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Abstract

Current research on multinational R&D assumes that main R&D is based at home country and views overseas R&D as additional to the home base. However, case studies in China have found that the base itself is also internationalized. Besides home-based-augmenting, home-based-exploiting, and home-based-replacing discussed in the literature, we have identified new types of host-based overseas R&D. Two of these are the host-based technology advancer, which focuses on original component innovation, and the host-based system owner, which focuses on system innovation. Both respond to local market opportunities. In addition, multinationals establish host-based local integrators to coordinate their R&D centers under different firm divisions. These findings suggest four topics for future research.

Keywords: multinational R&D; home-based; host-based technology advancer; host-based system owner; host-based local integrator; China

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1 Introduction

Since the 1980s Research and Development (R&D) Foreign Direct Investment (FDI) has been growing remarkably (Cantwell 1995; Patel & Pavitt 2000; UNCTAD 2005), and more importantly, overseas R&D is playing an increasingly important role in the R&D networks of multinationals (Almeida & Phene 2004; Florida 1997; Granstrand, Hakanson & Sjolander 1993). The early linear model of multinationals, in which knowledge is created at the headquarters at home and subsequently transferred to and applied in overseas subsidiaries, has been replaced by a new model, in which knowledge is created in all parts of the firm, and the competitiveness of the firm relies on its ability to integrate knowledge from all over the world (Almeida & Phene 2004; Bartlett & Ghoshal 1989; Gupta & Govindarajan 2000; Hedlund 1994; Nobel & Birkinshaw 1998). One highly recognized theoretical contribution is Knemmerles (1997) classification of overseas R&D: home-based-exploiting vs. home-based-augmenting.

Many other scholars following the offshore manufacturing tradition have found that overseas R&D in developing countries is primarily driven by low-cost human resources, and they view overseas R&D in developing countries as an expansion of offshore manufacturing. For this type of R&D, Lewin, Massini & Peeters (2009) proposed a new term: home-based-replacing R&D.

All these studies assume the existence of a home base, and overseas R&D is an extension of the home base. However, our case studies on multinational R&D in China identified three new types of host-country-based R&D, showing that R&D has been more entrenched throughout the world than current literature acknowledges. Furthermore, the multinational R&D network has evolved from a single- into a multiple-based network with internationalized bases.

China and India has always been in the center of research on multinational R&D in developing countries given their share of incoming R&D FDI (OECD 2008; UNCTAD 2005). Understandably, their remarkable emerging markets drive home-based-exploiting R&D and their low-cost and capable personnel supply attracts home-based-replacing R&D. However, our findings in China reveal the importance of market-pull innovation, that is, the market potential and new demand drive original innovation, which may change the whole landscape of multinational R&D network.

2 Home-Based Overseas R&D: A Literature Review

Pavit & Pattel (1999) once stated that unlike manufacturing and other activities, innovation would not be globalized. Their argument is based on the importance of tacit knowledge, which is “sticky” to locations. They found that the competitiveness of multinationals is largely determined by the strength of the technology in their home countries. Their argument is also consistent with earlier findings that overseas R&D is basically about adapting existing technologies from the home country to better serve the local market and the manufacturing sectors (Mansfield, Teece & Romeo 1979; Ronstadt 1977; Teece 1976). These authors share a common view about multinationals: that knowledge is created in the home base, diffused, and applied in overseas subsidiaries (Buckley &
Since the 1980s, however, the world has witnessed a significant growth of R&D FDI. First, within the triad, that is, the United States, Europe, and Japan (Archibugi & Iammarino 2002; Cantwell 1995; Patel & Pavitt 2000), and subsequently expanding to developing countries (OECD 2008; UNCTAD 2005). More importantly, overseas R&D plays a much more important role in knowledge creation (Florida 1997; Granstrand et al. 1993; Hakanson & Nobel 1993a; b; Kuemmerle 1997). Kuemmerle (1997) provided an important dualistic classification for multinational R&D: home-base-augmenting (HBA) and home-base-exploiting (HBE). HBA aims to take advantage of scientific knowledge and infrastructures available in the host country to augment the knowledge base at home; and HBE uses existing knowledge within the firm (typically developed within the home country) to support special local demand. Different types of R&D are also driven by different location-specific advantages: HBA is located in places with advanced innovation and technology resources and HBE in places with already a substantial investment in marketing or manufacturing from the firm (Kuemmerle 1997; 1999; Le Bas & Sierra 2002). The old one-directional headquarters-subsidiaries model of multinationals was replaced by a new model, a multiple directional network model, in which knowledge is created from all over the world and integrated into the network of the corporation (Almeida & Phene 2004; Bartlett & Ghoshal 1989; Gupta & Govindarajan 2000; Hedlund 1994; Nobel & Birkinshaw 1998).

