Multinational's global open innovation activities in emerging markets: A case of Japanese firms' collaborations with national research institutes in Thailand

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Abstract

This paper analyzes the management of multinational's R&D in emerging economies, taking the case of Japanese firms' R&D collaboration with NTSDA, Thai national research institute. A detail interview survey for two cases, Polyplastics, an engineering plastics manufacturer and Shiseido, a cosmetic company, both working together with NSTDA for R&D, reveals that there exist significant variations of motivations, scopes and outcomes of such activities. Home base exploiting type activities (Polyplastics) are easier to manage as a natural extension to home country activities, but it is important to motivate its partner to collaborate, since only exploiting local resources may not be sustainable for long time. While, home base augmenting type activities (Shiseido), a local activity has to be well coordinated in global operation at headquarter. In addition, it is difficult to see a short term benefit from such explorative activities, so that top management support becomes important to sustain such activities for certain amount of time.

Keywords: Multinational R&D, Thailand, open innovation, national innovation system

1. INTRODUCTION

Global activity and emerging markets continue to gain in importance as part of overall corporate activity. While growth stagnates in developed markets, emerging markets and rising incomes of consumers in emerging markets offer high potential. A recent trend involves a shift toward a perspective that regards emerging markets as potential research and development locations, not merely markets (von Zedwitz, 2005). Various motivations for multinationals to conduct R&D overseas are classified in home-base augmentation (HBA), strengthening R&D capabilities of a whole company, or for home-base exploitation (HBE), exploiting host country market based on home base technologies (Kuemmerle, 1997). There are substantial numbers of literature to present the typology of multinational's overseas R&D by scholars in international economics and management (Cantwell and Mudambi, 2005; Motohashi, 2010), surveyed by Gammeltoft (2006). This study illustrated six types of activities, but can be broadly categorized by the following three: (1) incorporating overseas research resources (ones not available in the home country), along the line of HBA; (2) development for localization of products and services, along the line of NBE; and (3) development for meeting the location specific requirement, such as safety regulations.

A common requirement for achieving all these goals is access to local research information, such as market needs, technical regulations and location specific technologies. In addition, operating overseas R&D requires local researchers with substantial technological backgrounds. Therefore, it is critical to find a local partner to facilitate accessing such local information and resources for effective operation of overseas R&D activities. In a case of emerging economies, since the technological level of local firms is relatively low, universities or public research institutions can be a good candidate for multinationals to cooperate with. This paper examines a case of Japanese multinationals' cooperation with the National Science and Technology Development Agency (NSTDA), a national research institution in Thailand.

Japanese businesses have a long history of operations in Thailand, and Japanese companies currently own more than 1500 subsidiaries in Thailand, the third highest number of subsidiaries of Japanese firms, after China and the United States. Under the ASEAN Free Trade Agreement (AFTA), the concentration of some particular industries by ASEAN nations is found. Thailand hosts a lot of automobile industry facilities, with most of which are subsidiaries of Japanese firms. In term of localization of R&D, a large multinationals such as Toyota and Honda set up their own development center near Bangkok, but it might be too risky for smaller automobile parts suppliers to own

independent R&D center in Thailand. Therefore, some of them are collaborating with Thai universities and national research institutes, including NTSDA for their R&D activities. In addition, Thailand hosts substantial number of multinationals in food and commodity products, backed by a large market of whole ASEAN region. Here again, we can find some cases of Japanese firms' joint R&D activities with Thai national institutions.

In this paper, we have conducted a detail interview survey on two Japanese firms, Polyplastics, a manufacturer of engineering plastics mainly used for automobile parts, and Shiseido, a cosmetic company, which have worked with NTSDA as a R&D partner. Though these two cases, we have drawn some managerial implications on operating overseas R&D with cooperation of local partners in emerging economies. We, first, provide an overview of national innovation system in Thailand, and the role of NTSDA in the next section, because it is important to understand local S&T settings and policy goals to proceed effective partnership activities. Then, we will present some results of the interview survey to Polyplastics and Shiseido. This section is followed by discussion on R&D management in emerging economies by comparing two cases. Finally, this paper concludes with managerial implications for multinationals' overseas R&D.

