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Innovation Policy Challenges for Japan

An Open and Global Strategy

Kazuyuki Motohashi

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Executive Summary

Productivity is increasingly important in the Japanese economy as an aging and shrinking population is expected to constrain labor input. Thus, the creation of innovation is critical for realizing economic growth and maintaining Japan's international competitiveness. Specifically, emerging countries such as China and South Korea are quickly catching up on Japan's level of technological prowess in electronics and other high-tech industries. For that reason, continual investment in R&D and provision of products and services that are competitive in the global market are crucial for Japan's international competitiveness.

As such competition heats up in the field of innovation, accelerating the speed of product development is becoming a vital issue for Japanese companies. At the same time, broadening the scope of R&D is also essential so as to keep up with increasingly complex products and systems that have developed as the result of technological advances. This paper examines the future of Japanese companies, with a particular focus on the "opening" and globalization of innovation that is critical to their international competitiveness.

This article also presents an overview of the policy challenges of the Japanese government in the area of a network-based innovation system. In Japan, the national innovation system is characterized by large companies, with substantial in-house R&D resources, dominating private R&D expenditure, while R&D collaboration between companies and universities is lacking. However, there is an increasing trend of R&D collaboration, particularly among small to medium-sized enterprises (SMEs). The Japanese government has also taken several policy actions to facilitate such open innovation activities, in the hope that they spread nationwide to include large companies.

What is vital for Japanese firms is to incorporate into their technology management both of the key elements – maintaining expansive R&D activities that do not sacrifice future growth potential through open innovation, and breaking into new growth markets through "globalization".

Contents

Introduction

Due to the economic recession triggered by the collapse of Lehman Brothers, Japanese companies slashed their research and development (R&D) budgets. More recently, as business performance showed signs of recovery, this type of spending began to pick up. However, the Tohoku earthquake dealt Japanese businesses a terrible blow, and uncertainty about the future has been growing once again. On the supply side, productivity is increasingly important in the Japanese economy as an aging and shrinking population is expected to constrain labor input. Thus, the creation of innovation is critical in order to achieve productivity-led economic growth and to maintain Japan's international competitiveness. Specifically, emerging countries such as China and South Korea are quickly catching up on Japan's level of technological prowess in electronics and other high-tech industries. Continual investment in R&D and provision of products and services that are competitive in the global market are thus crucial for Japan's international competitiveness.

As such competition heats up in the field of innovation, accelerating the speed of product development is becoming a vital issue for Japanese firms. At the same time, broadening the scope of R&D is also essential in keeping up with increasingly complex products and systems that have developed as the result of technological advances. What is important in balancing the speed and scope of R&D is devoting management resources to the promotion of "open innovation". Also, while the Japanese market is saturated, the rapid growth of emerging economies such as China, India, and countries in Southeast Asia precipitates the need for a global innovation strategy.

This paper examines the future of Japanese companies, with a particular focus on the "opening" and globalization of innovation that is critical to their international competitiveness. It also presents an overview of the policy challenges facing the Japanese government in establishing a network-based innovation system. In Japan, the national innovation system is characterized by large firms with substantial in-house R&D resources dominating private R&D expenditure, with a lack of R&D collaboration between firms and universities. However, R&D collaboration is increasing, particularly

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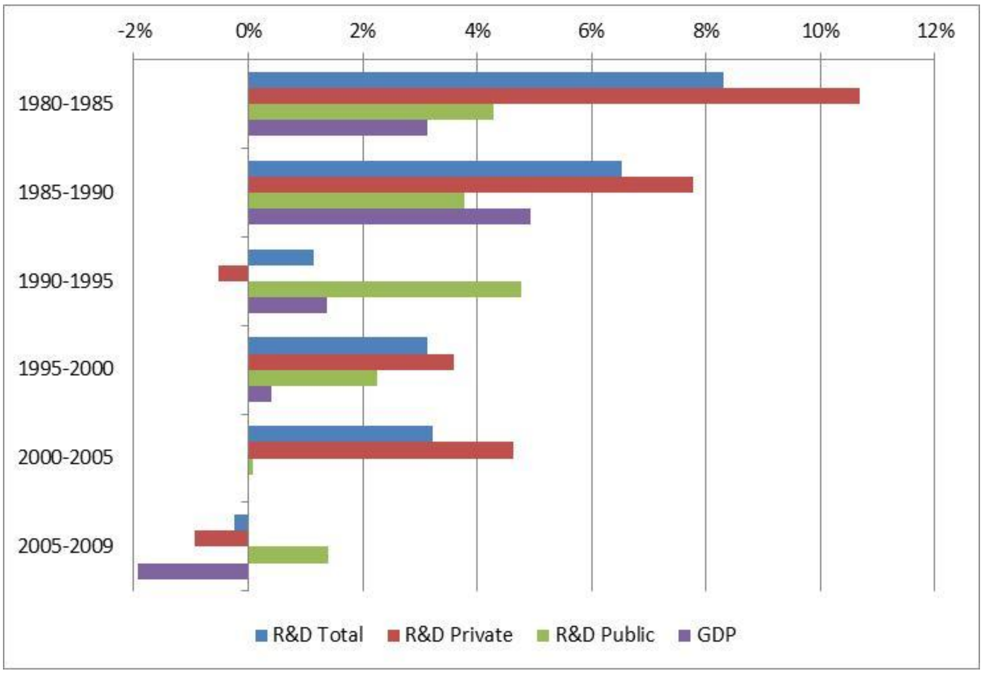
among small to medium-sized enterprises (SMEs) (RIETI, 2004). It has been found that the benefits of R&D collaboration on a company's performance are higher for young and small firms (Motohashi, 2005). The Japanese government has taken several policy actions to facilitate such open innovation processes, with the hope that this spreads nationwide and includes large firms. The Science and Technology Basic Plan for 2011–2015 puts an emphasis on collaboration between industry and universities both in education and research. In addition, more specific policies on a network-based innovation system, such as the Japanese SBIR (Small Business Innovation Research) and the R&D Partnership Program, are being implemented. In this paper, such policy actions are reviewed and their implications are examined.

