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Academic Patenting in Japan: Illustration from a Leading Japanese University

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Abstract:

In April 2004, the Japanese government incorporated the national universities as “independent administrative entities”. This important change in Japan’s research culture has allowed its universities to gain higher control and oversight over their strategic development trajectories. In this paper, we will present an analysis centered on the legislative changes concerning intellectual property and their impact on Japanese universities. We will particularly focus our attention on a leading Japanese research institution: Tohoku University. We will analyze the different mechanisms that have been put in place to foster the use of patents by faculty members. In that respect, we introduce a differentiation between university-owned and university-invented patents, and put emphasis on the difference in patenting behaviors among scientific disciplines. Finally, we argue that contractual research is a major channel for the technology transfer of Japanese universities’ knowledge and findings.

□**Keywords:** science policy, academic research, academic patenting, Japan.

JEL: O31, O34, O53.

1 Introduction

Recent work on universities has led many scholars to investigate the incentives behind academic patenting. This stream of literature began with the enactment of the Bayh-Dole Patent and Trademark Amendments Act of 1980, which allowed American universities to receive patents and grant licenses from research funded by the federal government. Patent grants to American universities have peaked in 2002 at just under 3,300, compared to 300 in the seventies. The biomedical related patent classes dominate these awards (National Science Board, 2008). Most observers attribute this tendency to the legislative change, but it is worth noting that the trend preceded the Act: Colyvas *et al.* (2002), based on case studies, argue that two other factors could explain the surge. First, the period saw the rise of important new areas of university research, namely molecular biology and computer science; both of which are of particular interest to the industry. Secondly, over the same time, various Patent Offices increased the range of research results that were patentable. In their view, these two elements were leading the increase in patenting and licensing, the principal effect of the Act being to accelerate these trends.

The increasing reliance on patenting has raised many questions in the literature. The enthusiasts spoke with emphasis of the increasing role of universities in economic development. The “Triple Helix” concept (Etzkowitz, 2003) sees patenting by universities as an indicator of their involvement in the commercialization activities, beyond the traditional role of research and teaching. In the same vein, Jensen and Thursby (2004) show that direct involvement of scholars has proven to be determinant in the success of technology transfer. Skeptics consider that the increase in patenting and commercialization by universities could lead to some caveats. It is possible that industry uses its growing relative importance to shape research agendas, inducing a redistribution of resources from basic to applied research. Other possibly negative effects of academic patenting include potential conflicts of interest, secrecy issues, delays in the publication process and increased costs of research (Heller and Eisenberg, 1998). A growing “anti-commons” perspective highlights the negative role of Intellectual Property Rights (IPRs) over scientific knowledge. Academic inventors may have to use patents to protect and exchange their new knowledge. In that respect, patenting is seen as a defensive mechanism to enable the diffusion of knowledge. This new situation may be less efficient than the previous reliance on pure “open science” because of the transaction and maintenance costs associated with patenting. A large number of studies has examined the impact of patenting activity on academic research; while the majority of the research has been centered on the US and Europe, very little has been said about Asia. The prime aim of this paper is to start filling this gap. We will look closely at the Japanese case and provide an analysis of a leading Japanese research university, Tohoku University. To our knowledge there is no study available in English on this topic centered on the recent Japanese context. We will investigate the mechanisms at stake, and meticulously whittle the salient figures.

Our analysis is based on data in English and Japanese for the Japanese context and on internal documents for Tohoku University. The work presented here has for main objective to analyze the implications of four years of drastic changes resulting from the Incorporation of national universities in 2004, as this marks the moment when Japanese national universities started gaining control of their strategic development. The national universities are not a

homogeneous entity anymore; they can develop their own distinctive strategy. The legal system where they evolved has changed dramatically, and each single university now has to adapt to this new environment. In this context, it is very interesting to study the changes in terms of IPR policies for the universities and to determine how these changes have modified the behavior of faculty members. For these reasons, we believe scholars would gain from an increased scrutiny of the Japanese experience: because of the difficulty of the Japanese language, many findings and documents have not yet been publicized to a wider audience. We intend to partly fill this gap.

This paper is organized as follows: Section 2 introduces the different channels of university technology transfer. Section 3 presents a description of the Japanese case in terms of institutional reforms and links them to academic patenting. Section 4 then moves to a description of the Tohoku University case. Section 5 discusses the implications of the increasing use of IPRs by Japanese universities.

2 The different types of university-based technology transfers

It is valuable to note that universities have always been involved in technological transfer. For instance, with the role of German academicians in the development of the 19th century chemical industry, or as the seminal work of Rosenberg and Nelson (1994) has documented, there is a long tradition of universities transferring knowledge and technology to firms, though this has mainly occurred through channels like publishing, consulting, conferences, etc. In the case of Japan the government launched, in 1886, the first Japanese Department of Engineering in the University of Tokyo. It was the first Engineering Department within a university (not in a College, Institute, etc.) in the world. This department has a long history of transferring knowledge and technology, as well as collaborating with industry (Murakami, 1994). These three examples stress the importance and long record of university-based technology transfers. Nowadays, the difference is that the political and economical spheres have put increasing pressure on universities to encourage a more active transfer of their knowledge to society, and particularly to contribute to economic development. As noted by Geuna and Muscio (2008), there is an institutionalization of university-industry linkages through the direct involvement of the university bureaucracy. As we will see in the next section, this process is prevailing in Japan, too.

In terms of technology transfer mechanisms, many different channels characterize university-industry relationships. First, there are the traditional publication and conference mediums. Within this first one are personal contacts; on the one hand among faculty members and students, on the other, between academic researchers, industry and government. The second way is the professionalization of knowledge transfer activities, the so-called third mission of the university. In order to fulfill this mission, Technology Transfer Offices (TTO) or Technology Liaison Offices (TLO) have been created within universities. TTOs tend to be focused mainly on the exploitation of IPRs via licensing or the creation of spin-offs, but are also active in supporting university-industry interactions via contractual research or consultancy.

The majority of studies focused on knowledge transfer use three kinds of data: patents and invention disclosures, licenses and spin-offs. Such data is increasingly employed as it

becomes widely available; the first two are now standardized information. This information is used as a proxy to measure technological transfer by universities. In this paper, we intend to focus on the academic patenting of Japanese institutions, as it becomes a widely used mechanism by research universities. Nevertheless, it is important to keep in mind that IPR-related activities are only a small part of the knowledge transfer activity of universities. Agrawal and Henderson (2002) argue that “too great a focus on patenting may seriously misrepresent the nature of the impact of the university on the private sector”.

