Japanese Financing Policies for Innovation Since the 1990s

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Abstract

Since the 1990s, the Japanese government has made considerable attempts at stimulating innovation with an aim to pull the country out of a possibly permanent economic decline. Several laws and policy initiatives were introduced to encourage better interaction between universities (and research institutions) and industry. The results of these efforts have been mixed. While the number of university-industry joint and commissioned research has increased, revenues from the licensing of university-owned patents have fluctuated year by year. Although the number of startups and spin-offs from universities rose, their long-term survival and contribution to the economy remain uncertain. The Japanese experience features both strengths and weaknesses. Strengths include the long-term commitment of policy makers, the ability to set specific targets, and the active engagement of several key economic ministries. Nevertheless, the effectiveness of these policy initiatives was hampered by limitations within the policies concerning the roles of universities and their mode of interaction with industry based on intellectual property rights, the inadequacy of demand-side innovation policies, the fragmentation of bureaucracy, and a lack of a credible evaluation system.

Keywords
Innovation financing policies, intellectual property rights, university-industry linkage, start-up firms, Japan

1. INTRODUCTION

1.1. Research Background and Research Questions

Since the so-called "lost decade" of the 1990's in which Japan suffered from poor economic performance, followed by the global financial crisis in 2008 and the Great East Japan Earthquake of 2011, Japan has constantly faced challenges in maintaining and improving upon its famed industrial

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competitiveness. In order to maintain its position in the world economy against emerging contenders such as China or Korea, Japan has had to work on its innovation system by supporting firms in bringing new ideas to market. In Japan, large firms play a significant role in the nation's innovation system, largely relying on in-house R&D. During the crises, especially with the recent earthquake, small- and medium-sized enterprises (SMEs) have begun to be emphasized as key players in stimulating economic growth. When a large enterprise faces bankruptcy and closure, startups and SMEs tend to be promoted in the process of economic renewal and job creation. However, many firms, especially SMEs and startups, often face significant hardships in accessing the financing needed for starting businesses, developing new products and processes, and developing linkages with larger companies (Pissarides, 1999; Hyytinen and Toivanen, 2005; Gompers and Lerner, 2001, 2004). In today's economies, economic growth is increasingly dependent on innovation where access to finance is seen as a critical factor in this process (Bygrave and Timmons, 1992; Freeman and Soete, 1997; Pissarides 1999; Wonglimpiyarat, 2007). Therefore, the formulation of effective financing policies that support innovation and innovative business is an urgent and timely issue.

The Japanese government has modified its SMEs support by introducing policy that reduces the structural and financial obstacles small businesses face. Specific policies such as SBIR (small business innovation research) are helping SMEs with their innovation needs. Independent administrative agencies also offer various funding programs that support innovation within firms such as the Japan Science and Technology Agency (JST), the New Energy and Industrial Technology Development Organization (NEDO), the Organization for Small & Medium Enterprises and Regional Innovation (SMRJ), and others that provide various kinds of funding, especially gap-funding programs aimed at supporting the creation of new firms. This study examines the effectiveness of these governmental financial mechanisms that support business innovation, mechanisms that include grants, loans, and public equity participation either directly or through private venture capital. We also assess institutions that affect the effectiveness of these policies, namely, the government's capacity in policy formulation and implementation processes, its trust, entrepreneurship, laws, and regulations.

1.2. Research Questions

Key questions include the following:

- Have these policies resulted in successful innovation outcomes? If so, to what extent? Why?
- What are the institutional factors that affect the effective implementation of these policies?
- What are the lessons learned for other countries, especially Asian ones catching-up?

1.3. Research Methodology

To carry out the objectives stated above, this research was performed at two levels: the macro-level analysis and the operating-level analysis. The macro-level analysis aims to elucidate the *general background* of policies for innovation financing and support in Japan, while the operating-level analysis closely examines the nature and effectiveness of *individual* policy instruments. By doing this, we understand both the bigger picture as well as the details of the Japanese policies examined here.

The macro-level analysis: Key stakeholders such as high-ranking government officials from the Ministry of Economy, Trade, and Industry (METI) and the Ministry of Education, Culture, Sports, Science, and Technology (MEXT) were interviewed to gain specific and new information. Research at this level focused on the linkage between innovation financing and other aspects of the innovation system such as the roles and capabilities of key players/actors, the linkage between them, and the extent of learning generated from such linkage.

The operating-level analysis: The operating level analysis examined innovation financing and support for policies/programs with emphasis on research subsidy loans, grant programs, and government direct equity participation (both directly and via venture capitals). The purpose of the analysis at the operating level was to evaluate policy content and its implementation, monitoring, and evaluation mechanisms of various financing programs. The institutional contexts underlying the successes or failures of these schemes, such as laws and regulations, the competencies of responsible organizations, entrepreneurship, and trust between the relevant players/actors, were also investigated.

The research was carried out from December 2012 to March 2013 using two methodological approaches:

i) The analysis of available secondary data based on government policy documents and evaluation reports.
ii) Interviews that focused exclusively on key people involved in key innovation financing schemes of relevant funding agencies, particularly JST, NEDO, and SMRJ. The interviewees included relevant government officials and other policymakers, academics, and management executives of selected recipient firms.

