Foreign R&D in Developing Countries: Empirical Evidence from Shanghai, China*

Yifei Sun, Debin Du and Li Huang

Abstract
This study examines foreign R&D in Shanghai and reveals that Shanghai has become one of the most concentrated centres of foreign R&D in China. Through interviews at 18 foreign R&D facilities in Shanghai, the study confirms the findings from previous studies that the majority of foreign R&D in China is adaptive and tactical in nature to serve the Chinese market. However, strategic foreign R&D does exist and such establishments are engaged in projects not only for China’s local markets, but also for the global market; they are not only involved in short-term product development, but also in long-term original research.

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Shanghai’s concentration of foreign R&D is clearly contingent upon the convergence of forces at the national, regional and local scales: China’s burgeoning market at the national scale, the concentration of manufacturing and foreign investments in the Yangtze River Delta at the regional scale, and Shanghai’s eminent position in China’s economic landscape and its attractiveness to quality labour at the local scale.

Introduction

Multinational corporations (MNCs) increasingly are adopting a global strategy for their research and development (R&D), and academics have shown growing interest in this phenomenon since the early 1990s.\(^1\) Topics researched range from the classification of MNCs’ overseas R&D, to examination of their motivations and organization.\(^2\) However, most studies have focused on developed countries, while developing countries have received scant attention, despite the fact that developing countries such as China and India have become hot spots of MNC R&D facilities.\(^3\)

In addition, most studies have focused on the national scale and there is a lack of studies on foreign R&D locations at the regional/local levels, such topics having only recently received academic attention.\(^4\) The bias towards the national scale may be because the majority of scholars working on this subject come from disciplines such as management, business and economics, which have a tradition of downplaying the role of locations in their conceptualization and theory-building.

Recently, there have been a few studies exploring foreign R&D in China.\(^5\) It has been found that most foreign R&D establishments are adaptive and tactical in nature and focus on product development for China’s domestic markets. However, creative and strategic foreign R&D does exist in China and some MNCs have set up facilities with the aim of conducting research for the global market in the long term.\(^6\) Existing studies also reveal that MNCs choose to establish R&D in China because of the need to develop and customize technologies for the local market, and the availability of high-quality labour with much lower costs than in developed countries.\(^7\) Other studies have explored the barriers to establishing foreign R&D in China.\(^8\) Nevertheless, most studies on foreign R&D in China have focused on the overall picture and the richness of empirical evidence has been sacrificed. It is unclear exactly what kinds of activities are being conducted in such foreign R&D establishments.

Through interviews with 18 directors/managers at MNC R&D
establishments in Shanghai, we aim to add new evidence to the literature on MNC R&D in developing countries, contribute to the literature on locations of MNCs R&D at the subnational scale, and particularly to provide rich empirical evidence so that people can better appreciate the nature of foreign R&D in China. Specifically, we will examine two major questions:

1) What kinds of activities are being conducted in foreign R&D in Shanghai?
2) What factors have affected the MNCs’ decision to choose Shanghai as their R&D site?

The remainder of the paper is organized as follows: The next section will briefly review the literature on categorization/organization of global R&D as well as issues related to R&D locations. Then, we will describe the methodology, and provide a short introduction to foreign R&D in China in general and Shanghai in particular. The following section gives a detailed categorization of foreign R&D facilities in Shanghai and their location considerations, while the final section summarizes the major findings from this study.

Global R&D and Its Location

There exists an extensive literature on globalization of R&D and we will concentrate on two major themes: organization/categorization as well as the location of global R&D.

Categorization/Organization of Global R&D

The literature has revealed that the organization of MNC R&D has moved from the centralized hub, to the decentralized federation, and then to the integrated network. Bartlett and Ghoshal identified four modes of R&D organization in MNCs: central-for-global (centralized development of technology at home for the global markets), local-for-local (decentralized development of technology for the local markets), locally-linked (development of specified technology at each location for the global markets), and globally-linked (development of technology through R&D cooperation in different countries for the global markets).

In the MNCs’ global R&D networks, the roles of different establishments vary and many studies have tried to categorize them.
Ronstadt’s pioneering studies on technological activities within American MNCs identified four types of R&D facilities: technology transfer unit (TTU); indigenous technology unit (ITU); global technology unit (GTU); and corporate technology unit (CTU). In another effort, Kuemmerle categorized global R&D activities into two groups: home-base-exploiting (HBE) R&D, and home-base-augmenting (HBA) R&D. HBE R&D aims to exploit firm-specific capabilities in manufacturing and marketing units, while HBA R&D is primarily established to acquire new knowledge and capabilities. Recently, Sun classified MNC R&D into two categories, strategic and tactical, according to their importance. Strategic R&D bears significance for the MNCs’ global markets in the long-term, while tactical R&D only has short-term significance for local markets. In addition to differences in markets and time-lines, strategic R&D also differs from tactical R&D in many respects, from the nature and extent of their activities, requirements for the quality of the labour force, communication patterns, commitment from top administrators and control models, to their locations in host countries.

Empirical studies have found that the majority of MNC R&D in foreign countries is adaptive in nature — adapting and customizing technologies generated in home countries for the local markets, particularly at the early stage of development. For example, Kuemmerle found that of the 156 foreign R&D units set up by 32 MNCs from the United States, Japan, Germany, France, and the Netherlands, 38% were of the HBA type while 62% were of the HBE type. Florida and Kenney reported that a large share of Japanese R&D facilities in the United States focused on customizing products for the US market and providing technical support to manufacturing.12

It has been theorized that foreign R&D investments in developing countries are more oriented towards adaptive/supportive technological activities with the domestic markets as the major service areas. For instance, Dunning suggested that it is possible for countries such as Brazil, India, Korea, Mexico, Singapore and China to attract R&D to customize for the local market, though it is difficult, if not impossible, for them to attract R&D of strategic importance to MNCs.13 Kuemmerle predicted that “it seems likely that Asian countries with large populations such as India and China will attract an increasing number of HBE facilities.” Reddy also reported that the majority of foreign R&D laboratories in India were of the TTU or ITU type.14 As such, foreign R&D activities in developing countries are only of marginal importance in the MNCs’ global innovation
network. In studies of foreign R&D in China, it has been confirmed that the majority involve more “development” than “research.” In conclusion, foreign R&D in developing countries is more likely to be tactical than strategic in nature.

