The Upgrading of Multinational Regional Innovation Networks in China

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Abstract

Theories of globalization of innovation assume a hierarchical structure of location in the global division of innovation, with advanced innovative activities in the advanced economies and routine ones in the developing economies. This paper attempts to explain why Multinational Corporations (MNCs) localize a wide spectrum of innovative activities to China since 1995, which ranges from process innovation, product innovation to basic research. By comparing the dynamic transformation of two MNC’s regional innovation networks (RIN) in China – namely Motorola and Microsoft – this paper argues that the innovation upgrading process can be better understood through examining the interaction between the MNC subsidiary innovation centers and the local institutions.

**Keywords:** Multinational R&D centers, regional innovation networks, upgrading, Local institutions, evolutionary process
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I. Introduction

This paper attempts to explain a new kind of foreign direct investment (FDI) to China that is not labor-intensive but knowledge-intensive. Since IBM first established their wholly owned IBM Research China in Beijing in 1995, well-known Multinational Corporations (MNCs) such as Intel, Microsoft, Nokia, Ericsson, SAP, Samsung and Matsushita all started to set up their research labs in China. According to the recent UNCTAD survey, 60.9% of the company responses choose China as the most attractive location for future foreign R&D investment, which exceeds the U.S. (40.6%). (United Nations, 2005:13). This unusual case of a developing country becoming a potential new ‘center of excellence’ in the MNC global innovation networks needs some explanation.

The most interesting question is not why a particular MNC invest certain segments of R&D2 in China, but why they invest in a surprisingly wide spectrum of R&D activities in China – ranging from production support, product adaptation, new product development, applied research and even basic research. Why can China attract such a wide spectrum of R&D activities?

By comparing the changes in the MNC regional innovation networks in China, this paper wants to show the complexity of the MNC innovation activities in China, which goes beyond the static explanation of the ‘abundant cheap engineers’ and the ‘large domestic market.’ In contrast, this paper argues that the

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2 Even though ‘innovation’ is a more appropriate term for this paper, I use ‘R&D’ and ‘innovation’ interchangeably. The main reason is many MNCs use ‘R&D center’ as the official title of their innovation center, and the public discourse in China also uses ‘R&D center’ as well.
Localization of the MNC R&D centers involve a learning process that results in the evolution of MNC R&D centers from an ‘experimental’ phase to a more mature and integrated phase.

There is a growing interest in MNC R&D research in China. While most scholars agree that China is becoming the new magnet for global R&D activities, with the number of R&D centers increasing from 30 in 1999 to 700 in 2005 (Xue, 2005), few have used micro-level evidence on the R&D activities to explain what exactly these MNCs are doing in China (Sun 2003 and Chen, 2007). Through firm-level and project-level analysis, this paper analyzes the technological nuances and transformations of these MNC R&D centers in China. If this tendency of the agglomeration of a wide spectrum of MNC R&D activities continues, the China case might represent a new stage of globalization of innovation in which certain (limited) large city-regions in developing countries can become new potential ‘centers of excellence’ for new technology and new product creation.

II. China breaking the iron-cage of the Triad?

Large MNCs increasingly extend or diversify their field of technological competence through internationally integrated networks of technological development. In each location, MNC’s integrated R&D networks tap into specialized local expertise. They differentiate their technological capability by

\footnote{A conference on “global R&D in China” held in Nanjing in May 2005 gathered all the prominent scholars and practitioners in this field. For more information, visit \url{http://www.csun.edu/~vs9503/Nanjing_meeting/Nanjing_meeting_program.htm}}
exploiting geographically separate, and hence, distinct streams of innovative potentials. In other words, MNCs reach out to different places for the most competent version of each needed complementary technology. (Cantwell, 1991; Cantwell & Odile, 1999; Cantwell, and Piscitello, 2000). The search for R&D competencies has favored R&D globalization in recent years, particularly because technical knowledge is increasingly concentrated in know-how clusters around the world (Storper, 1992; Boutellier, Gassmann and von Zedtwitz, 1999).

Based on the above assumption, John Cantwell and his colleagues further conclude that MNCs in Europe do not simply exploit local knowledge assets, but also contribute to local technological capabilities. By co-developing local technological capabilities together with the center of excellence, European MNCs set in a cumulative causation process, which results in the re-enforcement of the hierarchy of global technology districts (Cantwell and Janne, 1999). In short, the increasing globalization of innovation actually re-enforces the dominance of the technology districts in the Triad countries of Western Europe, the U.S. and Japan (Vernon, 1966; Pavitt and Patel, 1991; Patel, 1995).

This ‘limited’ globalization process (or triadization of innovation) concludes that: (i) cumulative causation will further reinforce the concentration of globalized R&D within the existing technology clusters in the Triad countries. (ii) MNCs rarely locate their R&D to developing countries due to their weak knowledge assets, poor infrastructure and limited market.

According to the above findings, even if some developing countries, such as India, China and
Singapore do get integrated into the MNC global innovation networks (GIN), the innovative activities are usually limited to local market product adaptation and adaptation to lower the production cost in the host countries (see Reddy, 1997; von Zedith, 2004; Amsden and Tschang, 2003). Thus, developing countries will remain at the bottom of the global innovation locational hierarchy, as exemplified by the product life cycle theory (Vernon, 1966; Ronstadt, 1984; Abernathy and Utterback, 1978).

In other words, the phenomenon of MNC R&D outsourcing to developing countries remain limited primarily to the ‘asset-exploiting’ R&D (Dunning and Narula, 1995), or ‘home-base exploiting’ R&D activities (Kuemmerle, 1999). The ‘asset-seeking’ or ‘home-base augmenting’ R&D activities are assumed to remain in the Triad. Figure 1 by Kuemmerle (1999: 186) below shows a good visual representation of the spatial hierarchy of innovation on the world-scale. The figure shows that in 1995, the share of R&D in the developing countries are limited to the home-based exploiting lab (or asset-exploiting) type.

![Figure 1](image-url)

Something might have changed after 1995. Some research shows that large developing countries such as China is able to engage in asset-seeking R&D (or ‘strategic R&D’ as used in Sun (2003)) because...
of the high uncertainties embedded in the fast growing large market (Sun, 2003; Chen, 2007). The locational window of opportunity in the new technological field in the Chinese market forces MNCs to upgrade their R&D activities in order to survive the harsh competition from both foreign and local firms in the domestic market (Sun 2003).

Many scholars focusing mainly on the triadiazation of innovation have found that ‘asset-seeking’ has become a new tendency in the globalization of R&D (Narula and Zanfei, 2003; Le Bas and Sierra, 2002; Pearce, 1999; Dunning and Narula, 1995; Florida, 1997). If it can be proved that China is joining this tendency, does it mean that China, as a fast growing developing country is able to break the iron-cage of the Triad in competing for their share in the ‘asset-seeking’ type of global R&D?

If this is the case, in less than a decade, we witness the reintegration of asset-exploiting activities (i.e. technology transfer, a default type in developing countries) and asset-seeking activities (technology creating, rare in developing countries) in China. The reintegration seems to echo the observation by Geryhadze and Reger (1999: 261) that the knowledge-generating process is moving closer to the ‘point-of-sales’ and closer to ‘the advanced manufacturing and efficient supplier network’. Except this time, the ‘point-of-sales’ is not wealthy Triad economies but the emerging China market, and China is also the ‘advanced manufacturing and efficient supplier network’. It is gradually upgrading from a low-tech and low-end global factory to include high-tech, high-end production networks after the mid-1990s.
III. Research Questions

What triggers this upgrading process? This research emphasizes the critical role of the local institutions. I argue that the interaction between subsidiary R&D centers and the local institutions is crucial in technological and organizational upgrading of MNC subsidiary R&D centers. The mainstream literatures on globalization of innovation do mention ‘environmental factors’ as one of the factors that influence the decision to locate their subsidiary R&D, but very few go further to analyze the process of the interaction that lead the evolutionary change of the subsidiary, and eventually the whole global innovation network.