The early wave of R&D globalization occurred primarily within the triad nations of the United States, Europe, and Japan (Archibugi & Iammarino 2002; Cantwell 1995; Patel & Pavitt 2000). Thus, developed theories largely reflect the reality within the triad. As the wave expanded to the developing world, scholars noticed some different dynamics in developing countries, such as the supply of low-cost personnel, which is particularly important to overseas R&D. Many researchers followed the tradition of previous multinational R&D studies and contributed a considerable amount of new wisdom (Gassmann & Han 2004; Lu & Liu 2004; von Zedtwitz 2004; Xue & Liang 2008). Many others, who adopted a different perspective to understand overseas R&D in developing countries, had few connections with previous multinational R&D studies, but adopted the offshore manufacturing perspective. In their studies, “R&D outsourcing,” or “Offshore R&D,” is commonly used rather than “multinational R&D” or “overseas R&D” used in previous multinational R&D literature. They view overseas R&D in developing countries as an expansion of offshore manufacturing and build their intellectual enterprise upon theoretical foundations such as “modularity” and “outsourcing” (Engardio & Einhorn 2005; Ernst 2005; Ernst & Kim 2002; Lewin et al. 2009). Overseas R&D in developing countries is viewed as primarily cost-reduction driven and aims to take advantage of local human resources to serve the home country and the global market (Chen 2004; Kumar & Aggarwal 2005; Lewin et al. 2009). In addition, this type of R&D is relatively routinized and peripheral. In addition to Kuemmerles HBA and HBE, Lewin et al. (2009) proposed a new term, “home-based-replacing,” for this type of overseas R&D.

Studies have attempted to synthesize these two streams of research, to provide a more complete framework applicable to both developed and developing worlds. For instance, Murtha, Lenway & Hart (2001) provided the following classification: efficiency-seeking, market-seeking, and knowledge-seeking, and they are actually corresponding
to HBR, HBA, and HBE respectively. In addition, many offshore R&D scholars are clearly aware of the challenge of applying current offshore manufacturing paradigms to the globalization of R&D, for example, cost-reduction or human resource-driven motivations do not sufficiently explain the establishment of R&D in developing countries (Kenney, Massini & Murtha 2009). Although from a different perspective, they agree that the purpose of R&D globalization is to take advantage of global resources and to create new platforms for knowledge creation and innovation, including those in developing countries (Kenney et al. 2009).

Therefore, both streams agree that the competitiveness of multinationals depends on their capability to absorb resources from different sites and integrate knowledge from these locations (Almeida & Phene 2004; Hakanson & Nobel 1993a; Kogut & Zander 1992; 1996). According to core competence literature, knowledge integration is recognized as the core competence of a firm, so it should remain at home (Baldwin & Clark 2000; Ernst 2005; Prahalad & Hamel 1990). Therefore, not surprisingly, all HBA, HBE, and HBR assume the existence of a home base. Overseas R&D centers are viewed as extensions of home bases and primarily connected to them, but not to one another. However, our study of multinational R&D in China reveals that R&D globalization may have become more entrenched than scholars have acknowledged. That is, a new multinational R&D network in which multinationals have built new bases in foreign sites and that the core competence has also been globalized has been emerging.