**Locations of Foreign R&D**

The globalization of R&D is the result of many forces, including demand and supply as well as environmental factors. It has also been observed by many scholars that establishing R&D in foreign countries is a process of globalization as well as of localization. MNC R&D functions, as is the case for R&D in general, are highly concentrated in a few areas in the host countries. In an early study on the location of industrial laboratories, Malecki revealed that nearly 90% of the laboratories were in the 177 standard metropolitan statistical areas (SMSAs), and the top 21 SMSAs concentrated 71.1% of the industrial laboratories, even though their share of the population was only about 38.4%. Important concentrations include New York–Newark-Jersey City, Los Angeles–Long Beach–Anaheim, and Chicago-Gary. The pattern of high concentration of corporate R&D in major cities is still the norm and such findings have been confirmed by studies in the UK and Japan.

Similarly, foreign R&D in host countries is also highly concentrated. For example, Dalton and Serapio reported that US had 701 foreign R&D centres in 1999, and the top locations included California (188), New Jersey (67), Michigan (41), Ohio (40) and other states. The top 11 states concentrated 75.2% of the foreign R&D facilities in the US. The major metropolitan areas that have attracted foreign R&D include Silicon Valley in California, the Los Angeles metropolitan area, and New Jersey, particularly the area around Princeton University.

To explain such clustering of R&D at the subnational scale, two types of models have been proposed: the rational choice model and the imitating behavioural model. In the rational choice model, R&D locations are considered to be the results of deliberate decision-making processes after the evaluation of two major categories of factors: 1) internal organization and management considerations and 2) external environmental considerations. Internal considerations include the relationships between R&D and other functions such as manufacturing, marketing, and sales departments within the same company. Location in proximity with other functions facilitates communication, resource sharing, coordination and
control, which are critical to the success of R&D.\textsuperscript{18} As such, many studies found that corporate R&D is often co-located with corporate headquarters and manufacturing facilities.

External factors are very numerous and Cantwell and Piscitello classify them into three major groups: intra-industry spillovers and specialization externalities, inter-industry spillovers and diversity externalities and external sources of knowledge and science-technology spillovers.\textsuperscript{19} Intra-industry spillovers are related to the concentration of firms from the same industry and sector in a small geographic area. Such a concentration of firms from the same industry facilitates knowledge diffusion and innovation through labour mobility, common infrastructure such as marketing and training agencies, and other formal and informal interactions among the firms. Inter-industry spillovers are associated with the clustering of firms from different industries in the same place or the degree of diversity of the local economy. Such a concentration helps attract and retain the talents that are critical to any innovation. Interactions among the firms in different industries may help generate new ideas that lead to new innovations. Essentially, the intra-industry spillovers are “localization economies” and inter-industry spillovers are “urbanization economies.” Finally the technological spillovers are related to the presence of strong local science and technology communities including universities, government laboratories, and other firms. Universities and governments are important sources of ideas, technologies, and talents. Extremely important in all three categories is access to a large pool of talent.

The importance of such factors for R&D in general and foreign R&D in particular has been tested and confirmed by a number of studies.\textsuperscript{20} For instance, Malecki found that when a US corporation has only one R&D site, that site would be with the headquarters; if the corporation has multiple R&D sites, one of them would be with the headquarters. Florida and Kenney pointed out that the majority of Japanese R&D in the US focuses on customizing products for the US market and thus the sites are located at or near existing manufacturing plants. Mariani found that among the 308 Japanese R&D facilities in Europe, 234 were co-located at the product sites, while only 74 of them were separate from production. Cantewell and Piscitello found that both intra- and inter-industry spillovers are significant in explaining regional differences of patent grants to foreign companies in Europe. Mariani also found that geographic proximity to the local science base is an important factor in explaining foreign R&D locations.
In comparison, proponents of the imitating behavioural model argue that the process of foreign R&D location is cumulative and path-dependent: the standard factors that are used to explain the concentration of foreign R&D are not sufficient. Instead, they argue that the constraints of the traditional resources considerations and the need to interact efficiently with others are reduced due to advances in telecommunications and the high mobility of research scientists and engineers. They point out that many managers experience difficulties in articulating the factors that are critical in their location decisions and “those named usually could be fulfilled by almost all metropolitan areas.” Instead, it is argued that information uncertainties and population-level learning through signalling and imitating are critical to understanding the process of the decision-making with regard to R&D locations. Information uncertainties lead people to follow signals from others, sometimes even without questioning the rationales. When companies look for R&D locations, they look at other companies to see where similar R&D facilities have been set up. Such a theory helps us to understand the emergence of R&D in new places while the traditional factor-based theories favour the traditional clusters. These arguments have been supported by studies of the locations of industrial research. In this study, we want to see what factors are at work in the MNCs’ decisions to use Shanghai as their R&D site.

Research Design

This study adopts a qualitative research approach, particularly through the use of case studies. Foreign R&D in China is still relatively new and few in-depth studies exist. There is even a lack of common understanding regarding basic questions such as how many foreign R&D facilities exist in China. For example, Walsh and von Zedtwitz have documented the differences among the various reports on the number of foreign R&D establishments in China: from 18 to 400. In a recent report, the number has increased to more than 700.22 Different authors and sources use different criteria in deciding what can be categorized as foreign R&D. Unfortunately, no authoritative data exist. That being so, there is little support for conducting large-scale quantitative research.