This study employed a triangulated research strategy where the interview data were supported by an examination of secondary data in order to provide a cross check on internal validity. The results were then compiled to synthesize the lessons learned from the successes and failures of the schemes.

In the following sections we provide an overview of Japanese innovation promotion initiatives since the 1990s, the general outcomes of such initiatives, details of the roles and specific schemes of selected government agencies, and finally, conclusions and lessons learned for other countries.

2. JAPANESE INNOVATION PROMOTION INNITIATIVES SINCE THE 1990s: AN OVERVIEW

From the Meiji Restoration of 1867 to the post-WWII high growth era, Japan caught up technologically with the West through learning and augmenting technologies imported from overseas through the licensing of patents, international exchanges of engineers, and, only in some industries before WWII, foreign direct investment by the global leaders of the time. Parallel to this, the private sec-

tor with its strong entrepreneurship management systems and domestic R&D towards building absorptive capacity and subsequently enabling inventions also played an important role. Government policies that promoted compulsory and higher education, created the necessary infrastructure and institutions, stimulated demand through public procurement, and (to lesser extent) provided tax concessions and subsidies for target industries were also critical (Odagiri and Goto, 1996).

Consequently, Japanese firms in several industries since the 1990s have caught up with the west and become forerunners themselves. The end of catch-up means that Japan can no longer rely on one-way technology acquisition from abroad. In addition, intellectual property rights (IPR) are more than ever strictly enforced by foreign firms. The maturity of Japan's leading industries such as electronics, steel, machinery, and automotive is indicated by the lower rate of new entry of firms since the early 1980s (Odagiri, 2006). In new industries such as information technology and biotechnology, Japan has not done so well internationally. Japanese companies' former strength in creating firm-specific tacit knowledge and skills based on practices of sharing experiences by the means of staff rotation and life-time employment cannot apply to these new industries where know-how and skills can be codified into abstract form and belong to people with advanced and specialized knowledge (Goto, 2000). The relative decline in the competiveness of existing leading industries and the failure to capture new industries, along with other reasons, contributed to the long economic stagnation from the 1990s to the present.

To revive Japan's competitiveness, its government since the mid-1990s has issued several policy initiatives aiming at fostering innovation. SMEs (accounting for for 99% of all enterprises and 70% of jobs) and new startups in emerging industries were expected to be key players in stimulating economic growth. However, private venture financing was limited. Many venture capital firms in Japan were the subsidiaries of banks, securities companies, or of other financial institutions. Their primary mission was to find healthy growing firms to which parent firms can give loans or issue bonds to in the future. There was also a lack of data concerning venture capital. Although the Japan Venture Capital Association was established in 2002, many of the major venture capital firms declined to join (Uchida, 2012). Therefore, there was a need for government innovation financing measures as a part of the overall initiatives towards fostering innovation. They could no longer be seen as separate actions. These policy initiatives can be summarized as follow:
These policy initiatives can be classified into four groups: strengthening S&T foundations (basic

Development of Japanese Government Policies to Foster Innovation

1995 – The S&T Basic Law
1998 – The Promotion of Technology Transfer from Universities to Private Business Operators Act (the TLO Law) and Small and Medium-size Business Innovation Research System Act (the Japanese SBIR)
1999 – Special Measures for Industrial Revitalization Act (The Japanese Bayh-Dole Act), the

new Small and Medium Enterprise Basic Law and the Law for Facilitating the Creation of New Business 1999
2000 –Development of Industrial Technology Enhancement Act
Allowing TLOs to use national university facilities free of charge
Allowing professors to hold positions in private companies
2001 – 1,000 university startups in 3 years (Hiranuma Plan)
2002 – Intellectual Property Basic Act with the establishment of an IP headquarters
2003 – 1st IP Strategic Program for the Creation, Protection and Exploitation of Intellectual Property and National University Corporation Act
2004 – Incorporation of National Universities

S&T law and executing plans), strengthening intellectual property right protection and commercialization, enhancing university-industry linkage, and promoting SMEs and start-up firms.

2.1. S&T Basic Law and S&T Basic Plans

Government policy began emphasizing S&T development starting with the enactment of the S&T Basic Law in 1995. Based on this law, the government is required to formulate a basic 5-year S&T plan every five years.

The first S&T basic plan (1996~2000) aimed for closer cooperation between industry and university/government research organizations, promotion of new university spinoffs, increase in the number of post-doctoral fellowships, more mobility of researchers, and more competitive research funds. The second plan stressed the importance of R&D commercialization by means of technology transfer of research results to private companies, activating high-tech ventures, fostering entrepreneurship in universities, improving small business innovation systems, and allocating research funds for small companies. Four priority areas were set in the third plan: life sciences, information and communication, environmental science, and nanotechnology/materials.

Regarding the S&T budget, the Japanese government spent ¥17 trillion on S&T during the first plan period. In the second plan from 2001~2005, the government spent ¥24 trillion, and for the third plan from 2006~2010 it spent approximately ¥25 trillion. For the 4th plan from 2011-2015, the expenditure is expected to be approximately ¥25 trillion. The increase in funding from government support resulted in the increase in ratio of government-funded research to GDP from 0.67% during the early 1990's to 0.69% in the late 1990's.

