The Impact of the Breadth of Patent Protection and the Japanese University Patents

Kallaya Tantiyaswasdikul

Abstract—**This paper explores the impact of the breadth of patent protection on the Japanese university patenting after the implementation of the act on Special Measures for Industrial Revitalization (Japanese Bayh-Dole act) in 1999. Using a panel data on the fifteen most productive Japanese universities in terms of the number of patent applications based on U.S. Patent and Trademark Office (USPTO) between 1999 and 2009, the number of IPC classes and the number of claims are observed as determinants to determine the patent's value. In this paper, a comparison analysis using regression between the patent with university assignee and the patent of university with co-assignee (university industry collaboration) has been proved based on the notion of the valuation of patent scope. The evidence suggests that the patent scope significantly affects valuations and there is a difference in terms of the nature of patents between patents with university assignee and university co-assignee. In light of the findings of this study, considering the breadth of patent protection is one of the key elements of science and technology policy.**

Index Terms— **Japanese University patents, patent analysis, patent breadth, innovation.**

I. INTRODUCTION

Recent work in both national innovation system and science and technology policy has concentrated on the relation between academic research and industrial innovation as a central focus of the role of university's spillovers and university research in driving economic growth [1]. The focus of university research outcomes in particular in university patenting has exploded since 1980 when there were major changes in federal law in the US including the passage of the Bayh-Dole act of 1980. An assessment of the effects of this changes- in particular the Bayh-Dole act made it significantly easier for American research universities to maintain the property rights to inventions acquiring from federally funded research [1]. The change appears to have had a powerful effect on the way in which university research is transferred to the industrial sector and technology-licensing offices have been established as well as many universities are actively pursuing industrial support [1].

The significant growth in patenting and licensing by US universities has been widely cited as an effect of the Bayh-Dole act initiative. There are several arguments presenting that the increased of these activities enhanced the social returns to publicly funded research academic [2]. Although there is little empirical analysis has been directed at assessing its impacts, these assessments and other factors have led governments in many OECD countries including Japan to consider policy initiatives that emulate the Bayh-Dole act [2]. This paper examines the effects of Japanese Bayh-Dole Act on university patenting in Japan focusing on the impact of the breadth of patent protection and the nature of Japanese university patenting.

To investigate Japanese university patenting after the implementation of the act on Special Measures for Industrial Revitalization (Japanese Bayh-Dole act) in 1999, this study contributes to the analysis of the impact of the breadth of patent protection to the valuation of patent using citation as the indicator. Drawing on Japanese university patents, this paper examines R&D output of university assignee patents and university co-assignee patents (university- industry collaboration). The study provides an empirical analysis of patent scope valuation using a panel data on the fifteen most productive Japanese universities in terms of the number of patent applications based on U.S. Patent and Trademark Office (USPTO) between 1999 and 2009 including the University of Tokyo, Tohoku University, Tokyo Institute of Technology, Osaka University, Kyoto University, Keio University, Nagoya University, Hokkaido University, Nihon University, Hiroshima University, Nara Institute of Science & Technology, Kyushu University, Kyushu Institute of Technology, Waseda University, and Tokai University.

This study investigates the samples of 1120 Japanese university patents including 617 university assignee patents and 503 university co-assignee patents. In this paper, a comparison analysis using regression between the patent with university assignee and the patent of university with co-assignee has been proved based on the notion of the valuation of patent scope. The impact of patent scope on patent citation through a zero-inflated Poisson regression analysis was analyzed. The evidence suggests that the breadth of patent protection including both of the number of IPC classes and the number of claims statistically affects the valuation of patents and there is a difference in terms of the nature of patents between patents with university assignee and university co-assignee. In light of the findings, considering the breadth of patent protection is one of the key elements of innovation policy.

The paper is structured as follows. Section II summarizes the existing literature on science and technology policy in Japan and the Japanese Bayh-Dole act. The summary of the study of patent analysis and the breadth of patent protection is presented in section III. Section IV explains the measurement of patent scope and technology classification and section V is the empirical analysis of Japanese university

Manuscript received September 19, 2012; revised October 31, 2012.
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DOI: 10.7763/IJIMT.2012.V3.332

patents.

II. Science and Technology Policy in Japan and the Japanese Bayh-Dole act

A uniform federal patent policy that allowed universities to retain their rights and ownerships to any patents deriving from publicly funded research is the significant result of the Bayh-Dole act of 1980. The passage of this act also allows universities to license their patents on an exclusive or non-exclusive basis [3]. The Bayh-Dole act of 1980 has been widely cited as an important initiative in the US economy during the 1990s, and some observers have asserted that the act has contributed to the rapid emergence of new high-technology firms and high rates of growth [4]. This assessment has led governments in many OECD countries including Japan to consider policy initiatives that emulate the Bayh-Dole act [2]. Japan has adopted the passage of the Bayh-Dole act of 1980, a piece of legislation that is widely credited with stimulating significant growth in university-industry technology transfer and research collaboration in the US [2] in 1999 as the act on Special Measures for Industrial Revitalization.

