Patent Ownership and Rewards for Inventions in Japanese Public Research Organizations

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1. Introduction

In the last several years, national universities and government research laboratories (hereafter public research organizations) in Japan underwent a couple of changes. First, more priority was put on technology transfer to the private sector, which mades the role of patents quite significant. Second, as a result of government restructuring, many government research laboratories acquired their own legal status which provided broad discretion to them.

Patents provide Japanese public research organizations additional measures to both promote technology transfer and motivate research employees. Broad discretion enables them to design their policies including patent policy as they like. On the other hand, they may have to face new challenges. One of them is who owns the invention, employers or employees? It is not a new issue, but the changing environment has made public research organizations rethink the current ownership policy. In particular, national universities used to let their employees retain the rights to invention. However, as technology transfer is becoming an increasingly important agenda, national universities have had to reconsider their policy as it has turned out that having the rights to invention in their hands, not in individual researcher's hands, may facilitate technology transfer.

Another challenge is how researchers in public research organizations should be rewarded when they assign the rights to invention to their employers. Traditionally, this is an issue that has annoyed the private sector, not the public sector. Two recent legal battles clearly illustrated the hot debate in private sector over the amount of compensation that is appropriate for transfer of employee's invention to an employer. Public research organizations may not be able to neglect the issue as they utilize patents aggressively, and because Japanese Patent Law requires employers, whether private or public, to provide employees "reasonable remuneration" when employees assign their rights to invention. Then, a question arises: what is reasonable remuneration? Private firms may avoid this question if they choose not to receive the rights to invention. Public research organizations may not because they need the rights to invention in order to transfer technology.

The remuneration issue looks like a zero-sum game because employees who develop inventions desire high rewards, whereas employers want them to be low. However, a zero-sum game approach cannot satisfy both employers and employees because the parties' interests conflict with each other. A win-win perspective needs to be introduced instead. Although the private sector is much more sensitive to the issue, managers in Japanese public research organizations should recognize that the benefits of a proper reward system for employees' inventions are not limited to individual researchers. The more inventions are

generated, the more opportunities the company and society have to benefit from technological progress .

This paper first describes the changes in Japanese public research organizations, then examines the current legal framework. Further, it takes a brief look at current practice in public research organizations. Lastly, it discusses a policy recommendation based on applying "Innovation Lottery Theory".

2. Recent changes in public research organizations

2.1 Increasing focus on patents in public research organizations

For a long time public research organizations in Japan were indifferent to patents. It was widely conceived that the results of research in public research organizations should be made available in the public domain. Today, public research organizations are eager to file patent applications. In fact, patent applications by universities increased by more than 50 % between 1999 and 2000 (Japan Patent Office, 2001). The Government of Japan has encouraged universities to continue in this vein by setting two goals: that the number of patents would increase 15 times in the next 10 years and that the number of technology licenses would increase 10 times in the next 5 years. It further established the most ambitious goal of 1,000 venture start-ups from universities and other public research organizations within the next 3 years (Headquarters for Industrial Structural Reform and Employment Measures, 2001). Why did they begin to pay attention to patents? It may be attributable to an evolving mission of public research organizations.

2.1.1 A new mission: technology transfer from the public sector to the private sector

In developed countries, as the knowledge economy evolves, a consensus is developing that public research organizations should play a vital role in technological progress. Today, the mission of public research organizations is not limited to the discovery of new scientific knowledge. They are expected to contribute to the practical application of their research. Since public research organizations usually do not have the capability to develop final products that society can enjoy directly, technology generated in the public sector should properly be transferred to a private sector that is willing to invest to develop final products.

The US was the first country to initiate technological transfer from the public sector to the private sector. In 1980, the so-called "Bayh-Dole Act" amended Title 35 of the US code by adding Chapter 18, Section 200-212. The Act enabled non-profit organizations to retain the right to inventions generated in government-funded research. Since then, universities and government research laboratories have developed institutional mechanisms to facilitate technology transfer. They patent and license their research output aggressively. As a result, many venture companies using public sector' technology were born. Today, there is little doubt that the US has the most effective technology transfer system.

Japan, on the other hand, only quite recently institutionalized this technology transfer mechanism from the public to the private sector. For a long time, Japanese universities were not expected to be a source of technologies that could facilitate industrial efforts to develop new products. However, the downturn of Japanese economy throughout 1990s, followed by

declining competitiveness, made the Japanese people rethink the role of the public research organization as a valuable source of technology. The US experience over the last 20 years reinforced the proposition that public research organizations should contribute to economic growth by generating useful technology and transferring it to the private sector.

After looking at the US system, including the Bayh-Dole Act, policy makers in Japan were confident that the use of patents and the establishment of start-ups based on public research organization technologies should be encouraged. A new policy objective was to create a virtuous cycle in which research output from universities would be transferred through patenting to a private sector that would commercialize it and then a reward would be paid back to the universities that would use it for new research that may generate further research output (MEXT, 2001a). A series of measures have been taken to this end.

- In 1998, "The Law Concerning the Promotion of Technology Transfer from Universities etc. to the Private Sector" was enacted. It aimed to facilitate the establishment of Technology Licensing Organizations (TLO) in public research organizations by providing financial assistance etc.