2.2. Basic Law on Intellectual Property and IP Strategic Programs

In 2002, the government of Prime Minister Koizumi made making Japan an "intellectual property-based nation" a national policy. The Basic Law on Intellectual Property was enacted in the same year. The ultimate goal is to increase national wealth by the effective use of intellectual property

through promoting the creation of high-quality IP, with strong protection of IP that can eventually commercialize into economic value. To implement the law, the government established within the cabinet an Intellectual Property Headquarters chaired by the Prime Minister. Subsequently, an annual strategic program for the creation, protection, and exploitation of intellectual property has been issued since 2003, and various measures in these programs were taken. For example, in terms of the creation aspect, a university Intellectual Property Headquarters and technology licensing organizations (TLOs) were established nationwide to serve as technology transfer mechanisms. For the protection aspect, a system improvement in order to reduce the time for patent examination was developed by a large number of fixed-term examiners. In terms of the exploitation aspect, an amendment of the Trust Business Law made intellectual property available as trust property.

2.3. Laws and Policies to Promote More Effective Technology Transfer from Universities and Public Research Institutions to Private Firms

Several laws and policies were implemented to increase interaction between universities and public research institutions and firms. In 1998, the Promotion of Technology Transfer from Universities to Private Business Operators Act (or the "TLO Law") was enacted followed by the Special Measures for Industrial Revitalization Act (dubbed "the Japanese Bayh-Dole") in 1999, the Industrial Technology Enhancement Act in 2000, and the National University Corporation Act in 2003. These four pieces of legislation were expected to play a vital role in changing the Japanese technology transfer environment between university and industry.

The TLO law established technology transfer licensing offices within universities in Japan. As part of executing the law, METI and MEXT developed guidelines for universities to set up their own technology transfer offices. TLOs need to submit their implementation plan to MEXT and METI for approval. An approved TLO is entitled to receive government subsidy for up to ¥30 million for a period of five years. The law also provides guarantees for TLOs' debts, which allows TLOs to obtain bank loans. Approved TLOs can also use the facilities of national universities free of charge when they work in relation to university technology transfer activities. Other laws were also revised to promote TLOs' activities such as the Japanese patent law, which was amended to allow a discount on annual patent fees and fees for requesting examinations for approved TLOs. SMEs that have transferred technology from TLOs can receive investment from the Small & Medium Business Investment & Consultation CO., LTD., a government-affiliated investment company.

The Industrial Technology Enhancement Act allows researchers that have the status of government officials in universities and public research institutions to participate as directors in research-exploiting firms and TLOs. It also permits TLOs to use university facilities and provides discounts for universities and their staff in patent registration.

The Japanese Bayh-Dole Act aims to promote the utilization of inventions arising from R&D supported by the Japanese government by means of giving IP ownership to universities and research institutions and promoting technology transfer of their research results to industry for commercialization. It allows universities and research institutions to retain ownership arising from government

contracted research. There are some differences from the US version. The US version expects universities to file patents on inventions they elect to own, but in the case of Japan the filing of patents is not mandatory. Under the US law, the university is expected to transfer technology to local small business. However, Japanese law does not provide any small business preference. The Japanese law allows large corporations to retain IP rights and the grantee is able to license government-funded technologies to both domestic and foreign companies. Furthermore, in the Japanese case, the government retains the right to refuse the transfer of rights, which is different from the US in that universities have the right to choose to retain or transfer their rights (Takenaka 2005).

The National University Corporation Act gives legal status to universities so that universities can own and manage their IP and have more authority when working with the industry. Prior to 2004, when universities still did not have legal status, IP ownership belonged to inventors and technology transfer was carried out informally between university professors and companies (J. Kitami, personal communication, 9 December 2012). After the existence of the TLOs system and the legal status given to universities, collaboration between university and industry was expected to take on a more formalized manner. The results of these changes are discussed later on.

Apart from enacting new laws, the Japanese government also increased the annual budget for collaborative research between university and industry. The budget at the end of the pre-1st S&T plan period was ¥3.6 billion in 1995. It rose to ¥5.8 billion under the first plan and increased by more than 100% under the second plan to ¥12.3 billion.

2.4. Laws and Policies to Promoting Innovation in SMEs and New Start-ups

The Japanese government also made attempts to stimulate innovation by SMEs by initiating several relevant laws and measures.

Amended in 1999, the **SME Basic Law** set a new framework focusing on reducing the gap between large enterprises and SMEs and fostering R&D, business innovations, and other creative activities in both established SMEs and startup firms. In the government's view, this law was a turning point that changed SMEs from being objects of protection into being a driving force in the economy. This new policy framework treats SMEs as a source of entrepreneurship, innovation, and job creation. SMEs can develop new technology through exchange programs with different businesses and partnerships among industry, academia, and government.

The Law on Supporting Business Innovation of Small and Medium Enterprises 1999 was purposed to support business innovation in existing SMEs. To execute the law, a small business innovation research program was introduced in 1999. Modeled after the US's SBIR program, it subsidises R&D for developing new technologies underpinning the creation of new industries. The responsible agency is the Small and Medium Enterprise Agency (SMEA) under METI. SMEA selects existing government-funded projects that could be used for SMEs and appoints them as SBIR supporting projects. Seven government ministries participate in the program. Prior to setting the SBIR research theme, the METI puts out an inquiry for all seven ministries. Each ministry then

voluntarily decides on the annual expenditure target for the program. The budget allocated by the cabinet to the SBIR program has steadily increased from ¥26.1 billion in 2003 to ¥37.1 billion in 2007 and ¥45.1 billion in 2011.

