The effectiveness of patent and the determinants of patenting activities in Korea

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Introduction 1

- The characteristics of patenting activities in Korea
- Dramatic increase since late 1980s → reaching ranks 3-4th in the world these days
- Going with growth of the number of firms doing patenting
- This may hints at the changing environments for Korean company for doing effective technological innovation.
- We try to analyze it from in terms of the effectiveness as a appropriation mechanism from the perspective of firm's internal factors, in particular innovative strategy.

Introduction 2

- Research question
- How much is the level of effectiveness of patent as one of appropriation mechanism of innovation output in Korea?
- What is the impact of innovation strategy on the use of patent as an appropriation mechanism or for technology protection in Korea?
- Appropriation can encompass the whole channel of getting returns in a broad sense such as direct appropriation of utilizing patented technology or indirect appropriation through using patents such as a tool for negotiating with other firms.

Previous work 1

- Previous work can be divided into two groups.
- The first group
- Trying to understand the effectiveness of patents as an appropriation mechanism and under which condition patent is effective.
- Patent is not an effective appropriation mechanism
- The utilization of patent has gone beyond the traditional incentive role from preventing competitor to so-called bargaining chips.
- The role of patents varies according to industries.

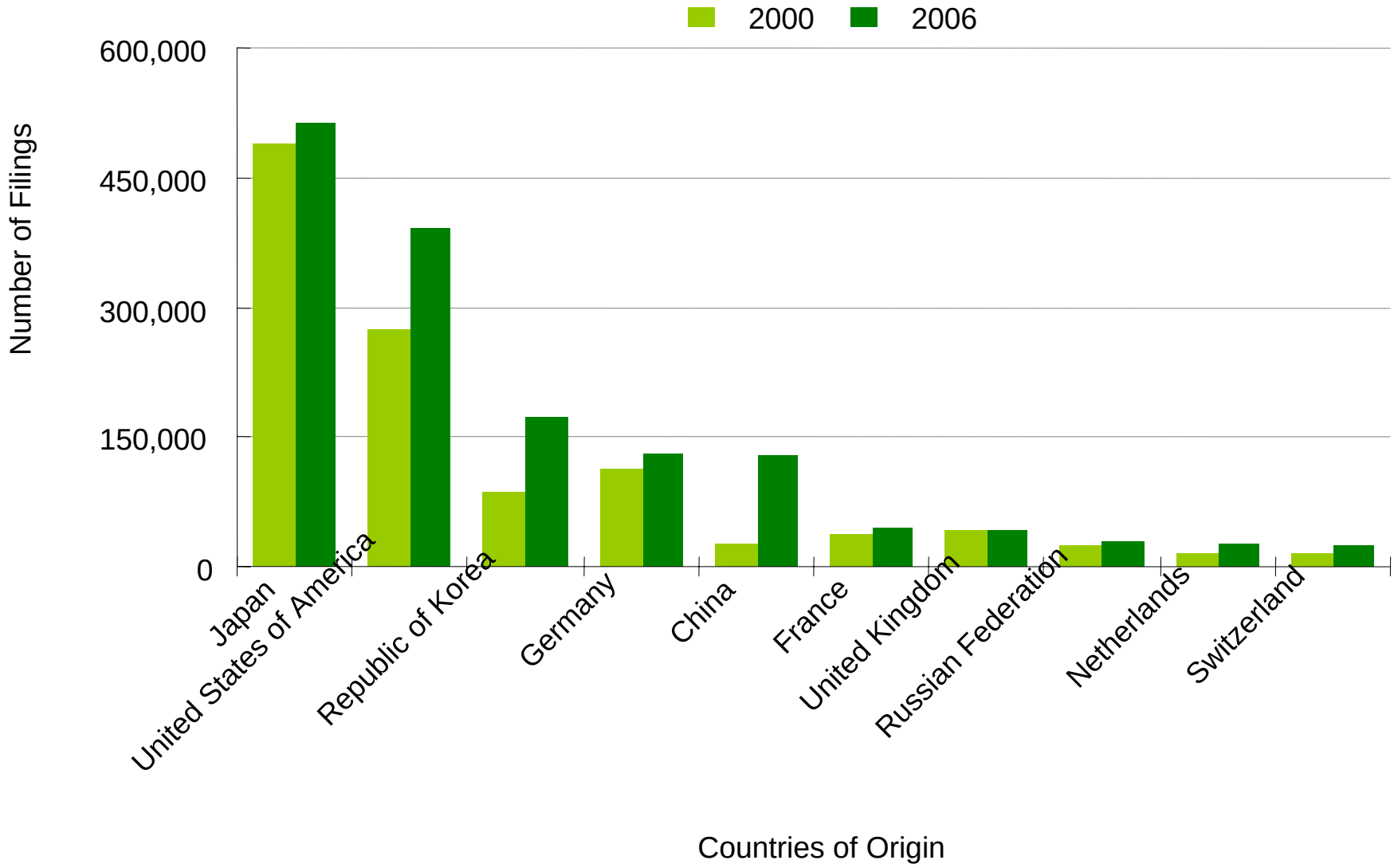
Previous work 2

- The second group focuses on the fact that patenting activities is strategic in nature.
- Analyzing determinants of patenting activities or factors influencing patenting activities.
- The difference of technological opportunities, the difference of national system and practice, and the characteristics of patent system as external factors
- Firm size, innovation strategy and way of innovating as internal factors.

