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How University's IP Management Affects on Industry-funded
Collaborative Research: Empirical study on the effect of IP management
by Japanese university on joint research with industry

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**How University's IP Management Affects on Industry-funded Collaborative Research:
Empirical study on the effect of IP management by Japanese university on joint
research with industry**

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Abstract: The link between IP management and collaborative researches of Japanese universities was evaluated by utilizing questionnaire surveys. It shows that correlation coefficient between activity of patent management and joint research of university is generally high. However, it depends on the counterparty with whom university enter into a contract. To be concrete, for joint research with large firms, the effect of patent management is not clear, while for joint research with SMEs, the effect is significantly positive. The authors argue that the conflict of IP policies between university and industrial firms caused such a difference. This study also shows that because of this conflict, industrial funded collaborative research shows a trend of shifting from joint research to donation research during FY2005-2007. The result shows that current university IP management may limit the utilization of university intellectual asset especially from joint research with large firms.

Keywords: university industry cooperation; patent management; firm size; joint research; donation; intellectual property policy; questionnaire survey; conflict; national university; regression model.

1 Introduction

In Japan, industry-university collaboration has been carried out in several ways. It includes contract researches including joint research and technology transfer. In addition to formal collaboration, it also includes informal information exchange, knowledge spillover through academic activity, etc. In Japan donation is sometimes utilized as a tool to conduct such informal collaboration. In these cases, most industrial firms provide donation to researchers or laboratories as a kind of compensation in order to acquire technology consulting or inventions. And unlike US, where most business activities are based on contract in order to get legal protection, in Japan, tacit

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trust and credit sometimes work better than contract. We call this type of collaboration as donation research. Though there might not be a formal contract, once trust is established, both university researchers and firms want to keep a long-term and reciprocal relationship. Even though these collaborations were effective, it is believed that this kind of closed collaboration is not appropriate, with respect to transparency and accountability.

Transparent patenting and licensing system for university was first established in the US after the Bayh Dole Act became effective in 1980. In Japan, government had introduced a similar system which has been effective since 1999, however, it did not affect patenting and licensing from national universities because a national university has no independent legal status. It was 2004 when national universities have been incorporated. Since then, dramatic increase of number of patents from university is observed. Since 2004, official patent management system was established in national universities to protect university's intellectual properties and promote university-industry collaboration.

Collaborative research is increasing rapidly after the privatization of national universities. However, although the number of collaborative research projects has increased rapidly, most of them are from large firms, on the other hand, SMEs encounter a difficulty in accessing to university's patent resource and conducting collaborative research. Baba et al. (2007) indicates that the collaboration between universities and SMEs in Japan is not as strong as that between universities and large firms. Kneller (2008, 2009) argues that in Japan's university-industry collaboration, large firms have preemption on accessing to university's patent resources. The system of university IP management enables large companies to preempt university discoveries and thus limits opportunities for new technology-based companies to grow. In this study, the author focuses on the linkage between IP management by universities and university-industry collaborative research both with large firms and SMEs and tries to find out the influence brought by IP management system established since privatization of national university during FY2005-2007.

2 Method

2.1 Hypotheses

In Japan, industry-university collaboration has been developed especially since 1998, when the technology transfer law was made effective. The number of patent applications has increased dramatically in the last 10 years. In the fiscal year 2005, the total number of patent applications from Japanese university reached 8,527. It is almost similar to the number reported by universities in the US.

After the privatization of national universities in 2004, department of IP management was setup to protect university's IP resource and promote university's collaboration with industry. Donation research, joint research and commission research are all experiencing a certain degree of growth).

In Japan, large firms have strong R&D strength and were autarky (Kneller, 2007). However, as circumstances changed, not all the research can be done by themselves especially when innovation sources like fundamental and frontier research are not located within firms. Outsourcing some of the research and getting technology and patents in a low-cost way becomes a better option. In fact, in Japan large firms have been conducting collaboration with universities for a long time sometimes utilizing donation research. They are abundant in R&D expenditure and therefore attractive for poorly funded university researchers to do collaboration with. On the other hand, large firms highly risk-averse. They demand a loyal partnership and less openness on information. These factors make SMEs harder to do collaboration with university because they are short at money and have less access to university's patent resource, which is mainly dominated by large firms.

However, one of the most important missions of university's patent management is to support the country's newly born industries and venture business by promoting collaboration with SMEs. This might lead to the more positive effect of university's patent management when collaborative partners are SME's. It is based on the assumption that university utilize patent not only for licensing but also as a tool to collaborate with industries.