2. NATIONAL INNOVATION SYSTEM IN THAILAND AND NSTDA

2-1. Characterizing NIS in Thailand and Recent Developments

Thailand has experienced advancing industrial concentrations in automotive and other industries and has enjoyed relatively steady economic growth. However, it was late in launching R&D targeting knowledge-intensive industries. Research and development costs account for 0.25% of the nation's GDP (as of 2006), a ratio remaining unchanged since 2000, indicating a lack of progress in knowledge intensification for the economy (Figure 1). Among ASEAN nations, Singapore's ratio of R&D costs to GDP, at 2.5%, is dramatically higher, followed by Malaysia and Thailand, in that order. Thailand has lower levels of research funding than China (1.5%) and India (0.8%).

In a concept of national innovation system, innovation performance such as new product development and process innovation is determined not only by firm's innovative capabilities, but also by linkages with other innovation players such as public research institutions and universities (Freeman, 1987). Cross country comparative analysis shows significant differences of national innovation system across countries (Nelson, 1993), and technology and innovation policies including public spending on R&D in national research institutions have to be reviewed by taking into account country specific institutional factors (OECD, 2004).

In this context, national innovation system in Thailand is described as not only lower in R&D intensity, but also "fragmented one", where a science sector (consisted by universities and public research institutes) and an industry sector are separated each other (Intarakumnerd et. al, 2002). A look at R&D costs by user sector shows high percentages for government and other not-for-profit institutions, with private-sector R&D costs accounting for only about 40% of the total (Table 1). Historically, private firms in Thailand paid little attention to innovative activities, so that there was a substantial gap in technological level between private firms and public research institutions (PRIs). In addition, universities and PRIs focus on fundamental research with little incentive to collaborate with industry (Brimble and Doner, 2007). As a result, the commitment to building knowledge pool by the government and private sector is far behind the one made by Korea, Taiwan and Singapore 10-20 years ago, when their levels of economic development is similar to Thailand today (Bell, 2002).

(Figure 1 goes about here)

(Table 1 goes about here)

However, it is a mistake to say that a science sector does contribute to industrial innovation at all. The style of university and industry linkages takes various forms, including training high skilled human resources, technical consultancy and services, shared equipment and facilities, joint research contract etc. Brimble and Doner (2007) provide detail analysis of university (including public research institutions) and industry activities in Thailand by industry. An active collaboration can be found in traditional industries such as agricultural, food and textile. In addition, there are some cases in high tech manufacturing, but most of them are initiatives by foreign company, such as Toyota's engineering and training at Chulalongkorn University on automobile and Seagate's joint R&D center with Khon Kaen University on hard disc. In addition, national innovation system of Thailand is in a process of change toward more integrated system (Intarakumnerd and Brimble, 2007). The Thai government used to draw its economic development strategy based on abundant natural resources and low cost labors. But after the Asian Financial Crisis in 1997, the strategy was changed to the long term development by innovation (JST, 2008).

At present, Thailand's science and technology policies are based on the Thailand National Science and Technology Strategic Plan (2004-2013). Through the 1990s, the Thai government advanced policies along an axis of economic growth, focusing on manufacturing based on low wages and the nation's natural resources. However, as economic growth slowed during the Asian economic crisis and competition with China and nearby ASEAN nations intensified, the country has shifted to policies that recognize the need to transition to innovation-based, high-value-added industries to achieve sustained growth. The National Science and Technology Strategic Plan (2004-2013) identifies the following four key points for establishing a knowledge-based economy and society:

- Development of national innovation systems and industrial clusters: organic cooperation between universities, public research institutions, and industry
- Development of human resources
- Improved capabilities in four key technology areas: (1) information technology and telecommunications; (2) materials technology; (3) biotechnology; (4) nanotechnology
- Development of an environment that promotes growth: fostering laws, economic systems, and social values that promote organic cooperation between innovation systems

This plan gives more attention to the demand side, in the form of innovation and industry needs, instead of focusing supply-side factors such as scientific outcomes stressed in the previous S&T policies. In addition, this policy clearly recognizes the importance of the concept of national innovation system and organic cooperation of industry, government and academy (JST, 2008).