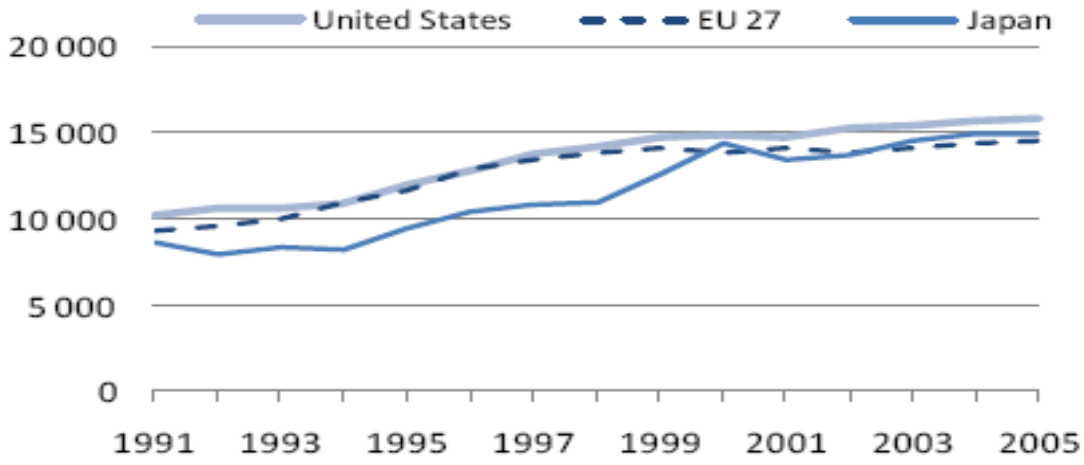
Previous work 3

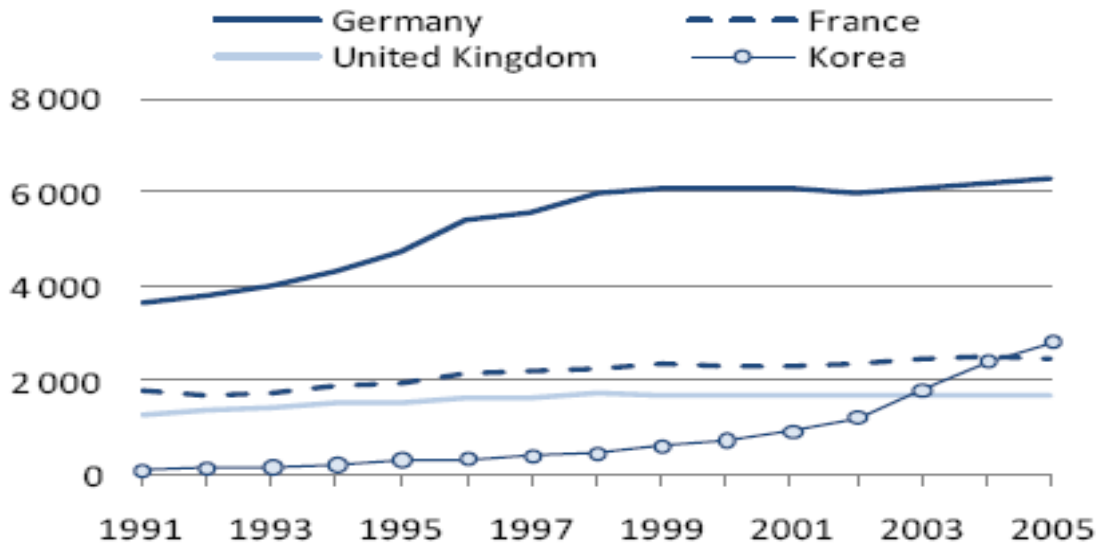
- We try to analyze the effectiveness of patent and its important determinants of patenting activities in Korea in terms of firms' innovative strategies.
- We set the firms' innovative strategies as targeting type of market, targeting type of innovation, and the way of innovation, considering the characteristics of Korea
- Targeting foreign markets enhances the utilization of patent.
- The type of product innovation can impact the possibility of patenting activities
- Way of innovation can influence those activities.

Patenting activities in Korea 1



Patenting activities in Korea 2





Patenting activities in Korea 3

- We can identify roughly the effectiveness of patent as a appropriation mechanism using KIS results(0~5)
- In 2000-2001, the most favorable mechanism is market preemption (the lowest score on 0), while the most important mechanism (the score on 5) are IP registration and market preemption in case of product innovation
- Secrecy is the most favorable mechanism, but at the same time, IP registration and secrecy is highly important(5).
- In 2002-2004, secrecy and lead time are shown to be favorable, but the most important mechanism is patent.
- The indicated effectiveness of patent has risen between two periods, relative to other mechanism.

Methodology and data 1

- Econometric analysis is done in order to analyze the impact of innovation strategy on the likelihood of using patent for technology protection.
- Firms' perception on the effectiveness of patent is assumed to show their incentive to do patenting activities.

- We can separate whether using patent is effective or not as a appropriation mechanism from at which level using patent is effective as a appropriation mechanism.
- The first can be estimated using probit model, and the second using ordered probit model.

Methodology and data 2

- We measure the level of effectiveness of patent using the results of *Korean Innovation Survey* (KIS) done in 2005 by Science and Technology Policy Institute in Korea.
- The definition and methodology of the survey is based on the revised edition of the *Oslo Manual* (OECD).

- *KIS* surveyed the importance given to each appropriation mechanism such as patent, secrecy, lead time, etc.
- This importance is used as proxy measure of effectiveness assessed by individual firms and accordingly the possibility of using patent for technology protection.

Methodology and data 3

- Dependent variables
- KIS asks “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.”
- The answer is ‘not applicable’ or ‘applicable’, and if select ‘applicable’ firm can select degree of importance from very low through middle to very high (5 point Likert scale) for each method.
- The effectiveness of patents can be captured by a dichotomous variable that measures whether or not firms perceive patents as effective.
- The level of effectiveness of patents is captured by the degree of importance given by firms.