The SBIR system divides the innovation process into three stages: (I) feasibility study, (II) development, and (III) commercialization. Two types of support are offered: 1) research and development support through subsidies or contract grants and 2) support for technological application development, such as patent fee reductions, loan guarantees, capital investment loans, and loans for facilities. Funded companies also have a better opportunity for government procurement. In some cases, low-interest loans were provided for scaling up the production of the prototypes that emerge from the development phase. Some SBIR subsidies also provide support for technical management and legal support by dispatching experts to a company to assist in the area of scaling up-production, management, product design, marketing, and strategy planning.

The differences between the US and Japanese SBIR programs can lead to different outcomes. The US SBIR program sets a common scheme and it is up to each implementing agency to design the details. However, a common scheme is not provided in the Japanese SBIR; the program design and research topic are up to each implementing agency. Second, the third phase of US SBIR (the commercializing phase) requires the complementary involvement of private equity and venture capital. This is not the case in Japan, as those establishments are not so well developed. Most importantly, the American government's procurement of products resulting from the SBIR programs has not been as successfully implemented by their Japanese counterparts As a result, there were no obvious "captive" markets for innovations which might be too risky and uncertain for private buyers (A. Nishizawa, personal communication, Dec 20, 2012).

The Law for Facilitating the Creation of New Business 1999 emphasizes assisting access to human resources and providing financial support for startups. The law authorized government loan guarantees to startups without requiring them to provide collateral or guarantors when borrowing through the Credit Guarantee Association. The law also required the government and special corporations to draw up expenditure targets for the government and special corporations, including subsidies for research & development in new technology for SMEs. The law was amended in 2002 under the name of the Law for the Support of Small and Medium Enterprise Challenges to allow exemptions from the minimum capital requirements. As a result, start-ups and new business ventures by SMEs could have easier access to government supporting programs. In 2001, the Japanese government had issued the three-year "Hiranuma Plan" to create 1,000 start-up companies from 2001 to 2004.

The abovementioned SMEs support laws were created based on the different requirement of SMEs according to their size and stage of growth. However, the law has overlapping support in some areas and the overall system has been criticized for being too complicated. There are also certain kinds of support missing that are otherwise necessary for the successful commercialization of products, such as market research, evaluation of business viability, and market development.

3. GENERAL OUTCOMES OF JAPANESE INNOVATION FINANCING AND PROMOTION INITITATIVES

There are three aspects to the general outcome of the aforementioned initiatives: increase in joint research between universities and industry, increase in licensing from universities, and increase in start-ups and university spinoffs. We will also investigate the results of the SBIR program.

3.1. Increase in Joint Research Between University and Industry

Similar to the criticism of the US's Bayh-Dole Act on the rate of innovation and quality of university research (for example, Mowery et al, 2004; Mowery and Ziedonis, 2002; Walsh et al, 2003), scholars such as Odagiri and Kato (1997) argue that Japanese university professors already had extensive collaboration with the industry, albeit personal and informal. In addition, even before the act, Japanese university research had already contributed to commercial innovation, especially in life sciences (Sakakibara, 2007). However, proponents of the act (for example Kneller, 2007) point out that the former practices (i.e. government ownership of IP and non-exclusive licensing) made collaboration undesirable for companies and faculty inventors. Certain policy makers share this argument. J. Kitami, for example, states that the new laws did facilitate professors with no previous contacts with the industry to start their engagement with assistance from TLOs (personal communication, 9 December 2012). Also through the work of TLOs, research results could reach many more firms than previous one-to-one personal collaboration, and the scale of research projects could be larger.

After universities became legal entities and thus IP owners, universities generally became more active in "formal" collaborative research with the industry. The amount of funds received from the industry increased over five years from ¥50,123 million in 2005 to ¥57,988 million in 2010 (Satomi, 2012). The number of joint and commissioned research projects also steadily increased (see Figure 1)

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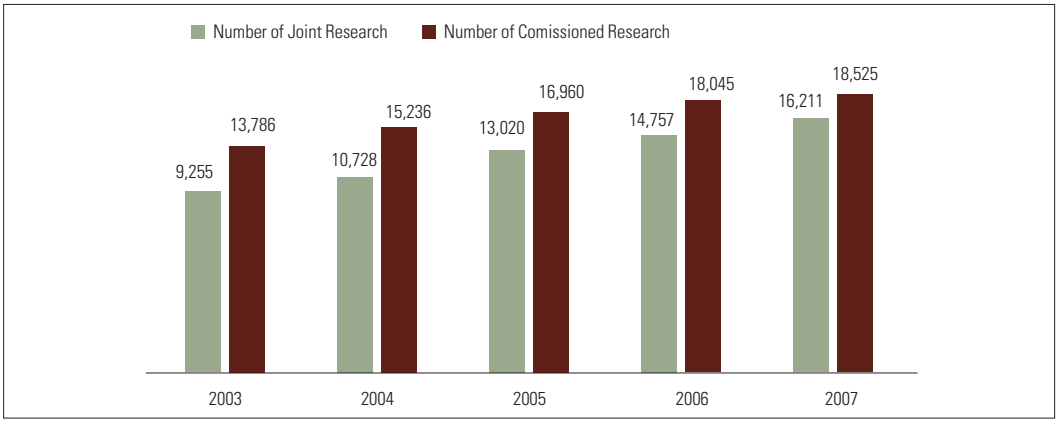
FIGURE 1. Number of University-Industry Collaborative Research Projects