2-2. National Science and Technology Development Agency (NTSDA)

The National Science and Technology Development Agency (NSTDA), a national research institute under the jurisdiction of the Ministry of Science and Technology, plays an important role in this National Science and Technology Strategic Plan. Established in 1991 under a law encouraging the development of science and technology, the NSTDA consists of four technology centers: (Biotechnology [BIOTEC], which engages in life-sciences research; Materials Technology [MTEC]; which carries out materials research; Information and Communications Technology [NECTEC], active in information technology and telecommunications; and Nanotechnology [NANOTEC], active in nanotechnology research). A Technology Management Center (TMC) oversees technology transfer activities. The NSTDA accounted for approximately 2400 researchers (as of May 2008) and had a 2008 budget of 3.6 billion baht, making it Thailand's largest public research institution. The NSTDA facilities form a part of a science park in northern Bangkok, near higher-education institutions such as Thammasat University and the Asian Institute of Technology (AIT). The NSTDA serves as the manager of this science park as well.

The NSTDA was established as an institute for basic research. Therefore, it is said that academic

research is widely regarded as playing the principal role, impeding effective joint research with industry (Intarakumnerd and Chairatana 2008). Intaralumnerd (2010) compares the NSTDA to Taiwan's Industrial Technology Research Institute (ITRI); the latter has played a major role in promoting the electronics industry in Taiwan. The study identifies as a major difference between the two institutes the presence or absence of a strategy for commercializing technologies. The ITRI was assigned a clear mandate—to promote the electronics industry—and has played the role of coordinator for private-sector consortia, including a project to develop laptop computers. In addition, it has hired many staff members with experience in private-sector firms. In contrast, while the NSTDA has hired many researchers with PhDs, it interacts mainly with academia and has little contact with private-sector firms. Thailand has struggled to pursue advanced scientific and technological research while the technological levels of its private-sector firms remain low.

However, since 2002, the NSTDA has adopted a new strategy emphasizing innovation, turning significantly in the direction of R&D targeting commercialization and joint research with the private sector. The establishment of the TMC in 2005 to promote technology transfers for research at the NSTDA is one sign of this shift. As a public research institute, the NSTDA does more than pursue its own research. It strives to raise the technological levels of Thai businesses through activities including technology transfers to and technical guidance for the private sector. Given the low starting point for the R&D capabilities of private-sector Thai companies, the NSTDA in many cases is active in research typically handled by private enterprises in developed nations. It also has established costly experimental research facilities, which it makes available for the joint use of private-sector firms.

Users other than Thai firms include numerous foreign-owned firms, including Japanese companies. As is shown in Table 1, R&D investments by government-affiliated institutions account for a large share of R&D investments, of which the NSTDA in turn accounts for a large percentage, making the NSTDA an attractive partner in localized R&D by Japanese and other foreign firms. The first benefit of engaging the NSTDA as a partner in joint research is the high quality of its research staff. The NSTDA employs approximately 400 researchers who have earned PhDs, including many researchers from leading Thai universities, making it one of the leading science-and-technology human resource pools in Thailand. Since the NSTDA also serves as a funding agency providing research funding to universities and other research institutes, it has compiled a database of researchers in Thailand and functions as a useful source of information on researchers in the country.

Also of great value is access to NSTDA's tangible and intangible research assets, including test equipment and a bioresource database. MTEC offers analytical equipment for analysis of the ingredients of materials used in auto parts and has provided testing services to Japanese automakers and other firms. A key benefit for manufacturers lacking research facilities in Thailand is the ability to use the NSTDA's testing equipment to analyze product defects locally. In addition, BIOTEC operates a database of bioresources in Thailand and is set to launch joint research efforts with Shiseido and Novartis based on this research platform.