In fact, although patenting has been exposed its presence in university-industry collaboration, licensing income from patents remains relatively low as compared to that in the US. Patent may not be just a tool for licensing but also for attracting industry firms and for an opportunity of new collaboration with them. Indeed, it is known that patents are utilized as strategic devices for trading technologies and for easing R&D collaboration between firms (Penin, 2005). We (Watanabe, 2008) argued that in the same way, a university may use patents as strategic devices for easing collaboration between firms rather than just obtaining licensing income. In our study, a regression model was used to analyze a questionnaire survey in FY2006 and case study. The result showed that Japanese universities' patent management has effect on university-industry joint research and commission research. The effect is different when the size of partner firm is different. The findings of these studies are interesting, but it is limited by only analyzing the cross-sectional dataset of FY2006. Based on previous research, the authors bring forwards the following hypotheses.

Hypothesis 1: National university' patent management has negative effect on joint research with large firms, while it has positive effect on joint research with SMEs.

As mentioned earlier, in Japan, the collaboration between university and large firms has a long history. Before the privatization of national university, when there was not a sound patent management environment, such collaboration was lack of transparency. Technology transfer was

often conducted privately between researchers and large firms. In these cases, usually donation researches are conducted. This kind of informal while effective alliance is argued to have lead to large firms' preemption on university's IP and research resource, which made SMEs difficult to access to university's IP resource and caused unfair competition.

After the establishment of a sound patent management system since 2004, it's presumed that a more transparent and fair environment will end the informal alliance age, impair large firm's preemption status. Therefore it has been predicted that donation researches might shift to contract researches including joint research. It was also expected to give SEMs a fair chance to collaborate with universities easier. However, the number of donation research turned out to be increasing even after introduction of patent management system.

It is considered that the increase of donation research is attributable to the behaviour of large firms avoiding patent management of university. Therefore, the authors presume the following hypotheses.

Hypothesis 2 : Universities' patent management caused a shift of industry financed research from joint research to donation research FY2005-2007.

Joint research and donation research are quite different in the transparency of technology transfer and other matters. The former is strictly managed while the latter remains in a black-box. As university's patent management are getting more and more detailed and strict since the privatization of national universities in 2004, the author doubts that industry firms are also responding to this change by shifting their research investment on less-monitored collaborative partnership such as donation research.

2.2 Questionnaire Survey

The data of this study comes from a questionnaire survey on university-industry collaboration. A brief introduction of the questionnaire survey and selection of data will be described in this part.

By the Ministry of Education, Culture, Sports, Science and Technology (MEXT), the questionnaire survey started from FY2004 and is conducted each year since then to monitor Japanese university's collaboration with industry. 3 years' data during FY2005-2007 of this survey are used in this study.

The target of this survey covers all Japanese universities and colleges, including national university, public university, private university, inter-university research institute, and polytechnic institutes. Table 1 shows the targets and response rate of the latest survey of FY2007. The targets include 86 national universities, 865 private universities and 98 public universities, all together

1049 universities. The response rate from university is 75.3%, polytechnic is 95.2, and research institute is 100%. Among them, response rate of national universities is 100%, public universities 72.8%, and private universities 74.5%.

The survey covers more than 6300 questions items, including data of patenting and licensing, universities' joint research with industrial firms; commission research; donation, clinical trial income, and management relating patent and other intellectual properties. Data are categorized in terms of organization, size of industrial firms (large firm and SMEs²), research field, industry, research period, geographic location of industry firms etc. the items of the survey changes slightly each year with new items added. The item of donation research was not included in FY2003's questionnaire survey. Some items related to patent management started from FY 2006's survey. The insufficient data of FY2005 was added by our own investigation.

Table 1. Target and Response Matrix of Questionnaire Survey: FY2007

Category	Target				Response				Response Rate
	University	polytechnic	Research Institute	Total	University	polytechnic	Research Institute	Total	
National	86	55	4	145	86	55	4	145	100.0%
Private	865	3	-	868	631	1	-	632	72.8%
Public	98	4	-	102	73	3	-	76	74.5%
Total	1,049	62	4	1,115	790	59	4	853	76.5%
Response Rate					75.3%	95.2%	100.0%	76.5%	

2.3 Sample Extraction

Figure 1 shows chronological data of joint research, the bar indicates number of cases. It's noticed that joint research has increased rapidly, and most joint research were conducted in national universities. The target of this study is therefore set on national universities.

Among all 86 national universities (FY2007), we extracted 70 cases of national universities which are conducting natural science research from the survey. After checking the data, the author found out that National University Corporation Tsukuba University of Technology (NTUT) has no joint research record for continuous 3 years. Therefore NTUT was also deleted from the data set, leaving us 69 samples of national universities for each year. Altogether we have three year's data of 207 samples. Among 69 universities, there are 50 comprehensive universities, 12 engineering universities, 4 medical universities, and other 3 universities. A dummy variable indicating university's category is made to distinguish their attribute. Data set relating to patent management,

² The definition of Large Firms and SMEs is officially defined by Small and Media Enterprise Law.

joint research, commission research, and donation research has been collected from the cases. The number of joint research with industry firms is used as dependent variable.