- In 1999, "The Law Concerning Special Measures To Revitalize Industries

  Capability" contained the so-called "Japanese Bayh-Dole provision" that allowed the private sector to hold ownership of intellectual property rights generated under government-funded research (Section 30).

- In 2000, "The Law Enhancing Industrial Technology Capability" urged deregulation of the government service code so that professors in national universities could serve concurrently as executives in private firms that aim to commercialize the professors' research output.

As these policies evolved, institutions were developed and patents began to be used aggressively by public research organizations, mainly by universities. As of December 2001, 25 TLO had been approved. As of September 2001, about 1,300 patent applications were filed by these TLO and more than 200 technologies were licensed out (JPO, 2001). Today, much more focus is put on patents as a vehicle of transfer technology in Japanese public research organization than ever before.

2.2 Transformation of government research laboratories into independent administrative institutions

Another major change in Japanese pubic research organizations was the introduction of a new management concept called an "independent administrative institution". This reform was one

piece of a complete restructuring of central government. In January 2001, all ministries and agencies underwent consolidation and reorganization. The number of ministries and agencies was reduced from 22 to 13. One of the guiding principles was to separate policy planning from policy implementation. The independent administrative institution concept, modelled on administrative agencies in the UK, was introduced to perform the policy implementation in a more efficient manner (Administrative Reform Council, 1997).

The independent administrative institution is, by definition, an independent legal entity. Before 2001, no government organization had its own legal status. They were subdivisions of a whole government. Consequently, uniform procedures and regulation were applied throughout the government. They had little discretion in managing themselves.

After April 2001, government organizations may enjoy much more freedom and flexibility in their management if they wish to become independent administrative institutions (IAI). Financial regulations that limit the use of budgets to pre-determined purposes are no longer applied so that IAIs can use their budgets for whatever purposes they think necessary. Approval for internal organizational change is not required so that they can design their organizational structure as they like. The number of personnel, salaries, and working conditions are no longer controlled so that they can implement their own human resource management strategy. However, the reform does not mean that independent administrative institutions are not subject to governmental control. Rather, the government provides each independent administrative institution mid-term goals to be achieved in 3-5 years. In response, each independent administrative institution makes mid-term plans to achieve mid-term goals. Then, outside committees consisting of third parties are supposed to evaluate their performance in light of their mid-term plans. In short, the focus is shifted from regulation before the fact to evaluation after the fact (Sawa, 2001).

Many governmental research laboratories moved to become independent administrative institutions. Out of 59 independent administrative institutions (newly created or about to be created), 29 perform R&D functions. The most drastic reorganization involved the National Institute of Advanced Science and Technology. It was created by consolidating fifteen research laboratories under the Agency of Industrial Science and Technology, and involved a complete structural redesign (Sawa, 2001).

On the other hand, national universities remain subdivisions of the government. More time is needed to fully discuss whether the same rules applied to independent administrative institutions should be applied to national universities that perform not only research but also educational functions. The discussion continues. It seems, however, to be a matter of time before a conclusion will be reached. By establishing new sets of rules better fitted to universities, the Ministry of Education, Culture, Sports, Science and Technology (hereafter "MEXT") is trying to form a consensus that national universities should move into independent legal status within a few years (MEXT, 2001b).

Transformation into independent administrative institutions provides managers with broad discretion. At the same time, broad discretion means that it is essential for each institution to design its management policies fitted to its mission. As described above, the role of patents is increasing as a vehicle of technology transfer. Also, patents may become a tool to motivate researchers. Therefore, patent policy in each institution should be designed to achieve two goals; to promote technology transfer and to encourage researchers to be creative. Before discussing individual organizational policy, the next section examines the current legal framework by which individual organizations must abide.

3. Current legal framework

3.1 Ownership

When researchers create inventions, who owns the rights to the invention? How is the right to an invention transferred? Is there any compensation required when the rights are assigned?

To address these questions, Japanese Patent Law, Section 35 paragraph 1 introduced the notion of an "employee's invention"[1] It defines an employee's invention as an invention that satisfies two criteria. First, an employee's invention by its nature should fall within the scope of the employer's business. Second, an employee's present or past duties assigned by the employer should cover activities that result in the employee's invention.

Since Japanese Patent Law gives individual inventors the right to apply for patents [2], not employers but employees who devise inventions own the rights to the invention in the first place. There is, however, no doubt that employers contribute in various ways to the completion of the invention by employees. They pay a salary to employees. They provide facilities and funding for research. Recognizing employers' contributions, Japanese Patent Law provides them free-ofcharge, non-exclusive license to use employees' inventions. (Japanese Patent Law, Section 35 paragraph 1). At the same time, the Law allows employers to make arrangements in advance that oblige employees to assign the right to their employee inventions to employers (Japanese Patent Law, Section 35 paragraph 2). Such arrangements could be in the form of either contracts or internal regulations.

It is up to employers whether they let employees hold the rights to invention or they have employees assign the rights to the employer. Recent data suggests that employers often use these arrangements to have employees assign their rights to invention. Japan Patent Office's statistics show that individuals filed about 14 thousand patent applications out of 437 thousand total applications in 2000 (JPO 2001). The fact that individuals filed only 3 % of total applications suggests that most of employees inventions are transferred to employers. This is not the case in national universities, but it is discussed later.

