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Motivations and barriers of foreign R&D activities in China

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The continued growth of the Chinese economy accompanied with the expansion of international investment in China has led to an increase of foreign research and development (R&D) activities in the country. Aside from the rising importance of R&D internationalization, research on foreign R&D in China has been neglected in the past due to its nascent state. In this article we examine drivers and barriers for conducting R&D in China. The focus of our research is on transnational companies which are typically characterized by decentralized R&D activities. Our research is mainly based on qualitative interviews with senior R&D managers. The success of foreign R&D activities in China strongly depends on the realistic estimation of its advantages and the proper identification and handling of barriers.

1. Introduction

China, the world's largest emerging economy, has become the most important investment destination for transnational companies (TNCs) for more than a decade. In 2002 China overtook the United States, as the biggest recipient of foreign direct investment, rising to an estimated US\$53 billion (Reuters, 2003). This clearly reflects the importance of the country's position as a major production site and marketplace for TNCs and also international investors' support for China's entry into the World Trade Organization (WTO) in November 2001.

Accompanied by a significant inflow of foreign direct investment, more and more TNCs are increasing their tendency for and involvement in local R&D activities. Equity-based R&D commitments are only part of TNCs' R&D endeavours in China. Most TNCs realize that their international expanding is a process of small steps to be taken in order to adapt gradually to the host country's unique environment. Previous research have shown that TNCs prefer to invest cautiously and benefit from experiences and knowledge gained from their prior operations and build upon the existing network of foreign value-added activities (Kogut, 1983; Li, 1995). This behaviour is in line with the results of recent research (Li & Zhong, 2003) which identified 276 international R&D alliances in China over the 1995 - 2000 period. They found that non-

equity-based R&D co-operative agreements outweighed equity-based R&D joint ventures.

Although one cannot ignore the increasing significance of foreign R&D activities in China, research on R&D management in China is still uncharted territory. In order to facilitate understanding of this recent phenomenon, our paper aims to answer three questions: (1) What are the most important motivations behind establishing R&D activities in China? (2) What kinds of barriers are TNCs' R&D managers facing?, and (3) What are the managerial implications?

2. Literature review

While R&D is usually one of the last objectives of an internationalization strategy (Mansfield, Teece & Romeo, 1979; Pearce, 1989), the process of R&D internationalization has continued in earnest. For example, between 1997 and 1998, the United States' foreign R&D spending, increased 28 percent, from \$17 billion to \$22 billion. While U.S. companies' overseas R&D spending reached \$17 billion in 1999, a growth of 25 percent (after adjusting for inflation) from 1997 (National Science Board, 2002).

R&D internationalization in the 1980s and 1990s was largely restricted to technology-based multinational companies. They strove to locate their R&D activities at centers of technological excellence, i.e. regions characterized by a high rate of new technology output. The pioneers of

R&D internationalization are high-tech companies operating in small markets, along with a scarcity of resources in their home countries (Gassmann & von Zedtwitz, 1999). Companies such as General Electric and General Motors in the USA, Toyota and Fujitsu in Japan, and Daimler-Benz in Germany had large home markets and a substantial domestic R&D base, meaning they had less pressure to internationalize their R&D activities. However increased competition from within and outside their industries in recent years has forced these companies to source technological knowledge on a global scale.

A principal issue in R&D internationalization is the location decision, which has been studied by a number of researchers including Brockhoff (1997); Pearson et al. (1993); Håkanson (1992); Gerpott (1994); Wortmann (1990); De Pay (1989) and Gassmann (1997) on various levels. These research works have produced invaluable knowledge that has immensely enhanced our understanding of the phenomenon of R&D internationalization. But this literature research on international R&D within the triad regions - USA, Japan and Western Europe. Country-focused in-depth researches were conducted for example in the U.S. (Ronstadt, 1977; Ronstadt, 1978; Mansfield, Teece & Romeo, 1979; Dunning & Narula, 1995; Dalton & Serapio, 1995), Japan (Westney, 1993; Papanastassiou & Pearce, 1994; Kenney & Florida, 1994; Asakawa, 1996; Odagiri & Yasuda, 1996; Asakawa, 2001), Sweden (Håkanson, 1981; Håkanson, 1992; Håkanson & Nobel, 1993a; Håkanson & Nobel, 1993b), and Germany (Wortmann, 1990; Beise & Belitz, 1996).