Drawing on the ‘Global Production Networks’ approach (Henderson, Dicken, Hess, Coe and Yeung, 2002), this paper argues that the interaction with local institutions, like industrial clusters, agglomeration of skilled labors, demanding urban customers, competing local firms, industrial policies is critical in understanding the evolution of MNC R&D organizations in China from an ‘experimental’ phase to a more mature and integrated phase.

The data used in this paper was obtained from my fieldwork in Beijing and Shanghai in June-September 2001, September 2002 to January 2003, and June 2005. The main source of data came from 25 informants from Motorola and 20 from Microsoft. Each of the informants was interviewed for around 1 to 3 hours through semi-structured questions. Most of them were from the various research labs.
Some are from the business arms (sales and business development). They were current or ex-research directors, research project managers, senior/junior researchers and interns.

To understand the upgrading process, I used a new typology for the subsidiary R&D center modified from the MNC global innovation organization literatures (Bartlett and Ghoshal, 1990; von Zedtwitz and Gassmann, 2002; Gerybadze and Reger, 1999). There are four types of major R&D centers in the host country according to their primary motives. The first two are asset-seeking R&D centers, namely the technology-driven R&D center (TD center) and the market-driven R&D center (MD center). The last two are asset-exploiting R&D centers, namely the production-driven R&D center (PD center) and the cost-driven R&D center (CD center). For more details on the typologies, please refer to Chen (2006).

My previous research shows a somewhat static explanation of the locational logic of individual R&D centers in Figure 2 (Chen 2004). It only explains partially how the diverse regional assets embedded in Beijing and Shanghai were able to attract a wide-spectrum of R&D activities.

Figure 2

IV. Multinational Regional Innovation Networks

To render a more dynamic understanding of the phenomenon, this paper compares two MNC
regional innovation networks (RIN) that undergo rapid localization and organizational change in China in the last decade. The two selected RINs are Microsoft in the software sector and Motorola in the telecommunication hardware sector.

**Motorola’s Global Innovation Networks**

Motorola represents a type of global innovation networks (GIN) called the ‘Dispersed Research and Dispersed Development model.’ Motorola’s ‘R’ and ‘D’ activities are dispersed widely around the world, albeit unevenly. The major Motorola R&D centers are concentrated in the U.S., France, Germany, Japan, Canada, Israel, India, Hong Kong, Singapore and China. However, despite aggressive globalization of its R&D outside the U.S., some core R&D still remain in the U.S.. For example, the research on CPU for PowerPC (used in Apple computers) is still carried out at the Schaumburg labs in Illinois, and it is unlikely that Motorola will move this R&D center off-shore in the future.

The formation of Motorola’s GIN took 30 years, since it first took its labor intensive manufacturing facilities (IC testing and packaging) to Hong Kong and Malaysia in the 1970s. At that time, only low-end process R&D functions essential to the production were set-up within the off-shore factories. More substantial R&D decentralization began in the 1980s. Major research labs were set-up in France and Germany to tap into the technological assets. In the 1990s, Motorola R&D further expanded to Japan,
Israel, Canada, India and China. Since the late 1990s, we saw a more aggressive reintegration and consolidation of ‘R’, ‘D’, manufacturing and sales in China (see Table 1).

Table 1

Motorola’s Regional Innovation Networks (RIN) in China

To understand the expansion of Motorola’s R&D investment in China since the late 1990s, we need to analyze the Motorola RIN in China. In Figure 3 below, at the top right hand corner, we see that Motorola’s major manufacturing complex is located in Tianjin’s various science parks. (Tianjin is a port city and a new manufacturing cluster 120km from Beijing.) Here Motorola has five major factories producing products ranging from network equipment to two-way radio, GSM handset and advanced IC for handsets and other communication products.

Figure 3

In the top middle section, we find five R&D centers in Beijing serving the corresponding factories in Tianjin. The R&D centers in Beijing support primarily the production in Tianjin, but also the joint-venture factories in Beijing, Hangzhou and Pudong (in Shanghai). These major R&D centers include the Personal
Communication Sector (PCS) R&D center, the Global Telecom Solutions Sector (GTSS) R&D center, the Digital DNA labs (DDL) labs and the Global Software Group (GSG) in Beijing; the MATC-Asia and the IC design house in Tianjin; the IC design house in Suzhou and the Motorola China Research Center in Shanghai. Included are also three large software development centers in Beijing, Chengdu and Nanjing.

After 3-6 years of experience in setting up these R&D centers in Beijing, Motorola established the Motorola China R&D Institute (MCRDI) in Beijing in November 1999 to coordinate the R&D activities of the 16 R&D centers spread across China with about 1,000 engineers.

Due to the length of this paper, I will focus on two market-driven innovation centers (MD centers) and a special MNC-University Joint-Research Labs to demonstrate how these MNC innovation centers interact with the local institutions, which led to the upgrading of technological competence and organizational linkages of the RIN and the two-way flow of knowledge.

The Motorola PCS R&D center (a market-driven center)

The PCS is the most important sector of Motorola. It is officially set up in 1999 by consolidating and upgrading two technical support centers in Beijing – Greater China Cellular and Paging Groups. It has currently 300 engineers researching on software, electrical, mechanical and industrial design development. The PCS R&D center serves mainly the PCS factory in Tianjin.

The PCS factory in Tianjin is Motorola’s first factory in China producing pagers. The pager
officially phased out in 1999. Due to increased demand for handsets over pagers, pager production was
slowly replaced by analog handset production since 1994. After 1998, the PCS factory began producing a
wide range of products, which include digital, dual-band, tri-band, GPRS and CDMA handsets.

I will use two innovation projects at the PCS as examples to show why and how PCS is no longer
merely an asset-exploiting center, but has upgraded into an asset-seeking center (technology creating). It
pioneers new product development for the Chinese market, which are later exported to regional and
global markets.

The first CDMA handset with detachable IC card

In 2001, to support Motorola’s expansion of the CDMA handset market in China, the Beijing PCS
R&D center developed the first CDMA handset (model V8060) using the Removable User Identification
Module (RUIM) card. This type of new CDMA phone is similar to the GSM handset with removable SIM
card. This new handset V8060 with RUIM technology was developed and first marketed in China because
it was the CDMA manufacturing license requirement set by the Chinese State Development and Planning
Commission and Ministry of Information Industry (MII). At the same time, the Motorola business arm
also managed to strike a deal with UNICOM, the officially designated CDMA service provider. This gave
Motorola the first-mover advantage over other MNCs to secure the CDMA manufacturing license. Thus,
Motorola was the only MNC among 19 local firms that were granted the license to produce CDMA
handsets for the local market. With the manufacturing license, V8060 handsets were manufactured in the
Motorola joint-venture factory in Suzhou, which gained experience from producing CDMA handsets for the U.S. market since 1997.

**The first smart-phone**

The PCS R&D center also design, development and market the first smart phone (A6188, and A6288) in 2001 because of the special demand of local Chinese users. PDA is not popular in China as compared to the U.S. Chinese users prefer the combination of PDA and handset (i.e. smart-phone). Even though Chinese users are latecomers, they nonetheless, want more integrated products with multiple functions. The success of this customized pioneer model has led to the new model with color screen (A388 model) later sold in the U.S. market. Thus, the competition for market share against local and foreign handset manufacturers in the domestic Chinese market is the major incentive for this innovation. This market characteristic triggered the PCS R&D center to initiate a collaborative innovation process among the Motorola IC design centers from Suzhou, Tianjin, Singapore and Hong Kong. They all collaborated in improving certain features of the Dragonball processor (the propriety technology of Motorola in the PDA), which was then modified and improved for the A6188/A6288/A388 smart phone and its software application.

