12 Multinationals' R&D in China and India

12.1 Introduction

When considering the R&D centers of Japanese firms by country, China is second to the US, and the number of R&D centers there is increasing. The importance of China as a center for R&D is not limited to just Japanese firms; western firms are also investing there. According to a UNCTAD survey, China is the most important country for R&D among companies in the advanced nations (UNCTAD 2005). IBM, Microsoft, Motorola, Nokia, Sony, Toshiba, Hitachi, Fujitsu, NEC, Samsung, and other leading high-tech companies have created research centers in China, from where global R&D is conducted.

According to a UNCTAD survey, India ranks just behind China and the United States as a top R&D center for multinationals (UNCTAD 2005). When comparing China and India, many companies are attracted to China's market and cheap labor, while India's strength lies in its high-quality R&D resources. In particular, India boasts the world's largest offshore centers for software, and many multinational firms have established IT-related development offices there.

This chapter focuses on China and India as a host country of multinational's R&D. As is described in Chap. 4, there is a great difference in economic institutions between China and India, which influences on multinational's R&D in these countries. A substantial foreign direct investment in China was found from 1990s, with setting up factories by using cheap production cost. A large amount of infrastructure investments in China allows this place become to be a factory of the world. Therefore, R&D activities in this place is related to manufacturing industries. In contrast, due to poor physical infrastructure in India, multinational sees this place as an offshore site of software. In addition, outsourcing R&D services industries are developed in India.

The following sections provide some empirical findings of multinationals' R&D activities in China and India, respectively. The typology of overseas R&D in the previous chapter is used for the analysis, and detail statistical analysis and case

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studies are provided for further understanding the issues in R&D activities in emerging economies.

12.2 China

12.2.1 Overview

After the implementation of open market policies in the 1990s, China received robust investments from foreign firms, making it the "factory of the world." In the 2000s, the Chinese government gradually deregulated foreign investments in finance, retail, and other service industries in accordance with the WTO rules, causing investments in areas other than manufacturing to flourish. The Chinese economy has continued to grow at a high pace, and, as of 2011, it has overtook Japan as the second largest economy in the world. The per capita incomes have increased in conjunction with this economic growth, and China is also attracting the attention of companies worldwide as a "market of the world."

As China developed to become the factory and market of the world, global firms from Japan and the West have set up R&D functions in their facilities in the country. Some centers are production-driven, supporting local production, whereas others are market- or policy-driven, responding to local market needs and various regulations. China has a greater number of scientists and engineers than Japan, as seen in the previous section. In addition, Chinese universities annually produce more than two million engineers, and companies are attracted to the high quality and relatively low wages of these resources. This is a market that is also attractive to the cost-driven R&D centers. Further, Beijing University, Tsinghua University, and other top-flight Chinese universities are conducting research that is internationally first rate. The Zhongguancun district in Beijing's northwest area, where these universities are located, yielded many venture firms primarily in IT, giving it the moniker the "Silicon Valley of China." Moreover, many high-tech firms such as IBM and Microsoft have their R&D centers there, with the research centers weighted toward technology-driven activities.

R&D conducted by foreign firms in China spans an extraordinarily broad range, and because of the vastness of the country, it is easy to imagine that R&D differs greatly by region. The differences in the R&D activities of Japanese firms in China from other western firms are also of great interest. Using Chinese statistics for science and technology, we examine the status of R&D conducted by foreign firms according to region and corporate nationality.

Figure 12.1 compares the ratio of R&D expenses to revenue (R&D concentration) in manufacturing firms above a certain size in China by ownership structure. Foreign firms are differentiated between wholly owned subsidiaries and joint ventures with Chinese firms. R&D concentration is highest among Chinese firms, followed by joint ventures and wholly owned subsidiaries. Foreign firms base their R&D, whether created according to the "technology acquisition" or "local development" model, on R&D resources in the home country. The R&D necessary for

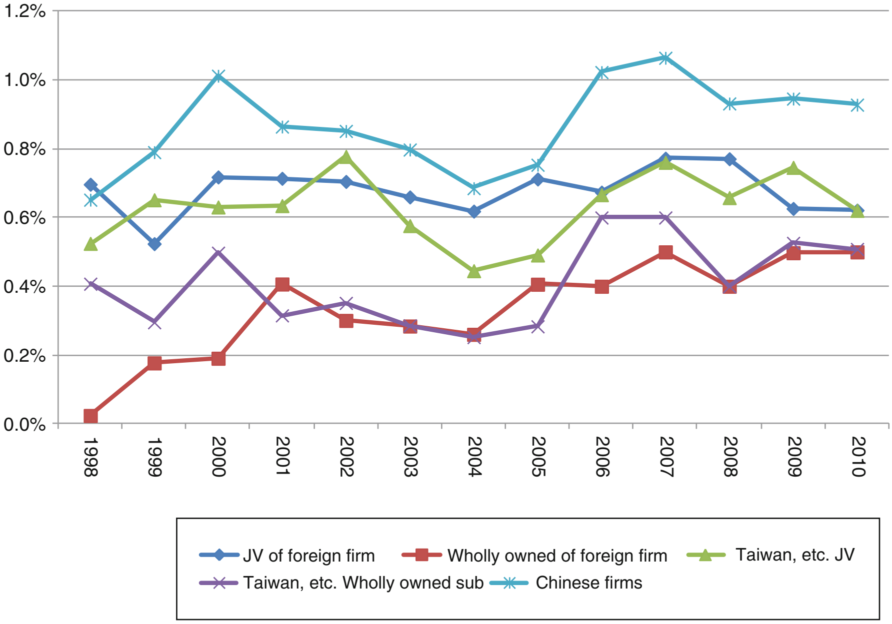

Fig. 12.1 Trend of R&D/Sales by ownership type (*Source*: *China Statistical Yearbook* (over various years))

business in China does not necessarily mean that all of it has to be done in China, so this conclusion is expected. Accordingly, when the R&D concentration including the home country is examined, note that Chinese firms do not necessarily have higher R&D concentration than foreign firms.