We obtained a list of 76 foreign R&D locations in Shanghai from the Shanghai Foreign Economy and Trade Commission. From other sources, including the Shanghai Science and Technology Commission, MNCs’ websites in both Chinese and English, and various news reports, we found
52 additional foreign R&D facilities. In total, we compiled a list of 128 foreign R&D establishments in Shanghai, though unfortunately contact information for the sources is incomplete. Through an extensive Internet search, we found telephone numbers or e-mail addresses for 79 of them. In the end, 18 companies agreed to be interviewed. Due to the limited number of companies that agreed to cooperate with us, it was not feasible to conduct comprehensive quantitative analyses.

Table 1 provides the profile of the R&D centres where we conducted interviews. The size of foreign R&D establishments varies significantly. The smallest one has only four employees, while the largest one has several hundred. The companies cover different sectors from chemistry, electronics, life science and materials to information communication technologies (ICT) and come from different countries including Austria, Belgium, France, Germany, Japan, and the US. Most of them were established after 2000. The R&D establishments also differ in organizational structure and ownership. Among the 18 foreign R&D investments, five are joint ventures between foreign companies and Chinese partners while others are wholly foreign-owned. Eleven establishments are independent enterprises with their own legal entities, while others are parts of a holding company. Clearly, there exists much diversity in foreign R&D in Shanghai.

We conducted interviews with the directors/managers of these foreign R&D facilities between 2002 and 2004. Such interviews were conducted at the interviewees’ offices and usually lasted from one to two hours. Depending on the background of the interviewees, certain interviews were conducted in English while others were in Chinese. The major questions discussed in the interviews include the following:

1) What are the main responsibilities of the R&D centre?
2) What were the considerations for deciding on its location?
3) How do they interact with other parts of the same company, with Chinese domestic enterprises and with the local science and technology community?
4) What problems have they encountered in establishing and managing R&D in China?

Originally, detailed questions were listed in a questionnaire consisting of structured and unstructured questions. During early discussion, however, this was found to be very restrictive. We therefore decided to conduct interviews using these questions simply as guides. In this study,
<table>
<thead>
<tr>
<th>Company Name</th>
<th>Home country</th>
<th>Industry</th>
<th>Year of establishment</th>
<th>R&amp;D activity</th>
<th>R&amp;D type</th>
<th>Ownership</th>
<th>Organization</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>PharMab. Inc.</td>
<td>USA</td>
<td>Life</td>
<td>2001</td>
<td>D</td>
<td>Tactical</td>
<td>Foreign</td>
<td>Ind. Ent.</td>
<td>Zhangjiang</td>
</tr>
<tr>
<td>Gloli Co. Ltd</td>
<td>Belgium</td>
<td>Life</td>
<td>2001</td>
<td>D</td>
<td>Tactical</td>
<td>Foreign</td>
<td>Ind. Ent.</td>
<td>Waitan</td>
</tr>
<tr>
<td>HP China Software Solutions Center</td>
<td>USA</td>
<td>ICT</td>
<td>2002</td>
<td>D</td>
<td>Tactical</td>
<td>MNC</td>
<td>Department</td>
<td>Jinqiao</td>
</tr>
<tr>
<td>Rockwell Automation Shanghai Research Center</td>
<td>USA</td>
<td>Machinery</td>
<td>1997</td>
<td>R</td>
<td>Tactical</td>
<td>MNC</td>
<td>Ind. Ent.</td>
<td>Chaohejin</td>
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<td>Yuhua Teltech Co.Ltd.</td>
<td>USA</td>
<td>ICT</td>
<td>2001</td>
<td>D</td>
<td>Tactical</td>
<td>Foreign</td>
<td>Ind. Ent.</td>
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<td>Pan Asiaen Technical Automotive Center Co. Ltd.</td>
<td>USA</td>
<td>Auto</td>
<td>1997</td>
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<tr>
<td>Bayer Polymer</td>
<td>Germany</td>
<td>Chemical</td>
<td>2000</td>
<td>D</td>
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<tr>
<td>Shanghai Alcatel Intelligent Terminal Equipment Co. Ltd</td>
<td>France</td>
<td>ICT</td>
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<td>Department</td>
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<tr>
<td>GE China Research and Development Center</td>
<td>USA</td>
<td>ICT</td>
<td>2000</td>
<td>R&amp;D</td>
<td>Strategic</td>
<td>MNC</td>
<td>Department</td>
<td>Zhangjiang</td>
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<tr>
<td>Infineon Technologies Center of Competence (Shanghai) C. Ltd</td>
<td>France</td>
<td>ICT</td>
<td>2003</td>
<td>Services</td>
<td>Tactical</td>
<td>MNC</td>
<td>Ind. Ent.</td>
<td>Zhangjiang</td>
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<tr>
<td>Honeywell Asia Technology Center</td>
<td>USA</td>
<td>Chemical</td>
<td>2004</td>
<td>R&amp;D</td>
<td>Strategic</td>
<td>MNC</td>
<td>Department</td>
<td>Hongqiao</td>
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<tr>
<td>Sharp Appliance Products R&amp;D Center</td>
<td>Japan</td>
<td>Electronics</td>
<td>2003</td>
<td>D</td>
<td>Tactical</td>
<td>MNC</td>
<td>Ind. Ent.</td>
<td>Jinqiao</td>
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<tr>
<td>Unilever Research China</td>
<td>UK</td>
<td>Life</td>
<td>2002</td>
<td>R</td>
<td>Strategic</td>
<td>MNC</td>
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<td>Chaohejin</td>
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<td>Alcatel Shanghai Bell</td>
<td>France</td>
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<td>2002</td>
<td>R&amp;D</td>
<td>Strategic</td>
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<td>Auto</td>
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<td>Tactical</td>
<td>MNC</td>
<td>Ind. Ent.</td>
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<tr>
<td>Shanghai EPSON Electronics Co. Ltd</td>
<td>Japan</td>
<td>ICT</td>
<td>1995</td>
<td>D</td>
<td>Tactical</td>
<td>MNC</td>
<td>Ind. Ent.</td>
<td>Chaohejin</td>
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<tr>
<td>DaimlerChrysler SIM Technology Co. Ltd</td>
<td>Germany</td>
<td>Auto</td>
<td>1999</td>
<td>D</td>
<td>Tactical</td>
<td>J.V.</td>
<td>Ind. Ent.</td>
<td>Hongqiao</td>
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</table>

