Can MNC R&D labs be an efficient channel of technology transfer to developing countries? – Evidence from MNC R&D labs in Beijing

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Abstract:

Governments in many developing countries are enthusiastically attracting MNC R&D labs with the hope to have technology transferred to local innovation system. However, my empirical study in China shows that technology transfer will not happen naturally. As hiring talented students is the major goal of MNC R&D labs, interactions with local innovation actors are limited. Furthermore, technological learning from exogenous forces will not bring key technologies to the local innovation system. It is thus important for developing countries to build up indigenous innovation capability to narrow their technology gaps with developed countries.

Keywords:
Technology transfer, Innovation and R&D, MNC-Host Country Relations, China
INTRODUCTION

Exogenous forces such as multinational corporations (MNCs) can participate into local innovation systems through interacting with private and public sectors in the region. MNCs’ research and development (R&D) labs, as the engine of innovation, are receiving much attention along with the looming trend of globalization of R&D. While MNCs are increasingly conducting R&D on a global scale for purposes of augmenting their own knowledge bases or exploring host countries’ resources (Kummerla, 1999a), governments in many countries—especially developing economies—are enthusiastically attracting MNC R&D on board with the hope to promote local innovative capacities through MNC R&D labs’ technology transfer or knowledge spillover.

When MNCs set up R&D labs in host countries, interaction with local innovation agents—no matter to what degree interaction happens—is a ubiquitous process. However, most empirical literature ignores how exactly they interact and what is the content of interaction. This paper fills the gap by specifically exploring whether MNCs R&D labs can be an efficient channel of technology transfer through interacting with key innovation agents in the region including local universities and local firms. Explicating the complex interactions between MNC R&D labs and local innovation agents will be of great interests to policy makers as well as MNC strategists. With an in-depth analysis of MNC R&D labs in Beijing from perspectives of both MNCs and local actors, this paper will enrich the knowledge on the impact of globalized R&D on host countries.

GLOBALIZATION OF R&D AND ITS IMPACT ON HOST COUNTRIES

Incentives of globalization of R&D

The incentives of MNCs locating R&D abroad can be broadly categorized into exploring attractive host country resources and being close to market, from a supply and demand perspective. Attractive host country resources, as potential inputs for MNC R&D labs, include low-cost labor, technology, local government preferential policies, etc. (Gassmann & von Zedtwitz, 1998; Reddy, 2000; von Zedtwitz, &
Some studies (Cantwell 1989; Florida 1997) show that the motivating factor for FDI in R&D may be a firm’s need to augment its knowledge base, since host country R&D organizations (such as research universities) have potential knowledge spillovers. Kuemmerle (1999a) termed this kind of incentives as “home-base-augmenting” (HBA). From the demand side, proximity to market helps MNCs tailor their innovation to consumers’ needs, and improves speed to market. Such proximity can also mean locating R&D labs close to MNCs’ manufacturing base, which can be categorized as “home-base-exploiting” (HBE) in Kuemmerle’s term. According to Bartlett and Ghoshal (1991), to exploit firm-specific capabilities in foreign environments, MNCs need to build R&D sites that are in close proximity to factories in host countries so that those R&D sites can facilitate technology transfer from the home country to the actual manufacturing.

The location incentives and activities for MNC R&D in developed countries and in developing countries can be quite different. While it is natural for MNCs to learn the latest technologies by locating in places that are on the cutting edge of innovation (Pearce, 1989, 1999; Håkanson and Nobel, 1993; Florida, 1997; Kuemmerle, 1999b), the literature of the 1980s and early 1990s suggested that MNC R&D was established in developing countries primarily for the purpose of local adaptation, supporting local manufacturing subsidiaries, and, at most, product development for local markets (Behrman & Fischer, 1980; Dunning, 1992, 1994, 1998; etc.). However, recently, a growing line of literature seen on the role of offshore R&D in developing economies has tended to suggest different location incentives. Although a close relationship with production is still observed for offshore R&D to some Asian countries (Amsden et al., 2001; Liu and Chen, 2003), Reddy’s work (2000) show the increasing importance of ‘global technology unit’ (GTU) in developing Asia. He reported that 77.6% of transnational corporations’ R&D units are focusing on product and process development for the global market, with a sample size of 286. Recent studies on MNC R&D in China (von Zedtwitz 2004; Quan, 2005; Sun, Du, Huang 2006; Sun, von Zedtwitz, Simon, 2007) have also shown that MNC R&D labs have changed their functions there from focusing on local Chinese market to more strategic purposes with a global perspective.
Impact of MNC R&D on host countries