Methodology and data 4

- Innovation strategies
- Traditional corporate innovation strategies is accessed from three dimensions : basic R&D vs. applied R&D, product innovation vs. process innovation, closed innovation vs. open innovation
- Additional factor, that is, type of market (export as proxy measure) is added from the perspective of non-advanced countries.
- We set 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.
- All of the independent variables can be set using the result of *KIS*.

Methodology and data 5

- A measure of firm size is included to test whether there are inherent advantages associated with size that are independent of other variables.

- A set of industry dummy variables is included
- Industry can be influential, coming from nature of technology and demand, and the behaviors of other firms including competitors and users.

Determinants of patenting activities 1

- Determinants of the effectiveness of patents – in case of product innovation
- Not only firms which do only actual product innovation, but also firms which do both actual product innovation and process innovation, regard patents as effective appropriation mechanism.
- Firms which do cooperative R&D are more likely to do patenting activities.
- Firms exporting to other countries are more inclined to regard patent as effective mechanism and ready to use it.
- Larger firms have a higher possibility to use patents as an appropriation mechanism than smaller firms.

Determinants of patenting activities 2

- Determinants of the level of effectiveness of patents – in case of product innovation
- Firms doing open R&D with other firms and other institutions feel strongly about the strength of patents as a protection method.
- However, other variables (type of innovation and type of market)' impact is not statistically significant.
- In case of product innovation, beyond the decision of using patent, the driver of active patenting may be the necessity of cooperation with other institutions.

Determinants of patenting activities 3

- Determinants of effectiveness of patents – in case of process innovation
- Even in protecting process innovation, doing both innovations makes it natural to think that patent is effective in protecting innovation output.
- Firms which do cooperative R&D are more likely to do patenting activities.
- Firms which aims for foreign markets and did export to other countries are more inclined to use patents as an appropriation mechanism.
- Larger firms have a higher possibility to use patents as an appropriation mechanism, than smaller firms.

Summary and implication 1

- Firm's size is important factor.
- In spite of increasing number of firms doing patenting activities, the overall trend of patenting activities in Korea is led by large enterprises.
- Product innovation matters.
- It can be inferred that Korean firms combines product innovation with patent mechanisms, in order to gain emerging market segments successfully.
- Cooperative innovative activities matter.
- And this may hint at the fact that appropriation can encompass the whole channel of getting returns in a broad sense, beyond appropriating the direct and instant output.

Summary and implication 2

- Type of markets matters..
- Exporting firms regard patent as effective mechanism, rather than pure domestic firms.
- It can be inferred that Korean firms which have grown up according to expanding market share in major advanced countries feel inevitable to do patenting activities to cope with the diffusion of pro-patent policies in advanced markets.
- limitations
- It is more plausible that firms utilize mix of each appropriation mechanism which is not independent, but rather interdependent.
- This paper's work is not free from endogeneity problem

Thank you

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I would like to appreciate insightful comments on earlier draft from anonymous scholars. All remaining errors are my responsibility.

The effectiveness of patent and the determinants of patenting activities in Korea

Abstract

This paper tries to analyze the level of effectiveness of patent and to identify the major elements influencing it in terms of innovation strategies, in order to understand Korean characteristics of technological innovation featuring high propensity to patent. Three factors such as type of innovation, way of innovation and type of market are captured as important elements constituting innovation strategies.

Major findings are as follows. Firstly, firm's size is critical for using patent mechanism. Secondly, among type of innovation, product innovation is very important, even in protecting process innovation. And cooperative innovative activities matter. Lastly, type of markets, especially foreign market compared to domestic market has positively influential on the effectiveness and utilization of patent.

Keyword: patents, innovation strategy, type of innovation, way of innovation, type of market.

1. Introduction

Along with world-wide surge of patenting activities, there has been dramatic increase of those activities in Korea since late 1980s, and ultimately have reached to the ranks 3-4th in the world these days. Understanding this phenomenon is crucial for making objective analysis about the characteristics of Korean innovative activities and their change for recent decades, because it may hints at the changing environments for effective technological innovation.

Meanwhile, Korea is very famous for its degree of concentration in terms of the composition of patenting. Large IT corporations such Samsung electronics and LG electronics, etc has shown aggressive application and registration of patent and occupied majority of patents in Korea. However at the same time there have been around 8,500 firms who do patenting in 2005 in Korea, according to the survey by Korean Institute of Intellectual Property. The process of dramatic increase in patenting accompanies the increase of number of firms who have done patenting in Korea.

There may be multiple reasons about it such as increasing composition of innovative activities which shows high propensity to patent, the increase of innovative activities itself, and the enhancement of patent as an appropriation mechanism. Among this reasons, it is traditional to approach it in terms of the effectiveness of patent as one of appropriation mechanism of innovation outputs. This approach can elucidate the meaning of patenting activities with relation to other appropriation mechanisms in non-advanced countries.

As expected, previous studies have dealt mainly with advanced countries. Their main argument is that patent is not an effective appropriation mechanism, compared to other appropriation mechanisms [Levin et al, 1987; Cohen et al, 2000]. If then, what are the determinants of patenting activities or crucial factors influencing propensity to patent? Although, numerous types of research has been done and diverse arguments has been suggested, it seems to be plausible to analyze it from the perspective of firm's internal factors, in particular, innovative strategy [Brouwer and Kleinknecht, 1999; Arundel, 2001; Peeters and Potterie, 2006 ; Hanel, 2008]. The fact that patenting activities are strategic in nature from the business perspective and the way of utilizing patent has expanded beyond the traditional areas these days makes this approach have much more importance than before.