R&D Trends and the Open Innovation Activities of Japanese Firms

Japan's economic growth rate has been sluggish since the collapse of the bubble economy in the early 1990s. Growth in businesses' R&D investment has been stagnant ever since. *Figure 1* shows trends in GDP and R&D investment growth (five-year average annual growth rate, GDP deflator-adjusted real values). Around 1990, GDP growth dropped from around 4% to below 2%. Recently, due to a sharp decline in GDP after the Lehman shock in 2008, its average growth rate from 2005 to 2009 fell to -1.9%. The growth of private R&D spending also decreased sharply in the early 1990s. It rose again between 1995 and 2005, but fell in recent years due to the financial crisis. On the other hand, public R&D increased in the period 2005–2009. At this moment, the impact of the Tohoku earthquake on R&D is unknown. However, private R&D spending is expected to plunge since many companies need to invest in restoration activities.

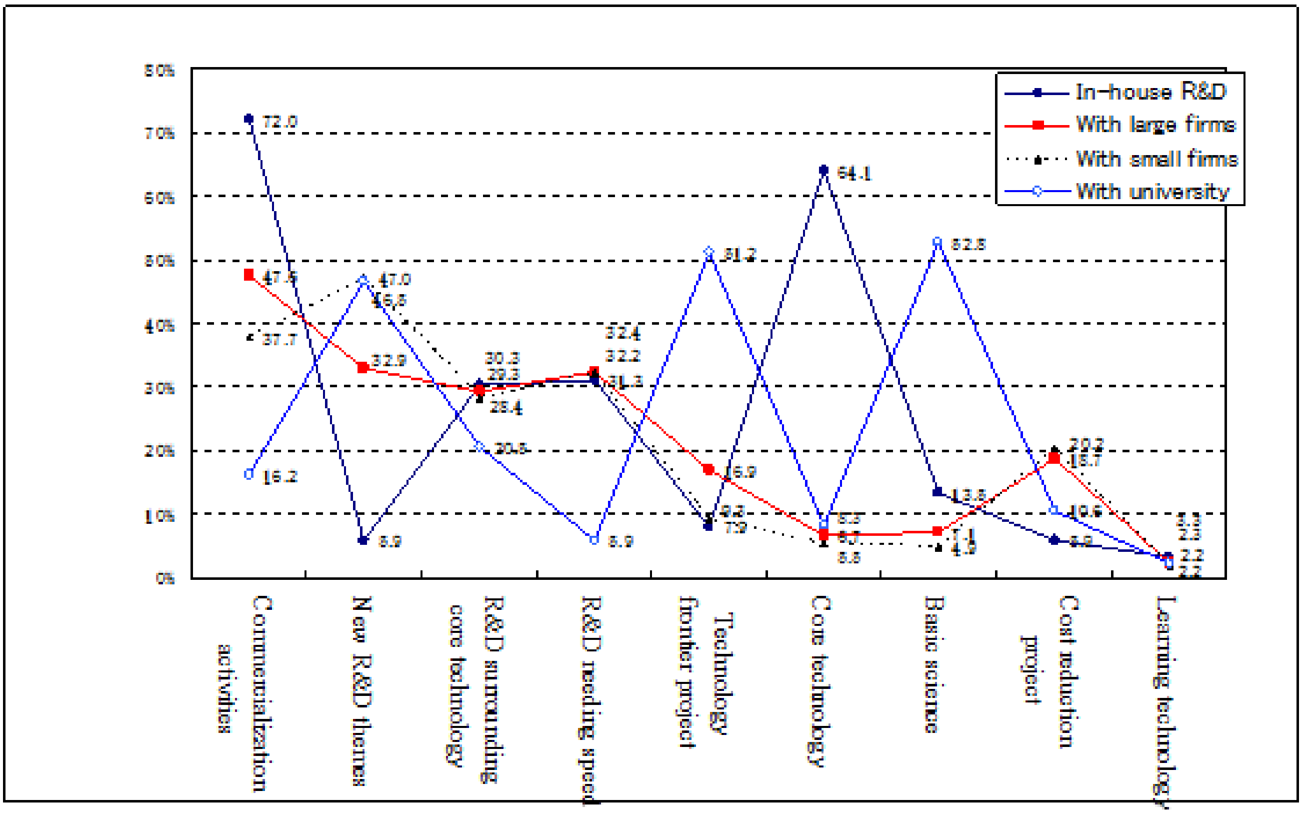
Figure 1: Annual growth rate of GDP and R&D