Nevertheless, recent developments of R&D internationalization have tended to take place outside of these traditional regions. While most R&D laboratories are concentrated in the triad countries, new R&D sites are now being created in the newly industrialized economies of South-East Asia.

In the broad field of R&D management in China, we have identified the following areas under investigation. One major research stream focuses on the macro perspective of R&D in China. The term R&D was often used as a synonym for national innovation and Science and Technology (S&T) systems. Issues such as evolutionary processes, structural and organizational particularities of Chinese R&D and innovation system were studied by Fischer (1983); Jin & Porter (1988); Brockhoff & Guan (1996); Guo et al. (1998); Liu & White (2001) and OECD (2002). A further and more recent research focus aims to outline the pattern and characteristics of foreign R&D activities in China (see Xue & Wang, 2001; Li & Zhong, 2003). Only few researchers have touch upon managerial aspects of managing R&D in China (see De Boer, Gan & Shan, 1998; Li & Atuahene-Gima, 2001; Ambrecht, 2002).

Our research aims to identify the most significant motivations and barriers of establishing and managing foreign R&D activities in China, which should be taken into account by R&D managers of TNCs. Based on our findings, we provide several relevant managerial implications.

3. Research methodology and data sample

Given the exploratory nature of our focus, this research is

mainly based on case studies, results from previous research, research of official Chinese publications and internet sites, and interviews with R&D managers who have had previous experiences in China.

The case study is widely considered to be an appropriate method to navigate unclear boundaries between phenomenon and context in the early stages of research. Particularly when the research questions examine a contemporary event, and when there is little or no control over behavioral events. This is especially true in the field of management, where case studies provide a strong relevance to problems in practice (Yin, 1998).

Our case studies have generally relied on the primary data source of in-depth expert interviews and secondary data such as company press releases and internet research. Between 2002 and 2003 we conducted 18 interviews with senior R&D managers involved with R&D activities in China. This kind of triangulation is able to minimize the bias of personal perspective and enhance validity of the information. To combine the advantages of unstructured and semi-structured interview methods, we started with open-ended questions; while in the second part of the interview we used a structured questionnaire protocol.

The range of companies under investigation includes automotive, machinery, IT and software: ABB, Siemens, SIG, Schindler, Microsoft, GM, VW, SiemensVDO Automotive. All companies are headquartered in Western countries.

4. Characteristics of TNCs' R&D activities in China

More and more transnational companies have identified China as a preferred place to conduct off-shore R&D activities. An analysis of the 2003 official statistics of the Ministry of Science and Technology provides clear indication of that increased awareness. Between 1987 and 2002, 65 transnational companies had established 82 R&D organizations (equity-based) in China (China S&T Statistics, 2003). In recent years, this awareness has grown; between 1988 and 1992 only an average of 0.8 new R&D units per year were established in China, while between 1998 and 2002 this number had grown to 8.4. While this statistic might not reveal the exact dimension of foreign R&D activities in China – i.e. Motorola with 18 R&D center's in place and 7 more under construction is only counted once in the statistic – one can clearly recognize the tendency for longitudinal growth. This fact is further underlined by several actual considerations of China as a place for future R&D locations by our interview partners.

The regional distribution of foreign R&D activities reveals TNCs' clear preference concerning their R&D sites in China. The majority of the TNCs' R&D centers are based in the two most economically important cities of China, Beijing and Shanghai (Li & Zhong, 2003; China S&T Statistics, 2003). The most attractive features of these two cities are highly qualified human resources, well-developed infrastructure, numerous industrial sectors and high-tech parks, and mature local scientific communities including top-class universities and research insti-

tutes.

As reported by the China Science & Technology (S&T) statistics, 65.9% of the R&D centers are embedded in TNCs' joint venture in China and the rest of the TNCs' R&D sites are registered as wholly-owned enterprises. A survey of China S&T statistics disclosed that the tendency for wholly-owned R&D centers is positively related to the technological sensitiveness of TNCs' business field, since wholly-owned R&D centers protect knowledge and prevent unwanted technology transfer. Findings of our interviews also support this result.

The computer and telecommunications industries are driving R&D investment in the China. Other important industrial branches with R&D investment in China include chemical, petrochemicals, biotech, pharmaceutical, automotive, transportation and power generation equipment (Xue & Wang, 2001; Li & Zhong, 2003; China S&T Statistics, 2003). These TNCs typically come from the triad regions. Most of them are from North America, especially from the U.S., followed by European Union and Japan. A further significant group of R&D investors come from Greater China, specifically Hong Kong and Taiwan (Li & Zhong, 2003; China S&T Statistics, 2003).

