%	20.00%	15.00%	100.00%
24	32.93%	5.39%	2.99%	10.78%	20.96%	26.95%	100.00%
25	51.16%	1.16%	2.33%	6.98%	5.81%	32.56%	100.00%
26	47.62%	4.76%	2.38%	19.05%	16.67%	9.52%	100.00%
27	32.73%	1.82%	3.64%	20.00%	12.73%	29.09%	100.00%
28	38.68%	3.77%	2.83%	16.04%	11.32%	27.36%	100.00%
29	32.67%	2.48%	2.48%	12.87%	21.29%	28.22%	100.00%
30	32.00%	4.00%	4.00%	24.00%	20.00%	16.00%	100.00%
31	33.64%	6.36%	0.91%	7.27%	27.27%	24.55%	100.00%
32	31.76%	0.68%	1.35%	12.84%	24.32%	29.05%	100.00%
33	35.56%	6.67%	0.00%	15.56%	11.11%	31.11%	100.00%
34	45.10%	2.94%	0.00%	11.76%	13.73%	26.47%	100.00%
35	58.33%	0.00%	0.00%	8.33%	12.50%	20.83%	100.00%
36	46.67%	2.22%	2.22%	13.33%	17.78%	17.78%	100.00%
Total	42.39%	3.36%	2.13%	12.00%	16.39%	23.73%	100.00%

Process Innovation							
Industry	0	1	2	3	4	5	Sum
15	69.39%	5.10%	3.06%	8.16%	7.14%	7.14%	100.00%
17	84.91%	1.89%	1.89%	5.66%	0.00%	5.66%	100.00%
18	81.25%	6.25%	12.50%	0.00%	0.00%	0.00%	100.00%
19	76.92%	7.69%	7.69%	7.69%	0.00%	0.00%	100.00%
20	77.78%	0.00%	0.00%	0.00%	11.11%	11.11%	100.00%
21	79.31%	6.90%	0.00%	0.00%	6.90%	6.90%	100.00%
22	88.89%	3.70%	0.00%	0.00%	3.70%	3.70%	100.00%
23	46.67%	13.33%	6.67%	6.67%	13.33%	13.33%	100.00%
24	60.67%	7.33%	4.00%	6.67%	8.67%	12.67%	100.00%
25	72.15%	5.06%	3.80%	2.53%	6.33%	10.13%	100.00%
26	67.65%	0.00%	2.94%	5.88%	5.88%	17.65%	100.00%
27	71.70%	3.77%	1.89%	3.77%	13.21%	5.66%	100.00%
28	64.52%	3.23%	5.38%	9.68%	8.60%	8.60%	100.00%
29	64.89%	2.66%	3.19%	7.45%	11.70%	10.11%	100.00%
30	70.00%	10.00%	5.00%	10.00%	5.00%	0.00%	100.00%
31	68.00%	7.00%	2.00%	6.00%	8.00%	9.00%	100.00%
32	60.94%	1.56%	1.56%	10.16%	15.63%	10.16%	100.00%
33	62.50%	2.50%	2.50%	15.00%	5.00%	12.50%	100.00%
34	65.66%	2.02%	4.04%	4.04%	10.10%	14.14%	100.00%
35	60.87%	0.00%	0.00%	8.70%	8.70%	21.74%	100.00%
36	78.95%	0.00%	0.00%	5.26%	7.89%	7.89%	100.00%
37	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
Total	67.66%	3.98%	3.06%	6.65%	8.87%	9.79%	100.00%

Note: 15. Manufacture of Food Products and Beverages; 16. Manufacture of Tobacco Products; 17. Manufacture of Textiles, except Sewn Wearing Apparel; 18. Manufacture of Sewn Wearing Apparel and Fur Articles, 19. Tanning and Dressing of Leather , Manufacture of Luggage and Footwear; 20. Manufacture of Wood and of Products of Wood and Cork, except Furniture; Manufacture of Articles of Straw and Plaiting Materials, 21. Manufacture of Pulp, Paper and Paper Products, 22. Publishing, Printing and Reproduction of Recorded Media, 23. Manufacture of Coke, Refined Petroleum Products and Nuclear Fuel, 24. Manufacture of Chemicals and Chemical Products, 25. Manufacture of Rubber and Plastic Products, 26. Manufacture of Other Non-metallic Mineral Products, 27. Manufacture of Basic Metals, 28. Manufacture of Fabricated Metal Products, except Machinery and Furniture, 29. Manufacture of Other Machinery and Equipment, 30. Manufacture of Computers and Office Machinery, 31. Manufacture of Electrical Machinery and Apparatuses n.e.c., 32. Manufacture of Electronic Components, Radio, Television and Communication Equipment and Apparatuses, 33. Manufacture of Medical, Precision and Optical Instruments, Watches and Clocks, 34. Manufacture of Motor Vehicles, Trailers and Semi-trailers, 35. Manufacture of Other Transport Equipment, 36. Manufacture of Furniture; Manufacture of Articles n.e.c., 37. Recycling of Waste and Scrap.

5. Determinants of Patenting Activities in Korea

KIS surveys the effectiveness of each appropriation mechanism separately for product innovation and process innovation. Therefore, statistical estimations for each innovation had to be made.

In the case of protection of product innovation, estimating the impact of innovation strategy on the possible effectiveness of patents as an appropriation mechanism gives us the following facts:

First, companies involved only in actual product innovation, regard patents as an effective appropriation mechanism and are more inclined to patent. Second, companies involved in both actual product innovation and process innovation are more likely to see the benefit of utilizing patents for appropriating innovative output. Third, firms involved in cooperative R&D are more likely to patent. Fourth, companies exporting to other countries are more inclined to regard patents as an effective mechanism. Last, though larger companies have more opportunity to use patents as an appropriation mechanism, the statistical significance is low.

However, experience of actual process innovation and efforts to innovate do not show any significant impact on the likelihood of using patents. This means that even though Korean industry is known for its high propensity to patent, the effort to innovate does not naturally lead to patenting activities when we consider other important factors.

In the case of protection of product innovation and firms utilizing patents, estimating the impact of an innovation strategy on the level of effectiveness of patents as an appropriation mechanism leads to the following facts:

First, companies involved in collaborative open R&D with other companies and institutions feel strongly about the importance of patents as a method of protection. However, the impact of other variables (type of innovation and type of market) is not statistically significant.

Therefore we see that the determinants of whether patenting is effective or not and the determinants of the level of effectiveness of patents are different, i.e. type of innovation and type of market influences the effectiveness of patenting, but does not influence the level of effectiveness. In the case of product innovation, apart from the decision to use patents, the drive behind active patenting may be the necessity to cooperate with other institutions.

Table 4: Determinants of the Effectiveness of Patents – Product Innovation

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-1.20652	0.232064	-5.19908	0
Product	0.659866***	0.12292	5.368262	0
Process	-0.15754	0.17048	-0.9241	0.3554
Propro	0.398791**	0.188991	2.110104	0.0348
Cooperation	0.186907**	0.073444	2.544879	0.0109
Export01	0.247783	0.081516	3.039703	0.0024
RD	-0.15301	0.187133	-0.81764	0.4136
LNSIZE	0.024721	0.014075	1.756372	0.079
IND17	-0.58214	0.213587	-2.72555	0.0064
IND18	-0.60169	0.372137	-1.61684	0.1059
IND19	-0.60344	0.380429	-1.58621	0.1127
IND20	0.517553	0.40993	1.262539	0.2068
IND21	-0.32913	0.277773	-1.18489	0.2361
IND22	-0.5038	0.310826	-1.62085	0.1051
IND23	0.334009	0.33819	0.987638	0.3233
IND24	0.424374	0.161886	2.621441	0.0088
IND25	0.020867	0.187601	0.111232	0.9114
IND26	0.269212	0.231603	1.162382	0.2451
IND27	0.442519	0.221101	2.001435	0.0453
IND28	0.401852	0.177199	2.267797	0.0233
IND29	0.490722	0.156718	3.13124	0.0017
IND30	0.654387	0.318471	2.054779	0.0399
IND31	0.513413	0.180452	2.845153	0.0044
IND32	0.523774	0.168482	3.108773	0.0019
IND33	0.364835	0.233755	1.560756	0.1186
IND34	0.233475	0.178254	1.309792	0.1903
IND35	-0.19358	0.292869	-0.66097	0.5086
Log likelihood				-865.902
LR statistic (27 df)				255.4785
Probability (LR stat)				0
McFadden R-squared				0.128557
Obs with Dep=0				618
Obs with Dep=1				840

Note: IND represents industry dummies. *** and ** represent the level of significance: 1 per cent and 5 per cent respectively.

Table 5: Determinants of the Level of Effectiveness of Patents – Product Innovation

Variables	Coefficient	Std. Error	z-Statistic	Prob.
Product	0.220605	0.166708	1.323303	0.1857
Process	0.250661	0.255631	0.980557	0.3268
Product*Process	-0.23923	0.268137	-0.89219	0.3723
Export01	0.092493	0.095092	0.972673	0.3307
Cooperation	0.201388**	0.079459	2.534511	0.0113
RD	-0.29194	0.193285	-1.51041	0.1309
LNSIZE	-0.00061	0.014885	-0.04104	0.9673
IND17	-0.05367	0.301884	-0.17779	0.8589
IND18	-0.07402	0.535397	-0.13825	0.89
IND19	-0.47044	0.529867	-0.88785	0.3746
IND20	0.230785	0.419919	0.549594	0.5826
IND21	0.135522	0.375216	0.361183	0.718
IND22	-0.28721	0.458326	-0.62666	0.5309
IND23	-0.15064	0.341744	-0.44081	0.6594
IND24	0.157311	0.180589	0.871101	0.3837
IND25	0.749806	0.236903	3.165031	0.0016
IND26	-0.28507	0.268607	-1.0613	0.2886
IND27	0.187334	0.234049	0.800406	0.4235
IND28	0.203004	0.202344	1.003265	0.3157
IND29	0.271466	0.175989	1.542515	0.1229
IND30	-0.15722	0.298108	-0.52738	0.5979
IND31	0.202221	0.196323	1.03004	0.303
IND32	0.369941	0.185285	1.996613	0.0459
IND33	0.234007	0.255089	0.917353	0.359
IND34	0.344101	0.211107	1.629982	0.1031
IND35	0.47843	0.388249	1.232275	0.2178
Log likelihood				-1101.74
LR statistic (27 df)				43.1626
Probability(LR stat)				0.025187

Note: IND represents industry dummies. ** represents the level of significance: 5 per cent,

Meanwhile, it was considered that patenting was ineffective in protecting process innovation, mainly because it not easy to detect infringement. We tried to estimate the impact of an innovation strategy on the likelihood that patenting is effective for process innovation.

The results can be summarized as follows. First, even in protecting process innovation, covering both innovations makes it natural to think that patenting is effective in protecting innovation output. Second, firms involved in cooperative R&D are more likely to patent. Third, firms aiming for foreign markets are more inclined to use patents as an appropriation mechanism. Lastly, larger enterprises are more likely to use patents as an appropriation mechanism.

Table 6: Determinants of the Effectiveness of Patents – Process Innovation

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-1.28122	0.239254	-5.35508	0
Product	-0.00419	0.143326	-0.02925	0.9767
Process	-0.00511	0.165488	-0.03085	0.9754
Propro	0.428708**	0.190347	2.252237	0.0243
Cooperation	0.155399**	0.077119	2.015042	0.0439
Export01	0.17719**	0.089636	1.976779	0.0481
Rd	-0.00991	0.039903	-0.24833	0.8039
Lnsize	0.031576**	0.01404	2.249044	0.0245
IND17	-0.54499	0.258002	-2.11235	0.0347
IND18	-0.32775	0.402569	-0.81415	0.4156
IND19	-0.14242	0.413714	-0.34426	0.7307
IND20	-0.23822	0.492255	-0.48394	0.6284
IND21	-0.30086	0.305235	-0.98566	0.3243
IND22	-0.51863	0.355425	-1.45919	0.1445
IND23	0.595148	0.35197	1.690904	0.0909
IND24	0.176867	0.172212	1.02703	0.3044
IND25	-0.06678	0.203842	-0.32762	0.7432
IND26	0.076133	0.267488	0.284624	0.7759
IND27	-0.1625	0.232971	-0.69751	0.4855
IND28	0.139468	0.192889	0.723051	0.4696
IND29	0.12362	0.166115	0.744188	0.4568
IND30	0.017244	0.3358	0.051351	0.959
IND31	0.063836	0.191285	0.33372	0.7386
IND32	0.247133	0.177905	1.38913	0.1648
IND33	0.154811	0.247424	0.62569	0.5315
IND34	0.108514	0.191296	0.567256	0.5705
IND35	0.217929	0.308139	0.707244	0.4794
Log likelihood				-777.534
LR statistic (27 df)				91.44649
Probability(LR stat)				6.24E-09
McFadden R-squared				0.055539
Obs with Dep=0				885
Obs with Dep=1				423

Note: IND represents industry dummies. ** represents the level of significance: 5 per cent

Meanwhile, in the case of process innovation protection and patent users, estimating the impact of an innovation strategy on the level of effectiveness of patents as an appropriation mechanism is not shown to be statistically significant.

6. Conclusions

This paper has tried to analyze the level of effectiveness of patenting and to identify the major elements influencing it in terms of innovation strategies in order to understand the Korean characteristics of technological innovation which feature a high degree of patenting but which are still limited in terms of technological innovation. In the Korean case, three factors such as type and method of innovation and type of market are considered to be important elements constituting innovation strategies.

The findings and their implications can be summarized as follows:

First, size matters. Despite the increasing number of firms patenting, the overall trend in Korea is led by the larger enterprises. As we have stated, patenting is no more just a direct protection mechanism of innovative output. Considering that its usage and method of utilization have developed, large enterprises utilize patents for various reasons such as enhancing their reputation, monitoring and providing incentives for their R&D personnel and as a bargaining tool. In addition, as mentioned by Blind et al. (2006), large enterprises increasingly set up their own independent patenting or IP organizations to engage in active patenting activities, compared with companies who do not enjoy the same advantages..

Second, in relation to traditional technological innovative strategies stemming from the experience of more technically advanced countries, product innovation matters. Even when protecting process innovation, both product and process innovation raise the possibility of the effectiveness of patents in protecting innovation output. This is connected to business strategies and the business environment in Korea. Companies arriving later on the market have to aim at emerging market segments where competition for new or improved products is fierce. In order to succeed in capturing that segment of the market, It can be assumed that Korean companies combine product innovation with patent mechanisms. Cooperative innovative activities are also important and the figures show that cooperative R&D has a positive impact on the effectiveness of patents. This is reiterated by Brouwer and Kleinknecht (1999) and Arundel (2001) who argue that the higher the R&D cooperation, the more patenting is utilized. This hints at the fact that appropriation can encompass the whole range of receiving returns in a broad sense such as direct appropriation through utilizing patented technology or indirect appropriation through using patents as a negotiating tool. Appropriation can be short- or long-term.

Third, the type of market matters. Results show that type of market (export is used as a proxy variable) has a positive influence on the effectiveness of patents in terms of product and process innovation. That is, exporters are more likely than purely domestic firms to regard patenting as an effective mechanism . We can therefore infer that Korean companies which have grown through expanding market shares in major developed countries feel obliged to patent to meet the challenge of pro-patent policies in advanced markets.

There are certain limitations: first, the picture of innovative strategies is too vague to be helpful to actual innovation-related decision-making; the main business of companies has a certain position in the value chain and their target markets can be different: for example, local domestic and international markets. Second, it is more plausible for firms to utilize varied appropriation mechanisms. In this way, the effectiveness of each mechanism is not independent but rather interdependent. Lastly, the results in this paper are not free from the problem of endogeneity. The data is cross-sectional and does not permit panel analysis, making it impossible to offer reliable instrumental variables. These facts should be taken into account in any future study.

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Chapter 4

Intellectual Property Rights, Spillovers and Innovative Activities in Korea

SUNG JIN KANG and HWAN JOO SEO

ABSTRACT
Our analysis investigates the impact of the strengthening of IPRs in Korea and tests the determinants of new technologies by using the panel difference GMM method, which led to the following results. First, unlike other firm- and industry-level studies of advanced countries, we found a very significant impact on innovation systems through the strengthening of IPRs.. Second, an accumulated stock of ideas (patents) leads to higher levels of technology, even though the effect tends to decrease in the long run.

1. Introduction

In modern economies, innovative activities and technology diffusion have become a cornerstone of economic growth. Thus, most countries have increased investment in R&D and passed laws related to IPRs in order to efficiently manage intellectual property. In particular, starting with the revolutionary change in IP laws in the US in the late 1970s, IPRs have been strengthened through TRIPS in 1994.

According to conventional economic theory (Nordhaus, 1969), the protection of intellectual property through IPRs, including patent rights, may create social costs in reducing the invention's usefulness in the short term. This is because such protection grants innovators temporary monopolistic power but drives economic growth in the long term by inducing greater innovative effort. Reforms of the US patent system over the last two decades, which include the extension of patent protection to new subject matter, the creation of the Court of Appeals for the Federal Circuit (CAFC) and the lengthening of the term of patents, have been considered good examples for supporting this conventional view. With the strengthening of patent rights, new patent applications from domestic inventors in the US climbed to nearly 150,000 per annum by the late 1990s from about 60,000 per year through most of the 1980s (Gallini, 2002). In addition, an increase in patent applications gave rise to a doubling – from 1985 to 1999 – of the patents that were annually granted to domestic inventors; further, the patent output of US universities quintupled between 1986 and 1999.

However, recent empirical studies that analyze the dynamic relationship between innovative activities and the reinforcement of patents rights cast doubt on the effectiveness of the patent system in encouraging innovation (Jaffe, 2000; Kortum and Lerner, 2000; Hall and Ziedonis, 2001; Sakakibra and Branstetter, 2001; Lerner, 2002). Theoretical studies by Scotchmer (1991), Helpman (1993), Bessen and Maskin (2000) and Shapiro (2000) also expressed pessimism on the impact of IPRs on innovative activity. For example, Helpman found that stronger IPRs would diminish both the Northern rate of innovation and Southern welfare when imitation is the only channel of technology transfer. Strengthened IPRs would raise imitation costs, restrict technology diffusion

and thus reduce in the long run incentives to innovate. If innovators expected slower loss of their technological advantages, they could earn higher profits per innovation, which would reduce their need to engage in R&D.

Even if no clear agreement is reached on whether or not the reinforcement of patent rights is an effective measure for encouraging innovation and diffusion, most countries are encouraged by the quantitative success in patenting activity in the US economy and have accordingly changed their patent systems in the past two decades in terms of strengthening patent rights. At the global level, IPRs have been included in international negotiations and the TRIPS Agreement in 1994 proved to be a milestone for harmonizing patent laws across countries.

Like advanced countries, such as the US, Japan and the EU, Korea has shown a significant increase in patent registration with a strengthened policy of IPRs. The experience of a middle-income country such as Korea might be a good example to use for investigating a number of important questions concerning the dynamic relationship between the strengthening of patent rights and innovation activity. Has the strengthening of patent rights led to more innovations and more patent applications from Korean firms over the past two decades? Have technology spillovers from patent applications from foreign companies in Korea played a critical role in the patent surge of domestic firms? What is the role of the firm- or industry-specific factors in the rise of patenting by Korean firms? Does the surge in patent applications from Korean firms represent a mere increase in the propensity to patent or a real increase in innovative activity? Answers to these questions can shed light on the specificities of the innovation activities of Korean firms and deliver important policy implications for other developing countries.

Using 20-year panel data on patent applications in Korea, we investigated the role of characteristics, such as the company size, debt ratio, capital-labor intensity, human capital and export ratio on innovative activities. These variables are in marked contrast to those in traditional studies that focus mainly on R&D and market structure. As an important factor, this study tested the knowledge-spillover effect. Patent rights contain conflicting characteristics: exclusion and diffusion of knowledge. In this study, spillover effects constituted the impact of patents in competitors in the same industries; the difference between spillovers from domestic and foreign companies and the variation in technology spillover across individual foreign countries.

To this end, we followed the most recent method of Schmoch et al. (2003) for code concordance between the technical classification of patents and the industrial classification of firm characteristics. To control for the possible endogeneity of a lagged dependent variable and other independent variables, we followed the panel difference GMM estimation (Holtz-Eakin et al., 1988; Arellano and Bond, 1991).

The following results were found. First, an accumulated stock of ideas leads to higher levels of technology even though the effect tends to decrease in the long run. Second, companies with higher capital intensities, higher export ratios and greater investment in human capital tend to make more patent applications. A higher debt ratio tends to discourage innovative activities, thus reflecting the importance of internal finance. Third, there is an inverted-U relationship between market structure and innovative activities.

Fourth, there is a negative spillover of domestic innovative activities to companies in the same field while those of foreign companies show positive spillovers. The disaggregation of domestic innovative activities shows a negative spillover of domestic companies but a positive spillover of

public research institutes. In addition, innovative activities in the US and EU tend to yield negative spillovers, while those in Japan show positive spillovers.

The estimation results of the productivity function indicated that the surge in patent applications by Korean companies is the result of a real increase in innovative activities rather than a mere increase in the propensity to patent.

This study confirmed that innovative activities stem not only from inputs such as R&D expenditure, but also from company characteristics and market conditions. Thus, in addition to higher R&D expenditure as a necessary condition, companies need to spend more time and invest more in the education and training of their employees. Further, the government needs to promote a more competitive environment by liberalizing the domestic market.

The paper is laid out as follows. Section 2 reviews previous empirical studies on the impact of IPRs on innovative activities. Section 3 summarizes the recent patent reforms in Korea. The data and estimation results are considered in Section 4. Section 5 presents a conclusion.

2. Literature Review

There has been an ongoing debate on whether stronger IPRs encourage or retard innovative activities (see Maskus, 2000 and Gallini, 2002 for an extensive survey). Nordhaus (1969), who initiated an economic analysis of the patent system, showed that by granting innovators temporary monopoly power the protection of intellectual property enhances incentives to allocate more efforts to R&D and innovative activities, and further encourages technology transfers through a reduction in transaction costs related to intellectual property. However, recent empirical and theoretical studies have not yielded a clear conclusion on whether the strengthening of IPRs leads to more or less innovation.

Through firm-level and case analyses, most of the empirical studies have focused on the impacts of IPRs alone without considering institutional complementarities; they show that strengthened IPRs have not led to an increase in innovative effort or output (Jaffe, 2000; Kortum and Lerner, 2000; Hall and Ziedonis, 2001; Sakakibra and Branstetter, 2001; Lerner, 2002). Kortum and Lerner (1999) investigated the diverse hypotheses to explain the recent overall surge in US patenting. They failed to find a close connection between the overall rise in patents and the strengthening of IPRs, in particular the creation of the CAFC in the US. They attributed the overall increase in patenting activity to a change in the management of R&D that is reoriented toward more applied research: they also cited the increase in research productivity caused by the introduction of information and communication technologies and the investment of venture capital, rather than by a series of patent reforms. Moreover, the survey evidence of Cohen et al. (2000) also supported the ineffectiveness of patents rights for the protection of inventions. They found that enterprises considered patents as less effective instruments for the protection of their intellectual property compared with alternative mechanisms, such as secrecy and lead-time. Sakakibara and Branstetter (2001) examined the case of the Japanese patent reforms of 1988: the transformation from a single-claim system to a multiple-claim system; the expansion of patent scope and periods and the increase in the duration of patent rights. They also showed that there is no significant evidence that the strengthening of IPRs in 1988 contributed to innovative activity in Japan.

In contrast, cross-country studies seemed to show relatively positive effects of IPR policies (Gould and Gruben, 1996; Maskus, 2000; Lerner, 2002; Kanwar and Evenson, 2003; Kang and Seo,

2005). Studying 177 patent-related shifts in policies in 60 countries over 150 years, Lerner found that the strengthening of IPRs bore an inverted-U relationship with innovations. Utilizing cross-country data, Kanwar and Evenson showed that IP protection (as measured by an index of patent rights) has a strong positive effect on technological change (measured by R&D expenditure). The same evidence has been found even after several pertinent control variables were considered. However, Park and Ginarte (1997) found that the institution of IPRs did not appear to have a direct impact on the technical efficiency of production in 60 countries for 1960-1990. Instead, the benefit of strengthening IPRs is to encourage the research sector to invest and take calculated risks on its investment. That is, stronger IPRs rather than innovative activities have the potential to improve economic growth by stimulating capital accumulation.

In the case of industrializing economies, previous studies provide no clear agreement about whether reinforcement of patent rights is an effective measure for encouraging innovation. Mansfield (1986) found wide differences among industries in the innovation-promoting role of patents. His survey revealed that 65 per cent of inventions in pharmaceuticals, 30 per cent in chemicals, 18 per cent in petroleum, 15 per cent in machinery, 12 per cent in metal products, 8 per cent in primary metals and 4 per cent in electrical machinery would not have occurred without patent protection. Following Mansfield's study, the World Bank (2001), Lerner (2002) and Lall (2003) showed that the economic effects of strengthening patent rights may vary according to the level of economic development, industrial structure and local technological capability. They insisted that the economic impact of reinforcing IPRs in industrializing countries would be negligible, because these countries usually specialize in low-technology sectors where the impact of IPRs is limited. Furthermore, if the characteristics of innovation in developing countries are sequential and cumulative rather than radical, the broadening of the scope of patents, which is one important way to strengthen patent rights, could discourage R&D incentives and thus decrease innovation in developing countries (Bessen and Maskin, 2000; Bessen, 2004). From the newly industrialized countries in Asia, Lall (2003) found that these Asian tigers moved to regimes of strong IPRs after accumulating their indigenous innovation capabilities by way of reverse engineering and imitation during the early stages of weak IPRs. Thus, he insisted that weak IPRs may help local firms in the early stages to build technological capabilities as it gives them opportunities for imitation and reverse engineering.

3. Experience of Korean Patent Reforms

The Korean patent regime has also gone through important changes in the past five decades, mostly in the direction of strengthening patent rights in the sense of reinforcing the exclusive rights that are conferred on patent holders, expanding the coverage of such rights and lengthening the patent period: the duration of protection was extended to 20 years from the date of application. Pharmaceutical products and chemical products, declared as non-patentable subject-matters in 1961, became patentable in 1986; protection against losses from compulsory licensing was reinforced from 1990; Korea joined the Paris Convention in 1980, the PCT in 1984 and UPOV in 2002.

Korean patent law has been amended 14 times over the last 50 years. Table 1 analyzes the amendment of Korean patent reforms by citing the five categories developed by Ginarte and Park (1997): extent of coverage; membership in international patent agreements; duration of protection; provisions for loss of protection; enforcement mechanisms. Coverage refers to whether Korea provides patent protection for utility models, pharmaceutical products and chemical products. Membership in three major agreements analyzes whether Korea is a signatory to three major agreements (Paris Convention, PCT and UPOV). Loss of protection measures protection against

losses arising from “working” requirements, compulsory licensing and revocation of patents. Enforcement is the availability of preliminary injunctions, contributory infringement pleadings and burden-of-proof reversals. Duration denotes the length of the patent term.

With regard to the reinforcement of patent rights through the expansion of the patent scope, the domain of the patentable subject matter and the lengthening of the term of patents, the fifth (1980), seventh (1986) and eleventh (1993) amendments have important effects. As Korea joined the Paris Convention in May 1980, the fifth patent law was amended to harmonize the domestic patent system with international standards. In particular, as the multiple-claim system was introduced in the fifth patent law reform, the extent to which multiple claims could be included in a patent was significantly expanded.

After the fifth patent reform, the seventh amendment was introduced to protect product innovation from July 1987. With this, patent protection was expanded to cover new subject matter, such as chemicals and pharmaceutical manufacturing methods. As the eleventh amendment was promulgated in December 1993 and came into force from 1994 to harmonize with TRIPS, patent protection was extended to products and processes in all fields of technology, ensuring that subject-matter coverage could reach the levels of developed countries. As the US increased the length of patent protection from 17 years to a minimum of 20 years from the filing date in compliance with TRIPS in 1994, Korea also adopted – through the eleventh amendment – a 20-year term of patent protection from the date on which a patent application is filed.

With strengthened IPRs in Korea, the degree of protection constructed by Park and Wagh (2002) is similar to the level of the EU and Japan and slightly lower than that of the US. Further, the numbers of domestic and foreign patents granted show a significant increase, especially after the major amendments to IP law in 1988 and 1994. For example, the number of patents granted in the US to Korean firms was zero in 1963 and three in 1970, but increased from eight in 1980 and 225 in 1990 to 3,944 in 2003. In terms of the ranking of countries that registered patents in the US, Korea was 43rd in 1970 and 37th in 1980, but ranked 17th in 1990 and fifth in 2003,. In Japan, in terms of patent registrations, Korea ranked fourth after Japan, the US and Germany. In the EU, Korea ranked fifth in terms of patent registrations after the EU, Japan, the US and Canada.

Table 1: A History of the Amendment of Patent Rights in Korea.

1961 (1st)	1980 (5th)		1986 (7th)	1990 (8th)	1993 (11th)
Duration of protection	12 years from the date of grant		15 years from the date of grant	-	20 years from the date of application
Extent of coverage	Pharmaceuticals, chemicals and food were declared as non-patentable subject-matters.		Patentability of pharmaceuticals and chemicals	Patentability of food Patentability of asexually reproducing plant varieties	Patentability of materials produced by nuclear transformation
Provision for loss of protection	Compulsory licensing and working requirement Revocation of patents (Amendment of 1963)	Abolition of the revocation of patents		Restriction on compulsory licensing	
Enforcement mechanism	Restriction of preliminary injunction. Preliminary injunction (Amendment in 1973) Legal penalty against infringement (1 million Korean won)	Legal penalty against infringement (10 million Korean won)	Legal penalty against infringement (20 million Korean won)	Contributory infringe-ment.. Burden of proof reversals	Burden of proof-reversals is extended to the case of offering for sale Legal penalty against infringement (50 million Korean won, amendment in 1997; 100 million Korean won amendment, in 2001)
Membership of international patent agreements etc.	Introduction of a modern patent system	WIPO (1979) Paris Convention (1980) PCT (1984) Harmonization with international standards Introduction of multiple claims	Agreement of Budapest (1988) Super 301, Real starting point for the enforcement of patent law in Korea	Promotion of patentee's rights	TRIPS (UPOV, 2002) Harmonization with TRIPS Setting up of a special court for patent cases

4. Estimated Results

Our analysis is divided into two parts: the effect of strengthened IPRs on firm-level (a) innovative activities and (b) productivity.

The first part considers the effects of IPRs on innovative activities that are defined as the stock of the patent application. However, the patent application is not guaranteed to be directly connected to real productivity or output. Therefore, as a second stage, we will estimate the impact of patent applications on the firm's productivity (labor productivity) taking technology spillovers into consideration.

In order to investigate these two main issues, we needed first of all the concordance of technological and industrial codes.

4.1. Concordance between Technological and Industrial Codes

The most recent attempt to define a concordance between the International Patent Classification (IPC) and the International Standard Industrial Classification (ISIC) was by Schmoch et al. (2003), which consisted of a report of the European Commission conducted jointly by laboratories in Germany, France and the UK. The concordance procedure is in three steps. The first step is to select a set of industrial sectors which are defined by the NACE and ISIC codes, as a basis for analysis. In the second step, these sectors are also associated with technical classifications in terms of IPC codes. In the third step, the technical and industrial approaches are compared by investigating patent activities in terms of the technology-based fields of more than 3,000 firms classified by industrial sector. This computation leads to the elaboration of a transfer matrix or concordance between technology and industry classifications. In the fourth step, the adequacy and empirical power of the concordance is verified by comparing country structures based on the concordance. Following this concordance methodology, the concordance between the IPC and the ISIC is followed by matching them with the Korea Standard Industrial Classification (KSIC) code.

4.2. Data

We used the number of patents applied for in KIPO, which has been released by the Korea Institute of Patent Information. This data consists of all patent records of domestic companies, domestic public institutes and all foreign agents (companies and individuals).

The variables that reflected firm characteristics are from the database of the Korea Listed Companies Association (KLCA). We were able to obtain information on 200 Korean firms from 1990 to 2001 and the observations available on the KLCA database number about 1,300.

The innovative activities of a company depend on tangible and intangible factors and its strategy. We chose sales, exports, debt, capital intensity and R&D expenditure as tangible factors and the expenditure on educational training as the intangible factor. All variables have been deflated by the 2005 aggregate produce price index. In addition, following Lee (2002), the market concentration ratio – as a market competition indicator – is defined as the concentration ratios of the top three companies in each sector.

i) Firm Size and Market Structure

What is most debated in empirical studies is the role of firm size suggested by Schumpeter. He indicated that it was advantageous for large companies and those under a monopoly to improve innovative activities. However, empirical studies showed mixed results; even though many studies support Schumpeter's hypothesis, Scherer and Ross (1990), for example, suggested that larger companies might be disinclined to innovate due to the increased inefficiency of R&D activities, bureaucracy, etc.

Besides testing Schumpeter's hypothesis, we considered the firm-size variable in order to investigate the demand-full hypothesis, which suggests that the realization of potential innovation depends on market demand, while scientific knowledge affects the inventive potential. For the UK and the OECD, Geroski and Walters (1995) and Guellec and Ioannidis (1997) found that innovative activities were pro-cyclical and led by market demand.

In addition, as noted above, to reflect market structure, we used the market concentration ratios of the top three companies in each field.

ii) Financial Resources

From the theoretical point of view of information economics, information asymmetry between investors and innovators or information secrecy on research proposals leads to a preference for internal financing in lieu of external debt as a financial source of research (Antonelli, 1989; Himmelberg and Peterson, 1994). In contrast, financial sourcing through debt financing might discourage innovative activities because the basic characteristics of innovative activities, the high specificity and intangibility, increase transaction costs and discourage debt financing (Galende and de la Fuente, 2003).

iii) Other Firm Characteristics

Following various empirical studies, we considered capital intensity, human capital and exports. First, Hall and Ziedonis (2001) found that in the US semiconductor industry, the more capital-intensive companies tend to engage in more innovative activities. Second, investment in education and training contributes to the improvement of human capital, which promotes innovative activities and economic growth (Lucas, 1988; Kiiski and Pohjola, 2002). Finally, companies with higher export ratios tend to invest more in innovative activities to survive in a more competitive world market. Lucas (1993) indicated that through market expansion, an export-oriented strategy plays a positive role in the introduction of new technologies and in learning-by-doing. Kumar and Saqib (1996) and Galende and Suarez (1999) found positive correlations between exports and innovative activities.

4.3. Estimation Model

4.3.1. Determinants of Innovation Activities

We introduce here a modified model of representative endogenous growth that is based on Romer (1990) by combining technology-gap theory, which includes the technology spillover effect, and the adoption capacities of an individual firm. First of all, assuming that A_{ijt} is the level of technology of firm i in industry j at time t, the technology-production function of Romer (1990) can be written as:

$$A_{ijt} - A_{ijt-1} == \psi S_{ijAt-1} . \qquad (1)$$

$A_{ijt} \_ A_{ijt-1}$ is the number of new ideas produced in the time-period, (t-1, t). Ψ implies the labor productivity in the creation of new ideas, which can be assumed to be a constant or a function of the stock of ideas that have already been invented. If the rate at which new ideas are produced depends on the stock of ideas already produced, then:

$$\psi = \phi A_{ijt-1}^{\alpha} . \qquad (2)$$

If α>0, the productivity of research increases with the stock of ideas that have already been discovered. If the "fishing out" case, wherein subsequent ideas are increasingly difficult to discover, can be assumed to correspond to α<0. If α=0, then the productivity of research is independent of the stock of knowledge (Jones, 1995).

One more issue we needed to consider was the possible duplication of R&D investment. Eq. (1) assumes that the average productivity of research depends on the number of people who are searching for new ideas at any point in time. However, it is more likely that some efforts might be duplicated. This possibility can be modeled by replacing S_{ijA1-1} with S_{ijAt-1}^{β} . Here, is between 0 and 1.