In the current circumstances, Japanese companies face the challenge of increasing innovation efficiency by maximizing their use of limited capital and human resources. One keyword given significant attention in this process is “opening.” Open innovation, characterized by using not only in-house but also external R&D resources (Chesbrough, 2003), is steadily making strides in Japan as a whole. Many have described Japan’s system of innovation as being in-house-oriented and mainly driven by large corporations, but external collaboration in R&D has been picking up in Japan since around the year 2000. This activity has mainly been occurring in small and medium-sized businesses, however, and intra-company or intra-group innovation activities are still the norm within large corporations (RIETI, 2004). Factors such as the accelerating speed of technological advances, the growing significance of science in innovation, and increasingly fierce R&D competition, caused by emerging and other companies catching up technologically, all form the backdrop for the push towards open innovation. Conducting all required R&D internally is prohibitive in mainly high-tech industries, such as electronics and pharmaceuticals, so shifting to an open innovation model is becoming a pressing issue for Japanese companies.

Opening up innovation is becoming even more important due to the recent deterioration in the economic environment. Effectively, using external resources to boost R&D efficiency is imperative to prevent strict budgetary constraints from hampering future growth potential. A report by the Research Institute of Economy, Trade and Industry shows that open-innovation activities such as R&D collaboration with other firms and universities has increased over time, and this trend is prominent particularly among small and young firms (RIETI, 2004). It also shows that “commercialization activities” and R&D for “core technology” are often conducted in-house, while “basic science” and “technology frontier projects” are often conducted through external collaboration with universities; the proportion of firms conducting basic science in-house is around 10-20% (*Figure 2*). The results indicate that, although most companies realize the importance of R&D in fundamental areas, in-house resources are focused on R&D for products close to commercialization, while fundamental research is left to R&D collaboration with universities. In addition, although it is natural for many firms to rely on external collaboration in new areas of R&D, due to a lack of human resources and pertinent facilities, a high proportion of these firms have chosen as their partners SMEs and start-up firms as well as universities. This trend is especially pronounced for large enterprises, indicating the increasingly important role played by new-technology-based firms in the Japanese national innovation system.

Figure 2: In-house or collaborative R&D by type



Source: RIETI's R&D Collaboration Survey (RIETI, 2004)

In the current economic environment, it is likely that many companies are being forced to narrow even further the scope of areas in which in-house R&D is undertaken. However, giving priority to the short-term at the expense of precluding future growth must be avoided. While effectively using external collaboration in revising their R&D projects, businesses must make an effort to retain whatever is important from a medium to long-term perspective.

The open innovation that has been conducted in large corporations has mainly involved incorporating external research resources, with little focus on exporting in-house projects. Promoting two-way open innovation that involves both outside-in and inside-out activities will be critical in the future. The "not invented here" (NIH) syndrome characteristic of large corporations is the main factor in research departments that inhibits outside-in activities, whereas the main thing that prevents inside-out activities is the "not sold here" (NSH) syndrome present in development departments. Even if the work of the research department cannot be effectively used internally, out-licensing this work to other companies may result in benefiting competitors in the market. As a result, the operating department that includes development will resist out-licensing, and the work of the research department will become a deadweight loss. In addition, in many cases the incentive gap between the research and development departments results in poor collaboration. In this way, problems with internal technology management are often the reason why open technology does not proceed smoothly. Thus, focusing on how to promote collaboration between the research and operating departments is the key to success.

Another important aspect of open innovation is Japanese companies' globalization activities. Dim prospects for economic growth in Japan and other developed countries are resulting in higher expectations for emerging markets. Countries such as China and India are growing in importance, not only because of their attractive markets but also as a source of human capital for R&D. Global US and European enterprises are becoming more active in R&D activities in China and India in order to take advantage of the research resources in those countries. In contrast, Japan is currently caught in a vicious cycle of macroeconomic contraction, constrained R&D investment, weakening international competitiveness, and declining performance. The key to breaking this cycle lies in the globalization of innovation.

Japanese firms, however, currently lag behind US and European firms in globalization. Companies around the world are turning to China and India as centers for R&D, but, even in China – which is viewed as closer to Japan both geographically and culturally – Japanese firms have been slow to arrive on the scene for this purpose. Compared to US and European firms, one characteristic of Japanese management of foreign business lines is strong control by company headquarters. According to a comparative analysis of innovation activities by Japanese, US and European firms in China, (1) foreign branches of Japanese firms are characteristically viewed as local branches of the home research facility; (2) foreign branches of US and European firms conduct activities independently and actively collaborate with local universities and research facilities, and (3) the profit margins of Chinese branches of Japanese firms are lower than those for US and European firms as a whole (Motohashi, 2010).