Most studies on the impact of MNCs on host countries are at the general level of FDI, where manufacturing accounts for the largest part of the story. When it comes to R&D only, inward R&D investment is generally regarded as beneficial to host country economic growth. Positive effects include employment of local people, technical support to local suppliers and customers, contract jobs from foreign R&D units to local R&D organizations, etc. (Dunning, 1992). For instance, the study initiated by the U.S. government (Dalton and Serapio, 1995) indicates “direct benefits to the United States include funding for R&D within the United States and employment opportunities for U.S. scientists and engineers. … The interaction between the R&D of the parent and that of its U.S. affiliate may have long term benefits for the U.S. R&D community.” Jaffe, Trajtenberg and Henderson (1993) documented local R&D spillovers in new products and processes from foreign investment to U.S. companies in the same industry and to spin-offs. Studies by Kuemmerle (1996) and the National Academy of Engineering (Reid and Schriesheim 1996) also demonstrate similar positive effects. Todo and Miyamoto’s (2002) empirical study show that knowledge diffusion is greater when MNCs have R&D activities in the host country than those without R&D activities. On the other hand, the counterview argues that R&D activities by foreign firms tend to tap into unique local R&D resources without substantially benefiting the host country, for example, causing ‘brain drain’ (Dunning, 1992). Positive or negative, most discussions on the impacts are limited in host developed countries, where MNCs have a relatively long tradition of investing in R&D.

It is only a recent phenomenon that globalization of MNC R&D shows its depth and breadth in developing countries. For instance, US offshore R&D to developing countries as a proportion of its total offshore R&D increased from 7.6% in 1994 to 13.5% in 2002 (UNCTAD 2005). Reddy’s study (2000) show that there were 196 MNC R&D facilities registered in India, 46 in Singapore, 16 in Malaysia, and 14 in China. According to the Chinese Ministry of Commerce, the number of MNC R&D labs in China has increased to 750 in 2006. A survey of 186 companies in 2004 worldwide by Booz Allen Hamilton and the business school INSEAD found a general trend of innovation moving east and predicted that China and India are on the verge of overtaking Western Europe as the most important locations for
foreign R&D for US businesses. According to the study, by the end of 2007 China and India combined will account for almost a third (31%) of global R&D staff, up from 19% in 2004\textsuperscript{iii}. The \textit{Economist Intelligence Unit} survey (September 2004), which interviewed 104 senior executives (with 37% from US-based companies, 34% from European companies and 16% from Asia-based companies), also indicates that over half of companies plan to increase their overseas investment in R&D in the next three years. China was identified as the top location by 39% of respondents, closely followed by the US, India and then the UK.

In host developing countries, the ‘brain drain’ phenomenon may become more pronounced due to the large salary gaps that MNCs can leverage. Among those few studies, Reddy’s research (2000) shows these R&D activities may create islands of ‘high-tech enclaves’ with little diffusion of knowledge into the developing economies. Although possible linkages between MNC R&D labs and local actors are identified such as joint research labs, personnel training centers, and spin-offs, through which technology and knowledge can be transferred or spilled over, not much empirical evidence and analysis are there to detail the impact of MNC R&D on host developing economies (Reddy 2000; Chen, 2004; Greatwall, 2002). Further examination is desired to analyze whether technology transfer can happen through various linkages identified.

**RESEARCH METHODOLOGY AND DATA**

My research is driven by a big surge in MNC R&D labs in China since the late 1990s, which is partly a result of the Chinese governments’ efforts in attracting MNC R&D labs for potential technology transfer. China also becomes a top choice for future R&D location, according to the \textit{Economist Intelligence Unit} survey.

Beijing is selected as the region for in-depth case study due to several reasons. First, starting from the mid-1990s, MNCs have competed to set up R&D labs in Beijing, and the number of foreign R&D labs continues to increase at an accelerating rate. Beijing has already attracted more than half of all the foreign
R&D centers in China\textsuperscript{vii}. Secondly, most MNC R&D labs in Beijing are focused on IT industries. Thirdly, Beijing is where extensive local resources can be mined. It is characterized by a dense cluster of high quality universities with which MNCs are eager to set up cooperative relationships for promising students and ideas.