Among foreign firms, R&D concentration in joint ventures is higher than in wholly owned subsidiaries. Recently, in particular, the R&D concentration of joint ventures is approaching that of Chinese firms. On the other hand, the R&D concentration of wholly owned subsidiaries is trending upward, but remains less than half of that of joint venture firms. As we noted in Chap. 7, forming a joint venture generally reduces risks associated with entering a foreign country, whereas having a wholly owned subsidiary lowers risks, (namely, relationship with the joint-venture counterpart) once it has been established within that foreign country. In addition, while there may be a stronger tendency toward a center-for-global model, in which a wholly owned subsidiary follows the direction of the home country, joint ventures tend to follow a local-for-local model that is closely aligned with the local market.

We discuss in detail by observing R&D outsourcing levels by ownership structure. Chinese science and technology statistics have conducted surveys regarding R&D expenditures not only within a corporation but also its external expenditures. External R&D costs can be divided into three expenditure types: (1) domestic universities and research organizations, (2) domestic corporations, and (3) foreign countries. Figure 12.2 shows the percentage of external R&D costs against total

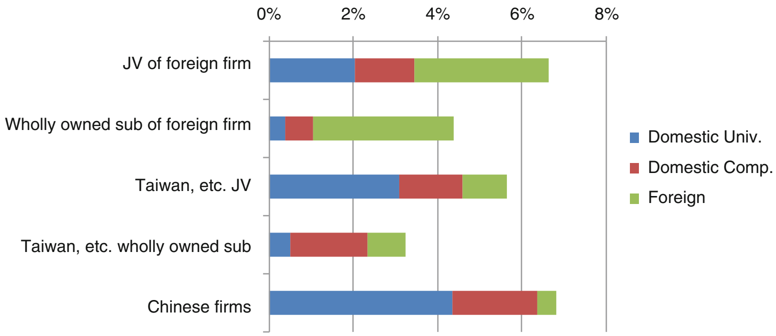

Fig. 12.2 External R&D expenditures/total R&D by ownership type (*Source*: Figures compiled from China's science and technology statistics)

R&D costs by ownership structure. Most foreign firms' R&D payments to foreign countries can be considered as technology license payments to the home country, indicating strong ties with the head office. On the other hand, payments to domestic universities, research organizations, or corporations can be thought of as metrics, indicating ties to local R&D resources. The differences between the R&D activities of wholly owned subsidiaries and joint ventures are evident in this graph. Specifically, wholly owned subsidiaries have strong ties with the home country, whereas joint ventures have strong ties with local resources. Overseas outsourcing by Chinese corporations is not an internal transaction, but it is simply a manifestation of activities to incorporate external R&D resources; thus, the percentage is low, with largest outsourcing to domestic universities or corporations.

We can summarize the discussion so far as follows. First, foreign firms conduct R&D in China on the basis of home country research resources; thus, the level of R&D concentration within local entities is lower than that for domestic firms. In addition, the level of R&D concentration within wholly owned subsidiaries is particularly low, even among foreign firms. These levels have been trending upward recently, but they are still less than half of that of joint ventures. In contrast, the level of joint venture R&D concentration has risen to about the same level as domestic firms. When comparing the activities of wholly owned subsidiaries and joint ventures in greater detail by examining the state of external expenditures of R&D costs, we observe that wholly owned subsidiaries have strong ties with parent companies and are not sufficiently capturing domestic R&D resources. On the other hand, joint ventures have some interaction with the home country, but incorporate local R&D resources through partnerships with domestic universities, research centers, and corporations. Moreover, we can observe a trend of R&D being conducted internally along with the use of local resources. Wholly owned subsidiaries delineate the functional division by using parent company technology, but primarily managing production and sales in Chinese facilities. As a result, the level of R&D concentration within Chinese facilities is low.

12.2.2 R&D Objectives and Regional Diversity

China is watched closely as both the factory and marketplace of the world. Accordingly, manufacturing support and local product development are placed high on the list of R&D objectives. In addition, "cost-driven" R&D are often carried out because of an abundance of engineers, and in high-tech concentrations areas such as Zhongguancun in Beijing, "technology-driven" R&D centers are being set up. We now examine which of these activities are primarily performed in which regions, as well as how conditions differ by region. We conducted a comparative analysis, creating metrics for scientific technology activities to understand the primary purpose of R&D (Motohashi 2010):

1. R&D cost concentration: the ratio of R&D costs to revenues
2. Development-orientation: the ratio of development cost to R&D costs
3. Level of domestic university alliances: the ratio of external research expenditures paid to domestic universities and public research organizations to total research costs
4. Level of home country ties: the ratio of external research expenditures paid to foreign countries to total research costs
5. Level of new product exports: the ratio of exports to revenues from new products

By comparing the metrics for foreign firms with those for equivalent Chinese firms (i.e., Chinese firms within the same industry of similar size), we ascertain the purpose of R&D activities within foreign firms. In addition, by comparing the situation by regions, we can compare the differences in R&D objectives in each regions (we compare Beijing, Shanghai, and Guangdong herein). The results of our analysis are shown in Table 12.1, where "+" means a high metric, and "–" a low metric. "0" simply means the metric was the same as the benchmark, which for this case were the Chinese corporations.