R&D in the regions that are expected to grow in the future is effective in developing products for the local market. In recent years, several companies have also been conducting reverse innovation, in which products developed in emerging markets are also used in advanced nations. Professor Vijay Govindarajan at Dartmouth and others use the case of GE's development of an ultrasound examination machine in China to illustrate an instance of a low-cost product originally developed for the Chinese market being used to obtain new customers in the US (Immelt et al, 2009). There is a strong desire among Japanese companies as well to make products designed in emerging markets not just local but also global products.

The need for companies to get to know the market is particularly important in technology management strategy for emerging markets. In many cases, Japanese products cannot penetrate “good-enough markets” as they are high-priced and have excessive functionality and/or quality. Products with high added value do not necessarily need to be highly priced, and firms need to focus on lowering costs while raising added value in product development. Also, the dramatically changing environment in emerging markets with rapid economic growth requires a system in which the development of new products rapidly takes account of local needs. It is important for Japanese firms to develop a systematic response method that increases the speed of decision-making, if they want to avoid trailing behind US and European firms, where authority is more easily transferred to local branches.

Science and Technology Policy in Japan: an Overall Framework

Science and Technology Basic Plan

In 1995, the "Basic Law on Science and Technology" was enacted. Under this law, the Japanese government produces a five-year Science and Technology (S&T) Basic Plan. The first plan covered 1996–2000, the second 2001–2005), and the third 2006–2010. The fourth plan covers 2011–2016. This plan, approved by the Japanese cabinet, serves as a linchpin of science and technology policy in Japan. Under the S&T Basic Plan, the government set a goal of public spending on R&D of 17 trillion yen for the five-year period of 1996–2000, 24 trillion yen for 2001–2005, and 25 trillion yen for 2006–2010. The amount for 2011–2016 also totals 25 trillion yen. It should be noted that this is a goal for R&D spending, and is not binding on the government. The public R&D spending during 2006–2010 was 21.6 trillion yen, 86.4% of the targeted 25 trillion yen.

However, this policy framework and policy planning reflect the strong commitment of the government to science and technology. This commitment is generally shared by the business community and the general public, as science and technology are considered to be the only way for resource-poor Japan to maintain its high standard of living against the threat of a rapidly aging and declining population as well as the challenges from other Asian countries, notably China. Under these Basic Plans, the university sector received funding to modernize its dated equipment and facilities, the competitive grants for researchers were raised, and the number of post-doctoral fellowships were increased. Thus, not only has the funding for scientific work been increased, but a new science system, largely modeled on the US system, has been introduced. In addition to greater reliance on competitive funding rather than block grants to universities, and more post-docs, a new system of peer-review and evaluation has been created.

The fourth S&T Basic Plan puts an emphasis on the strength of the Japanese science community in fundamental research, such as iPS cell technology and the discovery of new materials with super conductivity, and raises the importance of innovation, in the sense of enabling international competitiveness by capitalizing on these scientific strengths in the global era. As described in the previous section, the business environment for innovation is not good in Japan, while international competition is intensifying. In this regard, public investment in fundamental research, which may suffice for private R&D with relatively short-term goals, is critical to ensure the international competitiveness of the Japanese economy.

The fourth S&T Basic Plan proposes the internationalization of Japanese science and technology system – for example, the internationalization of universities, such as inviting international scholars and students to Japan, as well as strategic partnership with foreign universities. In addition, the construction of an Asia-wide research area is proposed. Public R&D spending is a solution that should be applied not only in Japan, but also in other Asian countries. As well, industry and universities are collaborating to identify competitive technology areas in Japan, and disseminate them to other countries in Asia. A further proposal is the creation of an open innovation platform, where industry and academia jointly discuss future strategy on technological development. It should be noted that health services and eco-innovations have been selected as areas on which to focus, and specific future tasks to be tackled have been identified. All these proposals are designed to respond to the challenges of changing the Japanese innovation system into a more open and global one.