Japanese Government has considered and encouraged the formation of various Science and Technology policy to revitalize the national innovation system toward a network-based approach and the Japanese Science and Technology Basic plan has strongly advocated the promotion and enhancement of active interactions among innovation actors [5]. Table I presents the evolution of the university technology transfer policies in Japan since the late 1990s, for example the Act on the Promotion of Technology Transfer from Universities to Industry (the TLO Act) was enacted in 1998 with an emphasis on university patenting, the Law on Special Measures for Industrial Revitalization or the Japanese Bayh-Dole act, the Intellectual Property Basic Law and National University Reform in the Second Science and Technology Basic plan.

TABLE I: The University Technology Transfer Policy in Japan

Science & Technology Basic Plan	Technology Transfer Policies
FY 1996-2000 The First science and Technology Basic Plan	- 1998 the Act on the Promotion of Technology Transfer from Universities to Private Industry (The TLO Act) - 1999 the Act on Special Measures for Industrial Revitalization (Japanese Bayh-Dole Act) - 2000 formulation of the Industrial Technology Enhancement Act
FY 2001-2005 The Second Science and Technology Basic Plan	- 2001 Hiranuma Plan (plan for 1,000 university-originated ventures in 3 years) - 2002 revision of the Ministry of Finance Property Administration Bureau Notification No.1 - 2002 revision of the TLO Law Notification - 2003 the Intellectual Property Basic Act - 2004 implementation of the National University Corporation Law

Since the enactment of the Act on the Promotion of Technology Transfer from Universities to Private Industry (the TLO Act) in 1998 followed with various policies to enhance the Japanese national innovation capacity, the number of patent applications by universities increased dramatically from 918 in fiscal year 2003 to 5,033 in fiscal year 2009 [6]. This evidence suggests that the series of science and technology policies implementation have achieved a certain measure of accomplishment [6].

III. Patent Analysis and the Breadth of Patent Protection

Patent analysis has long been considered as a rich data source from a few standardized approaches to the study of innovation and technical change [7], [8] since patents are a unique and highly visible method of technology transfer [1] that allows for a more comprehensive analysis [1]. Many attempts to determine the determinants of patent value have been observed [9], [10] and various empirical analyses have been conducted to approximate the patent value. Moreover, different datasets have been proved covering various time spans and employed dissimilar data sources [10].

To determine the quality of patents many indicators have been used as the variable such as patent renewal, patent family size, or the number of claims. To construct a variety of measures to interpret the importance of the invention covered by a patent the use of patent citation data is widely employed [1], [7]-[8], [11]. Significant evidences that reveal the links between an innovation and its technological antecedents and descendants are also included in citations [11]. Citations can be used for various purposes including tracing the process of technology development and evaluating the importance of a patent [7]. There are several advantages regarding the use of patent data however some serious limitation are included for example not all innovations are patented since not all of them qualify the patentability measure and a strategic decision of the inventor to relying on secrecy invention [8].

Considering the study of innovation and technical change, policy makers increasingly recognize the breadth of patent protection as an important science and technology policy instrument. The breadth of patent protection covers various topics such as the issue of the optimal length of award, which is an initial theoretical examinations of patenting and the optimal breadth of patent claims [12]. The breadth of IP protection has attracted increasing theoretical attention but little empirical evidence [12]. Some scholars examine the impact of patent scope on the diffusion of innovations and technological collaboration and some scholars model the tradeoff between patent length and breadth to find the proper structure for a patent [12].

IV. The Measurement of Patent Scope and Technology Classification

Historically, patent classifications can be classify into two major categories. The first type is the so-called application-oriented system that represent a particular industrial sector of an invention and the second one is the so-called function-oriented approach, which focus on the type of an invention that which may cross industry sector [13].

The United States national classification (USC) uses principally a ‘function-oriented’ classification contrary to the International Patent Classification (IPC) that has been influenced by the system of German ‘application-oriented’ classification and US/British ‘function-oriented’ approach [13].

This study uses the IPC classification as the representative of the technology field in patents since the IPC scheme reflects the economic importance of new inventions, as opposed to the technical focus of the U.S. scheme [12]. Based on database on the website of the World Intellectual Property Organization (WIPO), the technology classification of IPC is presented in Table II, which can be divided into 8 sections including section A: Human necessity, section B: Performing operations; Transporting, section C: Chemistry; Metallurgy, section D: Textiles; Paper, section E: Fixed constructions, section F: Mechanical Engineering; Lighting; Heating; Weapons; Blasting, section G: Physics, and section H: Electricity respectively.