In addition to the three types of home-based R&D discussed in the literature, we found three types of host-country-based R&D in China. The host-based technology advancer (HsBTA) is devoted to creating new technologies principally responding to local demand rather than seeking existing local technological knowledge; the host-based system owner (HsBSO) has ownership of new systems and integrates knowledge from other centers to develop new products for local markets; and the host-based local integrator (HsBLI) coordinates all R&D efforts within the host country to establish a well-connected and complete R&D infrastructure in China.

3 Component-System Innovation

While finding it difficult to classify R&D centers in China into HBA, HBE, or HBR, (in Table 1), we found the component-system innovation framework very helpful to our understanding of the underlying R&D organization structure in multinationals. This framework can be traced back to the work of Henderson and Clark (1990), who, unsatisfied with the radical-incremental innovation classification, added one more dimension to this classification: modular-architectural. In their typology, “radical” and “incremental” refer to the extent of technological change: whether existing technology is reinforced or overturned. “Modular” and “architectural” refer to the content: modular innovation is about changing the component of a product, and architectural innovation changes the ways that components are integrated into the system.

Component-system innovation classification fits well in the real world. As discussed by Nelson & Rosenberg (1993), product innovation in many industries, in particular the electronics and IT sectors, is characterized by a “combination of improvements in
components, and modifications in overall system design to take advantage of or drive these punctuated from time to time by the introduction of a significantly new system” (pp.14). However, some other sectors, such as chemicals and pharmaceuticals, do not produce products with complex systems, and product innovation is discrete without incremental improvement. However, their process innovation may be similar to system-product innovation.

Thus, the component-system framework should facilitate the investigations of R&D in multinationals: central laboratories focus on developing “cutting-edge” component technologies that may be applied to many different products, and R&D in business units focuses on system innovation that incorporates different technologies into a new product. In this paper, the former is the technology advancer and the latter is the system owner.

4 Method and Data

This study used the case study method introduced by Eisenhardt (1989) and Yin (1994). We gathered data from 31 R&D centers from 24 multinationals in six Chinese cities, Beijing, Shanghai, Nanjing, Suzhou, Guangzhou, and Shenzhen, which represent the three richest regions in the Chinese mainland. We collected data from three major sources: archives, interviews, and questionnaires. We first collected public information from the internet and then designed a unique interview protocol for each interviewee. Interviews were conducted from December 2007 to May 2008. For the last 25 interviews, we had questionnaires following each interview.

Our cases cover primarily four sectors: biotechnology, chemical, information and communication technology, and industrial; three origins: Europe, United States, and Japan; and three different positions in the global company: in corporate central laboratories independent to business units, within a business unit, and within a factory. Three centers were established between 1990 and 1994, four centers between 1995 and 1999, fifteen centers between 2000 and 2004, and nine centers after 2005.

Among these 31 centers, we found 20 centers with R&D activities similar (or partially similar) to HBA, 8 similar to HBE, and 8 similar to HBR. However, we had great difficulty classifying these centers into HBA, HBE or HBR for several reasons: (1) Several centers have multiple units in different divisions and undertake different activities (e.g., Cases 2, 23, and 27 have both HBA and HBE); (2) many centers conduct both HBA and HBE, so we classified them according to their major missions; (3) two centers were tagged as HBA/HBR because they utilized local human resources to do fundamental research serving their home country; that is, they were not exactly HBA because projects were led by their headquarters, but they were not exactly HBR either because their research seemed to be very high end; (4) most HBAs did not have the autonomy depicted by Kuemmerle (1997, 1999); and (5) most HBAs seemed to be driven by local market demand.
<table>
<thead>
<tr>
<th>Sector</th>
<th>Origin</th>
<th>Year</th>
<th>Type*</th>
<th>HBA HBE or HBR?</th>
<th>Serving local market?</th>
<th>Host-based ID</th>
<th>Case ID</th>
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<td>HsBSO</td>
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<td>Corporate</td>
<td>HBA</td>
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<td>Factory</td>
<td>HBE</td>
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<td>HBR</td>
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<td>BU</td>
<td>HBE</td>
<td>Y</td>
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<td>18</td>
</tr>
</tbody>
</table>