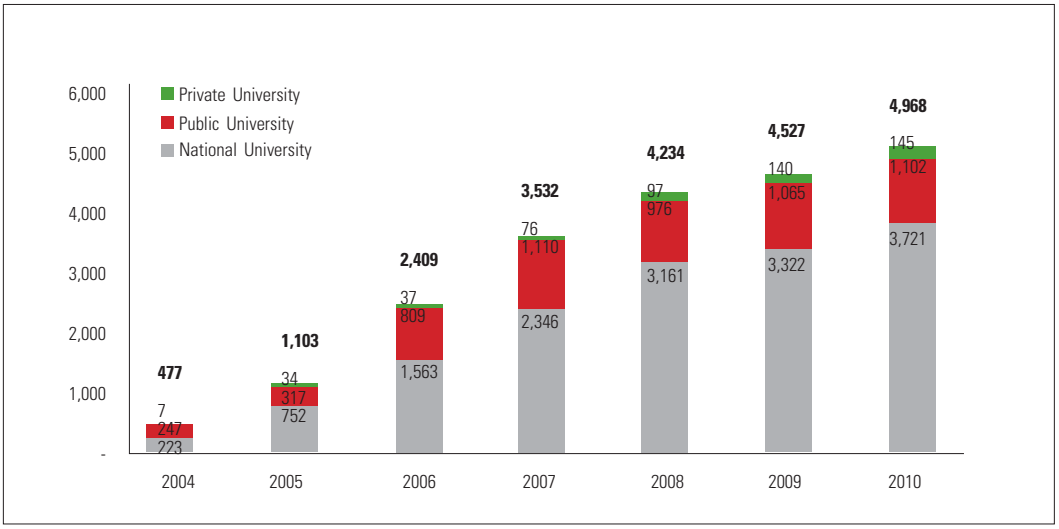
Source: WU (2012)

Quality-wise, using forward non-self citation of patent as an indicator, Motohashi and Muramatsu (2011) found that the results of scientific research at universities and other dominant recipients of public R&D funds began to contribute more toward corporate innovation after adoption of policies encouraging university-industry collaboration from the second half of the 1990s. In addition, there was a notable increase of research between universities and SMEs (versus with large corporations) after policies were implemented.

3.2. Increase in Licensing Activities

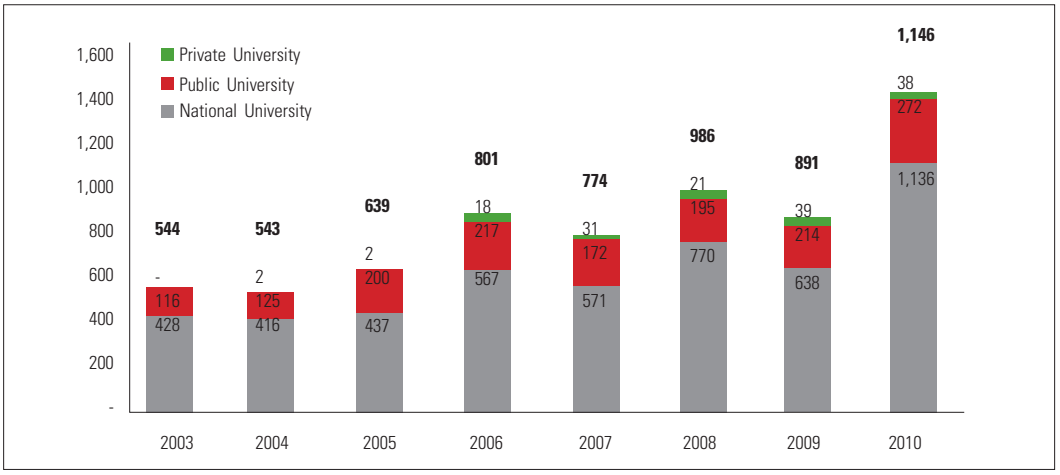
The number of domestic patent applications by universities and approved TLO has increased dramatically from 641 in 2001 to 8,527 in 2005. The number of licensing cases has also gone up (see Figure 2). However, licensing income received from these patents did not significantly or consistently increase, except for the year 2010 (see Figure 3). The small amount of revenues might come from several factors, such as the value of university inventions, experience in licensing activities (Nagaoka and Flamm, 2009), or even the willingness of universities to contribute their inventions to society with relatively small returns.