Structure of S&T policy formation and public S&T funding

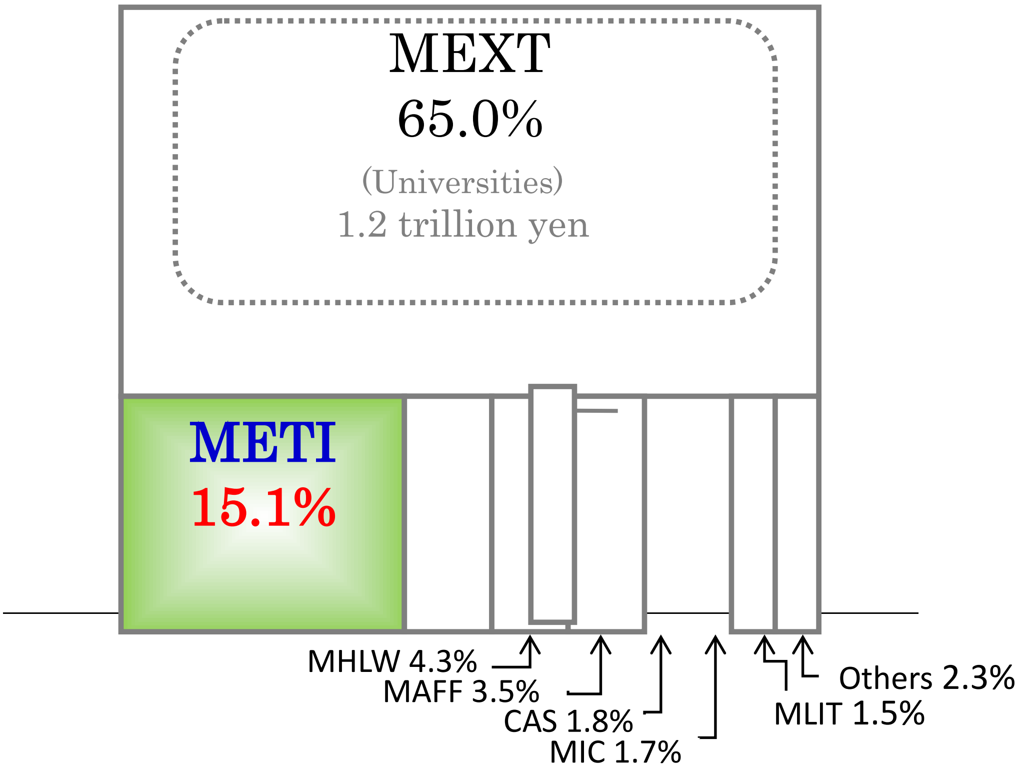
The structure of the Japanese national government changed drastically in 2001, in the course of administrative reform initiated by former prime minister Hashimoto. In this process, the structure of the ministries in charge of S&T policy was also reorganized. The Science and Technology Agency was merged with the Ministry of Education, creating a new ministry, the Ministry of Education, Culture, Sports, Science and Technology, called MEXT.

In addition, a new section to coordinate S&T policies by various ministries was created inside the Cabinet Office of the Prime Minister, called the Bureau of Science and Technology Policy. This bureau, with about 100 staff members comprised of government officials from ministries and scientists from academia and the private sector, is expected to act more strongly in coordinating S&T policies. Furthermore, most national research institutes, once sections of the national government, have had their status changed to Independent Administrative Institutions (IAIs), which are independently managed bodies that determine their own budgets and personnel for research activities.

The Bureau of Science and Technology Policy (BSTP) serves as secretariat of the new Council for Science and Technology Policy (CSTP), whose mission is to investigate and discuss not only basic strategy for S&T policies, but also resource allocation. Centralization of the decision-making system was one of the major features of the national government reform of 2001, and the Cabinet Office now plays a more important role in policy-making. This is the case for S&T policy, and the CSTP, backed by the BSTP inside the Cabinet Office, has become more influential in facilitating inter-ministerial budgets and human-resource allocation in the S&T area. Within the government, budgetary allocation is managed by the Ministry of Finance. Under this new system, the CSTP has discussed each ministry's budget proposal on S&T policies, and the Ministry of Finance has to comply with CSTP recommendations when drafting a government budget proposal to present to the Diet (national parliament).

Figure 3 shows the share of S&T budget by ministry. A total of 65% of the 3.57 trillion yen of the government budget in the fiscal year 2010 was spent by the Ministry of Education, Culture, Sports, Science and Technology. This ministry is in charge of basic R&D, and a substantial portion of this budget is institutional funding to universities and public research institutions. Industrial application R&D is managed by ministries in charge of the corresponding sector, and the largest budget is allocated to the Ministry of Economy, Trade and Industry (METI). In addition, other ministries such as the Ministry of Health, Labor and Welfare (MHLW), Ministry of Agriculture, Forestry and Fishery (MAFF) and CAS (Cabinet Secretariat), are providing R&D funding to their relevant policy areas. Innovation policy for an open and global system is mostly dealt with by METI (its innovation policies are discussed in more detail in the following sections).

Figure 3: Structure of S&T budget by ministry



METI: Ministry of Economy, Trade and Industry
MHLW: Ministry of Health, Labor and Welfare
MAFF: Ministry of Agriculture, Forestry and Fishery
CAS: Cabinet Secretariat
MIC: Ministry of Internal Affairs and Communications
MLIT: Ministry of Land, Infrastructure, Transport and Tourism
METI's innovation policy for an open and global system

METI's public R&D program

The Ministry of Economy, Trade and Industry (METI) is in charge of organizing R&D programs for industrial innovation. An R&D project by METI is typically organized by a group of companies working on large-scale R&D projects. The research funding is provided by METI, and public research institutions, such as AIST (Agency for Industrial Science and Technology), are also involved in such R&D projects. The VLSI (Very Large Semiconductor Integrated Circuit) project for advanced semiconductor technologies is one of the success stories among METI's R&D projects. It was started in 1976 to improve the technological capabilities of Japanese semiconductor manufacturers, which were substantially lagging behind US firms. In this project, the Electrotechnical Laboratory of AIST played an important role. This three-year project pushed Japanese electronics companies to the world frontier in terms of large-scale integration (LSI) technology.