In the questionnaire survey, one of the questions asked “what kinds of policies and rules are established relating collaboration with industry”. There are totally 23 policies or rules related to this question. All of them are summarized in Table 2 with brief descriptions. Because the question related to collaboration policies and rules was not included until FY2006, there are only two year’s data from questionnaire survey. The authors added the insufficient data of FY2005 by our own investigation from university’s home page.

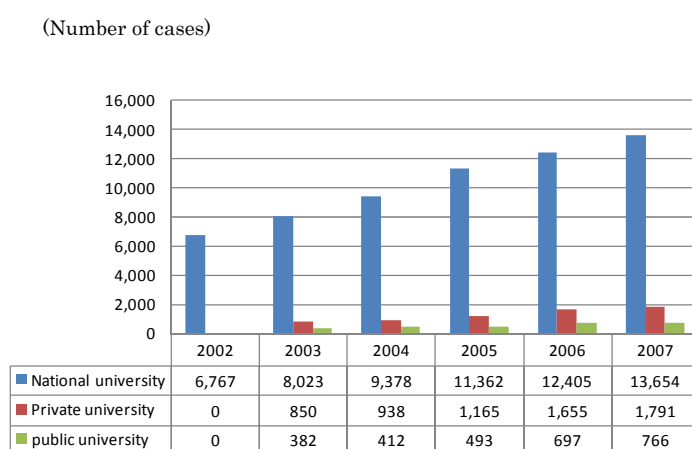


Figure 1. Joint Research in national universities, private universities and public universities: FY2002-FY2007

Among all policies and rules, there are intellectual property policy, licensing policy of research method patent, employee invention rules for faculty members and students, rules of compensation for invention etc. These are relating to IP management and we call these as “IP policies”. We assume that the number of these established IP policies correlates to how patent management is well done by the university (Watanabe, 2008)). In this study the number of IP policies is also used as independent variable to represent the degree of patent management by the university. There are also rules including general policy on U-I collaboration, rules on joint research etc. We call these as “General Collaborative policies”. The number of General Collaborative policies is used as variable to indicate to what degree of university’s U-I collaborative policy. There are other rules including rules on part-time job When faculty do such technology consulting job, permission from the university is necessary. The survey also reports the number of such permissions from university. The author thus uses the number of technology consulting to represent flexibility of university administration for cooperation with industry.

Table 2. University's Policies related to U-I collaboration.

NO.	Policy and Rules	Descriptoin
<i>General collaborative policies:</i>		
1	General Policy on U-I cooperation	Promote U-I cooperation and Technology Transfer
2	General Policy on internaional U-I cooperation	Promote international U-I cooperation and Technology Transfer
3	Rules on joint research	General guidance and rules on joint research with industry
4	Rules on commissioned research	General guidance rules on joint research with industry
<i>IP policies:</i>		
5	Policy on intellectual property	Promote IP creation and protection
6	Policy on licensing of research method patent	Smooth the usage of research method for academic purpose
7	Policy on the usage of research materials	Guidance on protection and usage of research materials
8	Policy on smoothing usage of research tool patents	Smooth the usage of reserch ol patents in life science.
9	Rules on copyright	Guidance on protection and usage of copyrights
10	Rules on employee invention for faculty members	Falculy inventions belong university
11	Rules on employee invention for faculty members and students	Guidance on transfer of students' invention
12	Rules on compensation for invention for faculty members	Compensate on faculty invention
13	Rules on compensation for invention for faculty members and students	Compensate on students' invention
14	Rules on non-disclosure agreement for faculty members	Protect research secret
15	Rules on non-disclosure agreement for faculty members and students	Protect research secret
<i>Other policies:</i>		
16	Policy on stocks	Univerity can accept stocks from industry, good for SMEs
17	Rules on disposal of stocks	Guidance on disposal of stocks
18	Rules on part-time jobs of faculty members	Faculty can do part-time job such as technology consulting
19	Rules on temporary dispaishment faculty members	Faculty can be temporary dispatched to another organization
20	General Policy on conflict of interest	Maintain university's neutual academic status
21	Policy on conflict of interest on clinical trials	Maintain university's neutual academic status in clinical trials
22	Rules on clinical trials	General guidance and rules on clinical trials from industry
23	Rules on faculty sabbatical leave	Grant Stabbtical Leaves to imporve teaching or research

3 Results

3.1. Single Year Analysis of FY2005, FY2006, and FY2007.

In the analysis, the effect of patent management on joint research was examined from FY2005 to FY2007. In fact, as was presumed before, the effect may be different in different year. Also, in the analysis above, the number of all IP policies as independent variable is used. However not all of them necessarily have correlation with the number of joint research. The author then examined the effect by analyzing each year's data separately

and utilizing a new independent variable, namely, to conduct T-Test first to check each rule's, then use the number of significant IP policies as independent variable.

First independent samples T-Test was conducted with the number of joint research as test variable. The result of FY2005 is shown in Figure 2 as an example. In the figure, the bar stands for the difference of number of joint research when there is a rule and not.