Notes:
1. J.V.: Joint Venture between MNC and Chinese partners. Foreign ownership refers to R&D facilities that established with foreign funding, not necessarily from MNCs. MNC: owned and operated by MNCs.
2. Organization: Ind. Ent: Independent enterprise, indicating that the centre/lab is registered and has its own legal entity status. Department refers a R&D facility which is part of a MNC and does not have its own legal entity. It may have the names of R&D Centre, R&D Department or R&D Laboratory, and others.
we will focus the discussion on the first two questions: what they are doing, and why they have chosen China in general and Shanghai in particular as their R&D location. The interviews give us more flexibility and richer contextual information about the issues discussed. Some interviews were tape-recorded with the agreement of the interviewee, while other interviewees preferred note-taking only. Notes from the interviews were compiled immediately afterwards, while the audio files were transcribed/translated into English later. In this study, we will focus on the 15 large multinational R&D facilities in Shanghai. Issues relating to PharMab, Gloli, and Yuhua TelTech will therefore not be discussed. Before reporting our findings, we will provide some background on foreign R&D in China in general, and Shanghai in particular.

**Foreign R&D in Shanghai**

Foreign R&D in China has been growing rapidly, particularly since 1997. The first foreign laboratory was jointly established by Nortel Networks and Beijing University of Posts and Telecommunications (BUPT). The number of independent foreign R&D establishments in China has increased to more than 700 in 2005.

Walsh identified four stages of foreign R&D development in China. The first stage (early-mid 1990s), “exploratory and strategic partnership,” was dominated by the so-called “Show R&D” activities, the primary purpose of which was to gain entrance to the Chinese market. Often the decision was the result of pressure from various sectors of the Chinese government. Examples include the joint laboratories developed between Nortel Network and BUPT. In the second, or expansion, stage (mid-late 1990s), China saw the establishment and expansion of many foreign R&D operations. Prominent examples included those of Microsoft, Lucent Technologies and Bell Labs, Intel and IBM. The third stage (late 1990s to the present), “the consolidation of R&D,” is characterized by “a more considered, strategic approach to R&D investment” and more MNCs are shifting towards more advanced R&D activities. The fourth stage, after 2003, characterized by Walsh as an “explosion,” was a period when foreign R&D investment in China grew extremely rapidly.

R&D investment in China covers a wide range of industries from ICT (including hardware, software, and information services), electronics, chemicals and bio-techs to materials and others, although the majority of them fall within the ICT sector. According to Walsh, 223 R&D centres,
programmes or laboratories were established between 1990 and 2002 in the computer and telecommunication sectors and more than half were from US MNCs.

The majority of foreign R&D facilities in China are concentrated in Beijing and Shanghai. For example, of the 199 foreign R&D establishments listed by von Zedtwitz, 78 were located in Beijing and 61 were located in Shanghai. von Zedtwitz also revealed that foreign R&D in Beijing concentrates in telecommunications and electronics, while those in Shanghai show much more diversity, with industries ranging from food and pharmaceuticals to engineering and others. von Zedtwitz argues that Beijing’s concentration of ICT companies has come about because it is essential for such industries to have strong interaction with the central government, while industries where style or taste is critical tend to be located in Shanghai, although in both cities there are additional attractions, such as a concentration of universities, state R&D institutes, foreign investment, and foreign corporation regional headquarters. Such findings are confirmed by our study.

Foreign R&D in Shanghai has been growing very fast, but it is not clear how many foreign R&D establishments have been set up there. Among the 91 foreign R&D establishments for which we have found information on the year of establishment, ten were established before 1995, 18 were established between 1995 and 1999, and 41 were established in or after 2000. Of the 108 R&D facilities for which we have information about the home countries of their parent companies, 40 came from US MNCs, 20 from Japan and 38 from European countries, with Germany, France, the Netherlands and Switzerland almost even. Of the 124 R&D facilities for which their industry has been identified, the ICT sector leads with 49 such establishments, with bio-tech companies (24) a distant second. Other sectors include electronics and home appliances (14), chemicals (10), automobiles (9), machinery (8) and food and pharmaceuticals (9).

Categorization of MNC R&D in Shanghai

Many studies have revealed that foreign R&D in China is developmental or tactical in nature, and our studies of foreign R&D in Shanghai confirm such observations. However, research and strategic foreign R&D facilities do exist there. The mandates of foreign R&D in Shanghai range from providing services to internal/external customers, creating technologies for the Chinese local market, and developing technologies for the global
market, to conducting research for the company’s future. All the four categories identified by Ronstadt can be found in Shanghai. To be more specific, we further differentiate three subtypes for the technology transfer unit in Ronstadt’s classification: internal service provider, external service provider, and technology adapter. Thus, six types of foreign R&D in total were identified in Shanghai (Table 2).

Table 2. Categorization of Foreign R&D in Shanghai

<table>
<thead>
<tr>
<th>Category</th>
<th>Ronstadt</th>
<th>R&amp;D activity</th>
<th>Technology timeline</th>
<th>Market</th>
<th>Strategic/ Tactic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal service provider</td>
<td>TTU</td>
<td>Service</td>
<td>Short</td>
<td>Local/ Regional</td>
<td>Tactic</td>
</tr>
<tr>
<td>External service provider</td>
<td>TTU</td>
<td>Service</td>
<td>Short</td>
<td>Local/ Regional</td>
<td>Tactic</td>
</tr>
<tr>
<td>Technology adapter</td>
<td>TTU</td>
<td>Development</td>
<td>Short</td>
<td>Local</td>
<td>Tactic</td>
</tr>
<tr>
<td>Indigenous technology developer</td>
<td>ITU</td>
<td>Development</td>
<td>Short /Middle</td>
<td>Local</td>
<td>Tactic</td>
</tr>
<tr>
<td>Global technology centre</td>
<td>GTU</td>
<td>Development/ Research</td>
<td>Middle/Long</td>
<td>Global</td>
<td>Strategic</td>
</tr>
<tr>
<td>Corporate research centre</td>
<td>CTU</td>
<td>Research</td>
<td>Long</td>
<td>Global</td>
<td>Strategic</td>
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</table>