A strong driver for foreign R&D is the market. If the company's business requires local product adaptation and intensive customer cooperation, it is likely that local development units will be established. (von Zedtwitz & Gassmann, 2002, p. 580). Due to the sheer size and specific requirements of the Chinese market, this implies that the majority of TNCs' R&D activities in China are market driven and development oriented. For example, software and mobile phone companies such as Microsoft or Nokia set up development centers to develop localized user interface with the Chinese language. Research results of Li & Zhong (2003) revealed that between 1995 and 2000 two third of TNCs' R&D alliances in China (including equity-based and non-equity-based alliances) are development oriented.

Nevertheless, several TNCs' laboratories have added sufficient resources to build specific leading-edge platforms, transforming the lab into a competency center for an entire global enterprise and to devote to fundamental research. For instance, Microsoft set up its research center in Beijing in 1998, conducting research on topics such as next generation multimedia and Chinese PC technology (Gelb, 2000). Siemens and IBM have already had long established corporate research labs in Beijing.

5. Motivations for establishing R&D in China

5.1 General motivations of foreign R&D

Prior to studying TNCs' motivations for establishing R&D in China, we shall briefly outline the results of earlier research on general motivations and drivers for conducting R&D abroad. Different approaches have been used to classify motivations for R&D internationalization. One approach broadly distinguishes between demand-oriented and supply-oriented drivers for the internationalization of R&D (see Granstrand, Håkanson & Sjölander, 1993; Dunning & Narula, 1995; OECD, 1998; Doz & Hamel, 1998). Demand-oriented motivation factors in-

clude the special needs of the local country/market, which require modifications of firm's products; or host country restrictions, such as local content requirements, tolls, import quotas, and fulfillment of standards. Supply-oriented factors include highly sophisticated foreign scientific infrastructure (e.g. new regional technological competence centers such as Silicon Valley, Prato or Modena), which takes advantage of host country scientific and knowledge inputs and accesses cutting-edge technology. Availability of well-educated local R&D specialists, ideally combined with low R&D personnel costs are further supply-oriented incentives to establish R&D abroad. A third group of motivations, environmental motivation factors, is mentioned by Granstrand et al. (1992).

In a more refined classification scheme, Beckmann and Fischer (1994) identify five categories of R&D internationalization drivers (input-oriented, output-oriented, external, efficiency-oriented and political/social-cultural). This classification has been used to classify drivers of R&D internationalization whereas the input- and output-oriented factors are principally in accordance with the supply- and demand-oriented view. The three other categories such as external, efficiency-oriented, and political/social-cultural factors reveal the multifarious character of motivations for R&D internationalization.

Based on our research interviews and literature analysis, we have relied on this scheme as a preliminary framework to examine the specific motivations for establishing R&D in the Chinese context. We have merged output and efficiency-oriented motivation factors into performance-oriented motivation factors and the external and political/social-cultural into business-ecological motivation factors (see table 1).

5.2 Input-oriented motivations

■ Availability of qualified personnel

Amongst the input-oriented motivations for establishing R&D in China, the huge human resource potential is of great importance. In 2002, 2.5 million students graduated from the counties' 3000 universities and colleges including 14,000 Ph.D.s, ranking China third behind the U.S. (ca. 40,000) and Germany (ca. 30,000) China also produced more than 66,000 masters students in 2002 (Ministry of Education P.R.C., 2003a). Many top-flight universities such as Tsinghua, Beijing, Zhejiang and Fudan produce high qualified in disciplines such as mathematics and natural sciences.