3.2 Compensation for assignment

When employees assign their rights to employers, they are entitled to claim a reasonable remuneration (Japanese Patent Law, Section 35 paragraph 3). One might think that something

would be paid even without any provisions when employees assign their rights to employers. Legal requirements of reasonable remuneration reflect the assumption that employees are usually put in a weaker position.

It does not, however, mean that a employer's interest should be neglected. If employers choose to let employees retain the rights to invention, they can still enjoy the free-of-charge license. When they need the rights to invention, they can make such arrangements in advance. As a whole, it should be understood that Patent Law tries to strike a balance between employers and employees, taking into account the weaker position of employees in general. (Nakayama, 2000, P331, Yoshifuji, 2000, P228)

On the other hand, Japanese Patent Law does not say much about how reasonable remuneration should be determined. All it provides is that two factors should be considered; the profit that employers will make and the contribution by employees. (Japanese Patent Law, Section 35 paragraph 4) Consequently, what employers think "reasonable remuneration" does not always conform to what employees think "reasonable remuneration".

Two recent incidents are clear examples, even though these cases happened in the private sector. In one incident, a Japanese scientist, who is now a professor in a US university, sued his former employer, a small Japanese firm, in August 2001. He is a famous engineer who successfully developed a blue light emitting diode (LED) for the first time. His reputation as an innovative scientist as well as his unique career, a-small-firm-employee becoming a professor in a US university, was enough to draw media's attention. For a long time, Japanese employees have been believed to be loyal to their employers. In this regard, this incident may represent a changing labor environment where as life-time employment collapses, so do employees' commitments to employers. In addition, the professor's claim also made big news. Reportedly, he claimed 200 million yen (about 1.7 million US dollars), arguing that he had not received enough remuneration for assigning the rights to his invention to his former employer.

The other incident was a Tokyo High Court's ruling in May 2001. (Tanaka v. Olympus Optical, Hanrei Jiho (No. 1753) 23 (Tokyo High Court, May 22 2001). It held that while employers could unilaterally establish internal regulations that require employees to assign the rights to invention, employers were not allowed to decide unilaterally the amount of remuneration. It continued that if remuneration set forth unilaterally by an employer was not enough, an employee was entitled to ask for more. This ruling seemed to shock many Japanese firms because they often have internal codes or regulations which govern the procedure for transferring the rights to employees' inventions and the amount of remuneration for such transfers. The Japanese Intellectual Property Association (JIPA), an industry association, raised grave concerns, arguing that the Tokyo High Court's ruling denied business practice that uniform procedures were necessary to deal with the enormous number of inventions generated every day (JIPA, 2001).

In spite of employer objections, the courts as well as legal scholars have asserted that Section 35 of Japanese Patent Law is a mandatory provision. (Tsujimoto v. Minolta, Hanrei Times (No. 536) 337 (Osaka District Court, April 26 1984), Nakayama, 2000, P331). In other words, they have asserted that contractual arrangements and internal codes should not be able to override employee claims for remuneration. Thus, it is no wonder that Tokyo High Court held in *Tanaka v. Olympus Optical* that when remuneration set forth unilaterally by an employer was not enough, employees were entitled to claim the amount equal to the difference between what was paid and what should have been paid. Furthermore, the Tokyo High Court's ruling contained aspects beneficial to employers because it allowed employers to unilaterally force employees to assign the rights so long as internal regulations provided so.

Nonetheless, pressure from the industry association was so strong that the Government of Japan begun discussing whether the current law should be revised. However, the current system is, in a sense, balanced between employers and employees as discussed above. It is not easy to design another balanced system that also satisfies both employers and employees. So far, no conclusion has been reached (METI, 2001).

Whether or not the law may be amended, it seems to be clear that each employer has some degree of discretion. It is true that his or her discretion is subject to legal constraints, but properly designed policy within his or her discretion may not only reduce the conflict between employers and employees but also enhance employee motivation.

3.3 When to reward : a gap between legal principles and innovation processes

Although it is not so controversial as the amount of remuneration, when to reward is worth consideration because it reveals a time gap between legal principles and the innovation process in reality.

When are employees legally entitled to claim remuneration? The Tokyo District Court held that it was at the transfer of rights. (Iida v. Nihon Kinzoku Kako, Hanrei Jiho (No.1104) 12 (Tokyo District Court, December 23 1983)). Otherwise, employees can get nothing if employers decide neither to file patent applications nor to use the invention. The Court continued that the amount of remuneration could be calculated at the transfer of rights even before patents were granted or the invention was used.

Realistically, it is not easy to evaluate the value of the invention before its practical application. Also, no one knows whether the invention can be patented at the time of the completion of the invention. Thus, it is no wonder that employers want to pay remuneration not at the transfer of rights but at each milestone such as filing of an application, patent registration, and practical application. Is such a payment method permissible? The court said yes in *Tsujimoto v. Minolta*. Admitting the difficulties of estimating reasonable remuneration, the court held that milestone payment was admissible.