3 The case of Japan

In this section, we introduce the legislative changes that occurred in Japan concerning the university-industry settings. We particularly focus on their influence on the IPR regime, and stress the importance of contractual research as a mean of transferring knowledge and technology.

3.1 University Reform

In order to understand the development of academic patenting activities in Japan, it is necessary to restate some key institutional reforms that have led to a dramatic increase in university-owned patent. We will investigate the changes of national universities' legal status where the majority of academic research takes place, as well as the modifications that occurred in the university-industry legal framework.

University-industry collaboration has evolved recently in order to facilitate interaction between the two institutions. Until 1980, restrictive government regulations caused levels of university-industry collaboration to remain low. In 1983, the Ministry of Education relaxed its regulations, and notably allowed national universities to cooperate with industry. However, it is only after the introduction of the 1995 Science & Technology Basic Law and the TLO Law that the real changes began.

We can step into the argument by briefly stating the main Laws that are structuring the technology transfer activities within universities. Below are the three main ones shaping the legal framework:

1. The 1998 *Law to Promote the Transfer of University Technologies* (the TLO Law) legitimized and facilitated transparent and contractual transfers of university discoveries to industry.
2. The 1999 *Law of Special Measures to Revive Industry* (the Japanese Bayh-Dole Law)
3. The 2000 *Law to Strengthen Industrial Technology* established procedures, through which university researchers can obtain permission to consult for, establish and even manage companies. It also streamlined the procedures for company sponsored commissioned and joint research.

All these legislative changes have been listed here to illustrate the increasing importance that the Japanese authorities place on university-industry collaborations and one

of its corollaries, patenting.

Another important factor is the change in status of national universities and its influence on patenting patterns. The anchoring points of the university reform is the Toyama Plan (2001) named after the Minister for Education, Culture, Sports, Science and Technology Atsuko Toyama. This plan proposed three major reforms: 1) the reorganization and incorporation of national universities, 2) the development of universities that conform to the highest international standards by using third party evaluation, and 3) increasing the proportion of competitive funding. The plan recommended that national universities should be transformed into national university corporations (NUC), a legally separate institution from the government. Following these lines, in April 2004, the Japanese government incorporated the national universities as “independent administrative entities”¹. Since 2004, the universities have gained a greater autonomy. They can recruit more easily academic and non-academic staff. Moreover, they can maintain the ownership of their invention, which was seldom the case before the Incorporation. Consequently, there has been a surge in cooperative contracts, in number and amount, as well as in patents.

[Fig. 1: Invention Disclosures and Patent Applications by National Universities]

Since 2004, national universities have been solely managing their intellectual property. Figure 1 shows the influence of these changes of status on invention disclosures and patent applications; the invention disclosures have started to rise before the Incorporation, with a strong hike from 2002 and 2003, it preceded the increase of patenting, thereafter the number only slightly increased indicating a kind of plateau around 7,500. As for patent applications, the number skyrocketed in 2004, and increased steadily thereafter. In 2007, the number of national patent applications decreased for the first time, while the number of foreign applications intensified. These figures indicate two tendencies: first the Incorporation entailed a huge increase in IPR activities; second, in 2007-8, it seems to have reached a peak. Furthermore, universities seem to have gained expertise and quality as the number of national applications decreased and foreign ones increased in 2007. Foreign applications are often judged of more value to the applicant as they cost more to start and maintain².

Universities all over the world are increasingly patenting the outcome of their research (Geuna and Nesta, 2006; Mowery *et al.*, 2001). Our data shows that Japan is also following this upward trend. Together with research and teaching, universities are being asked to be the generators of future economic growth. Nowadays, Japanese universities are directly managing their IPRs, and are thus more prone to maximize the number of patents they can produce. New rules have been enacted about the invention disclosure process in order to facilitate patenting. Secondly, with time passing, the administrative staff has complied with the new regulations, and has accepted the notion of patentability of university inventions, and market orientation of some research. At the same time, they have increased their expertise, which had the consequence to entail a slight drop in the number of applications: the inventions are now scrutinized more thoroughly.

¹ For a more details account of the process that led to the Incorporation refer to Carraz and Harayama (2008).

² Generally, in case of an international application, Japanese universities used the unified procedure provided by the Patent Cooperation Treaty. They employ the same documents as for the national application, with a delay of one year.

On a more sociological note, we can introduce the notion developed by Sine et al. (2003) on institutional prestige: in our case we could argue that the prestige of the university is linked to the level of the patenting activity together with the publication output. Recently, information has started to be compiled to rank universities by technological strength, based on the number of patents issued and their relevance (Staedter, 2003) As these indicators are often used in rankings, more is necessarily better. Hence, legal changes have put more emphasis on patenting in the decision-making processes of universities. Figure 2 shows the number of patent applications by Japanese universities in terms of patents per year: in 2003, 61 universities had applied for 1 to 9 patents, a number that rose to 115 universities in 2005. The tendency is the same for the highest bracket: in 2003, only one university applied for more than 200 patents, in 2005 there were 7. This illustrates the fact that universities quickly embraced the use of patents, at both ends of the spectrum. However, we should remain cautious about the total increase of patents applied by Japanese universities; universities not previously active in patenting account for a significant part of the growth in overall university patenting. This phenomenon has been similar in the US in the 70s, as noticed by Mowery *et al.* (2001).

[Fig. 2: Patent Applied by Japanese Universities According to Frequency]

3.2 Organizational structure of IP management institutions

In 1997, the Ministry of International Trade and Industry (MITI)³, in coordination with the Ministry of Education, Culture, Sports, Science and Technology (MEXT), proposed to extend the support of university-industry cooperation. An important part of this initiative was the creation of TLOs. In 1998, national universities had no independent legal standing, and thus it was difficult to apply for patents on inventions by their faculty and to license such inventions. The *Technology Transfer Law* authorized universities to establish independent or semi-independent TLOs that could sell or license inventions and distribute royalties to inventors and universities. However, academic inventors were not obliged to assign their inventions to the TLOs and could continue to transfer them directly to companies. Kneller (2003) suggests that inventors often turn to the TLOs when an invention has no takers.