**Internal Service Provider**

Large MNCs have increasingly adopted the multi-division and multi-location organization format. Some MNCs have developed a separate division/centre to serve the needs of other businesses. The customers of these divisions/centres come primarily from affiliated companies or units, and the major purpose of such centres is to provide support and services to other business units from the same MNC. This is particularly clear in software development in ICT companies such as HP, Motorola, Siemens and Nokia. In such sectors, companies are involved in both hardware and software and they need to provide complete solutions to their final customers. With the increasing complexity of some products, some corporations have set up separate software or service units. For example, Motorola has established a global software development centre and HP has one business unit focusing on services, whose customers include internal as well external businesses.
A good example is the HP China Software Solutions Centre. It was established in May 2002, a couple of months before our interview. It belongs to the HP Services Group, one of HP’s four core business groups. The Centre has two major groups of customers. One group comes internally from other businesses groups around the world, the other is made up of large enterprises in “Greater China” including mainland China, Taiwan, and Hong Kong, to whom it provides direct services. HP Services has three other similar software solutions centres in other countries, one of which is in India, was established in 1990 and has about 1,500 employees. HP plans to expand the Shanghai centre to a facility of similar size to the one in India by 2007. In July 2002, two months after it was set up, the centre already had 100 employees.

HP chose to locate in Shanghai principally because its production facility was there as well. Indeed, the R&D centre is on the same site as the manufacturing plant. Facility sharing and convenience of communication with the production unit were the major concerns for the R&D location.

That Shanghai has an advantage because of the concentration of foreign investment in the city and the surrounding provinces such as Jiangsu and Zhejiang is very clear. Many of the large foreign MNCs we interviewed have multiple investments in this area (Table 3).

**External Service Provider**

The second type of foreign R&D focuses on providing services to their customers in China and the Asian markets. For example, Infineon is a company working on mobile phone chip designs. The company was previously part of Siemens and became independent in 1999. Before its spin-off, Infineon’s customers came exclusively from Siemens. After the separation, they decided to expand their business in the Asian market, which had been growing very fast. Soon they found that the technical capabilities of their Asian customers (mobile phone manufacturers) were relatively weak and many of them could not build complete mobile phone sets without external technical support. They therefore decided to set up a technical support centre in Asia in the hope that the services they provide will help expand their Asian market. Originally, the centre was established in Hong Kong in 2001. It was then decided to establish another centre in Shanghai because of the rapid growth of Chinese mobile phone manufacturers. Indeed, they decided to establish their Asian Pacific Technical Support Headquarters in Shanghai, although the Infineon Pacific
## Table 3. Representative Investments in Shanghai and the Yangtze Delta for Selected MNCs

<table>
<thead>
<tr>
<th>Company name</th>
<th>Investments in Shanghai and the surrounding areas</th>
</tr>
</thead>
</table>
| **General Motor** | 1. Shanghai GM  
                      2. Shanghai Auto Industry Corporation (SAIC)-GM-Wuling |
| **Bayer** | 1. Bayer (China) Limited (Shanghai)  
                      2. Bayer Coatings Systems Shanghai Co., Ltd. (Shanghai)  
                      3. Bayer Jinling Polyurethane Co., Ltd. (Nanjing)  
                      4. Bayer Polymers Shanghai Co., Ltd. (Shanghai)  
                      5. Bayer Polyurethanes Shanghai Co., Ltd. (Shanghai)  
                      6. Bayer Technology Services (Shanghai) Co., Ltd. (Shanghai)  
                      7. Bayer CropScience Hangzhou Co., Ltd. (Hangzhou) |
| **Alcatel** | 1. Alcatel Shanghai Bell |
| **GE** | 1. GE (China) Co. Ltd (Shanghai)  
                      2. GE Lighting Co. Ltd (Shanghai)  
                      3. GE Lighting Technology Centre (Shanghai)  
                      4. GE Plastic (Shanghai) Co. Ltd  
                      5. GE Toshiba Organosilicon Co. Ltd (Shanghai)  
                      6. Shanghai GE Switches Co. Ltd  
                      7. Shanghai GE Broadcasting Co./ Ltd  
                      8. Shanghai Tonghua Automation Co. Ltd.  
                      9. GE FANUC Shanghai Co. Ltd.  
                      10. Wuxi Jujitsu GE Actuation Control Co. Ltd (Wuxi)  
                      11. Haiying GE Medical Equipment Co. Ltd (Wuxi) |
| **Infineon** | 1. Infineon Wuxi, Co. Ltd (Chip)  
                      2. Infineon Suzhou Co. Ltd (Chip)  
                      3. Infineon China (Headquarters, Shanghai) |
| **Honeywell** | 1. Honeywell Fire and Security Systems (Shanghai) Co., Ltd.  
                      2. CEA Honeywell Aircraft Wheels and Brakes Repair and Overhaul Co., Ltd. Shanghai  
                      3. CRIAA Honeywell (Nanjing) Aero-Accessories Co., Ltd.  
                      4. Honeywell CATIC Engine (Suzhou) Co., Ltd.  
                      5. Honeywell Turbocharging Systems (Shanghai) Co., Ltd. |
| **Sharp** | 1. Shanghai Sharp Co. Ltd (Air Conditioning, Refrigerator, and Washer)  
                      2. Changshou Sharp Co. Ltd (Copy Machine)  
                      3. Wu Xi Sharp Co. Ltd (LCD)  
                      4. Nanjing Sharp Co. Ltd (TV)  
                      5. Shanghai Mold Co. Ltd. |
| **Unilever** | 1. Unilever Food Co. Ltd (Shanghai)  
                      2. Unilever Co. Ltd (Home and Personal Care, Shanghai)  
                      3. Unilever China (Headquarters, Shanghai) |
Global R&D in Shanghai

headquarter is still in Singapore. The Shanghai centre administers the technical support network in Asia at sites including Hong Kong, Beijing, Singapore and Shanghai.