These two examples demonstrate that China is not a typical developing country market where MNCs can dump models already obsolete in the markets of developed countries. The competition to access the local market has forced Motorola to test and invest new high-end products. The domestic
customer demand for more integrated products (e.g. smart-phone) and the extremely competition for the manufacturing license to produce for the local market force the Motorola PCS R&D centers to become the producers of new products and new technology (‘asset-seeking’) and not merely the receivers of existing technology from developed economies (‘asset-exploiting’).

In short, the PCS R&D centers makes two major contributions in response to two specific China conditions:

(1) In order to keep up with the competitive market demand and new technological standard in China, it transforms from primarily a production support unit in the early 1990s to a major handset design and development center for the local and the global market since the late 1990s.

(2) Developing a pioneer product requires intensive collaboration among centers within the RIN and the GIN, and thus, transforms the one-way technology-transfer to a two-way knowledge flow between the local and global centers.

**The Suzhou IC Design Center (a market-driven)**

This case shows how the interaction with firms in the industrial clusters is another crucial factor behind the MNC decision to upgrade innovation activities in China.

Motorola has the major share in the global microcontroller (MCU) market. The Suzhou IC Design Center was set up in 1999 to do embedded microcontroller product designs for personal digital assistants.
(PDAs) with GPRS communications networks (General Racket Radio Services, the so called 2.5 GSM network) integrated with Bluetooth and 802.11b wireless local area network (LAN) technologies in the handsets and PDAs for the China and the global markets.

Motorola dominates the 8-bit microcontroller market in China (and the world) because of the high demand for low-end appliances and consumer devices from OEM firms clustered in the lower Yantze River Delta. To overcome the heavy dependence on imported foreign MCUs, local Chinese OEM firms prefer to form partnerships with local chip designers and makers, such as Motorola (Liu 2000). Even though helping a local OEM design a controller chip for a refrigerator may not be a very challenging job, it does bring revenue to the center and facilitate its expansion and upgrading. Locating in the IT industrial cluster and having close interactions with the OEM firms help the design center to learn and upgrade very fast. In less than a year after its establishment, its capability of embedded microprocessor design has upgraded from 8-bit to 32-bit. 8 bit designs are used in consumer electronics and PC peripherals. The 32-bit designs are used in handsets and personal digital assistants (PDA).

The internal resource that allows the center to rapidly respond to client requests is the Motorola Technology Library shared by Motorola design centers in the U.S., Hong Kong and Singapore. The Technology Library stores well documented functional modules. The local design engineers can make a new design based on the customer’s requirement by using advanced design automation tools. The new design is then validated by product and quality control engineers.
In order to develop new designs and methodology such as Bluetooth and other microcontroller applications, the center needs to upgrade itself and collaborate with regional universities. For example, it works with the National Wireless Communication Lab located at the South East University in Suzhou to setup product development tools and software development environments for China’s 3G system and handset in 2003.

In short, by (1) constant interacting with the diverse consumer-device-clients clustered in the greater Shanghai region, by (2) partnering with local universities to developing new tools, and by (3) interacting with the GIN (through the Motorola Library for example), the Motorola Suzhou IC design center accomplished two goals:

(1) It is able to upgrade and accumulate technology competence from low-end product adaptation to new product design for the mid-term market (e.g. microprocessor of the A6188 smart phone).

(2) It strengthens the R&D organizational linkages (e.g. collaborate with other IC centers in Tianjin, Hong Kong or even Singapore).

**The Motorola’s Joint Research Labs (a technology diffusion platform)**

MNC-University Joint Research Labs (JRL) is a good example to illustrate how MNCs co-develop with local knowledge assets. Both MNCs and large local firms like to form JRL with famous universities in China. The results of JRLs are mixed. Not many of these labs carry out genuine joint research projects.
Most MNCs use JRL merely as an image building gesture. The firms donate equipment or provide funding (usually 1-3 million RMP per year) to the JRL without engaging in any substantial joint research with their university partner.

Unlike these cases, Motorola’s semiconductor sector provided 12 millions US worth of funding and equipment to set up the first Motorola MCU JRL in the famous Tsinghua University in May 1995. (Its more precise name should be the Motorola MCU (Microcontroller) Application Center (MAC)). This lab improves the research capability of the Tsinghua University on embedded system and micro-computing application. After the successful Tsinghua JRL, Motorola set up 14 more MCU JRLs in engineering universities all over China. Unlike most MNC JRLs, Motorola’s MCU JRLs do not merely donate equipment, but also involve in designing the training programs for the labs. Faculties, students and trainees from the industry are constantly exposed to the Motorola MCU technologies through experiment, building new tools and functional modules, research and training. Why does Motorola’s JRL interact more closely with the local institution – university – than other MNCs?

Motorola observes a situation that can help diffuse its products in China. To raise more funding, some MCU JRLs provide practice solutions to private companies. Students are therefore, exposed to real case applications of MCU in their training. It is not a coincidence that the Motorola MCU JRLs choose ‘Motorola MCU’ (and not MCU from competitors) as the ‘best solution’ for their private clients. It is a result of their familiarity with this technology – a lock-in effect. Thus, MCU JRL serves as a very good
medium for the diffusion of the Motorola MCU products and services from the universities to the industries.

The MNC-University JRL is a very common method MNCs use to interact with the local knowledge assets. Successful JRLs such as the Motorola MCU JRLs serve three purposes:

1. It trains a new generation of experts who constantly research and improve on the Motorola technological platform. The experts, in return, uphold the reputation of the Motorola MCU technology.

2. It serves as a medium for the diffusion of the Motorola standard from the university to the industries through direct services and the mobility of the graduates and trainees.

3. It becomes an outreach network of the Motorola RIN to tap into the human resource hubs (or clusters) of famous engineering universities across China.

**The upgrading of the Motorola RIN in China**

We can now move from explaining the upgrading at the micro-level case studies to look at the evolution of the Motorola RIN in China as a whole. Its upgrading happens as a co-development with the Motorola GIN and the local institutions.

As the technology leader of handsets in the 1970s, path dependence on analog technology has resulted in serious defeat by the digital handset technology led by the European firms. In 1998, Christopher Galvin, Motorola’s then newly appointed CEO made a decisive shift to the digital platform to
rescue its losing handset market. Accompanying this shift was a shift towards more market-driven innovation strategies.

By taking the market seriously, Motorola’s GIN remakes its supplier-driven commodity chain into a more integrated model, putting the research, development, manufacturing and sales in a parallel process. Innovation now focuses on making the parallel process and dynamic interface work together. To do this, Motorola opens up its product development process to other departments. The sales department inputs on client demands, raw material supply and other information. At the same time, the manufacturing department gives suggestions on technology solutions to the product in question. This parallel process of innovation eliminates the asymmetry of information and the technological gaps between various groups.

This more integrated form of market-driven innovation process manifests itself spatially, leading to a tendency of reintegration of R&D centers at the sites of production and the market. By 1998, China is already the largest manufacturing site and the second largest market for Motorola. Therefore, it is logical for the GIN to reintegrate with the ‘point of sales’ and the ‘advanced manufacturing site’ in China.

To achieve the above goal of reintegration, Motorola underwent tremendous effort in making Beijing its major R&D center in the late 1990s.

Figure 4
In the first phase of R&D restructuring in China (1993-1997), Motorola’s R&D centers were limited to asset-exploiting units (technology-transfer and supporting unit) that focus on production and some product localization activities. The technology flow was mostly one-way technology transfer from the GIN to the in-factory technology transfer unit in Tianjin and the technical support center in Beijing (See Figure 4).