These court decisions may seem inconsistent. On one hand, since employees' claims for remuneration arise as they assign their rights to employers, the court held that the amount of

remuneration should be assessed at the time of transfer. On the other hand, the court recognized the difficulties of evaluating the invention at an early stage and thus admitted milestone payment under which payment was made contingent on patent registration or commercialization at later stages. To make these points consistent, the court in *Iida v. Nihon Kinzoku Kako* argued that post-transfer factors might be taken into account in assessing the objective value of an employee's invention at the time of transfer. This argument was followed by other court decisions. (Kanai v. Kaneshin, Hanrei Jiho (No. 1433) 12 (Tokyo District Court, September 30 1992), Anzai v. Gosen, Hanrei Jiho (No.1532) 118(Osaka High Court, May 27 1994)). You may think that this argument seems to be artificial. However, the courts should not be blamed. In fact, the key question in most of the cases brought to the courtroom centered on how the reasonable remuneration should be calculated when employers gained benefit by practical application of employees' inventions. Thus, the courts must have been well aware that the invention generates revenues at later stages, not at early stages.

The deep-rooted problem is that while legal provisions allow employees to claim remuneration at transfer of the rights to employees' inventions in order to protect them as early as possible, the real economic value of invention, if, any, arises far after such transfer. You can call it a gap between legal principles to protect employees and the innovation process in the real world. As far as milestone payment is concerned, the courts seemed to have filled the gap by arguing that the purpose of considering post-transfer factors was to evaluate the objective value of employees invention at the time of transfer.

Is the gap filled completely? Consider the following case. Suppose that one company makes an arrangement that employees are entitled to receive remuneration only after their invention is commercialized and brings profit to the employer. Is such an arrangement admissible?

If you take the position that employees deserve remuneration at the time of transfer of the rights to the employee's invention, you may reject this arrangement, arguing that employees are able to claim for remuneration regardless of whether the invention is commercialized or not. According to this argument, whether the invention is commercialized does affect the amount of remuneration, but it should not affect the existence of the employee's claim. Thus, you may reach a conclusion that employers are required to compensate employees even when an employee's invention has no commercial value.

Apparently, this conclusion may not be reasonable because the employers would then have to compensate employees for inventions with no economic value. You may respond that employers benefit from employees' inventions even when they seem to generate no economic value because filing an application or registration of patent provides employers a power to exclude competitors. Those who favor this argument may point out what the court said about the profit that employers will make in Section 35 paragraph 4 of Japanese Patent Law. As mentioned above, paragraph 4 provides that the profit that employers will make should be considered in deciding a reasonable remuneration. The court defined the profit that employers will make as the benefit from gaining a power to exclude unauthorized use of invention. (*Iida v. Nihon Kinzoku Kako*, *Kanai v. Kaneshi*, *Anzai v. Gosen*). Given this definition, you may

reach a conclusion that employers should compensate employees when inventions are filed or patented, but not commercialized.

There still remains a question. Are employers required to compensate even in the case where employees inventions are neither commercialized nor filed? If you follow the argument described earlier, you may contend that so long as employers hold the rights to invention made by employees, employers believe that there is some benefit in doing so and, thus, that employers should remunerate employees. It is true that employers do not have to receive the rights to employees inventions. Even after the rights are transferred, employers can assign them back to employees when they think that they have no need to retain the rights. But, it is not easy to clarify the profit that employers will make when employees invention is neither filed nor used.

4. Public research organizations' policy on patent ownership and remuneration

4.1 Patent Ownership

As mentioned above, most patent applications in Japan are filed by organizations, which suggests that most of the rights to employees invention are assigned to employers. However, national universities are exceptions to the prevailing practice.

National Universities

In Japan, there are more private universities (457) than national universities (99). Nonetheless, national universities have been regarded as leading organizations in academic research because more resources are devoted to higher education and research. While national universities have about 45,000 faculty working in graduate schools, private universities have about 27,000 faculty in graduate schools. That is why there is a high expectation that national universities will produce valuable knowledge in science and technology.

With regard to ownership policy, the inventions generated in national universities are currently dealt with in accordance with the Guideline established by the former Ministry of Education in 1978 (hereafter "MOE Guideline") (MOE, 1978).

In principle, the MOE Guideline provides that inventors keep ownership of the rights to inventions. There are exceptions. If the research is for the purpose of applied development, the rights to inventions are assigned to the government when such inventions are generated as a result of the use of either government funds specifically provided for such research or in government facilities designed for such specific purposes.

In practical terms, the MOE Guideline meant that university researchers might retain ownership of most of their inventions. In 1999, more than 80 % of inventions were owned by university inventors (MEXT, 2000).

Why did the MOE Guideline set different rules, even though the government could legitimately exercise the power to have researchers assign the rights to invention? There were two reasons. First, the purpose of national universities was not profit but education and academic research. Since academic research by university researchers is not identical to the research in private firms, national universities do not have to follow the practice prevailing in private sector. Second, the government and national universities were not thought to be capable of utilizing the rights to invention effectively (MEXT, 2000).

The MOE Guideline seemed to be beneficial to both employers and employees. Individual researchers had no duty to assign the rights to their inventions. Unlike private firms, the government or national universities had little interest in using, selling or licensing the inventions of their employees.

However, the MOE Guideline is heavily criticized today. A council under MEXT, a succeeding organization of MOE, was recommended that the MOE Guideline should be revised (MEXT, 2000).