In the global R&D network, technical support is on the bottom layer in terms of technological development. The chief task of these networks is to make sure that the technologies/products developed by the parent companies work for their customers (industrial as well as individual consumers). The R&D network for Infineon consists of several components. The first is integrated circuit (IC) or chip design, which is primarily located in Germany and France. Infineon also has a chip design centre in Bangalore, India. The second part of the network is platform development, which, based on designs specified in the previous stage, combines hardware and software to come up with the “engine” of mobile phones, though not the phones themselves. (These are produced in Denmark for Infineon.) The third stage is phone design, where manufacturers of mobile phones develop the final products and specify the features, designs, user interface etc. The Infineon Shanghai Centre only works on the final stage with mobile phone manufacturers, to customize the platform and help them produce complete and reliable final products. Other aspects of the Centre’s activities are related to testing: to make sure the products conform to the specific regulations and parameters in the country where the phones will be sold. The Centre also needs to make sure that the phones work with different network providers, equipment and in different physical settings: in elevators, on mountains, inside buildings, while driving and so on. Once problems are found, the Centre needs to do the debugging. Clearly, technical support and product tests are its main activities.

Infineon chose to locate in Shanghai for two major reasons: first, Infineon’s head office was in Shanghai, and second, it has a manufacturing facility in Wuxi, very close to Shanghai. Locating in Shanghai allowed such related businesses to share some infrastructure such as human resources etc.

Technology Adapter

When MNCs move to a different country, they sometimes need to customize their products according to local demands stemming from differences in regulations (as demonstrated in the case of Infineon), or unique local tastes and environments. A clear example is the Bayer
Polymer R&D Centre in Shanghai. The Centre was established in 2001 and employed about 30 people by summer 2004. It belongs to Bayer China, Ltd., whose headquarters are also in Shanghai. Indeed, the headquarters and the Centre are on the same site. The Centre concentrates the technical forces for Bayer’s operations in Asia, including those in Malaysia, Singapore, and Japan, in addition to China. The major responsibilities of the Centre are to provide technical support for their businesses, including pre-sale and post-sale services. In addition, the Centre also provides internal staff training for personnel from Hong Kong, Singapore, and Japan. The Centre consists of two laboratories: one for engineering plastic and the other for polyurethane (a broad class of thermoplastic polymers with good abrasion and solvent resistance). “Real R&D activities are rare and Bayer’s R&D centre is in Germany.” For example, the recipe for polyurethane, a chemical used to manufacture materials such as foam, was developed in Germany. Bayer’s Chinese customers may ask for different colours or degrees of hardness, and the Shanghai centre will conduct some experiments and make changes to the original recipe according to the demands of their specific customers in China. “If our customers are satisfied, our job is done. If our customers are not satisfied, we will make further changes till their requirements are met.” The same is true with engineering plastic, which is used in many products such as the coating of CDs, VCDs, computer bodies and boxes or cellular phones. Bayer’s customers in China may need the materials in different degree of hardness and intensity. If problems occur during their customers’ manufacturing process, the laboratory will do some experiments and find out if these are due to the materials. During the process, they may develop some new technologies/materials and would then apply for patents.

Indigenous Technology Developer

This category of foreign R&D specifically designs products for Chinese markets. Of the companies we interviewed, DaimlerChrysler SIM Technology Co. Ltd. and Shanghai Epson Electronics belong to this category. DaimlerChrysler established a joint venture with the Shanghai Metallurgy Institute of the Chinese Academy of Sciences (CAS), focusing on auto electronics. The auto industry has been growing very fast in China, but its R&D capabilities are still very weak. It is particularly weak in the area of auto electronics. However, electronics systems are becoming increasingly important components of modern auto industries.
The average proportion of electronic components is now about 25% of the total cost for complete auto vehicles, up from about 15% only ten years ago. In high-end vehicles such as Mercedes-Benz and BMW, the proportion can be as high as 35%. Such vehicles use as many as 30 engine management systems simply for power control to improve the engineering performance, make them safer and more powerful and reduce air pollution. An antilock braking system (ABS) is an example of such an engine control system and has been widely used in many vehicles. Other examples include automatic transmission, cruise control, power steering, CD players, air temperature control, GPS, pressure and rain monitoring, and auto light controls. The Chinese government has realized the importance of this segment, and now requires all vehicles to use electronically-controlled carbonators to improve fuel efficiency and reduce pollution. However, few Chinese domestic auto companies have such capabilities and the majority of these systems are provided by foreign companies such as Bosch and Delphi. Sensing the opportunity, DaimlerChrysler set up a joint venture with the Shanghai Metallurgy Institute of CAS in 1999, based on the joint laboratory they had established in 1995. The major business of the joint venture is to provide technical solutions for electronic control units for Chinese auto-makers. The joint venture focuses on two areas: electronics packing—used in board design, time-effectiveness analysis, and quality control—and auto electronics. Right now, the joint venture has about 30 employees and its particular focus is on control systems which involve both software and hardware. Their major interest is to help Chinese auto-makers develop such systems. However, the joint venture is not interested in manufacturing such systems, since DaimlerChrysler’s primary interest is in the final auto market, not in the component market.

Clearly, the location of the company in Shanghai was partly due to the pre-existing cooperation with the Shanghai Metallurgy Institute of CAS, but also to the fact that Shanghai is one of the centres for the auto industry in China, which makes it a very convenient place to work with their potential customers.

Global Technology Centre

As remarked before, some R&D establishments develop products and technologies not just for the local market, but also for the global market. An example is the Sharp Appliance Products R&D Centre in Shanghai. The Centre was established in 2003 and its official operation stared in early
2004. R&D in Sharp is organized into two tiers: central R&D at the headquarters in Japan and R&D centres under each business unit. The Shanghai Centre belongs to the Sharp electronics business group and is registered as an independent company: Shanghai Sharp Electronics Co. Ltd.