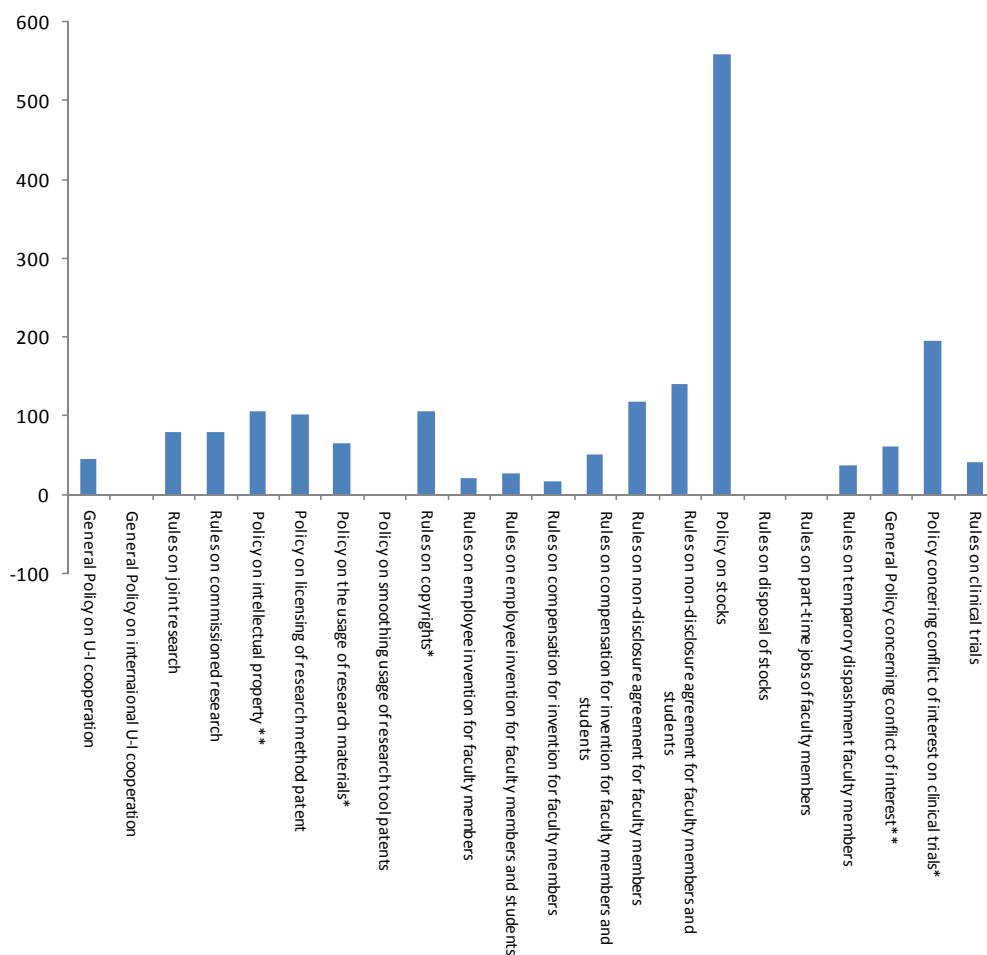


Figure 2. Independent samples t-Test: difference of mean and significance: FY2005

Generally, most groups with IP policies have more joint research than groups without such policies. However, each year is slightly different.

In FY2005, all samples shows positive values, that is to say, universities with rules have more joint research than those who do not. Among all the policies and rules, Policy on Intellectual Property, Policy on the usage of research materials, Rules on copyright, General Policy on conflict of interest, and Policy on conflict of interest on clinical trials turned out to be significant.

Among all the policies and rules, the policies that turned out to be significant in t-Test are summarized in Table 3. The author then used the number of significant IP policies as a new variable

to conduct multiple regression analysis. The independent variable is the number of joint research. The number of faculty, the number of solely issued patents, the number of consulting and general collaboration policies are used as control variables, because they both showed correlation with the number of joint research.

Table 3. Significant IP policies in t-Test on joint research: FY2005, FY2006, FY2007.

FY 2005:
Policy on intellectual property **
Policy on the usage of research materials *
Rules on copyrights*
FY 2006:
Policy on intellectual property *
Policy on licensing of research method patent *
Rules on copyrights*
FY 2007:
Policy on licensing of research method patent **
Policy on smoothing usage of research tool patents **
Rules on copyrights*
*=p<0.05
**=p<0.01

The results of regression analysis when independent variable is joint research with large firms are shown in Table 4(FY2005), Table 6(FY2006) and Table 8(FY2007). Those of regression analysis when independent variables are joint research with SMEs are shown in Table 5, Table 7 and Table 9.