Ironically, it turned out that individual researchers were just as poor at dealing with patents as government was. It was costly and time-consuming for each university researcher to file patent applications, prosecute them, maintain patents, find potential licensees, and negotiate with them. They are not well trained to do so. What happened consequently was informal transfer from individual researchers to private firms with which such researchers had a close relationship. It was neither transparent nor effective. Informal transfer based on long-term relationships, not on possibilities of commercialization, is considered one reason for unsuccessful technology transfer in Japan (Kneller, 2001).

If neither universities nor each individual researcher can manage patents effectively, who else can? An answer was sought in the American Research Universities TLO system where TLOs, deal with technology transfer issues as specialized organizations. As mentioned above, this understanding led to the legislation in 1998 to facilitate the establishment of TLOs in Japanese public research organization. However, the American Research Universities system was not just a model of TLO in Japan. Its patent ownership policy also drew attention of Japanese policymakers.

In the US, ownership rights to invention belong to inventors in the first place like in Japan. However, the US Code is different from the Japanese Patent law, in that the American Research Universities do not have a unilateral power to have their researchers assign the rights to invention. Instead, they use contracts to do so, because collecting individual researchers rights into one single organization has made technology transfer more efficient and effective. TLO could use its expertise and resources to deal with patent prosecution, marketing of technologies, and licensing negotiation, which would otherwise bother each researcher. In turn, TLO had more options to utilize patents without the approval of individual researchers, which increased chances of technology transfer. In short, university ownership of patents, combined with the TLO system, makes university-industry cooperation truly effective.

For these reasons, the council under MEXT recommended that the basic rule should be revised to have research employees assign the rights to invention to their employers. There is, however, one problem; who is the employer of researchers working in national universities? In the US, state universities have their own legal status. As discussed above, although it is planned, Japanese national universities do not currently have independent legal status. Independent legal status will make it easier for national universities to change their policies to require researchers to assign the rights to invention. In the meantime, individual researchers may retain the rights to invention. Thus, all TLO can is to persuade each researcher to assign his or her right to invention.

The experience of national universities suggests that, in order to promote technology transfer, they need to collect various rights into single capable organization. At the same time, assignment of the rights raises the question of compensation, which national universities have had no need to think seriously about before.

Government research laboratories

While national universities have uniform policies on patent ownership, other government research laboratories do not. They may choose whether they require their research employees to assign their rights. There are no official statistics that show how many of them do so, but there is indirect data that implies that they do so. As noted above, universities filed 577 patent applications in 2000. In the same year, the top four government research laboratories filed 607 patent applications, exceeding total applications by universities (JPO, 2001). Combined with the fact that applications by individuals were only 3% of the total, it may be inferred that most government research laboratories require assignment of the rights of employees' inventions.

Joint ownership of patents has been tried.. The Agency of Industrial Science and Technology (former AIST), one of the leading national research laboratories, used to provide joint ownership for inventions generated by their researchers. In a sense, joint ownership serves both employees and employers interests. Japanese Patent Law Section 73 allows each co-owner to use the invention without the other co-owner's consent[3]. Section 73 also provides that both transfer of each co-owner's interest and grant of license to a third party require the other co-owner's consent. Thus, the employee, a joint owner, can charge a royalty when the government, the other owner, seeks an approval for transfer or licensing.

However, the required consent of individual researchers could delay or hamper the process of technology transfer. Even if an employee gives consent, some private firms need the exclusive license or transfer of whole rights to secure a return for their investment. The existence of another co-owner reduces these firms incentives to pay for licenses. In addition, from the employees' points of view, they have to share the costs for application, examination and maintenance.

Consequently, the former AIST amended its internal code to oblige employees to transfer rights to employers as it became the "National Institute of Advanced Industrial Science and

Technology" an independent administrative institution (AIST, 2001). This case shows that assignment of the rights to one single organization facilitates technology transfer.

4.2 JPO Guideline for remuneration for government-owned invention

When government employees assign their rights to invention to the government, the government is required to compensate them in accordance with Section 35 of the Japanese Patent Law. Recognizing the necessity for uniformity, the Japan Patent Office established the Guideline for remuneration for government-owned inventions on behalf of the entire government (hereafter "JPO Guideline") (Japan Patent Office, 1998). It is applied to all governmental agencies. As discussed above, the government rarely owns the rights to inventions by researchers working in national universities. However, when the government does, the JPO Guideline is applied.

The JPO Guideline is going to be abolished by the end of Japanese fiscal year 2001 (March of 2002). Even so, it may still be worth consideration because it may remain influential even after its abolition, when each government agency or independent administrative institution is going to establish its own policy (after JFY 2002).

4.2.1 Kinds of remuneration

The JPO Guideline provides two kinds of remuneration: remuneration for patent registration and remuneration for royalties generated by licensing. Remuneration for use by government itself is not provided. This contrasts with private sector practice. According to a 1997 survey by the Japanese Institute of Invention and Innovation, many companies remunerate when they use employees' inventions (JIII, 2000). This difference is not surprising, however, because the government is not supposed to commercialize inventions by itself.