In order to establish a comprehensive IP management procedure, from the creation and evaluation of IPRs, to their management and licensing, the MEXT established a program to support the creation of in-house IP management offices (hereinafter referred to as “IP offices”) within universities. In August 2003, just before the Incorporation, 43 universities have launched an IP office to develop their own technology transfer management system. Their responsibilities partially overlap those of TLOs. In general, IP offices manage the whole IPR procedure from invention disclosure to patent application, and they have final authority over patenting and licensing decisions as the patent owner through the university. But some parts of the procedure, which need professional skills such as marketing, patent surveys and licensing, are outsourced to TLOs. In some universities, relations between the IP offices and TLOs have been managed smoothly, while in others, there has been friction. The issue is that they have different decision-making structures in terms of IP management and the way to deal with research contracts; it is particularly true in their way to manage license earnings, patent costs and contract specifications.

The inventor has different people to deal with, and the delimitation of power is not always clear between the TLOs and IP management Offices. An important issue to address

³ In 2001, the MITI was reorganized to the Ministry of Economy, Trade and Industry (METI).

for the newly incorporated universities is how to resolve the inherent complexity and coordination of a dual structure system. In terms of manpower, IP offices and TLOs employ a relatively similar number of staff for licensing and IP management related tasks, the difference being that IP offices have more personnel dedicated to the development of sponsored research and industrial liaison. Their job is not only to create IP, but to find industrial partners to cooperate with.

On a more practical level, there are three types of IP management organizational configurations. The IP office is always within the university; as for TLOs there are three kinds of settings. The first one is the “internal model”, IP offices and TLOs are merged within the university, it is usually seen in private universities and in some national universities that have launched their TLOs in the last 2 or 3 years. In this configuration, the two structures are coexisting within the university, but there is a division of labor. IP offices are handling the invention disclosure process, the management of IPRs resulting from contractual research, and they deal with the Japan Patent Office. TLOs are in charge of the practical use of the IPRs, such as finding licensing partners, and supporting the creation of university spin-offs.

The second type is “External & Exclusive”⁴, it is the case in most national universities. The TLOs are outside the university structure, though they are dealing only with a single university. Recently, some universities have exited this type, we could name for instance the Tokyo Institute of Technology. They have wholly integrated their TLOs to strengthen the coordination of their activities.

The third type is “External & non-Exclusive”. In that case one university has alliances or cooperation agreements with more than two TLOs depending on its policy and/or characteristics. This organization has the merit to foster the specialization of TLOs in terms of technologies; and/or activities, for instance some specialize in start-up support. One of its main demerits is the resulting complexity of the arrangements between multiple universities and TLOs. This type is concentrated on the Kansai area (Kyoto-Osaka-Kobe Region) where a large number of universities are concentrated in a relative small territory, it is rarely seen in the rest of Japan.

Hence, Japanese universities have 2 entities/offices simultaneously promoting technology transfer activities, especially IP-related activities. From the standpoint of intellectual property management, they pursue three goals, such as 1) Creation of Intellectual property, 2) Protection of Intellectual property, 3) Exploitation of Intellectual property. Practically, these goals are achieved by a number of activities: implementation of commissioned and joint research, examination of new inventions, patent application and management, technology transfer through licensing and marketing, support to start-up companies, managing consulting activities of faculty members, dealing with conflict of interests. In total, a recent MEXT survey of industry-academia technology transfer specialists, has defined 44 missions that are conducted by either IP offices or TLOs⁵.

[Fig. 3: IP Management in Japanese Universities: Incomes]

⁴ Or “Almost Exclusive” to be more precise. For instance, in the case of Tohoku University, its TLO (Tohoku Technoarch) deals with other universities of the region, however around 90% of its workload is centered on Tohoku University.

⁵ See Takahashi and Watanabe (2007) for an in-depth analysis of the subject.

Figure 3 shows the different sources of income of TLOs and IP offices, for the fiscal year (F.Y.) 2005. The first thing that we notice is that the income generated by licensing revenues is rather sleek. At best it accounts for 26,9% in the TLOs structures, while for the internal IP offices it drops to 13,6%. This figure shows that the lion's share of these institutions' revenue comes from subsidies. IP Offices are heavily subsidized by the universities and the MEXT, which runs a five year plan (2003-2008) to help fostering them. The TLOs receive important subsidies from the METI. The main point here is that these structures have been promoted by the government as a way to develop university-industry relationships, but the figure showing the different sources of income reveals a financial imbalance of the activity. So far they have not been able to cover their operating costs after ten years of operations for the oldest TLOs, and nearly five for the IP Offices⁶. This phenomenon is quite common, indeed not all the universities are winning in the patent casino, few patents actually bring in income, and many are paying more to run their technological transfer activities than they are bringing-in license revenues.

3.3 Contractual Research

Contractual research is an important aspect of Japanese universities' technology transfer policies. It is one of the main channels of university-industry collaboration and IP-related activities. In that respect, it has two important characteristics. First, researches resulting from such contracts are likely to be licensed smoothly because there is already an industrial partner; second, IPRs are at the center of the negotiation process while finalizing a contract. Thus we intend to explain concisely how it operates.

If a company, or any organization, wants to have a formal research agreement with a national university, then it has to enter into either a commissioned⁷ or joint research contract with the university. In case of joint research, the university receives funds and researchers mainly from private firms to conduct research on common projects⁸. Under commissioned research, researchers in universities are appointed by firms, research institutes, or governmental agencies to carry out research by contract. The principal difference between these two types of contract is that in joint research, company researchers can work in the university laboratories, while this option is not available under commissioned research contract. Generally, more than 80% of commissioned research projects are conducted with the national government, or with a private company under a national project scheme. On the contrary, the bulk of joint research contracts are directly carried out with private companies.

[Tab1: Contractual Research by National Universities]

Joint and commissioned research is an important mean of technology transfer for Japanese universities. The legal framework was enacted in 1983, and such transfers have grown in number and yen value ever since. Table 1 shows the trend over a 20-year period. In the last ten years only, joint research has been multiplied by 7 and commissioned research by 3. For joint research the average amount spent on one contract has been stable - if we exempt the first years' hike - whereas for commissioned research the amount has been increasing

⁶ IP offices have their own operating funds, so their accounting can be traced.

⁷ It is sometime referred by the term "sponsored research".

⁸ As for F.Y. 2007, 62,1% of the funds came from large companies and 14,4% from S.M.E.

steadily.