* “Corporate” refers to R&D center under corporate central laboratories; “BU” refers to independent R&D center under business unit; “Factory” refers to R&D department within factory; “Other” is center contains more than one type.
5 Host-Based Technology Advancer

The host-based technology advancer (HsBTA) is specialized in component innovation. Its task is similar to that of HBA: specialized in certain fields serving as the center of excellence within the firm and exploring new technologies for long-term competitiveness. Technologies developed here are also transferred to and applied in other parts of the firm. However, HsBTA and HBA differ in one main aspect: an HBA is mainly doing technology-push innovation, but an HsBTA is doing market-pull innovation. That is, HBAs are located in technology-leading countries to take advantage of the local knowledge base, but HsBTAs are located in markets with critical technological demand and respond to such demand to capture market opportunities. Although its primary goal is to serve local demand and secure success in the local market, technologies developed here are typically also valuable to other markets.

One R&D center in China specialized in speech and pattern recognition technology is ALPHA CHINA. When it was established, many other firms were also working in these fields in China, but they were simply adapting mature technology from the home country to support the Chinese language. Although ALPHA had already done many projects in these fields in other locations, ALPHA CHINA was not satisfied with the existing technologies, so it began to develop its own technologies. One of the technologies is the handwriting recognition technology, which initially supported both Chinese and English, and latter supported Japanese, Korean, Thai, Arabic, and other languages. Its speech recognition technology today can support about 15 different languages. ALPHA CHINA develops all the speech and handwriting recognition technologies used in all the corporate products.

In addition, R&D in ALPHA CHINA emphasizes future market needs, so it stays far ahead of current market demand. Several years ago, it recognized the market potential of image-understanding technology in personal electronic devices and initiated related projects. Nevertheless, this technology was viewed by business units as useless at that time because both the hardware and software environments were incapable of supporting such a demanding function. After three years, however, the hardware and software capacity has improved markedly, and ALPHA CHINA has developed a mature technology ready for use. Eventually, it has begun to use this technology, which has become a strong selling point, in its final products.

Similar to ALPHA CHINA, another center in China working on radio frequency identification (RFID) technologies based on natural language and ontology is BETA CHINA. The vastness and density of information processing and communication in China have led to a number of challenges for telecommunication technologies. Again, market demand has driven BETA R&D. For example, the BETA CHINA president is very satisfied with Chinese researchers except for one thing, that is, “they are too devoted to technology itself, but lack of the sense of innovating for the market, lack of the ability to view themselves as users and identify what special demand they have.”

Clearly, the motivation for conducting this type of R&D in China is not that China

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1 All firm names used in this paper are pseudonyms, in order to preserve their anonymity and protect informant confidentiality.
has already become a technology leader in these fields and provides state-of-the-art knowledge available for multinationals to absorb, but that the Chinese market has considerable critical demand and provides great market potential for innovation. R&D in response to local critical demand is not only important for defensively ensuring success in Chinese market, but also beneficial to aggressively opening up new global markets. R&D at both ALPHA CHINA and BETA CHINA has focused on topics that specifically relate to the needs of the Chinese market. For example, technology handwriting input is popular in China because of the complexity of the Chinese characters. Therefore, market-pull vs. technology-push distinguishes HsBTAs from HBAs. HsBTAs are driven by the market, which raises the following question: Why do multinationals set up HsBTAs rather than HBEs? One reason is that all these firms consider the fast-growing Chinese market tremendously promising and strategically important. More importantly, as many interviewees expressed, simply adapting existing technology from the home country is no longer sufficient to meet local demand or secure success in the Chinese market, which calls for original R&D rather than adaptive R&D. Another reason multinationals set up HsBTAs is, as many also pointed out, that technological development in in China is progressing very rapidly and remarkably in response to strong market demand, so China has the potential to become a technology leader. Therefore, multinationals locate not only HBEs but also HsBTAs in China.