The chief task of the Centre is to develop air-conditioners. Sharp established an air-conditioner plant through a joint venture in Shanghai in 1992, one of Sharp’s earliest investments and still among its most important ventures in China. At present, Sharp’s global air-conditioner manufacturing activities are concentrated in three countries: Thailand, China and Japan, with the Japanese plant serving the Japanese home market, the Chinese plant serving the Chinese market and the Thailand plant serving other markets beyond China and Japan. Before the establishment of the Centre, air-conditioners manufactured in China were designed at the electronics business group in Japan. The Shanghai R&D Centre will focus on the Chinese market first. It also plans to design air-conditioners for the Thailand plant. In addition, the Shanghai R&D Centre will design air-conditioners for other companies such as GE through Original Equipment Manufacturing (OEM). In the end, the Centre intends to become Sharp’s air-conditioner R&D centre and will provide designs for the Japanese market as well. The Centre plans to expand in the near future, aiming to introduce R&D in washing-machines as well. One of the reasons that the Centre was registered under the umbrella of a wholly Sharp-owned company instead of as part of the air-conditioner joint venture at Shanghai is that it plans to develop products for its plants in Thailand and Japan as well, although the Centre is on the same site as the joint venture in Shanghai. With 100% Sharp ownership, the Centre enjoys much more freedom and avoids potential problems related to intellectual property rights and technology transfer to other plants. Within a year from its inception, the Centre has 34 employees, 30 of them engineers. The majority of the employees are hired in China, and only six of them come from Japan.

Sharp chose to locate in Shanghai because of the concentration of its manufacturing facilities in Shanghai and the surrounding areas. Such ventures include Shanghai Sharp Co. Ltd (Air-Conditioning, Refrigerators, and Washing-machines), Shanghai Sharp Advanced Industrial Control Systems Co. Ltd. (Mould), Wu Xi Sharp Co. Ltd. (LCDs), Changshou Sharp Co. Ltd (Copy Machines), and Nanjing Sharp Co. Ltd (TVs). The manager emphasized that “Sharp has a principle: R&D centres should be
close to the manufacturing facility. Why? You will not be able to design good products if you do not have good knowledge of the products.” In addition, the availability and attraction of high quality labour in Shanghai is another major consideration. As the manager told us:

From our recruiting experience, we found that high-quality college students are willing to work in Shanghai. We have been hiring since last January and 80% of our candidates like to work in Shanghai. Among the 16 college student we hired this year, only four came from Shanghai and the others came from other places.

Corporate Research Centre

Corporate research centres are the most advanced facilities in the MNCs’ global R&D network. Such R&D establishments are strategic, and they perform R&D for the MNCs’ global market in the long-term. Examples include laboratories set up by Intel, Microsoft, Lucent/Bell Labs, IBM and others. In the accounts of R&D in MNCs in China, such facilities have been identified in Beijing, where many of China’s top universities and government research institutes are concentrated. However, no existing studies have documented the existence of such establishments in Shanghai. We find that such facilities do exist there and examples include the GE China Research and Development Centre, the Alcatel Research and Innovation Centre, and Unilever Research China.

Unilever Research China was established in 2002. The centre originated from a joint laboratory shared between Unilever and the Shanghai Organic Chemistry Institute in 1996, but now the centre is 100% owned by Unilever. Originally, the joint laboratory primarily worked on organic chemical materials, with Unilever providing the funding and projects and the Shanghai Organic Chemistry Institute providing space and labour. Its primary purpose was to develop new products for the Chinese market and to provide technical support for Unilever’s marketing activities in China. Meanwhile, Unilever had some small development facilities at their joint ventures in China. Later, Unilever decided to consolidate the dispersed R&D in order to improve efficiency and it established two major R&D facilities in Shanghai: Unilever Shanghai R&D Centre and Unilever Research China. The two establishments have different missions. The Unilever Shanghai R&D Centre focuses on product development, and belongs to the lowest level of Unilever’s global R&D. It is associated with local manufacturing and concentrates on local markets. Its major tasks are
to customize Unilever products for local markets and provide technical support for local manufacturing. Unilever has numerous facilities of this kind around the world.

In comparison, Unilever Research China is a different facility and is separate from the Shanghai R&D Centre. The Centre belongs to the highest level of Unilever’s global innovation network and is the youngest of its six global research centres. (The other five are located in the UK, the Netherlands, the US, and India.) The research focus of the China centre is on chemical and new materials, especially on natural ingredients, and on Chinese herbal medicine in particular. Now the Centre has about 75 employees.

The next level of Unilever’s global R&D network is its Global Technology Centres (GTCs), which are between Global Research Centres and Product Development Centres. The major responsibilities of such GTCs are to develop new recipes for Unilever’s global market based on research from Unilever global research centres and market demands. Unilever has a number of such technology centres in each major product area. Usually each product category has one to three such global technology centres around the world. Recipes developed by the GTCs are customized by the local R&D centres for the different markets. Clearly, the research centre has a strategic position in Unilever’s global R&D network (Figure 1)

Unilever chose to locate its research centre in Shanghai for several reasons. The manager told us that

Unilever was already in Shanghai in the 1930s and it liked Shanghai. It is the most developed commercial centre in China; it leads China’s consumption fashion; it has a relatively business-friendly environment; finally, it has a large pool of high-quality labour. That’s why our R&D chose to locate in Shanghai. Shanghai and Beijing are the only two locations where people are conducting high-quality research: they have the highest concentration of high-quality labour and universities. They also have research traditions. Finally, our headquarters are here and many facilities could be shared with our R&D facilities. I feel that there is not much difference between Shanghai and developed countries regarding labour quality and facilities. Here services are convenient and even better and the pace of life is quicker than in developed countries.