Considering technology spillover effects, the following "catching up" equation is assumed (Kang, 2002).

$$A_{ijt} - A_{ijt-1} = G_{ijt-1}^{\beta_1} S_{ijAt-1} \Theta_{ijt-1}^{\beta_3}. \quad (3)$$

In Eq. (3), $G_{it-1} \equiv \bar{A}_{it-1} / A_{iit-1}$ reflects the technology gap between the leading country (or firms) and firm *i* at time *t*, where $\bar{A}_{ijt-1}$ indicate the stock of ideas of the leading country (or firm) in industry j at time *t*. θ implies the ability to implement adopted ideas to the creation of their own new ideas, depending on firm characteristics and the market environment. If the average stock of ideas in the industry that firm i belongs to is higher than that of firm i, firm i will increase its effort to acquire new ideas to avoid a possible loss of competitive power in the market and will increase incentives for acquiring the technology, management and marketing advantages found in advanced companies. Otherwise, the firm cannot survive.

By combining Eqs. (1)-(3), we can derive the following generalized equation:

$$A_{ijt} - A_{ijt-1} = A_{ijt-1}^{\alpha} \bar{A}_{jt-1}^{\beta_1} S_{ijAt-1}^{\beta_2} \Theta_{ijt-1}^{\beta_3}. \quad (4)$$

Thus, the creation of new ideas in firm i depends on firm i's own stock of ideas (A_{ijt-1}), R&D investment (S), own characteristics and the market environment (Θ , and spillover from other companies and/or advanced countries.
Dividing Eq. (4) by A_{ijt-1}, we get:

$$(A_{ijt} - A_{ijt-1}) / A_{ijt-1} = A_{ijt-1}^{\alpha-1} \bar{A}_{jt-1}^{\beta_1} S_{ijAt-1}^{\beta_2} \Theta_{ijt-1}^{\beta_3}. \quad (5)$$

By taking first-order Taylor series expansions around zero of each variable, from Eq. (5), we can derive the following log-linear and dynamic form equation:

$$\ln A_{ijt} = \alpha \ln A_{ijt-1} + \beta_1 \ln \bar{A}_{jt-1} + \beta_2 \ln S_{ijAt-1} + \beta_3 \ln \Theta_{ijt-1} + u_{ijt}, \quad (6)$$

where, $(A_{ijt} - A_{ijt-1}) / A_{ijt-1} \cong \ln A_{ijt} - \ln A_{ijt-1}$.

Here, $u_{ijt} = \alpha_{ij} + v_t + \varepsilon_{ijt}$, where is the unobservable industry and firm-specific term, v_t is the year-specific term, and ε_{ijt} is white noise (ε_{ijt} ~iid(0, σ_{ε}^2)).

Eq. (4) has two main problems. First, the expected value of the error term is not zero; therefore, the coefficients estimated by ordinary least squares (OLS) may be biased. Second, due to the inclusion of lagged dependent variables, the model specification is subject to the endogenous problem even if other control variables are strictly exogenous.

First-differencing the equations removes the { α_{ij} }, thus eliminating a potential source of omitted-variable bias in estimation. However, we noted that in the first-differences, predetermined variables became endogenous. Arellano and Bond (1991) developed a GMM estimator that treated the model as a system of equations, one for each time-period. The equations differ only in their instrument/moment condition sets. The predetermined and endogenous variables in the first differences are instrumented with suitable lags of their own levels. Strictly exogenous repressors, as well as any other instruments, enter the instrument matrix in the conventional instrumental-variables fashion, i.e. in first differences, with one column per instrument.

Taking the first-difference of Eq. (6), we get:

$$\ln A_{ijt} - \ln A_{ijt-1} = \alpha(\ln A_{ijt-1} - \ln A_{ijt-2}) + \beta_1(\ln \bar{A}_{jt-1} - \ln \bar{A}_{jt-2}) + \beta_2(\ln S_{ijkt-1} - \ln S_{ijkt-2}) + \beta_3(\ln \Theta_{ijt-1} - \ln \Theta_{ijt-2}) + w_{ijt} - w_{ijt-1}. \quad (7)$$

The overall validity of the moment conditions is checked by the Sargan over-identification test. The null hypothesis of no mis-specification is rejected if the minimized GMM criterion function registers a high value, when compared with a chi-squared distribution for which the degrees of freedom equal the difference between the number of moment conditions and the number of parameters.

To check the serial-correlation property of the level residuals, we relied on the Arellano-Bond and statistics. If the level residuals are indeed serially uncorrelated, then, by construction, the first-differenced residuals in (7) will follow a MA(1) process which implies that autocorrelations of the first-order are non-zero but the second or higher-order autocorrelations are zero. Based on the differenced residuals, the Arellano-Bond m_1 and m_2 statistics, which are both distributed as N(0,1) in large samples, were used to test the null hypotheses of zero first-order and second-order autocorrelation respectively. An insignificant m_1 and/or significant m_2 will issue warnings against the likely presence of invalid moment conditions due to serial correlations in the level residuals.

4.3.2. Determinants of Productivity

The following production function (Eq. 8) is assumed to examine whether or not the increase in the number of patents is a mere increase in the propensity to patent or a real increase in innovative output:

$$Y_{it} = F(L_{it}, K_{it}) B_t^{spillover}. \quad (8)$$

In Eq. (8), i denotes the firm and t the year, Y is the output, L is the employment, and K is the capital stock. $F(\bullet)$ can be interpreted as the level of technology and $B_i^{spillover}$ denotes spillovers from other companies in the same industry and/or from foreign firms.

Assuming a homogenous-of-degree-1 production function and taking logarithms both sides, we obtain the following estimation equation:

$$\ln y_{it} = \alpha_1 + \alpha_2 \ln k_{it} + \alpha_3 \ln A_{it} + \ln B_t^{spillover} + w_{it}, \quad (9)$$

where $y_{it} = Y_{it} / L_{it}$, $k_{it} = K_{it} / L_{it}$ and w_{it} } are error terms.
A_{it}, which reflects the level of technology, is measured by the number of patent stocks that are sought by firm i and $B_i^{spillover}$ is measured by the number of patent stocks that are sought by other companies in the same industry and/or by foreign companies.

4.4. Estimation Results

4.4.1. Innovative Activities

Before the estimation results are presented, Table 2 describes summary statistics of the main variables used in the estimations.

Table 2: Summary Statistics.

Variable	Observations	Mean	Std. Dev.	Min	Max
Productivity	579,560	0.1193662	1.204575	0	18.72126
Capital per worker	579,560	0.0753144	0.8709753	0	17.00393
Patent stock of the firm	15,482	1.460179	1.800606	0	11.33219
Domestic patent stock of the industry	7,572	4.781106	1.77794	0	8.875147
Foreign patent stock of the industry	8,443	5.917365	1.407443	1.94591	8.943506
Debt-sales ratio	579,560	0.0007757	0.0142558	0	3.314051

Note: All variables are log-transformed.

Table 3 reports the estimation results of the simple model on the relation between R&D expenditure and innovation activities. To consider the possible endogeneity of R&D expenditure, a one-year lagged variable was used. Showing a positive and significant coefficient for this variable, the R&D-expenditure variable plays a positive role in innovation activities.[8] The elasticity of R&D expenditure of around 0.015-0.021 means that the number of patents increases by 0.015-0.021 with a 1 per cent increase in R&D expenditure.

In order to test the impact of strengthened IPRs, two different approaches were used. Model 1 defines two dummies, viz., 1988-90 and 1995-00, to reflect the seventh and eleventh reforms, respectively. In Model 2, respective year-dummies were used to avoid the overlap of periods in Model 1. For Model 1, two dummies were shown to be positive and significant, which indicates that the strengthening of IPRs has helped to promote innovative activities in Korea. With 1981 as the reference year, the coefficients for year dummies are shown to be positive and significant after the 1989 year dummy, while year dummies for 1982 to 1986 are negative and significant. The dummies for 1987 and 1988 are not significant. Thus, relative to 1981, innovation activities up to 1986 decreased while those subsequent to 1989 increased. In terms of the absolute values of the coefficients: there was an upward trend from 1988 to 1997 and then a slight decrease after 1998, which seems to reflect the 1997 financial crisis in East Asia, including Korea.

Figure 1 plots all the estimated coefficients for the year dummies of the random-effect estimation of Model 2. If it is assumed that the time trend might reflect the impact of change of IPRs over a period, it can be interpreted that strengthening of IPRs contributed to innovation activities. However, a more robust estimation is necessary to confirm the graphical analysis. This is because of an assumption that time dummies include other various non-innovative factors such as business cycle factors, and the graphical analysis shows very stable shaper over the sample period.[9] Considering that Korea has been one of the countries that showed the fastest growth in patent applications over the past two decades, the strengthening of IPRs is an effective tool for promoting innovative activities.

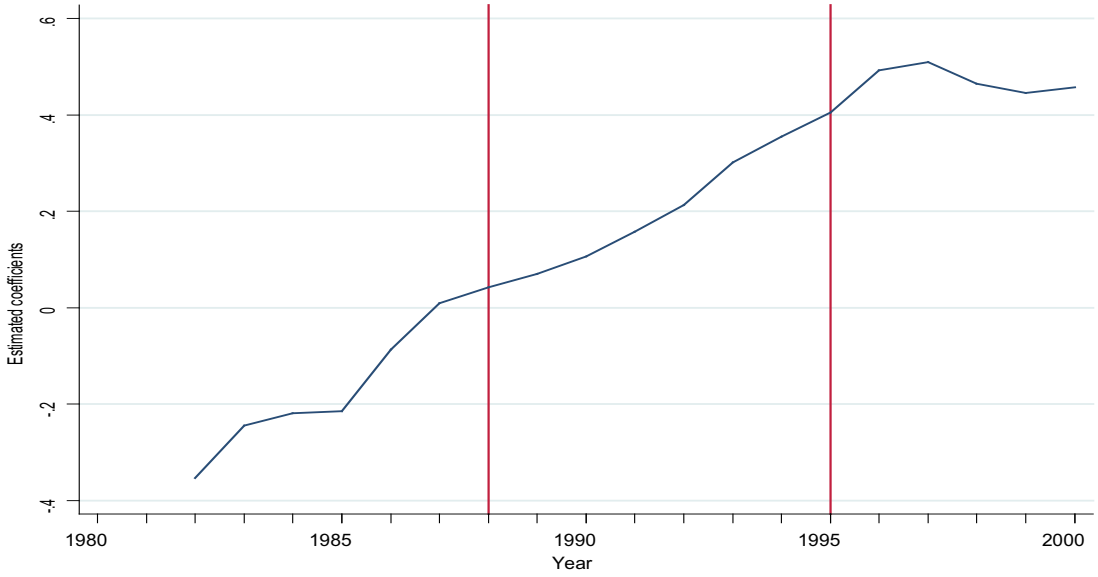
8 In contrast to this flow variable, the stock of R&D expenditure and the ratio of R&D expenditure to sales do not show significant coefficients. The stock of R&D expenditure is constructed by a perpetual inventory method with a depreciation rate of 10~15 per cent.
9 Taken from the constructive comments of referees.

Table 3: The Impact of Strengthening IPRs.

	Model 1		Model 2	
	Fixed	Random	Fixed	Random
Log (R&D expenditure) $_{-1}$	0.015	0.022	0.015	0.021
	(6.04)**	(9.95)**	(6.46)**	(9.88)**
=1 for 1988-00 (7^{th})	0.308	0.287		
	(14.71)**	(15.71)**		
=1 if 1995-00 (11^{th})	0.207	0.197		
	(14.93)**	(13.71)**		
=1 if 1982			-0.402	-0.357
			(5.13)**	(5.62)**
=1 if 1983			-0.307	-0.248
			(4.11)**	(4.03)**
=1 if 1984			-0.281	-0.235
			(4.51)**	(4.56)**
=1 if 1985			-0.256	-0.217
			(4.48)**	(4.53)**
=1 if 1986			-0.116	-0.087
			(2.61)**	(2.30)**
=1 if 1987			-0.006	0.019
			(0.16)	(0.60)
=1 if 1988			0.021	0.043
			(0.61)	(1.42)
=1 if 1989			0.058	0.080
			(1.83)	(2.78)**
=1 if 1990			0.098	0.115
			(3.05)**	(3.89)**
=1 if 1991			0.152	0.165
			(4.76)**	(5.51)**
=1 if 1992			0.202	0.213
			(6.44)**	(7.06)**
=1 if 1993			0.292	0.302
			(8.81)**	(9.20)**
=1 if 1994			0.345	0.356
			(9.87)**	(10.04)**
=1 if 1995			0.396	0.406
			(10.56)**	(10.53)**
=1 if 1996			0.484	0.493
			(12.45)**	(12.31)**
=1 if 1997			0.502	0.510
			(12.92)**	(12.73)**
=1 if 1998			0.458	0.465
			(12.64)**	(12.63)**
=1 if 1999			0.438	0.445
			(11.53)**	(11.51)**
=1 if 2000			0.454	0.457
			(11.92)**	(11.91)**
Constant	0.048	0.037	0.217	0.153
	(1.96)	(1.16)	(7.07)**	(1.66)
Observations	9,573	9,573	9,573	9,573
Firms	637	637	637	637
Overall R^2	0.01	0.08	0.07	0.16
Rho (Variance share due to α_i)	0.76	0.61	0.67	0.61
F value for (α_i) =0 (p value)	44.23(0.00)		28.83(0.00)	
BP LM χ^2 statistics for Var(α_i)=0 (p value)		37,398(0.00)		35,249(0.00)
Hausman χ^2 statistics (p value)		38.58(0.00)		51.74(0.01)

Note: Robust z statistics in parentheses; * significant at the 5 per cent level; ** significant at the 1 per cent level.

Figure 1: Trends of the Estimated Coefficients for the Year Dummies



Tables 4 and 5 present the estimation results of the technology production function through difference GMM estimation. The main difference between the two tables is in the definition of the technology spillover effect. In Table 4, the spillover effect is defined by domestic and foreign patents. The latter include those of the US, the EU and Japan. Table 5 disaggregates domestic patents by company and public research institute and foreign patents into those that correspond to the US, the EU and Japan. Year and field dummies were included in all estimation models but the results are not reported here.

All control variables, lagged and/or current, were chosen depending on the results with regard to over-identification and the serial correlations of orders 1 and 2. First of all, the Sargan over-identification test rejects the null hypothesis of no mis-specification, thereby confirming the correct choice of the combination of control variables. Second, the test results with regard to reject the null hypothesis of no autocorrelation, while the results with regard to accept the corresponding null hypothesis; thus, the level residuals are confirmed to be serially uncorrelated. In this manner, we confirm that the estimation models in Tables 4 and 5 are well-specified. In addition to specification issues: we considered various combinations of control variables to take into account multi-collinearity and missing-variable bias.

Since the estimation results of the same control variables were shown to be significant, we focused on Table 3, except for other control variables.

First, the coefficients for the stock of previous technology in Table 3 are about 0.556-0.569; showing that accumulated technology plays a positive role in innovative activities. Since <1, companies with an important accumulation of technologies tend to have lower technology growth rates. In other words, the elasticity on the growth rate of is in Eq. (5), viz., about -0.444~-0.431, depending on the model specification in Table 3.

Second, the coefficients for current and previous sales are shown to be positive and significant, thereby reflecting that innovative activities are pro-cyclical. These results are consistent with the findings of Guellec and Ioannidis (1997) for the OECD and Geroski and Walters (1995) for the UK. The companies that benefit from an economic boom expect to make profits and thus, tend to increase their innovative activities.

Third, the coefficient for R&D intensity is shown to be positive and significant, confirming the role of R&D intensity on innovative activities. Fourth, there is an inverted-U relationship between market concentration and innovative activities, related to the Schumpeterian hypothesis. Through this relationship, innovative activities are maximized at about 35-58 per cent of the market-concentration ratio. In Models (6) to (8) in Table 4, the market-concentration ratio for maximizing innovative activities is about 15 per cent.

Another set of variables reflects firm-level characteristics. Capital intensity plays a positive and significant role in innovative activities. The elasticity, 0.016-0.032, is lower than that of Hall and Ziedonis (2001) for the US semiconductor industry (0.34). The negative and significant coefficient for the debt ratio emphasizes the role of internal finance on innovative activities. As a company depends more on external debt, its innovative activity will shrink. Confirming the endogenous-growth theories of Lucas (1988) and Romer (1990) on the role of human capital in innovative activities, the coefficient for the ratio of the expenditure on training to sales is shown to be positive and significant.

Finally, the positive and significant coefficient for the export ratio to sales reflects that companies with a greater export ratio need to increase their innovative activities to survive in more competitive world markets.

Next, as one of the most important aspects of this study, we tested technology spillover effects through the innovative activities of domestic and foreign companies in the same field. We defined two different types of spillover effect: aggregate and disaggregate. The aggregate spillover effect is defined in terms of how the numbers of patents of domestic and foreign applicants affect the innovative activities of a company in the same field. The disaggregate spillover effect is defined by disaggregating the number of domestic patents into domestic companies and public research institutes and the number of foreign patents into three different groups, viz., the US, the EU and Japan.[10]

Interestingly, the number of patents of domestic companies in the same field plays a negative role, which implies negative technology spillovers. However, the positive sign for the number of patents of foreign companies reflects positive technology-spillover effects on domestic companies that are quoted on the stock market.[11]

10 The EU includes Belgium, Denmark, Finland, France, Greece, Ireland, Italy, Portugal, Spain, Sweden, The Netherlands and the UK.
11 Since the lagged variables of the stocks of domestic and foreign patents failed to reject the null hypothesis of misspecification, only current values are included. However, there seem to be no significant endogeneity issues because all the lagged variables are used as instruments.

Table 4: Difference GMM Estimation Results (Aggregate Spillover).

	Model 1		Model 2		Model 3	
Explanatory variables	Random effects	Fixed effects	Random effects	Fixed effects	Random effects	Fixed effects
Capital stock per worker	1.166***	1.172***	1.122***	1.127***	1.068***	1.070***
	(0.00268)	(0.00257)	(0.00361)	(0.00360)	(0.00557)	(0.00670)
Patent stock of the company			0.278***	0.274***	0.236***	0.194***
			(0.01310)	(0.01350)	(0.03320)	(0.03740)
Domestic patent stock of the industry					0.357***	0.382***
					(0.03760)	(0.04340)
Foreign patent stock of the industry					-0.0613	0.0188
					(0.05520)	(0.05850)
Debt-sales ratio	-0.988***	-0.953***	-1.404***	-1.356***	-1.298***	-1.206***
	(0.19900)	(0.20000)	(0.24200)	(0.24700)	(0.24700)	(0.29600)
Constant	1.208***	1.191***	0.938***	0.929***	0.233	0.346
	(0.10900)	(0.01500)	(0.10700)	(0.02140)	(0.31600)	(0.29600)
Observations	15,477	15,477	15,477	15,477	7,572	7,572
R-squared	0.674	0.723	0.684	0.734	0.537	0.748
Hausman statistics		53.67		21.22		-0.57

Note: Robust z statistics in parentheses; * significant at the 5 per cent level; ** significant at the 1 per cent level.

To clarify technology spillover effects in more detail, Table 5 reports the estimation results of the disaggregate spillover effect. The coefficients for domestic companies are negatively signed but those for public research institutes are positively signed. Thus, the negative spillover effect among domestic companies implies that competitive effects dominate learning effects and/or disclosure of information lead to a positive spillover effect. Hence, in the light of a patent application from a competitor, companies in the same industry feel more competitive and expect a low profit rate due to a loss of competitive power in markets; leading to low incentives in the patent race. However, patent applications from public institutions, such as universities and public research institutes, tend to promote innovative activities by providing useful information and knowledge through cooperative research activities between public research institutes and private companies.

To see the possible different effects of patent applications from foreign companies, we divided foreign countries into three main groups, the US; the EU and Japan. The estimation results indicated that patent applications from the US and the EU led to a lower number of patent applications from domestic companies, while those from Japan helped to increase the number of patent applications from domestic firms.

As Yang (2003) indicated from the results on Taiwan, the competitive effect of patent applications from developed countries is the dominant factor. As a result, domestic companies might be reluctant to join the patent race with developed countries because they consider themselves to be technologically backward and the domestic market too small; thus, they do not want to become involved in high risks and costs. However, when domestic companies are not technologically backward and there are patent applications in the same field through their research activities, the patent applications from foreign companies might contribute to more innovative activities because the learning effect might dominate the competitive effect.

We can examine the number of claims that can be assumed to reflect the size of the technology gap with respect to various patents. Between 1982 and 2000, Canada and the US showed 16.2 and 15.2 respectively; the UK and France exhibited 13.0 and 12.5 respectively, and both Switzerland and Sweden showed 11.8. However, Japan showed only 10.0 (KIPO and KIPI, 2003). A comparison of individual companies revealed a similar trend. The number of claims from IBM was 16.8, while those from Sony and Toshiba were 6.9 and 10.0 respectively. Thus, when we compare the level and quality of patents with the number of claims, patents that are sought by the

US and EU are more fundamental and qualitative than those that are applied for by Japanese companies. In this comparison, patent applications from US and EU companies with more fundamental technologies deter the innovative activities of domestic companies due to the effect of competition. However, patent applications from Japanese companies with a smaller technology gap with respect to domestic companies promote the innovative activities of those companies.

Table 5: Difference GMM Estimation Results (Disaggregate Spillover).

	Model 5	Model 6	Model 7	Model 8
Log(patent) $_{-1}$	0.531	0.532	0.557	0.556
	(72.59)***	(89.19)***	(47.19)***	(49.51)***
Log(sales)	0.044	0.024	0.021	0.001
	(4.98)***	(2.90)***	(1.07)	(0.07)
Log(sales) $_{-1}$	0.026	0.029	0.038	0.042
	(5.35)***	(6.09)***	(2.78)***	(3.01)***
Log(R&D expenditure/sales)	1.343	1.298	1.337	1.363
	(12.28)***	(10.74)***	(6.94)***	(7.04)***
Log(training/sales)	20.617	21.388	21.170	21.761
	(45.76)***	(46.14)***	(20.21)***	(22.75)***
Log(training/sales)) $_{-1}$	12.722	12.237	13.697	13.324
	(30.10)***	(27.24)***	(14.84)***	(15.11)***
Log(capital intensity)	0.043	0.068		
	(7.14)***	(14.53)***		
Log(capital intensity) $_{-1}$	0.013	0.014		
	(3.37)***	(3.42)***		
Log(leverage)	-0.015		-0.021	
	(3.95)***		(2.61)***	
Log(exports/sales)	0.163	0.141	0.152	0.142
	(11.73)***	(13.77)***	(5.86)***	(5.54)***
CR3	0.0007	0.003	0.003	0.003
	(0.595)	(2.10)***	(1.03)	(1.03)
$CR3^2$	-0.0001	-0.0001	-0.0001	-0.0001
	(6.28)***	(7.70)***	(3.75)***	(3.64)***
Log(domestic)	-1.170	-1.154	-1.145	-1.179
	(29.55)***	(23.75)***	(9.08)***	(9.23)***
Log(domestic public institutes)	0.388	0.415	0.382	0.495
	(3.48)***	(4.49)***	(1.69)*	(2.57)***
Log(US)	-0.128	-0.124	-0.201	-0.231
	(2.68)***	(3.27)***	(1.80)*	(1.91)*
Log(Japan)	0.682	0.635	0.715	0.697
	(14.97)***	(16.16)***	(5.45)***	(5.22)***
Log(EU)	-0.346	-0.307	-0.399	-0.372
	(8.22)***	(7.96)***	(4.30)***	(4.11)***
Constant	0.036	0.040	0.063	0.065
	(4.12)***	(6.11)***	(4.07)***	(4.23)***
Observations	1,098	1,105	1,143	1,150
Firms	178	180	190	192
Sargan statistics	153.46	159.71	143.47	144.68
(p-value)	(0.783)	(0.664)	(0.137)	(0.122)
p-value for the AR(1) test	0.001	0.001	0.001	0.001
p-value for the AR(2) test	0.939	0.925	0.862	0.894

Note: Robust z statistics in parentheses; * significant at the 5 per cent level; ** significant at the 1 per cent level

Following Bessen (2004), the broadening of patents leads to the hold-up problem of cumulative innovation; thus, it discourages R&D incentives and decreases technological innovation. In this manner, by increasing the possibility of patent infringement, the broadening of patents confers advantages upon first innovators and handicaps slower companies that develop new technologies; hence, it discourages investment in the development of new technologies. In this interpretation,

patent applications from US companies that have a higher number of claims might discourage investment in the development of new technologies by local companies due to the broadening of patents. However, patent applications from Japanese companies with a low degree of technology promote the innovative activities of domestic companies. The estimation results in Table 6 are from Kang and Seo (2005).

4.4.2. Productivity Function

Table 6 reports on whether or not an increase in the number of patent applications due to the strengthening of IPRs leads to an increase in the propensity to patent or results in innovative activities. In other words, the estimation results of Eq. (9) are to investigate how the strengthening of IPRs contributes to productivity through innovative activities.

The dependent variable is labor productivity, which is defined as the ratio of sales to employment. Independent variables are the per capita capital stock, the patent stock and the patent stock of the industry in which the company operates. Other independent variables divide the patent stock of industries into two parts: patents from domestic applicants and patents from foreign applicants.

Over all the estimation specifications, the per capita stock shows a positive and statistically significant coefficient and the debt ratio is negatively related to productivity, which is quite similar to the estimation result with regard to innovative activities. The total patent stock contributes positively to productivity, which implies that an increase in the number of patent applications due to the strengthening of IPRs is the result of innovative activities and thus results in an increase in productivity. The estimation results on spillover effects also show that the spillovers from domestic companies in the same industry improve labor productivity. However, the spillover effects from foreign companies are not statistically significant (Model 3).

Table 6: Estimation Results

	Model 1		Model 2		Model 3	
Explanatory variables	Random effects	Fixed effects	Random effects	Fixed effects	Random effects	Fixed effects
Capital stock per worker	1.166***	1.172***	1.122***	1.127***	1.068***	1.070***
	(0.00268)	(0.00257)	(0.00361)	(0.00360)	(0.00557)	(0.00670)
Patent stock of the company			0.278***	0.274***	0.236***	0.194***
			(0.01310)	(0.01350)	(0.03320)	(0.03740)
Domestic patent stock of the industry					0.357***	0.382***
					(0.03760)	(0.04340)
Foreign patent stock of the industry					-0.0613	0.0188
					(0.05520)	(0.05850)
Debt-sales ratio	-0.988***	-0.953***	-1.404***	-1.356***	-1.298***	-1.206***
	(0.19900)	(0.20000)	(0.24200)	(0.24700)	(0.24700)	(0.29600)
Constant	1.208***	1.191***	0.938***	0.929***	0.233	0.346
	(0.10900)	(0.01500)	(0.10700)	(0.02140)	(0.31600)	(0.29600)
Observations	15,477	15,477	15,477	15,477	7,572	7,572
R-squared	0.674	0.723	0.684	0.734	0.537	0.748
Hausman statistics		53.67		21.22		-0.57

Note: Robust standard errors in parentheses; *** p<0.01; ** p<0.05; * p<0.1.

5. Conclusions

We assumed that data on patent applications reflects a better proxy for innovative activities than R&D expenditure used in traditional studies. Then, we investigated the impact of the strengthening of IPRs in Korea and tested the determinants of new technologies by using the panel difference GMM method.

We found that, first, an accumulated stock of ideas leads to higher levels of technology, even though the effect tends to decrease in the long run. Second, companies with higher capital intensity, higher export ratios and greater investment in human capital tend to increase the number of patent applications. Further, a higher debt ratio tends to discourage innovative activities, thereby reflecting the importance of internal finance.

Third, there is an inverted-U relationship between market structure and innovative activities. In contrast to the Schumpeterian hypothesis, innovative activities are maximized at a market-concentration ratio of 35-58 per cent. Fourth, there is a negative spillover of domestic innovative activities to companies in the same field, while foreign company activities show a positive spillover. The disaggregation of domestic innovative activities shows a negative spillover for domestic companies but a positive spillover for public research institutes. In addition, the innovative activities of the US and EU tend to result in a negative spillover, while those of Japan show the reverse.

Lastly, the estimation results of the productivity function show that productivity has a positive relationship to the patent stock of a company and this is measured by the number of patent applications, i.e. possible increases in innovative activities.

This study confirms that innovative activities come not only from inputs, such as R&D expenditure, but also from firm characteristics and market conditions. Thus, in addition to higher R&D expenditure as a necessary condition, companies need to spend more time and invest more in the education and training of their employees. Further, the government needs to promote a more competitive environment by liberalizing the domestic market.

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Chapter 5

The Effects of the Patent System on Innovation and Productivity: Evidence from Korea's Firm-Level Data

TAEGI KIM and KEUN-YEOB OH

ABSTRACT

This paper evaluates the effects of patent system reforms in Korea on knowledge activities such as R&D expenditure and patent applications, and then attempts to determine whether increased knowledge has led to productivity growth in Korean manufacturing firms. We used Korea's firm level data, which covered 216 firms over the years 1985-2007. The Korean Patent System experienced a major policy change in 1986 and since then it has been continually strengthened.

Our results revealed that, during the time period studied, productivity growth rates were higher in high technology firms than in their low technology counterparts. Next, according to our regressions, strengthening the Korean patent system has had a positive effect on R&D expenditures and patents, and this increase in knowledge has led to significantly positive effects on productivity growth in Korean manufacturing firms. Moreover, the IPR reforms had a more profound impact in the high technology sector than in its low technology counterpart. We also detected evidence of knowledge spillovers among firms, in that innovation in a certain firm was shown to increase the TFP (Total Factor Productivity) of others.

1. Introduction

The endogenous growth theory, developed by Romer, 1986; Lucas, 1988 and Grossman and Helpman. 1991, identified technical changes and knowledge spillovers as the principal source of continuous economic growth. As opposed to previous theories of economic growth under conditions of constant returns, these models demonstrated how the economy can consistently expand as a consequence of investment in R&D and growth in human capital, both of which tend to raise levels of knowledge.

The Korean economy experienced rapid growth and significant structural changes beginning in the 1960s. Much of this economic growth appears to have been attributable to the growth in the stock of production inputs (labor and capital) rather than to productivity. In order to achieve sustainable economic growth, Korea must enhance the productivity associated with technological progress. Many researchers have pointed out that this task would require an increase in knowledge and both R&D investment and patenting can be considered measures of knowledge (Griliches, 1990).

Korea's patent system experienced a major policy change in 1986. Its underlying objective up to that point had been to restrict patentees' rights in order to obtain foreign technology, but after 1986 the policy shifted toward protecting inventions and strengthening patent rights. We surmise that R&D expenditures and patent applications have expanded as a consequence of strengthening the system in Korea. We also expect that this increase in R&D expenditures has had a positive effect on productivity.

A large body of research regarding the effects of R&D on productivity has been accumulated.[12] Literature focusing on the firm level indicates that R&D generally has a positive effect on productivity (Griliches and Mairesse, 1984; Wang and Tsai, 2003; Wakelin, 2001). Some studies have shown that there are knowledge spillovers among industries and among countries using R&D data at the industry level (Keller, 2002; Kim and Park; 2003; Singh, 2004; Kim, Maskus and Oh, 2009), and using patent data (Bottazzi and Peri, 2001; Jaffe, 1986 and Kwon, 2004).

The principal objective of this paper is to determine whether the strengthening of Korea's patent system led to increases in R&D expenditures or patent applications, and then to determine whether or not this increase in knowledge caused productivity growth in the Korean manufacturing sector. We employed Korea's 1985-2007 firm-level data, which cover data from 216 firms. Korean patent applications and patent grants have been increasing rapidly since the early 1990s and this may be attributable to the sizeable amount of R&D expenditure by private firms and public institutions, although the strengthening of the patent protection policy by the Korean Government may also play a role (Luthria and Maskus, 2004; Jung et al., 2004).

This paper differs from current literature in the following ways. First, it analyzes the effects of strengthening patent systems on innovation in Korean manufacturing firms. Second, we evaluate the effects of innovation on productivity growth using firm-level data, having extracted each firm's patent data from the raw Korean patent dataset. Finally, we evaluate the effects of knowledge spillovers on productivity at the firm level. It is quite difficult to find prior studies because the measuring index for knowledge spillover at the firm level is not a simple proposition. We utilized Jaffe's (1986) technology proximity index to determine the effects.

Our results reveal that, during the time period studied, productivity growth rates were higher in high technology firms than in firms in other sectors. Next, according to our regressions, the strengthening of the Korean patent system has had a positive effect on innovation, and has led to increases in R&D expenditure and patents; this increase had a significantly positive effect on productivity growth in Korean manufacturing firms. Additionally, we detected evidence of knowledge spillover among firms as innovation increased.

This paper is structured as follows. Section 2 presents a theoretical model supporting the empirical analysis, whereas Section 3 describes changes in the Korean patent system and the data sources. Section 4 presents the results using panel regressions with fixed effects. Finally, in Section 5 we present our conclusions.

2. Model

The patent system attempts to provide incentives to inventors to encourage technological development, which in turn stimulates economic growth. This paper assesses this notion using Korean firm-level data. The empirical analyses conducted consist of two steps. First, we determine whether the strengthening of the patent system has resulted in increases in R&D investment and patent applications. Second, we attempt to address another question: do increases in R&D investment and patent applications have a positive effect on total factor productivity? If the above two analyses reveal positive and significant results, we can safely assert that a strengthening of the patent system in Korea has positively affected economic growth.

12 For an early literature survey, see Griliches (1995).

The system has been strengthened over time since its establishment in 1946 and a particularly dramatic shift occurred in 1986. After 1986, the policy shifted toward protecting inventions, thus resembling the patent systems of developed countries.

In order to determine whether the strengthening of the patent system has encouraged R&D investment and patent applications, we utilized the following equation:

$$\ln \mathbf{KN_i} = \alpha_0 + \beta_1 \ln \mathbf{SIZE_i} + \beta_2 \mathbf{D} + \epsilon_i \qquad (1)$$

Here KN denotes knowledge stock whose proxy variables are R&D investment or patent applications, SIZE is the output (or employment) of a firm, and D is a dummy variable indicative of policy change. D is 1 for the years after changes in the patent system, and 0 for the years before.

In order to visualize the effects of knowledge on productivity, we considered the following production function, which is suggested in the endogenous growth model (Romer, 1986; Grossman and Helpman, 1991).

$$\mathbf{Y_i} = \mathbf{A}\, \mathbf{L_i^{\alpha}} \mathbf{K_i^{\beta}}\, \mathbf{n^{\gamma}} \qquad (2)$$

Here Y, L, and K are output, labor and capital, respectively. The variable n indicates the number of intermediate goods, although it could also be regarded as an indicator of quality. If this production function displays constant returns to scale in labor and capital, the sum of α and β should be unity. The overall production function is subject to increasing returns because of the existence of the intermediate inputs n.

Here n is an increasing function of knowledge stock, because intermediate goods are developed and improved by access to the existing knowledge stock and, as it increases, new intermediate goods are developed or the quality of intermediate goods is improved. Thus, we obtain:

$$\mathbf{Y_i} = \mathbf{A}\, \mathbf{L_i^{\alpha}} \mathbf{K_i^{\beta}}\, \mathbf{KN_i^{\gamma}} \qquad (3)$$

Here, KN denotes knowledge.

This equation may be readily represented in log form as:

$$\ln Y_i = \mathbf{A} + \alpha \ln \mathbf{L_i} + \beta \ln \mathbf{K_i} + \gamma \ln \mathbf{KN_i} \qquad (4)$$

We utilized R&D investments or patent applications as proxy variables for knowledge, because R&D expenditure is an input which leads to knowledge and patents represent an output of knowledge (Pakes and Griliches, 1984). The coefficients α, β, and γ represent the elasticities of output with regard to labor, capital and knowledge respectively.