Aside from domestic graduates, more than 580,000 students went to over 100 countries and regions worldwide for studying purposes between 1978 and 2002, with 150,000 of them returning to China (Ministry of Education P.R.C., 2003b). The majority of students chose to emigrate to other countries after graduating. Hence, China has suffered from an outflow of talents (brain drain) to a great extent. In recent years, Chinese governments, at both national and local levels, have introduced policies to induce highly skilled overseas Chinese to return to China (OECD, 2002). Increasing numbers of scientists and graduates have returned from abroad thanks to the enduring economic growth and better opportunities in China. In 2002, more than 18,000 of the so-called 'returnees' came

Table 1. Important motivations for TNCs' R&D establishment in China

Input-oriented motivations	Performance-oriented motivations
<ul style="list-style-type: none"> • Availability of high qualified personnel • Tapping informal networks and knowledge source • Local pocket-of-innovation 	<ul style="list-style-type: none"> • Customer and market-specific development • Adaptation to local production processes • Cost advantages
Business-ecological motivations	
<ul style="list-style-type: none"> • Governmental policy • Continuing economic growth and unique market size • Peer pressure 	

back to China, an increase of 47% compared to 2001 (Ministry of Education P.R.C., 2003b). These key people represent an additional pool of unique qualified human resources, as they bring experience and knowledge from around the globe.

▪ *Tapping informal networks and information sources*

In China, business success is heavily dependent on good informal networks and relationships - the frequently cited 'GuanXi'. The establishment of a local R&D center enables a company to build and maintain informal networks with universities and local scientific communities which can help TNCs to establish strategic partnerships and establish human resources in a long term. In addition, China's industrial development is at an emerging stage and the economy is undergoing a transition from planned to market based system. Hence changes in industrial regulations, legislations and policies are all the more dynamic. Their on-spot R&D activities and proximity to the government help TNCs to keep pace with changes in the dynamic Chinese environment and allows them to achieve critical competitive advantages.

Using local R&D to gather technology intelligence on local and international competition is yet another input-oriented motivation for TNCs' to conduct R&D activities in China.

▪ *Local pocket-of-innovation*

Since Chinese policy makers seek to raise the level of China's industrial production and increase countries competitiveness to an international level, special economic and other investment zones have been established and in doing so have become the main engine for growth in the Chinese economy. Notably, the High Technology Development Zones (HTDZ) or "science parks" have been designed to lure researchers, entrepreneurs, foreign R&D centers and venture capitalists from around the world.

As an example, Beijing's high-tech Zhongguancun area located northwest of the city is home to a large number of universities and scientific institutions including Tsinghua University, Beijing University and the Chinese Academy of Science. As a result, there are a number of start-up firms, foreign-capital firms and large-scale local firms that are seeking access to high potentials through building strong relationships with the universities. Furthermore,

these pockets-of-innovation attract investors with space, advanced infrastructure, and high-tech facilities they require along with financial incentives. As an example, the Chinese State Council and Beijing municipality both offer start-up firms located in Zhongguancun area tax-free operation for three years following their establishment, followed by a 50% discount for the next three years, and a 15% discount from the seventh year onwards, along with other tax incentives. Due to the substantial governmental support and geographical uniqueness, it is not surprising that several interview partners believe a few of these industrial and science parks will become centers of excellence in the future.

Since more and more Chinese cities and regions are trying to capture the attention of TNCs by various incentives, more TNCs have invested out side of Beijing and Shanghai, the two established hubs of foreign R&D activities in China. In 2001, Nokia established a new R&D center in Hangzhou, a city in the Pearl River Delta area surrounding Shanghai. They recently announced plans to consolidate their four existing joint ventures there. Motorola has established a new integrated circuit center in Suzhou, in the eastern Jiangsu Province (ca. 95 km from Shanghai) where Microsoft also has its third R&D center in China after Beijing and Shanghai.

5.3 Performance-oriented motivations

▪ *Customer and market-specific development*

One main reason why so many companies are establishing development bases in China is to locally develop products specifically for the China market. The necessity of adapting products to the foreign market is a widely shared belief of many interviewed R&D managers. Selling products without paying attention to the needs of the local markets is bound to fail. Locating R&D activities in China allows TNCs to adapt and tailor their products and services to the local culture and market needs. A typical example is adapting IT user interfaces, telecommunication or car infotainment products to be used with the Chinese language. Moreover specific local conditions in which products are operating require appropriate modification and redevelopment. For example, in China some automotive components such as air conditioning and combustion engines need to be redeveloped according to

local climatic conditions and local gas quality. In the next 2-3 years, over 75% of growth in electronic manufacturing capacities will take place in China. Risks of such a production shift purely for cost reasons are high; local development and product adaptation in these fast growing markets can support manufacturing operations and increase competitiveness.