One initial issue is to identify the number of MNC R&D labs in China and in Beijing, specifically. The number is in fact unclear as different data sources show surprisingly diverse numbers (Table 1). The difference in the number can partly be explained by the difference in definitions of MNC R&D labs. A large number usually includes those foreign companies whose R&D activities are integrated with manufacturing or services operations. My study only examines foreign R&D labs that are stand-alone facilities and are majority-owned affiliates of foreign parent companies\textsuperscript{v}.

Different industries have different technological and innovation characteristics, and firms in different industries tend to have different strategic behaviors in terms of R&D. In order to make case companies comparable and also broaden the sample pool, information technology (IT) industries are singled out in this research due to similarity among different IT industries in addition to the fact that IT industries are where R&D is most active. Furthermore, the IT industry is highly internationalized\textsuperscript{vi}. Attracted by the fast-growing market, most large IT firms have invested in China, including Intel, IBM, Microsoft, HP, Oracle, Cisco, Agilent, Nokia, and Motorola, and many of them have set up R&D labs there. To be consistent with Chinese statistics data, IT industries here include electronic and telecommunications equipment industry and computer applications and services industry\textsuperscript{vii}.

One reliable official data available on R&D in Beijing is the Beijing R&D Survey starting from the year 2000 (following a national R&D survey in 2000) by a joint official group including the Beijing Science and Technology Committee, Beijing Bureau of Statistics, Beijing Committee of Education, and Zhongguancun Administrative Committee of Science and Technology Park. Historical data is still absent.
According to the Beijing R&D Survey, there were fifteen foreign R&D labs in Beijing in 2000, focusing on computer applications and services industry (6), electronic and telecommunications equipment industry (2), and industrial instruments and office machinery (2). In 2002, the total number had increased to twenty-five, with the most widespread focus remaining on IT industries (15).

As data from official statistics and other public information are not sufficient to investigate the issue, information for this research is mostly gained through field study. About seventy interviews were conducted in Beijing, more than half of which involved fourteen foreign-owned R&D labs in Beijing (with most interviewees working as lab directors or other high-ranking managers of the labs). The remaining interviewees represent various backgrounds including industry experts, government officials, and university professors collaborating with MNC R&D labs in Beijing. In addition, over 200 interviews with managers, entrepreneurs, engineers, and officials from the recent few years of research on related topics in China also greatly contributed to my understanding of the issue. Although fourteen foreign R&D labs is not a big number, it is representative of the IT sector since there were fifteen foreign R&D labs in IT industries according to the 2002 Beijing R&D survey. Among the fourteen labs studied in Beijing, twelve were established in the year 2002 or earlier. This means that the study covers approximately 80 percent of the foreign IT R&D labs that were launched before the end of 2002 in Beijing. Furthermore, for those stand-alone R&D labs that were established after 2003, R&D activities are possibly not yet sufficiently developed to be studied in detail by the time when the field work was conducted in 2004 and 2005.

**EMPIRICAL FINDING: MNC R&D LABS’ INTERACTION WITH LOCAL INNOVATION SYSTEM**

**Strong interaction with local universities**

Interactions occur when different entities possess different specialized assets or capabilities, so that new benefits for each entity emerge when they bring their capabilities together. Findings of the Carnegie-
Mellon survey and the Levin et al (1987) surveys (Klevorick et al., 1995) both have indicated that university research makes important indirect contributions to industrial R&D in industries other than pharmaceuticals (Cohen et al., 1998). Close interactions often reflect the desire of industry to explore and have access to new research and discoveries in universities, and also reflect the motivation of universities to receive industrial funding and explore other potential benefits from R&D commercialization (see e.g. Cohen et al., 1998; Lee, 2000; Adam et al. 2001). Studies have also pointed out access to well-trained graduates as a major motivation for industry to build university-industry cooperation (Peters and Fusfeld, 1982; Parker, 1997; etc.). The importance of hiring graduates varies among different industries (Mowery, 1998).

In developing countries such as China, the underdeveloped institutional environment and immature market economy in transition on the one hand characterize each entity with unclear specialization boundaries, and on the other hand endow local universities with powers that surpass those related to their academic attributes. Therefore, incentives and channels of interactions between industrial R&D and universities may differ from those in developed countries. For example, local universities are sometimes deemed by MNCs as a ‘window’ to access to government in China. In addition, my research shows that MNC R&D labs are more active in interacting with local universities than with local firms because of the weak domestic industrial R&D capability. Five interaction models between MNC R&D labs and local universities are identified and analyzed at a more detailed level.