In the second phase (1998- ), the tendency toward more ‘market-driven R&D’ worldwide results in the intensified reintegration of R&D functions with the production sites, leading to the mushrooming of many advanced R&D centers in China. Firstly, new MD centers appeared in two forms. (1) The one upgraded from production and technical support units, such as the PCS R&D center mentioned above. (2) The new IC design houses established near their clients in the IT clusters of Suzhou (hence the Suzhou IC design center), and later Tianjin. Secondly, two new TD centers appeared. (1) The Motorola Advanced Technology Center (MATC) in Tianjin, which focuses on basic/applied research on new materials used in the manufacturing process. (2) The Shanghai Motorola China Research Center (MCRC), which focuses on basic research on human-machine interaction and speech technology. Thirdly, three new CD centers – such as the GSG – were setup to provide software support for the existing R&D centers within the Motorola RIN. Fourthly, there are many upgraded PD centers focusing on various different Motorola products. (See Chen (2004) for details on the evolution of the Motorola’s PD and CD centers).
In sum, the establishment of new R&D centers upgrades the Motorola RIN from a mere manufacturing complex with technical support to a full blown RIN, which includes all the four types of centers, namely CD, PD, MD, and TD. In addition to the increase in the spectrum of R&D activities, the RIN is upgraded in two major ways:

(1) The collaboration and networking between centers increased, e.g. the collaboration between IC design houses and the establishment of three software centers to serve all R&D centers.

(2) The upgrading of organizational and technological capabilities is made possible because of the close interaction of the RIN with the local clusters. IC design centers (MD centers) benefit from the OEM clients in the industrial clusters of greater Shanghai and Tianjin. MCU JRLs are established in many top universities to tap into the human resource clusters to secure badly needed skilled labors and to diffuse Motorola’s technological standard.

As a result of the upgrading of technology and organization, the nature of knowledge flow also shifts from mere one-way technology transfer to two-way knowledge flow (Figure 4). Through more collaboration on global R&D projects, Chinese R&D centers increase knowledge exchange with centers in other countries. Motorola’s China RIN has since increased their collaboration not only with the labs in first-tier cities in France and Germany, but also with second-tier cities in Singapore, India and Hong Kong.

We now move from a hardware MNC case to a software MNC case. The Microsoft case will
illustrate the critical role of the Chinese returnees and the local entrepreneurial engineer culture as stimuli for rapid upgrading.

**Microsoft’s Global Innovation Networks**

The Microsoft GIN is simple. It has dispersed basic research in many locations, and a centralized product development center in Redmond, Washington. The headquarters of the basic research networks Microsoft Research (MSR) is also located in Redmond (1991). The other centers include the MSR in Cambridge (1997), two small MSRs in the San Francisco Bay Area (2001), MSR in China (1998), and MSR in India (2005).

Before the establishment of MSR-Redmond in 1991, the Global Development Group (with around 20,000 employees) in Redmond was responsible for all the R&D of Microsoft. Even with the global MSR networks, a vast majority of the new product R&D was still carried out by the group. Microsoft centralizes development in the U.S. mainly because it is a professional software company. It wants to avoid the development of sensitive software in countries where intellectual property protection is fragile. This is especially true at the product development stage, when leaking of the source code can be devastating.
Microsoft Regional Innovation Networks in China

Microsoft R&D in China began with one R&D center focused on product localization founded in 1993. In addition, Microsoft also has a large global technical support HQ in Shanghai – upgraded rapidly from technical support for Chinese clients to Asian clients and now global clients in less than 5 years.

However, these two centers do not play a critical role in the Microsoft RIN. Thus, we will only focus on two TD centers undergoing massive upgrading in a very short period of time. They are the MSR-Asia (basic research) and its spin-off – Advanced Technology Center (new product development) – co-located in Beijing’s Zhongguancun (ZGC).

Figure 5

Microsoft Research-Asia (a TD center)

The main purpose of Microsoft Research Asia (MSR-Asia) is to do basic research, apply them to new products, or add new value to existing products. All MSR-Asia team managers have full autonomy from their Redmond headquarter to set their own research agenda, hire engineers and set goals. Team members from different labs constantly interact among collaborative labs. MSR-Asia in particular, is a large team with 180 researchers focusing on advanced user interface, networking and wireless, next-generation multimedia, and Asian information processing technologies.
MSR-Asia claimed that in 5 years, more than 70 different technologies advanced and developed at the lab were already entrenched in a broad cross-section of Microsoft products, such as Xbox games, Tablet PC and the new Office System. On average, they transfer more than one new technology into products each month (Microsoft, 2003a).

The eagerness to commercialize their technology can be illustrated by the engineers’ frequent flights between Beijing and Redmond. With less than one-third the number of engineers as compare to MSR-Redmond, MSR-Asia spends three times more on flight budget for its engineers. Due to the importance of face-to-face communication, researchers of MSR-Asia constantly fly to Redmond to demonstrate their new ideas to MSR-Redmond and the product development colleagues. First, they have to present their findings and get support from Redmond. After approval, they have to work closely with the product development team at Redmond to do more testing and refinement until the technology transfer is finalized. The constant urge of MSR-Asia to sell their ideas to the product development team in Redmond and see their research turn into products is a key characteristic of MSR-Asia. This is a major sense of achievement for its Chinese engineers.

The success of MSR-Asia depends highly on the Chinese returnees from the Silicon Valley. Before returning to China, the founder and chief scientist of MSR-Asia, Kai-Fu Lee, was the president of the Silicon Graphics Inc’s multimedia software unit and vice president of Apple Computer’s interactive media group in the U.S. Since he has authority in the areas of speech recognition, artificial intelligence,
3-D graphics and internet multimedia, it is not surprising that MSR-Asia’s main research projects were actually built around him since 1998. Later, Ya-Qin Zhang took over in 2001. Zhang’s expertise on Digital TV, MPEG, Multimedia and Internet technology added to the list of MSR-Asia’s core research agenda. The autonomy of MSR-Asia was highly tied to the expertises and decision making ability of the director.

However, the director cannot work alone. To jump-start the green-field research in Beijing, the founder Kai-Fu Lee – originally from Taiwan – invited more than 10 widely known Chinese scientists from the U.S. labs of SGI, Hewlett-Packard, RCA and Digital Equipment Corp to come back to China to build his dream team. These are all Chinese returnees, the so called ‘transnational technology community’, who are already established engineers or scientists in the Silicon Valley for 10-30 years. In fact, it is a conscious effort of these Chinese returnees to mimic the path of high-tech development from Taiwan 20 years ago.

‘The China mainland is similar to Taiwan 10 or 20 years ago. Some international talent went back to Taiwan at that time, and most of them have succeeded and the industry taken off. It’s a fact that the China mainland will exceed Taiwan in the near future, so a lot of people have considered returning to China at the dawn of this Change,’ said Kai-fu Lee. (Liu, 1999)
In the second year after its establishment (1999), Lee had already recruited 11 Chinese returnees leading 65 researchers. Most of the research projects in MSR-Asia are led by experienced Chinese returnees.

Newly recruited researchers at MSR-Asia are usually given a few months to decide on research topics that they are passionate about, instead of topics that they know best. Cross-fertilizing among research groups is highly valued in MSR-Asia. This is a major difference between R&D centers focusing on basic research and those focusing on product development. In basic research, researchers are given a free hand to choose the topic that interests them most without rigid result deadlines. This kind of more relaxed atmosphere is similar to that of Bell Labs Research China and IBM China research labs that target basic research in the late 1990s.