FIGURE 2. Number of Licensing Case Categorize by Type of University from 2004-2010



Source: JST University-Industry Collaboration Report 2011-2012

FIGURE 3. Licensing Income Categorize by Type of University from 2003-2010

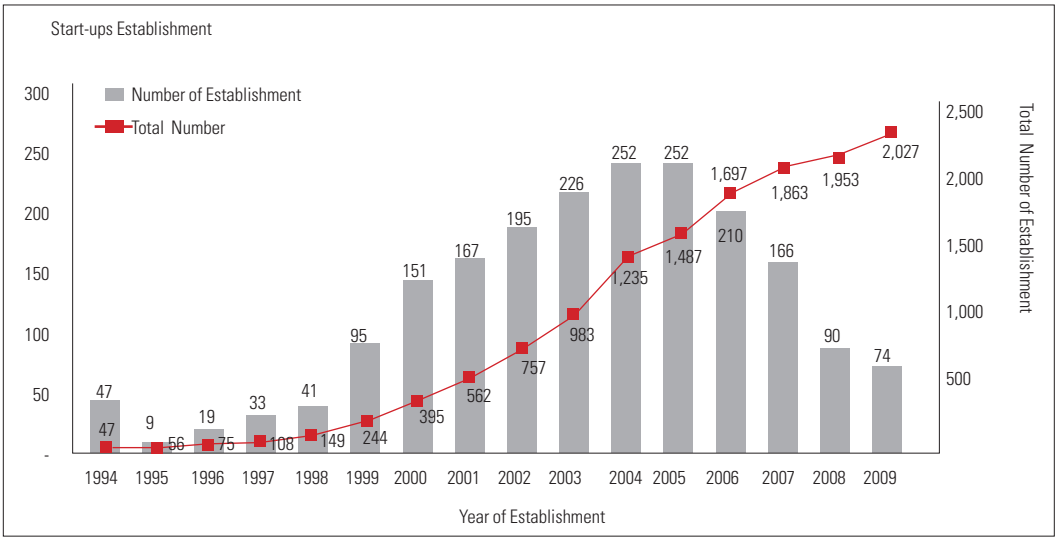


Source: JST University-Industry Collaboration Report 2011-2012

3.3. The Impact of Policies on Start-up and Spin-off of Universities

The formal TLO system legitimizes the negotiated transfer of IP rights to university startups. National universities can also now lend facilities for universities-based startups. In addition, the enactment of the Development of Industrial Technology Enhancement Act allows university researchers to consult and hold management position of startups. At the end of the Hiranuma Plan in 2004, the Japanese government achieved its target in creating new startups where over 1,000 companies were created (see Figure 4).

Figure 4. Number of University Start-ups Establishment



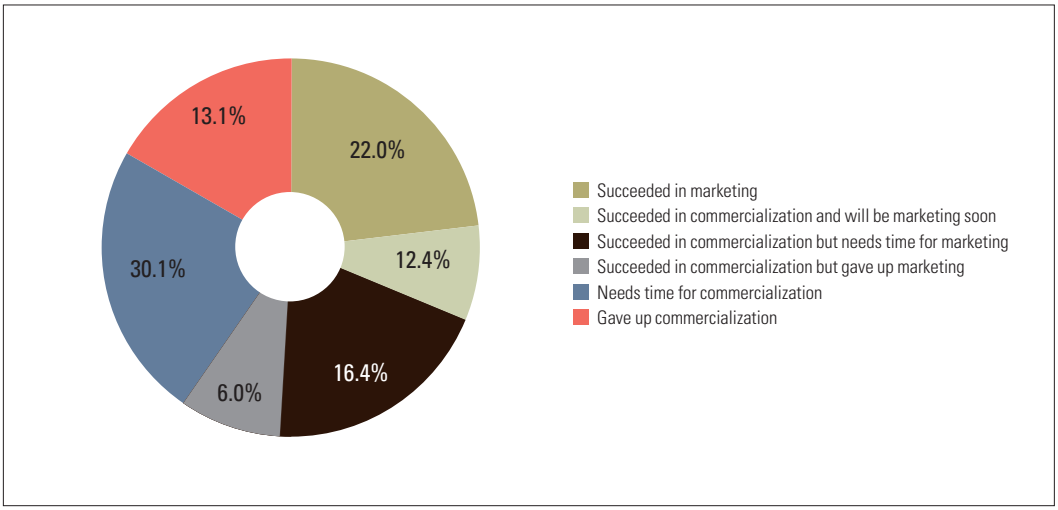
Source: Satomi (2012)

However, the question of survival and sustainability of these companies remains. From the year 2006 the government has reduced its support for startup ventures and university spin-offs. As a result, the number of new startups decreased significantly, while the bankruptcy rate of this type of firm increased. One of the reasons behind the failure of startups in Japan might come from the way these firms are managed. When university startups were created, their CEOs usually were faculty members who were generally lacking in business management skills. This is the opposite of the much fewer success cases where experienced people from the industry person were invited to be CEOs, who worked together with and not for university professors (A. Nishizawa, personal communication, Dec 20, 2012).

3.4. Effectiveness of the Japanese SBIR Program

In 2010, the Small and Medium Enterprise Agency conducted a survey of SBIR-awarded companies for follow-up. Questionnaires were distributed to 1000 companies and 491 replied. The following are some of the results (Figure 5). The success rate of commercialization is approximately 56.8%. This means more than 40% failed. Out of the firms that succeeded in commercialization, the ones that did not pursue marketing or gave up on marketing is approximately one third.

Figure 5. Success Rate of Commercialization/Marketing of SBIR Projects



Source : SBIR Survey 2010, Small and Medium Enterprise Agency.