**Pure image-building model**

One important incentive for MNC R&D labs to interact with local universities is to build its public image. In this model, MNC R&D labs provide money, hardware or software to local universities in Beijing, usually in the form of donations. Most often they tend to donate their own products (hardware or software or both) instead of money. For example, Microsoft Research Asia in Beijing has a software donation program of about $5 million in market value to support teaching and research at 15 Chinese universities ix.
By donating their own hardware and/or software products, MNCs help university professors and students get acquainted with MNCs’ products, which may contribute to their future market growth. More importantly, by building the familiarity with their products and their brands, MNC R&D labs are able to attract talented students, as found as a major goal of MNC labs in my survey. On the other hand, donation to local universities also helps MNCs build a good image to the local Chinese government. Stories are not scarce that MNCs entered the Chinese market but found that they couldn’t make any money until they build good governmental relationships, such as the case of Microsoft in China. Meanwhile, MNC R&D labs usually make donations only to prestigious Chinese universities such as Peking University and Tsinghua University, since these universities can provide both good accesses to local government and high quality students. However, in general, low level of interaction between the R&D lab and the university is typical in this model.

This model of pure image-building through donation is often adopted in the early stages of an MNC R&D lab’s entrance into China. Later, when MNC R&D labs realize that it’s not cost-effective, they tend to explore other ways of interaction ways (i.e. other models as described later) instead of pure donation. The Nokia R&D lab manager in Beijing indicated that the lab was finally managed to be out of the pure image-building model after several years of efforts from 1997 to 2000, according to my interviews.

Sponsored research model

The sponsored research model, where MNC R&D labs provide funding to sponsor research projects conducted in universities, is also a loose interaction model between MNC R&D labs and local universities. Usually university professors propose research topics and then the MNC R&D lab decides whether or not it wants to sponsor the research depending on how interesting the topic is and to what degree the topic is related to the current or future research of the lab (interviews). If the R&D lab likes the project, it will assign one or two researchers from the lab to work together with the university on the proposed topic. But even if researchers from the lab are willing to be involved in these university-proposed projects (such as a part-time advisory role), they do not actively participate in these projects.
Many MNC R&D labs in Beijing set aside some special funds to sponsor university research. From the proposals that professors have written, the MNC R&D lab can get some sense of the kind of technology research that universities are interested in. This is a cost-effective way for MNC R&D labs to keep abreast of new discoveries in the relevant fields in China. For instance, Bell labs in Beijing signed a joint funding agreement with the Division of Information Science of the National Natural Science Foundation of China (NSFC) in 2000. According to the agreement, the two parties will fund jointly some of NSFC’s key research projects and young scholar foundation projects. For the key NSFC projects, Bell labs can apply for funding together with some other organizations such as universities, but it doesn’t participate in project evaluation. For the young scholar foundation projects, the lab can help identify promising research topics. (interview)

Another incentive for MNC labs to sponsor university research is that they hope to be able to influence students with MNCs’ corporate values since sponsored research is mostly done by students under professors’ supervision. As to the universities, professors always like to have their research sponsored by outsiders mainly due to short of funding from the university or from government. Moreover, the selection of research proposals by MNC R&D labs also gives university professors some idea of the research idea’s industrial prospect. Since research topics are proposed by university professors, research results usually are kept as internal documents of the university. However, MNC labs retain the right to access to the research reports and documents, and they can also further develop ideas based on these research results.

Outsourcing model

When MNC R&D labs outsource projects to local universities, the R&D labs define the specific topics (in contrast to the sponsored research model) and then hand the projects over to local universities, providing a certain amount of money to university researchers. For example, Nokia had approximately 10 R&D projects outsourced to a few universities in Beijing in 2005.
R&D projects that are outsourced can be very different in nature. They can be either advanced technologies in the field that are related to their future core competences or marginal and peripheral technologies that have a low share of corporate technological assets and low level of competences, depending on MNC R&D labs’ perception of the partner university professors’ research capability. If the technology or knowledge involved in the outsourced research has some uncertainty in nature but is in a field that MNC R&D labs desire to get into in the future, MNCs will usually look for some star scientists in local universities to work on the projects (interview). In this way, MNC R&D labs will be able to lower their costs and use local talents to help them identify whether it is worthwhile to conduct further investigation in the technology field.