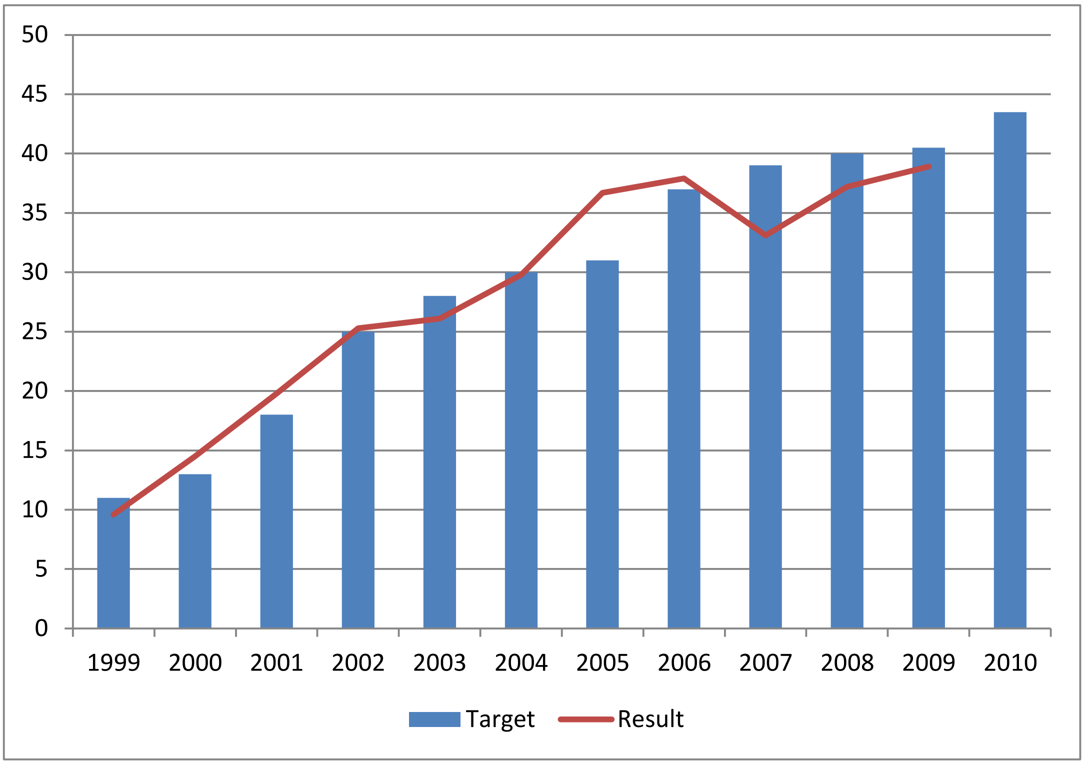
Japan used to have a substantial number of such projects in the area of advanced materials, mechanical engineering, energy development and environmental technologies. However, due to increasing technological complexity, participating companies found it difficult to identify a common technological target. In addition, as the Japanese companies gained their own technological capabilities, the government's role in supporting their industrial competitiveness became marginal. As a result, METI's R&D projects in the 1980s and 90s did not, in general, achieve substantial results. Therefore, METI revised the style of system for R&D projects in 2000. Under the new system, instead of focusing on specific technological development, the R&D projects are organized to meet specific social and policy needs. For example, "assuring a longer and healthier life" is one important social need. To meet this objective, a R&D program for medical services is organized. Since a technological breakthrough alone is not enough to achieve such social needs, a policy package that includes regulatory reform of the healthcare industry is initiated in parallel with the technology development project.

Another important policy focus of the R&D program is promoting innovation at SMEs. This policy is mainly managed by the Small and Medium Enterprise Agency inside METI. To understand recent developments in SME innovation policy, it is important to be aware of the fundamental revision of the SME policy framework that occurred in 1999, along with the revision of the SME Basic Law. Before this revision, SMEs had been treated as "weak enterprises" in the economy. The SME policy goal was to raise the level of SMEs as a whole so they could compete with large firms. The main point of the revision of the SME Basic Law is to throw out this social policy-type SME policy and to treat SMEs as the source of entrepreneurship, innovation and job creation. Now SME innovation policy has become a top priority, replacing policies aimed at insulating SMEs from competition from large firms. One example of an SME innovation promotion scheme is the Japanese SBIR (Small Business Innovation Research), named after the SBIR in the United States. This system was established in 1999 to activate SMEs with technology development capability and to support their creative business activities. Specifically, ministries in charge of R&D grants and non-profit special corporations, such as the Small and Medium Enterprise Corporation, a non-profit funding agency for SMEs, are to designate as "designated subsidies" their R&D grant systems designed for SMEs.