There is an additional value to operating in different cultures and countries such as China. A company can develop new products and forge advanced thinking on many product issues. Some managers do believe that products which satisfy the requirements of the most difficult consumer and market environments are likely to succeed anywhere in the world. Microsoft Research Center in China is pursuing problems of computing in Chinese due to the difficulty in inserting Chinese characters on a Western keyboard. Besides the improvement in software's suggestion and error-checking system, researchers also focus on data entry methods such as speech and handwriting recognition. The result will make computers more user-friendly in Chinese, but will in the end benefit all computer users (Gelb, 2000).

The elevator and escalator company Schindler established an R&D center in Shanghai in the late nineties because Shanghai is one of the most booming and sophisticated markets in the construction business. Chinese customers are less risk averse than western customers which is typical for booming economies. In 2003 Schindler conducted a field study for a new web based personalized infotainment system in the elevator cabin – an advanced experiment which would be less likely to be accepted in Europe or the US. Based on that study Schindler has planned to multiply the system requirements for the product launch worldwide.

▪ *Cost advantage*

Due to the general low cost level in China, running similar R&D facilities in China costs about only one-tenth of what it would in the U.S. (Li & Zhong, 2003). The lower wage structure in China attracts TNCs' R&D activities as well. Although the wage of highly qualified Chinese R&D staff is high compared to the Chinese domestic level, it is still 1/4 or 1/5 of R&D staff salary in the triad regions. Companies in the software industry that typically went to India are now starting to evaluate China. Reasons are increased labour costs in India. Moreover, as mentioned in the above section China has enacted a series of preferential policies to encourage establishment of foreign R&D activities which stand for further cost advantage potentials for doing R&D in China, such as foreign R&D centers in China that can import certain equipment duty free.

▪ *Short R&D cycle time and adaptation to local production processes*

Localized R&D allows for a shorter R&D cycle time especially for products which require customer and market-specific accommodations. Furthermore, local R&D activities can assist manufacture operations to improve quality, learn to produce new offerings, reduce costs, or increase capabilities (Ambrecht, 2002). The packaging specialist, SIG, is going to open an R&D unit in Suzhou in 2003 to

support their manufacturing units.

5.4 *Business-ecological motivations*

▪ *Governmental policy*

For over a decade, one can observe China's increasing sensitivity towards technology's contribution to economic growth. "Revitalising the Nation through Science and Education", a strategy which was officially adopted in 1995 by the Chinese government to speed up Scientific and Technological Progress (OECD, 2002), and has led to rapid growth of China's national science and technology activities. In 2000, China spent \$ 11 billion on R&D, amounting to 1% of their GDP. It represents an increase of 150% over 1995 levels of \$ 4.2 billion (China Statistics Bureau, 2001). Furthermore, although OECD countries provide over 90% of FDI globally, their share of FDI in China is much smaller. Therefore, China has the ability to attract long-term, relatively capital-intensive and high-tech projects from multinational enterprises in OECD countries (OECD, 2003). As a result, China has continued to liberalise the approval process for FDI and a number of preferential policies have been put in place in order to encourage foreign business, especially TNCs, to set up local R&D investments.

Chinese policy makers believe that an effective way to bridge the gap to the international technology level is to intensify the linkage to the international R&D community. One important means is the establishment of high-tech parks combined with incentives such as free rent, low tenancy costs, favourable lease terms, and tax relief.

As identified by Ambrecht (2002), there are several multi-faceted reasons behind these kinds of policies. Foreign laboratories will bring capital investment, ancillary spending, and job opportunities. Moreover they help to attract excellent ethnic Chinese specialists from around the world back to China to conduct advanced research. The proximity to international research facilities will also spur the Chinese high education system through their demand of local high-quality technical personnel and co-operation with Chinese R&D facilities. Moreover, the business background of these R&D laboratories could help China create market value out from the leading-edge technologies being developed in Chinese universities and research institutions. Furthermore, local R&D activities are considered to be important evidence that the company is interested in developing long-term commitments in China. It helps to build trust and good working relations with government and to receive official support. But due to the enticement of financial incentives and other business advantages, some foreign firms are even tempted to register their China activities as "R&D," whether their research does or does not entail genuine research and development activities (see Walsh, 2003).

Given the pure power of the Chinese government, they are in a position to play one foreign investor against another in order to accelerate TNCs' investment level and R&D commitment. Prior to China's accession to the WTO, foreign investors were regularly pressured to transfer technology in return for market access. For example, there was intense competition between several global automobile companies concerning the establishment of an automobile joint venture in Shanghai in the late 1990s,

which was speculated to be the last such approval for many years. General Motors finally won the license to establish a joint R&D center in Shanghai (see The Economist, 1999; Walsh, 2003).