But more often, outsourced projects only involve marginal technologies, due in part to the low opinion that R&D labs often have of the local Chinese universities (interview). MNC R&D labs will then just contract with some departments or institutes in good local universities and specify their needs. In fact, outsourcing is often seen in some software institutes within local universities such as Peking University Software Institute and BUAA Software Institute that have been recently established as a result of the government policy of promoting the development of the Chinese software industry.

Cost-saving is a major incentive for MNC R&D labs to outsource R&D projects. For instance, the simple coding and testing work done by students in the software institutes is especially of low-cost. In most developed countries, simple jobs like these are mostly done by small low-technology firms. However, in China, the newly established software institutes are eager to help students get some industrial experience as promised in their mission statements. Since a large amount of work in the MNC R&D labs in China is for product development or localization as shown in the survey, students are often used as low-cost but high quality labor for those low-technology projects.

A low degree of interaction between MNC R&D labs and partner universities can be observed in the outsourcing model, since low-technology does not need much MNC lab involvement. Results from the outsourced work are usually well codified. Intellectual property rights (IPR) in general belong to MNC R&D labs as stated in the contracts.
My survey of the 14 R&D labs shows that the outsourcing model is not used as an important interaction channel. The average score rated by the MNC labs is only 0.57 on a scale from 0 to 5 and is the lowest score among all kinds of interactions which MNC R&D labs build there. In more detail, one MNC R&D lab gave a score of ‘4’, one lab ‘2’, two labs ‘1’, and the remaining ten labs rated ‘0’.

**Joint lab model**

In my survey, the average score rated as degree of importance for this model of interaction is 2.95 on a scale from 0 to 5, which is much higher than interactions in the form of subcontract or outsourcing (0.57). This shows that cooperation between MNC R&D labs and local universities is active in Beijing. However, how cooperation is happening exactly can only be understood through further analysis of the joint lab model based on interviews.

In this model, joint labs are usually located within universities, with financial and daily operations supports from MNC R&D labs. A joint lab typically has a formal organizational structure, according to my interviews. A committee, usually with representatives from both parties, is necessary to decide the types of research projects to be undertaken in a joint lab. Research topics in the joint lab can be proposed by either university professors or by the MNC R&D lab, followed by a discussion in the committee. While the lab premise is provided by the university, the MNC will assign researchers to join the joint lab for project discussions on a frequent basis (such as two or three times per week). In some cases, MNC researchers work in the joint lab for a couple of days per week. The director of the MNC R&D lab often becomes an advisor for university students as well. He or she will sit on the committee to supervise graduate students’ theses together with the students’ academic advisors in the university.

Through close interactions, both codified knowledge and tacit knowledge embodied in personnel are transferred in both directions. In addition to gaining industrial knowledge and obtaining funds, university staff learn from MNCs on how to improve management capability. MNCs gain knowledge or technology in the explicit forms of papers and patents, and are also able to know about students’ research and collaboration capabilities through close interactions. MNCs also advertise their corporate values to
students and attract talents to their R&D labs. Needless to say, image-building is still a very important incentive for MNCs to set up these joint R&D labs in local universities. On the other hand, cooperation with world well-known MNCs is also an image-building opportunity for the university.

Top Chinese universities usually have many joint labs with MNCs. Figure 1 show the increasing number of joint labs in Tsinghua University. In general, a joint lab committee there is made up of 6 people, three from each side. The chair person of the committee often comes from the university. The committee members discuss and decide on the research agenda, with funding provided by the MNC R&D lab and joint laboratory space proved by Tsinghua (interview at Tsinghua).

In some cases the joint R&D lab is not a real entity. Although a signboard of the joint lab may be posted on the door, there are no regular members but only one administrative person from the university (sometimes a university professor) serving as a coordinator. When there are specific research projects, the joint lab becomes active and will have a few professors closely associated with it. These professors will still stay in their own offices supervising a group of students working on the joint research projects. When research projects change, some other professors will then be more actively involved in the joint lab. In this case, no daily operation fee is needed from the MNC side. The Peking University IBM Innovation Institute, which was established in 2001 between the IBM Chinese Research Lab (CRL) and Peking University, is an example. There are about three projects every year and funding from IBM is about 500,000 RMB (~USD 70,000) to 1,000,000 RMB (~USD 140,000) per year (Interview with the director of the joint lab).