Another difference was that the JPO Guideline does not provide remuneration at the time of patent application, whereas the JII survey shows that almost all companies that responded to the survey paid remuneration at filing of patent applications. Does this mean that the government should follow private firms, which seem to be more favorable to employees, in order to stimulate individual researcher's creativity? This issue will be addressed in later sections.

4.2.2 Annual Ceiling

The JPO Guideline sets a ceiling on the amount of remuneration that one employee can receive annually. Currently, the ceiling is 6 million yen, which roughly equals 50 thousand US dollars. The council under MEXT criticized this ceiling, arguing that the ceiling on remuneration reduces incentives for university researchers to produce useful inventions and transfer them to private firms (MEXT, 2000). What effects, if any, does a ceiling have on individual researcher's motivation? This is also addressed in later sections.

4.2.3 Computation formula

Computation of performance-based remuneration should be noteworthy. Performance-based remuneration is proportionate to royalties generated by licensing. The JPO Guideline sets 4 different formulas as described below.

Annual Royalties	Remuneration
Below 500 thousand yen	Royalties*30%
Above 500 thousand yen and Below 1 million yen	(Royalties minus 500 thousand yen) *20% plus 150 thousand yen
Above 1 million yen and Below 1.5 million yen	(Royalties minus 1 million yen) *10% plus 250 thousand yen
Above 1.5 million yen	(Royalties minus 1.5 million yen) *5% plus 300 thousand yen

In short, marginal remuneration decreases as royalties generated by the invention increase. Furthermore, it should be noted that the ratio of remuneration is quite low when annual royalties exceed 1.5 million yen. By contrast, TLOs in American research universities such as Stanford and MIT pay 30 % of royalty income, whatever the amount may be, to inventors. It is true that the Government of Japan pays 30% of royalties unless they do not exceed 500 thousand yen (about 4.2 thousand US dollars). However, if inventions lead to successful commercialization, annual royalties generated by inventions easily exceed not only 500 thousand yen but also 1.5 million yen (about 12.6 thousand dollars). In 1999, American research organizations generated $862 million through 8,308 licenses/options (AUTM, 1999). Simple average royalty per one license is about 100 thousand dollars. Since distribution may be asymmetric as described below, the median may be less than 100 thousand dollars. Even so, in many cases, government researchers in Japan are likely to be far less rewarded than US researchers even when both Japanese and American researchers generate inventions with the same commercial value.

5. Innovation Lottery Theory System

5.1 Relationship between innovation and its economic value

How do we evaluate the above-mentioned practices from the viewpoint that remuneration may motivate researchers? To answer this question, it is useful to consider the following hypothetical situation.

Suppose that you have a data set of numerous patents/technologies and their economic value. Then you draw a diagram in which the horizontal axis is economic value of

patent/technologies and the vertical axis is the number of the patents/technologies which generate the corresponding economic value. This graph would show the distribution of the relationship between patents/technologies and their economic value. What does this graph look like? Is it a bell-curved shape (normal distribution) under which the distribution is concentrated around the mean?

Scherer (2001) said no. Based upon research results, he asserted that the distribution is asymmetric. While a few innovations bring huge economic value, the majority of innovations bring moderate value only. Some examples provided by Scherer are as follows.

- Among 766 German patents which were filed in 1977 and retained until the end of the term of protection, the top 10% accounted for 88% of total aggregated economic value.

- Among 486 technologies that were licensed out by six US universities during four years in the mid-90s, one technology (covered by three patents) regarding genetic engineering by Cohen-Boyer generated 24% of total royalty revenue.

Scherer pointed out other examples. However, it was not his purpose to enumerate these examples. Rather, his purpose was to determine whether the asymmetric distribution of the economic value of innovation is reasonable or unfair as a reward system.

5.2 Innovation Lottery Theory

Scherer argues that asymmetric distribution is an ideal reward system. To explain his idea, Scherer uses an analogy to a lottery.

The probability of winning a lottery is quite low. While a few winners receive huge rewards, the majority loses. Moreover, you need to purchase lottery tickets to participate in lottery. This means that the expected return on a lottery is negative. Nonetheless, we know from experience that the higher the reward and the lower the chance of winning, the more appealing the lottery is. Why do people purchase lottery tickets even though they expect negative return?

Scherer argues that the key to answering this question is the shape of the utility curve when wealth increases by huge amounts. The normal assumption with an utility curve is that marginal utility decreases as wealth increases (decreasing marginal utility). According to Scherer, the assumption of decreasing marginal utility holds until some point, but once you go beyond a critical point, marginal utility increases as wealth increases. When wealth increases by a huge amount, so does utility. Although participation in lotteries may reduce the initial wealth due to expected negative return, the huge utility increases associated with huge wealth increases prevent the expected utility from decreasing. This is because huge utility increases in the case of winning can outweigh slight utility decrease in the case of losing even if the chance of winning is much smaller than that of losing. That is why people purchase lottery tickets in spite of an expected negative return.

How can this phenomenon be applied to innovation? Needless to say, innovation is risky in the sense that most of R&D efforts fail. Even so, researchers and scientists devote themselves to R&D activities with uncertain results. What motivates researchers and scientists to engage in this risky business? The innovation lottery theory predicts that it is large rewards contingent on success that drivesthem to innovative activities.