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

Based on the background stated briefly before, we are interested in the questions which follow below.

- How much is the level of effectiveness of patent as one of appropriation mechanism of innovation output in Korea?

This question has two meanings. Firstly, even in the traditional meaning of appropriation, there has been no systematic measuring the level of effectiveness of patent in Korea. This makes it hard to understand the Korean patenting activities. Second, we try to extend the meaning of appropriation from the role of patents. There has been diverse reason to do patenting these days, such as from protection from

imitation through incentives for employees to bargaining chips (see Blind et al, 2006). In these regards, appropriation can encompass the whole channel of getting returns in a broad sense such as direct appropriation of utilizing patented technology or indirect appropriation through using patents as a tool for negotiating with other firms. This entails some possibility to do more patenting than in the past and the differential patenting rate according to differential sectors.

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

This question is on the relationship between patent and firms' internal innovation strategy as discussed before. We try to find the evidence on these questions using Korea Innovation Survey done by Science and Technology Policy Institute (STEPI) in Korea. The definition and methodology of the survey is based on the revised edition of the Oslo Manual (OECD).

Previous research dealing with the patent 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 Korea Innovation survey (KIS) and compare the results between KIS done in 2002 and that done in 2005. Based on these discussions, we represent the methodology and data, and result of estimation in the next two sections.

2. Previous literature

Previous literature can be summarized as two trends. The first group is relatively early, compared to second group, and they try to understand the effectiveness of patents as an appropriation mechanism and under which condition patent is effective [Levin et al, 1987; Cohen et al, 2000]. Through their result, we come to know that patent is not an effective appropriation mechanism and is not a major appropriation mechanism even in large corporation doing massive patenting activities. In addition, it is known that the utilization of patent has gone beyond the traditional incentive role through preventing competitor and avoiding being sued to the so-called bargaining chips. The role of patents varies according to industries, typically between discrete product industry such as chemistry industry and complex product industry such as electronics industry.

The recognition that patenting activities are to be strategic in nature from the business perspective and the way of utilizing patent has expanded beyond the traditional areas has generated the second group. Second group does research focusing on the determinants of patenting activities or factors influencing patenting activities. The factors can be summarized as external ones and internal ones. External factors are the difference of technological opportunities in each sectors [Brouwer and Kleinknecht, 1999], the difference of national system and practice [Cohen et al, 2002], and the characteristics of patent system and the technological competence of competitors [Harabi, 1995]. Internal factors are firm size, innovation strategy and way of innovating [Brouwer and Kleinknecht, 1999; Arundel, 2001; Peeters and Potterie, 2006].

Previous literatures have some limitations in that they are mainly based on industrial countries that have long history of patent system and innovative activities, and do not consider non-advanced countries which have short history of industrialization. Considering the understanding from previous works and their limitations, this paper tries to analyze the effectiveness of patent as an appropriation mechanism and the important determinants of patenting activities in Korea in terms of firms' innovative strategies.

Considering the characteristics of Korea, the firms' innovative strategies can be categorized as targeting type of market, targeting type of innovation, and the way of innovation. The distance to lead-user markets, typically located in advanced countries, and the distance to leading sources of technology, typically belonging to advanced firms, universities, or public research institutes located in advanced countries, can be pointed out as characteristics of non-advanced countries. Which market do the firms at non-advanced countries aim to enter is very important for their technological innovation. Furthermore, Korean firms have grown up due to 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 type of innovation and way of innovation in terms of firms' innovative strategies.

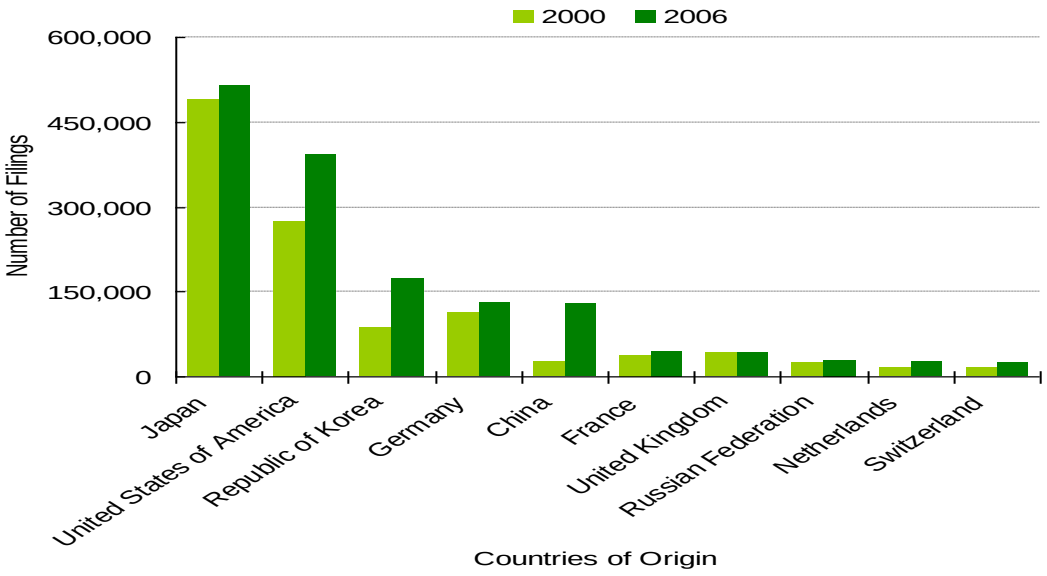
When we take these characteristics into consideration, it is plausible conceptually that the innovative strategies comprising three dimension have an important influence on the Korean firms' patenting activities. In specific, the hypotheses can be set as

follows. First, targeting foreign markets enhances the utilization of patent. Second, the type of product innovation can impact the possibility of patenting activities. Third, way of innovation can influence those activities.