Our measure of productivity, the total factor productivity (TFP), is defined as the residual between output and inputs of labor and capital in the production function, as follows:

$$\ln \mathbf{TFP_i} = \ln \mathbf{Y_i} - \alpha \ln \mathbf{L_i} - \beta \ln \mathbf{K_i} \qquad (5)$$

Here, TFP denotes total factor productivity. From equations (4) and (5), we can see that TFP has the following relationship to the quantity of knowledge:

$$\mathbf{lnTFP_i = lnA + \gamma\, lnKN_i} \qquad (6)$$

Coefficient also demonstrates the elasticity of TFP with regard to knowledge. This coefficient illustrates to what degree investment in R&D or patents and the proxy variable of knowledge, contribute to productivity.

In this paper, we also considered knowledge spillovers among firms. These allow for an escape from diminishing returns and lead to economic growth at an undiminished rate into the future (Romer, 1986, Grossman and Helpman, 1991). The relevant equation can be expressed as follows:

$$\mathbf{lnTFP_i = \alpha_0 + \beta_1 lnKN_i + \beta_2 lnKNO_i} \qquad (7)$$

Here, KNO denotes the knowledge spillover from other firms. The expected coefficients of β_1 and β_2 are positive, as we anticipate that knowledge accumulation will have a positive effect on productivity.

3. Data

3.1. Data Sources

Our study utilized the data of 216 manufacturing firms over the years 1985-2007, each of which own more than 10 patents and all of which have been quoted on the Korean Stock Exchange over the specified time period.[13] The data for output, labor input, capital stock and intermediate goods at the firm level were derived from the KISVALUE (Korea Investors Service-Financial Analysis System) database (2008).[14] Since the values in the KISVALUE database are expressed in current terms, we converted current values into constant values using price indices from the Bank of Korea (BOK, 2008). As a price index for R&D investment, we used the average values of the producer price index and wage index, as in the studies of Coe and Helpman (1995) and Hall (1990). Data regarding unit labor cost from the OECD (2007) were used as the wage indices.

Patent application data for each firm were obtained from the KIPO database and we used the raw dataset of patent applications, which covered more than one million patents. Every patent application included the name of the applicant and we matched each firm's patent applications with the input and output data from KISVALUE by using the firms' names.

3.2. Calculation of Knowledge Spillover

To assess knowledge spillover, we calculated other firm knowledge using Jaffe's method. Jaffe (1986) measured the magnitude of spillovers using a function of the technological distance between firms. He utilized the distribution of firms' patents over patent classes and defined the spillover pool as the weighted sum of all other firms' R&D, with the weights set proportional to the technological proximity.

Jaffe evaluated the similarity between firms using patents classified by international patent classification (IPC) codes. If two firms applied for patents for similar IPCs, they were considered to

13 One of the problems here may be the absence of a suitable amount of pre-patent reform data. The authors attempted to extend the data back in time. However, it was found that the data for the previous time period were insufficient.
14 The KISVALUE codes for each variable are listed in the Appendix.

have a substantial mutual effect on one another. Thus, the patent similarity between two firms can be calculated via the following correlation coefficient.[15]

$$Prox_{ij} = \frac{\mathbf{F_i F_j'}}{\sqrt{\left(\mathbf{F}_{\ i}\mathbf{F_i'}\right)\left(\mathbf{F_j F_j'}\right)}}$$

Here, Fi and Fj are the IPC patent vectors of firms i and j, respectively. Proxij is the proximity or correlation between firms i and j. If every patent applied for by two firms belongs to the same IPC category, Proxij is 1. Additionally, if two firms applied for completely different IPC categories, Proxij is 0. Thus, Proxij is between 0 and 1. It becomes closer to unity as the technologies of the two applicants become more similar.

The spillover knowledge from other firms can be calculated using the proximity index as the weight. Other-firm R&D (RNDO), and other-firms patents (PATO), can be calculated as follows.

$$\mathbf{RNDO_i} = \sum_{\mathbf{j \neq i}} \mathbf{Prox_{ij} RND_j}$$

$$\mathbf{PATO_i} = \sum_{\mathbf{j \neq i}} \mathbf{Prox_{ij} PAT_j}$$

The weight increases with greater proximity between the firms, which means that knowledge shared increases the mutual influence of the firms. For example, a new patent or new knowledge on semiconductors will have a greater effect on the development of technology in firms in the same sector than on those, for example, in the food industry.

3.3. Data Description

Table 1 shows the share of output, R&D expenditure and patents by technology sector in 1985 and 2007. We classified all firms into technology sectors in accordance with OECD guidelines (2007). In our sample, the figures were as follows: 29 in the high-technology sector (HI); 110 in the medium-high-technology sector (MH); 43 in the medium-low-technology sector (ML) and 34 in the low-technology sector (LO). We saw that share of output, R&D expenditure and patent applications increased rapidly in high-technology firms over the years 1985-2007. Average R&D intensity was also quite high in this sector in 2007, even though there was an overall increase during that period. R&D intensity represents the ratio of R&D expenditure to output.

The share of R&D expenditures was highest in MH firms in 1985, but in 2007 that of HI firms rose to the top as their share increased from 7.1 per cent in 1985 to 71.4 per cent in 2007. The share of patent applications was highest in HI firms in both 1985 and 2007. In 2007, over 90 per cent of the total R&D expenditures and the total patent applications concerned high- and medium-high-technology firms; these two sectors were responsible for 73.5 per cent of total manufacturing output. Table 1 shows that the firms in the high-technology sector grew faster than those in the low-technology sector.

15 See Jaffe (1986) for details.

Table 1: Share of Output, R&D Expenditure, Patent Applications by Group

	No. of Firms	Output		R&D Expenditure		Number of Patent Applications		R&D Intensity	
		1985	2007	1985	2007	1985	2007	1985	2007
High Technology	29	12.3	30.6	7.1	71.4	55.2	66.5	0.09	4.57
Medium-High Technology	110	43	42.9	62.4	24.4	28.9	28.3	0.24	1.11
Medium-Low Technology	43	32.8	21.4	20	3.5	12.1	4.7	0.1	0.32
Low Technology	34	11.9	5.1	10.5	0.8	3.8	0.6	0.14	0.3
Total	216	100	100	100	100	100	100	0.16	1.96

Source: KISVALUE Database (2008) and KIPO Database (2008).

Note: 1) Classification of each technology group is based on OECD (2007): High Technology (30, 32, 33); Medium-High Technology (24, 29, 31, 34, 35), Medium-Low Technology (23, 25, 26, 27, 28), Low Technology (15, 16, 17, 18, 19, 20, 21, 22, 36, 37). The numbers in parentheses are ISIC code (rev 3). 2) R&D intensity=R&D/output*100.

Table 2 shows the growth rate of variables by the four technology sectors during the period 1985-2007. In total, output increased on average by 11.6 per cent annually, with capital input increasing faster than labor input. The average annual growth rate of labor was 1.6 per cent, and that of capital stock was 11.5 per cent. This implies that the capital-labor ratio in production increased during the period studied. The average annual growth rates of R&D expenditure and patents were 24.2 per cent and 20.0 per cent respectively, with R&D expenditure and patenting increasing more rapidly than outputs and inputs.

The output growth rate in the HI sector was 27.1 per cent, more than twice that of the total rate and in addition, R&D expenditure and patents increased more rapidly in this sector. As for TFP, the highest average annual growth rates were attained in HI firms (11.23 per cent).[16] TFP in other sectors was substantially lower, and the average TFP growth rate for the total sample was 2.51 per cent. Table 2 shows that during the period studied, knowledge accumulated more rapidly in HI firms and the TFP growth rate was also higher in high-technology firms than in the low-technology sector.

Table 2: Annual Average Growth Rates of Output, Input, R&D and Patents (1985-2007)

	No. of Firms	Output	Labor	Capital Stock	R&D Expenditure	Number of Patents	TFP
High Technology	29	27.1	5.6	19.6	37.9	21.1	11.23
Medium-High Technology	110	11.4	1.2	11.2	19	19.9	1.56
Medium-Low Technology	43	7	-0.7	8	14.7	15	0.4
Low Technology	34	6.1	-0.8	8.8	10.4	9.9	0.8
Total	216	11.6	1.6	11.5	24.2	20	2.51

Note: Output, capital stock; R&D expenditure are in constant terms; labor is the number of employees; TFP is the simple average of those of the firms in each group.

4. Empirical Results

4.1. Changes in the Korean Patent System

The Korean Patent System has been revised 16 times since it was first established in 1946. The most profound policy change in the system occurred in 1986, when the policy shifted from a weak system to a strong system based on the protection of inventions and patent rights. After 1986 policies shifted toward protecting inventions and strengthening patent rights.[17] Two factors can be mentioned regarding this 1986 policy shift. First, in the 1986 Uruguay Round, the strengthening of IPRs was one of the major issues addressed. The Korean Government was compelled to strengthen the patenting system, to match the systems in developed countries. Secondly, the demand for patent protection rose with Korea's economic development and technological evolution. Its industrial structure needed to move toward a capital-intensive or technology-intensive model in order to achieve sustainable economic growth, and the government thus attempted to encourage R&D investment with a robust patent system for this purpose. The Korean patent system has thus undergone continual strengthening since 1986.

Jung et al. (2004) measured the strength of the patent system using the method developed by Ginarte and Park (1997). The results of that study demonstrated that the Korean patent system was substantially strengthened as the indices changed from 3.99 in 1986, to 4.28 in 1990, 4.67 in 1995 and 5.00 in 2002.

Major changes year-on-year are as follows. In 1986, the patent system allowed substance patents and the patent period was extended from 12 to 15 years. In 1990, the patent system added food to the list of patentable goods and introduced a domestic priority rights system. In 1995, the list of patentable goods was again expanded and the patent period extended from 15 to 20 years. Korea also joined the WTO/TRIPS Agreement in 1995 and in 2002 became a member of UPOV.

This paper considers the effects of patent system reforms imposed in the years 1987, 1990, 1995 and 2002. It appears likely that the stronger patent protection regime in Korea, implemented since 1986 has encouraged R&D expenditure and patent applications (Luthria and Maskus (2004); Maskus (2000).

4.2. Trends in the Patent System, R&D and Patents

Before addressing the effects of the patent system, some relevant trends in R&D investment and patent applications by Korean manufacturing firms are shown using line graphs. As we used firm-level panel data, we regressed the R&D or patents on the year dummy variables under consideration which means that we used a year dummy to match each year and then estimated the regression coefficients for each year dummy.

(1) R&D Investment

Figure 1 shows the results RNDT, RNDL and RNDP as the simple trend of R&D, the trend of RND with the control variable "labor" and the trend with the control variable "production" in the regression model. As the three lines show similar trends, only one figure need be interpreted as a representative case. If the trend showed rapid increase in the years 1987, 1990, 1995 and 2002, we can assert that the IP policy change had an immediate effect on R&D or patents. Here, DRND is the increase in R&D for the year and DPAT applies to patents.

16 We estimated the total factor productivity indices based on the method of Caves et al. (1982), which is a multilateral index that allows for comparisons of TFP levels among industries and time periods.

17 Maskus and McDaniel (1999) and Cohen et al. (2001) showed that the weak patent system in Japan from the 1960s to the mid-1990s positively affected Japanese productivity growth, as it played a pivotal role in diffusing technical information among Japanese manufacturing firms.

Figure 1: Changes of Year Dummy: R&D Expenditure

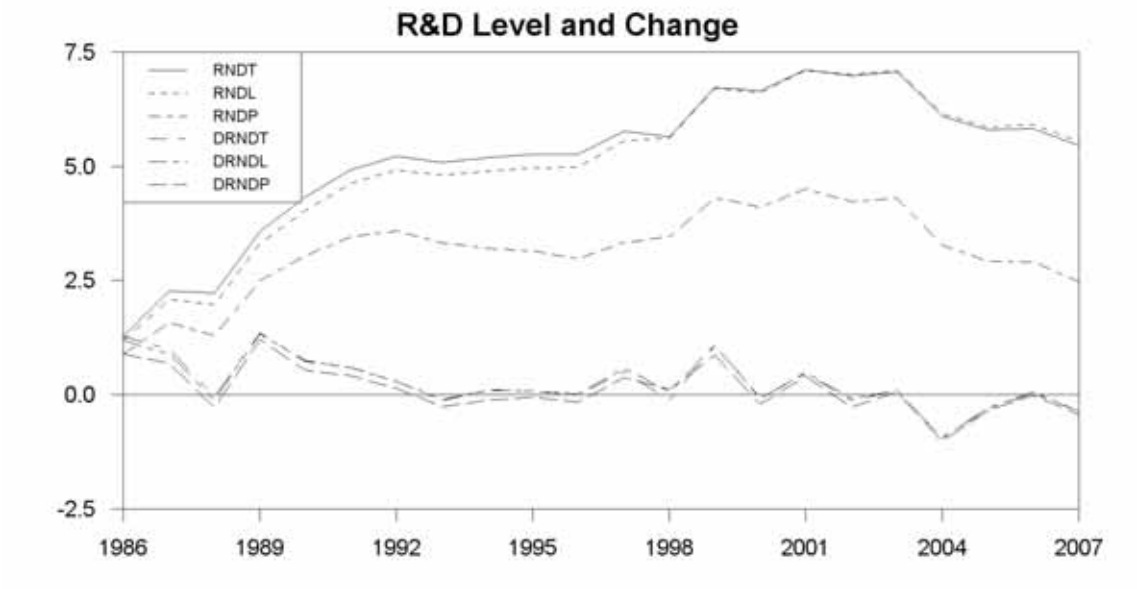


Figure 1 shows that R&D investment (RNDT) increased rapidly during the early 1990s, plateauing during the mid-1990s. The trend continued upward from 1999 to the beginning of the 2000s. After 2003, it decreased dramatically until recently and this trend appears comparable for the other variables, RNDL and RNDP. At the foot of the figure, the differences are plotted for the sake of clarity.

If the strength of the patent system encouraged R&D, we should be able to detect significant positive change (DRNDT) occurring around incidences of relevant policy changes, especially as policy changes are generally announced prior to coming into effect, so those affected generally prepare in advance. Therefore, as a reasonable response, it is not unusual to find that R&D investment changed prior to policy change. We must keep in mind that if the policy changes included changes in the clauses of IP laws, these effects could prove permanent.

According to Figure 1, we can see the positive values of difference in R&D (DRNDT) for the years 1986, 1987, 1989, 1990, 1991, 1997, 1999 and 2001.[18] We might consider the positive values around 1987 as the Korean patent system becomes stronger (introduction of substance patents). The change to the patent system in 1990 also appears to have influenced R&D, judging from the positive values observed around that year. However, accession to WTO and IPR policy changes did not appear to have increased the R&D activity of Korean firms. The government enforced the IPR laws quite strenuously in order to meet WTO criteria, and there were a large number of prosecutions for infringement in the first half of the 1990s. R&D does not seem to have immediately responded substantially to this policy change; however in contrast in 1997, positive values were observed, which may indicate the effects of the 1995 change. In 1998, we experienced negative R&D growth (i.e. DRNDT as a negative value) owing to the Asian currency crisis. Here, if we control the regression with firm size (LABOR) or production (PROD), the change does not appear to have been negative. This may indicate that the reduction in R&D was not the result of R&D behavior, but was rather caused by a downturn in the business cycle.

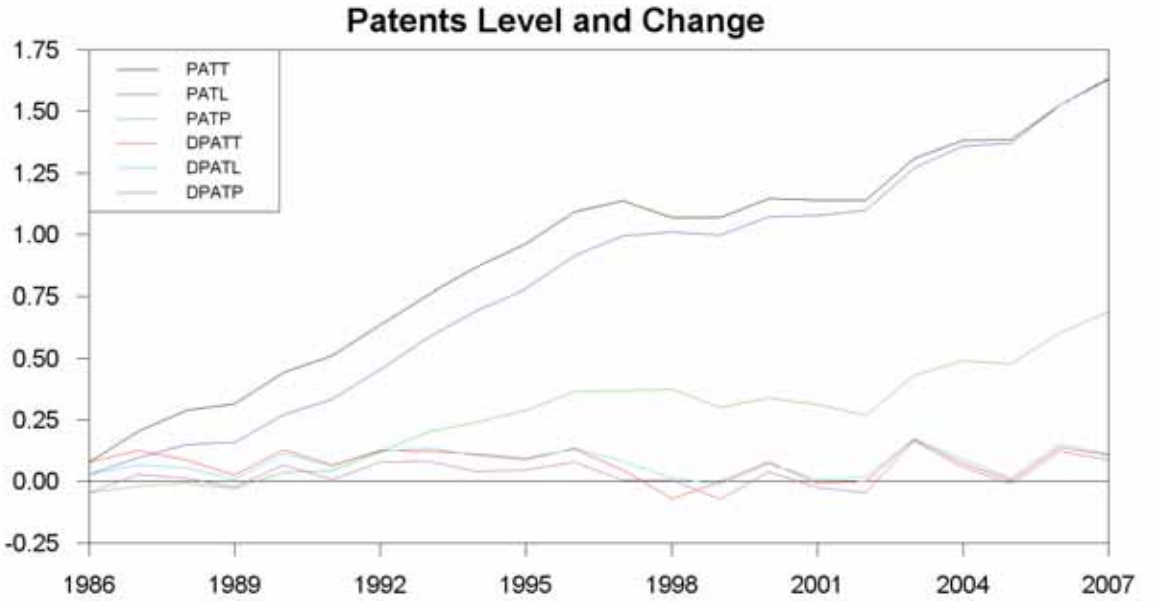
18 Here, the values in Figures 1 and 2 are estimates for the year dummy variables with or without the control variables.

From 1999 to 2001, there was an important worldwide venture business boom, and we saw an upswing in R&D, followed by a major reduction once the craze had passed. Strengthening of IPRs was not sufficient to offset this drop.

(2) *Patents*

What were the effects on patents? In Figure 2, the number of patent applications is given. Patent trends appear similar to each other both with and without the control variables. In general, the years 1987, 1988, 1990, 1992, 1993, 1994, 1995, 1996, 2000, 2003, 2004, 2006, 2007 showed increases in patents granted. This does not correlate precisely with year-on-year changes in R&D activity. However, we can interpret the figures as follows. The reforms of 1986 appeared to be effective in encouraging patent applications. In Korea, from the beginning of the 1990s, the government made major efforts in IPR policy to prepare for Korea's accession to the WTO and the positive values in the years 1992-1996 may represent the results of these efforts. Even though the currency crisis resulted in a negative effect in 1998, the venture business boom increased R&D significantly, giving rise to an upswing in patents in the 2000s. This rise could of course have been caused by the patent reform in 2002.

Figure 2: Changes of Year Dummy: Patent Applications



4.3. Regression Analysis using Policy Dummy Variables

We used a regression analysis to evaluate the effectiveness of policy changes in Korea and R&D investment and the number of patent applications were utilized as the dependent variables. The policy changes were indicated by the year dummy variables for the timing of the reform. For example, if we wished to assess the effects of the 1987 policy reform, we used those for the years after 1987 and zeroes for the years before 1987. If the regression coefficients were positive and significant, we can conclude that the policy change was effective. We considered the years 1987, 1990, 1995, 2002 as the years of IPR policy reforms.

The fixed effects model was used in the panel data regressions. The individual fixed effects are included in this section, which leaves no constant terms in the regression.[19]

19 We tried to use GMM developed by Arellano-Bond (1991), but we could not obtain better results, thus we report the results using the fixed effects model.

(1) Whole Firms

First of all, the regressions for whole firms were implemented with the explanatory variables of policy dummies and control variables. The numbers of employees and production values for each firm were used as control variables. We hoped that production in each year would partially reflect the effects of the business cycle as well as company size. All values are expressed in constant values.

Table 3: Effects on R&D Expenditure

	Dependent Variable = RND							
	(1)		(2)		(3)		(4)	
LABOR	1.061	(6.142)			1.053	(6.090)		
PROD			1.482	(11.297)			1.477	(11.246)
1987	1.871	(5.862)	1.317	(4.096)	1.873	(5.866)	1.319	(4.103)
1990	2.207	(8.674)	1.5	(5.759)	2.207	(8.675)	1.503	(5.767)
1995	1.265	(6.166)	0.344	(1.612)	1.318	(6.220)	0.384	(1.741)
1998*					-0.375	(-0.996)	-0.266	(-0.713)
2002	0.315	(1.611)	-0.360	(-1.830)	0.26	(1.281)	-0.396	(-1.950)
$\bar{R}^2$	0.481		0.490		0.481		0.490	
Obs	4,968		4,968		4,968		4,968	

*The 1998 dummy shows a total of one in 1998 and zero in the other years.
** Numbers in ( ) are all t-values.

Let us consider models (1) and (2) in Table 3. Note that both the control variables LABOR (employment) and PROD (production) have positive coefficients, which could indicate that these values exerted a positive influence on R&D activity and this is consistent with our expectations. Turning to the coefficients for dummy variables, the sizes of the coefficients are 1.3-1.8 per cent and 1.5-2.2 per cent for the 1987 and 1990 dummies, respectively. The 1990 reform is shown to have exerted a slightly greater influence than the 1987 reform. The coefficients of the 1995 dummy variable are dependent on the model; when labor is utilized as a proxy variable for the firm size, the coefficient is 1.265, but otherwise it appears to be insignificant. Finally, the 2002 dummy is insignificant at the 5 per cent level. This could be the result of the disappearance of the venture business boom around the beginning of the 21st century.

Korea sustained a sizeable shock to its economy at the end of 1997, due to the Asian currency crisis, which gave rise to a substantial tailing-off of production and R&D activity in 1998, although recovery was rapid. Thus, we used an additional dummy for the year 1998, and reported the results in columns (3) and (4). The currency crisis dummy in the table does not appear very significant. We then analyzed the patent application data. In a fashion similar to that for R&D activity; we regressed the patent data on the policy change dummies, controlled with some variables.

Table 4: Effect on Patent Applications

	Dependent Variable = PAT							
	(1)		(2)		(3)		(4)	
LABOR	0.521	(19.707)			0.522	(19.713)		
RND	0.008	(3.620)			0.008	(3.628)		
PROD			0.466	(23.365)			0.466	(23.376)
1987	0.122	(2.509)	-0.002	(-0.055)	0.122	(2.505)	-0.003	(-0.063)
1990	0.334	(8.562)	0.139	(3.515)	0.334	(8.560)	0.138	(3.504)
1995	0.506	(16.110)	0.199	(6.155)	0.501	(15.453)	0.192	(5.738)
1998*					0.034	(0.598)	0.046	(0.814)
2002	0.395	(13.236)	0.152	(5.086)	0.4	(12.903)	0.158	(5.127)
$\bar{R}^2$	0.783		0.788		0.783		0.788	
Obs	4,968		4,968		4,968		4,968	

Table 4 shows that patent applications were closely related to employment, R&D, and production. For example, according to model (2), patents increased by 0.466 per cent where production increased by 1 per cent. By way of contrast with R&D, the 1987 reform does not appear to have significantly affected patent applications. As the principal reform in 1987 was the introduction of substance patents, it would be expected that this area might take some time to yield results in the form of new patents. Reforms in 1990, 1995 and 2002 were all influential with regard to patent applications. Note that, even though we obtained negative coefficients in the R&D factors, the coefficients here are positive numbers. We could interpret these numbers as the effects of increased R&D during the venture boom period prior to 2002, as increased R&D expenditure naturally increases patenting.

Columns (3) and (4) show cases with the currency crisis included as a year dummy, but no significant coefficient was detected when some controlling variables were used. This result enabled us to suggest the following: even though there was a reduction in patents in 1998, the reduction in the number of patents in that year might not have been attributable to a reduction in patenting, but rather to a business cycle downturn.

(2) Analysis by Technology Sectors

The effects of policy change differ depending on industry characteristics. For example, it is quite simple to copy a new technology in the computer game software industry or in the pharmaceutical industry if no patent protection exists. By way of contrast, in some other industries significant physical capital is required for the production of generic products, and patent infringement causes few problems (Gould and Gruben, 1996). Sometimes, a very high level of technology is needed just to copy a relevant product. Taking account of this, we split the industry into two sectors according to level — high-technology and low-technology industries;[20] generally, IPR protection is considered more important in the high-technology sector. With regard to R&D investment, as is shown in Table 5, all the reforms other than those of 1987 affected the high-technology sector more than its low-technology counterpart.

20 We used the OECD industry classification criteria. Here, high technology and medium-high in OECD criteria are merged with high technology, whereas medium-low technology and low technology are merged with low technology. However, it remains unclear as to how something as broad as electronics could fit into one category. For instance, some subsectors within electronics are extremely high-tech, others medium-tech and some are low-tech. So far, we have been unable to find a better categorization scheme.

Table 5: Effect on R&D by Sector

	Dependent Variable = RND2							
	(1)				(2)			
	High Tech		Low Tech		High Tech		Low Tech	
LABOR	1.112	(5.747)	0.659	(1.782)				
PROD					1.43	(9.955)	1.247	(3.482)
1987	1.67	(4.286)	2.276	(4.127)	1.108	(2.830)	1.844	(3.247)
1990	2.456	(7.908)	1.759	(4.007)	1.716	(5.405)	1.26	(2.728)
1995	1.394	(5.572)	0.988	(2.776)	0.376	(1.439)	0.429	(1.144)
2002	0.744	(3.130)	-0.539	(-1.561)	-0.047	(-0.197)	-0.852	(-2.532)
$\bar{R}^2$	0.448		0.516		0.46		0.519	
Obs	3,197		1,771		3,197		1,771	

With regard to patents, we can observe similar effects (Table 6). The only exception was the 1995 reform with the production value as a control variable. Overall, the IPR reforms appear to have had a significant impact on the high-tech industry.

Table 6: Effect on R&D by Sector

	Dependent Variable = Patents							
	(1)				(2)			
	High Tech		Low Tech		High Tech		Low Tech	
LABOR	0.556	(17.632)	0.363	(7.319)				
RND	0.006	(2.292)	0.007	(2.268)				
PROD					0.468	(20.119)	0.375	(7.809)
1987	0.157	(2.491)	0.075	(1.017)	0.022	(0.360)	-0.013	(-0.171)
1990	0.383	(7.530)	0.254	(4.297)	0.168	(3.283)	0.12	(1.939)
1995	0.545	(13.374)	0.425	(8.881)	0.194	(4.598)	0.239	(4.747)
2002	0.453	(11.734)	0.264	(5.696)	0.171	(4.373)	0.126	(2.787)
$\bar{R}^2$	0.807		0.678		0.811		0.678	
Obs	3,197		1,771		3,197		1,771	

4.4. Effect of R&D and Patents on TFP

In the previous section, we determined that the strengthening of patent protection affected both R&D activity and patent production. Now let us examine the effects of R&D and patents on productivity. We included the R&D activity and patents owned by other firms in order to assess the cross-firm effects of technology spillover. We applied a fixed effects model showing both individual fixed effects and the time-fixed effect.

Note that, apart from domestic patent reform, many other aspects of firms' external environments were changing in the late 1980s and early 1990s and these other changes could have driven both the increase in R&D and the increase in patenting. For example, after 1985, the Japanese yen appreciated sharply against the US dollar, but the Korean won, partly pegged to the US dollar, did not. The timing of the exchange rate shift roughly coincided with the first step in Korean patent reform. Interestingly, the Korean won appreciated in the 1990s, and this would seem to have occurred at roughly the same time that growth in R&D spending leveled off. We might consider these effects by controlling directly for the exchange rate or by identifying a subset of R&D-investing and patenting firms for whom foreign markets were unimportant. Furthermore, the Korean economy had been battered by the economic shocks over the previous two decades and this

included incentives for R&D and patenting; thus, we preferred to control for them to more convincingly estimate the true marginal impact of domestic patent reform. However, we found that the export data of individual firms were not stable and we were unable to attain any meaningful results. Additionally, it proved difficult for the authors to identify certain shocks and other incentives that would be helpful in explaining the increases in R&D and patents.[21] Thus, we employed both the individual fixed effects and the time-fixed effect in order to control for all these changes in the external environment.

Table 7: Effect of R&D and Patents on TFP: Whole Firms

	Dependent Variable = TFPID							
	(1)		(2)		(3)		(4)	
RND	0.003	(3.657)	0.001	(2.368)				
RNDO			0.468	(39.969)				
PAT					0.03	(5.601)	0.027	(5.022)
PATO							0.168	(7.899)
$\bar{R}^2$	0.665		0.749		0.666		0.67	
Obs	4,968		4,968		4,968		4,968	

In Table 7, the regression coefficients for the explanatory variables of R&D and patents are all positive and significant. R&D investment and patents appear to have exerted a positive influence on the increase in total factor productivity in the Korean firm-level data. Interestingly, the R&D of other firms (RNDO) was more important than the in-house R&D (RND) regarding productivity and this situation was similar in the case of patenting. This result is consistent with the industrial-level data analysis (for example, Kim et al., 2009 and Lach, 1995).

Table 8: Effects of R&D and Patents on TFP by Sector

	Dependent Variable = TFP							
	(1)				(2)			
	High Tech		Low Tech		High Tech		Low Tech	
RND	0.0008	(0.788)	0.0001	(0.230)				
RNDO	0.485	(33.673)	0.095	(4.755)				
PAT					0.018	(2.556)	0.003	(0.687)
PATO					0.23	(7.908)	0.064	(3.185)
$\bar{R}^2$	0.771		0.571		0.693		0.568	
Obs	3,197		1,771		3,197		1,771	

According to Table 8, the R&D activities (and patents) of other firms led to a greater increase in productivity than in-house R&D (and patents), and this applied to both high- and low-technology sectors, although these effects were felt more strongly in the former. For instance, a 1 per cent increase in the R&D of another company in the high-technology sector affected productivity by 0.485 per cent, whereas the corresponding value in the low-technology sector is 0.095.

21 We appreciated the reviewer's reminder which led us to consider these points.

5. Conclusions

This paper has evaluated the effects of patent system reforms in Korea on knowledge activities such as R&D expenditure and patent applications, and then attempted to determine whether increases in knowledge influenced productivity growth in Korean manufacturing firms. We used Korea's firm level data, which encompassed 216 firms over the period 1985-2007.

The results of our descriptive analysis revealed that R&D expenditure and patents increased more rapidly than output and input. Overall, the average annual growth rates of R&D expenditure and patents were 24.2 per cent and 20.0 per cent respectively, whereas average output increased annually by 11.6 per cent. Thus, average R&D intensity, which is defined as the ratio of R&D expenditure to output, increased from 0.16 in 1985 to 1.96 in 2007, and the R&D intensity of the high-technology sector increased rapidly, from 0.09 in 1985 to 4.57 in 2007. In 2007, 71.4 per cent of total R&D expenditure and 66.5 per cent of total patent applications were made by high-technology firms. As for the average annual growth rate of TFP, the highest rates were achieved in the high-technology sector (11.23 per cent). TFP in other sectors was much lower and its average rate of growth overall was 2.51 per cent. This demonstrates that over the period studied, knowledge was accumulated more quickly and TFP growth was higher in high-technology firms than in the low-technology sector.

The Korean patent system experienced a major policy change in 1986, when it shifted from a weak to a strong system based on the protection of inventions and patent rights. Since 1986, the system has been continually strengthened as major reforms were undertaken in 1986, 1990, 1995 and 2002. The government has attempted to encourage investment in R&D with a strong patent system in an effort to achieve sustainable economic growth and the 1986 reforms appear to have been effective in terms of encouraging patent applications. From the beginning of the 1990s, the government assiduously prepared for Korea's accession to the WTO on the matter of IPRs, and, as a result, the numbers of patent applications and grants have increased rapidly since the early 1990s. Even though the currency crisis resulted in a downturn in 1998, the venture business boom increased R&D greatly, thus giving rise to an upswing in patents in the 2000s: this could also have been accelerated by the patent reforms of 2002.

The results of panel data regression with policy dummy variables demonstrated that the policy reforms have had a positive effect in increasing R&D expenditure and patent applications and thus increased knowledge-led productivity growth in the manufacturing sector. When we divide the industry into two according to technology level, IPR protection is generally considered more important in the high-technology sector. As expected, the regression results demonstrated that IPR reforms had a more profound impact in this sector than in its low technology counterpart. We have also detected evidence of knowledge spillover among firms, where innovation in one company was shown to increase the TFP of others.

APPENDIX

Table 1: KISVALUE Item Code for Each Variable

Variable	KISVALUE Source	KISVALUE Item Code
Output	profit-and-loss account	Sales (121000)
Intermediate Input	manufacturing cost account	Raw material cost (151000) + Expenses (153000) – (Depreciation(153130) + Tax and public charges (153150) + Rent (153160) + Welfare (153240))
	profit-and-loss account	Sales and management cost (124000) – [Labor cost (124100) + Tax and public charges (124214) + Rent (124215) + Depreciation (124216)]
Capital Stock	balance sheet	Tangible assets (113200) + Intangible assets (113400) + Postponed assets (114900)
Labor	balance sheet	Number of employees (105000)
Wages	manufacturing cost account	Labor expenses (152000)
	profit-and-loss account	Labor costs (124100)
R&D Expenditure	profit-and-loss account	Research cost (124406) + Current R&D cost (124410) + Current development cost (124420)
	manufacturing cost account	Research and R&D cost (153141)

Table 2: Price Index for Each Variable

	Item
Output Price Index	Producer's Price Index (KSIC 2-digit Industry)
Price index for intermediate input	- Price index for raw material cost is the weighted average index of the raw material index and intermediate input index, where weight is reported in BOK price index dataset.
	- Rest of values in intermediate inputs are deflated by producer's price index for all industries.
Price index for capital stock	Price index for final capital good
Price index for R&D	0.5×manufacturing producer's price index 0.5×wage index

Source: Price indices are from the Bank of Korea Database (2008) and wage indices are from the OECD (2008) Korean unit labor cost.

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Chapter 6

Finding Effective Combinations of Knowledge Transfer Modes in Public Research Organizations and Firm Interactions: The Case of Korea

BOO-YOUNG EOM and KEUN LEE

ABSTRACT
This paper investigates the impact of the diverse modes of knowledge transfer from Public Research Organizations (PROs) on firm performance in Korea. It examines which specific ways of combining modes of knowledge transfer are more effective and how different the impacts of these modes are across different sectors. The impacts were measured in terms of patents and sales, and the three main findings were as follows. First, the joint implementation of knowledge transfer modes from PROs generates an effect of synergy on knowledge creation, leading firms to file more patents. Specifically, the impact of patents/licensing is reinforced when they are combined with non-IP modes. Interestingly, joint non-IP modes prove to facilitate patent filing, while either single or joint IP modes do not. Second, the joint implementation of knowledge transfer modes from PROs contributes to industrial innovation through patents, but that from universities still faces limitations in industrializing knowledge through sales. Third, the joint implementation of knowledge transfer modes from PROs facilitates industrial innovation through patent-filing mainly in the high- or medium-technology sector, but still faces limitations in industrializing knowledge through sales, even in the above-mentioned industries

1. Introduction

It is relatively recent for policymakers around the world to have started paying attention to knowledge transfer from universities to firms. This change reflects the recognition that public research should be utilized more to generate social and economic benefits (Mowery and Sampat, 2005). From the firms' point of view, universities have become an important source of new knowledge, especially in the developed world (Bettis and Hitt, 1995; Etzkowitz and Leydesdorff, 1997). From the universities' point of view, their so-called "third mission", i.e. entrepreneurial service for economic development, is now emphasized separately from their traditional missions of education and research (Etzkowitz and Leydesdorff, 2000). However, there is also an argument that too close a relationship between industry and universities is detrimental to the scientific potentials of the latter (Dasgupta and David, 1994). On the other hand, the so-called triple-helix view argues that universities need to be directly linked with industry in order to maximize the industrialization of knowledge.

Worldwide, many countries seem to be seeking their own route to industrializing knowledge. In the US, for example, the Bayh-Dole Act in 1980 allowed universities the ownership of publicly financed inventions. Since then, OECD member countries have followed this lead and adopted policies for IP management (OECD, 2003). The most developed form of knowledge transfer is found in entrepreneurial universities, such as at Stanford University in the US and at Beijing and Tsinghua

Universities in China. On the other hand, Japanese universities, having focused on education and research, are in transition to becoming entrepreneurial. In Korea, the Law on Industrial Education and Industry-University Cooperation was enacted in 2003 (Eom and Lee, 2010).