First, foreign firms show a general tendency toward low levels of R&D concentration, with a high share of development within their R&D. This shows that companies conduct R&D in China on the basis of technology in their home country, with somewhat greater emphasis on development. In addition, alliance levels with

Table 12.1 Comparison of R&D-related indices

	Nationwide	Beijing	Shanghai	Guandong
Concentration of R&D	–	–	0	–
Development orientation	+	0	0	0
Dom. Univ. alliances	–	+	0	–
Home country connection	+	+	0	+
New prod. exports	+	+	0	0
Type of R&D	Prod.-driven	Tech.-driven	Market/cost-driven	Prod.-driven

universities are low, whereas the levels of ties with the home country are high. Finally, note that export levels of new products are high. On the basis of these patterns, we can say that these R&D models are "local development" rather than "technology acquisition," and that because of the high levels of exports, there is a strong tendency toward "production-driven" R&D. As a side note, if we assume that this pattern is a "market-driven" model, new products developed in China would be sold in the Chinese market, decreasing the level of exports. If companies followed a "cost-driven" model, the increase in the number of R&D personnel would require a higher level of R&D concentration. If companies followed a "policy-driven" model, products used in this analysis would be destined for domestic markets; however, the high levels of new product exports indicate that this model also does not fit.

As shown, R&D activities for foreign firms in China generally support production facilities. We can predict that this differs on the basis of the region where their facilities are located. Next, we compare the metrics of the Beijing, Shanghai, and Guangdong regions.

First, foreign firms in Beijing have similar level of development ratio as the benchmark, but a relatively lower ratio compared with the country as a whole. Compared with an average foreign firm, companies in the area focus much more on research. In addition, Beijing has a high level of domestic university alliances. This shows that foreign firms conducting R&D in this region place a great deal of importance on partnerships with Chinese universities such as Beijing University and Tsinghua University. Overall, foreign firms in Beijing have a relatively high level of "technology-driven" R&D.

In Shanghai, the level of R&D concentration was similar to that of our benchmark and high compared with the average foreign firm, which has a low level of R&D concentration. Ties with the home country were also at the same level as our benchmark and lower than the average foreign firm, which has a high level. Further, the levels of new product exports were again the same as our benchmark, and lower than the average foreign firm, which is high. In other words, local subsidiaries showed comparably high level of independence from the home country and tended to provide finished goods to local markets, making their R&D activities weighted toward a local-for-local model. Accordingly, these activities were "market-driven" with "cost-driven" characteristics because of the relatively high level of R&D concentration.

The last region, Guangdong, contains cities such as Shenzhen and Dongguan in the Pearl River Delta that are the epicenters of the "factory of the world." Thus, we can predict that R&D activities in this area will be skewed toward a "production-driven" model. The pattern of our metrics for this region is roughly the same as that for an average foreign firm but with several differences. The level of research orientation is the same as our benchmark, but relatively low compared with the average (which is high). The level of new product exports is also the same as our benchmark, and is relatively low compared with the average (which is high). The Pearl River Delta has workers with wage levels on the rise, and it has been difficult to maintain the low-cost production exporting model. Local governments in Shenzhen and elsewhere has been aiming to lure universities, other institutions of higher learning, and research facilities, and are making efforts to develop high value-added industries. In addition, Guangzhou, the capital of the Guangdong Province, has an agglomeration of automotive industry companies. The products manufactured here supply domestic markets, which is one factor impacting a stronger-than-average trend toward domestic markets in a research-driven pattern.

12.2.3 Differences Due to the Nationalities of Foreign Firm

Finally, we examine the differences in R&D center management because of the nationalities of foreign firms. China has gradually deregulated foreign capital regulations, and the percentage of foreign firms is increasing annually. Among those, Japanese firms have a relatively higher share of wholly owned companies than their counterparts in the US and Europe (Motohashi 2012). Moreover, as we look at the state of R&D outsourcing, Japanese firms have an overwhelmingly high percentage of expenditures compared with foreign countries (Fig. 12.3). Most of these expenditures are thought to be license payments for home-country technology, and therefore, they are considered internal transactions. Global R&D management within the Japanese firms is strongly skewed toward a center-for-local model, where management of local facilities is centralized within the home country. On the other hand, the US firms have a high percentage of outsourcing expenditures to domestic universities and research organizations, and have better access to and incorporation of local technology resources. The European firms lie somewhere in between the Japanese and US firms. Other Asian firms from Korea, Singapore, and elsewhere are much like those from Japan, where overseas facilities have strong ties with their home countries.