3. Patenting activities in Korea

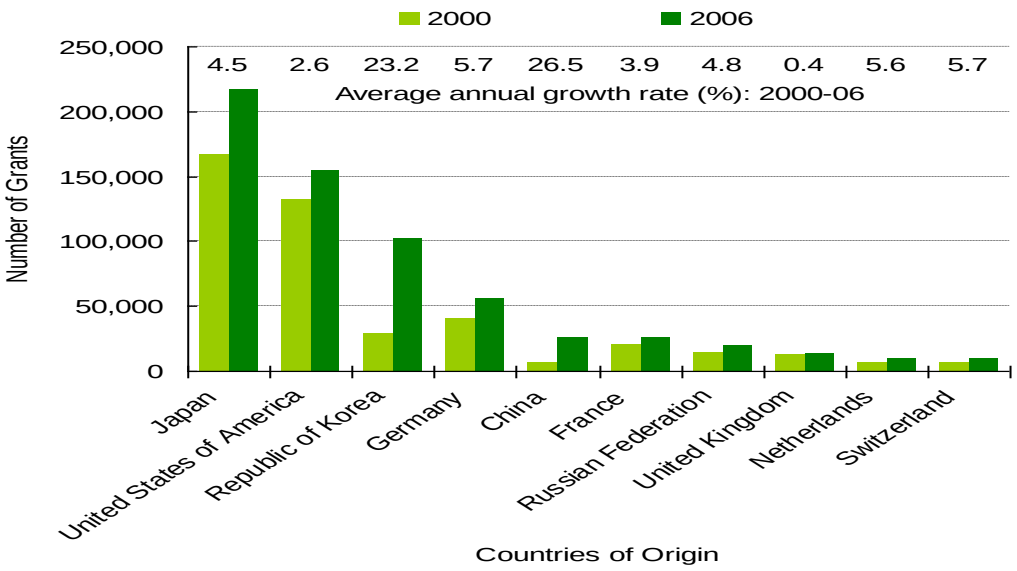
Korea has registered dramatic increase in patenting activities, compared to other countries. This can be confirmed just by reviewing the patent statistics by country of origin theses days. In addition, considering the aspect of patent quality, we can refer to the statistics of triadic patent families.

<Figure 1: Increase in patent application by Korea>



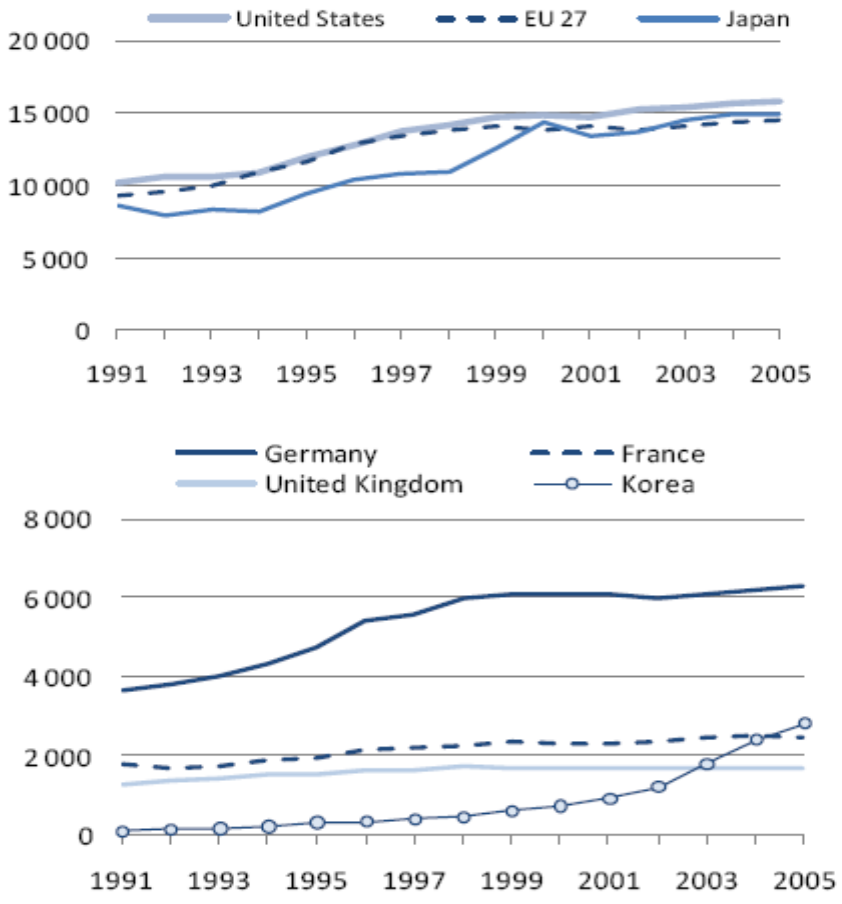
Source: WIPO

<Figure 2 : Increase in patent registration by Korea>



Source: WIPO

<Figure 3: Increase in triadic patent families by Korea>



Source: OECD, Compendium of patent statistics 2008

These statistics confirms the striking increase in patenting activities in Korea. Although it is known that this phenomenon has been led by Korean large corporations, in particular in the area of ICT, it is also accompanying the number of patenting entities and the increasing recognition of importance given to the patenting activities.