According to the survey, the issue most critical for success in the commercialization phase is access to finance, followed by the ability to develop marketing strategies, manage R&D, and scale up production. In addition, the survey illustrates that the program was administratively difficult in its implementation. In particular, the application process was too complex.

4. ROLES OF GOVERNMENT AGENCIES IN FINANCING AND PROMOTING INNOVATIONS

We discussed in the previous section the overall policy initiatives of the Japanese government and the effectiveness of such initiatives. This section will examine the roles and effectiveness of government agencies responsible for executing policies. Two types of agencies will be investigated: funding agencies and research institutions. For funding agencies, we will cover the Japan Science and Technology Agency (JST), the New Energy and Industrial Technology Development Organization (NEDO), and the Organization for Small & Medium Enterprises and Regional Innovation (SMRJ). For research institutions, we will explore the roles of the National Institute of Advanced Industrial Science and Technology (AIST) and RIKEN.

4.1. Japan Science and Technology Agency (JST)

Established as the Japan Information Centre of Science and Technology (JICST) in 1957, this agency became an independent administrative organization under the name of the Japan Science and Technology Agency in 2003. JST is one of the core institutions under MEXT responsible for the implementation of S&T policy in Japan, including the government's S&T Basic Plan. JST is a comprehensive funding agency that works from the knowledge creation phase to the final step where the fruits of research are utilized by Japanese industry and society. JST also works to provide a sound infrastructure of S&T information and raises awareness and understanding of S&T-related issues in Japan. Many of its programs focus on stimulating innovation in the private sector and promoting knowledge transfer from universities. Two types of programs are of particular note.

4.1.1. Programs to Exploit University Patents

One program provides patent experts to help universities across Japan develop their "patent portfolios." At present there are twenty-three patent investigators, experts in different fields of technology. These experts had experience in research and development at private companies over long periods of time. The main thrust of the program is to increase the potential for patent utilization by creating related patents around existing core ones.

Another program is to cooperate with investment institutions in utilizing unused patents held by universities. This program consists of four activities:

- Provisions of patent maps and portfolio information. Over 100 patent maps have been developed so far. JST also develops software for patent mapping.
- Cooperation with investment institutions to invest in commercially utilizing patents.
- Support for increasing the value of university patents by providing financial support of ¥2-3 million for examining the practicality of patents and acquiring additional data to raise the motivation of companies to achieve practical application. There are also grants of ¥0.5 million for IP departments or TLOs at universities for conducting activities such as technological enhancement, creation of applied invention, product testing, and even marketing surveys, which are important for successful utilization of IP.

- Utilization of the J-Store and the S&T commons. J-Store is an online database that is comprised of both unpublished patents and patents from universities across Japan. For unpublished patents, universities can use the J-Store as a market testing bed, and if there is an interest from the industry side, then the university can decide whether to pursue patent registration and license agreements. Any university in Japan can publish its inventions on J-Store. At present there are 20,000 research results on the J-Store website.

4.1.2. A-STEP Program

The Adaptable and Seamless Technology Program Through Target-driven R&D Program (A-STEP) was designed to support collaboration between university and industry and also to support SMEs and the private sector in high-risk projects. The program is claimed as "seamless" as it has sub-funding programs covering feasibility studies to full-scale R&D of various types and all fields of S&T. Annual spending of the program in 2011 was $208 million. A-STEP consists of seven sub-funding programs as follows:

• Exploratory Research and Seeds Validation

These two programs are grant programs for the feasibility studies phase. The objective is to examine the possibility of the commercial viability of research results obtained in academia. The seeds validation sub-program requires joint submissions of proposals between university and company.

• High-Risk Challenge Program

The objective is to help companies pursue high-risk R&D that has high impact but may be too novel and risky for companies. This program also requires a joint application between university and company.

• Ventures Program

This program supports startup companies from universities. The main characteristic of this program is that the applicants consist of three parties: university professors, entrepreneurs, and TLOs. An entrepreneur is expected to be CEO, whose ability is also evaluated.

• Promoting R&D Programs

This program is to help companies promote high-risk and long-term R&D. The funding method is to match grants on a 1:1 basis, but if a company is considered as SME the ratio changes to 2:1 between JST and company. This program also requires joint application between university and company. A project leader can come either from university or industry, depending on the individual case.

• Promoting R&D Programs for Small Businesses

This program aims to help SMEs carry out development for commercialization. It is a grant and royalty scheme. A company receives a grant from JST, and once it makes and sells a product based on the research results from a university, it pays back in the form of royalty. In this scheme, SMEs can use a grant to commission a university to carry out part of the development project.

• Drug Development Program (Full-Scale R&D)
This program focuses on drug development and offers support for full-scale R&D (pilot production). It aims to help pharmaceutical companies carry out drug discovery and development. The target is to complete clinical trials from one stage to the next. Once the applicant succeeds in an initial stage, it is entitled to receive another grant for a further stage. The overall project period is five years.

• Contract Development Program
This program can be considered as a soft loan because if the project is successful the company has to reimburse 100% of its grant to JST, but only 10% of the granted amount if it fails. The aim is to drastically reduce the potential risk of developing challenging new technologies.