A high percentage of the local subsidiaries of Japanese firms are structured as wholly owned subsidiaries, and have a strong tendency to operate under centralized management by the home country. One reason for this is the geographical proximity of Japan and China. When the foreign country is nearby, it is relatively easy to

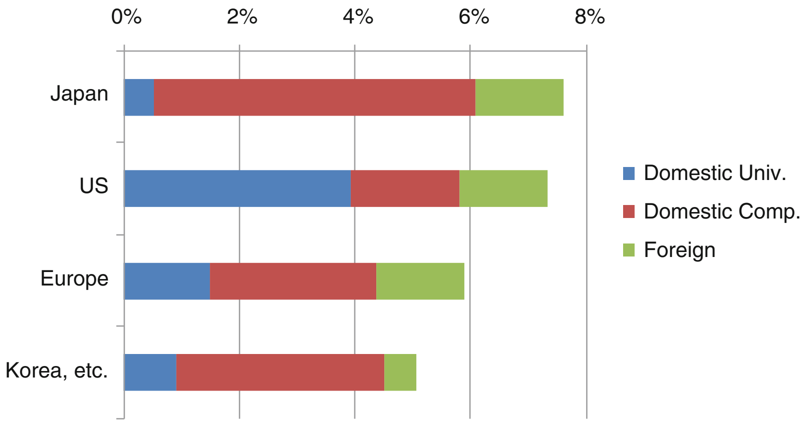

Fig. 12.3 External R&D expenditures/total R&D by home country (*Source*: Figures compiled using China's science and technology statistics)

manage the local subsidiary from the home country, providing an incentive to operate in a center-for-local model that mortgages the independence of the wholly owned subsidiary's management. On the other hand, the offices of European and US firms are geographically far from China, and the time and language differences create significant barriers to close communication. In these situations, it can be more effective to give local subsidiaries more autonomy.

More so than their European and US counterparts, the Japanese corporations have a history of internationalizing corporate activities with a headquarters-driven central authoritarian style (Bartlett and Ghoshal 1989; see also Chap. 2 of this volume). It is quite possible that the Japanese management of China-based R&D centers reflects this same central authoritarian style that governs its entire global businesses. By implementing a center-for-local model, R&D efficiencies are gained by realizing linear innovation where products are manufactured for the Chinese market based on Japanese technology. However, it is weak on innovation through an interactive R&D model, where Chinese advance technologies and ideas for new products and product development are incorporated. From a global perspective, as the superiority of emerging nations increases, a locally-for-global model—the utilization of local innovation ideas for global R&D—will become more important in the future. Accordingly, it is important for the Japanese corporations to value the independence of their foreign subsidiaries and incorporate ideas from local innovations in the company as a whole.

12.3 India

12.3.1 Overview

The history of foreign firms in India is not long. The management of the economy after gaining independence from Britain in 1947 kept the country extremely inaccessible. Until 1991, when new economic policies deregulated trade and direct investment, there was almost no activity by foreign firms. In the automotive industry, Suzuki Motors was the exception; it was allowed to enter the Indian market in the 1980s through a joint venture with an Indian company. In the 1990s, GM, Ford, DaimlerChrysler, and Hyundai entered the market. In the IT industry, the late 1990s saw the creation of offshore centers for software development. IBM formed a sales company through a joint venture with the Tata Group in 1991, and in 1999, the company formed IBM India as a wholly owned subsidiary, creating a structure under which subsidiaries for software development and offshoring could be placed. GE has conducted business in India since its time as a British colony, although the company's activities gained momentum in the late 1990s. In 1997, GE established an offshore development center, and since the 2000s, it has further energized its business there with an eye to the Indian market.

The Indian government began incentivizing foreign firms in earnest in the 2000s. As India was a British colony, it had a deep-rooted wariness with regard to foreign capital, allowing only gradual deregulation. At the outset of the 1990s, China began bringing in foreign capital, and by 2000, it was experiencing an average annual economic growth of greater than 10 %. On the other hand, India's economic growth was stagnant at about half that, 5.5 %. Thus, galvanized by the steadily growing economy of its neighboring country through external liberalization, India undertook large-scale reforms of direct investment in 2002, apart from in certain industries. Further deregulation occurred in 2005 in service industries such as telecommunications, financial services, and real estate. Special economic zones were established in 2005, in which foreign firms in many industries were allowed to create wholly owned subsidiaries and receive tax incentives. Since 2006, the average economic growth have been accelerated, and the country is expected to become an economic power in twenty-first century. As a result, the activities of foreign firms have not been limited to offshore centers focused on global markets; they also focus on the Indian market itself.

Figure 12.4 shows the results of a survey—conducted in 2004 by the Economist—of 500 global executives on the most attractive countries in terms of globalization objectives (Economist Intelligence Unit 2004). India was deemed the most attractive location for "new opportunities in outsourcing," followed by for "access to a highly skilled labor force," indicating that software resources in India are highly rated not only for their low cost but also for their quality. Overall, 24 % of the executives listed R&D activities in India as being alongside those in Europe, the United States, and other advanced countries. From the perspective of foreign firms, India is highly attractive as an R&D destination. On the other hand, China is attractive for its low-cost labor and new customer markets, with only 11 % of executives listing R&D activities, less than half the percentage listed for India. This likely reflects a