We approach this process from the perspective of effectiveness of appropriation mechanism. Appropriation is essential for firms trying to generate sustainable competitive advantage with technological innovation to do innovate. As known, there are various mechanisms for appropriation. Patent is just one of the mechanism which can be utilized for appropriate the innovative output. In case of Korean firms, we can refer to the result of KIS.

Here we try to identify the effectiveness of patent recognized by firms, compared to other appropriation mechanism. In addition, we can compare the result of 2002 survey and that of 2005, in order to get the picture of change these days.

In 2000-2001, the most favorable appropriation mechanism is market preemption for product innovation, related to new product innovation and improved product. The next mechanisms are secrecy and IP registration. However, at the same time, the most important mechanisms are IP registration and market preemption. In case of process innovation secrecy is the most effective mechanism, as expected. However, as is product innovation, the highest importance given to each mechanism shows that IP registration is no less than secrecy. This may imply that even though not effective overall, there may be some tendency to regard patents as important mechanisms for protecting innovation.

<Table 1: Appropriation mechanism 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%

KIS 2005 covering 2002-2004 disaggregate IP into each right, so it is impossible to compare both results directly. On average, secrecy and lead time show most effective mechanisms, but the gap between these mechanism and patent is not high as is in 2000-2001, and as the most important mechanism patent is selected. These characteristics are shown in process innovation.

<Table 2: Appropriation mechanism 2002-2004>

2005 product innovation

	0	1	2	3	4	5	sum
patent	42.39%	3.36%	2.13%	12.00%	16.39%	23.73%	100.00%
utility model	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%
trademark	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

patent	67.66%	3.98%	3.06%	6.65%	8.87%	9.79%	100.00%
utility model	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%
trademark	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

Now we present the empirical model which analyzes the determinants of patenting activities in Korea. In specific, we will try to perform econometric analysis in order to determine the impact of innovation strategy on the likelihood of using patent for technology protection. In detail, whether and at which level using patent is effective is analyzed in terms of the innovation strategy utilizing probit model and ordered probit model respectively.

4.1 econometric model

We assume that firms' perception on the effectiveness of patent shows their incentive to do patenting activities. We can separate whether using patent is effective as a appropriation mechanism from at which level using patent is effective as a appropriation mechanism. The first can be estimated using probit model, and the second using ordered probit model.

As known, probit model can be utilized when the dependent variable is binary. The expected effectiveness of patent 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 firm specific and industry specific exogenous variables.

Ordered probit model can be used when the dependent variable is categorical with same interval of order. It is also assumed that the expected level of effectiveness of

patent is taken a function of innovation strategy and firm specific and industry specific exogenous variables as is in probit model.

4.2 Data

We will try to measure the level of effectiveness of patent using the results of *Korean Innovation Survey* (KIS) done in 2005 by Science and Technology Policy Institute in Korea. The Korean Innovation Survey is approved by the Korea National Statistical Office as Designated Statistics under the Statistics Law and aims at analyzing the technological innovation of manufacturing firms. The definition and methodology of the survey is based on the revised edition of the Oslo Manual (OECD). The revised edition of the Oslo Manual defines innovation in a broad manner, where organizational and marketing innovations as well as technological innovation are also 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 previous survey of so-called Yale Survey or Carnegie Mellon Survey utilized by Levin et al (1987) and Cohen et al (2000) in terms of the effectiveness of patent recognized by firms. But there are some differences between them in that KIS comprises various issues related to innovation. KIS make it possible to analyze the underlying factors influencing the effectiveness of patent and patenting activities. This survey comprises non-patenting firms, but even non-patenting firms at present can share the recognition and perception of the effectiveness of patent.

KIS surveyed the importance given to each appropriation mechanism such as patent, secrecy, lead time, etc. It is possible to interpret this importance as proxy measure of effectiveness assessed by individual firms and accordingly the possibility of using patent for technology protection, considering the efficacy of patent has strong correlation with the propensity to patent [Baldwin et al, 2000]. We can analyze this importance by diverse classification such as firm size, industry, types of technological innovation, etc.

4.3 variables

4.3.1 Dependent variables

KIS asks “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.” [1]The answer is ‘not applicable’ or ‘applicable’, and if select ‘applicable’ firm can select degree of importance from very low through middle to very high (5 point likert scale) for each method, such as patents, utility model, industrial design, trademarks, secrecy, complexity of design and lead-time advantage on competitors. The effectiveness of patents can be captured by a dichotomous variable that measures whether or not firms perceive patents as effective and accordingly they feel it is good to apply. However, this variable does not comprise the level of effectiveness of patents. It is possible to capture the level of effectiveness of patents with the degree of importance given by firms and it represents the strength of protection made by patents when utilized by firms.

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 aims to cultivate broad areas of technology and diverse application. The goal of reaping from instant use may lead firms to concentrate on the 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 done by firms. The second dimension is with the type of technological innovation, such as product innovation and process innovation. This may influence how innovative activities should be done, also constrained by the nature of technology and the selection of appropriation methods. The last dimension has relation with the mode of innovative activities, that is, so-called closed mode versus open mode. In specific, this can be measured by whether firms do cooperative R&D with other firms or other institutions. Arundel (2001) captures corporate innovation strategy as R&D intensity and the share of R&D expenditure targeting product innovation or process innovation, and he regards cooperative R&D agreements as information strategy.

[1] This question does not distinguish domestic context from general context. It is impossible to find out which markets the firms answering this question have in mind with. Therefore, it is inevitable to interpret this question and its answer deal with general situation comprising Korean and major countries.