On the company side use of joint and commissioned research, we could cite a MEXT (2007) survey which was sent to Japanese companies with a capital superior to ¥1 billion, with the aim of understanding their research strategies better⁹. One part of the questionnaire was related to their outside partners, especially universities. Responding to where the companies intended to spend more money as an external provider of research, Japanese universities came first. When asked to provide an appreciation of their joint activities with Japanese universities, 36,8% judged contractual research with university as a positive experience, second only to the ability of the university to solve complex problems (49,9%). More specifically, a question was formulated to evaluate the pros and cons of conducting contractual research with universities¹⁰. On the positive side, the three most common answers are: the enhancement of the firm's research capabilities, the outsourcing of basic research, and the creation of a research network. On the negative side, the top three are: the non applicability of some university research, the lack of secrecy, and the difficulty to gain a monopoly on the IP resulting from common research. This shows that the companies value collaboration with the university, as it expands their knowledge capabilities, but they have some concerns about the openness of the relation, which might be seen as a possible threat to the traditional open environment of university research.

4 Tohoku University

This section will present the case of Tohoku University, a leading Japanese research university. The aim is to show how it adapts itself to a new environment favorable to patents.

4.1 A short presentation

In this section we briefly presents our unit of analysis, Tohoku University, and give figures about the recent trends in its patenting activity.

Tohoku University was founded in Sendai in 1907 as Tohoku Imperial University. It was the third Imperial University in Japan. It is located in Sendai, the most important city of the Tohoku Region (North-East of Japan). It is known as a strong research university; the 2008 Shanghai academic ranking put it in 4th place among Japanese universities and 79th in the world. The Thomson ISI list of the most cited papers in the world ranked Tohoku University 2nd in the field of material science, 13th for physics and 22nd for chemistry. In the national context it is widely known as one of the flagship universities¹¹.

In order to define its patenting activity, we have to make a distinction between university-owned patents and university-invented patents. University-owned patents are

⁹ Of the 1,791 initially contacted, 941 companies replied.

¹⁰ The companies could choose up to 4 responses in a panel of 12.

¹¹ Flagship universities" in Japan are defined as top national and private research universities -- namely, the seven former imperial universities (Tokyo, Kyoto, Hokkaido, Tohoku, Nagoya, Osaka, and Kyushu); the Tokyo Institute of Technology (a top national university in engineering); and three leading private universities (Keio, Waseda, and Ritsumeikan.) Yonezawa (2007).

patents where the university owns the IPRs. Unfortunately, data on university-owned patents are only a reliable indicator for the US and Canada. For European data, in the 80s and 90s, there is a downward bias if you only look at university-owned patents. This is due to the tendency of European academic researchers to leave the property rights of their invention to the firm that financed the project, but yet to be included in the list of inventors. Therefore, there is no official record of these transactions by the university administration, we have to use a different indicator to encompass this phenomenon: University-invented patents. They are the ones that have at least one faculty member listed as inventor, whether the university is assigned the patent or not. In recent years there have been a few studies on university-invented patents to take into account this fact, notably in Belgium, Finland, France, Germany and Italy¹².

[Fig.4: Tohoku University Patents]

In the case of Japan, the phenomenon was mainly similar until the Incorporation. Kneller (2003) illustrated how a majority of university discoveries were transferred directly from inventors to companies under the guise of donations, the researcher being listed on the patent application as an inventor. Recent reports from the National Institute of Science and Technology Policy (NISTEP) (Kanama and Okuwada 2007, 2008) investigate this issue. They use the concept of university-invented patent. They have listed the names of all researchers that have filed an invention disclosure during the period 1993-2004 at Tohoku University, then looked up all these names in the Japanese Patent database in the inventor section. In the case of a university-invented patent, the university does not have any ownership rights on the patent, despite the fact that there is at least one faculty member listed as an inventor; university-owned patents are the property of the university. One of the many interesting results of this NISTEP study is presented in Figure 4. It describes Tohoku university-owned and invented patents. We see that up to 1999, university-owned patents were quite inconsequential: their number started to rise in 2000 as a consequence of the TLO Law and Japanese Bayh-Dole Act, but it really shows a dramatic increase after Incorporation. Until 2000, only a minority of the inventions disclosures led to a patent application by the university. Alternatively, university-invented patents were quite high throughout the period, with an increase in 1999-2000 and a decrease after 2004 when the university started to manage its IPRs more aggressively. Overall, we see from Figure 4 that university members have been active for a long time in the IPR business with changes of ownership during time, from the research partner to the university, and that the trend is upward. This result can be used to give a better understanding of Figure 2, the rise of the patenting activity that occurred in 2004 did not come from a vacuum. The potential was there before; it just took more informal channels to diffuse. The faculty members were transferring their IP rights to the companies they were collaborating with. We will see in the next section how this informal cooperation changed to a more formal one especially through cooperative research.

4.2 patenting

The aim of this section is to explain the trend of Tohoku University patenting activity from the Incorporation to 2007. We will take into account: the total number of applications by the university, and the distinction between single application (i.e. the university is the sole

¹² See Guena and Nesta (2006) for an overview of these studies.

applicant, in that case it exercises full ownership) and co-application, namely the university shared the ownership with a third party (third parties may be companies, research organizations, government agencies, etc.). The following analysis focuses on the above-mentioned elements. To begin with, it is important to restate that one of the principal elements of university-industry cooperation in Japan is contractual research, its importance has been increasing since 1995 (1st Basic Plan on Science and Technology) until the year 2008, the movement preceded and sustained itself after the Incorporation of 2004. In the same token, the proportion of co-application has increased as well. Notably, after the Incorporation, the proportion of co-applications has remarkably widened. In 2005, national universities, TLOs and public research organizations have applied for 5,878 national patents, among which 28% are linked to joint research and 15% to commissioned research, collectively research contracts are at the source of 47% of co-applications (Ijichi and Nagaoka, 2007).