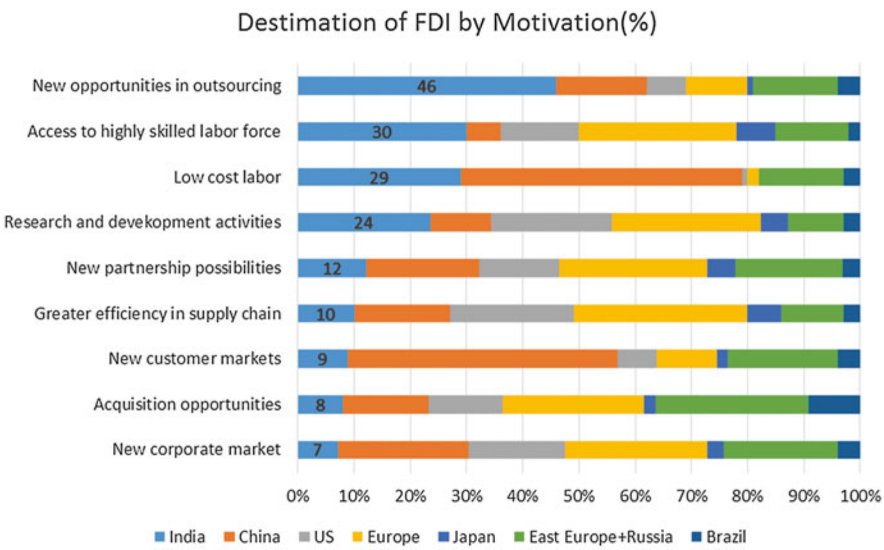

Fig. 12.4 Attractiveness of FDI destination by host country (*Source*: Economist Intelligence Unit 2004)

belief in India's R&D capabilities in software and pharmaceuticals, fields in which India has competitive domestic companies.

R&D activities of foreign firms in India gathered steam in 2000. IBM is a typical example, creating the India Research Laboratory in 1998 as part of its global research facilities. In 2001, the company established the India Software Laboratory to conduct software-related R&D. In 2000, GE established the John F. Welch Technology Center (JFWTC) in Bangalore, with close to 4,000 researchers working on a variety of R&D activities. There are no formal statistics on R&D centers for foreign firms in India, although in 2010, the country had 471 companies with 649 research centers (Krishna et al. 2012).

Table 12.2 shows the total patents by company, according to the USPTO, registered between 2006 and 2010 by inventors living in India (Basant and Mani 2012). IBM leads the way, followed by Texas Instruments, GE, and others. Of the 15 companies, four are IT or telecommunications companies, five are semiconductor companies, three are software-related companies, and two are electronics-related companies—GE and Honeywell. The remaining company is Sabic Plastics (a chemicals company based in Saudi Arabia). Many of the patents are software related. In addition, the companies are mostly from the United States, although European firms such as ST Microelectronics and SAP are also ranked. Japanese firms were slower to enter India than their European and US counterparts, with companies only recently creating research laboratories. For example, in 2010, the pharmaceutical manufacturer Eizai created a production process research center (Eizai Knowledge Center India) in the state of Andhra Pradesh. In 2011, Hitachi opened its Hitachi India R&D Center in Bangalore. However, as seen in greater detail below, some companies have in-house R&D capability, such as Suzuki Motors, which conducts

Table 12.2 Number of patent applications by firms (USPTO Patents)

1	IBM	IT	250
2	Texas Instruments	Semiconductor	211
3	GE	Medical devices	193
4	ST Microelectronics	Semiconductor	135
5	Honeywell Inc.	Electronics	93
6	Intel	Semiconductor	92
7	Cisco	Telecom equipment	91
8	Symantic	Software	91
9	Broadcom	Semiconductor	60
10	Hewlett-Packard	IT	57
11	Microsoft	Software	49
12	Sun Microsystems(*)	IT	43
13	Sabic Plastics	Chemicals	39
14	Freescale Semiconductors	Semiconductor	35
15	SAP	Software	31

Source: Basant and Mani (2012)
Note (*): Sun Microsystems was bought out by Oracle in 2010

full-scale development of new cars in production facilities and not through independent R&D centers.

R&D activities of these companies in India are likely to be primarily cost driven. With Indian software engineers, companies can churn out software for product development at a global level. A high percentage of such activities are conducted in India. However, akin to IBM Research India, certain companies with research groups in India position the country as a center for knowledge creation at a global level rather than for mere offshore development activities. GE's JFWTC employs about 4,000 staff, about 500 of which engage in research (Jin 2008). The research capabilities of universities and public research institutions are not particularly high; therefore, companies do not absorb cutting-edge technology in India. However, the activities of utilizing outstanding personnel to pursue India-originated research output are technology driven. Intel created the Intel India Development Center in Bangalore as an important CPU development center. The X86 Zeon microprocessor was developed in this center and was the first six-core chip produced by the company.

Economic growth in India has raised citizens' income levels and pushed market-driven R&D for the local market. Though difficult to ascertain from patent data, some car manufacturers are developing passenger cars for the local market. Along with Indian income levels, the number of passenger cars sold in India is rapidly rising. In 2012, 2.77 million cars were sold, fourth highest in the world behind China, the United States, and Japan. However, 80 % of these are small cars costing between $5,000 and $10,000 and requiring lower costs in line with market needs. In India, Suzuki Motors is particularly strong in the small-car market, in which it has a 40 % share, and it has long developed passenger cars for the local market through its local entity.

This type of market-driven R&D is HBE, wherein the headquarters in the home country drives the localization of technology for the local market. However, as HBE progresses, "local for local" activities arise, wherein products are developed for the local market through local initiatives. GE Healthcare developed a portable ECG in JFWTC. Using ideas unique to India, it created a product that could be manufactured at one-third the cost of US products, and in a case of reverse innovation, it went on to sell the portable ECG in the US market. This was a case of innovation-driven R&D, wherein local ideas are turned into products that expand the knowledge base of headquarters in the home country. We discuss the cases of Suzuki Motors and GE Healthcare in greater detail below, as we explain the state of R&D activities in India.