From the perspective of non-advanced countries, type of market has importance for making technological innovation and innovative strategies. This necessitates different proper way of responding to different nature of market demand and needs, and therefore impacts how technological innovation should be done. Even roughly, type of market can be categorized as domestic one and foreign one. Even though domestic market has been globalized and converged toward global market, the way of addressing the demands from domestic market is still very different from that of foreign market from the perspective of firms in developing countries. In specific this can be captured by whether the firms do export to other countries or not.

In this paper, we set 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. The traditional first dimension is not important for Korean firms in my view, considering that average Korean firms including large corporations usually concentrate on the applied R&D.

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

4.3.3 Firm specific factors

A measure of firm size is included to test whether there are inherent advantages associated with size that are independent of other variables [Hanel, 2008]. With relation to size, there are two conflicting possibilities [Blind et al, 2006]. First, smaller firms may utilize patent much more than larger firms, because smaller firms lack alternative protection mechanism and weak appropriation method, so patent has more importance to smaller firms than large firm. Second, it is plausible larger firms can use more patent, because their resource permit holding independent patent organization and that organization has incentive to do patenting activities continuously. In this paper, size is measured by the average sales for each firm.

4.3.4 Industry specific factors

Industry can be influential in terms of its importance in the external environment surrounding firms. The influence can be from nature of technology and demand, and the behaviors of other firms including competitors and users. A set of industry dummy variables is included for 22 manufacturing industry groups.

For product innovation, it is shown that the patent mechanism is relatively effective in IT and electronics industry, chemical industry, and metal industry. These industries include Manufacture of Coke, Refined Petroleum Products and Nuclear Fuel, Manufacture of Chemicals and Chemical Products, Manufacture of Basic Metals Manufacture of Other Machinery and Equipment, Manufacture of Computers and Office Machinery, Manufacture of Electrical Machinery and Apparatuses, n.e.c.,. Manufacture of Electronic Components, Radio, Television and Communication Equipment and Apparatuses, Manufacture of Medical, Precision and Optical Instruments, Watches and Clocks. But the patent is not effective in the Manufacture of Textiles, Except Sewn Wearing apparel, Manufacture of Sewn Wearing Apparel and Fur Articles, Tanning and Dressing of Leather, Manufacture of Luggage and Footwear.

In case of process innovation, whereas patent is effective in Manufacture of Coke, Refined Petroleum Products and Nuclear Fuel, it is not in Manufacture of Textiles, Except Sewn Wearing apparel, Manufacture of Sewn Wearing Apparel and Fur Articles as is in case of product innovations.

<Table 3: The differential effectiveness of patents by industries>
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%

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 Semitrailers

35. Manufacture of Other Transport Equipment 36. Manufacture of Furniture; Manufacturing of Articles n.e.c. 37. Recycling of Waste and Scrap

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%

5. Determinants of patenting activities in Korea

KIS surveys the effectiveness of each appropriation mechanism separately for product innovation and process innovation. Therefore, it is inevitable to do statistical estimation for each innovation.

In case of protection of product innovation, estimating the impact of innovation strategy on possibility of effectiveness of patents as an appropriation mechanism makes it possible to find following facts.

Firstly, firms which do only actual product innovation, regard patents as effective appropriation mechanism, and are more inclined to do patenting activities. Secondly, Firms which do both actual product innovation and process innovation, also think that it is good to utilize patents for appropriating innovative output, compared to other

firms. Thirdly, firms which do cooperative R&D are more likely to do patenting activities. Fourthly, firms exporting to other countries are more inclined to regard patent as effective mechanism and ready to use it. Lastly, though larger firms have a higher possibility to use patents as an appropriation mechanism than smaller firms, the level of statistical significance is not high.

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

<Table 4: Determinants of the effectiveness of patents – in case of 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% and 5% respectively

In case of protection of product innovation and firms utilizing patents, estimating the impact of innovation strategy on the level of effectiveness of patents as an appropriation mechanism makes it possible to find following facts.

Firstly, Firms doing open R&D with other firms and other institutions feel strongly about the strength of patents as a protection method. However, secondly, other variables (type of innovation and type of market)' impact is not statistically significant.

Therefore it is shown that the determinants of whether the patent is effective or not and the determinants of the level of effectiveness of patents is different. That is, type of innovation and type of market has an influence the effectiveness itself of patent, but does not influence the level of effectiveness. In case of product innovation, beyond the decision of using patent, the driver of active patenting may be the necessity of cooperation with other institutions.

<Table 5: Determinants of the level of effectiveness of patents – in case of product innovation>

variables	Coefficient	Std.	z-	Prob.

		Error	Statistic	
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. ** represent the level of significance 5%

Meanwhile, it is said that patent is not effective in protecting process innovation, mainly because it not easy to detect the infringement in case of patent related to process. We try to estimate the impact of innovation strategy on the likelihood that

patent is effective in case of process innovation.

The results can be summarized as follows. Firstly, even in protecting process innovation, doing both innovations makes it natural to think that patent is effective in protecting innovation output. Secondly, Firms which do cooperative R&D are more likely to do patenting activities. Thirdly, Firms which aims for foreign markets and did export to other countries are more inclined to use patents as an appropriation mechanism. Lastly, larger firms have a higher possibility to use patents as an appropriation mechanism, than smaller firms.

<Table 6: Determinants of the effectiveness of patents – in case of 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. ** represent the level of significance 5%

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

6. Conclusions and discussion

This paper try to analyze the level of effectiveness of patent and to identify the major elements influencing it in terms of innovation strategies, in order to understand Korean characteristics of technological innovation which features high propensity to patent but still have limitation in terms of doing technological innovation with frontier technology. Considering Korean characteristics, three factors such as type of innovation, way of innovation and type of market are captured as important elements constituting innovation strategies.

The findings and their implication can be summarized as follows.