6 Host-Based System Owner

In ICT and industrial sectors, a host-based system owner (HsBSO) is the system innovator and project owner. It identifies market demand, defines the products/services, designs the system/architecture, and integrates a variety of components into final products/services. In the biotech sectors, an HsBSO is the integrator, combining a variety of disciplines (e.g., chemistry, molecular biology, cell biology, physiology, and laboratory technology) to develop effective treatments for diseases. It owns the entire process from target identification, hit identification, lead identification and optimization, to clinical trials, each of which may involve support from the other centers. Although the chemical sector is similar, the process is slightly different. It can be simplified as followers: Define the desired new features, discover the materials, and design the final product to take advantage of the discovered materials. In the ICT and industrial sectors, the component is a technology module; in the biotech and chemicals sectors, the component is a certain discipline or a certain step in the process. For all sectors, system innovation is not simply the task of assembling, but it is a sophisticated process requiring significant effort.

Conducting new product development in developing countries is not a new phenomenon. However, most of the observations in the literature included a very narrow form of product development whereby in the early stages, including market demand analysis, product definition, architecture design, the headquarters retained all the control; in the later stages, overseas R&D centers received specific instructions from the headquarters and conducted relatively routinized development or design; and during both stages, the headquarters retained ownership of the system and controlled all of the project management at the macro level. We found many R&D centers of this kind in China. As
our interviews found, these mentioned activities controlled by the headquarters are internationalized very late. Many interviewees expressed a desire for system ownership, suggesting its strategic importance. According to the description of core competence in strategic management literature (Barney 1991; Hoopes, Madsen & Walker 2003; Peteraf 1993; Prahalad & Hamel 1990), scholars also agree that system ownership is crucial to the competitiveness of a firm, and therefore, it should remain in-house. However, it is now offshored and internationalized. HsBSOs maintain system ownership, identifying market demand and technological opportunities to create new business opportunities, gathering knowledge produced in all the divisions of a firm, and managing the uncertainties from both the market and technology sides. Therefore, the establishment of HsBSOs indicates a new stage of R&D globalization, in which not only original component innovation (HBA), adaptive R&D (HBE), and the labor-exploiting R&D (HBR) internationalized, but also system ownership (HsBOS) moves abroad.

Another R&D center in China in the healthcare equipment sector, GAMMA CHINA, has ownership of low-end products. Low-end product does not indicate low-intensity technology, but instead its development may require even higher creativity because it requires more efficient systems and components to fulfill the same functions. One of its ongoing projects is the nuclear magnetic resonance (NMR) system, a sophisticated, costly system. To significantly reduce the cost of the NMR, GAMMA CHINA plans to design a new system and develop new component technologies. To achieve this goal, it cannot simply modify the existing system, but instead, it must make great technological breakthroughs at both the system and component levels. GAMMA CHINA owns the system, but it does not develop all its components. Taking its CT apparatus as an example, it has expertise in the power system and the detector for the CT apparatus, but for many other components, such as X-ray generators, it must depend on technologies developed by R&D centers in other countries. At the system level, it shares all knowledge with the high-end product system owner.

DELTA CHINA develops new drugs for liver and stomach cancer, which is much more common in East Asia than in the United States and Europe. Because of the physiological differences between East Asians and Caucasians, the same drug may have different effects. Therefore, R&D at DELTA CHINA conducts pathology research, beginning with identifying biological targets and further searching for chemicals that can effectively influence the targets, but not merely clinical trials to test existing drugs.

Because of the advantages of HsBSOs, firms may find HBEs insufficient if it wishes to succeed in local markets and overall international competitiveness. After all, success in local markets demands original R&D, system innovation, and product development. Furthermore, critical market demand creates new business opportunities for a firm. As emphasized in this paper, both HsBTAs and HsBSOs are primarily driven by local market demand. However, the “local market” must be broadly defined as a market centered at, but not limited to, a particular country that has the most critical and greater demand that prompts new technology breakthroughs. In addition, because a local market has a considerable share of the sales of one specific product, this market should more strongly influence the development of new products for the purposes of efficiency. GAMMA CHINA views China as the center of low-end health equipment market, and 30% of its CT apparatuses are sold in China while 70% are sold in other markets. Products
developed in China primarily for low-end consumers are popular and profitable not only in Chinese market and other developing countries, but also in relatively less developed rural areas in the United States. The targeted drugs researched at DELTA CHINA will not only serve the patients in China, but also people suffering these diseases in other countries, particularly in other Asian countries, whose people are physiologically similar.