The target budget allocated for SME innovation promotion under this scheme is presented in *Figure 4*. From 1999 to 2010, the amount rose steadily. Under the Japanese SBIR scheme, SMEs receiving a grant by designated subsidies are also entitled to the following benefits (these mainly apply to commercializing activities based on the technological outputs from government subsidiary research projects):

- Expansion of debt guarantee lines by the special debt insurance for SMEs
- Expansion of debt size by the Law on Subsidy for Facility Introduction Funds for Small-Scale Enterprises
- Special loan system of the Japan Finance Corporation for Small Business

Figure 4: The SBIR budget target and actual totals (billion yen)



Source: Author's collection from various government sources

University-industry collaboration policy

University-industry collaboration policy is jointly organized by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) and the Ministry of Economy, Trade and Industry (METI). This is important from the viewpoint of promoting the apportioning of public spending on R&D to industrial innovation. *Annex Table 1* shows the evolution of the University-Industry Collaboration (UIC) policy in Japan since the late 1990s. The Act on the Promotion of Technology Transfer from Universities to Private Industry (the "TLO

Act") was enacted in 1998. The policy of promoting TLOs (technology licensing organizations) to activate technology transfers was spelled out on the basis of this Act, and 47 TLOs approved by MEXT and METI were established by 2009. The Act on Special Measures for Industrial Revitalization (the "Japanese Bayh-Dole Act"), which was enacted in 1999 and modeled on the Bayh-Dole Act enacted in the US in 1980, allowed universities to retain title to inventions resulting from state-funded research. In Japan, however, since many research universities were national universities, restrictions on retaining rights to invention were applied. As state organizations, national universities had to comply with rigorous restrictions on the assertion of their rights with regard to patent filing. Universities rarely filed patent applications, and in cases where inventing was part of a university research scientist's academic duties, the rights to inventions were generally vested in the individual, i.e., the professor, and not the organization.

To address these problems, national universities were incorporated in 2004, and restrictions on technology transfers were relaxed. A mechanism was introduced to create competition among universities. The university budget was paid in a lump sum as an institutional discretionary fund for operating expenses. The total amount of the institutional fund was steadily reduced while competitive funds were expanded. Because the funds for joint research undertaken with the private sector constitute an important source of income for universities, there was a shift in their identity as corporations increased the incentive for universities to engage in UICs. In addition, incorporation made it possible for a university to own intellectual property as an organization. The 2002 Outline of Intellectual Property Strategy spelled out a principle whereby the title to inventions devised by university employees was vested in the university as a corporation, rather than in the individual inventor. From the fiscal year 2003, MEXT promoted the establishment of "Programs for the Establishment of University Intellectual Property Offices" to support intellectual property activities in universities, and the operational framework for and management of intellectual property in universities were put in place; principally at 34 universities whose programs were accepted in MEXT's solicitation of bids.

As described above, the series of UIC promotion policies devised a method of establishing university ownership of university research results and transferring the resulting technologies to the private sector through licensing agreements with corporations. It has become a common practice for companies and universities to co-own the results of joint research, as specified by contractual agreements. This arrangement transformed the nature of UICs from informal relationships between companies and individual researchers (where the results of joint research would be owned by the company as intellectual property, while the academic researcher would be compensated through scholarship donations and other means) to formal collaborations on a contractual basis, with the university patent office serving as the intermediary.

After 2004, the number of university patent applications surged. But what is the quality of university research? This question is not new in the United States, where university patents increased dramatically after the Bayh-Dole Act was enacted in 1980 (Henderson et al, 1998; Mowery and Sampat, 2005). Motohashi and Muramatsu (2011) show that the new policies increased the number of UIC patents in the late 1990s and that the quality of patents did not decrease. However, it is also found that strong intellectual-property (IP) policies pursued by universities may reduce the incentive for firms to commercialize inventions resulting from UIC collaborations. It follows that IP policies at national universities, which now have a uniform system guided by MEXT, should be flexible, depending on a company's needs.

R&D partnership system

Finally, an R&D partnership system was introduced in 2009, based on legislative action by METI to enable the creation of a new legal entity. When multiple firms engage in a joint R&D project, they can create a new entity such as a Limited Liability Corporation (LLC) or Limited Liability Partnership (LLP). An LLC has a legal personality which enables its asset and patent ownership and economic transactions with other firms. However, the amount invested in an LLC cannot be treated as R&D expenditure, so parent companies cannot benefit from an R&D tax credit. On the other land, fees to LLP can be treated as R&D expenses, but an LLP cannot claim its own juridical personality, so economic activities such as asset management have to be dealt with by each of the participating companies individually. R&D partnership, created by special legislative action, constitutes a special entity intended to combine the upsides of both LLC and LLP.

R&D partnership has some features that fit the characteristics of joint R&D activities. First, after the R&D process is completed and moves into the commercialization phase, this entity can be transformed into a corporate body (corporatization) without disbanding the partnership. In addition, it is possible to partition the whole entity – for example, to corporatize the commercialization part while maintaining the R&D part as an R&D partnership.

Universities and public research institutes can participate in an R&D partnership. National universities and independent administrative institutes (an organizational form of most Japanese government research laboratories) are not allowed to invest in private companies in general. However, an R&D partnership can attract them as a participant by asking for in-kind (non-cash) contributions only.