Application approval is based on peer review. Each peer review panel is specialized in a different field of technology. The head of the panel is usually a former R&D director of a company. The review criteria are novelty, validity of target, invention, execution and commercialization possibilities, and risk. The approval process normally takes about six months.

The A-STEP program has various sub-programs based on the different stages of development, signaling different levels of risk, type, amount, and duration of support. Grantees can be both large firms and SMEs. Nonetheless, the aim of all sub-projects are better utilization of results of university research. Most of the projects require joint applications between university and industry. JST claims the success rate of A-STEP to be approximately 25%. According to JST's officials, failed granted projects are not a problem. MEXT, which supervise JST, takes into account the nature of financing risky and innovative projects.

Besides its funding programs, JST also provides several support programs in order to match the "seeds" with "needs." JST has a weekly new technology presentation meeting, which is a venue for university researchers to introduce their research results to industry people. Annual exhibitions under the name of "Innovation Japan" are also held to introduce universities' technology seeds to the public. In the other direction, JST holds a seminar where industry people can present their problems or needs to academia. This forum proved to be particularly useful for SMEs and companies without their own research departments.

5. CONCLUSION AND LESSONS LEARNED FOR OTHER COUNTRIES

Japan has put considerable effort into stimulating innovation after its economic strength entered decline since the 1990s. Several laws and policy initiatives have been introduced throughout these years, especially to encourage better interaction between universities (and research institutes) and industry. Nonetheless, the results of these efforts are mixed, even if the number of university-industry joint and commissioned research has increased. Revenues from licensing of university-owned

patents fluctuate year by year, although the number of startups and spin-offs from universities rose and met the target of 1000 in the year 2004 as planned. The long-term survival and contribution on the economy of these new firms are still questionable.

Japan's experiences in the last two decades show both strengths and weaknesses and generate valuable lessons learned for other countries.

Regarding strengths, Japan's experiences illustrate strong political commitment from policymakers. A series of new laws, policies, and institutions have been introduced one after another. Specific industry and numerical targets (such as creating 1000 new startups within three years) have been set and achieved. Unlike other countries, several key economic ministries and agencies besides those responsible for S&T development also play their parts actively in new initiatives like the SBIR program. Policies are implemented in several directions, both bottom-up and top down. Monitoring and evaluation, effective or not, did take place and were parts of policies from the very beginning.

Nevertheless, the Japanese experiences demonstrate certain weaknesses or limitations.

Firstly, Japanese laws and policy initiatives paid too much emphasis on the roles of universities and, to a lesser extent, public research institutions in enhancing overall innovation capabilities and opportunities in Japan. Most new grants given by funding agencies were tied up with exploiting university research. Interaction between firms and universities and its results were their main concern. These policy initiatives neglected other sources of innovation such as from large domestic corporations, foreign multinational enterprises, SMEs, local communities, and interaction between these actors. Since Japan's catching-up phase, large companies and their interactions with suppliers played a very important role in stimulating both radical and incremental innovations. The more recent policy initiatives should not have almost completely neglected their roles. These policy initiatives also did not pay enough attention to marketing innovations, organizational innovations, innovations in business models, and innovations from new interactions between science, arts, and the service industry. These are important new sources of today's innovations and Japan has considerable strengths within them based on their customs and culture. The recent Japanese experiences are, therefore, different from those of other leading Asian countries like Singapore (Wong and Singh, 2012) and Taiwan (Liu and Wen, 2012) where innovation policies since the 1980s have been more holistic in how they engaged various actors in innovation systems and covered many types of innovation beyond those that are science-based and university-led.

Second, initiatives to promote better university-industry linkage were also very much in favor of the modes of knowledge transfer based on intellectual property rights. This is too narrow, as there are other modes of knowledge transfer and cooperation between university and industry. In some industries, particularly engineering-based ones like automotive and machine tools, informal interaction between university professors and industry to facilitate transfer of tacit knowledge tends to be more important. That was the cases before these new policy initiatives were introduced in the 1990s and it is not something that should be overlooked. Policies acknowledging and promoting more of such interactions are needed.

Third, most of the laws and policy initiatives, for example the Bayh-Dole Act, the SBIR Law, the Limited Partnership Law, and the technology licensing offices, have been adapted from American precedents. The effectiveness of some of these laws and practices (especially the Bayh-Dole Act) is debatable even in the US. More importantly, some elements underlying the successes of the American policies were not sufficiently implemented in Japan, particularly the US government's procurement of products and technologies from the research done by SMEs and startups that were financed by federal government funding. This is a very critical demand-side policy initiative that creates captive first markets for innovations that might be too risky and uncertain otherwise to be accepted in the private market. Japan's initiatives were only supply-side policies, and the demand-side ones, being the integral part of the US's successes, were lacking.

Fourth, there is still fragmentation between policy programs across government agencies, especially those under different ministries. There are still "turf walls," unnecessary overlapping, and insufficient coordination of policies especially by MEXT and METI. JST's A-STEP claims to provide "seamless" schemes of government financial supports, but this seamlessness seems to be only within JST and not across agencies.
Last but not least, although monitoring and evaluation were parts of several programs, they are not very systematic and tend to vary across agencies. Self-evaluation practices are common. Even external evaluations by third parties may not be highly credible, as external evaluators have close ties with implementing agencies.

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