TABLE II: THE TECHNOLOGY CLASSIFICATION OF IPC SCHEME

Tech no.	Title	Corresponding IPC
1	Section A: Human necessities	
1.1	Agriculture	A 01
1.2	Food stuff; Tobacco	A 21-A 24
1.3	Personal or domestic articles	A 41-A 47
1.4	Health; Amusement	A 61-A 63
2	Section B: Performing operation; Transporting	
2.1	Separating; Mixing	B 01-B 09
2.2	Shaping	B 21-B 32
2.3	Printing	B 41-B 44
2.4	Transporting	B 60- B 68
2.5	Micro-structural technology; Nano-technology	B 81-B 82
3	Section C: Chemistry; Metallurgy	
3.1	Chemistry	C 01-C 14
3.2	Metallurgy	C 21-C 30
4	Section D: Textiles; Paper	
4.1	Textile or flexible materials	D01-D 07
4.2	Paper	D 21
5	Section E: Fixed Constructions	
5.1	Building	E 01-E 06
5.2	Earth or rock drilling; Mining	E 21
6	Section F: Mechanical engineering; Lighting; Heating; Weapons; Blasting	
6.1	Engines or pumps	F 01-F 04
6.2	Engineering in general	F 15- F 17
6.3	Lighting; Heating	F 21-F 28
6.4	Weapons; Blasting	F 41-F 42
7	Section G: Physics	
7.1	Instruments	G 01-G 12
7.2	Nucleonic	G 21
8	Section H: Electricity	
8.1	Basic electric elements	H 01
8.2	Generation, conversion, or distribution of electric power	H 02
8.3	Basic electric circuitry	H 03
8.4	Electric communication technique	H 04
8.5	Electric technique	H 05

In this paper, technology classification based on IPC code was analyzed. I employ a proxy of patent scope base on the IPC scheme using a panel data on U.S. Patent and Trademark Office (USPTO) between 1999 and 2009. Like Lerner [12] the first four digits of the IPC class was obtained for example a patent assigned to classes H05H 3/02, H05H 3/00, and H01L 021/360 is falling into two classes, H05H and H01L. The samples are composed of 1120 Japanese university patents dividing into two groups including 612 university assignee patents and 503 university co-assignee patents. In this paper, the impact of patent scope on patent citation through a zero-inflated Poisson regression analysis was analyzed using the number of IPC classes and the number of claims as independent variables.

V. EMPIRICAL ANALYSIS OF JAPANESE UNIVERSITY PATENTS

The 1998 TLO act and the 1999 Japanese Bayh-Dole act have been widely discussed as an important initiative in the continuous increased number of university patenting between 1998-2008 since many Japanese universities have expanded their academic inventions result in patent applications. By the end of the first decade of the acts, these universities display remarkable similarities in their patent portfolios. Fig. 1 depicts the overall patenting in these Japanese universities, which reveals that the number of patents grew during 1998-2006 with the 10-fold increase in 2006 and gradually declined (accessed data on May 30, 2012). The dramatic increased of number of patents between 2005 and 2007 is due to the implementation of the National University Corporation Law in 2004. The effects of the passage of the Japanese Bayh-Dole act on the content of academic research and patenting of Japanese universities were critical. The most significant change in the content of research at these universities, one associated with increased patenting after 1998 and decline in 2009 (accessed data on May 30, 2012).

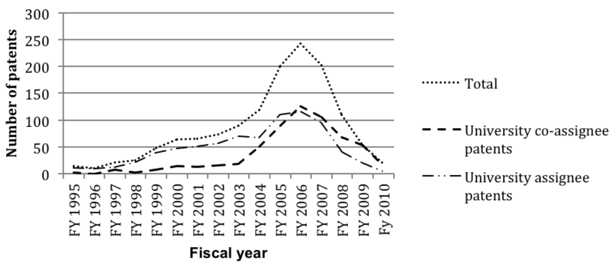

Fig. 1. Trends in Japanese university patenting

TABLE III: DESCRIPTIVE STATISTIC OF UNIVERSITY PATENTS

Variable	Mean	STDEV.S	Maximum	Minimum
University assignee patents				
Forward citations	0.89	2.31	22	0
IPC Classes	1.6	0.92	9	1
Claim	10.49	6.88	52	1
Years	4.83	2.61	10	0
University co-assignee patents				
Forward citations	1.18	5.06	64	0
IPC classes	1.39	0.77	6	1
Claims	12.03	7.4	47	1
Years	3.3	2.1	10	0

In this study the data collected were top fifteen Japanese university patents granted by the USPTO between 1999 and 2009. The descriptive statistics of the data is shown in Table III including mean, standard deviation, maximum, and minimum value of each variable. The samples are composed of 1120 Japanese university patents dividing into two groups including 612 university assignee patents and 503 university co-assignee patents.