Finally, the NSTDA is located in the North Bangkok Science Park (NBSP). Firms establishing business facilities in the science park are eligible for the highest tier of investment incentives from the BOI (Board of Investment). In Thailand, investment incentives for overseas firms are categorized by region; ordinarily, incentives are higher for areas more remote from urban centers. In the case of the NBSP, despite a convenient location less than an hour by car from Bangkok, its status as a science park gives it eligibility for special considerations, including an eight-year exemption from corporate taxes and halving of overall taxes for five years.

In association with efforts related to the rural economy that include the cultivation of black tiger shrimp and the development of multipurpose trucks for rural use, the NSTDA pursues state-of-the-art research including metagenome analysis of Thailand's microbial resources.[1] The results of such research move to private-sector firms through technology transfers brokered by the TMC. Listed below are the NSTDA's main technology transfer activities.

- Industrial Technology Assistance Program (ITAP): a program supporting improvements in

manufacturing processes and product-development capabilities of small and medium-sized enterprises

- Company Directed Research and Development Program (CDRDEP): low-interest loans for R&D targeting commercial applications
- NSTDA Investment Center (NIC): an agency that invests in technological ventures
- Intellectual Property Services (IPS): the section responsible for managing NSTDA intellectual property and for promoting licensing services
- Thai Science Park (TSP): operating an incubation center for technology based start-up companies

3. CASE STUDIES OF JAPANESE FIRMS IN COLLABORATION WITH NTSDA

Research and development efforts by Japanese firms in industries such as chemicals (primarily those related to the auto industry), food products, and everyday goods are already underway in Thailand. Some of these firms are NSTDA partners. We have conducted the detail interview survey about the multinational's R&D in cooperation with NSTDA. We picked up two Japanese firms, Polyplastics, an engineering plastics manufacturer and Shiseido, a cosmetic company, to understand the motivations behind the collaborative activities from both sides of firms and NTSDA[2].

3-1. The Polyplastics Technical Solutions Center

Polyplastics is a manufacturer of engineering plastics materials (high-performance plastics used in motor vehicles and home appliances), a joint venture between Daicel (with a 55% share) and Ticona (a member of the Hoechst Group, holding a 45% share). It owns the world's largest polyacetal (POM) plant and holds a 57% share of the Japanese market for that material. It also boasts the leading market share for polybutylene terephthalate (PBT).

Polyplastics manufactures and sells plastics. Its Technical Solutions Center provides technical support related to plastic products developed and produced by its customers. First established in Japan (Fuji city), it secured the top share in the Japanese market through this technical support facility. In recent years, it established facilities in China (Shanghai), in Taiwan (Kaohsiung), and in Thailand within the MTEC at the NSTDA in 2008. Given the concentration of auto-industry locations in the ASEAN region, particularly in Thailand, the Technical Solutions Center in Thailand currently provides technical support for the production and analysis of defects to plastic molding subcontractors that make plastic parts for automakers.

The performance of the plastic materials, the design of the molded parts, molding equipment, and configurations all affect the quality of high-performance plastic parts. For this reason, the services of the Technical Solutions Center encompass the four stages of materials selection, product and mold design, molding process, and analysis of molded products. In Thailand, the Technical Solutions Center handles the molding process and analysis of molded products. When customers encounter some problems, the Center analyzes defective parts (for example, conducting analysis when a part contains impurities) and examines cross sections of the parts to identify the cause of the defect and provide guidance. Sometimes, the Center representatives visit workplaces to check on molding processes and to propose improvements.

Most of Japanese automobile manufacturers, such as Toyota and Honda, set up product development centers near Bangkok. Major automobile parts suppliers such as Denso, also, are leading overseas development activities in Thailand. Along the line of such major customers' activities, Polyplastics considers it important to build solid relationships with them by providing technical support to ensure the quality of its materials at the development stage of automobile parts. It also sees demand for further services in areas such as materials selection and computer-aided engineering (CAE) through product and mold design.