In the case of an LLP, patents are owned by each participating company, so commercialization of R&D becomes tricky if even one patent-holder does not agree to it. However, under this new system, the agreement of two-thirds of participants is required. This entity is also suitable for university start-ups. A university can participate in this partnership and attract partnership fees from private companies since the R&D tax credit applies to participation fees.

It is too early to evaluate the impact of this organizational innovation, but it is likely to facilitate open innovation in Japan.

Conclusion: Strengthening Competitiveness through the Construction of a Global Ecosystem

What is vital for Japanese companies is to incorporate into their technology management both of the key elements: maintaining expansive R&D activities that do not sacrifice future growth potential through "opening" while breaking into new growth markets through "globalization". Although the current circumstances are difficult, continuing to invest in R&D, based on a company's long-term vision, can keep Japanese companies competitive in the global market. On the other hand, as the world becomes flatter (in Thomas Friedman's sense) and Japanese firms compete toe-to-toe with US and European firms while responding to the threat of firms from emerging countries catching up, revising R&D strategy from a short-term perspective may endanger the continued existence of Japanese firms altogether.

Many Japanese companies possess outstanding technology, which is second to none in the world. The country's manufacturing prowess is also exceptional, and generally Japanese products and quality of service are arguably the best in the world. On an individual product level, however, it is relatively easy to close the gap to Japan's superiority, and in many cases the country's competitiveness is only temporary. This is particularly conspicuous in the electronics field, where technology advances at breathtaking speed and technical information is becoming more and more digitalized. The gap between the level of technology at Korean firms such as Samsung and LG and at Japan's general electronics makers is quickly closing. Also, momentum has been building for joint efforts by the public and private sector to export infrastructure business. For example, in the water business, Japanese firms have an overwhelming advantage in elemental technology such as membrane technology, but the companies that are actually integrating, packaging, and commercializing such technology are European, such as Veolia and Suez.

To link global innovation to big business opportunities in emerging markets, it is essential to create a global innovation ecosystem through efforts such as strengthening relationships with governments and collaborating with businesses and universities in particular countries. Many companies shy away from collaboration with companies in emerging countries such as China for fear of leaking technologies. However, a paradigm shift is now required, in which the focus is on extracting value not so much from individual elemental technologies, but from constructing a whole business system that includes the designing and packaging of products and services. In some cases, a strategic mindset of “small sacrifice for greater gain” may be necessary. Furthermore, a business system is not comprised of just one firm, but should be an organic ecosystem in which many firms collaborate. As we examine the international competitiveness of Japanese firms in the future, a pressing issue is creating a technology management strategy that focuses on building such a global ecosystem.

At a difficult time for private companies following the Tohoku earthquake, government interventions in the Japanese innovation system are important. METI and other relevant ministries are introducing policies to support the network-based innovation model. However, most policies are inward-looking, and the Japanese government still shows limited commitment to the globalization of R&D activities. Multinationals in Japan are competing with their peers in the US, Europe, etc, for emerging international markets such as China. In this situation, the shift of R&D activities overseas is inevitable. This may facilitate technological leakages outside of Japan and provoke public concern about the hollowing-out of high value-added activities. However, the world is changing dramatically, and the government must respond to rapidly altering policy needs and support the innovation activities of companies in an open and global era.

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Annex

Table 1: Evolution of Japan's UIC (University-Industry Collaboration) policy

1998	Formulation of the Act on the Promotion of Technology Transfer from Universities to Private Industry (the TLO Act) → Promoted the establishment of TLOs (Technology Licensing Organizations) Amendment of the Law for Facilitating Governmental Research Exchange → Made it possible to use government-owned land at low cost for joint university–industry research
1999	Creation of the Small Business Innovation Research Program ("Japanese SBIR") Formulation of the Act on Special Measures for Industrial Revitalization → Japanese version of the Bayh-Dole Act/licensing fee halved for approved TLOs Establishment of the Japan Accreditation Board for Engineering Education (JABEE)
2000	Formulation of the Industrial Technology Enhancement Act → Enabled gratis use of national university facilities by approved/certified TLOs; allowed university researchers to serve concurrently as TLO directors, board directors of companies commercializing research results, and statutory auditors of stock corporations
2001	"Hiranuma Plan" announced "Plan for 1,000 university-originated ventures in three years"
2002	Revision of the Ministry of Finance Property Administration Bureau Notification No. 1 → Allowed university-originated ventures to use national university facilities Revision of the TLO Law Notification → Made it easier for businesses to start approved TLOs
2003	Formulation of the Intellectual Property Basic Act → Obliged universities to voluntarily and actively seek to develop human resources, research activities, and disseminate research results Amendment of the School Education Law → Created special-emphasis graduate school systems, increased flexibility in establishing university faculties/departments
2004	Implementation of the National University Corporation Law → Status of university researchers: "non-civil servant type", capital contributions to approved TLOs Implementation of the Act for Partial Revision of the Patent Act → revision of patent-related charges relating to universities and TLOs

Source: Motohashi and Muramatsu (2011)