Each analysis shows that number of faculty members is significant. However it is also clear that the significant dependent variables are different between each case (with large firms or SME's) of regression analysis. It shows that the number of IP policies is significant to estimate the number of joint research with SMEs. in 2005 and in 2006. However, the number of IP policies, is not significant to estimate the number of joint research with large firms in 2005 and 2006. In the analysis of joint research with large firms, the number of solely issued patent and faculty is significant instead.

In 2007, the dependence of IP policies on joint research with large firms is not so clear. However the regression coefficient of IP policies in Table 9 (with SME's) is much larger than that in Table 8(with large firms). Overall trend of comparisons are considered to be consistent through these three years

Table 4. Multiple regression analysis: Joint research with large firms as dependent variable: FY2005

Variable	Independent variables			
number of faculty	0.337**	0.335**	0.333**	0.342**
Solely issued patents	0.639**	0.630**	0.632**	0.643**
number of consulting	-0.14			
General collaboration policies	0.021	0.021		
IP policies	0.04	0.042	0.048	
Adjusted R2	0.856	0.856	0.856	0.854

N=69
* =p<0.05
**=p<0.01

Table 5. Multiple regression analysis: Joint research with SMEs as dependent variable: FY2005

Variable	Independent variables			
number of faculty	0.22	0.245**	0.246**	0.362**
Solely issued patents	0.068			
number of consulting	0.143	0.179	0.179	
General collaboration policies	0.055	0.059		
IP policies	0.271*	0.278*	0.278**	0.292**
Adjusted R2	0.256	0.266	0.274	0.266

N=69
* =p<0.05
**=p<0.01

TABLE 6: Multiple regression analysis: Joint research with large firms as dependent variable: Y2006

Variable	Independent variables included standard coefficients			
number of faculty	0.484**	0.486**	0.479**	
Solely issued patents	0.366**	0.367**	0.405**	
number of consulting	0.138	0.138	0.134	
General collaboration policies	0.055	0.058		
IP policies	0.012			
Adjusted R2	0.826	0.815	0.815	

N=69
* =p<0.05
**=p<0.01

TABLE 7. Multiple regression analysis: Joint research with SMEs as dependent variable: FY2006

Variable	Independent variables included standard coefficients			
number of faculty	0.379*	0.383*	0.517*	0.480**
Solely issued patents	0.047	0.03	-0.058	
number of consulting	0.039	0.041		
General collaboration policies	-0.026			
IP policies	0.361**	0.358**	0.330**	0.313**
Adjusted R2	0.36	0.369	0.379	0.387
N=69				
* =p<0.05				
**=p<0.01				

TABLE 8. Multiple regression analysis: Joint research with large firms as dependent variable: FY2007

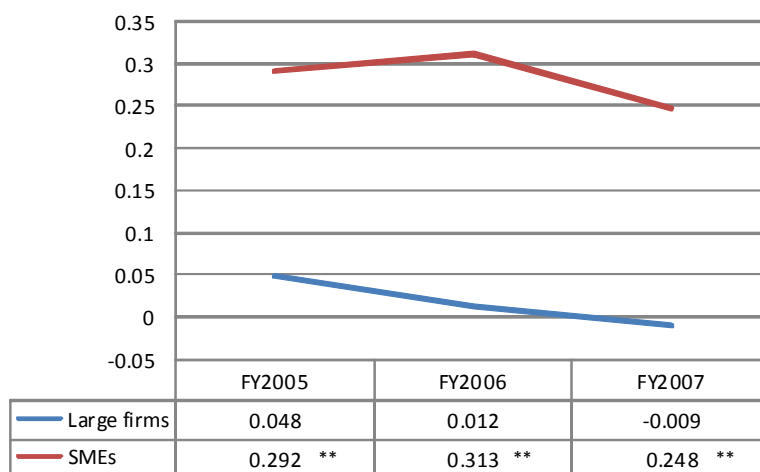
Variable	Independent variables included standard coefficients	
number of faculty	0.451**	0.450**
Solely issued patents	0.373**	0.369**
number of consulting	0.145*	0.147*
General collaboration policies	0.107	0.105
IP policies	-0.009	
Adjusted R2	0.851	0.851
N=69		
* =p<0.05		
**=p<0.01		

TABLE 9. Multiple regression analysis: Joint research with SMEs as dependent variable: FY2007

Variable	Independent variables included standard coefficients			
number of faculty	0.409**	0.411**	0.479**	0.521**
Solely issued patents	0.05			
number of consulting	0.13	0.13		
General collaboration policies	0.127	0.128	0.163	
IP policies	0.216	0.217	0.192	0.248**
Adjusted R2	0.429	0.438	0.436	0.425
N=69				
* =p<0.05				
**=p<0.01				

The results of 3 year's multiple regression analysis are summarized. In Figure 3 regression coefficients of IP policies to estimate joint research with large firms in three years are represented as blue lines and those to estimate SME's are represented as red lines. It shows that the effect of patent management has different effect on joint research when the size of the counterpart firms is

different. For joint research with large firms, the effect of patent management turns out to be not significant in all three years, while for joint research with SMEs, the effect of patent management is significantly positive. During FY 2005-2007, the effect of Japanese university's patent management on joint research with large firms is decreasing, while the effect on joint research with SMEs increased from FY2005 to FY2006, and then experienced a decline from FY2006 to FY2007.