When a university files for a domestic patent in Japan, there are two options; a co-application or a single application: for co-applications it may or may not be linked to a research contract. In cases of collaborative contracts between a university and a company, the name of the university inventor is listed as well. As for the technological classification, the recommendation of the second Science and Technology Basic Plan (2001, March 30) is to divide the technologies into four categories as follows:

1. Life Sciences,
2. Information and Telecommunications (IT),
3. Environmental Sciences,
4. Nanotechnology/materials.

When the invention disclosure is filed, the inventor chooses one the above-mentioned categories to classify it. Practically, in case of contractual research, the university manages the IPRs in the following manner:¹³

1. Tohoku University (TU) shall own all IPRs arising from the results of its contractual research.
2. TU may license such IPRs to the company for a fee or may transfer all or parts to the company.
3. If TU and the company jointly hold any IPRs, TU and the company shall enter into a joint application agreement or joint ownership agreement, which shall include the three following clauses:
 - A. TU may not Exploit the IPRs in any area outside of the research area;
 - B. The Company may Exploit the IPRs itself without the consent of TU;
 - C. The Company shall pay to TU all expenses paid by TU to file an application and maintain such IPRs until the company enters into an agreement with TU, and shall pay all necessary expenses after the execution of such agreement;

[Fig.5: Tohoku University Patents Application by Technological Field and Type of Contract]

¹³ To be precise, there are some minor differences in terms of IPRs between commissioned research and joint research contracts.

During 2004-2007, 735 professors have been listed as inventors on at least one patent; in 2008 there was an increase of 27,8% of the faculty involved in patents. As a matter of comparison, we can compare to similar data available for the Massachusetts Institute of Technology (M.I.T) where, from 1983 to 1997, approximately half of the teaching staff has been involved in at least one patent, in three years about a quarter of Tohoku university staff has filed an invention disclosure, of which many will lead to a patent.

In the case of co-applications, there are two scenarios: a research contract that leads to a co-application, and a co-application without prior research contract. Unfortunately, we do not have data for the first year (2004), but since 2005 the university administration has kept statistics on this subject. Figure 5 displays the proportion of single and co-application on the abscissa and the proportion of patent applications linked to contractual research on the ordinate, the data is grouped according to technological fields. The data clearly reveals some tendencies: there is an increase in the proportion of co-applications, and it is linked significantly with contractual research. There are also differences among the technological categories: IT increasing its share in the total number of co-applications but having relatively less use in contractual research. In nanotechnology, a high proportion of applications are linked to prior contracts. On the other hand, life sciences have a high share of single application by the university and fewer associations with contracts.

The overall tendency lies in the fact that the administration of the university puts a lot of emphasis on collaborative research contracts, as they are the source of research funding, future inventions and resulting patents. Besides, various measures have been taken to support the university-industry relations in Tohoku University: the university-industry liaison office has been strengthened, each department now has administrative employees in charge of the liaison, furthermore some professionals from outside the university have been hired to facilitate university-industry collaboration.

5 Discussion

The increasing reliance on IPRs by Japanese universities is definitely a widespread phenomenon. Furthermore, the speed with which these changes took place is quite impressive: in a few years' time, they have greatly expanded their usage of IPR alongside an increased reliance on contractual research. The relations seem to have become more contractual since the Incorporation. Table 2 shows the speed and scope of IPR activities by Japanese and American universities. In only a few years, Japan has increased its IPR-related activities. The amount spend by invention disclosure is at the same level as in the American case. In terms of number, and considering their relative size, the number of invention disclosures and patent applications are quite similar. The ratio, patent application to invention disclosure, is higher in Japan, which can be partly explained by the pressure to develop their patenting activity, a relative lack of experience by the university administration in evaluating the inventions, and strong incentives placed on the researchers. The number of patents granted is relatively low, which is normal as it is quite a new phenomenon. As for licensing and university spin-offs, the numbers in Japan are still quite low compared to the US.

[Tab.2: IPR's use by Japanese and US universities in 2005]

On a more theoretical perspective, an important question remains: What are the implications of the increasing use of IPRs by Japanese universities. As we have illustrated, a lot of emphasis has been put on this particular channel of technology transfer by the university. The question then is whether or not it is detrimental for the research done by the faculty members.

First, we can argue that this channel is not the most important one. Agrawal and Henderson (2002), based on both qualitative and quantitative data from the MIT, have showed that patenting is a minority activity. Indeed, a majority of the faculty in their sample had never patented. Furthermore, publication rates far outstrip patenting rates. On a more qualitative point of view, most faculty members estimate that patents account for less than 10% of the knowledge that is being transferred from their labs. Additionally, considerable concern has been expressed in recent years regarding a possible negative impact of patenting on the public good's nature of academic work. This is called the crowding-out hypothesis. Two stories are at stake here: first the possible risk of a switch towards a more applied research by academic scientists as opposed to basic research; second a change in the reward structure encouraging to seek IP protection of the research results, therefore possibly postponing scientific publications.

As a consequence, there is a need for better understanding of the influences of these policy changes on the research activity of faculty members. One related question, often used as a proxy to this problematic, is the link between patenting and publication activities of academic researchers. Empirical research tends to indicate that these activities are complementary rather than substitutive. Many studies of academic inventors have shown a positive correlation between patenting and publishing, suggesting that commercialization does not come at the expense of public disclosure of scientific discoveries by scientific members (Breschi *et al.* (2005), Carayol (2007), Van Looy *et al.* (2006), Stephan *et al.* (2007)).

In the case of Japan, we have to take into account its long history of university-industry relationships. For instance, the Department of Engineering of Tokyo University has an extensive relation with industry; 32% of the department members have been an inventor on at least one industrial patent, 46% of them had no less than a paper collaboration with firms, and 22% did both (Baba and Goto, 2007). The figures are very high for both channels. The next step would be to gain a better understanding of the different mechanisms at stake in the Japanese context, when choosing how to transfer a university technology. To start with, we have already shown (Fig 5) that depending on the technological fields, the patenting strategies differ in terms of contractual research and patent application considerations. Then, it is important to comprehend what incentives are at stake for the faculty members. Further researches are needed.

On the case of Tohoku University, Carraz and Takahashi (2009) have conducted an econometric analysis on the determinants of academic patenting by Tohoku university staff since the Incorporation. The paper intends to explain which factors are at stake in the patenting behavior of faculty members. Three types of variables have been tested: publications, funding, and individual characteristics. We have used a Zero Inflated Negative Binomial model as it fitted the characteristics of the variables. The first result relates to the publication level. We find a positive and significant relation between patenting and publishing. Accordingly, these two activities seem to be complementary, which is in line with

many empirical studies. At the department level though, the quality of the department publications affects the probability of a researcher to stay in the non-patenting regime. We can see in this pattern a kind of specialization, with some research units putting more focus on publishing for high quality journals and some other doing research more related to patenting outcomes.