The ‘enthusiasm’ of the engineers of MSR-Asia to reach out to the development group is not an original part of the design of MSR-Asia. Rather, it is a slow evolution based on the specific engineer culture in ZGC, Beijing. My interviews with Chinese engineers show that many of them are impatient with basic research. In an atmosphere where entrepreneurship is highly celebrated, especially in ZGC, many engineers still dream of selling their invention and getting rich. The impatience can be felt in the air of ZGC, where thousands of students discuss in their rundown dormitories about how and when to start a company. Not surprisingly, many begin their startups in the dormitory. The entrepreneurial spirit is not much different from Stanford or MIT in the 70s and 80s. However, the condition for startups in China is
much worse than their U.S. counterparts, mainly because of the imperfect capital market and the lack of institutional support. Venture capital is virtually non-existent in China. Despite the NASDAQ crash, the entrepreneurial spirit remains high among engineers in Beijing.

Therefore, it is not surprising that MSR-Asia has a higher ‘(reverse) technology transfer’ rate than other MSR in Cambridge and the Silicon Valley. In fact, the urge to get their ideas into products make these engineers the intangible assets of the company. It is a key managerial wisdom to keep these researchers committed to their research and loyal to the company. In other words, in order not to make them feel ‘bored,’ the project managers have to constantly bring challenging topics to the team, provide them chances to go to meetings, expos or even meetings with Bill Gates.

In short, the entrepreneurial spirit, the excitement of turning research in products, and the charismatic director as a cultural bridge are the major drives behind MSR-Asia. In this way, it gradually transforms itself from a basic research lab to a hybrid lab devoted to commercializing new products from the result of their basic research. Thus, it ends up producing more reverse technology transfer and distinguishes itself from the rest of the MSR worldwide.

**The Digital Ink Project: From ideas to product**

I will analyze the research and development process of ‘Digital Ink’ to demonstrate the process of ‘experimental learning,’ which creates an intensive two-way flow of knowledge between MSR-Asia and the Redmond development center. I will also show how it is eventually incorporated into a global product.
sold worldwide.

Digital Ink Technology was the brain-child of Wang Jian, a senior software engineer in the Multiple-User Interface group of MSR-Asia. It becomes the core technology, which distinguishes the Tablet PC from notebook computers. Without Digital Ink, Tablet PCs would simply be a notebook with handwriting recognition. This is one of the many highly recognized and popularized inventions of MSR-Asia.

Wang Jian joined MSR-Asia in mid 1999. He brought with him an idea to perfect a natural form of human-machine interaction.

‘Before I joined Microsoft, I focused my work on interaction in 3D systems, like virtual reality … But after working on this for more than five years, I started thinking we should provide a more natural interface for the work people do everyday instead of developing an interface for a more specialized system, like virtual reality,’ said Wang Jian.

Soon after the project began, Wang learned about the Tablet PC project in Redmond and researchers got together and started collaborating. Wang headed the work on ink parsing, the technological base of digital ink. Digital ink attempts to make sense of what is being drawn on the tablet so users can benefit from the computing power in the device. According to Wang, ink parsing technology is how computers understand free form notes. The technology needs to recognize whether people are writing, drawing or
sketching. In short, ink parsing is a foundation for understanding the ‘natural note taking’ process. Ink Technology however, keeps writing in its original forms, but not in a graphic form such as the PDF or the JPG formats, which are too large and cannot be digitally analyzed. The user can use a search function (so-called fuzzy search) to locate the keyword of particular notes on particular pages. (Ross, 2002)

Before Wang’s independent research on Digital Ink, the Tablet PC research team in Redmond has already begun research on handwriting recognition for the Tablet PC. However, their note-taking application has met severe problems, because ‘it only allowed users to write in neat horizontal lines across the page, from left to right, in perfect grade-school precision,’ according the Suzanne Ross, a team member of the project. If a user starts to write sideways, vertically, in circles or at the margin, the recognition will not work. (Ross 2002)

While this Redmond team was having this ‘disciplinary writing’ problem, Wang Jian brought his team to Redmond in April 2000 and presented (Wang Jian used ‘sell’ instead of ‘presenting’) their ink processing technologies to Bill Gates and Alex Loeb, the Vice president of the Tablet PC group.

In fact, Wang Jian first presented his idea at the Microsoft ‘TechFest 2000.’ He was surprised to find Bill Gates listening quietly to his ideas among the crowd. Wang recalled that not many people knew the existence of MSR-Asia during his first visit to Microsoft Redmond after the TechFest. When they

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4 Microsoft’s annual ‘TechFest’ is designed to let different research teams from different MSRs come together to present their new ideas and findings. ‘TechFest’ is a rare occasion in which ‘R’ and ‘D’ people meet face-to-face. In fact, many new collaborations begin from this meeting.
presented their Ink-technology to Bill Gates and the Tablet PC team, the Tablet PC team discovered that Wang’s ideas has the ability to support skewed writing in note-taking instead of neat horizontal writing, a potential solution to their ‘disciplinary writing’ problem.

The presentation has impressed both Bill Gates and the Tablet PC department at Redmond. The two departments, MSR-Asia and the Tablet PC department under the Redmond Development center, decided to work together.

It was not until May 2001 that the first version of Ink Technology was completed. In July 2001, during a Bill Gates meeting, Digital Ink Technology was officially incorporated into the first version of the Tablet PC. Immediately, MSR-Asia formed a special task force of 12 people. Three of them took turns to work with the developers in the Tablet PC department until the launching of Tablet PC in Nov. 2002. After the launching of the first version of Digital Ink Tablet PC, Wang and his team continued to research and improve the technology.

The case study of MSR-Asia and its Digital Ink project demonstrates the synergy of local entrepreneurial engineering culture and the transnational technological network (led by the Chinese returnees,) in speeding up the commercialization process. It also reflects the need of close face to face interaction in the whole innovation process.
Advanced Technology Center (a market-driven center)

As a result of the increasing need for (reverse) technology transfer from Beijing MRS-Asia to Redmond, a flexible organization – the Technology Transfer Group (TTG) – was set up in late 2001 to handle the journeying and communication between the two continents. However, the main problem is not the pain of long flights or the 16 hours time difference between the two continents. The real problem is incompatible priorities between the research and development teams. When researchers hand off an invention to the product developers, the developers are often preoccupied with improving the existing product and rarely have time to refine and test the new invention in order to commercialize it. Therefore, after the success of the ‘Digital Ink’ and 10 other projects, MSR-Asia decided to set up a new product development organization to refine and test the new code invented by MSR-Asia.

The birth of the Advanced Technology Center (ATC) in 2003 is the result of this effort to bridge the gap. The ATC program managers team up with relevant Redmond product groups to develop and refine codes handed off by the researchers from MSR-Asia into global products. Since the establishment, many of the ATC products have gone into the Windows XP operating system, such as Movie Maker 2.1, a video-editing technology that can easily summarize sports and news highlights, and compress an hour of video into five minutes (Ruderi, 2005).

Due to the unique position of the ATC as a critical building block within the Microsoft global
innovation networks, it has grown very fast, from 20 employees in 2003 to 100 at the end of 2004, after receiving more than 30,000 resumes (Ruderi, 2005). Microsoft CEO Steve Ballmer was so confident about the ATC that he eliminated the ‘ceiling’ for the employee size for the ATC. However, the ATC has difficulties finding qualified software developers. The ATC needs experienced software developers, and not mere programmers, which is actually lacking in China because of its short industrialization experience. As of 2006, the ATC is still aggressively recruiting software developers not only from Beijing, but also from the whole China.

The need for close interaction between research and development has resulted in the spin-off of the development center (ATC). The MSR-Asia ‘basic research’ center is upgraded to an integrated ‘research & development’ center. In the process, transnational (cross-border) trust and institution (ATC) are built to further institutionalize the ‘two-way knowledge flow’ between MSR-Asia and the development team in Redmond.