Industry-university relationships or knowledge industrialization modes between the two vary according to country and should be understood in each country context (Eun et al., 2006). The relationships or modes are also diversified in response to the needs at the time. While the traditional role of universities (i.e. education and research) still remains important, their relative importance as vectors of knowledge transfer is changing. This study begins with this recognition and takes Korea as an example. While Eom and Lee (2010) studied the earlier period using the Korean innovation survey of 2003, although limiting their focus on the extent of collaboration between universities and firms, this paper covers a more recent period using a new intensive survey conducted in 2007. With more recent data, we intended to capture recent changes and focus on the various modes of collaboration. We also examined the diverse combination of knowledge transfer modes and investigated their levels of effectiveness, which was not done by Eom and Lee (2009).

In Korea, government policy is moving towards facilitating patenting/licensing spin-offs, etc., while universities are in transition to becoming entrepreneurial like those in Japan. Knowledge industrialization, specifically formal and IP modes of transfer, is now emphasized more than ever. However, if we are to evaluate only the aspect of knowledge industrialization, the role of Korean universities could be unjustly underestimated. Hence, this paper attempts to deal with all possible information channels and their combinations, and analyzes their different contributions to industrial innovation measured in terms of patents and new sales. Public research institutes (PRIs) play a key role in national R&D; thus, they have also been included in the analysis.

This paper utilizes data from the Survey on Korean Industry-University/PRI Relationships conducted jointly by the Science and Technology Policy Institute (STEPI) and the East Asia Institute (EAI: Center for Economic Catch-up) with the support of the International Development Research Council (IDRC) based in Canada. The Survey on Korean Industry-University/PRI Relationships followed the framework of the Carnegie Mellon and Yale Surveys with certain modifications to reflect the Korean situation. The survey involved 500 manufacturing firms covering the period 2004-2006 and included information on industry-public research organization (PRO) interactions from the firms' perspective, such as information channels and interaction, motives and obstacles, etc. The firm-level data from the survey were merged with financial statements of firms available from the KIS VALUE data compiled by a credit rating agency. We took the number of employees, R&D expenditure and industry classification from this data and a total of 383 samples were finally used for empirical analysis.

The structure of this paper is as follows. Section 2 conceptualizes the modes of knowledge transfer from PROs to analyze the Korean situation. Section 3 discusses the hypotheses and model specifications and conducts an empirical analysis on the impact of the mode of knowledge transfer on firm performance. Finally, Section 4 summarizes and concludes the work.

2. Modes of Knowledge Transfer from PROs in Korea[22]

Knowledge and technology are often used interchangeably, probably because they share the same characteristics. However, knowledge is different from technology in terms of "purpose, degree of codification, type of storage and degree of observability" (Landry et al., 2007). The former is tacitly stored in people's heads; it is intangible with the imprecise impact of its use and concretizes theories and principle; the latter is codified in software or blueprints, tangible with the precise impact of its use, and changes technological environments. That is, knowledge is a broader concept than technology; thus, technology transfer represents a much more limited set of activities than knowledge transfer.

Much has been written on the channels of technology transfer. Licensing is the most efficient channel, referring to merger and acquisitions (M&A), new/joint ventures, strategic alliances and technology assignments as its alternatives (Megantz, 1996). Further, patenting and licensing are the performance indicators of technology transfer in universities (Sandelin, 1994). However, there is limited information available on informal or non-IP modes, although a large segment of knowledge from universities is transferred to industries through them. Meanwhile, knowledge transfer activities may be categorized into seven types: research submission, presentations, workshops, consulting, product development, business activity and knowledge commercialization (Landry et al., 2007). Another classification with five categories may also be used: education, research, university technology utility, consulting and informal contact of general information (Arvanitis et al., 2008).

However, the above-mentioned studies still have limitations; they either cover only a few modes or they define no classified mode. This paper overcomes these limitations and covers all possible interactions between firms and PROs, classifying the modes of knowledge transfer. This analysis is based on the study by Eun et al. (2006) explaining industry-university relationships in terms of the governance forms of knowledge industrialization where knowledge flows from universities to industry. They suggested two criteria for classifying specific governance forms: economic efficiency and social contract. The former is the choice between market and hierarchy (X-axis), while the latter is related to how universities are classified: teaching, research or entrepreneurial (Y-axis) (see Appendix, Figure A1). They situate 10 types of knowledge industrialization forms in a two-dimensional space: education in the down-middle as it is teaching-oriented and neutral between market-like and hierarchical; joint conference is placed in the down-left as it is research-oriented and market-like; joint research and joint research centers are in the middle-left as they are research-oriented and slightly market-like; technology sale and patent/licensing are in the upper-left as they are entrepreneurial and market-like and spin-off, incubator, science park and university run enterprises (URE) are in the upper-right as they are entrepreneurial and hierarchical.

Industry-PRO relationships in Korea have evolved through the influence of the government's science and technology (S&T) policies. In the 1960s, Korea, having been left with no industrial infrastructure, started economic development by establishing legal and organizational frameworks. The Korea Institute of Science and Technology (KIST) and the Ministry of Science and Technology (MOST) were established in 1966 and 1967 respectively, and the Science and Technology Promotion Law was enacted in 1967. During this period, mechanical and skilled labor education was given priority.

22 This section is based on Eom and Lee (2010).

Korea, in transition from light to heavy industries in the 1970s, promoted national R&D by establishing PRIs because the R&D capacity of universities and firms was weak. A number of PRIs were established based on the Special Research Institute Promotion Law of 1973 in the fields of machinery, shipbuilding, chemical engineering, marine science and electronics. According to the MOST (2006), the percentage share of PRI in the total R&D expenditures exceeded that of both universities and firms, although the latter's share has steadily increased. Meanwhile, chaebol firms based on heavy industries began to grow rapidly in the mid-1970s. The government played a crucial role in their growth by providing them with exclusive advantages, quality manpower and resources. Education in engineering and science was given priority during this period.

In the 1980s, faced with regulations on technology transfer by developed countries, the government prioritized the building of a national R&D capacity (Kim, 1993). Most importantly, the government initiated national R&D programs in 1982 with an emphasis on large-scale national projects. Several ministries were involved in these programs, and large sums were put into R&D budgets and investment. Since then, the industry-university or PRI cooperation in Korea has been proceeding through specific programs.[23] The R&D capacity of universities and especially of industry grew from the mid-1980s, when major firms (chaebols) started their in-house R&D by hiring quality scientists and engineers from abroad or by acquiring technology in collaboration with foreign partners. Universities shifted towards becoming research-based, thus conducting joint R&D with firms. As a result, the role of PRIs became weaker than in the 1970s-1980s (Song, 2004). According to the MOST (2006), the percentage share in total R&D expenditure of firms surpassed that of PRIs. During this period, Korea, as a catch-up country, considered the copying of technology to be more important than its creation. Thus, chaebol firms benefited from their technological innovation, their large-scale investment in R&D and the government's selective support (Lim, 2006). As Kim (1997) mentioned, the dynamic growth of the Korean economy was possible then through the aggressive accumulation of technological capabilities by chaebol firms.[24]

In the 1990s, the R&D capacity of the universities and industry noticeably developed. Since then, Korea's rank with regard to the number of SCI papers published has been growing due to the contribution of universities. Korea ranked 19th in 1996, with universities accounting for 83.0 per cent of the total contributions (Lee, 1998). During this period, various policy measures were implemented to support university research or to facilitate industry-university cooperation: Science Research Centers (SRCs), Regional Research Centers (RRCs), and the Brain Korea 21 (BK21) program are some examples. In the 2000s, the government decided to extend these measures to the second phase through the BK21 project, the New University Regional Innovation (NURI) project, the Connect Korea (CK) and the Hub University for Industrial Collaboration (HUIC) project (KRF, 2006 and 2007). Most importantly, laws and institutions geared towards knowledge industrialization were established during this period. The Technology Transfer Promotion Law was enacted in 2001, laying down that public universities should establish units or institutions for technology transfer and the training of specialists. The promotion of industry-university cooperation gained more momentum as universities began to establish the so-called "industry-university cooperation foundation" in 2004, which was based on the enactment of the 2003 Law on Industrial Education and Industry-University Cooperation . Since 2007, 134 universities have established industry-university cooperation foundations within their campuses, out of which 59.8 per cent (80 universities) have set up technology licensing offices (TLOs). The number of TLOs

23 A representative example is the DRAM semiconductor co-developed by private firms and the Electronics and Telecommunications Research Institute (ETRI) to catch up with developed countries. GRIs played a role as the major institutes in conducting or managing these projects (Lee and Lim, 2001).

24 As of 1996, the 30 largest chaebols accounted for 40 per cent of Korea's total output, and business groups such as Samsung, Hyundai, LG and Daewoo had as many as 80 affiliates (Ungson et al, 1997).

rapidly increased and in 2004, there were 43 whereas there were only 32 in 2003 (KRF, 2007). Moreover, the industrialization of technology from PROs has been developing recently (MOCIE, 2007). The number of technologies developed by PROs reached 42,038 in 2006, with an increase of 22.1 per cent, up from 34,439 in 2004. The number of technology transfers also increased by 65.4 per cent from 6,570 to 9,014, the rate rising to 21.4 per cent from 18.5 per cent during this period and royalties from technology transfer reached 82,030 million Korean won in 2006, a 45.2 per cent increase from 56,490 million Korean won in 2004.[25] In terms of the type of technology, patenting was the most used, accounting for 55.2 per cent of the total, followed by know-how (34.0 per cent), other (7.5 per cent), trademarks (2.4 per cent) and utilities (0.9 per cent). By type of transfer, PROs used licensing the most (68.4 per cent), followed by sales (21.1 per cent) and other (10.5 per cent).

In the survey, Korean firms were asked to evaluate the importance of 15 different information channels and interactions with PROs using a four-point Likert scale. We grouped them into five modes of knowledge transfer: Type 1 (informal activity: publication/reports, conferences/ seminars, information exchange and consulting); Type 2 (education: recently hired graduates and irregular personal exchange); Type 3 (R&D cooperation, contract R&D, joint R&D and R&D consortium); Type 4 (patenting/licensing, patents and licenses) and Type 5 (business activity: technology incubators, technology parks, spin-offs, and university/PRI-run enterprises).[26] Each mode was composed of firms that reported a score of 2-4 on the four-point Likert scale (above "important") in at least one of the relevant channels and interactions. The first three were non-IP modes, and the remaining one was an IP mode of transfer.

According to Table 1, Korean firms tend to use non-IP modes more than the IP-modes of knowledge transfer. From universities, 62.6, 46.5, and 52.0 per cent out of the total use informal activity, education and R&D cooperation respectively, while 35.2 and 21.4 per cent conduct patenting/licensing and business activities respectively. From the PRIs, 56.8, 36.2, and 39.7 per cent use informal activity, education and R&D cooperation respectively, while 33.7 and 11.8 per cent conduct patenting/licensing and business activities. As seen in Table A2, consulting, recent graduate/personal exchange and joint/contract R&D score relatively higher in frequency and degree of importance, reflecting their importance in the traditional function of universities or PRIs in Korea. Patenting and licensing score relatively high, which implies that they are the most frequently used mode of IP. These findings are consistent with the survey by MOCIE (2007) showing that a high degree of knowledge from PROs is transferred without being patented. Know-how and some forms other than patents, designs and trademarks accounted for about 40 per cent of the total technology transferred in 2006.[27] Overall, industry-university knowledge transfer is more active than industry-PRI knowledge transfer in both IP and non-IP modes.[28]

25 However, in comparison with developed countries, the technology transfer of PROs is less active in Korea. As of 2006, the rate of technology transfer as measured by the ratio of the number of technology transfers to those developed was 24.2 per cent, which is lower than that for the US (35.9 per cent) and Europe (46.8 per cent). Regarding R&D productivity as measured by the ratio of royalty from technology transfers to R&D expenditure, the ratio was 1.5 per cent, which was also lower than that of the US (4.8 per cent) and Europe (3.5 per cent). Based on these figures, we can say that Korean PROs tend to invest less on R&D but create and transfer more technology than the US (except universities) and Europe, eventually generating lower sums of royalty payments (Table A1).

26 This includes the networks of firms, universities and PRIs, but it is categorized into IP modes because technology incubators, technology parks, spin-offs and university/PRI-run enterprises are interrelated and based on networks as well as IPRs.

27 Considering this aspect of non-patented technology, we need to look into joint R&D and technical assistance in detail. According to the survey, firms were more likely to conduct cooperative R&D with PROs for new product/process development, followed by basic/applied technology development and existing product/process development (Table A3.1). Regarding technical assistance, they are more likely to utilize technical training/consulting, equipment and testing/certification services. As to the impacts of cooperative R&D and technical assistance from PROs, firms evaluate highly increases in both corporate and product competitiveness, but their evaluation is slightly higher on PRIs than on universities, except for employment increase (Table A3.2).

28 Compared with industry-industry interaction, the pattern is similar to that of industry-PRO interaction: a higher number of firms engaged in informal activities (publications/reports, 57.0 per cent; conferences/seminars, 62.1 per cent and information exchange, 60.1 per cent) rather than patents (57.0 per cent) and licenses (39.2 per cent). On the other hand, there are two differences here. One is that industry-industry interactions are more active than industry-PRI interactions overall in terms of the frequency and degree of importance. The other is that recently hired experts (36.2 per cent) and joint/contract R&D (46.2 per cent and 37.9 per cent) are relatively less important in terms of frequency and degree. As such, firms are more dependent on patents and licenses.

Table 1: Modes of Knowledge Transfer from PROs

Modes	Universities	PRIs
Informal activity	249 (62.6)	226 (56.8)
Education	185 (46.5)	144 (36.2)
R&D cooperation	207 (52.0)	158 (39.7)
Patent/licensing	140 (35.2)	134 (33.7)
Business activity	85 (21.4)	47 (11.8)

Now, let us examine the modes of knowledge transfer from PROs by sector. In each mode of knowledge transfer from universities, a higher number of firms is involved in the high-technology sector (with a higher score of evaluation in the survey) than in the other industries (Table 2). In the automobile, chemistry, machinery and electronics sectors, over 50 per cent of firms receive knowledge from universities through non-IP modes: informal activity, education (except machinery and electronics) and R&D cooperation. In the case of IP modes, 30-40 per cent of firms receive knowledge through patent and licensing and 20-30 per cent through entrepreneurial universities. However, there are few sector differences in terms of business activities.

Regarding PRIs, over 50 per cent of firms receive knowledge through informal activity in the automobile, chemistry, machinery and electronics sectors. However, in the case of education and R&D cooperation, only firms in the automobile and chemistry sectors are active. Among IP modes, 48.6 per cent of firms use licensing in the automobile sector and 49.3 per cent in the chemistry sector. However, as in the case of universities, there is little distinction between sectors in business activities.

These results reflect the current state in Korea, i.e. although industry-PRO interaction occurs mainly in specific industries, for example, IT and automobiles, it is not always the case (Yun, 2003).

Table 2: Modes of Knowledge Transfer from Universities by Sector

	Universities					PRIs				
	Informal Activity	Education	R&D Cooperation	Patent/licensing	Business Activity	Informal Activity	Education	R&D Cooperation	Patent/licensing	Business Activity
Automobiles	32 (91.4)	24 (68.6)	29 (82.9)	15 (42.9)	4 (11.4)	26(74.3)	19 (54.3)	21 (60.0)	17 (48.6)	9 (25.7)
Chemistry	48 (71.6)	35 (52.2)	40 (59.7)	33 (49.3)	10 (14.9)	45(67.2)	30 (44.8)	32 (47.8)	33 (49.3)	6 (9.0)
Machinery	38 (70.4)	24 (42.1)	31 (54.4)	18 (31.6)	7 (12.3)	36(63.2)	17 (29.8)	21 (36.8)	18 (31.6)	7 (12.3)
Electronics	51 (58.6)	42 (48.3)	44 (50.6)	32 (36.8)	15 (17.2)	51(58.6)	34 (39.1)	34 (39.1)	29 (33.3)	12 (13.8)
Food	19 (67.9)	17 (60.7)	11 (39.3)	12 (42.9)	2 (7.1)	13(46.4)	11 (39.3)	8 (28.6)	7 (25.0)	2 (7.1)
Textiles	13 (61.9)	8 (38.1)	8 (38.1)	8 (38.1)	4 (1.9)	11(52.4)	10 (47.6)	7 (33.3)	5 (23.8)	3 (14.3)
Wood	8 (47.1)	5 (29.4)	5 (29.4)	4 (23.5)	1 (5.8)	8(47.1)	3 (17.6)	5 (29.4)	3 (17.6)	1 (5.9)
Rubber	9 (39.1)	5 (21.7)	9 (39.1)	4 (17.4)	4 (17.4)	7(30.4)	2 (8.7)	7 (30.4)	3 (13.0)	2 (8.7)
Non-metal products	4 (44.4)	4 (44.4)	4 (44.4)	4 (44.4)	1 (11.1)	4(44.4)	3 (33.3)	4 (44.4)	3 (33.3)	2 (22.2)
Metal products	20 (46.5)	16 (37.2)	21 (48.8)	8 (18.6)	3 (7.0)	23(53.5)	10(23.3)	17 (39.5)	13 (30.2)	3 (7.0)
NEC	4 (36.4)	3 (27.3)	5 (45.5)	2 (18.2)	0 (0.0)	2(18.2)	1 (9.1)	2 (18.2)	1(9.1)	0 (0.0)

3. Empirical Analysis

3.1. Hypotheses

University R&D is characterized as core or basic but not practical. Thus, its results are diffused through publication, graduate employment or informal contacts rather than through reverse engineering. Publications and patents are the most important methods of knowledge transfer for innovation (Cohen et al., 2002). Graduate employment is also an effective channel of knowledge transfer (Zucker et al., 2002). Moreover, cooperative research is the most prevalent form of this transfer (Meyer-Krahmer and Schmoch, 1998). University R&D may also be characterized as new

or creative. Industry-university cooperation is appropriate or essential for innovating firms in the pursuit of new technology (Tether, 2002). The contribution of this cooperation to radical innovation is new not only to industry but also to the market (Monjon and Waelbroeck, 2003).

However, empirical evidence on the impact of research or partnership with universities is obscure.[29] Based on data from 147 US publicly traded biotech companies, Research-I university linkage or total federal funding generated more patenting and sales (George et al., 2002). Informal activities of universities, graduate employment, informal contacts and R&D cooperation/consortium contributed to the leading number of patents filed and sales based on data from 2,533 Swiss firms (Arvantinis et al., 2005). On the other hand, industry-university/PRI had an insignificant or a significantly negative impact on the sales of innovation outcomes based on CIS data from the Nordic countries of Finland, Norway and Sweden (Loof et al., 2002). Based on the analysis of KIS data, there is also an insignificant impact from cooperation with universities/PRIs on the innovation probability of Korean firms (Sung, 2002).

The empirical results of the last two seem to be related to the "complementarities" issue. Mohnen and Roller (2002) argue that the function of components in innovation systems is overlapping or interrelated; they act together and reinforce each other. They explain this as follows: "a group of activities is complementary if doing more of any subset of them increases the returns from doing more of any set of the remaining activities". A firm's internal capacity is helpful for utilizing external technology effectively, and this underlines the complementarities between the internal and external outsourcing of know-how (Arora and Garbaredella, 1994). Unfortunately, many empirical analyses have missed these "synergy effects," which come from the combination of a firm's internal and external R&D activities in evaluating R&D performance (Lucena, 2009). This synergy effect in innovation has been confirmed in Spanish cases through a discrete test of complementarities in innovation policy applying the methodology of Kodde and Palm (1886); (Lucena, 2009). As shown in cases from Belgium, firms that adopt more than one innovation policy perform better than those that adopt one only (Cassiman and Veugelers, 2002). In this respect, the insignificant results of the studies of Loof et al. (2002) and Sung (2002) originate from a methodological problem; i.e. all cooperation modes sharing similar characteristics were estimated simultaneously without the appropriate control of complementarities.

Based on the above, a degree of complementarity is expected to occur among the modes of knowledge transfer from PROs and the joint modes of transfer—IP and IP modes, IP and non-IP modes, or non-IP and non-IP modes—may generate the synergy effect to facilitate company innovation.

However, considering the Korean situation where knowledge industrialization systems have not been well developed, the impact of transfer modes may be revealed as patents rather than sales. This is supported by Eom and Lee (2009), explaining this phenomenon in terms of the level of development in knowledge industrialization systems: i.e. the system is underdeveloped in Korea, and thus the impact of interaction with PROs may be revealed as patents rather than sales. They also differentiate their result from the case of developed countries whose relevant systems have been well-developed; and their innovation outcomes therefore connected to sales as well as to patents.

29 There are few empirical studies on science parks or entrepreneurial universities as relevant studies focus mainly on theory.

Based on the above, the following hypotheses are proposed:

Hypothesis 1:
Joint modes of knowledge transfer from PROs rather than a single mode may contribute to innovation in Korean firms.

Hypothesis 2:
The synergy effect of joint transfer modes is significant only in the case of patents filed but not in sales.

Firm heterogeneity in the choice and performance "by sector" is emphasized in most of the literature. This is explained in terms of the characteristics and accessibility of the knowledge in universities. Industry-university interaction matters to science-based industries (Meyer-Krahmer and Schmoch, 1998). Moreover, learning from advances in technology is crucial for science-based industries (e.g. electronics and chemicals) for which industry-university interaction should be more important (Pavitt, 1984). Some studies underline the fact that specific forms of knowledge transfer from universities are significant for specific industries or R&D activities. Further, publications, conferences, informal contacts and consulting are "widely important" across industries; patents are "only important" for pharmaceuticals; cooperative research is "at least important" in R&D-based industries (Cohen et al., 2002; Beckkers and Freitas, 2008). As for electronics, the influx of students into the sector is the most important mode of knowledge transfer (Balconi and Laboranti, 2006). Ironically, however, the empirical evidence in the sector heterogeneity for PROs is weak. Based on the above, our third hypothesis is as follows:

Hypothesis 3:
Joint modes of knowledge transfer from PROs lead to more patents filed and higher sales in the high-technology sector.

3.2. Model Specifications

This paper analyzes how exclusive combinations of the modes (joint modes) of knowledge transfer from PROs affect firm performance in two ways: patents and sales. First, the impact of the modes on patents filed is estimated using the negative binominal model. The number of patents is a count data including 0 and positive numbers; hence, the Poisson model is appropriate. However, the negative binominal model is used due to the over-dispersion problem. The survey asked firms how many patents they filed during the same period. These numbers are used as the dependent variable. Second, the impact of the modes on sales are estimated using the OLS. For this, a log value of sales in 2006 is used as the dependent variable. The model for this analysis is as follows:

$$INNO = \sum_{I=0}^{2^k-1} \gamma_I s_I + \alpha Z + \epsilon$$

This is specified by a set of state variables S_I, and control variables, Z (the notation of a firm i is omitted). Considering the presence of complementarities between knowledge transfer modes, we followed the study of Mohnen and Roller (2005), which controls them by estimating the exclusive combinations of innovation policy. For consistent estimation, we used 32 (2^5) exclusive combinations of the modes (joint modes) rather than five separate modes simultaneously. First, we defined five dummy variables indicating the firms that use informal activity (Informal), education (Education), R&D cooperation (RD), patent/licenses (Licensing) and entrepreneurial university/PRI

(Business), respectively. We then set up 32 exclusive combinations from those dummies: firms that use no mode of transfer.

(No InformalEducationRDLicensingBusiness), firms that use only entrepreneurial university/PRI (BusinessOnly), firms that use only patent/licensing (LicensingOnly), firms that use both patent/licensing and entrepreneurial university/PRI (LicensingBusinessOnly), etc.

Finally, we obtained the state variables, {so, s1, s2, s3 …. s31} = {(00000), (00001), (00010), (00011) … (11111)}.

Control variables, Z are composed of firm size, R&D intensity, affiliation with business groups, firm age, exports and sector dummies. Firm size (SIZE) is measured as a log value of employees. The larger the firm, the more active it is in technological innovation based on its internal resources (Schumpeter, 1942). However, it may be faced with difficulties in innovation due to its organizational or managerial inefficiency (Sung, 2002). R&D intensity (RD_INT) is measured as a ratio of R&D expenditures to sales. The higher the R&D investment, the higher the innovation performance based on the firm's R&D capacity. Moreover, the impact of investment on innovation may be invisible if it lags (Mohnen and Hoareau, 2003). Affiliation with business groups (GROUP) is measured as 1 if the firm belongs to a group and 0 if not. An affiliate can be an innovator benefiting from its mother firm in terms of financial or technological support (Chang and Hong, 2006). Firm age (AGE) is measured as a log value of the firm age. The newer the firm, the more active it is in technological innovation. Export (EXPORT) is measured as 1 if the firm exported from 2004-2006 and 0 if not. The more open the company is to global competition, the more active it is in technological innovation. Sector (SECTOR) is measured based on its classification: high-tech industries (HT), medium-high-technology industries (MHT), medium-low-technology industries (MLT), and low-technology industries (LT). They follow the OECD classification which is based on R&D intensity. The variable is 1 if the firm belongs to a specific technology group and 0 if not.

Before moving to the empirical analysis, the next section verifies the correlations or complementarities between the modes of knowledge transfer from PROs.

3.3. Complementarities between Knowledge Transfer Modes from PROs

We started by using Pearson's test to check if there were correlations between the modes. As expected, all correlation coefficients were statistically positive, strongly supporting the existence of a high level of correlation in cases of both universities and PRIs (Table A4).

Next, we controlled for the unobserved factors, firm characteristics and sector dummies using the Multivariate Probit model to estimate the complementarities between the modes. The LR statistics were 410.58 and 563.62 for universities and PRIs respectively. This strongly rejects the null hypothesis of the non-existence of correlations between the equation disturbances (Table A5). According to the estimates of the variance-covariance matrix of residuals, all coefficients are significantly positive ranging from 0.62 to 0.81 for universities and from 0.72 to 0.84 for PRIs. This also confirms the presence of complementarities between knowledge transfer modes from PROs.

3.4. Empirical Results

(1) Patents versus Sales

This section examines how different or joint modes of knowledge transfer from PROs affect firm performance in terms of patents and sales (Table 3). This uses the negative binominal model for the count data of patents filed and the OLS for sales. In the case of knowledge transfer from universities, the coefficients of (11100), (00101) and (11110) are statistically significant, as presented in the second column. This shows that the joint implementation of at least two modes of transfer instead of a single mode leads to more patents filed by Korean firms. Specifically, the combination of all non-IP modes and IP and non-IP modes (R&D cooperation-entrepreneurial university and informal activity-education-R&D cooperation-patent/licensing) facilitate the patent-filing activities of firms. In the case of PRIs, the coefficients (11100) and (11110) as presented in column four are statistically significant. This implies that the joint implementation of all non-IP modes and that of IP and non-IP modes (informal activity-education-R&D cooperation-patent/licensing) facilitate the patent-filing activities of firms. Based on these results, joint non-IP modes of knowledge transfer from PROs contribute to the patent-filing activities of Korean firms. Patents/licensing are also facilitators but only when combined with non-IP modes. On the other hand, business activities—spin-offs or entrepreneurial university/PRI—have no significant impact, which reflects their immaturity as a mode of knowledge transfer in Korea.

However, for sales, a significantly positive sign is found only in the case of knowledge transfer from PRIs, as presented in column five. Moreover, it is only in the case of (11110) where patents/licenses are combined with non-IP modes of knowledge transfer. On the other hand, neither IP modes, non-IP modes, nor joint modes of transfer have made significant contributions in the case of universities. This result is different from the study by Eom and Lee (2009), which reveals no significant impact on sales when the modes are used separately but not exclusively combined. At the same time, this partly supports the empirical result of Eom and Lee (2010), which explains the reason for the knowledge transfer from PROs leading to more patenting rather than sales from the underdeveloped systems of knowledge industrialization in Korea.

We therefore conclude that the joint implementation of knowledge transfer modes from PROs facilitates innovation by Korean firms through patents, but this joint implementation still faces limitations in industrializing the knowledge through sales.

Among other variables, the coefficient of the SIZE variable is significantly positive for both patents and sales, suggesting that larger firms tend to be more innovative than smaller ones. On the other hand, the coefficient of RD_INT is statistically significant, but it has different signs for patents (+) and sales (-). This can be interpreted to mean that the firm's in-house R&D facilitates its knowledge creation in the form of patent-filing but faces certain limitations in its effect on sales over a short period.

Table 3: Impact of the Joint Modes of Knowledge Transfer from PROs on Firm Performance: Patents vs. Sales

	KT from Universities		KT from PRIs	
	Patents (Negative binominal model)	Sales (*OLS*)	Patents *(Negative binominal model)*	Sales (*OLS*)
LSIZE	0.87(9.47)***	1.13(24.94)***	0.82(8.81)***	1.13(24.35)***
RD_INT	0.10(3.31)***	-0.02(-2.13)**	0.09(2.79)**	-0.02(-1.89)*
GROUP	-0.27(-0.84)	0.18(1.26)	-0.06(-0.20)	0.21(1.54)
LAGE	0.05(0.28)	0.11(1.28)	0.07(0.43)	0.12(1.75)*
EXPORT	0.42(1.48)	0.08(0.67)	0.32(1.09)	0.09(0.74)
HT	0.96(2.98)**	0.17(1.16)	0.75(2.34)**	0.20(1.38)
MHT	0.65(1.98)*	0.09(0.64)	0.45(1.41)	0.16(1.09)
MLT	0.71(2.03)**	0.26(1.67)	0.37(1.08)	0.31(2.06)**
(00000)	-0.26(-0.82)	0.08(0.51)	0.86(0.78)	0.06(0.14)
(00100)	-0.56(-0.79)	0.28(0.81)	-0.88(-0.42)	-0.71(-0.69)
(00101)	2.34(1.81)*	-0.28(-0.43)	-	-
(01000)	-0.13(-0.10)	0.57(0.88)	0.74(0.43)	1.29(1.65)
(01100)	-0.97(-0.98)	0.07(0.14)	1.03(0.75)	0.73(1.20)
(10000)	-0.79(-1.51)	0.12(0.50)	0.81(0.71)	-0.62(-0.13)
(10010)	-0.77(-1.02)	0.27(0.75)	1.06(0.86)	-0.41(-0.79)
(10011)	0.31(0.17)	0.08(0.08)	-	-
(10100)	0.30(0.67)	0.10(0.47)	1.11(0.95)	1.11(0.95)
(10101)	-	-	0.39(0.25)	0.39(0.25)
(10110)	-0.67(0.90)	0.36(1.00)	1.27(1.07)	1.27(1.07)
(10111)	0.34(0.43)	-0.43(-1.10)	1.01(0.67)	1.01(0.67)
(11000)	0.60(1.17)	-0.28(-1.10)	2.44(2.06)**	2.43(2.06)
(11001)	-0.50(-0.30)	0.70(1.07)	-	-
(11010)	0.22(0.33)	0.08(0.24)	1.11(0.90)	1.11(0.90)
(11011)	-1.94(-1.48)	-0.87(-1.33)	1.38(0.99)	1.38(0.99)
(11100)	0.84(1.98)*	0.21(1.00)	0.70(0.59)	0.70(0.59)
(11101)	0.96(0.11)	0.15(0.55)	1.67(1.11)	1.67(1.11)
(11110)	1.17(2.88)***	-1.18(-0.95)	2.29(2.03)**	2.29(2.03)**
(11111)	-	-	1.35(1.18)	1.35(1.18)
No. of bos	374	374	374	374
R^2	0.12	0.73	0.11	0.73
LL/Adj R^2	-861.18	0.73	-864.23	0.73
Prob(LR/F-stst)	0.00	0.00	0.00	0.00

Note: Numbers in parentheses indicate z-values/t-values

***, **, and * represent 1%, 5%, and 10% levels of significance, respectively.

(2) Sector Heterogeneity

This part examines how different or joint modes of knowledge transfer from PROs affect firm performance by sector. The same models were used for this analysis as those in the previous analysis (Table 3).

The left of Table 4.1 presents the results of the impact of knowledge transfer modes from universities on the number of patents filed. The coefficients of MHT*(11100), MLT*(10010) and HT*(11110) are statistically significant, implying that the joint implementation of all non-IP modes and that of IP and non-IP modes (informal activity-patents/licensing and informal activity-education-R&D cooperation-patent/licensing) generate more patent filing in some industries. Specifically, patents/licenses combined with all non-IP modes are important for high-technology

industries, and those combined with informal activity are important in medium-low-technology industries: moreover, all joint non-IP modes are important for medium-high-technology industries. In the case of PRIs, sector heterogeneity is significant in a few industries (shown on the left in Table 4.2). The coefficients of MLT *(11111) and HT*(11100) are statistically significant, implying that the joint implementation of IP and non-IP modes (informal activity-education-R&D cooperation-patent/licensing-entrepreneurial PRI) is important for medium-low-technology industries, while that of all non-IP modes is important for high-technology industries. Here, we conclude that more combined knowledge transfer modes from PROs are necessary in sectors where technology is changing fast.

However, with regard to sales, a significantly positive sign is not found in any mode of knowledge transfer even in the high- and medium-high-technology industries as we would have expected (as shown on the right in Tables 4.1 and 4.2). Neither IP modes, non-IP modes, nor joint modes of transfer have made significant contributions to these industries. Even patenting/ licensing and business activities (technology incubators/parks, spin-offs and entrepreneurial universities/PRIs) have been unable to affect the industrialization of technology.

Based on the above, we conclude that the impact of sector heterogeneity on knowledge transfer modes from PROs can be observed in some industries, mainly in the high- and medium-high-technology sectors, but in the form of patents rather than sales.

Other variables such as SIZE and RD_INT showed similar patterns as those in the previous analysis.