▪ *Continuing economic growth and unique market size*

Aside from stagnated world economy, the dynamic growth of Chinese national economy and its overwhelming market size has made China amongst the most strategically important markets for TNCs. Especially in IT and telecommunications, multinational giants such as Microsoft, Nokia, Motorola, and Siemens have invested hundred of millions of dollars into their R&D activities in China, which is in essence an investment in China's future market. For example, China has become the world's largest mobile phone market with more than 200 million users by the end of 2002 (People's Daily, 2002). The critical mass of the Chinese and the Asian markets is increasingly influencing mobile phone size, style and applications globally. As a response to the strong demand for affordable, entry-level mobile phones in the Chinese and Asian markets, Siemens Mobile division has established the global headquarters for voice-centric mobile phones in Beijing in October 2002. According to Siemens (2002) this marked the first time that the central responsibility for one of Siemens mobile's business activities had been established in China.

▪ *Peer pressure*

TNCs' motivations for establishing local R&D in China are rooted in the awareness of possible mid- and long-term competitive advantages which have been discussed in the above sections. Seeing that TNCs' competition on the Chinese market has intensified and the number of foreign-invested R&D centers in China has grown in recent years, those who do not have such investments, have come under increasing pressure to invest in R&D. Even though most interview partners did not want to admit to peer pressure as a driver, it had been mentioned during informal follow-ups.

6. Barriers for managing R&D in China

As discussed in the previous section, China is a very attractive location for transnational companies' R&D units. On the other hand, there are still high barriers before exploiting that potential. Despite the aforementioned advantages and rewards for setting up R&D activities in China, the following barriers could neutralize them to a certain extent.

6.1 Barriers in human resource management

▪ *Difficulty in management due to Chinese language and cultural gap*

Given the general lack of experienced indigenous R&D managers in China, the majority of upper R&D management are staffed by foreign expatriates. Unfortunately, most of them do not have adequate or non management experience in the Chinese environment. The Chinese language is an initial barrier in management. Although some

of the top Chinese research staff have a good command of English, most of the local engineers only have limited English capabilities.

An even larger obstacle for Western managers is to overcome the cultural gap during the daily interactions concerning issues like communication style, "face saving" etc.. A Western manager may have done everything correctly according to their understanding of good management style. However, the lack of experience and sensitivity to Chinese mentality and culture will usually incur managerial inefficiency, wrong decisions and inadequate leadership. Western managers coming mostly from low context cultures (e.g. German, U.S.), are used to capturing the meaning of a message with words alone. They believe spelling it out clearly is the only way to avoid ambiguity. On the contrary, the Chinese Culture is a very high context culture (Hofstede, 1994). A message is delivered with nonverbal signals (e.g. tone of voice, use of silence, facial cues, and body language), unspoken assumptions, and the context or environment surrounding the conversation. People from high context culture assume that the receiver of the message is intelligent enough to understand its true connotation. Lack of awareness and proper handling of interference between high and low context communication styles can eventually lead to misunderstanding, confusion and ineffectiveness.

▪ *Diversity of R&D staff*

The R&D teams of TNCs in China are diversified and typically composed of three groups of people. Local graduates make up the majority of the R&D staff. Western expatriates and global Chinese comprise the other two groups of the team. Although diversity in R&D teams can increase creativity and innovation, it also provides sources of potential conflict. In addition to general difficulties of managing intercultural teams, one particular challenge lies in the potential conflicts between local Chinese staff and global Chinese.

In our context, 'global Chinese' is a generic term for three subgroups of Chinese people working for foreign R&D: Mainland Chinese returnees with education and working experiences abroad; Chinese from Greater China (i.e. Taiwan, Macao and Hong Kong); and overseas-born ethnic Chinese. On the one hand they share the same Chinese origin and culture and have almost no language difficulties with each other. On the other hand, due to multi-layered differences between these subgroups due to such elements as different educational background, different working style and perception, and in particular the huge gap in pay for the various levels (see also De Boer, Gan & Shan, 1998); one should be wary to generalize these three sub-groups of Chinese people. Western expatriates are often not aware or underestimate these differences.