As Scherer admitted, the innovation lottery theory is just a model and you cannot prove an utility curve with increasing marginal utility at the higher end. It is also true that not all inventors or creators are motivated by monetary rewards. In particular, researchers in the public sector are less interested in monetary reward. Even so, the innovation lottery theory still has some implications for the patent system because the patent system itself is designed on the assumption that the promise of exclusive rights encourages invention.

The innovation lottery theory provides one explanation for why successful innovation takes place more often in venture companies. Since large organizations are risk-averse, they will not participate in an innovation lottery. Even when they do, the reward contingent on success is not large enough to motivate their employees.

The innovation lottery theory also suggests that so long as the innovative activities are motivated by monetary rewards, patent protection should not be weakened only because successful innovators gain large monetary rewards. It should be noted, however, that the innovation lottery theory does not favor stronger patent protection in any case. The innovation lottery theory does not justify anti-competitive behaviors. All it suggests is that companies should not be jealous of huge rewards in the hands of a few successful innovators.

6. Policy Recommendations

6.1 Ownership of rights

Allowing employees to retain ownership of the rights to inventions may stimulate employee motivation. In this case, employers may still use the invention free of charge by virtue of the Patent Law Section 35. Even so, some employers may wish to own the right, given their contribution to the completion of employees' inventions. In this regard, join ownership may serve both employees' and employers' interests.

However, neither employee ownership nor joint ownership serves the interests of public research organizations that regard technology transfer as an important mission, as the national universities' case or the AIST case illustrated. In order to make technology transfer more efficient and effective, public research organizations should collect various rights into one single organization with both expertise and resources.

Therefore, it is the right policy to have research employees assign the right to inventions when public research organizations have a mandate to promote technology transfer. Fortunately, Japanese Patent Law makes it relatively easy for employers to have employees assign the right to inventions. Public research organizations should take advantage of it.

6.2 Remuneration for assignment

While transfer of rights from employees to employers may facilitate technology transfer, managers in public research organizations need to make every effort to prevent such a transfer from reducing researchers' motivation. That is why it is important for them to design remuneration policy that increases researchers' incentives. Innovation Lottery Theory furnishes them with some useful suggestions.

6.2.1 Remuneration for patent application/registration or remuneration for performance

Since innovation is motivated by large rewards contingent on success, performance-based remuneration plays a more important role than compensation for patent application/registration. Given organizational budget constraint, they should allocate more funds to performance-based remuneration.

Under the current law, the courts held that when employees' inventions contributed to employers' profits, employees can ask for their share of the profit as reasonable remuneration. Thus, employers are obliged to pay performance-based remuneration when employees' inventions contribute to employers' profits. Even if there were no legal obligation to do so, however, the important role of performance-based remuneration would not change at all from a functional point of view.

On the other hand, should public research organizations adopt remuneration for patent applications that many private firms are using? The answer is no. Remuneration for patent application may not be effective for encouraging innovation, even though many private firms do it. The importance of the large reward contingent on success does not deny remuneration for patent application. However, these kinds of remuneration might promote applications that are unlikely to be used or patented. For the same reason, remuneration for patent registration in the JPO Guideline may not be effective in increasing researchers' motivation.

Unfortunately, under the current law and its interpretation, it may not be permissible to abolish remuneration for patent application/registration and consolidate it into performance-based remuneration because the current system tries to protect employees at earliest stage. However, Innovation Lottery Theory suggests that innovation is motivated even when the expected return is negative so long as reward contingent on success is large enough. Thus, flexible interpretation of current legal provisions should enable employers to consolidate remuneration for patent application/registration into performance-based remuneration. Furthermore, it is worth considering an amendment of the Patent Law that enables employees to ask for remuneration only after employers benefit from the invention in real economic terms. Researchers' motivation will not be reduced so long as performance-based remuneration guarantees large rewards.

6.2.2 Ceiling on performance-based remuneration

The ceiling on the amount of performance-based remuneration should be abolished. From a legal point of view, it does not make sense because employees are able to claim more if the courts judge that employees deserve more compensation. In addition, from a functional point

of view, a ceiling denies a possibility of large reward contingent on success and thus, harms the incentives for innovation.

In this regard, abolition of the JPO Guideline is good news. The remaining question is, however, how each governmental agency or independent administrative institution will design its remuneration system after the abolition of a uniform guideline. No ceiling should be set in a newly established remuneration system.

6.2.3 Computation of performance-based remuneration

As the revenue generated by the invention increases, the average remuneration should increase also (increasing marginal remuneration). At minimum, the inventor's share of royalty income should remain the same even when royalty income increases.

Decreasing marginal remuneration in the JPO Guideline has an adverse effect on incentives for innovation. Again, policies of each governmental agency will be important after the JPO Guideline is abolished. A new policy should have increasing marginal remuneration.

Furthermore, 5% is too low as the share of royalties exceeding 1.5 million yen, compared with US universities. The share should be 30%, at least, or higher if possible.

6.2.4 Is monetary reward relevant to researchers in the public sector?

So far, the discussion in this paper has been based upon the assumption that financial reward motivates researchers in the public sector. You may respond that researchers in the public sector are not motivated by monetary reward. It may be true that researchers in the private sector are much more driven by monetary reward than those in public sector. There is, however, no reason to believe that big financial rewards do not increase the motivation of public sector researchers at all. As discussed above, many recent reforms in public research organization have been implemented or are going to be implemented in order to take advantage of private sector practices. One example is the use of patents. Another is the independent administrative institution. If so, why are public research organizations prohibited from using monetary reward as an incentive for researchers?