TABLE IV: REGRESSION COEFFICIENTS FOR RESPONSE VARIABLE: NUMBER OF FORWARD CITATIONS

Independent variable	The total number of University patents	University assignee patents	University co-assignee patents
Number of IPC classes	-0.145***	-0.137***	-0.179***
	(0.035)	(0.047)	(0.064)
Number of claims	0.008***	0.016***	-0.011***
	(0.004)	(0.005)	(0.005)
Number of year	0.310***	0.208***	0.462***
	(0.016)	(0.213)	(0.023)
Constant	-0.712	-0.394	-1.056
Number of observations	1120	617	503
Log likelihood	-1564.534	-706.5411	-723.9048
LR chi2(3)	457.78	91.01	572.36

*** p<0.01; ** p<0.05 Standard errors in parentheses

The patent data used in this study was extracted from the USPTO. I analyze the impact of patent scope on citations through a zero-inflated Poisson regression analysis. I find the dependent variable, the number of citations in Japanese university patents documents after the implementation of the 1998 Promotion Law in Japan using the data of patent extracted from the USPTO, which apply between 1 April 1999 and 31 March 2009 in USTPO database (2012). I use as independent variables the number of four-digit IPC classes to which the patent was assigned and the number of claims. Like Lerner [12], to control for the differing periods of time that these patents have had to garner citations, I employ as an additional independent variable the time from the patent award to 31 March 2009. Thus, I estimate

$$NFCITE = \beta 0 + \beta 1 NIPC + \beta 2 NCLAIM + \beta 3 NYEAR \quad (1)$$

NFCITE = number of forward citations

NIPC = number of four-digit IPC classes

NCLAIM= number of claims

NYEAR = number of years from award date to 31 March 2009

The result of a zero-inflated Poisson regression analysis is presented in Table IV. The evidence suggests that the number of IPC classes or the breadth of patent protection and the number of claims significantly affect valuations of patents and there is a difference in terms of the nature of patent between patent with university assignee and university co-assignee.

The number of claims has some relations to the previous technology of the invention. In case of new invention based on the existing notion, the number of claims could not be exceeded many since the knowledge of that invention relates to the antecedent technology. In contrary, for the new discovery, the number of claims tends to be excessive. For the nature of co-assignee patents, when the number of claims increase the number of forward citation decrease. This occurrence is interpreted as the breadth of protection in terms of the number of claim has negative impact on the number of forward citations. In case of the co-assignee patents, when the purpose of patent is more commercialize, the target is broader; it is better to have less claims.

In contrast to the case of university co-assignee patents, the number of forward citations of university assignee patents increases when the number of claims increases. In this case, the number of claims reflect freshness that means new inventions provide some incentives to researchers, the researcher would like to catch up new technology, considering this point when the number of claims increases, the number of forward citations also increases.

The scope of patent that is revealed in IPC classes represents the technology field and the evidence suggests that the number of IPC classes has significant impact on the number of forward citations, which is the indicator of the patent’s value.

In the previous study of Lerner [12], the number of IPC classes has positive impact to the number of forward citations, this is understandable since a patent that fall into many technology fields could provide many possibilities for researchers in many areas to cite. In this case, the number of IPC classes indicates the quantity aspect. However, in this result, when the number of IPC classes decreases, the number of forward citations increases, the number of IPC classes indicates the quality aspect.

Since the implementation of the 1998 TLO act and the Japanese Bayh-Dole act, many Japanese universities have expanded their academic inventions resulted as the continuously increase in number of patent grants between 1998 and 2008. By the end of the first decade of the acts, these universities display remarkable similarities in their patent portfolios especially the university co-assignee patents that increase dramatically. To Japan, this borrowed policy instrument that apply to a very different institutional context is likely to have high success however, considering the breadth of patent protection, policy implementation should be considered since the breadth of patent protection is one of the key elements of IP policy. Concentration on commercialization, to increase the number of forward citations, the claim should be minimized since the number of claims represents the difficulty to use the patent, so with a large number of claims the number of forward citations is small. For the strategy of university patenting, a university focuses more on one specific technology field can attract more citations. If the university focuses on one specific IPC class, most of the effort will contribute to the focused field and could produce new invention. Small number of IPC classes has high quality because researchers focus on just one particular area of study.

ACKNOWLEDGMENT

I would like to express my gratitude and appreciation to Professor Oda Hisaya, Graduate School of Policy Science Ritsumeikan University for his support and encouragement.

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