▪ *Low individual initiative and innovative mindset*

The majority of local R&D staff are recruited from China's leading universities. During the interviews, most of the managers shared the opinion that Chinese graduates have a solid education and are highly skilled in solving certain well defined tasks. But there is an awareness of a lack of practical experience and individual initiative, which is to a degree in line with the findings of Walsh

(2003, p. 96). It could be argued that this phenomenon is attributable to the Chinese education system, which is characterized by a narrow curriculum design and neglect on development of individual initiative.

To a greater extent, an R&D staff member's individual initiative is decisive for creativity and innovation. As Walsh (2003) stated, developing a more innovative mindset among Chinese staff is a primary concern of foreign R&D managers at this stage. Risk taking behavior and entrepreneurship in the widest sense have to be promoted. As a result, the management and the development of R&D staff in China requires much attention.

▪ *High employee turnover rates and lack of loyalty*

Like many other foreign enterprises in China, many R&D departments are plagued by high staff turnover rates, particularly those located in large cities such as Beijing and Shanghai, where sufficient new opportunities are available. In general, there are three main causes of staff turnover. Some of them who leave because they have simply found a better paid job elsewhere, while some go abroad to obtain graduate degrees. Only a few, but worth mentioning, leave to work for or establish high-tech start-up enterprises (Walsh, 2003). This is a common phenomenon not only impacting foreign companies in China, but Chinese domestic high-tech companies and research institutes are suffering from high turnover as well. Foreign companies are often used as career springboard. Working for a foreign company provides Chinese graduates not only higher salary and practice experiences; it also makes them familiar with Western management practices and provides them with possibilities of advanced on-the-job training. These kinds of references enable them to get a job with better payment and perspectives. In the worst case scenario, they would be hired by competitors.

As stated by several foreign managers and also confirmed by Chinese employees, compensation strongly influences the affiliation and loyalty of Chinese R&D staff. Beside money issues, one should not ignore the level of attachment to western employers. It could be argued that given the fact that China has made a strong effort in building national consciousness; many Chinese employees strongly associate themselves to their own country than to their Western employer. As a result some R&D managers have expressed their lack of trust in local people, since they are afraid of lack of loyalty and losing knowledge to the competitor. This is especially relevant within Sino-foreign joint ventures whereas the parent company of the Chinese partner or simply the partner themselves participates in or owns other domestic enterprises operating on similar business fields. For example, ABB has lost plenty of technological knowledge through their Swiss-Chinese joint ventures. The lack of trust in local people is one reason why Schindler's competitive intelligence unit in Switzerland consists of two Chinese staff members.

Building long-term staff loyalty is a challenge for human resource managers in China. It is particularly relevant for R&D labs, given that know-how travels with people.

6.2 Bureaucracy and uncertainty in legal changes

As mentioned in the above section, the Chinese government provides incentives for foreign R&D activities in China. According to the experiences of some interviewed R&D managers, receiving promised preferential conditions such as tax relief and other incentives can be a stressful and prolonged procedure, due to multiple bureaucratic hurdles and very specific rules. Importing test materials can be difficult (IBM), transferring people from Beijing to Shanghai requires an official permit (requires long-term preparation (Siemens, ABB)).

Therefore, a good relationship (GuanXi) network with the government is crucial to business efficiency and success. This kind of relationship network needs time and occasional financial support. As one Western expatriate manager mentioned, relationship investments takes the form of sponsoring of IT equipment for local universities or other contributions to non-profit official organizations such as municipal kindergarten. However, one should not mistake this kind of financial aid for a bribe.

Due to lack of transparency in Chinese policymaking, China's industrial, political, legal, technological policies and strategies are difficult to discern. This provides more uncertainty for foreign R&D activities in China. Furthermore, even if the intervention on foreign enterprises' activities by the Communist Party of China (CPC) has decreased in recent years and the party branch (i.e. the party secretary) within some wholly owned foreign company is not involved in the business at all, some interviewees still mentioned that the a strong governmental influence remains. As one manager said: "There are still numerous possibilities for Chinese government to make everything difficult."

6.3 Intellectual Property Rights

Given the challenging nature of the Chinese economy, foreign investors must assume some inadvertent technology transfers. As Schumpeter noted, innovations should lead to temporary monopolistic profits in order to harvest previous R&D investments. Therefore a strict legal intellectual property system with little uncertainty for the innovator is a prerequisite for technological process and high rates of innovation. The current Chinese intellectual property rights (IPR) framework has been in existence for less than two decades (Yang, 2003). Although, China has made progress in protecting IPR and has ratified different international treaties and conventions to show the world that it strives to be in step with international IP standards, piracy of intellectual property (IP) remains rampant in China. This is an area in which foreign enterprises have serious concerns. The International Intellectual Property Alliance estimates that over 90 percent of business computer software in China is pirated (IIPA, 2003). Microsoft loses several billion dollar losses due to piracy.