**The upgrading of the Microsoft RIN in China**

The Microsoft regional innovation networks in China take three phases to complete. In the first phase (1993 to 1998), it only has a product localization unit set up as a political gesture to please the Chinese government. The focus of Microsoft was to aggressively penetrate the Chinese market. It paid little attention to R&D investment.
In 1997, Microsoft filed a lawsuit against two local retailers that loaded pirated Microsoft software onto personal computers. It created a public outcry, and Microsoft became the symbol of the aggressive monopoly bulldozing its way into the Chinese market. In the height of anti-Microsoft sentiment, Bill Gates decided to launch MSR-Asia – a basic research center in Beijing, its first in the developing countries (see Chen, 2004).

Figure 6

From the day of its establishment, MSR-China has to prove to the public, the government and the engineering community in ZGC that they are genuinely doing useful research for the benefit of the Chinese software industry and are not using very high salary to ‘buy out Chinese brains’ in ZGC, as the media criticized. The external pressure forced MSR-Asia to be transparent to the public and the engineer community in ZGC, Beijing. These dual purposes of transparency and commitment to basic research—that is more accessible to the public – give MSR-China its distinctive porous and accessible character, which is different from the stereotypical ‘secretive’ R&D centers of MNCs and local firms.

In phase two (1999-2003), by aggressively recruiting experienced Chinese returnees to lead the center, MSR-Asia was able to ‘jump-start’ into new technological domains, which are not the existing
knowledge in ZGC. Instead of *mining* on the existing knowledge base of ZGC, MSR-Asia uses the highly skilled labor, experienced Chinese returnees and its superior development capabilities in Redmond, to *create* new knowledge, new technology and new organization.

In phase three (2003 - ), as the result of the close collaboration, MSR-Asia ‘upgrades’ its basic-research facility to include a highly secretive product development center – the Advanced Technology Center (ATC)— the first development center outside Redmond. The task of the ATC is to incorporate the algorithms invented in MSR-Asia into commercial global products. More importantly, the ATC helps MSR-Asia to remain a strong basic research center. According to director Zhang of MSR-Asia, the purpose of setting up the ATC is to allow ‘streamlining technology transfer with ATC, [so] we will enable researchers [at MSR-Asia] to remain focused on solving the hard problem in computer science that the industry is faced with.’(Microsoft, 2003b)

With both the ‘R’ and ‘D’ set-up in ZGC to target strategic basic research and development, the Microsoft innovation networks expand aggressively by forming joint-research labs (and thus research networks) with many top universities in greater China, which includes Hong Kong and Taiwan (See Figure 6).
V. Discussion

Comparing the MNC RINs in China

Motorola and Microsoft represent two unique types of MNC R&D networks in China with very different starting points. Motorola follows the evolutionary process, starting from one end (CD and PD) and slowly expanding towards the other end (MD and TD) through a localization and learning process. In contrast, Microsoft begins with both ends (TD in Beijing and CD in Shanghai), with the middle section (MD, i.e. the Redmond Development center) staying exclusively in the home country. By building a dream team of experienced Chinese returnees and motivated local engineers, the TD center based on basic research (MSR-Asia) was able to rapidly spin-off another hybrid TD/MD center based on the development of new products (the ATC).

With two extreme starting points, both RINs eventually converge and cover a wide spectrum of R&D activities in China. Most of other MNC RINs have certain combinations of these two models, and gradually build their RIN from an ‘experimental’ phase to a more ‘integrated’ phase.
Table 2 shows a complex and diverse picture of the localization of the two MNC RINs in China. In less than one decade, both MNCs have upgraded their RIN to include asset-exploiting and asset-seeking types of global R&D. Table 2 summarizes the major characteristics of both RINs. I will further explain two different upgrading models: the bottom-up evolutionary process vs. the top-down evolution process.

**Bottom-up evolution process: The agglomeration of production networks and demanding local customers**

As a hardware company, Motorola went to China to exploit its ‘world factory’ condition, characterized by low production cost and the agglomeration of telecommunication industrial clusters in Tianjin, Beijing, Shanghai and Shenzhen. The dense network of suppliers from all over the world (especially from Taiwan) has made China the major telecommunication equipment production site (Yang and Hsia, 2004). However, the external advantage is not sufficient without improving internal organizational absorption capability. As early as the early 1990s, Motorola has started improving its absorption capability to facilitate technology transfer. Through English language training (instead of translating Motorola’s technical documents into Chinese) and systematic internal training at the Motorola University in Tianjin, Motorola improves the absorption capabilities to facilitate the first ‘asset-exploiting’ stage. Some argues that Motorola’s 100% ownership advantage in manufacturing, in contrast with most foreign-local joint-ventures in the early 1990s, provides Motorola with incentive to
invest heavily in internal training. Thus, it improves its absorption capability faster than its joint-venture competitors (Burkley, Clegg and Tan, 2005).

This prior competence accumulated in the ‘asset-exploiting’ phase was important for Motorola’s ‘upgrade’ to the new product development phase. For example, the PCS R&D centers transformed from the exploitation of the best practice knowledge to creating products. The success of Motorola is its ability to build on critical organizational know-how, international transfer of technology and tacit knowledge, and the adaptation of technologies to different production and market environment (e.g. Kagut and Zander, 1995).

Industrial clusters and internal capability training is not enough without the competitive Chinese domestic market in IT products. Chinese urban consumers have unusually high demand for the ‘newest’ and ‘latest’ technology with affordable price. They would not trade off between the price and technology (Chen 2006). A good example, the DVDs quickly phased out the VCDs, demonstrating the uncompromised desire of the urban Chinese consumers for ‘high-tech’ products. Due to this unexpected demand for ‘high-tech’ (DVD player) goods, the DVD player almost wiped out the VCR immediately after it hit the Chinese market in the 1990s. The usual assumption that a developing country will start off consuming inferior and cheaper products obsolete in the developed market (such as the VCR), and upgrade to higher-end products later (such as the DVD), was proven to be a deadly mistake that cost many VCR makers to lose out in the China competition.
Fierce competition from local firms on price, and high demand for newer products from consumers have forced MNCs to reorganize and reintegrate their operations in China in order to meet the challenge of shortening product cycles. Many soon realize the imperative to reintegrate R&D, production, distribution, sales and services in China. As a result, many MNCs set up MD and PD centers to integrate with existing production and sales networks. With MD centers, it is possible to compete in high-end products with other foreign MNC rivals and local imitators (e.g. smart-phone and CDMA phone with RIUM card are all targeting the high-end market). With PD centers, it is possible to lower the production cost to compete with the local Chinese firms on low to medium end products. As a result, almost all the major brand name producers, Motorola, Ericsson, Nokia, Nortel, Samsung, Matsushita, Alcatel, Philips, NEC, Lucent Technologies and other communication MNCs have set up their R&D centers in various ‘integrated’ ways in China to support their design, production and sales as well as their suppliers and vendors.

**Top-down evolution process: The synergy of Chinese returnees and local entrepreneurial culture**

At the other extreme, without any prior technological competence embedded in the local knowledge economy, MSR-Asia and other MNC TD centers manage to jump-start green-field basic research in China. In a short period of time, some of them managed to transform themselves into fast learning organizations.
There are three conditions that make this unusual upgrading process possible.

Firstly, it is the locational window of opportunity. Many MNCs (such as IBM, Intel, Nokia, Motorola, Microsoft) have already identified the new technologies in the future market of China and Asia in general, and thus begin their advanced research on these areas of multiple user interface, wireless network application, next generation multimedia, and natural language processing. These are the new technological domains that are not yet well established in the advanced countries, giving opportunity for other places to ‘jump-start’ or ‘catch-up’ (Storper and Walker, 1989). Many large MNCs have rushed to set-up their TD centers, including Microsoft, IBM, Intel, Motorola, Lucent Technology, Samsung, LG, Panasonic and so on. Thus, we are witnessing a re-agglomeration of TD centers focusing on the future market of the ICT sector.