Table 4.1: Impact of the Joint Modes of Knowledge Transfer from Universities on Firm Performance by Sector

	Patents (*Negative binominal model*)								Sales (*OLS*)							
	Model 1 (00000)	Model 2 (01100)	Model 3 (10000)	Model 4 (10010)	Model 5 (10100)	Model 6 (10110)	Model 7 (11100)	Model 8 (11110)	Model 1 (00000)	Model 2 (01100)	Model 3 (10000)	Model 4 (10010)	Model 5 (10100)	Model 6 (10110)	Model 7 (11100)	Model 8 (11110)
LSIZE	0.89(9.38)***	0.87(9.52)***	0.87(9.27)***	0.88(9.67)***	0.86(9.42)***	0.87(9.43)***	0.86(9.43)***	0.82(9.19)***	1.13(25.07)***	1.13(24.73)***	1.13(24.54)***	1.15(25.48)***	1.14(24.97)***	1.13(24.93)***	1.13(24.75)***	1.14(25.16)***
RD_INT	0.10(3.39)***	0.10(3.34)***	0.10(3.24)***	0.11(3.55)***	0.10(3.27)***	0.10(3.34)***	0.09(3.22)***	0.10(3.59)***	-0.02(-2.16)**	-0.02(-2.11)**	-0.02(-2.04)**	-0.02(-2.02)**	-0.02(-2.11)**	-0.02(-2.13)**	-0.02(-2.15)**	-0.02(-2.16)**
GROUP	-0.31(-0.94)	-0.29(-0.89)	-0.26(-0.82)	-0.24(-0.74)	-0.29(-0.89)	-0.25(-0.76)	-0.14(-0.42)	-0.04(-0.12)	0.21(1.49)	0.15(1.08)	0.19(1.35)	0.20(1.41)	0.17(1.22)	0.19(1.34)	0.15(1.07)	0.22(1.55)
LAGE	0.03(0.18)	0.06(0.34)	0.03(0.18)	0.00(0.00)	0.07(0.41)	0.06(0.38)	0.09(0.52)	-0.05(-0.32)	0.12(1.72)*	0.11(1.59)	0.11(1.54)	0.09(1.31)	0.11(1.59)	0.12(1.65)	0.12(1.64)	0.09(1.34)
EXPORT	0.39(1.36)	0.41(1.46)	0.43(1.50)	0.59(2.10)	0.40(1.40)	0.43(1.53)	0.43(1.53)	0.53(1.95)*	0.09(0.77)	0.08(0.65)	0.09(0.74)	0.05(0.39)	0.09(0.78)	0.07(0.62)	0.08(070)	0.08(071)
HT	0.74(1.78)*	0.99(3.04)***	1.02(3.11)***	0.99(3.06)***	0.97(3.06)***	1.02(3.07)***	0.94(2.86)**	0.62(1.92)*	0.40(2.21)**	0.16(1.08)	0.18(1.22)	0.17(1.21)	0.15(1.00)	0.20(1.40)	0.16(1.09)	0.16(1.06)
MHT	0.44(1.06)	0.68(2.06)**	0.60(1.77)*	0.66(1.98)*	0.71(2.99)**	0.70(2.12)**	0.46(1.39)	0.67(2.02)**	0.12(0.68)	0.09(0.63)	0.12(0.83)	0.16(1.12)	0.11(0.76)	0.10(1.67)	0.12(0.82)*	0.22(1.42)*
MLT	0.66(1.46)	0.70(1.46)*	0.72(2.03)**	0.52(1.50)	0.70(2.13)*	0.73(2.06)**	0.66(1.86)*	0.68(1.94)*	0.39(1.83)*	0.25(1.60)	0.24(1.55)	0.24(1.56)	0.27(1.73)*	0.26(1.67)	0.28(1.73)	0.34(2.15)
(00000)	-0.63(-1.06)	-0.26(-0.82)	-0.28(-0.88)	-0.35(-1.10)	-0.28(-0.88)	-0.29(-0.90)	-0.26(-0.82)	-0.27(-0.89)	0.35(1.39)	0.07(0.48)	0.08(0.54)	0.09(0.63)	0.06(0.43)	0.07(0.46)	0.07(0.48)	0.08(0.54)
(00100)	-0.57(-0.81)	-0.57(-0.81)	-0.58(-0.83)	-0.60(-0.86)	-0.57(-0.82)	-0.31(-0.40)	-0.60(-0.86)	-0.43(-0.64)	0.32(0.95)	0.27(0.80)	0.36(1.02)	0.25(0.75)	0.26(0.76)	0.34(0.98)	0.27(0.78)	0.25(0.76)
(00101)	2.45(1.89)*	2.36(1.82)*	2.38(1.84)*	2.37(1.86)*	2.31(1.79)*	2.31(1.78)*	2.38(1.86)*	1.91(1.51)*	-0.22(-0.33)	-0.28(-0.42)	-0.30(-0.45)	-0.31(-0.47)	-0.29(-0.43)	-0.29(-0.43)	-0.28(-0.43)	-0.37(-0.57)
(01000)	-0.03(-0.02)	-0.13(-0.10)	-0.16(-0.13)	-0.26(-0.20)	-0.12(-0.09)	-0.18(-0.13)	-0.14(-0.10)	-0.11(-0.08)	0.56(0.87)	0.58(0.89)	0.55(0.84)	0.54(0.85)	0.57(0.87)	0.55(0.84)	0.58(0.88)	0.54(0.85)
(01100)	-0.90(-0.92)	-0.98(-0.99)	-1.00(-1.01)	-1.01(-1.04)	-0.97(-0.99)	-0.89(-0.90)	-1.00(-1.03)	-0.78(-0.82)	0.07(0.15)	0.06(0.14)	0.07(0.15)	0.09(0.20)	0.05(0.11)	0.15(0.30)	0.05(0.11)	0.06(0.12)
(10000)	-0.74(-1.40)	-0.80(-1.53)	-0.74(-1.36)	-0.78(-1.51)	-0.82(-1.56)	-0.84(-1.61)	-0.76(-1.46)	-0.93(-1.85)	0.19(0.79)	0.12(0.49)	0.20(0.77)	0.17(0.71)	0.12(0.52)	0.11(0.44)	0.11(0.47)	0.10(0.41)
(10010)	-0.81(-1.06)	-0.77(-1.02)	-0.76(-1.00)	-0.30(-0.37)	-0.78(-1.03)	-0.78(-1.02)	-0.76(-1.02)	-0.71(-0.98)	0.28(0.78)	0.26(0.73)	0.26(0.73)	0.52(1.34)	0.27(0.74)	0.32(0.89)	0.26(0.73)	0.29(0.80)
(10011)	0.39(0.22)	0.29(0.16)	0.13(0.07)	0.21(0.12)	0.26(0.15)	0.25(0.14)	0.44(0.25)	0.16(0.09)	0.18(0.20)	0.06(0.07)	0.30(0.32)	0.04(0.05)	0.05(0.11)	0.07(0.08)	0.05(0.05)	0.01(0.02)
(10100)	0.24(0.52)	0.37(0.80)	0.35(0.74)	0.33(0.74)	0.35(0.76)	0.29(0.14)	0.30(0.68)	0.27(0.62)	0.16(0.72)	0.10(0.45)	0.09(0.42)	0.07(0.34)	0.18(0.79)	0.09(0.40)	0.09(0.41)	0.07(0.33)
(10110)	0.60(0.81)	0.67(0.91)	0.68(0.92)	0.66(0.89)	0.67(0.90)	0.79(1.01)	0.64(0.87)	0.63(0.88)	0.38(1.05)	0.36(0.99)	0.39(1.05)	0.38(1.07)	0.36(1.00)	0.51(1.35)	0.36(0.99)	0.40(1.11)
(10111)	0.39(0.48)	0.34(0.42)	0.39(0.48)	0.30(0.37)	0.31(0.38)	0.31(0.39)	0.42(0.54)	0.14(0.18)	-0.36(-0.92)	-0.43(-1.10)	-0.45(-1.14)	-0.46(-1.20)	-0.44(-1.13)	-0.44(-1.13)	-0.44(-1.11)	-0.47(-1.22)
(11000)	0.60(1.17)	0.59(1.16)	0.72(1.36)	0.56(1.11)	0.58(1.13)	0.57(1.12)	0.68(1.35)	0.55(1.11)	-0.24(-0.94)	-0.29(-1.12)	-0.32(-1.22)	-0.21(-0.83)	-0.29(-1.13)	-0.30(-1.16)	-0.29(-1.12)	-0.28(-1.11)
(11001)	-0.53(-0.31)	-1.47(-0.02)	-0.52(-0.31)	-0.36(-0.21)	-0.52(-0.31)	-0.47(-0.28)	-0.59(-0.34)	-0.64(-0.39)	0.66(1.01)	0.18(0.20)	0.71(1.08)	0.75(1.17)	0.70(1.08)	0.93(1.39)	0.70(1.06)	0.72(1.12)
(11010)	0.18(0.28)	0.22(0.34)	0.20(0.30)	0.16(0.25)	0.22(0.33)	0.20(0.30)	0.16(0.24)	0.23(0.36)	0.14(0.43)	0.07(0.24)	0.07(0.24)	0.07(0.24)	0.07(0.25)	0.06(0.19)	0.09(0.28)	0.11(0.34)
(11011)	-1.90(-1.45)	-1.96(-1.49)	-1.98(-1.51)	-2.01(-1.54)	-1.93(-1.47)	-1.99(-1.51)	-1.96(-1.51)	-1.66(-1.30)	-0.91(-1.41)	-0.86(-1.33)	-0.85(-1.31)	-0.85(-1.33)	-0.88(-1.35)	-0.89(-1.36)	-0.87(-1.33)	-0.86(-1.34)
(11100)	0.89(2.05)**	0.83(1.91)*	0.90(2.11)**	0.74(1.76)*	0.98(2.19)**	0.81(1.86)*	-1.44(1.30)	0.73.(1.77)*	0.25(1.18)	0.15(0.70)	0.21(0.98)	0.21(0.98)	0.23(1.06)	0.20(0.93)	0.38(0.87)	0.20(0.95)
(11101)	0.13(0.23)	0.04(0.08)	0.09(0.17)	0.01(0.03)	0.02(0.04)	0.01(0.02)	0.16(0.30)	0.01(0.01)	0.19(0.70)	0.14(0.53)	0.11(0.40)	0.22(0.83)	0.13(0.48)	0.13(0.49)	0.13(0.49)	0.12(0.44)
(11110)	1.22(2.95)***	1.15(2.83)**	1.16(2.86)***	1.13(2.79)**	1.17(2.88)***	1.12(2.72)**	1.14(2.84)***	0.17(0.22)***	-0.15(-0.83)	-0.18(-0.96)	-0.17(-0.93)	-0.15(-0.81)	-0.20(-1.05)	-0.18(-0.97)	-0.18(-0.97)	0.31(0.82)
S*HT 1)	0.62(0.89)	0.11(0.06)	-1.29(-1.32)	-1.46(-1.35)	0.07(0.06)	-0.63(-0.87)	1.25(0.97)	2.24(2.57)**	-0.31(-1.20)	1.54(1.65)	-0.19(-0.44)	-0.25(-0.50)	0.75(0.41)	-0.50(-1.49)	0.08(0.14)	0.00(0.01)
S*MHT	0.59(0.84)	-1.46(-1.13)	0.23(0.40)	-1.00(-1.32)	-0.89(-1.40)	-2.29(-1.43)	3.06(2.54)**	-0.39(-0.43)	0.08(0.26)	0.02(0.04)	-0.25(-0.88)	-0.40(-1.16)	-0.32(-0.98)	-0.40(-0.57)	-0.36(-0.70)	-0.10(-1.43)
S*MLT	0.15(0.21)	1.53(0.02)	-0.20(-0.21)	2.25(2.11)**	0.08(0.10)	-0.11(-0.10)	1.77(1.19)	-0.21(-0.20)	-0.29(-0.93)	1.04(0.81)	0.39(0.80)	0.61(1.15)	-0.26(-0.61)	-0.16(-0.33)	0.35(-0.51)	0.93(-0.70)
No. of bos	374	374	374	374	374	374	374	374	374	374	374	374	374	374	374	374
R^2	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.13	0.74	0.73	0.73	0.74	0.73	0.73	0.73	0.74
LL/Adj R^2	-860.54	-859.68	-860.33	-856.45	-860.33	-860.02	-857.24	-853.75	0.74	0.71	0.71	0.72	0.71	0.71	0.71	0.72
Prob(LR/F-stst)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 4.2: Impact of the Joint Modes of Knowledge Transfer from PRIs on Firm Performance by Sector

	Patent (*Negative binominal model*)				Sales (*OLS*)			
	Model 1 (00000)	Model 7 (10110)	Model 10 (11100)	Model 11 (11111)	Model 1 (00000)	Model 7 (10110)	Model 10 (11100)	Model 11 (11110)
LSIZE	0.80(8.61)***	0.82(8.95)***	0.77(9.43)***	0.82(8.84)***	1.12(24.31)***	1.13(24.93)***	1.13(24.12)***	1.13(24.38)***
RD_INT	0.08(2.62)**	0.09(2.79)**	0.09(2.92)***	0.08(2.68)***	-0.02(-2.02)**	-0.02(-2.13)*	-0.02(-1.80)**	-0.02(-1.79)**
GROUP	-0.10(-0.32)	-0.03(-0.09)	0.04(0.13)	-0.02-0.08)	0.23(1.70)*	0.19(1.34)	0.24(1.69)	0.22(1.61)
LAGE	0.04(0.21)	0.10(0.59)	-0.05(-0.33)	0.02(0.13)	0.14(1.98)*	0.12(1.65)*	0.12(1.63)	0.10(1.45)
EXPORT	0.50(1.71)*	0.31(1.04)	0.48(1.69)*	0.43(1.45)*	0.11(0.93)	0.07(0.62)	0.08(072)	0.11(0.94)
HT	1.33(2.96)***	0.90(2.72)**	0.37(1.19)	0.75(2.25)*	0.37(1.85)*	0.20(1.40)	0.21(1.42)	0.18(1.18)
MHT	0.63(1.37)	0.56(1.75)	0.49(1.54)	0.39(1.18)**	0.10(0.52)	0.10(1.67)	0.14(0.96)*	0.21(1.45)*
MLT	1.22(2.47)**	0.43(1.21)	0.41(1.19)	0.15(0.42)*	0.52(2.34)*	0.26(1.67)*	0.30(1.91)	0.38(2.39)
(00000)	1.82(1.53)	0.89(0.81)	0.72(0.69)	0.97(0.88)	0.28(0.56)	0.06(0.13)	0.07(0.16)	0.05(0.12)
(00100)	-0.58(-0.28)	-0.96(-0.46)	-0.70(-0.34)	-0.82(-0.39)	-0.68(-0.66)	-0.71(-0.69)	-0.76(-0.73)	-0.69(-0.67)
(01000)	0.78(0.47)*	0.74(0.44)	0.73(0.44)*	0.73(0.43)*	1.37(1.76)	1.28(1.63)	1.29(1.65)	1.30(1.67)
(01100)	1.19(0.89)	0.99(0.72)	1.04(0.79)	1.08(0.79)	0.84(1.37)	0.73(1.19)	0.75(1.22)	0.72(1.17)
(10000)	1.14(1.00)	0.84(0.74)	0.59(0.54)	0.93(0.81)	0.07(0.15)	-0.07(-0.14)	-0.05(-0.10)	-0.08(-0.17)
(10010)	1.18(0.97)	1.08(0.88)	0.92(0.78)	1.32(1.06)	-0.31(-0.60)	-0.42(-0.80)	-0.40(-0.77)	-0.43(-0.83)
(10100)	1.39(1.20)	1.11(0.96)	0.99(0.88)	1.26(1.07)	0.12(0.25)	-0.00(-0.00)	0.02(0.04)	-0.02(-0.04)
(10101)	0.63(0.41)	0.37(0.24)	0.43(0.29)	0.49(0.32)	0.14(0.20)	0.07(0.10)	0.09(0.13)	0.10(0.14)
(10110)	1.47(1.25)	3.04(1.49)	1.21(1.07)	1.41(1.19)	-0.13(-0.26)	-0.17(-0.17)	-0.15(-0.30)	-0.15(-0.30)
(10111)	1.50(1.00)	1.02(0.68)	0.74(0.51)	1.10(0.73)	0.52(0.76)	0.35(0.51)	0.37(0.53)	0.33(0.48)
(11000)	2.90(2.45)**	2.46(2.08)**	2.15(1.90)*	2.49(2.10)**	0.06(0.11)	-0.11(-0.19)	-0.08(-0.16)	-0.11(-0.22)
(11010)	1.37(1.13)	1.09(0.89)	1.27(1.08)	1.17(0.95)	0.44(0.80)	0.37(0.67)	0.37(0.67)	0.41(0.74)
(11011)	1.45(1.05)	1.33(0.96)	1.43(1.07)	1.43(1.02)	0.06(0.10)	0.02(0.03)	0.03(0.05)	0.01(0.02)
(11100)	1.05(0.88)	0.71(0.60)	0.69(0.61)	0.78(0.66)	0.12(0.23)	0.03(0.05)	-0.03(-0.05)	0.03(0.06)
(11101)	2.11(1.42)	1.70(1.14)	1.27(0.88)	1.74(1.16)	0.07(0.10)	-0.14(-0.20)	-0.13(-0.18)	-0.17(-0.25)
(11110)	2.48(2.24)**	2.24(1.99)**	0.90(0.64)	2.37.(2.10)**	0.18(0.38)	0.09(0.18)	0.10(0.21)	0.55(0.83)
(11111)	1.58(1.40)	1.36(1.20)	1.24(1.14)	0.33(0.23)	-0.14(-0.30)	-0.25(-0.51)	-0.24(-0.49)	-0.26(-0.54)
S*HT	-0.81(-0.50)	-2.47(-1.36)	2.62(2.52)**	0.59(0.52)	-0.28(-0.83)	-0.05(-0.05)	-0.23(-0.37)	-0.12(-0.23)
S*MHT	-0.09(-0.13)	-2.02(-1.20)	0.16(2.54)	1.00(0.90)	0.25(0.86)	-0.22(-0.20)	0.32(0.49)	-0.71(-1.36)
S*MLT	-0.98(-0.68)	-1.16(-0.59)	0.12(1.19)	2.19(1.79)*	-0.39(-1.30)	0.270.26)	0.41(0.57)	-0.79(-0.40)
No. of bos	374	374	374	374	374	374	374	374
R^2	0.12	0.12	0.12	0.12	0.74	0.73	0.73	0.74
LL/Adj R^2	-860.54	-860.02	-857.24	-858.32	0.72	0.71	34.14	34.59
Prob(LR/F-stst)	0	0	0	0	0	0	0	0

4. Conclusions

In an economy which is catching up fast, Korea's national system of innovation is unbalanced or immature due to the dominance of the government and a few large chaebols (Eom and Lee, 2010). It is also due to the weaker roles of universities and SMEs. These unique characteristics have prevented knowledge industrialization systems from developing and it was only in the mid-1990s that the country realized the significance of knowledge industrialization, promoted through government initiatives. This paper has investigated the impact of the diverse modes of knowledge transfer from PROs on firm performance. It has examined which specific ways of combining two modes of knowledge transfer are more effective and the different impact of these modes across different sectors.

Impact was measured in terms of patents and sales and the three main findings were as follows. First, the joint implementation of knowledge transfer modes from PROs generates a synergy effect on knowledge creation, thus leading firms to file more patents. Specifically, the impact of patents/licenses is reinforced when they are combined with non-IP modes. Interestingly, joint non-IP modes prove to facilitate patent filing by firms, while either single or joint IP modes do not. Second, the joint implementation of knowledge transfer modes from PRIs contributes to industrial innovation through patents, but that from universities still faces limitations in industrializing

knowledge through sales. Third, the joint implementation of knowledge transfer modes from PROs facilitates industrial innovation through patent filing mainly in high- or medium-technology industries, but it still faces limitations in industrializing knowledge through sales even in those mentioned previously.

The above results imply that patenting/licensing modes are effective, but their impact is reinforced when combined with non-IP modes. The traditional missions of Korean PROs, i.e. informal activities, education, and R&D cooperation, are still important and still work in knowledge creation in spite of the emphasis on their "third" mission. Moreover, the finding that the mode of business activity has no significant impact on industrial innovation implies that a new policy initiative to facilitate spin-offs, science parks and entrepreneurial university/PRI needs to be set out.

This paper's contribution is the conceptualization of the diverse modes of knowledge transfer from PROs through an analysis of the Korean case, thereby identifying the effective combinations of knowledge transfer modes that facilitate innovation in firms. This analysis, however, does not cover the dynamic role of the modes in industrial innovation because of the cross-sectional data used.

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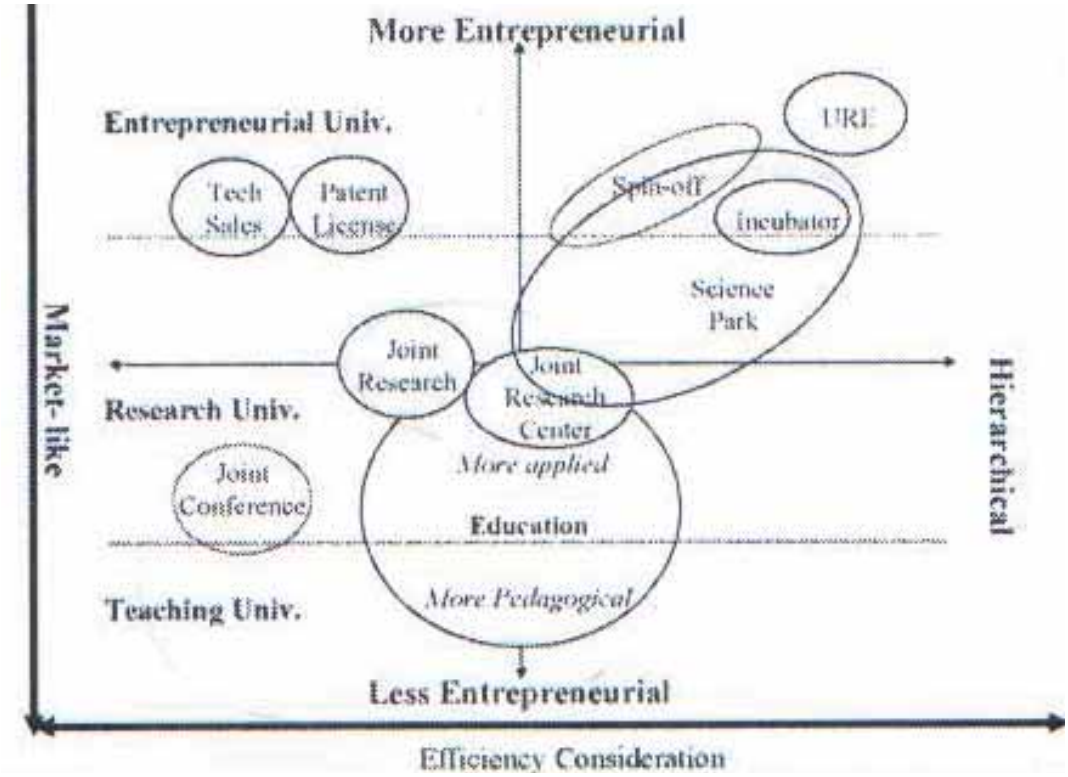
APPENDIX

Figure A.1: Governance Forms of Knowledge Industrialization from University to Industry



Source: Eun et al. (2006)

Table A.1: Comparison in the Performance of Technology Transfer (as of 2005)

	Korea			US			Europe			Japan
	University	PRI	Total	University	PRI	Total	University	PRI	Total	
No. of developed technologies	4,156	4,305	8,551	11,413	1,614	13,027	1,375	1,486	2,861	9,400
No. of technology transfers	715	1,358	2,073	4,053	630	4,683	384	955	1,339	1,852
Rate of technology transfer	17.2	31.5	24.2	35.5	39	35.9	27.9	64.3	46.8	19.7
(hundred million US dollars)										
Royalties from technology transfer	8	73.7	81.7	2,600	336	1,936	90	245	335	
R&D expenditure (hundred million US dollars)	2,387.50	3,178.60	5,566.10	36,662	4,081	40,742	4,264	5,348	9,612	
R&D productivity (%)	0.3	2.3	1.5	4.8	8.2	4.8	2.1	4.5	3.5	

Source: MOCIE (2007). A Survey on the Technology Transfer of PROs.
Note: 1) Korea: A Survey on the Technology Transfer of PROs: 2005 (145 universities and 114 PRIs).
2) U.S.: AUTM U.S. Licensing Survey: FY 2005 (152 universities and 29 PRIs).
3) Europe: ASTP (Association of Europe Science and Technology Transfer Professionals): FY 2004-2005, (22 countries, 74 universities and 27 PRIs).
4) Japan: A Survey on Intellectual Property: FY 2005.

Table A.2: Modes of Knowledge Transfer from PROs in Detail

	Universities		PRIs	
	No. of firms	Degree of importance	No. of firms	Degree of importance
Publications/reports	162 (40.7)	55.25	173 (43.5)	56.25
Conferences/seminars	162 (40.7)	56.75	155 (38.9)	57.5
Information exchange	173 (43.5)	57.25	146 (36.7)	58.75
Consulting	191 (48.0)	61.5	164 (41.2)	60.25
Recently hired graduates	120 (30.2)	61.75	96 (24.1)	59.5
Irregular personal exchange	143 (35.9)	57	111 (27.9)	59
Contract R&D	174 (43.7)	66.5	131 (32.9)	65.25
Joint R&D	181 (45.5)	66	134 (33.7)	65.5
R&D networks (eg R&D consortium)	124 (31.2)	57.5	97 (24.4)	57.75
Patents	102 (25.6)	55.5	111 (27.9)	55.75
Licenses	99 (24.9)	58	89 (22.4)	56.75
Technology incubators	67 (16.8)	54.75	37 (9.3)	54
Technology parks	61 (15.3)	59	41 (10.3)	55
Spin-offs	50 (12.6)	54.5	34 (8.5)	56
University/PRI-run enterprises	37 (9.3)	57.5	29 (7.3)	56

Table A.3.1: Performance of Cooperative R&D and Technical Assistance from PROs

		Universities		PRIs	
		No. of firms	No. of cooperative R&D and technical assistance	No. of firms	No. of cooperative R&D and technical assistance
Cooperative R&D	Basic/applied technology development	75 (18.8)	188	34 (8.5)	73
	New product/process development	95 (23.9)	243	56 (14.1)	148
	Existing product/process development	60 (15.1)	137	31 (7.8)	64
Technical Assistance	Testing/certification service	45 (11.3)	141	47 (11.8)	266
	Equipment utilization	65 (16.3)	286	67 (16.8)	408
	Prototype	36 (9.0)	103	21 (5.3)	49
	Technical training/consulting	103 (25.9)	378	72 (18.1)	195
	Education	34 (8.5)	78	24 (6.0)	108

Note: A point on a seven-point Likert scale is converted to a 100-point Likert scale.

Table A.3.2: Evaluation of Cooperative R&D and Technical Assistance from PROs

Performance	**Universities**	**PRIs**
Employment increase	48.33	47.91
Increase in IPRs	56.06	58.77
Sale increase	54.91	56.63
Cost reduction	52.34	56.2
Corporate competitiveness increase	65.64	66.21
Product competitiveness increase	59.35	60.2

Note: A point on a seven-point Likert scale is converted to a 100-point Likert scale.

Table A.4: Pearson's Test

	Informal	Education	RD	Licensing
Education	0.62***			
RD	0.61***	0.54***		
Licensing	0.52***	0.54***	0.48***	
Business	0.41***	0.41***	0.46***	0.44***

	Informal	Education	RD	Licensing
Education	0.56***			
RD	0.61***	0.57***		
Licensing	0.59***	0.54***	0.56***	
Business	0.33***	0.41***	0.40***	0.43***

Table A.5: Variance-Co-Variance Matrix of Residuals

	e1	*e2*	*e3*	*e4*
e2	0.81***			
e3	0.70***	0.65***		
e4	0.79***	0.74***	0.65***	
e5	0.72***	0.62***	0.66***	0.67***

	e1	*e2*	*e3*	*e4*
e2	0.84***			
e3	0.81***	0.79***		
e4	0.87***	0.75***	0.77***	
e5	0.76***	0.72***	0.74***	0.72***

Chapter 7

The Impact of the Copyright Law on the Musical* Industry in Korea

BYUNG-HEE SOH, JIHYANG LEE and DONG-UK KIM[30]

ABSTRACT

In Korea, even after the enactment of the Korean Copyright Act in 1957, the law was not amended for 30 years until its overall amendment in 1986. Survey questionnaires were collected from artists and producers in the musical industry to investigate if any change in attitude concerning copyright in the musical industry had occurred since that time. We learned that the treatment of foreign copyrighted works and the general production environment of the musical industry have changed. There seems to be a great need for education on copyright, and improvement in the governance structure of the planning and management firms in the entertainment business needs to be made. The will of producers and artists to acknowledge copyright in the various fields concerned in the production of a musical has been analyzed and there was a significant difference between the responses from the two groups on some issues concerning copyright. Several policy implications are discussed and a few suggestions made for improvement. We conclude that the overall impact of the copyright law on the growth of the musical industry in Korea has been positive.

1. Introduction

There were no copyright laws enacted in Korea for almost 10 years after the establishment of the Korean State in 1948 and at that time copyright law was only briefly mentioned in the Constitution. Even after the enactment of the Copyright Act in 1957, the law was not amended for 30 years until its overall amendment in 1986. It goes without saying that a right that has not been clearly defined and protected by law cannot be honored. Such was the state of copyright law in Korea before international pressure led to the transformation of its copyright laws over the past two decades.

In our research, we wanted to discover how well various copyrights are acknowledged and observed and what kind of impact the copyright laws have had on the current awareness level and environment of copyrighting in Korea. For this purpose, investigating the musical industry is useful because a musical is a composite work covering various fields. The domestic market for music is quite small but the musical industry has been one of the most rapidly growing sectors in the performing arts over the past decade. Copyrights in the industry represent an assembly of copyright issues covering various fields of the arts because of the necessity of collaboration among them in the production of a musical. Therefore, by investigating the copyright practices in the musical industry, we can deduce policy implications for other areas of the performing arts such as concerts, dance, theater and opera.

* Theatrical play with songs and dancing.

30 We would like to thank the Korea Musical Theater Association for its cooperation in our survey of its members. We would also like to thank IPR lawyer S.K. Hong for his advice on some parts of this paper. We are most grateful for the helpful comments by two anonymous referees.

In this paper we have tried to observe any changes of attitude on treating copyrighted material in music production based on the amendments to the Korean Copyright Law. We have surveyed the level of respect of copyright in the different categories of copyrighted material which is an essential component of the production of a musical, such as the script, music, stage-set and costumes. We have investigated which copyrights among the various fields of art involved in the production of a musical should be regarded as deserving of protection and which should not, according to the responses of the producers and artists. We tried to see if there had been any change in the number of original Korean musical works since the tightening of the copyright law and the rise in royalty payments for the importation of copyrighted music, trying to figure out the overall impact of copyright laws on the growth of the industry. We also tried to see if the quality of musicals has improved due to the stricter enforcement of contracts between Korean producers and foreign copyright owners. Stricter enforcement of copyright law resulted in an escalation of royalty payments and might possibly have induced a higher number of domestically created works to replace foreign copyrighted material.

In order to investigate these questions, we have sought earlier research outputs on copyright in the industry in Korea, relevant statistics and data; however, statistics were either unavailable or insufficient and it seems that the various aspects of copyright involved in a musical production have not yet been given full attention in this field of research. Therefore, we have resorted to drawing up a survey on this research. Most of the musicals in Korea are produced by specialized planning and management companies in the performing arts industry rather than by performing art groups or by theaters. Many producers are employees of these companies and artists are employed in a production of works or, if they are not directly employed, their output is used in the production in return for payment. We collected questionnaires from producers and artists who have participated in several musical productions and we have used ANOVA and ANCOVA to analyze parts of our survey results.

The following section is an overview of the history of the Korean Copyright Act. The impact of the copyright law on the musical industry is analyzed in Section 3; the growth of the industry, the treatment of foreign copyrighted works and the general production environment are analyzed. The observance of copyright by producers and artists in the various component fields that make up a musical is analyzed in Section 4. An analysis of three groups of people involved in the production of musical shows that there is a significant difference in the responses; the understanding of copyright among performers and producers differs in certain respects. Some policy implications are derived and a few suggestions for further research are presented along with some caveats on the limitations of the present paper in the final section.

2. Transformation of the Copyright Law in Korea

2.1. An Overview

The Korean Copyright Act was enacted in 1957 and completely reviewed in 1986 and 2006, with partial amendments in the years between; it has altogether been amended 15 times with the most recent amendment in 2008. The first law relating to copyright in Korea appeared in 1908 toward the end of the Yi Dynasty. This law was a copy of an agreement in 1877 between the United States and Japan regarding inventions, designs, brands and copyrights.[32] During the period between the

31 Most of the research on copyright in Korea is done by legal scholars and there have been very few papers by economists. We have researched several academic economic journals such as the Review of Cultural Economics and the Korean Journal of Economic Literature which publishes the titles of papers of various economic journals issued annually in Korea since 1998. We have also researched DBpia, which is an online academic data portal covering 112 economic and management journals in addition to 61 journals on law and administration between 1998 and 2008. This research yielded only 19 papers on the economic aspects of copyright in Korea.

32 Ministry of Culture, Sports and Tourism and Copyright Commission, History of Fifty Years of Korean Copyrights, 2007.

liberation of Korea from Japanese rule in 1945 and the founding of an independent Korean Government in 1948, the copyright law was a part of US Army Law (specifically Article 21). The same copyright law was carried over to Article 100 of the Korean Constitution declared at the time of the inauguration of the new and independent Korean State in 1948. After the Korean War (1950-1953), popular cultural activities boomed and the plagiarism of movies, recorded music, plays and radio broadcasts became a social issue. The Berne Convention for the Protection of Literary and Artistic Works was published in one of the leading daily newspapers at that time and public opinion moved toward the enactment of the Korean Copyright Act in 1957.

It was not until then that the Korean Copyright Act was written and enacted solely for the purpose of implementing copyright protection. The parliamentary record of the debate shows that the new copyright law was not a copy of an earlier Japanese law but was based on the Berne Convention. This law laid the foundation for copyright in Korea and was the guiding law for the next 30 years. However, it had become clear that it focused almost exclusively on domestic protection and, lacking comprehensive protection of internationally copyrighted materials, could not keep up with changing technology and international trade conditions. In 1985, the US demanded stronger protection of intellectual property in Korea. The government accepted this demand as part of a trade agreement in 1986 and joined the UNESCO-led Universal Copyright Convention of 1952 (UCC) in 1987. As a result, the copyright law was completely overhauled to include clauses to honor international copyrights and it came into effect on October 1, 1987.

The Uruguay Round (1986-1994) on the international trade of goods resulted in the establishment of the WTO in 1995, which replaced GATT. Within these trade talks, the copyright environment was also changing rapidly. As a member of the WTO, Korea was obliged to follow its stipulation that member countries honor copyrights in accordance with the Berne Convention even if the country was not a signatory. Thus, a further amendment to the law in 1995 was inevitable in preparation for the WTO/TRIPS Agreement, due to come into effect in Korea on January 1, 1996. The impact of digital technology on copyrighted material was tremendous and many countries amended their copyright laws under WIPO's leadership. The US enacted the Digital Millennium Copyright Act in 1998 and Korea amended its copyright laws in order to comply with it in January 2000 and October 2004, with an overhaul of the Copyright Act in December 2006, the last amendment becoming effective on June 29, 2007. In 2008, another amendment integrated separate laws concerning computer software programs into the main Copyright Act. The most important amendments and their salient features are summarized in Table 1.

2.2. Enactment of the Copyright Act in 1957

Although this law was a milestone in systematizing the protection of copyrighted material domestically, it lacked elements of protection for international cooperation. For example, no foreign copyrighted material was protected unless there was a special clause guaranteeing its protection or unless it was published in Korea for the first time. Korea did not join any international treaties nor sign any agreement with other countries regarding copyright protection during that period. The law allowed a wide range of free use of copyrighted materials, regarding the use of recorded music, films and phonograms for the purpose of public broadcasting as acts of non-infringement of copyright.

The practical enforcement and influence of the copyright laws on the cultural industry in Korea can be divided broadly into three periods, i.e. the period before the strict enforcement of the copyright law when a Broadway production could be reproduced without any compunction or fear of a lawsuit by the copyright owner. During this period, copyright was virtually ignored in the Korean

musical industry even though there had been a law since 1957, and foreign copyrights were almost never honored. As the Korean economy grew, international complaints also grew and this international pressure brought about the amendment of the Copyright Act in 1986, becoming effective in 1987. Until 1987, there had never even been a single amendment to the Act since its first enactment in 1957.

Table 1: Amendments to the Copyright Act and Their Impact

Date of amendment (implementation)	Articles pertaining to cultural industries in general Articles pertaining to the performing arts Impact of the amendment on the musical industry
1908 (1908)	Copyright Act of Japan was implemented during the Japanese occupation (based on the Copyright Act of Japan, 1877)
1945-1956 (1945, 1948)	US Army Law (Article 21) was in force during the period (1945-1948). The same law was copied into the Korean Constitution in 1948.
1957 (1957)	Copyright Act of Korea enacted for the first time (based on the Berne Convention) Non-formality principle (no need to register) Period of copyright protection to be 30 years after the author's death
1986 (1987)	Protection of foreign copyrighted material (Joined the UNESCO-Universal Copyright Convention in 1987 (UCC) Neighboring rights introduced for the first time: period of protection to be 20 years Social awareness about copyright; importance of contract is enhanced First formal contract written for a musical from abroad (Guys and Dolls, 1994)
1995 (1996. 2010)	Implementation of protection of foreign copyrighted material (Joined the Berne Convention in 1996) Protection period of neighboring rights extended to 50 years Right of reproduction added to the neighboring rights Formal royalty contract for musicals (Gambler, Fame, The Sound of Music, etc., 1998); PMC (local) Production registered its copyright and obtained a royalty in 1998. Restoring rights retrospectively: Prior copyrighted works restored by the Berne Convention
2000 (2000)	Right of transmission added to copyrights (including transmission through the Internet) Copyright of database protected for five years Regulations against infringement strengthened Legal disputes over Cats: a prior copyrighted work restored by the Berne Convention
2004 (2005.2001)	Right of transmission granted to the performers and phonogram producers (in preparation for WPPT membership)
2006 (2007.2006)	Overall amendment Infringement of copyright to be an offense without prior complaint Fair use of copyright for educational purposes Online Service Provider (OSP) must install filter if requested by the copyright owner
2008 (2009.2011)	Integration of copyright and computer software programs

2.3. International Pressure and the 1986 and 1995 Amendments

The amendment of 1986 was, to all intent and purposes, an entirely new enactment of the Copyright Act.[33] It was a direct result of the Korea-US Intellectual Property Rights and Insurance Understandings signed in 1986 and, in part, in preparation to join the UNESCO-led UCC in 1987. The UCC promotes the treatment of foreign nationals and non-formality principles[34] while obliging Korean producers to be more careful about using copyrighted work from abroad. As copyright laws became stricter and legal disputes arose, producers and artists became more aware of copyright and had to adjust their behavior accordingly.