12.3.2 Market-Driven R&D in Maruti Suzuki

Suzuki Motors entered the Indian market in 1982 through a joint venture with the nationalized car manufacturer Maruti Udyog Ltd. At the time, the Indian government did not allow domestic activities of foreign firms, and the joint venture was only realized at the behest of the Indian government. Suzuki Motors later increased its share in the joint venture (Maruti Suzuki), and in 2003, turned it into a wholly owned subsidiary concurrently with its listing on the Indian Stock Exchange. According to the statistics by the Society of Indian Automobile Manufacturers (SIAM), Multi Suzuki produced 1.18 million cars in 2012, of which 120,000 were exported; the remaining 1.06 million were sold domestically. That year, 2.77 million cars were sold in India, giving Suzuki the highest market share in the country at 38 %.

Cars comprise thousands, even tens of thousands of parts, and there are as many parts manufacturers. Car manufacturers (assembly manufacturers) work directly with the largest of these, Tier 1 suppliers, which in turn are supplied by many Tier 2 or Tier 3 suppliers; this represents a hierarchical structure characteristic of the industry. Producing cars in India requires the construction of a supply chain with these parts manufacturers.

For example, Denso is a Tier 1 supplier of electronic control units, fuel pumps, and injectors. It imports critical parts from Japan and primarily engages in assembly in India. Although it has some local procurement of resin and die cast parts, Tier 2 suppliers in India are not mature, and Japanese Tier 2 suppliers are mostly small- and medium-sized companies that have yet to enter the Indian market. "Cutting costs requires us to increase our local procurement, which is an important initiative for us, and the automakers are cooperative. We cannot decrease our quality, but we need to change our way of thinking by, for example, getting rid of some functionality to meet Indian market specifications" (from 2011 interview with Denso India executives).

The development of low-cost cars meeting Indian specifications is achieved jointly by car manufacturers such as Suzuki Motors and parts manufacturers such as Denso. For Denso to increase its procurement from local Tier 2 suppliers, they must collaborate with Suzuki Motors on the functionality standards that must be met by end products. This type of collaboration furthers localization of production processes for Suzuki Motors and enables greater cost competitiveness for its products.

In addition, Maruti Suzuki continued developing an infrastructure to develop small cars in India. Until then, when the company introduced new models to the Indian market, it created local models based on those already developed and mass produced in Japan. However, the introduction of the Swift in 2005 transformed that modus operandi, with cars of the same quality and specification simultaneously produced in Japan, Hungary, India, and China. This policy further advanced in 2009, with the release of the A-Star. This car is a global model, produced in India, and it is not only sold in India but also exported to Europe. By periodically conducting exchanges among the engineers, Maruti Suzuki and Suzuki Motors in Japan continue to develop the infrastructure in India. There are three stages in local design. The first is designing the front and rear body, specifically the shape of the lights and front grill. Maruti Suzuki has already reached this level. The second stage is designing the entire body, and the final stage is developing the entire car, including the platform. According to Maruti Suzuki staff, it "would like to be at stage two in a few years" (from a 2009 interview with Maruti Suzuki executives).

12.3.3 Reverse Innovation at GE Healthcare

The John F. Welch Technical Center, or JFWTC, is GE's research laboratory in India. It employs 4,000 researchers and engineers and is one of the company's largest research centers. Of the total employees, about 300 engineers develop products for GE Healthcare. Below, as an example of innovation-driven R&D, we explain the concept of reverse innovation by examining the portable ECG developed at the JFWTC (Immelt et al. 2009; Govindarajan and Trimble 2012).

GE Healthcare held a high share of the global ECG market, although at prices between $3,000 and $10,000, the products were too expensive to be accepted in the Indian market. In addition, as patients in India were dispersed in areas not easily accessible by faster means of transportation, portability was critical. Furthermore, as certain locations did not have electric power, battery capabilities were necessary. GE Healthcare understood that existing products did not meet these market needs, and in response to these needs and to significantly reduce costs, it formed a new product development team at the JFWTC. In 2007, this team introduced the MAC400, an $800 portable ECG, into the market. Existing products had a digital signal processor (DSP), keyboard, and printer, which were all high-quality components that needed to be specially ordered. In contrast, the MAC400 used standard, low-cost components to drastically reduce costs. Moreover, the product was lightweight and battery operated, thus making it popular in India. GE continued to further improve the product, and it is now sold in 60 countries, including the United States, as an entirely new product category. This example from GE Healthcare is one of reverse innovation, wherein a product created through the initiative of a foreign R&D center spurs innovation both globally and in the home country.

GE is a rare example of reverse innovation achieved by companies from advanced countries. However, we will likely see more instances of products from emerging countries spreading to other emerging countries, such as a product developed in India being sold in China. A 2009 survey by the Ministry of Economy, Trade and Industry (METI) noted that the percentage of companies responding affirmatively to whether locally developed products will be supplied solely to the relevant country decreased from 55.6 % 5 years ago to the current 28.2 %. In addition, this number is predicted to further decrease to 9.3 % in the next 5 years. Conversely, companies responding that they would supply locally developed products to the entire world remained at 14.6 %; however, this number is predicted to increase to 35.2 % in the next 5 years (Ministry of Economy and Trade and Industry METI 2010). Thus, the tendency is clear—products designed in emerging countries are developed not only for local markets but also for global markets.

However, many issues remain that before this can be achieved. Govindarajan and Timble (2012) noted that to be successful in an emerging country, companies from advanced countries must adopt a completely new approach to management. In addition, management must modify its views such that emerging countries can be positioned as core growth engines for the company. This is because business environments in emerging countries can completely differ from those in advanced countries. In

GE Healthcare's ECG project, the company aimed to provide a product with 50 % of the performance of existing products but at 15 % of the price. This goal could not be achieved by merely improving existing products; therefore, the company initiated a project to develop a new unique product in its Indian research laboratory.