Opening the center at the NSTDA (MTEC) created advantages in three areas: (1) information; (2) human resources; and (3) facilities. In the area of information, contact with the NSTDA allowed Polyplastics to infer the developments needs of the nation and its customers and to develop ways of advancing company activities overseas. In the area of technical information, the environment also provided easy access to advanced technologies promoted by the NSTDA. In the area of human resources, interactions with NSTDA staff provided technological motivation. The NSTDA's public image (its numerous PhD-holding research scientists and its elite status in Thailand) as well as its geographic advantages (commuting environment and location in suburban Bangkok) make it possible to attract and retain high-end human resources. In the area of facilities, rarely used and costly devices such as molding machines and measurement instruments can be shared with other researchers. The NSTDA also offers large seminar rooms, which Polyplastics is considering for its own seminars.

From the viewpoint of NSTDA (MTEC), working together with Polyplastics is beneficial for its researchers to know industrial applications of chemical compound. Polyplastics offers an internship for NSTDA researchers in Japan. MTEC is supposed to provide technical services for local automobile suppliers, so that such experience contributes significantly to upgrading quality of the services. In return, Potyplastics can be benefited by accessing to high-end human capital in Thailand. This kind of mutual benefits make this partnership quite successful.

3-2. Shiseido South East Research Center

As a cosmetics manufacturer, Shiseido Thailand, the Thai subsidiary of Shiseido Co., Ltd., examines potential applications of natural resources such as herbs native to the Southeast Asia region. In 2001, an Indonesian nongovernmental organization took issue with some Japanese cosmetic firm's application for a patent on the use of Indonesian natural plants, a matter widely covered in the press. Despite the absence of any actual violation of patent law, the report prompted a movement that eventually developed into a consumer boycott. To placate critics, this company chose to withdraw all patents related to Indonesian plants. Around the same time, similar rumors from NGOs in Thailand have led to boycotts and hurt other Japanese cosmetics and pharmaceutical manufacturers. These cases made Shiseido considers seriously about the risk management associated with R&D activities involving natural life resources in emerging economies, in a sense that compliance with local regulation is not enough.

The company began working with the NSTDA, in part, in response to such risks. In activities involving cosmetics raw materials or other materials based on the natural resources of Thailand, partnerships with local public research institutes and joint applications for patents based on such research help address these risks, granting the resource-producing nation access to rights and demonstrating a willingness to share benefits with the resource-producing nation for returns on products produced with resources from the resource-producing nation.

In 2005, Shiseido was at work on a plan to develop R&D facilities around the world under its global R&D strategy. Within this framework, Shiseido had already rented offices inside the BIOTEC facility, where it engaged in joint research on Thai herbs. In October 2006, the facility began operating as the company's Southeast Asia Research Center. It comprises two offices: one inside the science park where the NSTDA is located and a sales company (Shiseido [Thailand] Co., Ltd.) located in Bangkok. The Southeast Asia Research Center is currently active in three main areas: (1) basic research; (2) risk response and information-gathering for laws and regulations related to cosmetics; and (3) local sales support.

Shiseido's partnership with the NSTDA (BIOTEC) primarily explores two areas: use of Thai herbs as cosmetics raw materials and research into the effects of indigenous microbials on skin (particularly focusing on Propionibacterium acnes), both at the level of basic research. In the former area, it has applied for a patent jointly with the NSTDA, as announced at a joint press conference with NSTDA and BIOTEC representatives in attendance. This press conference was, in part, intended to preempt any possible damage from consumer rumors by presenting research as a proactive effort benefiting the resource-producing nation. The second area involves joint research whereby BIOTEC performs

genetic analysis, after which results and future steps are determined jointly, with the two parties identifying research themes that meet the needs of both sides. Shiseido acknowledged the benefit of joint research with the NSTDA as accessing to outstanding researchers, many of whom have earned PhDs. However, they pointed out some problems at NSTDA as well, such as poor management as regards to intellectual property.

The benefit at the NSTDA side is learning from Shiseido about R&D methods for private-sector firms, like quality standards in developing raw materials from plant extracts and assay methods for cosmetics development. As regards to Shiseido's complaint about slow patent application procedure, they responded that under the Plant Variety Law, patenting procedures involving bio-resources in Thailand entail various complexities to ensure patents do not affect traditional use of the plants in Thailand. In addition, as a national research institute, the NSTDA must be careful to consider the perceptions of the public when a foreign firm is granted a patent for biological resources in Thailand.