33 The Ministry of Culture, Sports and Tourism and Copyright Commission, History of Fifty Years of Korean Copyrights, p.130, 2007.
34 The non-formality principle states that even in a country which requires registration of copyright before it can take effect, if copyrighted material is marked by the copyright symbol © and it gives the author's name and the year published, it will be regarded as formally registered material.

After a further amendment of the Copyright Act in 1995, the producers had to pay royalties and they started bringing in large-scale musicals through so called license-production agreements. In some cases, if a Western production became a hit domestically, the foreign copyright holders would deny the renewal of the contract a couple of years later and would try to come to Korea with their own production or demand much higher royalties. Frustrated by the behavior of the foreign copyright owners, some producers decided to create original musicals rather than pay expensive royalties for Broadway productions. Under the new law, the period of protection was extended from 20 years to 50 years from the first public performance and penalties for infringement became more severe. It also recognized the right of re-production for the performers in accordance with the Berne Convention. The copyright could be retroactively honored and for this reason, the retroaction was extended by 30 years up to 1957. The rights to the rental of phonograms were granted to the performers under a new system in the copyright industry and the maximum fines for infringement were increased ten-fold in the 1994 amendment. With these amendments, foreign nationals were accorded the same treatment as Korean nationals.

2.4. Digitization and the New Features of the Copyright Act in the 2000s

The infringement of copyright on the Internet has been growing rapidly in Korea since the early 2000s. The Copyright Protection Center publishes the *Annual Report of Copyright Infringement Prevention* each year and in 2006, statistics, per person, per month showed that there were 45 music downloads, 27 MPG downloads, and 13.5 downloads of cartoons/comics. The damage to the relevant industries due to these pirated copies was estimated in 2006 to be 456.8 billion Korean won for the musical industry, 339.1 billion Korean won for the movie industry (moving images together amounted to around 1,149.9 billion Korean won), and 412.5 billion Korean won for the publication industry. Growing international concerns about online infringement and the amendments of copyright laws in Japan (1997, 1999) and the US (the Digital Millennium Copyright Act, 1998), while facing an ever-changing digital environment, forced Korea to amend its Copyright Act concerning the digital and Internet environment several times in the 2000s.[35] The amendment in 2004 granted the right of transmission to performers and phonogram producers in anticipation of joining the WIPO Performances and Phonograms Treaty (WPPT). This was to protect performers who hitherto had only enjoyed the protection of related rights in the changing environment of moving distribution channels from offline to online.

In 2006, the second overall amendment took place to keep abreast of the digitization of the copyright industry. This amendment aimed not only to protect copyright owners, but also to promote the fair use of copyrighted material: the concept of “the public” was extended to include a specific number of people.[36] Lawsuits against individuals using copyrighted material for profit no longer needed a formal complaint from the copyright holder and police could now had automatic powers to arrest the offender. Before 2008, copyrights covering computer programs and all other forms of copyright were handled by two separate laws and by two different ministries. However, the new President M.B. Lee’s re-organization of the government eliminated the Ministry of Information and Communication and so MCST took charge of the protection of computer software. The amendment of 2008 integrated copyright on computer software into the framework of the Copyright Act and delegated matters concerning all copyrights to the Korea Copyright Commission, with immediate effect.

35 Song, Young Shik and Lee, San Jung, Copyright Law, 4th ed., Seoul: Sechang Publications, 2007.
36 See Article 2 (definition) 32 of the Copyright Act which states that “the public” shall mean a non-specific group of people (including a specific group).

3. The Impact of the Copyright Law on the Musical Industry

3.1. Growth of the Musical industry

The first musical played in Korea dates back to 1966 when the theater group "Yegreen" produced Come by Stealth, Darling! which was about a love affair between a newly appointed provincial governor in Cheju Island and a beautiful and proud local courtesan in the Yi Dynasty. Since then, the musical sector has grown to be one of the most popular entertainment industries in Korea. In 2008, sales of tickets rose to 205 billion Korean won (163 million US dollars) and the number of tickets sold was slightly over 4 million as shown in Table 2, which is almost double the sales volume in 2006. The number of performances has increased 14-fold in a period of 16 years. In 1991, musicals accounted for 34 out of 748 of all live shows in theaters, which amounted to only 4.5 per cent of the performances; in 2001, musicals accounted for 9.7 per cent of all live shows except for children's plays. In 2007, the number of musicals rose to 477 out of 1,645 theatrical performances of all genres except children's plays, which amounted to 29.0 per cent of the total.[37] There have, however, been occasional setbacks over the period as can be seen in Figure 1 when the number of performances in a given year was lower than in the preceding year.

In the 1970s, Korean popular songs were also popular in Japan and some Korean songs were recorded by Japanese singers without royalties being paid to the composer or to the songwriter. In the case of one very popular Korean song, around 20 Japanese singers made albums and sold over 3.5 million copies in Japan. The Korean songwriter did not receive a penny because there was no formal agreement on copyright between the two countries at that time.[38] After the amendment of 1986, copyright royalties for songs broadcast were paid according to an agreed formula and the income of the creative artists was notably better protected than before. In addition, foreign songs and stories could no longer be used free of charge and the royalties to be paid were high. Because of these high royalties for foreign copyrighted songs, the producers of movies and the broadcasting companies sought domestic sources of music and films, thus encouraging the creativity of local authors, composers and singers.

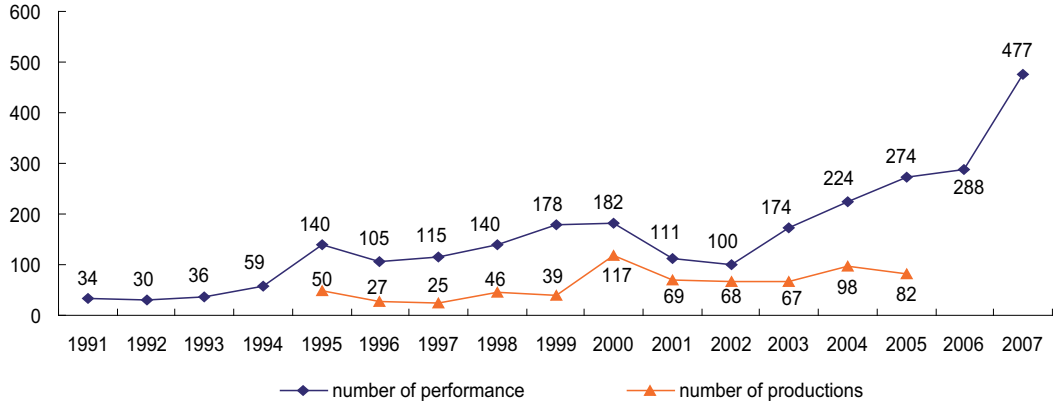
Table 2: Growth of the Musical Market

	Musicals		
	2006	2007	2008
Tickets sold in 1,000 Korean won	104,277,551	163,912,245	205,181,633
growth rate (%)	-	57.20%	25.20%
US dollars	112,174,603	174,709,278	163,166,309
Exchange rate	929.6	938.2	1,257.50
Number of tickets sold	3,394,312	3,521,484	4,051,504
growth rate (%)	-	3.70%	15.10%

Source: Weekly@Arts Management, No.20, 2009. 3.19-25/Exchange rate based on BOK year-end rate.

37 Source: Arts Council Korea. More recent figures are not available.
38 Copyright Commission (2007, p.121).

Figure 1: Number of Musical Performances



Source: Arts Council Korea, Cultural and Artistic Yearbook, 1999·2000·2007·2008.

This increasing demand for a supply of domestic artistic creations had a huge impact on the domestic output of popular songs and films. During the 1980s, more than 80 per cent of albums sold were of US popular songs and the Korean output made up only 20 per cent: this situation completely reversed in less than 10 years. It took longer for the movies to counter Hollywood blockbusters. Domestic movies occupied only 25.1 per cent of screens in 1998, but this rose to more than half in 2003 and to 64.7 per cent in 2006. In recent years, an increase in domestically created productions in the musical industry has also been observed.

The number of productions and performances of musicals between 1995 and 2005 is shown in Figure 1; however information on numbers of original musicals produced or of licensed musicals is sporadic. In 1996, there were 12 original Korean productions and 15 licensed musicals out of a total of 27. Thus 44.4 per cent of the musicals performed in Korea in that year were Korean copyrighted works and 55.6 per cent were licensed-musicals.[39] In 2007, there were 119 original Korean productions and 54 licensed-musicals out of 205 total productions.[40] Thus, 58.0 per cent of the musicals performed in Korea in 2007 were Korean copyrighted works and only 26.3 per cent were licensed musicals, showing a decrease of 50 per cent in just a decade. We may, therefore, tentatively conclude that in recent years there appears to have been a shift toward creating original musicals rather than using foreign imports.

Turning to the legal aspect of copyright, we observed that the number of registrations of copyrighted works in all categories of the industry more than tripled between 2001 and 2006 as shown in Table 3, even though the informality principle was maintained. The number of grievances conciliated averaged 86.3 between 2001 and 2006 as seen in Table 4. Almost 40 per cent of the total 860 cases of grievance conciliation were in the literature category. In the theater category to which musicals belong, there have been only five grievance conciliations since 1988.[41] The cases of grievance are quite low in view of the tremendous growth in the number of performances, and this may be due to the unique Korean culture and production environment as we shall see from the survey results in the following sections of this paper.

39 Arts Council Korea.
40 Ministry of Culture, Sports, and Tourism and.Korea Arts Management Service, Survey Report on Musicals 2008. The other performances include nonverbal performances (17) and performances by the original company visiting Korea (15).
41 Copyright Commission, Conciliation Statistics, 2009.

Table 3: Copyright Registration (unit: number of cases)

Classification	1987~2000	2001	2002	2003	2004	2005	2006	Total
Number of cases	5,505	3,615	4,980	6,508	7,167	10,553	12,241	50,569

Source: Copyright Culture, Copyright Commission, p.13, October 2007.

Table 4: Copyright Grievance Conciliation (as at August 31, 2006. unit: number of cases)

Classification	1987~2000	2001	2002	2003	2004	2005	2006	01-06 Average Total
Number of cases	351	67	109	111	73	67	91	86.3 869

Source: Conciliation Statistics, Copyright Commission, 2009. 3.31.

3.2. Setting up the Survey on Copyrights in the Musical Industry

Survey questionnaires on attitudes toward copyright in musical productions were sent out to 131 authors and artists (artists' groups), 61 planners and 120 producers (producers' groups), members of at least one of the following organizations: Korea Association of Performing Arts Producers; the National Theater Association of Korea; Korea Musical Theatre Association (KMTA). The questionnaires were in two parts: a set of general questions and a section on questions addressing each of the two different groups separately. We used an e-mail online survey with cooperation from the Korea Musical Theater Association to distribute the questionnaires.[42]

We sent out official KMTA e-mails requesting responses to the survey in its name stating our research purpose and mentioning WIPO.[43] In addition to the e-mails, we called and visited some of the respondents to request them to fill out the questionnaires. For those respondents who had participated in other theatrical performances in addition to musicals, we asked that they restrict their responses to musicals only. Since 95 per cent of the planning and management companies for musicals are located in Seoul, our survey was addressed to Seoul-based producers and artists. During the period February 4-20, 2009, out of a total of 312, we obtained responses from 106 artists and 104 producers, giving us 210 responses which we analyzed.

The characteristics and the fields of specialization of the creative artists who returned the questionnaire are reported in Tables 5 and 6: about 55.7 per cent were male and 44.3 per cent female and about 80 per cent were aged between 30 and 40. They were well educated with 96.2 per cent having a Bachelor's degree or higher. Among the respondents, 64.1 per cent had worked for over 11 years and 38.7 per cent had worked in more than six jobs in one year. Each year, 39.6 per cent had worked at between three and five jobs. Their fields of specialization were as follows: director 15.1 per cent; performer 15.1 per cent; composer 13.2 per cent; set designer 11.3 per cent, choreographer 9.4 per cent, script writer 10.4 per cent; other designers 25.5 per cent.

The questionnaire for the producers was almost identical except for a few questions reflecting professional differences. The characteristics of the producers who returned the questionnaires are also reported in Table 5. More than 60 per cent of those who returned the questionnaire were male and slightly less than 40 per cent were female. More than 80 per cent were between 30 and 40; they were well educated (95.2 per cent with a Bachelor's degree or higher) and about one-third had worked for over 10 years. Slightly fewer than half had produced medium-sized musicals and more than half had staged three to five productions annually.

42 We employed an online service provider who collected these replies and tabulated them for us.
43 The respondents were able to click the survey button in the e-mail which linked them to the questionnaires so that they could click and send their responses . The answer sheet would then automatically be sent to the collecting agency and tabulated.

Table 5: Characteristics of the Respondents

Category		Percentage	
		Creative artists	Producers
Gender	male	55.70%	63.50%
	female	44.30%	36.50%
Age	20s	6.60%	4.80%
	30s	48.10%	44.20%
	40s	33.00%	41.30%
	50s	12.30%	8.70%
	60s	-	1.00%
Education	up to high school	3.80%	4.80%
	up to college	58.50%	60.60%
	up to graduate school	37.70%	34.60%
Years in career	1-2 years	-	5.80%
	3-5 years	-	21.20%
	1-5 years	10.40%	27.00%
	6-10 years	25.50%	25.50%
	11-15 years	24.50%	31.70%
	16-20 years	23.60%	-
	16+ years	-	14.40%
	20+ years	16.00%	-
Work participation per year for artists or productions per year for producers	1-2 works	21.70%	28.80%
	3-5 works	39.60%	51.90%
	6-8 works	20.80%	16.30%
	9+ works	17.90%	2.90%

Table 6: Field of Specialization of the Respondent

Category		Percentage
Field of work	original story	1.90%
(Creative artists only)	script	10.40%
	adaptation	0.00%
	lyrics	0.00%
	composition	13.20%
	direction (performance)	15.10%
	choreography	9.40%
	set design	11.30%
	lighting design	5.70%
	cinematographic design	2.80%
	sound design	3.80%
	costume design	4.70%
	prop design	6.60%
	acting or playing musical instrument (performance)	15.10%
Scale of the musical	small scale work	41.30%
(Producers only)	medium scale work	45.20%
	large scale work	13.50%

3.3. Survey of Attitudes Regarding Copyright in the Musical Industry

As shown in Table 7, most of the respondents (94.3 per cent of artists and 83.7 per cent of producers) had experience of using a copyrighted work in their own production of a musical without the permission of the copyright owner. Artists most often used the creative work in re-performances without permission (40.6 per cent) followed by a broadcasting transmission (20.8 per cent); transformation of the original work (16.0 per cent); use in a performance (8.5 per cent); use of the original work in the production of a derivative work without permission (4.7 per cent); others (3.8 per cent). However, almost one-fifth of producers used copyrighted work without permission in a performance (21.2 per cent); transformation of an original work (20.2 per cent); in a re-performance (19.2 per cent). Producers also used copyrighted works without permission for a broadcasting transmission (13.5 per cent) and in the production of a derivative work (9.6 per cent).

The reasons for this kind of copyright infringement were listed by the artists as follows: lack of users' acknowledgement of copyrights (50.0 per cent); desire to reduce costs (39.6 per cent), lack of the copyright holder's legal counter-measures (5.7 per cent); lack of copyright protection by the legal system in Korea (2.8 per cent) and the copyright holders' negligence in protecting their own copyrights (1.9 per cent). Most producers cited the lack of acknowledgement of copyright by users (56.7 per cent) and the desire to reduce costs (32.7 per cent) as the main causes. Compared with artists (1.9 per cent), a significantly higher number of producers regarded the copyright holders' negligence in protecting their own copyrights (6.7 per cent) as a reason. Some listed the lack of the copyright holder's legal counter-measures (2.9 per cent) and the lack of copyright protection by the legal system in Korea (1.0 per cent). On the question of acknowledging copyright, most of them (77.3 per cent of artists and 72.1 per cent of produces) answered that the permission of the copyright holder must be obtained if the work were to be used in a concert or gala and most of them (66.0 per cent of artists and 79.8 per cent of producers) would be inclined to sue the violator if their own work were plagiarized. Only 5.7 per cent of artists and 8.7 per cent of producers have registered their work with the Copyright Commission.

In Table 8, we summarized the responses by the creative artists who participated in the performance of musicals. The majority (79.2 per cent) of artists has experienced signing a contract specifying the royalties[44] but had difficulty in calculating payments (52.4 per cent) in deciding whether to transfer the ownership of the copyright (21.4 per cent) and in the understanding of the contract (17.9 per cent). Slightly less than half of them (48.1 pert cent) replied that their main priority in signing a contract concerned royalty payments and others (25.5 per cent) replied that it was the transfer of copyright. For the contract period, contracts covering two to three years (50.9 per cent) were most common, followed by contracts extending beyond three years (27.4 per cent) and transfer of ownership (21.7 per cent). The main reasons for signing such contracts were listed as: demand by the producers (45.3 per cent); on one's own accord (29.2 per cent) or by convention (23.6 per cent).

44 For questions with a bearing on contracts or income, about 20-30 per cent of the respondents chose not to answer. In such cases, we calculated the percentage by excluding the non-answers.

Table 7: Types of Copyright Infringement

	Items	Frequency (number)		Percentage (%)	
			Authors		Authors
		Producers	Artists	Producers	Artists
Types of Infringement*	Use of the performance (including partial use)	22	9	21.2	8.5
	Transformation of the original work without permission	21	17	20.2	16
	Use of a creative work in re-performance without permission	20	43	19.3	40.6
	Use of the original work in the production of a derivative work without permission	10	5	9.6	4.7
	Transmission in a broadcasting without permission	14	22	13.5	20.8
	Sub-total of the infringements	87	100	83.7	94.3
	Not applicable	17	6	16.3	5.7
	Total	104	106	100	100
Cause for Infringement**	Lack of users' acknowledgement of copyright	59	53	56.7	50
	Users' desire to reduce costs	34	42	32.7	39.6
	Lack of a copyright holder's legal counter-measures	3	6	2.9	5.7
	Lack of copyright protection by the legal system in Korea	1	3	1	2.8
	Copyright holders' negligence in protecting their own copyrights	7	2	6.7	1.9
	Total	104	106	100	100

* Question: Which of the following forms of using a work without the copyright owner's permission do you perform most often while planning a musical performance?

** Question: If creative works have been used without due permission from the copyright holder, what do you think is the main reason for such an infringement?

Most of them (56.6 per cent) considered that the expected increase in royalty income as a crucial factor in regarding copyrights has become more important in recent years, while only 26.4 per cent thought it was the enhanced level of awareness of copyright that was important. Only 7.5 per cent of artists indicated the strengthening of the Copyright Act to be important, while 8.5 per cent replied that there was not much difference between the present and the past.

The following is a summary of the responses from producers. Almost all (96.2 per cent) had experienced signing a contract specifying copyright ownership but had difficulty in calculating royalty payments (67.3 per cent), and whether to transfer the ownership of the copyright (21.4 per cent). Only 3.1 per cent of producers had difficulty in understanding the copyright contract in contrast to 17.9 per cent of the artists. Slightly more than half (53.8 per cent) replied that the top priority in signing a contract was payment of royalties and others replied that it was a matter of transferring the copyright (17.3 per cent) or the contract period (also 17.3 per cent). For the contract period, a contract covering two to three years (40.4 per cent) was most common followed by a contract extending beyond three years (39.4 per cent) and transfer of ownership (20.2 per cent). More producers than artists tended to sign a contract for a longer period.

The main reason for signing such a contract was on one's own accord (49.0 per cent); demand from the producers (31.7 per cent) or by convention (18.3 per cent). An almost equal number of them regarded the expected increase in royalty income (46.2 per cent) or enhanced awareness by

producers (44.2 per cent) as crucial factors for considering copyright as more important in recent years compared with 26.4 per cent of artists who regarded it as an enhanced level of awareness of copyright. Only 5.8 per cent of producers indicated that strengthening the Copyright Act was important while 3.8 per cent replied that there was little difference between the present and the past.

Table 8. Experience of Signing a Contract

Question	Items	Frequency (number)		Percentage (%)	
		Producers	Authors & Artists	Producers	Authors & Artists
Experience of contract*	Yes	100	84	96.2	79.2
	No	4	22	3.8	20.8
	Total Response	104	106	100	100
Priority of contract**	Authors' fees (copyright fees)	56	51	53.8	48.1
	Retention period of the copyright	18	9	17.3	8.5
	Ownership of the copyright	18	27	17.3	25.5
	Permission to transform the copyrighted work	12	3	11.5	2.8
	No response	0	16	0	15.1
	Total responses	104	106	99	100
Difficulty in signing a contract***	Understanding the terminology of a contract	5	1	5.1	1.2
	The amount or rate of royalty	66	44	67.3	52.4
	Whether to transfer the ownership of the copyright or not	21	18	21.4	21.4
	Disadvantage resulting from unfavorable conditions in the contract	3	6	3.1	7.1
	Understanding the copyright contract itself	3	15	3.1	17.9
	No response (no experience of contract)	6	22	0	0
	Total Response	104	106	100	100

* Have you ever signed a contract specifying copyright when you took part in a musical performance?

** If you are writing a contract with a producer for your contribution in the production of a musical, what should be the main priority?

*** What is the most difficult aspect of signing a contract or licensing agreement for your creative works?

As shown in Table 9, the proportion of artists who have experienced legal disputes was only 4.7 per cent, either because the question did not arise (31.0 per cent); the legal process was too complicated (26.0 per cent); they took no legal action through fear of discrimination in future work (23.0 per cent) or resolution through negotiation was attainable (17.0 per cent). The most common infringements in a musical were unauthorized use of the work in a re-performance (40.6 per cent) followed by unauthorized transmission of a work (20.8 per cent); unauthorized alteration of the work (16.0 per cent); unauthorized use of the performance (8.5 per cent); unauthorized use of a derivative work (4.7 per cent) The main reason for this was the unawareness of copyright (50.0 per cent) and the desire to reduce costs (39.6 per cent). The majority felt that copyrights in Korea were not well protected (84.0 per cent) and more education on them (97.2 per cent) was needed.

Table 9: Reasons for Lack of Disputes

Reasons	Frequency (number)		Percentage (%)	
	Producers	Authors Artists	Producers	Authors Artists
Because there have been no complaints nor grounds for dispute.	57	31	68.7	31
Due to high legal fees, I ignored the problem.	6	3	7.2	3
Due to complications and difficulties of litigation, I didn't pursue a legal solution.	7	26	8.4	26
The problem was settled through negotiation.	12	17	14.5	17
Because of potential and predictable disadvantages in my future as an artist, I dropped the question.	1	23	1.2	23
Sub-total	83	100	100	100
No response	21	6	-	-
Total	104	106	-	-

When asked if they had any experience with legal disputes over copyright, more producers (17.3 per cent) than artists (4.7 per cent) answered that they had experienced legal disputes. Among reasons for not filing lawsuits were that there had been no reason for disputes (68.7 per cent); the legal process was too complicated (8.4 per cent); fear of discrimination in future work (1.2 per cent) and resolution through negotiation was attainable (14.5 per cent). While almost a quarter of artists (23.0 per cent) feared some form of retaliation if they filed a lawsuit against a producer or a company, only 1.2 per cent of producers expressed such a fear. Most of them (96.2 per cent) responded that a dispute-resolution institution could be beneficial.

The most common infringements of musicals were unauthorized use of the performance (21.2 per cent), followed by unauthorized alteration to the work (20.2 per cent); unauthorized use of the work for a re-performance (19.2 per cent); unauthorized transmission of work (13.5 per cent) or unauthorized use of a derivative work (9.6 per cent). The response by producers and artists of “not applicable” could be interpreted to mean that they had not made any unauthorized use of copyrighted works. The main reasons for infringement were reported to be lack of awareness of the copyright (56.7 per cent) and the desire to reduce costs (32.7 per cent).

The majority of producers and artists indicated that copyrights should be granted to directors and producers. However, more producers wanted copyrights to be granted to producers (79.8 per cent) compared with the response from artists (67.9 per cent) while more artists wanted copyrights to be granted to directors (80.2 per cent) compared with the response from producers (65.4 per cent). The majority of producers as well as artists felt that copyrights were not well protected in Korea and more education on the subject may be necessary.

3.4. Treatment of Foreign Copyrights in the Musical Industry

There were two notable incidents of copyright issues related to foreign-licensed musicals in 2000. The five-year probation period, which was one of the provisions under the amended Copyright Act of 1995 expired in 1999. The first incident was a lawsuit for royalty payments for the musical Cats. The agent representing the copyright owner in South-East Asia, The Really Useful Group, sued the Korean performance group Daejoong, claiming that it had performed Cats without a copyright contract. The agent demanded 130 million Korean won which amounted to 22.5 per cent of the

total income of the group in that year in Seoul. This incident sounded a warning bell for the performing arts industry, which was used to using foreign work without a formal contract with the copyright owner.

In contrast, the second incident in the same year was an exemplary case, not only because of honoring the copyright, but also receiving a commendation from the copyright holder. The Hakjeon theater imported a German musical, Line 1 (Linie 1-Musikalische Revue) from the Berlin Gribbs Group and modified the script to a Korean situation, calling it Subway Line 1. The theater company had paid royalties for the previous six years to Volker Ludwig the copyright holder in the sum of 100 million Korean won (approximately 83,000 US dollars). The Korean version of the musical was praised as being better than the original version and the German Copyright Council notified the owner of Hakjeon theater and in an unheard-of gesture; waived any further royalty payments in recognition of almost one thousand performances of the musical in six years in Seoul and the contribution made by Hakjeon in the popularization of the original play Line 1 in Korea.

In 2008, 42nd Street was to be produced by the Daejoong performance group without a license from its copyright owner, TAMS, in the US. The group argued that since it had written new music and the original story was based on the movie made in 1933, which was over 50 years old, copyright had not been infringed. Legal experts let it be known that the copyright for the original musical started from the time it was first staged in 1980. Later, in 2008, the group changed the title of the musical to Broadway in Dreams and produced the musical as an original Korean production which took place on present day Broadway in New York. This demonstrates how copyright protection actually works in the Korean musical industry because if it had been fifteen years earlier, the producer would have used the original title, 42nd Street, without any qualms.

From our survey, the proportion of producers who have produced one or two licensed-musicals was 39.4 per cent and the proportion of those producing three to five was 14.4 per cent. Among them 52.1 per cent of producers had to renew the license every year and 27.4 per cent had to renew it every three years. Slightly fewer than a third (29.8 per cent) refused to answer the question and to reveal the arrangement. Most producers (93.3 per cent) answered that the license fee was too high. For those who answered that they had produced original musicals instead of licensed musicals, 57.7 per cent cited the reason as high licensing fees. The proportion of those who had entered into at least one license arrangement was 62.5 per cent. More than a third (36.5 per cent) thought that royalties for a license should be lower than 10 per cent and 35.1 per cent thought that royalties should be lower than 8 per cent while 20.3 per cent thought that they should be lower than 5 per cent.

3.5. Performance and Production Environment

Both artists (80.2 per cent) and producers (74 per cent) thought that as a result of the strengthened protection afforded by copyright royalties, the quality and the number of musicals produced have increased. However, asked about the level of satisfaction with the remuneration they receive, 76.4 per cent of artists said that they were not satisfied. In contrast, the majority (82.7 per cent) of producers thought their remuneration satisfactory as shown in Table 10. The proportion of artists satisfied with their remuneration was only 2.8 per cent while producers registered around nine times higher (25.0 per cent) which is not surprising since the producers make the decisions on remuneration to the artists and to themselves. They most often use certain proportions of the total cost of production (38.5 per cent) or a fixed fee (31.7 per cent) regardless of production costs. The rest differentiated between remuneration according to the ability of the artist (15.4 per cent) and his/her contribution to the production (14.4 per cent).

Table 10: Economic Remuneration

Opinions		Frequency (number)		Percentage (%)	
		Producers	Authors Artists	Producers	Authors Artists
Satisfaction with economic remuneration in a musical production	extremely dissatisfied	3	14	2.9	13.2
	dissatisfied	15	67	14.4	63.2
	no opinion	60	22	57.7	20.8
	satisfied	25	3	24	2.8
	extremely satisfied	1	0	1	0
Total		104	106	100	100

Producers reported that the price of tickets is based on the break-even point according to the size of the concert hall (51 per cent); on consideration of the increase in production costs such as labor (25 per cent) or the market for ticket prices in general (20.2 per cent). Only 3.8 per cent of producers mentioned the rise in copyright royalties and licensing fees as the deciding factors for determining ticket prices. The overall outlook on protection of copyright is negative. Almost two-fifths of producers (38.4 per cent) and three fifths of artists (62.2 per cent) expressed negative opinions on the prospect of a copyright protection environment. Only a quarter of producers (25.0 per cent) and one-tenth of artists (9.4 per cent) were content with the copyright protection environment although producers were more positive than artists. Those who had no opinion scored 36.5 per cent and 28.3 per cent respectively.

The copyright protection environment is still undergoing transformation although there have been several disputes between producers and creative artists. Let us take a brief look at one well-documented case in 2007, where the producer (SJ B-boys) of a popular musical The Ballerina who loved a B-Boy sued the former director of the musical, Jucheol Moon and the dancing group, Gorilla Crew for infringement of copyright. In the previous year, SJ B-boys had purchased the right from JS Pictures for the original work Freeze. Based on this story, SJ B-boys created The Ballerina who loved a B-Boy in collaboration with the dancers in Gorilla Crew and the then director of the musical, Mr. Moon. However, SJ B-boys replaced the actors and dancers in 2007. Earlier, the director, Mr. Moon and the Gorilla Crew tried to stage the musical separately but were prevented by SJ B-boys. The issue here was who owned the copyright to this musical in which they collaborated.

3.6. Impact of Copyright Law by Age Group

If the Copyright Act, amended several times since 1987[45] had any impact on the use of copyright in Korea, different responses to our survey questions would accord with different age groups. Those who are now in their thirties were still children at primary school in 1987 but they may have been educated in social issues such as copyright during the course of their schooling. Those who are now in their forties were at least in their late teens or in high school in 1987, which was about the age when they might have become conscious of matters such as copyright. Those who are

45 Korea joined the UNESCO-led UCC (Universal Copyright Convention of 1952) in 1987.

now in their fifties were at least in their late twenties and most of them had graduated by 1987, not giving them the opportunity to learn about copyright. Our hypothesis was that if the Copyright Act had had an impact, then there would be a notable difference between the younger age group who had been exposed to the new laws and the older group which was already past the age of formal education in 1987 when significant changes in the laws were introduced.

We ran simple t-tests for the homogeneity of the mean dividing the respondents into two age groups. First, we divided the respondents into those under 40 (109 respondents) and over 40 (101 respondents).[46] The result of the t-test showed no significant difference between the two age groups except for the question on awareness: (I am aware of the copyright issues concerning musicals) with the value of t being -3.333 and the value of p being 0.001. The mean of the under 40 group was 2.95 (S.D.=1.022) and the over 40 group was 3.42 (S.D.=0.983) Given the nature of the question, even this difference may have little to do with the impact of the Copyright Act; it may simply mean that the respondents in the older group have more experience and more knowledge of what goes on in the music field, including copyright issues.

Since taking 40 as our dividing point did not yield much difference between the groups, we increased the dividing line to 50 with 187 respondents below 50 and 23 respondents above 50. The result of the t-test showed no significant difference in the mean between the two age groups except on the question on public showings: (We must obtain permission from the copyright owner in order to show a part of a musical or gala concert to the public) with the value of t being 2.183 and the value of p being 0.030. The mean of the under-50 group was 3.88 (S.D.=0.908) and the mean of the over-50 group was 3.43 (S.D.=1.080). The younger generation seems to have a stronger inclination to obtain permission from the copyright holder and this difference is significant, which could be the result of different exposure and education on copyright between the two age groups since 1987. Even though it was only one question, the nature of the questionnaire was such that none of the other questions[47] addressed the type of issue that may indicate the impact of the Copyright Act. Thus, the law must have had somewhat less impact on the mindset of those who work in industries affected by copyright.

4. The Awareness of Copyright in the Musical Industry

4.1. Comparison of the Acknowledgment of Copyright in Different Fields

We have surveyed the level and extent of knowledge of copyright in various fields of the arts sector, such as scriptwriting, lyrics, musical composition, stage sets, costumes, acting, playing musical instruments, all of which are essential components in producing a musical. We surveyed two groups separately to find out which field should be acknowledged even if it is currently not the case and if so, what percentage of copyright royalties should be allocated. We looked first at the responses from the creative artists and then the producers.

We asked the question: “Among the fourteen art fields involved in staging a musical, which activities should be protected by copyright?” Responses from the creative artists are summarized in Figure 2, ranked by frequency of response and those of the producers are summarized in Figure 3, also ranked by frequency of response. The activities entitled to high copyright royalties were: original story, music composition, lyrics and script. These were undisputedly ranked top in the minds of creative artists and producers.

46 The age distribution of the respondents is shown in Table 5.
47 For the exact wording of all eight questions, see Table 11.

Specific rankings, however, varied slightly between the two groups. While script is ranked fourth by the artists, it is ranked second by the producers. There is also a wide difference between the two groups in rankings for production and direction. The artists ranked direction in 11th place and production in 13th while production was ranked 6th and direction 7th by producers. The lowest ranking field in both groups was sound design, considered as such by 74.59 per cent of artists and 52.9 per cent of producers. Producers and creative artists were disinclined to grant copyright to performers and only around 17 per cent of artists and 5 per cent of producers seemed to think that performers (actors, singers, conductors) deserved copyright protection.