Originally, GE Healthcare's case was a local development project for a local market. Similar projects, although on a small scale, are likely to be found among global companies. However, for a product to be sold at a global level, and for a project to attract investment of major resources, a management's views must undergo transformation. Senior management must decide whether it will concentrate serious efforts in emerging markets for the company's future growth. In the case of GE Healthcare, Immelt, the company's chairman, appointed a project leader who reported directly to him, which helped overcome various internal and external obstacles and generated significant results.

However, great risks are involved in making huge investments in a new region, where the business environment differs greatly from that in advanced countries. A management concern is the extent to which risk can be reduced in a high-risk/high-return investment. Simply because a project is based in local markets and features new concepts does not imply that it should be managed entirely by the local subsidiary. Accordingly, companies can form local growth teams (LGT) that are highly independent yet still report to senior management, as in the case of GE Healthcare. It can be effective to appoint personnel or organizations to serve as bridges between the home country and an emerging country in order to monitor an LGT's progress as well as simultaneously take locally generated ideas for new businesses and share them with the entire company (Washburn and Hunsaker 2011).

12.3.4 Organizational Management of Local R&D Centers

As is described in Chap. 11, there are four types of global R&D organizations (Ghoshal and Bartlett 1990).

1. Center for global: the home country takes the lead in conducting R&D for global markets.
2. Local for local: foreign research laboratories act independently in responding to local market needs.
3. Local for global: R&D for global markets is conducted in foreign research laboratories.
4. Globally linked: multiple research laboratories in various countries collaborate in a network structure to work on a single project.

Determining the ideal type depends on the specifics of a project and company policy. In companies that primarily use pattern (1), the role of foreign research facilities is minimal. This pattern may be effective for discovering and capturing cutting-edge technology, but it does not require a large-scale center. This is a centralized R&D management method wherein foreign research facilities work under the direction of the home country. Patterns (2) and (3) can be classified as decentralized management styles and require R&D centers of a scale that allows for some autonomy. For (2), R&D centers typically work as part of a larger organization in a particular region, and among foreign R&D centers, these are the most independent from the mother country. On the other hand, in (3), foreign centers often act under the control of the mother country in targeting global markets. Finally, in (4), companies have global R&D centers, each with a particular role in pursuing corporate-wide projects. This pattern leads to classifications that go beyond "centralized" or "decentralized."

There are tremendous risks in the globalization of R&D. Decrease in corporate-wide R&D efficiency due to failed management of foreign R&D facilities can shake the overall competitiveness of a company. Accordingly, foreign R&D centers are often created on a small scale and controlled by headquarters and then gradually made larger. Thus, the positioning of the local entity generally progresses sequentially from patterns (1) to (4). In other words, companies do not abruptly start with a local for local or "local for global" local entity, both of which leave much to the discretion of the local entity. It is more realistic for the R&D division at headquarters to take the lead in creating the local entity and then gradually increase its autonomy (Motohashi 2012).

Figure 12.5 graphically shows this evolutionary process for foreign research laboratories. The vertical axis shows the level of the competency creation mission

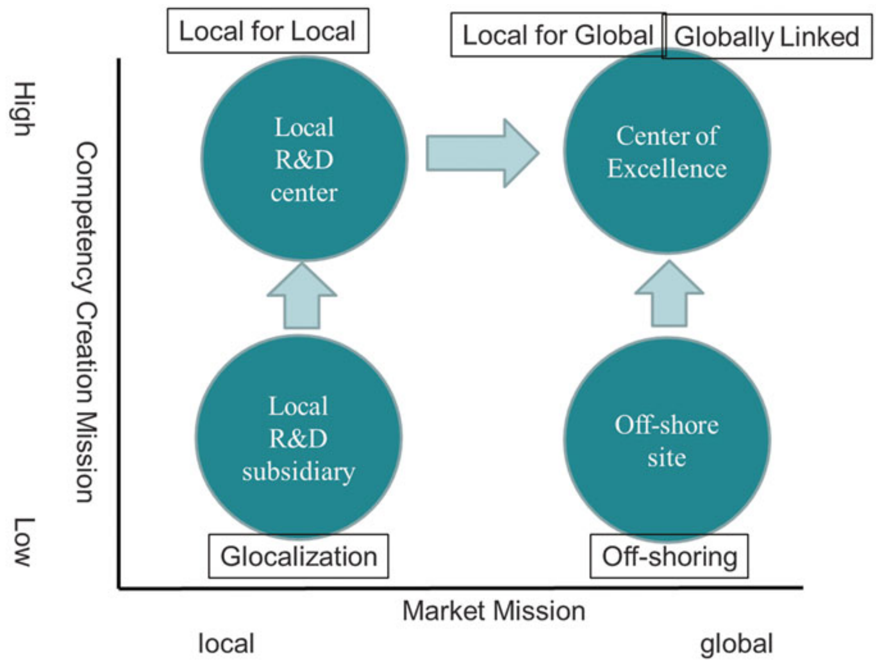

Fig. 12.5 Evolutionary model of overseas R&D activities

for the local entity, and the horizontal axis shows whether the target market is local or global. The competency creation mission shows the importance of a local entity for a multinational firm in its knowledge creation activities at a global level (Cantwell and Mudambi 2005). The progression from (1) to (4) can be shown as a shift from local R&D subsidiaries to local R&D centers and finally to centers of excellence (COE). In this process, a company first increases its competency creation mission in accordance with specific local circumstances, and when the capabilities of the local entity have grown sufficiently, the company positions the local entity as part of the global R&D organization.