Note: ** =P<0.01

Figure 3. Correlation Coefficients between IP policies and Joint Research with Large Firms and SMEs: FY2005-2007

3.2. A Trend of shift from Joint research to Donation Research from FY2005 to FY2007.

In this part the change of ratio of donation research numbers and joint research numbers from FY2005 to FY2007 ($\square Y$) is examined.

At first, independent samples T-Test was conducted with $\square Y$ and rules related to university-industry collaboration in FY2005. The result of T-Test is summarized in Figure 4. In the figures, the bar stands for the difference of number of joint research when there is a rule and not.

Among all the policies and rules, General Policy on University-Industry cooperation, Policy on Intellectual Property, Policy on licensing of research method patent, Policy on the usage of research materials, Rules on copyright, and Policy on conflict of interest on clinical trials turned out to be significant. Among all these policies and rules, the four IP policies that are significant in T-Test are summarized in Table 10. The number of significant IP policies will be utilized as independent variable.

The descriptive statistics and correlation matrix are shown in Table 11. It is noted that the average value of the change ratio of donation research numbers and joint research numbers from FY2005 to FY2007 ($\square Y$) is -1.17. That means that the shift from donation research to joint research is

overall trend.

The result of regression analysis when independent variable is ΔY is shown in Table 12. The number of IP policies is positively significant to estimate ΔY . While the dummy variable which marks medical university is negatively significant to estimate ΔY .

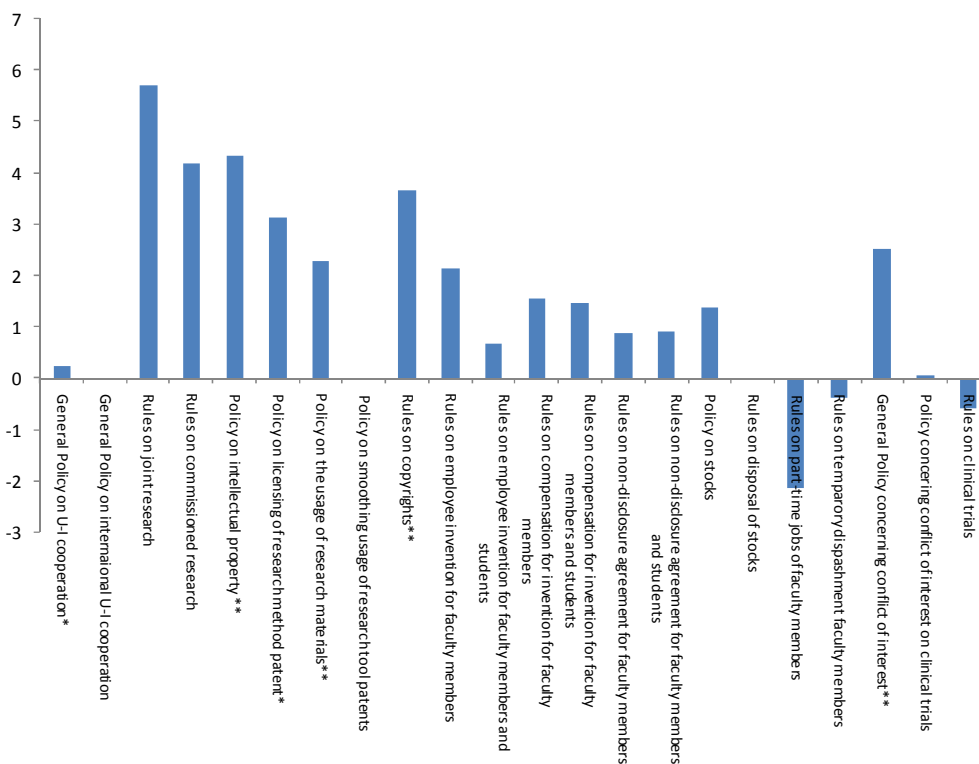


Figure 4. Independent Samples T-Test: Difference of Mean and Significance

Table 10. Significant IP policies in T-Test on ΔY : FY2005

FY2005

- Policy on intellectual property**
- Policy on licensing of research method patent*
- Policy on the usage of research materials**
- Rules on copyrights**

*= $p < 0.05$

**= $p < 0.01$

Table 11. Descriptive statistic: means, standard deviations and correlations

Variable	Mean	s.d.	1	2	3	4	5
1. ΔY	-1.17	4.66					
2.number of faculty	986.9	837.53	0.069				
3.Solely issued patents	51.82	61.44	0.122	0.739**			
4.number of consultings	133.69	262.02	0.085	0.638**	0.770**		
5.General collaboration policies	2.24	0.715	0.145	0.148	0.19	0.084	
6.IP policies	0.147	0.84	0.429*	0.346**	0.350**	0.189	0.336**