Conclusion and Discussion

The main purpose of this study is to understand the extent and scope of
Figure 1. Unilever’s Global R&D Networks

<table>
<thead>
<tr>
<th>Category</th>
<th>Global R&amp;D / Technology Centre</th>
<th>Global Research Lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spreads and Cooking</td>
<td>Unilever Bestfoods Nederland (The Netherlands)</td>
<td>Vlaardingen (The Netherlands)</td>
</tr>
<tr>
<td>Products</td>
<td>Unilever R&amp;D Vlaardingen (The Netherlands)</td>
<td></td>
</tr>
<tr>
<td>Savoury</td>
<td>Unilever R&amp;D Colworth (UK)</td>
<td>Port Sunlight (UK)</td>
</tr>
<tr>
<td>Dressings</td>
<td>Unilever Bestfoods Crawley (UK)</td>
<td></td>
</tr>
<tr>
<td>Beverages</td>
<td>Birds Eye Wall’s Ltd Gloucester (UK)</td>
<td></td>
</tr>
<tr>
<td>Health and Wellness</td>
<td>Unilever UK Technology Centre</td>
<td>Colworth House (UK)</td>
</tr>
<tr>
<td>Ice Cream</td>
<td>Unilever Bestfoods North America Englewood Cliffs (US)</td>
<td>Edgewater, New Jersey (US)</td>
</tr>
<tr>
<td>Frozen Foods</td>
<td>Hindustan Lever Research Centre Bangalore (India)</td>
<td></td>
</tr>
<tr>
<td>Foodservice</td>
<td>Unilever Germany Technology Centre</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unilever Bestfoods Heibronn (Germany)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unilever Italy Technology Centre</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shanghai (China)</td>
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</tbody>
</table>
foreign R&D in Shanghai, China. It demonstrates clearly that there is a large concentration of foreign R&D there. Both tactical and strategic foreign R&D can be found, though the majority of it focuses on providing customer services and developing and customizing products for the Chinese market, rather than research per se. However, strategic R&D does exist, as in the case of Beijing. Certain R&D centres are developing products for the global market, in addition to developing products for China’s local markets, while others are engaged in original long-term research. In comparison to foreign R&D in Beijing, where it is also concentrated, foreign R&D in Shanghai is more diversified regarding its industrial distribution, and covers sectors from ICT, electronics, chemicals, and bio-techs, to materials and others, although the majority is still in the field of ICT. Such a characteristic is clearly related to the concentration of diverse manufacturing and foreign investment in Shanghai and the surrounding areas.

It is clear that the time when foreign R&D was in China “just for show” is over. Factors such as the growing market in China, the abundance of low-cost and high-quality labour and preferential policies are all important. Particularly important is the fast-growing Chinese market. Some foreign R&D is developing products directly to serve Chinese customers, some are providing services to Chinese manufacturers which lack R&D capabilities, while others follow their customers who have moved to China. Without the growing market in China, impacts of other factors will not be strong enough to attract foreign R&D there.

On the question of choosing Shanghai as an R&D site, our study confirms that the process of deciding on location is quite rational and both internal/organization and external/environmental considerations are important. Regarding internal considerations, MNCs set up R&D in Shanghai because many of them have large manufacturing investments in Shanghai and the surrounding areas. For others, this area is where their customers are concentrated. Many of them have set up their local/regional headquarters in Shanghai as well. Considering that the majority of foreign R&D in China is adaptive, developmental and tactical in nature, linkages with manufacturing and customers are more critical than interactions with regional/local headquarters. The former type of relationship focuses on technical issues and is information-intensive. In comparison, interactions with headquarters are more administrative in nature, where the head offices provide accounting, legal, logistics and other types of services which are less important.
Particularly important is the visibility of Shanghai in the national and international economic landscape and its image of openness, both of which are extremely attractive to high-quality labour across China, and even from overseas. The concentration of foreign investment in Shanghai and the nearby Yangtze River Delta and its central location on the east coast further strengthen Shanghai’s competitiveness in attracting foreign R&D. Again, governmental policies and pressures are not major considerations, although the relatively business-friendly government is a consideration among many companies.

In China, Shanghai’s only major competitor is Beijing, which has attracted a larger share of foreign R&D than Shanghai. The major reason is that the majority of foreign R&D facilities in China are in the IT industry, and Beijing still has the largest concentration of well-known IT enterprises. In addition, Beijing’s concentration of China’s best universities, government laboratories and government agencies cannot be challenged by any other Chinese cities. However, Shanghai’s attraction to foreign R&D could be strengthened in the long term due to its attractiveness to foreign investment in general and its more diversified industrial structure.

Notes

3. A recent survey by the Economic Intelligence Unit revealed that China has become MNC executives’ number one choice for future R&D spending, followed by the United States and India. See Economic Intelligence Unit, Scattering the Seeds of Invention: The Globalization of Research and Development (Hong Kong: Economic Intelligence Unit, 2004), p. 9; other studies include: Prasada Reddy, “New Trends in Globalization of Corporate


6. See Sun (Note 3).

7. See von Zedtwitz (Note 4) and Xue et al. (Note 5).

8. See Gassmann and Han (Note 5).

9. See Lars Hakanson, “International Decentralization of R&D — the Organizational Challenges,” in Bartlett et al. (eds.) (Note 2).

10. See Bartlett and Ghoshal (Note 2).

11. See Ronstadt (Note 2) and Kuemmerle (Note 2) and Sun (Note 3).


14. See Kuemmerle (Note 2) and Reddy (Note 3).
19. See Cantwell and Piscitello (Note 4).
20. See Malecki (Note 18), Florida and Kenney (Note 12), Mariani (Note 4) and Cantwell and Piscitello (Note 4).
21. See Appold (Note 4).
23. See Great Wall Enterprise Institute (Note 5).
24. See Walsh (Note 22).
25. See von Zedtwitz (Note 3) and Great Wall Enterprise Institute (Note 5).
26. The other three business groups in HP are the Personal Systems Group, focusing on personal computer-related products; the Imaging and Printing Group, focusing on printers and image-related products; and the Enterprise Systems Group, focusing on providing services to large enterprises.
27. The Institute has been renamed the “Shanghai Institute of Microsystem and Information Technology.”
28. See Sun (Note 3).