It is well known that the Human Genome Project public consortium, an international public consortium, and Celera Genomics, a US firm driven by commercial interest, competed for sequencing the human genome in 2000. Although Celera started the sequencing far later than the HGP public consortium, the speed of its sequencing was overwhelming, which clearly illustrated how expectations for financial reward motivated researchers. However, this does not imply that all research output should be patented. Instead, public research organizations should preserve the intellectual commons by putting basic scientific knowledge in the public domain. Nonetheless, when they do patent, they have to make use of monetary rewards as incentives for researchers.

7. Conclusion

The environment surrounding Japanese public research organization is changing dramatically. As technology transfer became one of its important missions, public research organizations have begun to use patents aggressively. Transformation into independent legal entities provides broad discretion to them.

How can public research organizations use their broad discretion to design patent ownership and reward policy in order to promote technology transfer without reducing researchers' motivation? This is the main question that this paper tried to address. Although the focus of this paper is the Japanese research organization, it is a question that many research organizations across nations could face as the knowledge economy evolves. Today, public research organizations in many developed countries aim to promote technology transfer while encouraging their research employees to produce new and useful knowledge. In this context, the argument made in this paper is as follows.

Public research organizations whose missions include technology transfer should require employees to assign their rights to inventions to facilitate technology transfer. At the same time, in order to prevent ownership policy from reducing employeess motivation, they should formulate remuneration policy, taking into account Innovation Lottery Theory's teaching that the promise of large reward despite low probability is critical to promote innovation. Remuneration is one of the tools for managers to influence researchers' motivation. When employers successfully design remuneration policy as an incentive mechanism, both employers and employees can enjoy a win-win situation.

It is not surprising to conclude that the mechanism under which a few successful innovators receive large rewards contingent on their success is more effective to promote innovation than is fair distribution of reward. It is what Schumpeter pointed out more than 50 years ago, when he wrote:

> Spectacular prizes much greater than would have been necessary to call forth the particular effort are thrown to a small minority of winners, thus propelling much more efficaciously than a more equal and more "just" distribution would, the activity of that majority of businessmen who receive in return very modest compensation or nothing less than nothing, and yet do their utmost because they have the big prizes before their eyes and overrate their chances of doing equally well. (Schumpeter, 1950 P73-74).

As Schumpeter pointed out, large monetary reward motivates people. It encourages researchers in public research organizations, too. Providing large rewards to an individual researcher does not a contradict public research organization's mission. Large rewards can be possible only when an invention leads to commercial success, which is also a successful example of technology transfer. Needless to say, public research organizations serve the public interest by producing new scientific knowledge. At the same time, it should be

remembered that it is individual researchers who can produce such knowledge. Every possible measure should be taken to motivate them. Thus, managers in public research organization should not hesitate to make use of remuneration for invention as an incentive to researchers.

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1 Section 35 of Japanese Patent Law is as follows. (available at http://www.jpo.go.jp/shoukaie/patent.htm)

35. Employees' inventions

(1) An employer, a legal entity or a state or local public entity (hereinafter referred to as the "employer, etc.") shall have a non-exclusive license on the patent right concerned, where an employee, an executive officer of a legal entity or a national or local public official (hereinafter referred to as the "employee, etc.") has obtained a patent for an invention which by reason of its nature falls within the scope of the business of the employer, etc. and an act or acts resulting in the invention were part of the present or past duties of the employee, etc. performed on behalf of the employer, etc. (hereinafter referred to as an "employee's invention") or where a successor in title to the right to obtain a patent for an employee's invention has obtained a patent therefor.

(2) In the case of an employee's invention made by an employee, etc. which is not an employee's invention, any contractual provision, service regulation or other stipulation providing in advance that the right to obtain a patent or the patent right shall pass to the employer, etc. or that he shall have an exclusive license on such invention shall be null and void.

(3) The employee, etc. shall have the right to a reasonable remuneration when he has enabled the right to obtain a patent or the patent right with respect to an employee's invention to pass to the employer, etc. or has given the employer, etc. an exclusive right to such invention in accordance with the contract, service regulations or other stipulations.

(4) The amount of such remuneration shall be decided by reference to the profits that the employer, etc. will make from the invention and to the amount of contribution the employer, etc. made to the making of the invention

2 Section 29 paragraph 1 of Japanese Patent Law provides that "any person who has made an invention which is industrially applicable may obtain a patent". (available at http://www.jpo.go.jp/shoukaie/patent.htm 3 Section 73 of Japanese Patent Law is as follows. (available at http://www.jpo.go.jp/shoukaie/patent.htm)

73. Joint patent rights

(1) Each of the joint owners of a patent right may neither transfer his share nor establish a pledge upon it without the consent of all the other joint owners.

(2) Each of the joint owners may, except as otherwise prescribed by contract, work the patented invention without the consent of the other joint owners.

(3) Each of the joint owners may grant neither an exclusive license nor a non-exclusive license without the consent of all the other joint owners.