As for contractual funding, whether public or private, we have found a positive correlation. Moreover, getting public contractual funding significantly affects the probability of reaching the patenting regime. This appears to be counterintuitive, but it may be justified by the fact that the amount of public funding is a signal of the quality of the research done. At the departmental level, public funding affects negatively the dependent variable. It is very interesting, as it shows again a kind of specialization, the amount of public contractual funding being negatively correlated with the patenting activity.

Lets now move to the individual characteristics. One of the main criteria of evaluation for a scientist and his/her parent academic institution is the quality of their publication portfolio. In the academic sphere, the game is defined by the priority of the discovery and the underlying peer-review system that validates the discovery (David, 2007). There is a reinforcing mechanism in place, which provides more opportunities to the ones who are already successful, the *Matthew Effect* as it is often called in the literature. Therefore, young researchers may not consider patenting if it affects negatively their publication outcome, while older researchers may have more incentives to patent as they may place more value on social wealth (Carayol, 2007). We therefore assumed an inverted-U shape relationship between age and patenting activity. In our data set, The *Age1* dummy variable, researchers from 26 to 35 years old, correlates positively with patenting. Therefore the youngest scholars differ from the older ones in their patenting decision patterns. This could be linked to the fact that career advancement and patenting seem to be related: there is a positive link between the dummy promotion and patenting. It signals a possible change of reward structure as the IP activity and promotion seems to be positively correlated, along with the fact that the younger generation is getting engaged relatively more in IP activities compared to the older.

6 Concluding remarks

Japanese universities have embraced academic patenting enthusiastically since the Incorporation of national universities. They have increased their reliance on IPR strategies. At the governmental level, many regulations have been enacted since the mid-90s in order to promote university-industry relations. At the university level, the supporting structures have strengthened, but one should be cautious in interpreting these trends. First, they were not built from scratch, we have showed that the IPRs were already transferred to companies on a large scale, the difference being that these relationships are now more formalized in the form of contracts. Second, the Japanese system isn't exempt from some cultural idiosyncrasies: for instance one of the main mechanism used for technology transfers is contractual research, whereas licensing and university spin-offs are quite rare. By developing the use of IPRs, the relations with contractual partners become more formal, and consequently easier to monitor. However if one of the tacit goals is to develop an entrepreneurship based on IPRs, there could be a kerfuffle over the efficiency of the maneuver.

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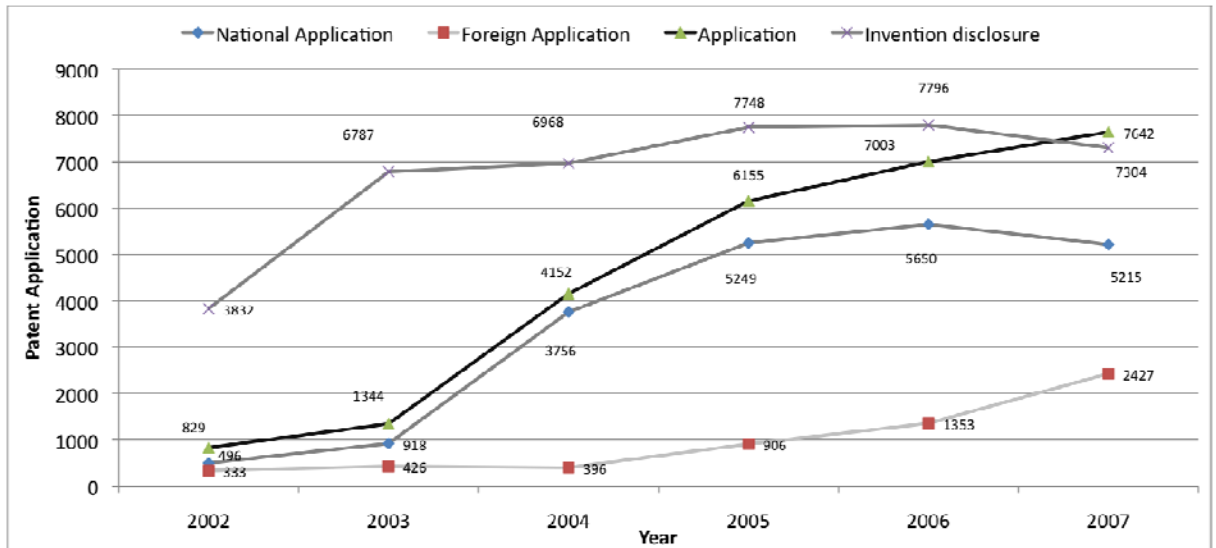
References

- Agrawal, A. and Henderson, R. (2002). Putting patents in context: Exploring knowledge transfer from MIT. *Management Science*, 48(1):44–60.
- Baba, Y. and Goto, A., editors (2007). *Empirical Research on University-Industry Linkages in Japan* (In Japanese). University of Tokyo Press.
- Breschi, S., Lissoni, F., and Montobbio, F. (2005). From publishing to patenting: Do productive scientists turn into academic inventors? *Revue d'Economie Industrielle*, 110:75–102.
- Carayol, N. (2007). Academic incentives, research organization and patenting at a large French university. *Economics of Innovation and New Technology*, pages 71–99.
- Carraz, R. and Harayama, Y. (2008). Japanese university reform seen through bureaucratic reform and changes in patterns of scientific collaboration. In Weber, Luc, E. and Duderstadt, James, J., editors, *The Globalization of Higher Education*, chapter 8, pages 93–107. *Economica*.
- Carraz, R. and Takahashi, M. (2009). Incentives to patent in a leading Japanese university. *Mimeo*.
- Colyvas, J., Crow, M., Gelijns, A., Mazzoleni, R., Nelson, R., Rosenberg, N., and Sampat, B. (2002). How do university inventions get into practice? *Management Science*, 48(1):61–72.
- David, P. (2007). The historical origins of 'open science': An essay on patronage, reputation and common agency contracting in the scientific revolution. *Stanford University Working Paper*, pages 1–82.
- Etzkowitz, H. (2003). Innovation in innovation: The triple helix of university-industry-government relations. *Social Science Information*.
- Geuna, A. and Muscio, A. (2008). The governance of university knowledge transfer. *SPRU Electronic Working Paper Series*, 173.
- Geuna, A. and Nesta, L. (2006). University patenting and its effects on academic research: The emerging European evidence. *Research Policy*, 35(6):790–807.
- Heller, M. and Eisenberg, R. (1998). Can patent deter innovation? The anticommons in biomedical research. *Science*, 280(5364):698–701.
- Ijichi, T. and Nagaoka, S. (2007). Management of IPRs for upstream research inventions in universities and national r/d institutes in Japan: Results from the IIR IP survey 2006. *Hitotsubashi University, Institute of Innovation Research* (In Japanese).
- Jensen, J. and Thursby, M. (2004). Proofs and prototypes for sale: the licensing of university inventions. *American Economic Review*, 91(240-259).
- Kanama, D. and Okuwada, K. (2007). A study on university patent portfolios: Portfolio of patent application from Tohoku university (In Japanese). *Technical Report 147, National Institute of Science and Technology Policy*.