Research projects in joint labs can also be pure university research or projects contracted to the university by MNCs. The ownership of intellectual property rights is clear in these cases, belong to the university in the former case and to MNCs in the latter. For more closely collaborated projects, ownership is discussed case-by-case depending on each party’s inputs as well as negotiations. In all the joint labs in
Tsinghua University, the university exclusively owns about 30% of all the intellectual property (IP) rights involved, MNCs 5%, and the rest with shared IP ownership.

*Internship, training programs, and other*

Although less interactive, hiring interns and recent university graduates is considered to be the most important relationship between MNC R&D labs and local universities, as shown in the survey to the fourteen MNC labs. They rank these relationships the most important, with ‘hiring recent graduates’ an average score of 3.93 and ‘hiring interns’ an average score of 3.14. This can be illustrated by the fact that over 95% of MNC R&D lab employees on average are local hires and a large percentage of them are graduates from local universities.

The number of interns that an MNC R&D lab has varies from a few to a couple hundred per year. For instance, Bell Labs in Beijing has had about 200 interns since its establishment in 2000. SUN China Engineering & Research Institute had about 20 interns in 2001, 40 in 2002, and 50 in 2003. The number of interns in Microsoft Asia Research in Beijing was approximately 200 in 2003 alone.

Interns usually work in MNC R&D labs for two to three months during the summer or in a less busy semester. These interns bring back knowledge they learn from the R&D labs to their universities, which may have direct or indirect influences on their fellow students and even on their advisors. Needless to say, incentives of hiring interns from the MNC side include knowing students’ research and working capabilities, in addition to the benefits of low cost. Later, some R&D labs may recruit nearly 50% of their interns as formal employees after the intern term ends.

There are also other kinds of university-MNC R&D lab relationships such as joint training programs, researcher exchange programs, and post-doc working stations in MNC labs. For example, in Microsoft Research Asia (MSRA), a visiting researcher program brings prominent professors from local universities to MSRA. Another exchange program sends 30 Microsoft Research Asia researchers to Chinese universities as honorary guest professors to collaborate with professors and supervise Ph.D. students.
Finally, summarizing what have been discussed above, a comparison of the MNC R&D lab-local university interaction models is given in Table 2.

[Insert Table 2 about here]

**Weak interaction with local firms**

Interaction between MNC R&D labs and local firms is very weak. As shown in Figure 2, MNC R&D labs in general do not actively interact with local firms. On a scale of ‘0’ to ‘5’, the highest score marked by MNC R&D labs is only ‘1.64’ (direct production linkage). This can be compared with how MNC R&D labs evaluate their relationships with local universities, where the highest average score is given as ‘3.93’ (hiring recent graduates). Interviews with lab managers can further confirm the preference of building linkages with local universities over firms. When asked further for ‘direct production linkage’, it usually means that MNC R&D labs provide some sort of product technical support to local firms. Collaborative projects or subcontracts, which can characterize more interactive relationships in terms of R&D, is not rated as important, as shown in the figure. Only three out of the fourteen MNC R&D labs acknowledge the existence of joint ventures with local firms; and only a couple labs rate a ‘competitive relationship’ as significant, as most MNC R&D labs believe that local firms are not strong enough to be their competitors. However, MNC R&D labs express positive future outlook on relationships with local firms. Nine out of the fourteen labs state ‘yes’ for future cooperative relationships, though it is not yet clear exactly what kinds of cooperative relationships can happen.

[Insert Figure 2 about here]

My surveys and interviews show that the three most prominent types of R&D activities in which local firms are involved with MNCs are localization, testing, and application development. Most localization
work is related to translation into the Chinese language, sometimes with simple programming. Testing is another common task that MNC R&D labs hand over to local firms. In a ‘black box’ testing, local firms test whether certain ‘output’ can happen given certain ‘input’ parameters from MNC labs. After running the test, if the ‘output’ data are not as expected, local partners will simply deliver the results back to MNC R&D labs for further testing and modification. As we can see, most testing work is low-end technology related and local firms have no idea at all about how the codes look like inside the ‘black box’. Application development has relatively more technology involved. These applications are usually developed for the Chinese market. For example, in the Intel Beijing lab’s project cooperation with Lenovo, Intel provides key technology and interface specifications. Lenovo will then further develop products based on Intel’s technological platform.