N=69
*= $p < 0.05$
**= $p < 0.01$

Table 12. Multiple regression analysis: ΔY as dependent variable

Variable	Independent variables included standard coefficients					
number of faculty	-0.16	-0.15	-0.152	-0.179	-0.11	
Solely issued patents	-0.069	-0.08	-0.075	0.107		
number of consulting	0.144	0.148	0.146			
medical University	-0.608**	-0.608**	-0.608**	-0.603**	-0.601**	-0.594**
engineering university	-0.014					
General collaboration policie	0.027	0.024				
IP policies	0.275**	0.275**	0.282**	0.274**	0.271**	0.238*
Adjusted R2	0.463	0.472	0.48	0.467	0.488	0.485

N=69
*= $p < 0.05$
**= $p < 0.01$

There is a possibility that if the number of joint research is saturating, that may also lead to the increase of ΔY . To exclude this possibility, the author conducted another regression analysis which utilized the number of joint research as one of the control variables. The descriptive statistics, correlation matrix and the regression analysis is calculated and examined. In this model, the correlation coefficient of IP policies is still significant (0.346). It shows that the number of IP policies is significant to estimate ΔY even though the number of joint research is controlled.

4. Discussion

In this study, the authors focus on policies and rules of patent management by university and analyzed their effect on university-industry collaboration. First, joint research with large firms and SMEs during FY2005-2007 was analyzed. A main finding is that the difference of firm size affects the dependence. The results of three year's multiple regression analysis shows that the effect of patent management has different effect on joint research when the size of the counterpart firms is different, namely, the effect is not clear on joint research with large firms while significantly positive on joint research with SME's. This result partially supports hypothesis 1.

As for the effect of firm size on collaboration, several previous studies suggest the possibility.

Acs et al. (1994) infer that small firms' R&D spending responds disproportionately more to university research, and conclude that small firms have a "comparative advantage at exploiting spillovers from university laboratories. Motohashi (2003) argues that in Japan, university-industry collaboration is spreading to smaller and younger companies that are focused on R&D, and its impact on innovation and productivity is greater at these firms. While Cohen et al. (2002) argue that large firms tend to conduct more R&D and be involved in more public research. Kneller (2008) argues that in Japan's university-industry collaboration, large firms have preemption on accessing to university's patent resources, which makes it unfair for SMEs to survive the competitiveness. A recent empirical study by Baba et al. (2007) also indicates that the collaboration between universities and SMEs in Japan is not as strong as that between universities and large firms.

The conflict of IP policies between university and industrial firms caused such a difference is argued. Such conflict lies in two aspects.

The first one is that large firms and SMEs have different policies on the payment related to joint research. Usually, large firms' policy conflicts with universities' policy. Our previous study suggests that the acceptance of patent management of university for SMEs is higher than that for large firms. A previous interview with Hiroshima University (Watanabe, 2008) suggests that university patent manager is trying to control initiative to contract with industry by utilizing solely owned patents. Actually, jointly owned patents are not incentive for university patent manager to utilize because they cannot license them without counterparts' permission. The situation of having a lot of jointly owned patents is like "many off-limit areas for newcomers." To use jointly owned patent strategically, large firms can preserve the right to access to patent resources of universities. Because SMEs usually do not conduct such strategic management to produce jointly owned patents, they have less opportunity to access to the patent resource of universities. The result that the number of solely owned patents is not significant in joint research with SMEs suggests that SMEs cannot access to the patent resource enough by far.

At the same time, because large firms have relatively clear IP policies to conduct such strategic alliance, they try to apply it not only to industry-industry collaboration but to industry-university collaboration. Even though large firms have to spend more money for joint research contract, they stick to their policy because they place greater emphasis on avoiding future risk and costs associated with. After all, large firms prefer advance cash payment to avoid risk of paying royalty in the future. However a patent manager of university tries to preserve the right to obtain licensing fee in the future. Such a conflict leads to negative effect on joint research contract with large firms.

On the other hands, SMEs are usually far from fertile cash flow. Therefore, university is generally not so positive to collaborate with SMEs from just an economic viewpoint. However they can expect royalty in the future if SMEs agree with option contract to pay royalty for university when they will succeed in commercialization of the result from joint researches. At the same time, SMEs usually prefer taking a risk to pay royalty in the future rather than to pay more cash for joint research. It is trade-off between obtaining smaller lump sum without risk or larger and risky royalty in the future. Large firms tend to select lump sum. On the other hand, SMEs tend to select future payment. After all, such patent management enables university to obtain reasonable funds and at

the same time possibilities to obtain licensing income. Similar to industry-industry collaboration, universities use patents not only as a monopoly right for licensing but also as a device for obtaining joint research opportunities.