As seen in Sec. 12.3.1, a characteristic of R&D organizations in India is the emphasis on their position as offshore development centers for the global market. Ghoshal and Bartlett's (1990) classifications noted above were created when the internationalization of R&D activities was being implemented among advanced countries and cost-driven offshore development was not considered as an option. These offshore development centers play their part in the R&D process locally under the direction of headquarters, making their competency creation mission low, although their target market is global (the bottom-right portion of Fig. 12.5). However, as already seen, R&D center activities for foreign firms in India are not limited to offshore development. IBM and Microsoft's Indian research laboratories play important roles in the companies' global research networks. In addition, the Intel India Development Center develops cutting-edge CPUs. These research facilities are given a high competency creation mission and are placed in the Center of Excellence quadrant. In other words, R&D centers in India can progress from being offshore sites to COEs.

Naturally, not all foreign R&D centers follow the path to becoming COEs, and it is not realistic for even multinational firms to have COEs throughout the world. The level of a competency creation mission is determined by the global strategy of the multinational firm and the economic environment of the country in question (Cantwell and Mudambi 2005). India is blessed with an R&D environment characterized by many outstanding software engineers; this facilitates the progression of its research facilities from being offshore sites to COEs. In addition, economic growth accelerated in the country from 2000 onward, making its market attractive.

As a result, progression from local R&D sites to local R&D centers can be observed, as in the case of Suzuki Motors, and GE's JFWTC can be regarded as having evolved from a local R&D center to a COE. Increasing the competency creation mission of foreign R&D centers in India is essential to winning both the local and global competitions for innovation, due to its growing importance of both supply and demand sides of R&D. Both Suzuki Motors and GE Healthcare have invested in India for long time, but the levels of local R&D centers, classified in Fig. 12.4, are different. While GE's R&D center can be illustrated as an example of reverse innovation, Multi Suzuki's activity is still in the process of local R&D subsidiary to local R&D centers. Since new product development in automotive industry requires much more coordination of activities within and between firms, it takes more time to reach the stage of "center of excellence" than the case of health care products. However, more autonomy to facilitate local innovation is imperative, even for automotive industry, in order to capture the opportunity associated with growing presence of emerging economies in global business.

To achieve this, multinational firms must accelerate the evolution of foreign research laboratories as indicated on both axes in Fig. 12.5. To increase the competency creation mission of local entities, companies must recruit outstanding personnel in the local entity and improve the quality of R&D activities. At the same time, companies must decentralize authority and increase the autonomy of local entities. Outputs from R&D activities are often uncertain, and the creativity of each researcher is essential (Kim et al. 2003). Accordingly, problems arise when headquarters exerts overwhelming control: researcher incentive is damaged and local knowledge cannot be fully leveraged. However, delegating authority to local entities can divert their activities from the company-wide mission. As seen on a global corporate-wide level, there is a danger that resources will not be used effectively (Acemoglu et al. 2007). Thus, training local managers and rotating researchers between the local entities and headquarters are important countermeasures (Brickey et al. 2001). In addition, rather than formal mechanisms such as regulations and compensation schemes, companies will find it effective to work on social controls via close communication between headquarters and local entities as well as by sharing the corporate culture (van Ecker et al. 2013).

12.4 Conclusion

As an overall trend gathered from the results of our analysis of R&D of foreign firms in China, we found that a "production-driven" model predominated. However, the Beijing region has a strong element of research and technology acquisition activities, whereas Shanghai, with its local markets, has predominantly "market-driven" activities. Thus, R&D objectives vary according to regional environments. In addition, we noted characteristics of R&D on the basis of the nationality of a company, with the Japanese firms being weighted toward "production-driven" activities and a centralized authoritarian style of management led by company headquarters.

As for India, thanks to an abundance of quality research personnel, there is significant offshore development by US firms, particularly in the field of software. Moreover, companies such as IBM, Intel, and GE conduct cutting-edge R&D in India. The economic growth and increasing income levels in India have made the Indian market attractive, and local R&D activities have been on the rise, particularly in the automotive market. Thus, India has world-class potential both as a global R&D center targeting global markets and as a regional R&D hub for its local market and markets in emerging countries.

For multinational firms, realizing the high potential for innovation in China and India requires increasing the competency creation mission of local R&D centers. In doing so, companies must attract outstanding personnel to their local entities and provide a high level of autonomy by loosening the control from headquarters. However, in a corporate-wide innovation strategy, making the activities of local entities effective will require the engendering of unity through social controls such as international personnel rotation and training, close communication, and permeation of the corporate culture.

However, economic and social environments in China and India greatly differ from those in Japan, the United States, and Europe. Although companies headquartered in advanced countries may attempt to instill their corporate culture in these host countries, this is easier said than done. Accordingly, companies must create a management system in local entities with a high degree of transparency, using clear and formal rules and incentive systems. In addition, for the results of local R&D activities to be used as company-wide knowledge at a global level, companies must create a knowledge management system. Moreover, local R&D centers must assume the role of partners that link Indian universities and public research institutions. Here, too, harvesting local knowledge and technology into corporate-wide competency is critical. To share local intelligence throughout the company without stifling it, companies must adopt a flexible company-wide approach that accepts diversity.

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