4. COMPARING TWO CASES AND SOME DISCUSSION

There are some contrasting points between two cases in the previous section. First, Polyplastics uses the Technical Center at MTEC, NTSDA as a natural extension of technical center in Japan. In addition, there is a clear motivation at the beginning of activity, i.e., serving for local customer needs, and it operates consistently with this purpose. As automobile industry's activities globalize, there is a growing demand for Polyplastics to serve for local customer needs. However, it should be noted that overseas operation of automobile industry is centrally organized, in a sense that production technology is basically the same for all over the world. Therefore, the technical services by Polyplastics are supposed to be the same for all locations, but regional proximity to the customers is required by assuring timeliness of service provisions. Therefore, it is easier to operate the Center at NTSDA smoothly as an extension of existing activities at home country.

In contrast, Shieseido has broader missions. An initial motivation of joint R&D center at BIOTECH, NATSDA came from risk management associated with new product development using local natural resources. Shiseido might be able to do by itself, if it were not such risk concern. After the strategic decision was made to stop developing natural concept cosmetic products using Thai herb, the general manager of Shiseido R&D center seeks for collaborative research projects at basic level, such as research on indigenous microbials on human skin. A scientific research has explorative characteristics in nature, so that it is difficult to come up with clear goal. The Shiseido South East Research Center itself has other missions such as information collection of local regulations and technical support for local products. These activities are basically independent from those in joint laboratory with NSTDA, so that the mission of the joint laboratory is set to explorative cooperative research by using NTSDA staffs and experiment facilities.

With regards to the typology of overseas R&D by Kuemmerle (2007), Polyplastics' Technical Center is working as HBE (Home Base Exploitation), while Shiseido joint R&D laboratory is classified as HBA (Home Base Augmentation). Polyplascitcs uses technological bases at home for serving for local market needs. Therefore, the resources at NSTDA are used to fulfill this purpose. However, it should be noted that Polyplastics not only exploits local resources, but also invests in human resources by providing internship opportunities in Japan. This kind of mutual beneficially treatment makes collaborative relationship sustainable. In contrast, Shiseido's activities are for searching technological contents in Thailand, and this knowledge is supposed to augment home base technological capacity. Therefore, it is important for the Shiseido South East Research Center to be integrated global R&D network at Shiseido.

In terms of ensuring sustainable partnership activities, it is important to understand the motivations of your partner to work together with you. From NTSDA's viewpoint, both Polyplastics and Shiseido are valuable information source for industrial R&D. In the Thailand National Science and Technology Strategic Plan (2004-2013), the importance of demand side S&T policy, i.e., promoting the service to industrial needs, is articulated. Along this line, NTSDA came up with the strategic planning focusing on commercialization of technology and joint research with industry in 2002. Working together with

Japanese firms with high level industrial R&D becomes essential part in building up NTSDA's capacity to fulfill this strategy.

Both Polyplastics and Shiseido acknowledged the quality of researchers at NTSDA. Many of them hold phd degree from top ranking universities, and knowhow of industrial R&D from joint research activities are embodies with them. Therefore, they may be a good candidate for local researchers for Japanese firm, when they have a chance to expand local operations. However, this is the case for their competitors, so that deep commitment to partnership activities with local players is double edged sword (Motohashi, 2011). Therefore, it is important for multinationals to consider competitive environment in local market, when they consider joint R&D with local partners. In this regards, a local firm is not so competitive at this moment for both engineering plastics and cosmetic industry in Thailand. In addition, non Japanese multinationals such as US and European firms are not so active as compared to countries with much greater market such as China and India. Therefore, NTSDA can be an attractive place to invest R&D for Japanese multinationals in general.