A further illustration on MNCs’ cooperation with local firms can be given by a networking security software company in Beijing. The main product of this firm is firewall software. The core technology came from the original founder, who had previously worked for an IBM R&D lab in the United States. Due to the original founder’s personal connection, the firm now is cooperating with IBM on a software product called ‘risk manager’. Because the Chinese government policies prohibit entrance of foreign companies into the field of networking security, IBM needs to find local firms to develop corresponding security software to interface with its own product in order to enter the Chinese market. In the collaboration, interface protocols are defined by IBM then handed over to the local company and there is no cooperation in any core technology. According to the CEO of this local firm, overall cooperation with MNCs accounts for a very small percentage of the company’s development tasks. In his view, if MNC R&D labs cooperate with local firms, mostly the purpose is still just for image-building. Another local firm working on urban infrastructure software, in cooperation with a Finnish company, tells a similar story. According to its CTO, the core technology—the hydraulic balance model—will never be seen by this local company: “Most cooperative work is on Chinese language localization and some interface related simple programming work. No further interaction is found in terms of ‘real’ technology.”
DISCUSSIONS AND IMPLICATIONS

Presence of MNC R&D labs as an effective channel of technology transfer?

Enthusiastic government usually holds the belief that technology will be transferred to local innovation system when MNC R&D labs are located in the region. However, empirical study from this research shows that technology transfer will not happen naturally. In fact, as shown in some other recent studies (Sun, 2003; Quan, 2005; Sun, von Zedtwitz, Simon, 2007), the major incentive of MNCs is to strategically configure resources in their global production network. Furthermore, the degree of interaction between MNC R&D labs and local innovation actors are influenced by factors such as MNCs’ own concerns on technology strategies and complementary assets. (Quan, 2005) In general, MNC R&D labs in Beijing have more active interaction with local universities than with local firms, since hiring students and building good images are major incentives for the MNC labs.

On the other hand, although transfer of technology (especially key technology) from MNC R&D labs directly to local innovation actors is limited, the presence of these labs may still help in the advancement of local innovation capability. For instance, local partners can obtain some know-how knowledge especially when interactions are tight. As discussed earlier, local universities learn from MNC R&D labs on what are considered to be good research topics and sometimes are able to gain some idea about international frontier technology. Through cooperation, industrial knowledge is also to some degree brought to universities and universities learn to identify industrial needs. Students get the opportunity to be close to real business practice. The improvement of lab management can also be seen as important institutional learning to local universities. MNC R&D labs usually have rigid process management, set clear deadlines, and strictly implement goals at every stage. My interviews tell us that university professors and students now learn to have clear milestones and to nicely follow schedules through their cooperative research with MNC R&D labs, thus achieving more efficiency.

However, not all interactions bring considerable institutional learning opportunities for local actors, especially when the degree of interaction is very loose. In fact, among the five MNC R&D lab - local
university interaction models analyzed earlier, only the joint-lab model features tight cooperation. Furthermore, interaction in the joint-lab model may also be loose if, for example, MNCs pay more attention to their image-building instead of substantial results coming from cooperation. Overall, technology transfer is very limited from MNC R&D labs to the local innovation system.

**Foster indigenous innovation**

Technological learning from exogenous forces will not bring key technologies to the local innovation system. It is crucial for developing countries to build up indigenous innovation capability to narrow their technology gaps with developed countries.

Recent policies and propaganda suggest that the Chinese government is adamant in developing indigenous innovation capability. The ambition is well articulated in the National Medium- and Long-Term S&T Development Plan (2006-2020) and the Fourth National Science & Technology Conference in 2006 (following the first conference in 1956, second in 1978, and third in 1995) was held to deploy and implement the Plan. However, innovation capability in China currently is still weak. Take patent as an example. Although the number of patents granted in China has increased at a double digit rate, invention patent, which represents more advanced technology and fundamental innovation capability, accounted for only a quarter of the total. Incremental innovation shown as utility model and external design patents accounted for 75%. Furthermore, foreign entities outside of China took the majority of the relatively small number of invention patents registered in China. As a result, although the number of invention patents in China ranked third internationally after Japan and the US, about two thirds of the invention patents were granted to institutions/firms outside of China. Comparatively, fourth-placed South Korea has the majority of invention patents coming from its domestic entities.