Figure 2: Fields to which Copyright should be Granted with High Level Royalties: Responses from Creative Artists

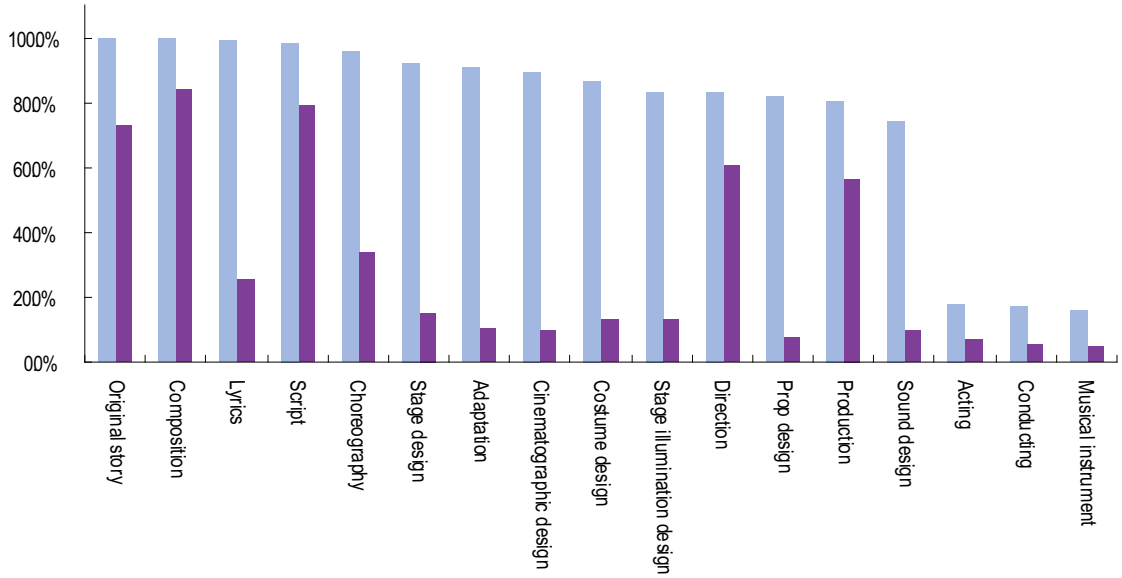
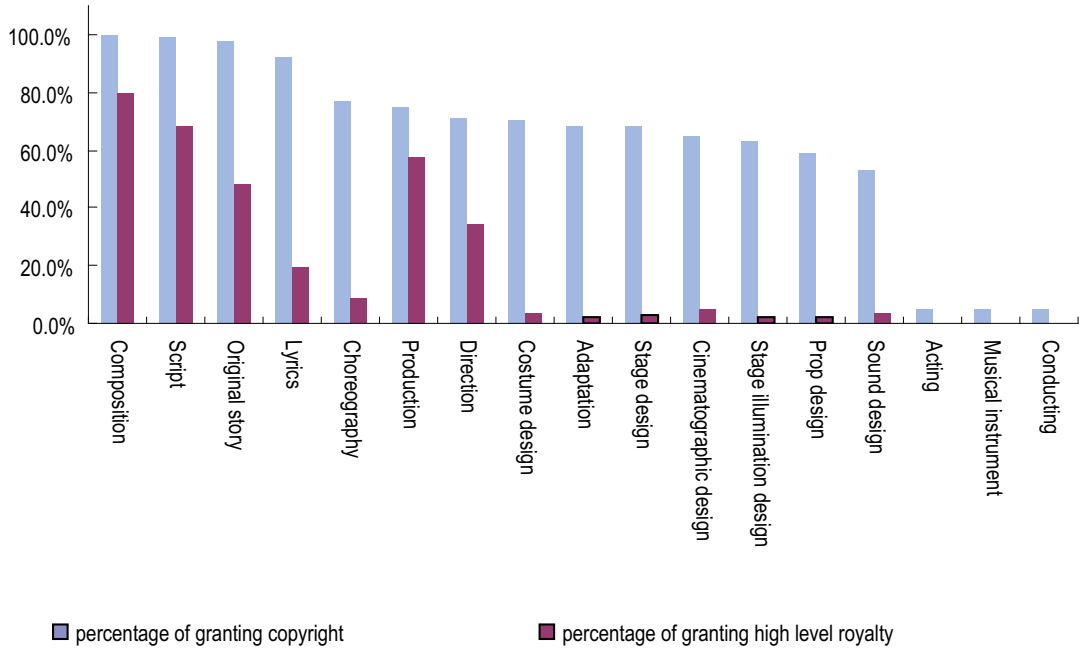


Figure 3: Fields to which Copyright should be Granted with High Level Royalty: Responses from Producers



4.2. ANOVA of the Questionnaire

We collected three sets of survey questionnaires from three different groups to evaluate changes in attitude and awareness of copyright in the musical industry. One set came from 74 creative artists (authors, artistic, and technical staff) and one from 32 performing artists (actors, actresses, singers, musicians and directors) who have worked in music productions. The last one was from 104 producers who have worked in management companies that plan and produce musicals in Korea.

The creative artists, performers and producers of musicals in Korea were surveyed on the level of their awareness of copyright concerning musical performances on a 5-point scale of Likert measures: a strongly positive response was given five points; a positive response four points; a neutral response three points; a negative response two points and a strongly negative response one point. Thus, a group average of more than three points signified a positive response and any point above four to a maximum of five points indicated a very positive response. Likewise, in reverse, fewer than three points meant a negative response and any point less than two to a minimum of one indicated a very negative response. The variances between these responses were analyzed using the analysis of variance (ANOVA). The questions used and the mean and standard deviation of the responses as well as the result of the one-way ANOVA are listed in Table 11.

Before applying ANOVA, the homogeneity of the variance was tested using Levene's test and the criterion for homogeneity was satisfied with the exception of the question of "legal action against copyright infringement". Among the responses to the seven remaining questions in Table 11, "the need for more education on copyrights" showed the most positive result. The overall mean was 4.55 and there was no significant difference between the groups. To the question on the awareness of copyrights in musical performances, the respondents showed that they were not very well informed. Let us compare the mean and standard deviation of the responses by the three groups. The group-mean in the responses from artists, performers and producers showed 2.80, 2.75 and 3.18 respectively. The Duncan test showed that there was little difference between creative artists and performing artists ($p=0.794 > 0.05$) but the difference between the two artist groups and the producers was significant ($sig.=0.000 < 0.05$). As would be expected, the producers seemed to be more aware of copyright, due to their own experience.

The most negative response for copyright protection was found in the musical industry whose overall mean was 1.97 points. Artist groups gave a lower score (1.75 and 1.85) than producers (2.12). There was a difference between the lowest-scoring group, performing artists and the highest-scoring group, producers ($sig.=0.022 < 0.05$). We can surmise that since performers are only covered by related rights whereas producers deal with the economic rights of the copyrighted material all the time, the latter are better informed about the current situation and they are familiar with the advantages for them in using copyright law. Since performing artists may be dissatisfied with their situation of being excluded from most of the copyrights and only entitled to related rights, they may actually feel their rights are insufficiently protected.

All three groups responded positively (overall mean: 3.83) for obtaining permission of the copyright owner to show a part of the musical to the public. The degree of positivity reflects the difference in interests between the groups. Authors or creative artists are of course on the receiving end of the copyright royalties whereas producers pay. These royalties form part of the production costs and producers may want to economize on them. Creative artists gave the highest positive response (4.09) followed by performing artists (3.75) and producers (3.67).

The Duncan test showed a clear difference between authors/creators and producers.

All three groups seemed to think that the quality of musical performances has increased (creative artists: 4.26; performing artists: 4.06; producers: 4.06) due to strengthened copyright laws in general. However, there was a distinct difference between the two artist groups and the producers in regard to the economic remuneration in the musical industry. Artists agreed that it is not satisfactory (creative artists: 2.16; performing artists: 2.06) but the producers disagreed slightly (3.06). All in all, the outlook on the reality or the environment of copyright in the musical industry in Korea by producers was slightly negative (2.82) while the outlook of the artist groups was more positive (creative artists: 3.47; performing artists: 3.41).

Table 11: The ANOVA Result

							Duncan test**	
Question		N	Mean	S.D.	F	Sig.	**1**	**2**
Awareness	**CA***	74	2.8	0.979		0.000	2.8	
I am aware of the copyright issues concerning musicals	**PA**	32	2.75	0.95	18.307		2.75	
	PR	104	3.58	0.932				3.58
	OA	210	3.18	1.027			p=.794	p=1.00
Protection	**CA**	74	1.85	0.696		0.022	1.85	1.85
Copyright in musicals is well protected in Korea	**PA**	32	1.75	0.916	3.871		1.75	
	PR	104	2.12	0.804				2.12
	OA	210	1.97	0.797			p=.499	p=.079
Education	**CA**	74	4.57	0.664		0.83	4.57	
I feel the need for education on copyrights	**PA**	32	4.59	0.56	0.187		4.59	
	PR	104	4.53	0.539			4.53	
	OA	210	4.55	0.587			p=.590	
Public showing	**CA**	74	4.09	0.797		0.01		4.09
We must get permission from the copyright owner in order to perform part of a musical or gala concert before the public	**PA**	32	3.75	1.016	4.692		3.75	3.75
	PR	104	3.67	0.97			3.67	
	OA	210	3.83	0.936			p=.661	p=.051
Lawsuits	**CA**	74	3.74	0.952		-	-	
I would file a lawsuit if my own copyrighted work is performed without my permission	**PA**	32	3.78	1.008	-		-	
	PR	104	4.13	0.772				-
	OA	210	3.94	0.892			-	-
The effect of copyright protection	**CA**	74	4.26	0.994		0.383	4.26	
More musicals have been produced and their quality has improved since copyright has been better protected	**PA**	32	4.06	0.982	0.964		4.06	
	PR	104	4.06	0.984			4.06	
	OA	210	4.13	0.987			p=.322	
Compensation	**CA**	74	2.16	0.703		0.00	2.16	
I am satisfied with the economic compensation received for musicals in which I participate	**PA**	32	2.06	0.564	46.051		2.06	
	PR	104	3.06	0.735				3.06
	OA	210	2.59	0.838			p=.456	P=1.00
Environment for copyright	**CA**	74	3.47	0.996		0.00		3.47
All in all, the reality of copyright in musicals in Korea is positive	**PA**	32	3.41	0.979	11.501			3.41
	PR	104	2.82	0.932			2.82	
	OA	210	3.15	1.01			p=1.00	p=.716

Note: * CA: Creative artists; PA: Performing artists; PR: Producers; OA: Overall.
** p is the significance probability.

4.3. The ANCOVA Result

Among the respondents, some had attended lectures or education programs on copyright but some had had no formal exposure to such programs. This difference in exposure to this information may have influenced their awareness on copyright. Also, the difference in gender, age and level of education may have had an effect.[48] Therefore, we used an analysis of covariance (ANCOVA) to check for differences among the groups even after controlling for these four covariates. In order to apply ANCOVA to a dataset, the homogeneity of regression or homogeneous regression coefficients need to be met. We tested the interaction effect between covariates and the independent variables to verify the homogeneity. The result of the analysis of covariance of only the questions which survived this test is shown in Table 12.

Table 12: The Result of the ANCOVA Test of "Between-Subject Effects"

Covariate	Dependent Variable	Type III Sum of Squares	d.f.	Mean Square	F	Sig.	Partial eta^2	Observed Power
Exposure to education on copyrights	awareness	17.000	2	8.500	10.936	0.000	0.096	1.000
	protection	1.960	2	0.980	1.741	0.178	0.017	0.363
	effect of copyright protection	0.573	2	0.286	0.299	0.742	0.003	0.097
Gender	awareness	31.027	2	15.513	17.944	0.000	0.148	1.000
Age	awareness	32.513	2	16.256	18.624	0.000	0.153	1.000

We tried to see if the covariates had any significant effect on the dependent variables through the test of "between-subject effects". In the case of "exposure to education on copyrights" as the covariate, the question on awareness (I am aware of the copyright issues concerning musicals), the question on protection (copyright in musicals is well protected in Korea), and the question on the effect of copyright protection (more musicals have been produced and their quality has improved since copyrights have been better protected) satisfied the assumptions. In the case of protection, the difference between the three groups turned out to be insignificant with the value of F being 1.741 and the significance probability, p being 0.178. Its explanatory power was low (partial =0.017) and the value of observed power was also low (0.363). Thus, after taking into account the fact that some of the respondents had been exposed to education on copyrights, there was no difference between the three groups on their views on copyright protection in Korea. However, analyses for the other two headings, namely awareness and the effect of copyright protection, gave the same result as the ANOVA.

Next, taking gender and age as covariates, only the question on awareness (I am aware of the copyright issues concerning musicals) satisfied the assumption and supported the result of ANOVA. When we controlled for gender, the value of F was 17.994 and the value of p was 0.000. When we controlled for age, the value of F was 16.256 and the value of p was 0.000. This meant that gender and age had no affect on the different responses in the three groups. Finally, the question on the level of education as a covariate did not pass the homogeneity of regression test.

48 About 36 per cent of producers and 22 per cent of performing artists had reeived training on copyrights while this applied to only 7 per cent of creative artists. The proportion of males was 63.5 per cent, 78.1 per cent and 45.9 per cent for producers, performing artists and creative artists respectively. Age distribution and years of education are shown in Table 5.

5. Policy Implications for Copyright in the Musical Industry

5.1. The Practice of using Copyrighted Work without Permission

In this last section, we derived policy implications and highlighted stylized facts by analyzing the survey results reported in the preceding sections. Most of the artists and producers have used copyrighted work in their own productions without the permission of the copyright owner. About two-fifths of artists have used at least one creative work in a re-performance without permission while almost one-fifth of the producer group had used copyrighted work without permission in a performance, in a transformation of the original work and in a re-performance. Both artists and producers regard the main reason for the infringement to be a lack of understanding of copyright and the desire to reduce costs. However, if their own work had been plagiarized, they said they would resort to legal procedures. The proportions of respondents who had made no unauthorized use of copyrighted work were 16 per cent of producers and 5 per cent of artists.

From this result we can infer that the artists and producers in the Korean musical industry are still at a stage of being inclined to use other people's copyrighted work without paying royalties while also wanting to defend their own copyright. We did not specifically ask if the penalty for infringement is too light but more severe penalties may be necessary to deter them from casually infringing copyright; if the expected cost of infringing were higher than the projected saving on production costs, then producers would not pirate copyrighted work.

Another factor to consider is the governance structure of the planning and management companies which produce musicals. If the producers are employed by a company as simple salary earners, then they have no reason not to withhold royalties for a copyrighted work they plan to use in their production because the royalties will be paid by the company and could be deductible for tax purposes. However, if the company's accounting system is opaque and there is an owner-manager of the company who would take any profits for his own use, producers working for such a company would be pressured to reduce costs on even such a legitimate expense. Thus, more transparent accounting practices and improvements in the governance structure of the planning and management firms in the entertainment industry may be necessary.

5.2. Experience of Signing Contracts

One way to guarantee receipt of royalties is by signing a contract. The majority of artists and almost all producers have experienced signing a contract specifying payment for copyright but had difficulty in calculating the royalties and in deciding whether to transfer the ownership of the copyright at the time of the initial contract. Almost no producers and one-seventh of artists had difficulty in understanding the copyright contracts.

While the artists were more concerned with royalties, producers were concerned not only with royalties but also the transfer of copyright and duration of the contract. More producers tended to sign longer-term contracts than artists. For slightly fewer than half of the artists, demand from producers was the main reason for signing such a contract, with fewer than one-third of artists choosing to do this of their own accord. In contrast, 50 per cent of producers have signed such a contract of their own accord and about one-third have done so because of demands made by producers or a company.

We can infer that producers have more experience in signing contracts and so they have a better understanding of copyright. A more secure working environment for artists should be systematically provided so that they are not forced to sign a contract against their wishes. They

should be able to make demands relating to copyright on their work without fear of unfavorable treatment by producers in the future. Educational programs on copyright should be geared more toward artists than producers, and education for the consulting organizations who draw up contracts for both artists and producers must also be provided if they cannot afford to consult their own lawyers.

5.3. Legal Disputes

Very few artists have experienced legal disputes either because of complicated legal procedures, or the fact that the matter had not arisen. They also felt they had no legal recourse for fear of discrimination in future work, or they had resolved problems through negotiation. In contrast, three times as many producers (one-sixth of all producers) have been involved in legal disputes. However, we should note that those who reported that they chose not to pursue litigation for fear of disadvantageous treatment in the future comprised about 20 per cent of artists but only 1 per cent of producers. Thus there seems to be a need for systematic protection for artists who may face retaliatory action by producers if they demand higher remuneration or file a lawsuit for infringement of their copyright.

5.4. Level of Awareness of Copyright

We collected three sets of survey questionnaires from creative artists, performing artists and producers who have worked on the production of musicals to assess their level of awareness of copyright and the change in the attitude toward copyright in the musical industry. We surveyed them on a 5-point scale of the Likert measures and the variances of their responses were analyzed with one-way ANOVA and ANCOVA.

We found little difference between the performing and creative artists in lack of awareness of copyright issues but the difference between the artist group and the producer group was significant. Even when we tested ANCOVA using exposure to education on copyright as a covariate, the difference in response by the groups on awareness (I am aware of the copyright issues concerning musicals) supported the ANOVA result. We may therefore presume that producers are better informed about copyright through their experience in production.

All three groups responded positively on obtaining permission from the copyright owner to show a part of a musical in public. For this, creative artists gave the most positive response followed by performing artists and producers. For producers, slightly fewer than half regarded an enhanced level of awareness to be a crucial factor for a copyright-honoring environment compared with only one-quarter of artists. Producers appeared to be more aware of the importance of an enhanced level of awareness. The strongest result from the ANOVA test was for the need for more education about copyright. Its overall average was 4.55 and there was no statistically significant difference between the groups. Therefore more education on copyright seems to be required.

5.5. Granting Copyright to Fields of Specialization

Recently certain performing artists in Korea have demanded that their work be covered by copyright in addition to related rights. We asked the artists and producers in which fields copyright that should be granted from among 14 relevant fields in the production of a musical, regardless of their current status of copyright. The original story, composition of the music, the lyrics and stage script were undisputedly ranked top by both creative artists and producers as deserving of high copyright royalties.

However, there was a wide difference between the two groups in ranking production and direction. Direction was ranked 11th and production 13th by the artist group while production was ranked 6th and direction 7th by the producers. The lowest ranking field for both groups was sound design and they were also disinclined to grant copyright to performers. However, the majority in both groups indicated that directors and producers should benefit from copyright.

5.6. Licensed Musicals

About one-third of respondents refused to answer the questions related to contracts and almost all the producers considered that the license fee was too high. More than half of those who answered that they had produced original Korean musicals instead of licensed musicals said that the reason was to avoid the very high license fees. In Korea in 2007, 58.0 per cent of musicals staged were Korean copyrighted works and only 26.3 per cent were licensed musicals. We may, therefore, conclude that in recent years there appears to have been a shift towards creating original works rather than importing licensed musicals. The ANOVA result showed that all three groups considered that the quality of musical performances had increased (creative artists: 4.26; performing artists: 4.06; producers: 4.06) due to strengthened copyright protection.

5.7. The Importance of Copyright

More than half of the artists and producers thought that the expected increase in royalty income was a crucial factor in regarding copyright as more important in recent years. However, even though copyright is important, few artists and producers indicated that the strengthening of the Copyright Act was important. They felt that there was not much difference between present and past levels of copyright protection.

The overall response to the protection of copyright in the musical industry was negative. More artists than producers considered that copyright in the industry is inadequately protected. We may surmise that since the performers are only covered by related rights whereas the producers constantly deal with the economic rights of copyrighted material, the latter are better informed about the current situation and are familiar with using the Copyright Act in their own interests. Since performing artists may be dissatisfied with being covered only by related rights, they may actually feel their rights are not protected well enough. The ANOVA result shows that the outlook on the reality of the situation in the Korean musical industry by producers is negative while the two artist groups were slightly more optimistic.

6. Conclusions

We would have liked to juxtapose the years in which the copyright law was significantly amended with the changes in attitude of artists and producers in the musical industry and in terms of the changes in musical industry statistics to pinpoint the impact of the changes in the law. However, no significant time series data on the industry were available. Even if we had the data, since the Copyright Act has been amended almost every year since 1986, totaling 15 amendments, the impact of one specific amendment could be detected with difficulty by a juxtaposition of the changes that have taken place.

The changes in attitude toward copyrighted work by producers were not as easily observable as the plagiarism and piracy in other cultural industries in which copyrights were concerned with tangible media.[49] Therefore, a survey of the artists and producers was necessary to discover their levels of awareness of certain copyright issues.

We observed that the overall impact of the Copyright Act on the growth of the Korean musical industry seems to have been positive, i.e. the replacement effect or, in economic jargon, import substitution of licensed musicals by domestic creations has been taking place and has resulted in enhanced quality and an increase in the production of home-grown musicals. When we divided the respondents into two age groups, by the age of 50, the younger generation appeared to be more inclined to abide by the law. This difference may be a result of enhanced exposure to and education on copyright in the formative years of the younger generation since 1987. We can infer that the law must have had a positive impact at least on the younger generation working in industries such as the musical industry. However, the overall outlook on the reality or the environment for copyright protection was only slightly positive.

Copyright protection in the musical industry especially for the artist group was considered unsatisfactory; they required a more secure working environment to enable them to enforce copyright on their work without fear of unfavorable treatment by producers in the future. We need to change the awareness of and the knowledge on copyright by providing more education, especially for artists. Many of the artists surveyed felt that there should be a consulting organization to draw up contracts.

There were some limitations in this research: the survey questionnaires to investigate attitudes toward copyright in musical productions were sent out to artists and producers using an online survey method through e-mails. In February 2009, out of a total of 312 e-mails, we obtained responses from 106 artists and 104 producers. The results of our research have been obtained from a survey of some 210 artists and producers in the musical industry. The sample size of 210 out of an estimated 4,000 artists and 2,000 producers in the musical industry is sufficiently large, although we have to keep in mind that the result is based on a survey not on hard statistics from direct data. Our attempt to discover the impact of copyright on the growth of the musical industry was thwarted by the limitations of the statistical data. For more meaningful empirical research, systematic data collection is essential. More effort is also required to make available to researchers the statistics in the industries involved in copyright, including the musical industry.

49 The number of illegal dealings in plagiarized products is available in only certain fields such as music, cinematography and publications. The statistics show that offline seizures have been declining due to the shift to online infringement. Offline, the number of seizures was 9,044 with 893,499 items in 2002, reducing to 1,118 seizures concerning 149,276 items by 2006. In 2006, the number of online seizures was 34,744 concerning 5,899,424 items. The data were provided by the Copyright Protection Center, Reference Data in Copyright, (2006).

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Korea Reprographic and Transmission Association, *www.copycle.or.kr*

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Chapter 8

Intellectual Property Promotion Policies and Their Impact in Korea

NOWOOK PARK

ABSTRACT
This paper examines the impact of IP promotion policies and their implications for Korea. First, it provides a description of IP promotion policies in Korea; their creation and utilization. Creation can be divided into two categories: provision of information and consulting services, plus operation of educational programs and competitive events. Policies aimed at utilization cover, building infrastructure for IP transactions and subsidizing the early stages of utilization, i.e. estimating the value of existing intellectual property and making a mock-up product. Second, it examines the impact of IP promotion on creation and utilization of intellectual property. Although conclusive evidence was impossible to find due to lack of data, the following suggestive evidence: (1) while the provision of information and consulting services have a positive impact on IP creation, developing relevant and customized services is a prerequisite for success; (2) educational programs and competitive events for young people can arouse interest in intellectual property and affect career choices; (3) while subsidizing the early stages of the IP utilization process helps small business, individuals and public institutions, streamlining the subsidizing process is necessary to maximize benefits. Since promotion policies in Korea focus on low-income groups with little access to information, they could provide relevant policy implications for developing countries.

1. Introduction

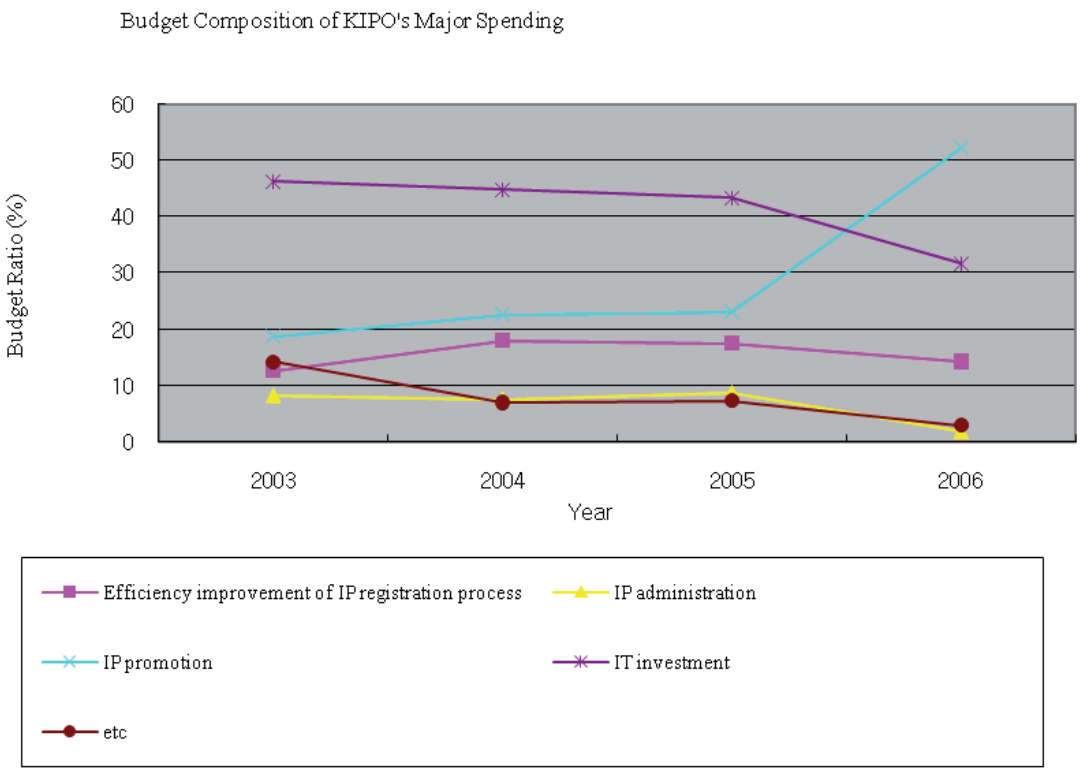
Korea, with few natural resources, has not only been a model example of economic growth but also of innovation. Up to the 1990s, the country was a byword for rapid economic growth based on mass production with the advantage of a pool of cheap labor; now it is known for innovative high technology products. For example, Korea is in the forefront of technology in shipbuilding, IT, biotechnology, etc.

It is no coincidence that Korea's transformation from a low-technology to a high-technology economy occurred against the background of the dramatic growth in intellectual property. According to WIPO, Korea ranked third in terms of patent applications filed in 2004. The growth rate in patent filing by residents shows that Korea ranked third through increasing local patent filing by 76 per cent between 1995 and 2004 and ranked top in terms of resident patent filings per GDP. These figures suggest that Korea is one of the most active countries in creating intellectual property. While there are many possible contributory factors for this dramatic increase, this paper will focus on the promotion policies adopted by KIPO.

KIPO has been using its efforts not only to render the administrative process of patent filing and registration efficient, but also to promote the creation, utilization and protection of intellectual

property. As the economy has grown, KIPO's budget has changed, with higher spending on promoting IP policies (from 18.7 per cent of major program spending in 2003 to 52.2 per cent in 2006 (see Figure 1)). This shift suggests that, as Korea achieves a remarkable level of administrative efficiency of patent filing and registration, KIPO focuses more on IP promotion.

Figure 1: Growth of KIPO's Spending on its IP Promotion Policy



This paper will endeavor to look in detail at IP promotion and its impact on the creation and utilization of intellectual property; KIPO has implemented various policies to this end. For the purpose of creating intellectual property, it has established a research institute, operates local support centers to provide information and consulting services, supports educational programs on invention and hosts competitions for inventors. In order to facilitate the utilization of existing intellectual property, it has built an infrastructure for IP transactions and provides help to individuals, small and medium-sized enterprises (SMEs) and public institutions by evaluating the value of their intellectual property and offering subsidies.

From the viewpoint of developing countries, IP protection may not bring in many benefits if they cannot create and utilize their own intellectual property. As some existing research suggests, strengthening protection of intellectual property tends to benefit developed countries although the benefit to developing countries is uncertain. The main cause for this asymmetry may lie in the fact that developing countries do not have their own intellectual property to protect. Of course, in the long run, IP protection may provide a favorable environment for innovation by providing incentives to invent. However, in the short term, there is little to protect. In order to reap the benefit of IP protection, developing countries need to find ways to promote the creation and utilization of intellectual property. This paper will examine from this perspective what type of promotion policies have been adopted and implemented in Korea and what has been their effect on the creation and utilization of intellectual property.

This paper, which also provides an evaluation of an IP promotion policy and its implications in Korea, is in three parts. First, it provides a description of the policies; in particular, goals, targets and contents. Promotion policy covers two areas: creation and utilization of intellectual property. Polices geared to creation can be divided into two categories: provision of information and consulting services, and operation of educational programs and competitive events. Policies aimed at utilization consist of two facets: building infrastructure for IP transactions and subsidizing the early stages of the utilization process, i.e. estimating the value of existing intellectual property and making a mock-up product.

Second, it examines the impact of promotion policies on the creation and utilization of intellectual property. It investigates whether these policies have achieved their intended goals: (1) whether the provision of information and consulting services increased IP creation, (2) whether educational programs and competitive events motivated participants to engage in the creation of intellectual property; (3) whether facilitating IP's value estimation process and mock-up product making process helps individuals, SMEs and public institutions to utilize their intellectual property.

Third, policy implications will be discussed. Since promotion policies in Korea focus on groups with less access to finance and information, they may prove relevant for developing countries. Based upon empirical evidence and surveys, effective means of policy design and implementation are also discussed.

2. Description of IP Promotion Policies in Korea

In this section, a brief description of policies aimed at the direct promotion of intellectual property implemented by KIPO will be given: after the overview, a detailed description of specific policies will be given. Three policies have been chosen for evaluation based on the data available and budget size; operation of regional IP centers designed for consulting services; operation of invention class and subsidizing the certification process of existing IP value. Evaluation will be focused on the examination of the program's intended outcome regarding changes among program participants and responses of program participants on the relevance of program design and implementation.

KIPO's policies for IP promotion are aimed at two areas: creation and utilization of existing intellectual property. Although IP protection policies can be viewed as an indirect way of promoting intellectual property, this paper will focus only on the direct issues. Since KIPO is a public agency, its policy targets are mostly centered on SMEs, individuals and public institutions. In order to facilitate IP creation among its program participants, KIPO provides information/consulting services, educational programs and competitions. For the purpose of facilitating the use of existing intellectual property, KIPO has also built an infrastructure for IP transactions and subsidizes the early stage of the utilization process, such as evaluating the value of existing intellectual property and making a mock-up product.

To provide IP-related information and consulting services, KIPO has established a research institute and regional centers: it provides funding to the Korea Institute of Intellectual Property which focuses on IP research and subsidized the operation of 31 regional IP centers offering consulting services to local individuals, SMEs and public institutions in 2006. Since this study will focus on examining the effects of the latter program, a detailed description will be given below.

The consulting services provided by the centers include on-site assistance for the development and use of intellectual property among local SMEs and research services on patents pertinent to

local conditions. One of its main goals is to provide information and technical assistance for SMEs and individuals to promote IP creation locally, while the number of patent applications from Seoul and its surrounding area accounted for more than 70 per cent in the late 1990s and early 2000s. The provision of IP-related information and consulting services in the local areas was spotty before the regional IP centers were expanded and received more resources: the budget for the regional centers increased from 811,200 Korean won in 2003 to 5,235,538 Korean won in 2006 and the number of employees working in the centers increased from 22 in 2003 to 78 in 2006. Since 2004, increased spending on the program has followed an upward trend and the title of the regional centers changed from ”local support center for patent information” to “the regional IP center”.

To educate students on invention-related activities, KIPO offers subsidies to schools running “invention classes”. Table 1 shows the number of new invention classes year-on-year, with a total of 182 in 2006. At the end of 2005, elementary schools were running 58.9 per cent; 24 per cent were run in middle schools; 7 per cent in high schools and the remaining 10.1 per cent in other locations. These figures show invention classes to be more focused on the early stages of the learning process.

Class content varies and depending on the length and content, it can be taught as a one-day course, an introductory course, an advanced course, a class for talented students, for business, etc. The average number of participants per class was 2,862, of which 87.4 per cent were students, 8.4 per cent were parents and the remaining 4.2 per cent were teachers. In 2005, the total number of participants increased to 395,158 from 271,613 in 2002. The participation ratio among students increased from 3.5 per cent in 2002 to 5.0 per cent in 2005.

Table 1 Number of New “Invention Classes”

Year	95	96	97	98	99	00	01	02	03	04	05	06	Total
Number	1	3	38	3	18	16	16	16	15	16	16	24	182

Source: KIPO.

To facilitate the use of existing intellectual property among SMEs, individuals and public institutions, KIPO builds the infrastructure for IP transactions and provides subsidies for IP value assessment and mock-up product manufacturing. Since the aim of this paper is to examine the impact of the IP value assessment program, a detailed description will follow.

The goal of the program is to help SMEs, individuals and public institutions which lack financial and marketing capability to utilize their existing intellectual property by subsidizing a part of the IP value assessment fee. The logic behind this is that once the value of intellectual property has been assessed and certified by accredited institutions, then, based on its assessed value, the owner can borrow from an institution to start his own business or sell rights to potential buyers. To achieve this, there need to be institutions to evaluate existing intellectual property and KIPO is attempting to train qualified evaluators and develop centers by designating certain institutions and providing training programs; as of 2006, 41 institutions have been designated as official evaluation institutions. In 2002, a subsidy of 730 million Korean won was allocated to evaluate 57 cases and in 2005, a subsidy of 1,682 million Korean won was paid to evaluate 169 cases.

Table 2: Trend of Subsidized IP-Value Assessment

Year	2001	2002	2003	2004	2005
No of Cases	50	57	76	127	169
Subsidy (million Korean won)	491	730	1,074	1,583	1,682

Source: KIPO.

3. Empirics

3.1. Empirical Strategy

This paper tries to empirically examine the impact of the three programs: regional IP centers, invention classes and IP value assessment programs. While the first two have been designed to facilitate creation of IP among SMEs, individuals, public institutions and students, the value assessment program is aimed at stimulating the use and transaction of existing intellectual property among policy target groups. To evaluate their impact, data analysis between beneficiary and comparison groups should be utilized. Since these programs all have specific policy target groups and identifiable program participants, our empirical strategy should be in examining the differences between participants and non-participants. To exclude the issue of endogeneity or selection bias, it was considered preferable to create a randomized control group. However, since all three programs have been implemented without setting up a properly designed program evaluation, we did not have a randomized control group for comparison purposes.

As an alternative, we needed to control for other factors that may influence the program outcomes by utilizing detailed data on the characteristics of participants and non-participants. Due to data limitations, even this alternative cannot be readily employed. In particular, we did not have individual level data on non-participants; available data consists of survey data on participants and aggregate data on the general public. Not only the problem of data availability may present a challenge in providing conclusive evidence but also the nature of the program. The ultimate outcome for the programs intended to facilitate IP creation is the additional number of IP applications and registrations created through the programs. In our context, KIPO implements consulting and educational programs for the purpose. The increased IP creating activities due to these programs will be realized over time, demonstrating that there will be a time lag between program implementation and impact. If progress in the performance of participants over time is not followed up, it will be virtually impossible to examine the ultimate impact of the program. In view of this difficulty, we may settle for using intermediate or short-term outcome measures for the evaluation. Keeping these limitations in mind, the empirical methodology adopted for each program evaluation is discussed below.

The intended outcome of the regional IP center program is to increase IP creation activities in local areas. And, to assess the impact, we need to see whether IP applications or registrations increased through the services provided by the regional IP center. However, since the impact on IP creation will take time and other factors may play a significant role in affecting the final outcome, it will be hard to identify the program's impact unless very detailed data on the confounding factors is collected over a long period. The history of regional IP centers is relatively short and data on the confounding factors at the local level is unavailable. It means that we will be unable to identify the program impact based on the final outcome, which is an increase in localized IP creation activities.

Given these limitations, the following specification will be estimated by utilizing short-term outcome measures and available data on the regional IP centers. Short-term outcome measures consist of the number of services provided to local residents by each center as well as user satisfaction.