First, firm's size matters. In spite of increasing number of firms doing patenting activities, the overall trend of patenting activities in Korea is led by large enterprises. As said, patent is no more just direct protection mechanism of innovative output. Considering that its usage and way to utilize has increased these days, large firms can utilize patents for various reasons such as enhancing tool for their reputation, tool for monitoring and giving incentive for their R&D personnel, and tool for bargaining power in the course of bargain. In addition, as referred by Blind et al(2006), large firms has increasingly set up their own independent patent or IP organization in Korea, this organization purses active patenting activities, compared to firm not having that kinds of organization.

Second, with the relation to traditional technological innovative strategies which stemmed from advanced countries' experience, product innovation matters. Even in protecting process innovation, doing both actual product innovation and process innovation make the possibility higher that patent is effective in protecting innovation output. This fact has something to do with Korean firms' business strategies and their business environments. Korean firms as a latecomer have to capture emerging market segments where competition for new product or improved product is fierce. It can be inferred that Korean firms combines product innovation with patent mechanisms, in order to gain that segments successfully. Furthermore, Cooperative innovative activities matter. All of the estimation shows that the cooperative R&D has a positive impact on the recognized effectiveness of patents. This has a same vein with Brouwer and Kleinknecht (1999) and Arundel (2001) who argue that the higher R&D cooperation is, with the high possibility patent strategy is utilized. And this hint at the

fact that appropriation can encompass the whole channel of getting returns in a broad sense such as direct appropriation of utilizing patented technology or indirect appropriation through using patents as a tool for negotiating with other firms, beyond appropriate the direct and instant output. Appropriation can be done in short-term or longer-term.

Third, type of markets matters. The estimation result shows that type of markets (export is used as proxy variable) has a positive influence on the effectiveness of patents in terms of product innovation and process innovation. That is, exporting firms regard patent as effective mechanism, rather than pure domestic firms. It can be inferred that Korean firms which have grown up according to expanding market share in major advanced countries feel inevitable to do patenting activities to cope with the diffusion of pro-patent policies in advanced markets.

The limitation is as follows. First, the picture of innovative strategies is too rough to be helpful to actual innovation-related decision-making and not concrete. Firms have their own position on the value chain where their main businesses take place, and their target market can be different, for example local market, domestic market, and concrete international market, and this differential target goes along with appropriation strategy in broad meanings. Second, it is more plausible that firms utilize mix of each appropriation mechanism. In this perspective, the effectiveness of each mechanism is not independent but rather interdependent. Lastly, this paper’s work is not free from endogeneity problem. The data is cross-sectional and does not permit panel analysis and it is impossible to find out proper instrumental variables. These facts should be considered in the future study.

References

Arundel, Anthony (2001), “The relative effectiveness of patents and secrecy for appropriation”, Research policy, Vol. 30

Arundel and Kabla (1998), “What percentage of innovations is patented? Empirical estimates for European firms”, Research policy, Vol. 27

Arundel and Patel (2003), Strategic patenting, Background report for the trend chart policy benchmarking workshop new trends in IPR policy

Baldwin, John, Petr Hanel, David Sabourin (2000), “Determinants of Innovative Activity in Canadian Manufacturing Firms: The Role of Intellectual Property Rights”, working paper, Micro-Economic Analysis Division, Statistics Canada

Brouwer and Kleinknecht (1999), “Innovative output and a firm's propensity to patent. An exploration of CIS micro data”, Research policy, Vol. 28

Cohen et al (2002), “R&D spillovers, patents and the incentives to innovate in Japan and the United States”, Research Policy, Vol. 31

Cohen, Nelson and Walsh (2000), “Protecting their intellectual assets: appropriability conditions and why U.S. manufacturing firms patent (or not)”, NBER working paper No. 7552

Hall, Bronwyn (2004), “Exploring the patent explosion”, NBER working paper

Hanel, Petr (2008), “The use of intellectual property rights and innovation by manufacturing firms in Canada”, Econ.Innov.New.Techn, vol. 17(4)

Harabi, Najib (1995), “Appropriability of technical inventions. An empirical analysis”, Research policy, Vol. 24

Jaffe, A. (2000), “The U.S. patent system in transition: policy innovation and the innovation process”, Research Policy, Vol. 29.

Jaffe and Lerner, Innovation and its discontents, MIT press

Knut Blind, Jakob Edler, Rainer Frietsch, Ulrich Schmoch (2006), “Motives to patent: Empirical evidence from Germany”, Research Policy

Levin, Klevorick, Nelson, Winter (1987), “Appropriating the returns from industrial research and development”, Brookings papers on economic activity

Park, Kyoo-Ho (2006), Research on the change of patent policies and the utilization of patent – focusing on the role in the market for technology, Science and Technology Policy Institute (in Korean)

Park, Kyoo-Ho (2006), “Study on the Determinants of IP Protection of Innovation Results in Korean Manufacturing Sector”, Research on technological innovation (in Korean)

Peeters, Carine and Bruno van Pottelsberghe de Potterie (2006), “Innovation strategy and the patenting behavior of firms”, Journal of Evolutionary Economics, Vol. 16

Reitzig, Markus (2004), “The private values of 'thickets' and 'fences': towards an updated picture of the use of patents across industries”, Economics of innovation and new technology, Vol. 13(5)

STEPI (2005), Report on the Korean Innovation Survey 2005: Manufacturing Sector (in Korean)

STEPI (2002), Report on the Korean Innovation Survey 2002: Manufacturing Sector (in Korean)

Ziedonis, Rosemarie Ham (2004), “Don't fence me in: fragmented markets for technology and the patent acquisition strategies of firms”, Management science, Vol. 50, No. 6