The second one lies in industrial firm and university's different opinion on transparency of joint research. The deep-rooted informal collaboration and technology transfer between university and industry was thought to be an effective and stable type of alliance in Japan. One of the merits of informal collaboration is that industrial firms can keep the whole process least transparent and thus to protect their business secret and set barriers for other competitors. However, this kind of informal collaboration and misuse of transparency caused a problem of large firms' preemption on university's IP resource. Kneller (2009) argues that the system of university IP management that enables large companies to preempt university discoveries and thus limit opportunities for new technology-based companies to grow. The preemption here refers to the joint research partner receiving exclusive control over not only discoveries definitely within the scope of the joint research project, but also a wider penumbra of inventions related to the theme of the project-discoveries that relied mainly on government funding. This is said to be strangling Japanese entrepreneurship and makes it unfair for SMEs to survive the competitiveness. On the other hand, the openness of academic activity is highly valued in university because university's open and neutral status in research is important for the national innovation system. The preemption of large firms may contribute to the degradation of university's science and research level.

After the privatization of national university, patent management was updated to make a more transparent and fair academic environment for society. However this change restricted informal technology transfer and threat large firms' preemption status at the same time, therefore, the conflict of different opinion on information-openness and transparency also leads to negative effect on joint research with large firms. As a result, the improvement of transparency gives SEMs a fair chance to collaborate with universities easier. Therefore, national university' patent management turns out to have positive effect on joint research with SMEs during FY2005-2007.

Finally, the effect of patent management on joint research/donation research ratio was verified. It's found out that there is a possibility that joint research is shifting to donation research during FY2005-2007. This result completely support hypothesis 2.

As shown in Table 11, multiple regression analysis utilizing 7 variables estimates $\square Y$, a variable to represent a shift from joint research to donation research, quite well by regression equation. IP policies and a dummy of medical universities turned out to be significant. This suggests that patent management is a main reason that caused a trend of change in industry financed research from joint research to donation research FY2005-2007.

As mentioned earlier, large firms' IP policies encountered a conflict with university's patent management. Under such circumstance, joint research is much more complicated than donation research. In joint research, at first, an application should be submitted to the university. Then both parties begin to negotiate on details of the contract such as expense, period, and researchers. This usually takes quite a few months because university and industry both work towards its own objective. Industry wants a technology transfer, usually patents, in a low risk way. Large firms

prefer advance cash payment to avoid risk of paying royalty in the future. However a patent manager of university tries to preserve the right to obtain licensing fee in the future. Such a conflict makes a joint research negotiation very difficult to go smooth.

As a result, although joint research makes it easier for large firms to preempt inventions, they still prefer a less transparent collaboration. In fact, the target of university's current patent management system doesn't include donation research, which makes give large firms a chance to conduct an informal and less information-open collaboration. This is obviously a loophole in university's patent management, which was proven to have caused a change in university-industry collaborative research, namely, industrial firms prefer to choose donation research instead of joint research to shelter their conflict with university's patent management. This mechanism leads to production of joint owned patents with university which cannot be controlled by university nor government. Is this IP management system really reasonable as innovation system? At least as for collaboration with large firms, the reform of the system seems to be necessary.

On the other hands, as for collaboration with SMEs, it is considered that the university IP management contributes to it. Our study shows that university IP management is favorable to collaborate with SMEs than with large firms. However the effect is still not enough. Not like in US, little successful startups has been generated from university IP. In this regard, the IP management to promote startups more effectively should be improved. This is an issue for future studies.

5. References and Notes

Acs, Z. J., D. B. Audretsch, M. P. Feldman (1994). *R&D spillovers and recipient firm size*. Rev. Econom. Statist. 76 .

Baba, Y., A.Goto (2007). *Empirical Research on University-industry Linkages in Japan*, University of Tokyo Press.

Cohen, W., R. R. Nelson., J. P. Walsh (2002). *Links and Impacts: The Influence of Public Research on Industrial R&D*, Management Science.

Kneller, RW. (2007). *Bridging Islands: Venture Companies and the Future of Japanese and American Industry*. Oxford University Press, USA.

Kneller, RW et al (2009). *Large Companies' preemption of University Inventions by Joint research Is Strangling Japanese Entrepreneurship and Contributing to the Degradation of University Science*. Vol. 5, No.2, 2008. Journal of Intellectual Property Association of Japan, P36-43.

Motohashi, K (2004). *University-Industry Collaboration and the Importance of R&D-focused Small and Medium-sized Enterprises – Their Implications on Japan's Innovation System*. Research & Review, 2004/03.

Penin, J (2005). *Patent versus ex post rewards: A new look*, Research Policy 34, 641-656.

Watanabe, T. Et al (2008). *Effect of Patent Management on Joint Researches of Universities in Japan*. IAMOT 2008, 6th-10th April 2008, Dubai International Convention and Exhibition Centre (DICEC), Dubai, UAE.