Some may view these measures as output rather than outcome, particularly the number of services provided by the center. They can be seen to indicate that the services are useful because, as they are voluntary, requests from the public will increase if this is the case. In addition, customer satisfaction may represent hard data but it will indicate customer opinion on the services provided. With the following equation, we examine whether spending has a correlation with short-term outcomes at each regional center after controlling for other factors. This may affect the performance of the centers, and not only available variables but also fixed effect estimates will be utilized, since we have a data set on local IP centers covering three years. The fixed effect model will control for the characteristics which are invariable over time (three years), such as regional characteristics and responsibility for the operation of the center. Other control variables included each center's operation period and year-on-year effect.

$$Y_{it} = \delta_i + \eta_t + \alpha \bullet Budget_{it} + \beta \bullet \mathrm{C}_{it} + \varepsilon_{it}$$

where i refers to each regional center; t refers to each year; is a dependent variable, such as the number of services provided or customer satisfaction; is a vector of budget size; is a vector of other control variables, such as the number of years each regional center operated up to the survey year and previous year's budget size; refer to fixed characteristics of each regional center which do not vary over time; are year dummies to capture the yearly macro-shocks that affect every region; are disturbance terms.

A survey conducted on the participants in the invention class program will be used. Since the general public and non-participants have not been surveyed, there will be few comparisons for an analysis of the results. Additional difficulties were involved in evaluating an educational program such as invention classes: the results only tending to appear after a long time lapse. Therefore, without follow-up data, identifying outcome is impossible. The history of invention classes is too short to track down the intended outcome of the program and KIPO does not have a follow-up system on the progress of the participants. With these limitations, participant response to the question as to (1) whether they are involved in invention activities and have applied for IP protection and (2) whether invention classes are likely to affect their decision to pursue scientific careers will be presented as suggestive evidence of the program's impact.

To evaluate the impact of the IP value assessment program without complication by endogeneity and selection bias problems, a randomized control experiment design is also needed. However, as in the case of the regional IP centers and invention class programs, we do not have a randomized control group and detailed data on the characteristics of firms, individuals and public institutions. Moreover, since the program goal is to facilitate the utilization of existing intellectual property, arguably, the only feasible way of identifying the actual utilization of existing intellectual property among IP holders is to conduct a survey. With a systematic and periodic survey, it would be almost impossible to measure the program impact. For program evaluation, the survey should be conducted on non-participants as well as participants. Unfortunately, we do not have comparable surveys on both groups in that the same questions were not posed to both groups and there is no clear separation of program participants in the survey. As a result, we can compare the extent of the use of intellectual property between program participants and general IP holders which may also include program participants.

3.2. Data

For the analysis of the regional IP center program, administrative data from each center provided the following information: the number of services provided, budget, the establishment date, location, organization administration and number of employees. In addition, KIPO's survey conducted in 2005 and 2006 on the service users of the center gave us information on user satisfaction levels. To examine the general trend of IP applications and registrations in each region, Patent Trends in Korea published by KIPO has been utilized.

To examine the impact of the invention class, the program participant survey conducted in 2006 by the Korea Institute of Public Finance with the help of KIPO, where respondents consisted of 128 invention class teachers and 134 students, has been analyzed. Since the survey was conducted on site, the response rate was almost 100 per cent. For the overview of the general trend of IP applications among students, Patent Trends in Korea was also used.

Lastly, in order to examine the IP value assessment program's impact on the utilization of existing intellectual property, survey data on rights holders and program beneficiaries was utilized. The former was done in 2002, 2004 and 2005 by telephone interview on 1,000 people, and the latter was done annually between 2002 and 2005. The former provided information on the use of intellectual property among rights holders and the latter among program beneficiaries.

3.3. Results

Table 3 presents summary statistics on the data that will be used to assess the impact of spending on the regional IP centers. The satisfaction level, one of our dependent variables, is the number converted from the 5 to 100 point scale; data on levels of satisfaction is available for 2005 and 2006 rising from 76 points in 2005 to 80.2 points in 2006. The minimum score did vary, passing from 67.8 to 69.2. However, the maximum score was very much higher, moving from 81.9 to 90.4. These high scores came from newly established centers in 2006 and indicate that there may have been a large untapped regional demand and local users were more likely to be satisfied with just having access to the center.

The average budget for the centers has increased every year, rising dramatically in 2006: 49 million Korean won in 2004;, 52 million Korean won in 2005; 168 million Korean won in 2006. The average number of services provided at each center increased between 2004 and 2005 from 3,720 to 5,838, but then slightly decreased to 5,475 in 2006 despite a big budget increase.

Table 4 shows the summary statistics by region. Because the standard deviation within each region is higher than between each region, it is difficult to argue that there has been any significant difference in the satisfaction level of users across the regions.

Table 3: Summary Statistics by Year

		2004			
Variables	No. of Obs.	Mean	SD	Min	Max
Satisfaction[1]	0	-	-	-	-
Service[2]	25	3719.84	3789.908	173	13799
Budget[3]	23	49.54348	35.38037	34	155
Age	25	3	1.5	0	4
		2005			
Variables	No. of Obs.	Mean	SD	Min	Max
Satisfaction[1]	25	76.008	3.351234	67.8	81.9
Service[2]	28	5837.714	7664.918	53	34963
Budget[3]	28	52.43496	60.67877	16	313.23
Age	28	3.571429	1.894017	0	5
		2006			
Variables	No. of Obs.	Mean	SD	Min	Max
Satisfaction[1]	29	80.22759	5.236746	69.2	90.4
Service[2]	30	5474.667	9375.664	105	50378
Budget[3]	31	168.8883	155.7322	38.87	677.23
Age	31	4.225806	2.092999	1	6

Note: 1. Satisfaction refers to the level of customer satisfaction measured by the survey; 2. Service refers to the number of services provided to customers; 3. Budget refers to the budget allocated to the regional center; 4. Age refers to the number of years the regional center has been operational.

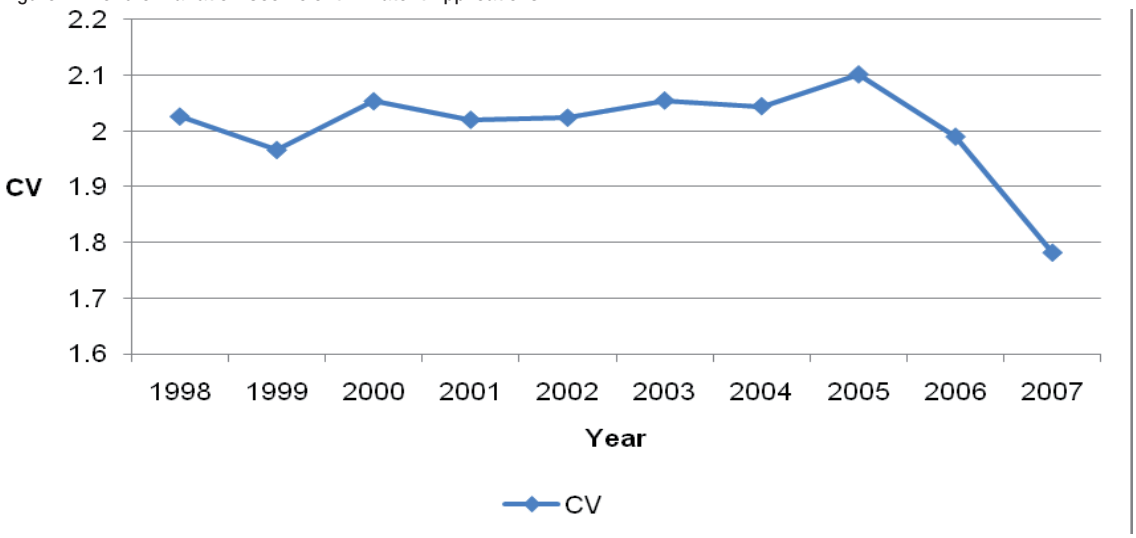
Table 4: Summary Statistics by Region

		Gangwon Area			
Variables	No. of Obs.	Mean	SD	Min	Max
Satisfaction[1]	7	79.4	6.452392	72.7	90.4
Service[2]	10	385202	2703.208	202	7983
Budget[3]	10	82.1011	73.8822	33	270.642
Age	10	3.4	1.712698	1	6
		Chungcheong Area			
Variables	No. of Obs.	Mean	SD	Min	Max
Satisfaction[1]	8	77.2625	4.099108	72.4	85.3
Service[2]	15	2284.933	2450.048	83	8099
Budget[3]	14	122.988	185.0568	16	677.23
Age	15	2.733333	2.120198	0	6
		Youngnam Area			
Variables	No. of Obs.	Mean	SD	Min	Max
Satisfaction[1]	19	77.95789	5.555509	67.8	87.7
Service[2]	28	7316.821	10938.85	300	50378
Budget[3]	28	89.10379	91.82749	32.5	313.23
Age	28	4.428571	1.425393	1	6
		Honam and Jeju Area			
Variables	No. of Obs.	Mean	SD	Min	Max
Satisfaction[1]	9	79.32222	4.655046	71.9	84.4
Service[2]	14	6901.071	7296.525	53	24361
Budget[3]	14	100.6546	106.6816	16	422.372
Age	14	4.357143	1.823232	0	6

Note: 1. Satisfaction refers to the level of customer satisfaction measured by the survey; 2. Service refers to the number of services provided to customers; 3. Budget refers to the budget allocated to the regional center; 4. Age refers to the number of year the regional center has been operational.

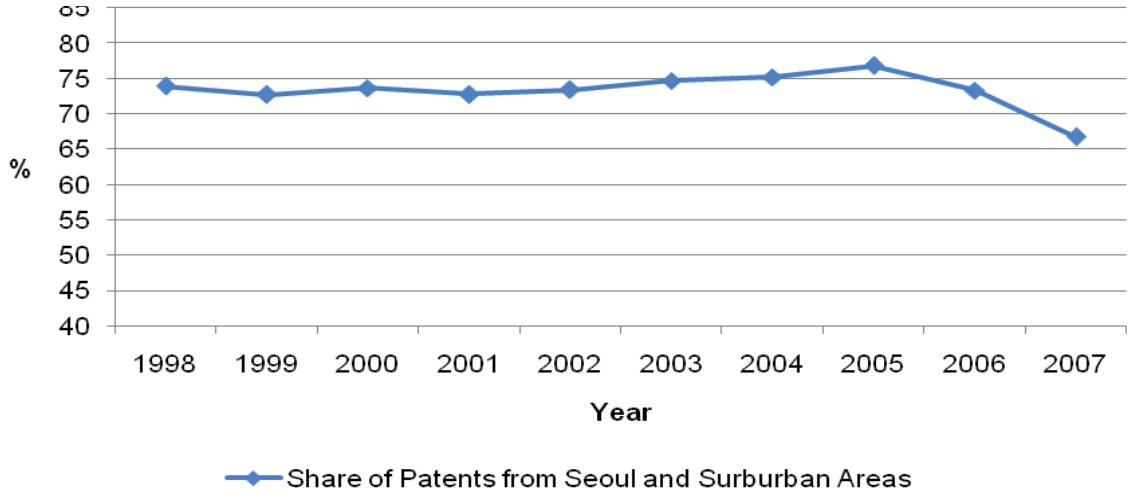
Before presenting the results of our estimation, we need to examine whether IP-related activities vary greatly across regions, because up to now Korea has relied on a Seoul-centered development pattern and, as a result, creation and use of intellectual property has been heavily concentrated on Seoul and its surrounding area. To cope with this problem, KIPO shifted the program's focus to activating more IP activity in the regions. Figure 2 shows the trend of dispersion in patent applications across regions suggesting that regional variations have been decreasing since 2006. In addition, Figure 3 shows that the share of patent applications in Seoul and the surrounding area started decreasing in 2006; it had been over 70 per cent between 1998 and 2006 but it dropped to 66.7 per cent in 2007. Since it may be related to population changes in the regions, the number of patent applications divided by the labor force has been used instead of the number of patent applications as shown in Figure 4. However, Figure 4 shows that the decline since 2006 still holds: of course, it remains to be seen whether this trend stabilizes over time. Figure 4 suggests that regional variations have been decreasing, although, with data limitations, we cannot prove whether that has partly been due to KIPO's efforts through the regional centers, although it does suggest that the situation KIPO is trying to address through setting up regional IP centers has recently been improving.

Figure 2: Trend of Variation Coefficient in Patent Applications



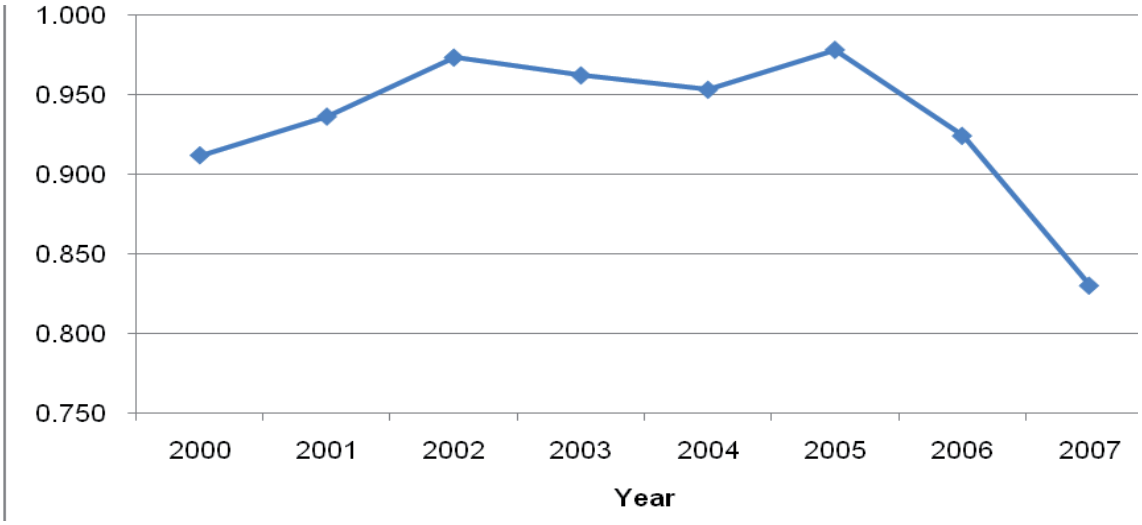
Note: Coefficient of variation = Standard deviation/mean.

Figure 3: Share of Patent Applications from Seoul and the Surrounding Area



Note: Seoul and the surrounding area covers Seoul and Gyounggi-Province.

Figure 4: Trend of Variation Coefficient in Patent Applications after Controlling for the Labor Force



Note: Coefficient of variation = Standard deviation/mean.

As discussed in the section on empirical strategy, dependent variables represent levels of satisfaction with service and the number of services provided at the center as a short-term outcome measure for the performance of the regional IP center. We estimate that fixed characteristics over time in each region are controlled by the fixed-effect estimation method; annual macro effects are controlled by year dummies, and the length of time each center has been operating has been included to control for the effect of accumulated institutional experience. We also wanted to see whether the amount of money spent affects the performance of the center, as well as user satisfaction levels and the number of services provided.

Table 5 examines variables that may affect levels of user satisfaction. Budgets for the current year are not significant as the operational period is the most significant factor in user satisfaction. However, if we include a one-year lagged budget in the explanatory variable, the lagged budget size and accumulated operation period become significant. The fact that the significance and size of institutional experience rises suggests the centers' performance is improving over time. On the other hand, although the effect of the size of the previous year's budget was less than significant, the effect was minimal: 1 million Korean won, reducing the satisfaction level by 0.055 points. Thus, it is safe to say that budget size is not an important factor in estimating user satisfaction.

Table 5: Impact of Budget Size on User Satisfaction

	I	II
Budget	-0.005 (-0.82)	-0.007 (-1.31)
Previous year's budget		**-0.055** **(-2.11)**
Operation period	1.827 (1.68)	**3.469** **-1.74**
2006 Year dummy	2.288 (1.29)	1.526 (0.79)
Constant	67.924 (15.97)	66.642 (14.96)
Fixed effect	Included	Included
No. of obs.	54	50
R2	0.831	0.845

Note: Numbers in parenthesis represent t-statistics.

Table 6 examines the impact of budget size on the number of services provided; which may signify both local demand and quality; quality of service may therefore create additional demand. Since using the services offered by local centers is not mandatory, it is likely that higher usage proves better service; the number of services provided may be complementary information to user satisfaction.

Our results show that variables are insignificant without using the previous year's budget figures. With an increase of 1 million Korean won in the previous year's budget, the number of services multiplied by 87. However, it is uncertain why the current year's budget does not affect the number of services offered.

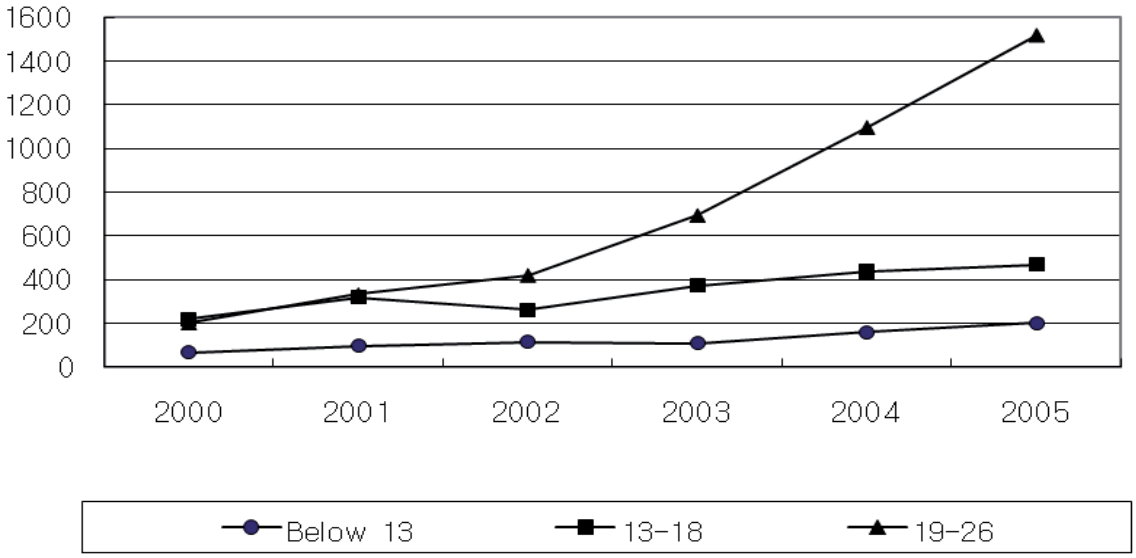
Table 6: Impact of Budget Size on the Number of Services Provided

	I	II
Budget	-0.972 (-0.14)	-1.083 (-0.21)
Previous year's budget		**87.028** **(3.71)**
Operation period	1946.559 (0.73)	**7292.974** **(4.04)**
2005 Year dummy	2006.471 (1.12)	
2006 Year dummy	1438.337 (0.47)	-7814.727 (-4.46)
Constant	435.003 (0.12)	-13593.95 (-3.37)
Fixed effect	Included	Included
No. of obs.	81	50
R^2	0.814	0.969

Note: Numbers in parenthesis represent t-statistics.

Now let us move to the invention class program. Figure 5 shows the trend of patent applications among students and as most school-aged children are in education in Korea, age is a good proxy for identifying students among patent applicants. This figure shows that since 2005, patent applications among college-aged students increased dramatically, while patent applications from other youth groups increased slightly. It is not easy to judge whether the current level of patent applications among students is appropriate, but Figure 5 suggests the trend has recently been upward.

Figure 5: Trend of Patent Applications among Students



The impact of invention classes in elementary and secondary schools can be varied and they may stimulate students' interest in invention, which could lead to patent applications while the student is studying or at a later date. It could affect students' career choices, leaning towards science or IP-related areas. As the expected impact of the program is diverse, the time-frame for its realization can also be diverse; it can be based on when students are in class, after moving from elementary to secondary school, when they go to college or when they start work. Therefore, it is extremely hard to pin down the effect of the invention class program without a good experimental design that is lacking in this case.

While acknowledging limitations, we have used the survey conducted on the program participants in 2006 to assess the program impact and have seen that the student participation ratio in the classes has been improving. Table 7 shows that the participation ratio increased from 3.5 per cent in 2002 to 5 per cent in 2005. Given the voluntary nature of participation, it suggests that interest in the program is rising.

Table 7: Participation in Invention Classes

	2002	2003	2004	2005
No. of invention class	113	128	142	158
No. of participating students	271,613	326,533	350,657	395,158
No. of participating parents	27,262	28,370	24,994	37,828
No. of participating teacher	8,944	9,655	10,162	19,167
Ratio of participating students	3.50%	4.20%	4.50%	5.00%

Note: Ratio of participating students = no. of participating students / total no of students in schools where invention classes are offered.

Based on the survey conducted on students and teachers, we examined responses on two key questions: (1) whether they were involved with invention and applied for IP protection and (2) whether the invention class was likely to affect their career decisions.

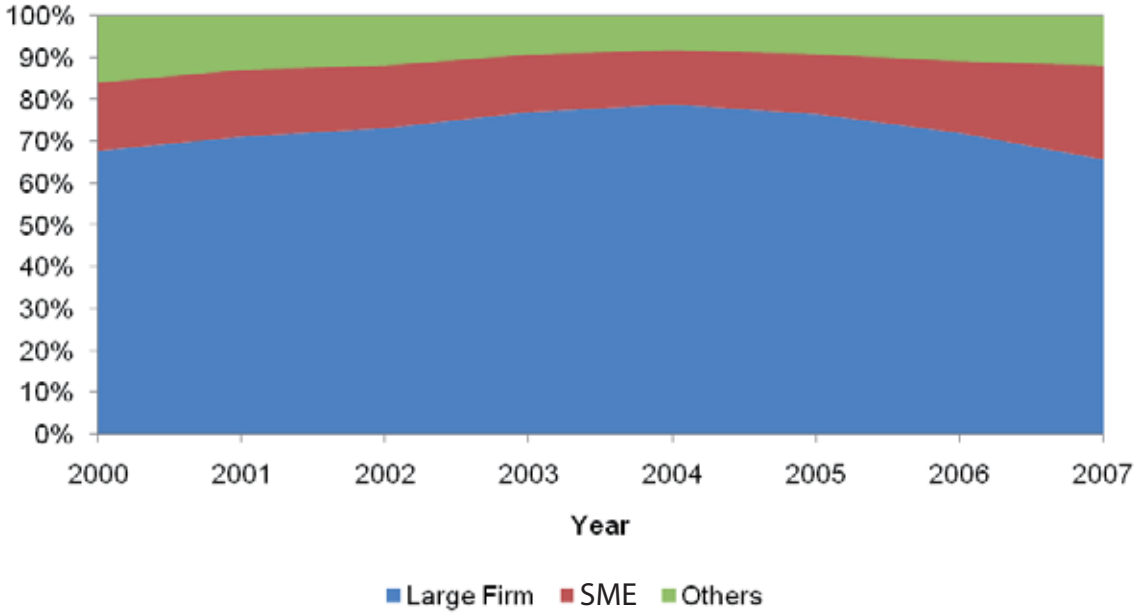
For the first question, 44 per cent of students replied that they invented something during or after participation in the program and 28.2 per cent said they had applied for IP protection. Fifty-five per cent of applicants for IP protection recorded that their applications were successful. Considering they were elementary or secondary school students, the numbers are impressive: 46.1 per cent of teachers replied that students or teachers applied for IP protection, with 45.8 per cent saying they had made fewer than five applications through invention classes and 23.7 per cent between five and 10. The average was 18.5 which can be considered quite high.

For the second question, 93.6 per cent of students replied that invention class programs influenced their career choice; 61.9 per cent replied they would like to pursue IP-related careers and 86.6 per cent said they would continue with IP creating activities; 83.1 per cent said they would be likely to apply for IP protection in the future. These responses suggest that program participants assessed their experience with the program very positively.

Obviously program participants were usually highly motivated and positive responses were expected. However, as long as the program participation ratio is improving and short-term outcomes based on the participants' responses are also positive, we may conclude that it is achieving its intended goal by stimulating IP-related activities.

Now we turn to the IP value assessment program and before examining its impact, let us briefly overview the trend of the share of IP applications from SMEs as background information. Figure 6 shows that throughout the period 2000-2005, the proportion of applications by them has been between 13 and 16 per cent, but in 2006 it increased to 17.2 per cent and in 2007 to 22.6 per cent. This was mainly due to a drop in IP applications in major firms such as Samsung and LG Electronics in both years. Therefore, it remains to be seen whether the SMEs' share will also increase in the future. Figure 6 shows that IP creation is dominated by large firms in Korea, particularly Samsung and the LG and Hyundai conglomerates. KIPO is, however, trying to promote IP creation and utilization among SMEs, individuals and public institutions.

Figure 6: Share of IP Application by Firm Size



The IP value assessment program is an effort to promote the use of existing IP among SMEs, individuals and public institutions. Its intended outcome is increased utilization of existing IP protection by providing a subsidized value assessment process. To examine the program's impact, we may need to compare the utilization ratio of intellectual property between participants and non-participants in the program, but we have only found surveys on participants and general IP holders and these do not contain detailed information on the characteristics of respondents and their IP requirements. These limitations have prohibited us from conducting program evaluations based on an experimental or quasi-experimental design.

Within these limitations, we have tried to examine the program's impact and Tables 8 and 9 are based on the surveys conducted on general IP holders. The surveys are from 2002, 2004 and 2005 and individuals and public institutions were included from 2004 and 2005 respectively. Table 8 shows to what extent patent holders use their patents for commercial purposes. Large firms increased their commercialization ratio over time from 21.9 per cent in 2002 to 50.5 per cent in 2005. For SMEs, there was an important decrease in 2004 and although it could result from an abnormality in the survey, the exact reason is unknown. Other than that, the ratio of SMEs was between 54 and 59 per cent. Ratios for individuals and public institutions were much lower than those for SMEs and large firms.

Table 9 presents the same information on utility models; in 2005 large firms increased their ratio to 68.6 per cent and SMEs also increased their ratio to 67.9 per cent, although the latter was lower than that of large firms for 2005. Ratios of individuals and public institutions were relatively low compared with SMEs and large firms but the gap is smaller when compared with patents.

Surveys carried out on general IP holders suggested that SMEs were more active in the commercialization of their intellectual property, even though the gap with large firms decreased. This was surprising because we expected large firms to be in a better position due to greater marketing capacity and financial resources. The reason why the utilization ratio of SMEs was higher could lie in the fact that large firms create and hold intellectual property not only for the purpose of immediate commercialization but also for strategic considerations; they wish to preempt competing technology and wait for the right time to enter the market. In contrast, as SMEs have less scope in managing their intellectual property, their immediate concerns would usually be how to commercialize it to their advantage. Therefore, we cannot draw definite conclusions purely based on the commercialization ratio. To make fair comparisons, we would need to exclude IPRs held for strategic concerns which are not observable to outsiders.

It would not be prudent to place much importance on the gap between large firms and SMEs and in fact in 2005, this gap was quite small. If we consider the strategic motivations of large firms in holding intellectual property and assume the equal capability of commercialization, the commercialization ratio for SMEs should be much higher. Thus to see the impact of the IP value assessment program, we needed to look at the gap between the commercialization ratio from the general survey and that from the survey conducted on the program beneficiaries. For reference, we included Table 10 to show more detailed survey results, as a detailed survey was conducted in 2005.

Table 8: Commercialization of Existing Patents

	2002	2004	2005
SMEs	59.20%	29.10%	54.50%
Large firm	21.90%	49.80%	50.50%
Individual	NA	26.00%	37.60%
Public institution	NA	NA	27%

Note: Commercialization refers to the activities using existing rights for business purposes, such as selling them to a buyer, borrowing money, starting own business, et

Table 9: Commercialization of Existing Utility Models

	2002	2004	2005
SMEs	59.70%	59.00%	67.90%
Large firm	27.90%	48.60%	68.60%
Individual	NA	46.30%	38.00%
Public institution	NA	NA	60%

Note: Commercialization refers to the activities using existing rights to business purposes, such as selling them to a buyer, borrowing money, starting a business, etc.

Table 10: Commercialization of Intellectual Property

	No. of IP Subjects		Commercialization Ratio of Registered IP (%)		Success Ratio of Registered IP (%)		Success Ratio of Commercialized IP (%)		Transfer Rate (%)		No. of Commercialize IP Subjects Subsidize by Government	
	Patents	Utility Models	Patents	Utility Models	Patents	Utility Models	Patents	Utility Models	Patents	Utility Models	Patents	Utility Models
Average	11.8	4.6	33.2	51.5	18.4	34	55.1	66	7.5	3.5	0.3	0.
Large firm	208.1	51.1	50.5	68.6	24.2	40.6	48	59.2	6.2	7.8	0.5	0.
SME	4.3	3.6	54	67.9	30.6	46.9	56.5	69.1	2.3	1.4		
Government unit	11.8	3.2	13.2	39.2	4.4	21.5	33.3	54.8	1.7	1.3	0.1	
Research institute	196.4	3.9	7.1	8.5	1.7	7	24.3	81.8	15.6	1.8	1.3	0.
Individual	3.7	3.5	37.6	38	30.2	26.3	79.9	69.4	3	2.8	0.1	0.
University	39.3	8.5	6.7	12.3	5.8	4.5	85.7	36.5	7.6	0	0.3	0.

Note: Results from the telephone survey conducted in 2005. Sample size was 1,000.

Table 11 presents the survey results conducted on IP value assessment program participants during 2002-2005. The commercialization ratio surveyed was little changed at between 75 per cent and 79.5 per cent, although compared with the ratio from the general survey, which was between 55 per cent and 69 per cent, it was quite high. However, it was not easy to determine whether the subsidized ratio was high enough to justify government spending. Roughly speaking, the gap between the ratio from general surveys and surveys on program beneficiaries fluctuated between 11 per cent and 25 per cent; making it impossible to draw any conclusions. In 2005, the gap between large firms and SMEs decreased to 4 per cent for patents and to -0.7 per cent for utility models,[50] suggesting that the commercialization ratio among SMEs when compared with large firms did not improve and could call into question the effectiveness of utilization of the IP promotion policies pursued by KIPO. We were unable to consider whether other factors were relevant and further research is warranted to pin down the effectiveness of these policies.

Table 11: Utilization of Intellectual Property: Benefits from the IP Value Assessment Program

	2002	2003	2004	2005	Total
Supported IP (No.)	**50**	**57**	**76**	**127**	**310**
Response Rate	**32 (64.0%)**	**39 (68.4%)**	**46 (60.5%)**	**58 (45.7%)**	**175 (56.5%)**
Commercialized ratio	**75%(24)**	**79.5%(31)**	**76.1%(35)**	**79.3%(46)**	**77.7%(136)**
IP transaction	0%	0%	21.7%(10)	13.8%(8)	10.2%(18)
Loan	9.4%(3)	7.7%(3)	4.3%(2)	10.3%(6)	8%(14)
IP certification	12.5%(4)	15.4%(6)	10.9%(5)	0%	8.6%(15)
Marketing	28.1%(9)	33.3%(13)	19.6%(9)	39.7%(23)	30.9%(54)
Others	25%(8)	23.1%(9)	19.6%(9)	15.5%(9)	20%(35)
Non-use	52%(8)	20.5%(8)	23.9%(11)	20.7%(12)	22.3%(39)

Note: Results from the telephone survey conducted in 2002-2005. Respondents were IPR holders who received subsidized IP value evaluations.

50 Here we assumed that the respondents would mostly be SMEs and they accounted for 80 per cent of the total.

4. Conclusions

We have described IP promotion policies implemented by KIPO and examined their impact. KIPO's promotional policy for implementation of IPRs can be broken down into three categories according to purpose: creation, utilization and protection of Intellectual property. Policies aimed at facilitating IP creation and utilization were more directly related to promotion, while those geared to protection were indirectly related. We focused on the policies designed for creation and utilization and also selected three programs for examination based on the data available: (1) operation of the regional IP centers for the purpose of providing information and consulting services;, (2) setting up invention classes for elementary and secondary school students; (3) the IP value assessment program, with KIPO providing matching grants and necessary support.

To examine the effect of the regional centers, we examined (1) the trend in Seoul and its surrounding area and (2) the relationship between budget size and user satisfaction levels for each center and between budget size and the number of services provided. Although we could not pin down the effect on the Seoul area, overall trends show the regional concentration of IP protection applications starting to change in 2006. However, this could be due to other factors and it remains to be seen whether the trend will be sustained over time. We could not find any significant relationship between budget size and user satisfaction levels although the previous year's budget size had increased the number of services provided in regional centers. To consider final results for the centers, we may need to examine their impact on the application and registration in each region with other confounding variables. However, this was not possible mainly because we did not have detailed data at the local level. Further studies are required to see whether the regional centers contributed to IP creation among local SMEs, individuals and public institutions.

To improve the performance of the regional centers, some recommendations were identified through the survey: users desired more specialized services from competent sources and a performance management system for the regional centers needs to be considered to introduce competition among them Budget size did not affect user satisfaction; efficient and relevant use of resources was required to improve the program's performance.

While it is hard to deny that there is local demand for information and consulting services in this field, the key question is whether the regional centers can provide a quality service to meet the demand. In fact, KIPO recognized that developing a good information system on existing IPRs and training personnel who can provide relevant consulting services are crucial for IP creation and utilization (KIPO, 2006). It suggests that there is ample room for improvement in the area of information and consulting services.

To assess the impact of the invention class program, we relied heavily on one survey, as no previous figures were available and no follow-up efforts were contained in the program. The overall trend for application and registration showed that college students became very active in IP activities during 2003-2005, while younger groups also gradually improved. According to the administrative data on invention schools, the number of participants is increasing by more than 5 per cent each year and the rate of participation is also increasing each year. The survey results show that most students said that the class influenced their career plans and they were actively involved in class activities. Intellectual property applications were filed by 28.2 per cent and 55 per cent of them were successfully registered. Considering that a majority of the participants were elementary and middle school students, these figures are impressive and the results suggest that involvement at an early stage of the learning process is very effective in promoting IP-related activities.

It is hard to measure the intended outcome of the IP value assessment program, which covered the use of existing IPRs among SMEs, individuals and public institutions. Since they usually lack the capacity to make best use of their IPRs compared with large firms, they may need assistance and KIPO provided this in the process of an IP value assessment. To examine the program's impact, we examined the commercialization ratio of IPRs among large firms and SMEs, and found that the level of commercialization among the latter was usually higher than for the former, which is not surprising due to the strategic use of IPRs in large firms. The key point is not the absolute level but the gap between large firms and SMEs and between SMEs assisted by the program and those not. We found suggestive evidence that the gap was not narrowing, which may suggest that KIPO's policies aimed at promoting utilization among SMEs are not working well enough to remedy the issue. The assisted group had a higher utilization ratio; however, this was an expected result because IP holders with better capabilities tended to participate in the program; therefore, the problem is how to measure the size of the gap between the two groups and as this fluctuated during 2002-2005, a trend was also hard to identify. Further studies based on experimental design or intensive data collection are therefore required, although for the time being, we believe that the overall trend is not upward.

Based on the survey conducted on the program participants, we would make two recommendations on program management: improving the expertise of evaluation institutions and enhancing coordination between programs aimed at promoting commercialization. As more venture firms seek assistance from the program, more competent and specialized evaluators are needed. Since there are a few programs aimed at promoting the use of IPRs, i.e. a mock-up product manufacturing program, a loan program and a preferential purchase program, streamlining these programs for potential users is required. They could be enhanced through utilizing information from other programs, because they support a series of questions that needs to be solved before IP commercialization. For example, before commercializing IPRs, a prospective user may need to verify its projected value and based on this, he may apply for funding from financial institutions. He may also want to make a mock-up product for the purpose of interesting investors or securing bank loans. The government could also give preferential status for public purchasing programs to SMEs. Since these processes are interlinked, if information from each program were shared and utilized, administrative costs would be significantly reduced.

Lastly, the importance of performance data management cannot be exaggerated if government is serious about the performance of spending programs. The results from the evaluation of three programs suggest that proper data management is required to monitor and evaluate their performance. Some programs conduct a periodic survey on their participants, but the design of the survey does not produce information necessary for performance evaluation. Some programs do not even properly maintain previous survey results, therefore before considering performance, we would require a basic investment in performance data management.

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For more information contact WIPO at www.wipo.int

World Intellectual Property Organization
34, chemin des Colombettes
P.O. Box 18
CH-1211 Geneva 20
Switzerland

Telephone:
+41 22 338 91 11

Fax:
+41 22 733 54 28

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