Secondly, it is the synergy of Chinese returnees and local engineers. Experienced Chinese returnees are the key bridging agents between the western R&D management and the local engineer culture, especially in the MNCs from the U.S.. The synergy created by the interaction between these Chinese returnees and the local entrepreneurial engineers make it possible to create a learning organization that is able to create new knowledge.

Thirdly, it is the exploitation of academic assets in ZGC and major universities in other city-regions. Through managing an academic-like atmosphere, MSR-Asia excels in tapping into the academic-alumni-student networks (Chen, 2007) centered around major campuses in ZGC. This relatively
porous institution aggressively make linkages with the surrounding universities through many programs, such as intern-ship program, joint research labs, visiting scholar program, joint-conference and so on. This has created opportunities for cross-fertilization, making the ‘jump-starting’ (or leap-froging) of new research possible.

**The impact on China’s innovation systems: Formation of the new technological community**

The phenomenon of MNCs localizing R&D in China has a very short history of less than 10 years. It might be too early and difficult to assess the impact on China’s national innovation systems (NIS) at this stage. For example, patent analysis is out of the question because most MNCs are just starting to apply for their patents. However, we can make a tentative assessment. There are two negative and two positive impacts on China’s NIS from the standpoint of local firms and local research institutions.

**The negative impacts**

First, MNC RINs have intensified the competition for talents in Beijing and Shanghai, forcing some MNCs and large local firms to move their R&D centers to less developed cities in order to avoid ‘overcrowding’ (Sun and Wen, 2007; Chen, 2004)). Local research institutes have a hard time keeping their best researchers from leaving for the MNCTD centers. Local firms have to increase the salary and
benefits to compete for the talents.

Second, the asymmetry of technology capabilities between MNCs and local firms poses the danger of motivating the local firms to give up on technological development and focus only on complimentary collaborations with MNCs. One way of complimentary collaboration is to encourage MNCs to focus on their strength in technology development while local partners focus on their strength in distribution, after-sale service and getting loans. These ‘win-win’ situations in the short-run might create technological dependency in the long-run (Chen 2007).

The positive impacts

First, the localization of MNC R&D in China provides demonstration effects for the local firms. The clustering of MNC R&D centers in Beijing and Shanghai has raised serious issues about the lack of core technology competence among local ICT firms. Many large firms have since begun to invest in their research labs. Legend (now Levono after purchasing the IBM PC sector) set up their own research labs in 1999 to diversify its PC based products. In addition, the mobility of senior researchers from the MNC R&D centers to the local firms and local research institutes allow them to bring their embodied Western R&D management knowledge to the local organizations.

Second, the three-way mobility of researchers among local public research institutions, local firms and MNC R&D centers might facilitate the emergence of a local technological community based on
certain technological domains, which arose from the locational windows of opportunity. One example is the speech technology community in Beijing, and Shanghai to a lesser extent.

According to my informant (who left Intel China Research Center for a local company in late 2002), the Institute of Acoustics at the Chinese Academic of Science (CAS) has been doing research on Chinese speech since the 1960s, together with three major research labs in Beijing - two major labs at the Tsinghua University and another one at the CAS. Before the 1990s, despite the eagerness of researchers in these public research institutes to reach out and commercialize their research, very few succeeded in coming close to marketable products. The reason is the paramount difficulty for these public research labs to break away from their Soviet style mission-oriented innovation model, which did not bother about the market in the past.

In the early 1990s, the Institute of Acoustics at the CAS has already begun to reach out to the MNCs, even before the establishment of MNC R&D centers in Beijing. It had a 5 year joint research project with AT&T since 1993. After the arrival of TD centers in ZGC in the mid 1990s, TD centers of Microsoft, IBM, Intel, Nokia and Motorola all do research on speech technology. For example, IBM was focusing on localizing its famous ViaVoice technology to cater to the Chinese and Cantonese languages. The Intel team was doing research on inventing a speech chip that can process human language faster. All these MNC R&D centers have different degrees of collaboration with the public research labs mentioned above through join research, providing funding, and other informal interactions. Many students and faculties
from the Local labs are recruited to work in the TD centers. Inevitably, many of them continue to have informal exchange of ideas and information with their former mentors in the labs.

The collaboration with the TD centers does not necessarily improve the ‘technology’ level of these local labs. However, it is more about exposing the local labs to the technology frontiers, and stimulating their desire to catch-up with the latest competition in these frontier technologies as demonstrated by the TD centers. It also encourages their participation in publication, conferences and dialogues with the international technology communities.

I asked another ex-researcher who left Intel China Research Center to work in a local firm about the idea of a ‘speech technology community’ in ZGC. His reply is:

This is an interesting idea [technology community] that I have not seriously thought of before.

Now that you have mentioned it, we do have former classmates [from the local labs who are now working in different companies] having a weekly gathering at a Taiwanese café at Nanqiying [a hangout place in between Tsinghua University and Peking University]. We talk about our work, latest technology, life and also job opportunities in this field.

Internet BBS forums also help to tie this community together and enlarge its reach to include
research teams outside Beijing, such as Jiaotong University in Shanghai. Many graduate students in this field are exchanging information about the expertise and compare the advantages and disadvantages of working in the public labs and the TD centers.

These informal network-building goes beyond looking for a good job towards building a new technology community that was non-existent (or fragmented and isolated) in the past. In the middle of the ‘speech technology community’ building blocks is the cluster of TD centers. This newly created technology community (both real and virtual) has potential to become the true bearer of technology accumulation in China for years to come.

The encounter with the MNCs TD centers not only creates competition for technology breakthroughs, but also arouses national pride to build strong ‘national enterprises’. In 2000, a confident local ‘text to speech (TTS)’ company founded by CAS graduates initiated a proposal to fund and glue the CAS Institute of Acoustics and the CAS Institute of Linguistics together to kick off a new round of research on China’s own speech technology. Their imaginary competitor is IBM and its well established ViaVoice product. The ambition of this local CAS graduate is to set up the ‘Bell Labs of China’ to retain the talents in the CAS joint-research labs, so the local researchers have a chance to choose to stay in the well funded public research labs, instead of going to IBM, Microsoft and other TD centers.5

There are still much research to be done on the formation of the local technological community

5 “Special Interview with Liu Qingfeng,” CTI forum September 9, 2004 http://www.ctiforum.com
stimulated by the present of MNC TD centers, and their aggressive interaction with the local knowledge assets. I suspect that this form of informal technology spillover through the mobility of researchers will have the most significant impact on the national innovation systems of China.
VI. Conclusion

The tentative findings in this research seems to suggest a potential new stage of globalization of R&D characterized by MNCs moving beyond the dichotomy of ‘advanced research in the Triad countries’ and ‘low end routine research’ in the developing countries. MNCs began to seek a wider scope of assets from a greater geographical scope, especially targeting the large emerging market economies since the mid 1990s, such as China and India. In trying to create new technology for the future market and dominate the current market simultaneously, MNCs gradually relocate their Technology-Driven centers and Market-Driven centers respectively to these fast growing emerging markets. This finding echoes Pearce’s findings on the tendency of the MNC R&D subsidiaries in the U.K. (Pearce, 1999), except that it is now extended to China, and possibly India.

In other words, the combined factors of a dynamic large market, highly motivated and entrepreneurial engineers and the mediation of the transnational Chinese returnee community are the main motivations behind the new stage of globalization of innovation in which large MNCs take the risk of over-stretching their global innovation networks (GIN) to the developing countries. These risks are largely reduced by improvement in communication technologies, web-based R&D technologies, and global R&D management skills (Boutellier, Gassmann and von Zedtwitz, 1999).