7 Host-Based Local Integrator

Lawrence & Lorsch (1967) defined the central task of organizing as differentiating (segmenting an organization into distinct specialized subsystems) and integrating (“achieving unity of efforts among the various subsystems in the accomplishment of the organizations task” (pp.4)). As discussed before, overseas R&D seeks various local advantages, and the competitiveness of a firm relies on its ability to absorb external knowledge and integrate internal knowledge created worldwide. Therefore, one central task of the firm, historically performed at the home base, is to control and coordinate R&D in multiple sites. That is, all overseas R&D centers are primarily connected with the home base but not with one another. However, we found several multinationals that have started to build local R&D headquarters to integrate their previously unconnected R&D centers in China.

Many multinationals have set up several and some have established many R&D centers in different cities in China. These centers are under different central laboratory branches or business unit divisions. These centers get budgets from and report to different head offices in the home country, and important decisions, such as those pertaining to finances, operations, and personnel promotion are determined by different head offices. That is, management has a vertical, not a matrix structure. Centers are connected with their head offices, not with one another. Centers in China may share the same building and administration services, but they may have no substantial connection to R&D activities. However, several firms have begun to build a matrix management structure, in which they are integrating their R&D efforts under different divisions to establish a complete R&D infrastructure and a well-connected network that may efficiently responds to local market opportunities. We refer to this type of center, which serves as a local R&D headquarters, as host-based local integrator (HsBLI). The HsBLI, however, focuses its efforts on management, not real technological R&D.

EPSILON, with several R&D centers located in different cities in China, has established a complete R&D system covering all stages of the life circle of R&D. These centers are under different firm divisions. However, EPSILON set up EPSILON CHINA and established a matrix management structure. Different R&D centers in China not only report to their corresponding head offices in the home country, but also to EPSILON CHINA. They receive budgets from different headquarters in the home country, but EPSILON CHINA coordinates the allocation of funds. EPSILON CHINA also has its own budget to initiate projects and typically encourages collaboration among different R&D centers. In particular, EPSILON CHINA has an internal venture funds program, to which every employee in China can submit a project proposal. Then, EPSILON CHINA selects and funds annually a certain number of projects, which are typically cross-divisional.
Because of its R&D structure, largely team-based, EPSILON facilitates cross-divisional collaboration and dynamic local networking.

ALPHA also set up ALPHA CHINA II as its nominal China headquarters for its approximately 20 centers in China (the number has been rounded to preserve anonymity). Although it has much less power than EPSILON CHINA, and the management structure is still principally vertical, it has begun to invest a considerable amount of money to facilitate local collaboration among its centers. For example, it organizes many conferences and meetings every year to create opportunities for collaboration and networking, which, as expressed by one interviewee, ALPHA has never done in other countries before. GAMMA CHINA has also gained more power to initiate and coordinate cross-divisional projects, so it has been conducting more local projects that have become higher priority.

As mentioned before, HsBLI does not focus on technological R&D, but instead on management supporting and governing R&D. Prahalad & Hamel (1990) clearly stated that R&D itself is not a “core competence,” but collective learning and coordination are. This notion is well accepted and reflected in the strategic management literature (Almeida & Phene 2004; Bartlett & Ghoshal 1989; Gupta & Govindarajan 2000; Hedlund 1994; Nobel & Birkinshaw 1998). Furthermore, although scholars have recognized the limitations of R&D as an indicator for innovation, this limitation has become increasingly problematic (OECD 2007). Although studies pertaining to the innovation globalization focusing on only R&D have proven helpful and fruitful to related research, more comprehensive studies might examine the globalization of innovation in which R&D is only one component. Thus, we include HsBLI in our discussion.