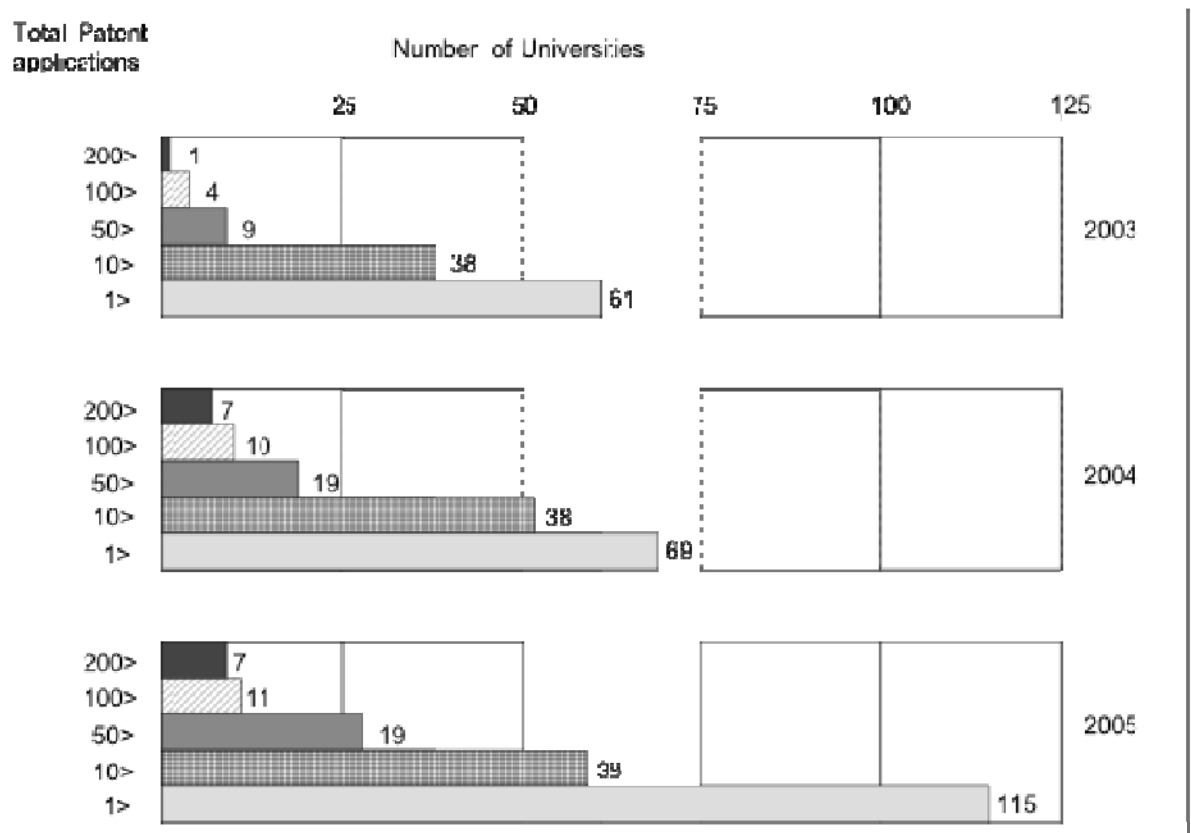
- Kanama, D. and Okuwada, K. (2008). A study on university patent portfolios (2): The impact of intellectual property related policies and the change into corporation of national university (In Japanese). Technical Report 154, National Institute of Science and Technology Policy.
- Kneller, R. (2003). University-industry cooperation and technology transfer in Japan compared with the US: another reason for Japan's economic malaise? *University of Pennsylvania Journal of International Economic Law*, 34(2):329–449.
- MEXT (2007). Survey on the research activity of private companies (In Japanese). Survey.
- Mowery, D. C., Nelson, R. R., Sampat, B. N., and Ziedonis, A. A. (2001). The growth of patenting and licensing by US universities: an assessment of the effects of the Bayh-Dole act of 1980. *Research Policy*, 30(1):99–119. National Science Board (2008). *Science and Engineering Indicators*. National Science Foundation.
- Murakami, Y. (1994). *The cultural Aspects of Science* (In Japanese). Seidosha.
- National Science Board (2008). *Science and Engineering Indicators*. National Science Foundation.
- Rosenberg, N. and Nelson, R. R. (1994). American universities and technical advance in industry. *Research Policy*, 23(3):323–348.
- Sine, W., Scott, S., and Di Gregorio, D. (2003). The halo effect and technology licensing: The influence of institutional prestige on the licensing of university inventions. *Management Science*, 49(4):478–496.
- Staedter, T. (2003). Academic patent binge. *Technology Review*, dec./jan.
- Stephan, P., Gurmu, S., Albert, S., and Black, G. (2007). Who's patenting in the university? evidence from the survey of doctorate recipients. *Economics of Innovation and New Technology*, 16(2):71–99.
- Takahashi, M. and Watanabe, T. (2007). Research and analysis on industry-university collaboration: Activity of IP management centers of universities and technology licensing organizations (In Japanese). Technical Report 5th annual meeting, Intellectual Property Association of Japan.
- UTTA (2007). *University Licensing Survey* (In Japanese). University Technology Transfer Association.
- Van Looy, B., Callaert, J., and Debackere, K. (2006). Publication and patent behavior of academic researchers: Conflicting, reinforcing or merely co-existing. *Research Policy*, 35(4):596–608.
- Yonezawa, A. (2007). Japanese flagship universities at a crossroads. *Higher Education*, 54:483–499.