5. CONCLUSION

This paper analyzes the management of multinational's R&D in emerging economies, taking the case of Japanese firms' R&D collaboration with NTSDA, Thai national research institute. A detail interview survey for two cases, Polyplastics, an engineering plastics manufacturer and Shiseido, a cosmetic company, both working together with NSTDA for R&D, reveals that there exist significant variations of motivations, scopes and outcomes of such activities. Home base exploiting type activities (Polyplastics) are easier to manage as a natural extension to home country activities, but it is important to motivate its partner to collaborate, since only exploiting local resources may not be sustainable for long time. While, home base augmenting type activities (Shiseido), a local activity has to be well coordinated in global operation at headquarter. In addition, it is difficult to see a short term benefit from such explorative activities, so that top management support becomes important to sustain such activities for certain amount of time.

In addition, it should be noted that globally open innovation activities (working together with local players for R&D) is double edge sword, in a sense of helping upgrading partner's technological capability, which leads to helping your competitors. However, a negative side of global open competition depends on market competition and labor market condition. The side effect of open innovation becomes greater, when you have strong competitors in local market either local players or multinationals. Moreover, when the employee turnover rate is high in labor market, The side effect become greater, because technological know-how at partners are often embodies in researchers. In case of Thailand, the side effect is relatively smaller as compared to China and India, since technological capabilities at local firms are relatively low. In addition, the market is not quite competitive with less presence of US and European multinationals. However, it should be noted that the situation changes dynamically in emerging market, so that a continuous effort to monitoring local environment is required for effective global open innovation activities.

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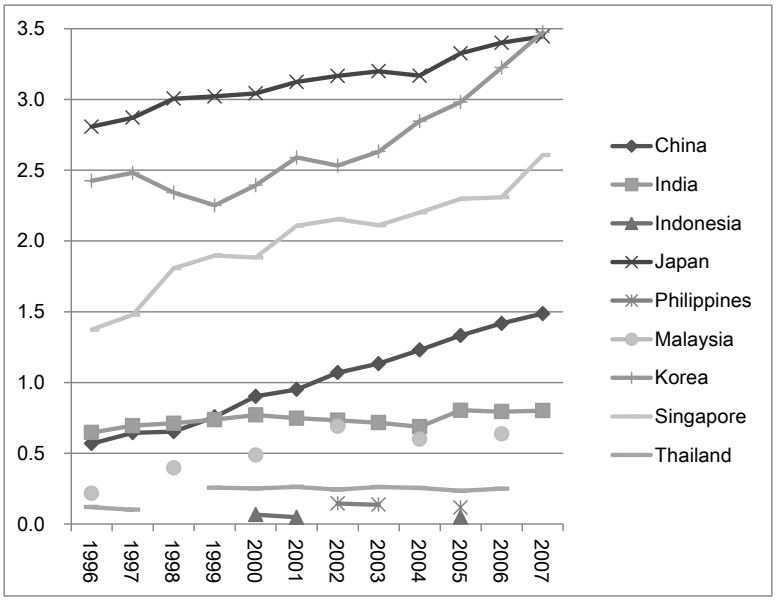
Figure 1: The ratio of R&D expenditure to GDP (%)



Source: UNESCO statistics

Table 1: R&D costs by user sector (%)

	Year	Business	Government	Other non-profit
China	2007	72.3	19.2	8.5
India	2004	19.8	75.3	4.9
Indonesia	2005	3.7	96.2	0.0
Japan	2007	77.9	7.8	14.3
Korea	2007	76.2	11.7	12.1
Malaysia	2006	84.9	5.2	9.9
Philippines	2005	58.6	18.6	22.9
Singapore	2007	66.8	12.2	21.0
Thailand	2006	40.9	17.2	41.9
Viet Nam	2002	14.5	66.4	19.0

Source: UNESCO statistics

[1] A method of genome sequencing through direct genome DNA preparation of groups of microbes, to conduct genetic analysis of microbes difficult to cultivate such as those related to mushrooms

[2] This information comes from interviews with Southeast Asia Research Center General Manager, Mr. Ogawa for Shiseido and Thailand Technical Solutions Center General Manager, Mr. Miwa for Polyplastics. From the NSTDA, we spoke with parties related to the research institute including BIOTEC Executive Director, Dr. Kanyawim and MTEC Executive Director, Dr. Udomkichdecha.