To further reduce the risk, most R&D centers begin as small experimental units, often in the
production and product adaptation unit or software development unit. MNC R&D centers are often
‘surprised’ by the highly motivated engineers and highly demanding consumers during their close
interaction with the local institutions. This encouraged them to gradually expand experimental units to
full-blown R&D centers through an evolutionary and learning-by-doing process. Besides the increase in
scale and scope, the technology level of these centers often rise gradually (or rapidly) from ‘experimental
R&D units’ (with a few exploratory research projects) to ‘strong research units’ that might lead particular
technology domains within the GIN. The upgrading of individual R&D center requires strong and
supportive regional innovation networks linked to the global innovation networks. This results in a
multi-way flow of new knowledge among units within the RIN and GIN.

In this light, China is unique only in the sense that it attracts both asset-seeking and asset-exploiting
types of innovation embedded in the MNC’s regional innovation networks in the evolutionary process
Thus, a few large city-regions in China may represent an example of city-regions in a developing country
poised to capture the critical asset-seeking innovation functions of MNCs, which used to be confined in
the Triads in the last century. Only the near future will tell whether this is really the case and whether, as a
result, new dynamics of comparative advantage are really coming into existence in the world economy.
References


and Path-Dependent, but Not Much Variety. Research Policy 26, 141-156.


FIGURE 1: LABORATORY LOCATIONS ABROAD 1995

Source: Figure 2 of Kuemmerle (1999): 186
FIGURE 2: THE LOCALIZATIONAL LOGIC OF MNC R&D CENTERS IN BEIJING AND SHANGHAI

Regional Innovation Networks

- **Technology Driven**
  - Basic & Applied Research (BR & AR)

- **Market Driven**
  - Enhanced Development (ED)
  - Product Innovation

- **Production Driven**
  - Advanced Development (AD)
  - Process Innovation

- **Cost Driven**
  - Local, regional & global technical support (TS)

**Beijing city-region**
- Concentration of human capital in basic research
- Strong alumni-scientist community
- Proximity to Zhongguancun IT district
- Capital City effect (proximity to the central government agencies)

**Shanghai city-region**
- Vibrant local business environment
- Effective local governance
- Multiple Industrial clusters
- Advanced service clusters

Source: Modified from Chen (2004), Figure 9.1, page 492.
# Table 1 Motorola’s Globalization of Production and Innovation 1970 to 2005

<table>
<thead>
<tr>
<th>1st wave (70s)</th>
<th>2nd wave (early 80s)</th>
<th>3rd wave (late 80s)</th>
<th>4th wave (late 90s)</th>
<th>Fifth wave (Since 2000)</th>
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<tbody>
<tr>
<td>All R&amp;D remains in the US.</td>
<td>Manufacturing moves to developing countries, such as Hong Kong, Singapore and Malaysia (low cost).</td>
<td>Manufacturing moves to China (local market + low cost). Some low-end R &amp; D moves to first-tier innovative cities of Germany and France.</td>
<td>More “D” (and increasing “R”) move to China to reintegrate with its manufacturing. More low-end “R” (especially software development) moves to second-tier innovative cities in India and Ireland.</td>
<td>First-tier R&amp;D centers continue to exist while second-tier R&amp;D centers continue to expand slowly despite the financial downturn (due to global overproduction since 2001). Re-agglomeration and consolidation of whole value chains begin in China. From “R” &amp; “D” to manufacturing and sales.* New basic research labs set up in Shanghai.</td>
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<td></td>
<td>Major R&amp;D still in the US. Some advanced R&amp;D moves to first-tier innovative cities of Germany and France.</td>
<td>IC design centers also added to the manufacturing sites in Hong Kong, Singapore. Manufacturing begins to move to China from Southeast Asia.</td>
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<td>Major advanced R&amp;D still carried out in the U.S. and Europe.</td>
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</tbody>
</table>

Source: By author

*Note: New factories and new R&D centers continue to emerge in China, while other factories outside China either close down or stop expansion. For example, Motorola’s “asset light” restructuring by outsourcing its IC fabrication cut down its 27 front-end and back-end factories in 2000 to 10 by 2002 (8 IC fabs and 2 assembly and testing operations).
FIGURE 3 MOTOROLA REGIONAL INNOVATION NETWORKS IN CHINA

Source: By author.
FIGURE 4  MOTOROLA R&D ORGANIZATIONAL ‘UPGRADING’ 1992-2003

First Phase 1992-1997
(One-way technology transfer)

Second Phase 1998-2003
(Two-way knowledge flows)

BR: Basic Research (TD)
AR: Applied Research (TD)
ED: Exploratory Development, include Product Development (ED*: IC Design Center)
PD: Process Development (PD*: software development)
(PD*: Software Development)

Source: By author
FIGURE 6 THE UPGRADING OF MICROSOFT’S REGIONAL INNOVATION NETWORKS

First Phase: Before 1998
(One-way technology transfer)

Second Phase 1999-2003
(Two-way knowledge flows)

Third Phase: after 2003
(Center of Excellence)

Joint-research labs with many top universities in greater China regions

REDMOND, U.S.

BEIJING

PPA

REDMOND, U.S.

BEIJING

PPA

TS

SHANGHAI

REDMOND, U.S.

BEIJING

PPA

TS

SHANGHAI

R: Basic Research (TD)
D: Product Development (MD)
PA: Existing product adaptation and localization (PD)
TS: Technical Support (CD)

Two-way knowledge flow (strong)
One-way technology transfer (strong)

Two-way knowledge flow (weak)
One-way technology transfer (weak)

By author.
<table>
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<tr>
<th>Table 2</th>
<th>Comparing Regional Innovation Networks: Motorola vs. Microsoft</th>
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<tbody>
<tr>
<td><strong>Incentives to invest R&amp;D</strong></td>
<td><strong>MOTOROLA</strong></td>
</tr>
<tr>
<td>China</td>
<td>Production-driven (e.g. DDL) and increasing Market-driven (e.g. PCS) and technology-driven (e.g. Motorola China Research Center).</td>
</tr>
<tr>
<td><strong>Global Innovation Networks</strong></td>
<td>Dispersed Research (all over the world with increasing share in China) and Dispersed Development (all over the world, with increasing share in China).</td>
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<td><strong>Technology &amp; Product</strong></td>
<td>Localized product for local market, later customized to fit other global market. Both localized and generic process technology on improving design and production efficiency.</td>
</tr>
<tr>
<td><strong>Major R&amp;D locations</strong></td>
<td>Beijing. Most R&amp;D centers are located in Beijing to maximize the exploitation of the local knowledge assets and to support a relatively close manufacturing complex in Tianjin. Motorola has dispersed micro-controller joint-research labs in major universities all over China to promote Motorola own product and technology. Shanghai has added a basic research center. Two IC design houses are located in the IT clusters of Tianjin and Suzhou.</td>
</tr>
<tr>
<td><strong>Upgrading of the Regional Innovation Networks</strong></td>
<td>Motorola follows the conventional evolutionary path in which the R&amp;D centers follows the need to increase the efficiency of production and product adaptation to the local market. It began with a bottom-up upgrading demand of the existing manufacturing facilities, and slowly evolves into a more integrated network with MCRDI as the coordinating body of 16 R&amp;D centers (CD, PD, MD and TD) in China.</td>
</tr>
<tr>
<td><strong>Asset-seeking vs. asset-exploiting</strong></td>
<td>Asset-exploiting: ■ Upgrading of the manufacturing facilities ■ Decentralize new product development to compete in the current and future market in China ■ Engage in advanced product development to compete with MNCs and local imitators for the current and near-future market. ■ Engage in basic research to exploit the technological window of opportunity in the wireless and speech technology in the future Chinese market.</td>
</tr>
</tbody>
</table>

Source: By author.