Figures:

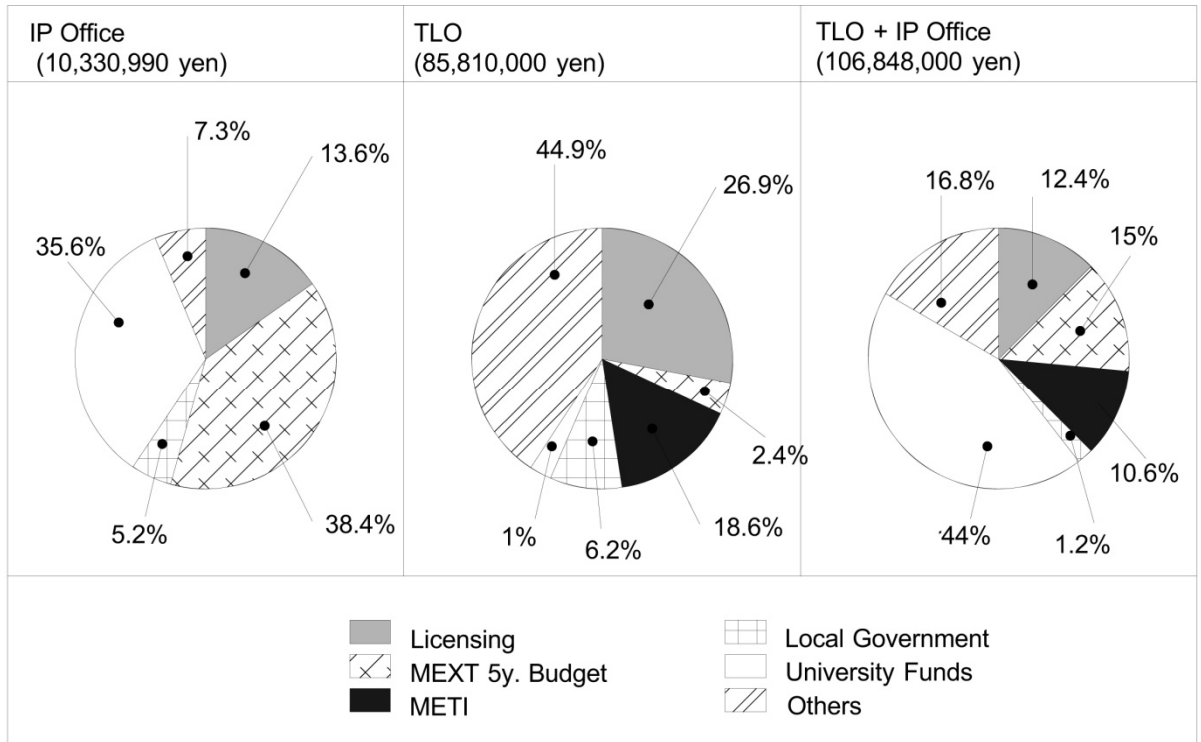
[Fig. 1: Invention Disclosures and Patent Applications by National Universities]



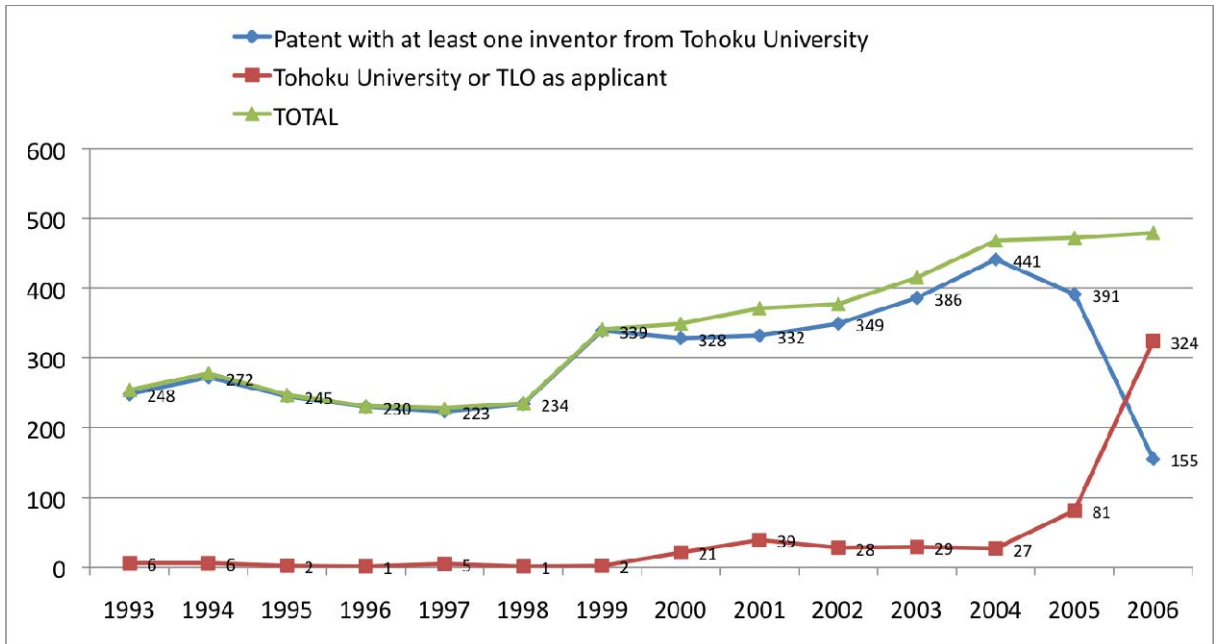
[Fig. 2: Patent Applied by Japanese Universities According to Frequency]



[Fig. 3: IP Management in Japanese Universities: Incomes]



[Fig.4: Tohoku University Patents]



Tables

[Tab1: Contractual Research by National Universities]

Category	Fiscal Year 1985	Fiscal Year 1985	Fiscal Year 1985
Joint Research	216	1,704	12,405
Av. Amount per contract	□¥5,157,405	¥2,413,730	¥2,442,790
Commissioned Research	1,700	3,027	10,082
Av. Amount per contract	¥2,051,765	¥4,662,370	¥10,926,640

a) The number are compiled from the MEXT website; b) \$1=¥120

[Tab.2: IPR's use by Japanese and US universities in 2005]

	Research cost per invention disclosure	Invention Disclosure	Patent Application	Patent Application/ Inv. Disclosure	Patent Registration	License	License Income	University Spin-offs
Japan	¥M200	9,924	7,187	72%	295	1,056	¥Bn. 1,07	46
USA	\$M2	17,382	10,270	59%	3,278	4,932	\$Bn. 1,395	462

a) Source: adapted from UTTA (2007); b) \$1=¥120