On the other hand, business environment in China is far from well developed for innovation. Small size, insufficient channel for capital exit, information asymmetry, poor management skills, weak intellectual property protection, and inadequate regulations all are the shadows that spook investors and entrepreneurs. Most firms, satisfied with ready technologies developed by MNCs, are fighting for thin
profit margins, while high royalties are collected by MNCs holding intellectual properties. In the meantime, the few innovative firms may be easily suffocated by the complicated *guanxi* networks.

It is vital for the Chinese government to value the right environment for indigenous innovation. Creating an innovative economy is not a matter of only getting ingredients such as high-tech labors and money, or of attracting MNC R&D labs to the locality, but of building institutions that support innovation and leaning. Without the right milieu to cultivate innovation activities, the prospects for China’s long term competitive advantage look dim.
Table 1: Estimates of MNC R&D Labs in China, by different sources

<table>
<thead>
<tr>
<th>Number of MNC R&amp;D labs in China</th>
<th>Data source</th>
<th>Year observed</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>Ministry of Commerce, China</td>
<td>2004</td>
</tr>
<tr>
<td>400</td>
<td>People’s Daily</td>
<td>Oct 2002</td>
</tr>
<tr>
<td>223</td>
<td>Walsh(2003)</td>
<td>2002</td>
</tr>
<tr>
<td>148</td>
<td>Chung-Hua Institute for Economic Research</td>
<td>2002</td>
</tr>
<tr>
<td>120</td>
<td>People’s Daily</td>
<td>April 2002</td>
</tr>
<tr>
<td>82</td>
<td>China Science and Technology Statistics</td>
<td>2002</td>
</tr>
<tr>
<td>40</td>
<td>Great Wall research report (2002)</td>
<td>2002</td>
</tr>
<tr>
<td>33</td>
<td>Xue (2002)</td>
<td>2000</td>
</tr>
</tbody>
</table>
Table 2: Comparison among different MNC R&D lab-local university interaction models

<table>
<thead>
<tr>
<th>Pure image-building model</th>
<th>Outsourcing Model</th>
<th>Sponsored research model</th>
<th>Joint lab model</th>
<th>Internship, training programs, and other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organized through Projects?</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Project proposed by</td>
<td>N.A.</td>
<td>MNC R&amp;D lab</td>
<td>University</td>
<td>Either MNC R&amp;D lab or university or both</td>
</tr>
<tr>
<td>Degree of cooperative interaction</td>
<td>Very loose /Almost none</td>
<td>Loose</td>
<td>Loose</td>
<td>Tight (but may also be loose)</td>
</tr>
<tr>
<td>MNC R&amp;D lab incentives and benefits</td>
<td>Image building (build good public image to university as well as to the Chinese government; attract talented students)</td>
<td>Cost-saving</td>
<td>Understand student research and working capabilities</td>
<td>Access to Chinese government research funding</td>
</tr>
<tr>
<td></td>
<td>Access to university discoveries/knowledge</td>
<td>Industrial knowledge</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Access to Chinese government research funding</td>
<td>Access to university facilities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>University incentives and benefits</td>
<td>Funding (in the form of hardware or software or money)</td>
<td>Industrial knowledge</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>International horizon</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Identification of good research topic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Some management knowledge</td>
<td>Management know-how; institutional learning</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 1  Number of MNC-Tsinghua University joint R&D labs, 1992-2002

Data source: Tsinghua University Science & Technology Office.
Figure 2 Relationship with local firms

- Joint venture collaboration in projects: 1.00
- Subcontracting: 1.43
- Competitors: 1.00
- Direct production linkage: 1.14
- Average score: 1.64
REFERENCES


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i MNCs were already locating more than 10% of their R&D activities overseas in the 1970s and early 1980s (Mansfield, Teece and Romeo, 1979)

ii Respondents came from 19 countries and 17 industry sectors with a combined annual R&D spending in 2004 of $76bn, representing nearly one-fifth of the global total for all corporations.

iii Source: [www.silicon.com](http://www.silicon.com)

iv Data source: China Ministry of Science and Technology.

v Majority-owned affiliates of foreign parent companies are those affiliates in which the combined ownership of home country foreign parents is more than 50 percent (Moris 2004).

vi This fact may also bring potential bias to the study. MNCs’ R&D activities in other industries may behave differently from those in IT industries at the global scale.

vii The industries are mostly covered in NAICS code 334 and NAICS code 51 (North American Industry Classification, 2002).

viii The number here is conservative.


xi Source: Tsinghua University Science & Technology Office