8 Discussion and Conclusion

In addition to HBAs, HBEs, and HBRs discussed in the literature, we have identified new forms of host-country-based overseas R&D in China. This study shows that R&D globalization has progressed farther than home-based overseas R&D and the multinational R&D network is evolving from a single-based to multiple-based network. Multinationals no longer simply extend their antennas to other countries to absorb leading technologies (HBA), exploit human resources (HBR), and transfer knowledge to serve local needs (HBE) while maintaining their bases in the home country; they have begun to build new bases in foreign countries: conducting component (HsBTA) and system innovation (HsBSO) to respond to local market opportunities, and networking and integrating local R&D efforts to establish a well-connected dynamic local R&D network (HsBLI).

Given the “theoretical sampling” strategy (Eisenhardt 1989) implemented in our study and the limited sample size we have, we are not able to infer any solid, generalizable conclusions about how overseas R&D varies across sectors, origins, and so forth. This is one important limitation of this study. Nevertheless, it is very impressive that we found seven host-country-based R&D centers out of our 31 samples.

This deeper wave of R&D globalization also has several implications for future research. First, we need more detailed classifications for knowledge-augmenting R&D. The HBA-HBE framework has provided considerable insight into the study of overseas R&D. Since knowledge-augmenting R&D has already been recognized as much more
important for both the competitiveness of a firm in practice and multinational R&D studies in academia, we need a more detailed classification of knowledge-augmenting R&D to guide further investigation. The HBR represents a different form of knowledge-augmenting R&D primarily in developing countries. Our findings suggest the need to distinguish between technology-push knowledge-augmenting R&D (HBA) and market-pull knowledge-augmenting R&D (HsBTA), and to draw from the wisdom of general innovation studies. This paper, for instance, distinguishes between component (HsBTA) and system innovation (HsBSO), which have very different tasks and dynamics.

Another direction for future research could be the reevaluation of the role of the market in multinational R&D. Previous home-based overseas R&D literature implicitly assumes a technology-push linear model of innovation and views the market as passive demand waiting for adaptive R&D (Kuemmerle 1997; 1999; Le Bas & Sierra 2002). However, our findings suggest that market demand is also important for original R&D, and this observation is definitely not novel, at least not in the general innovation study literature. Market-pull model emphasizes the importance of market demand in driving not only incremental but also radical innovation (Rosenberg 1969; Schmookler 1966; Sherwin & Isenson 1967). The literature pertaining to the “lead user” (Franke & Shah 2003; Luthje, Herstatt & von Hippel 2005; von Hippel 1988; von Hippel 1994) of new product development highlights the role of users as important sources for innovation. This literature may shed light on further studies on multinational R&D. As argued in our HsBTA and HsBSO examples, their primarily driver is market, and what makes China so special is its market. The vast, heterogeneous, and demanding market calls for original innovation in both technology components and system architectures, and such original innovation is not only important for success in Chinese market, but also profitable and competitive in other markets.

A further suggestion for future study is to expand our attention from technological R&D to broader innovation issues. According to strategic management scholars, technological R&D itself is not “core competence.” In addition, scholars devoted to innovation measurements and indicators also claim that R&D is too narrow of an indicator of innovation. Thus, new contributions to the understanding of innovation globalization may have to embrace innovation that covers a much wider scope.

This study might also provide some insight into the potential impact of R&D globalization on developing countries. Multinational R&D may help developing countries directly tap into the global knowledge network (Chang, Shih & Wei 2008; Ernst & Kim 2002; Padilla-Perez 2008). However, multinationals locate their operations in places with existing local advantages (Lall 2001); therefore, developing countries may not be able to attract high-level R&D. Athreye and Cantwell (2007) found that multinational R&D tends to enlarge technology gaps between countries rather than lead to technology convergence. However, findings of this paper imply another promising scenario for developing countries (at least for large ones): their markets may attract high-end R&D and help local technological advances.
References