One major reason for this kind of concern is weakness of IP infringement enforcement at the international level. Starting and winning a patent case in China is still almost impossible and definitely time consuming. Additional concerns of foreign companies regarding IPR include

long patent application procedures, and lack of public acceptance of IPR legislation (OECD, 2003). Sometimes, the deficit in IP protection stops foreign firms from importing their core technologies, research, or equipment to China. Nevertheless, the number of foreign applications for patents attributable to High-Tech industries has continued to rise. This is mainly due to pressure by increased competition and governmental policy to transfer technology to China.

IP management in China is intricate but achievable if enough effort and resources have been put into it. For example, Siemens' corporate research lab in Beijing has a special group designated to intellectual property issues in China. New technologies stemming from wholly foreign-owned R&D centers in China are filed initially, and in some cases exclusively, in the foreign companies' home country. In general, foreign investors are encountering some IP difficulties in conducting innovative research in China at present, and as a result truly innovative results in China will continue to take time.

7. The Case of SiemensVDO Automotive

Siemens has a Corporate Research lab in Beijing, employing 25 people. The mission is to contribute to corporate research (active research), to handle intellectual property issues of Siemens in China (local IP presence), and to promote Siemens standards in the early and emerging phase before dominant designs have been established (market development). In addition to this corporate R&D activity, SiemensVDO Automotive, a wholly owned subsidiary of Siemens, is in the evaluation process of establishing a development center in China.

SiemensVDO Automotive has 137 business locations worldwide and with about 43,600 employees tackling the all-important automotive markets. SiemensVDO is a supplier of automotive products, and the 16 product divisions, which can be seen as profit centers, are embedded in a matrix organization. More than 70% of the product range is younger than three years, highlights the emphasis on innovation. The Asia strategy of SiemensVDO is to expand their position and double turnover in Asia by 2005/2006. China is considered a strategic and important market to achieve this goal.

In China SiemensVDO started its activities in 1995, and has invested in six operating units in the country. In the 1990s, establishing joint ventures was a compulsory means to enter the Chinese market. In the meantime most of the units have turned to wholly owned enterprises. The local production facilities of SiemensVDO in China mostly manufacture products which were developed in Europe. The majority of SiemensVDO's customers are international auto manufacturers such as Volkswagen, BMW, Hyundai. Until now, all R&D projects are development and application oriented, and there are no research activities at all. Due to the lack of local development capacity, these projects are supported by and consist of members of R&D teams based in other countries such as Korea or Australia.

■ Motivations and barriers of on-site R&D Activities

The management of SiemensVDO is aware of the importance of the Chinese market and the strategic significance of creating competitive advantages in China. For them, there are several reasons to carry out local development. Firstly, with more upcoming new models introduced into the Chinese car market, it will be vital to keep their product development in line with the model releases from different car manufacturers. In order to respond to the customer demands quickly in the future, it will not be sufficient to conduct development activities through headquarters R&D department. Secondly, there are cost saving potentials due to the low engineering man-hour costs in China. Cost savings can be achieved products developed abroad (e.g. in Germany) that are sometimes over-engineered regarding the lower requirements of local customer. Thirdly, the engineering support to local customers will be easier to follow out as via a central R&D department. Fourthly, due to specific local conditions in which the automotive product are operating, some of the development activities must be conducted on-site. For instance, the local air and climatic conditions and local gas quality needs and development work in power train adjustment. Also onboard infotainment services need localized adjustments with respect to culture and language.

At this stage the volume of products which could be developed locally is still inadequate to achieve sufficient economies of scale. One major reason is the congested car market in China. About 2400 companies are involved in the manufacturing of vehicles. At present there are 120 complete vehicle plants, of which 12 have a yearly output exceeding 10,000 units, and only three have a production capacity exceeding 300,000. According to industry experts, an enterprise with an annual output of less than one million is not competitive in the international market. One further dilemma which is a general concern for all automotive R&D managers in China is the lack of experienced automotive specialists. Although there are several universities in China with automotive faculties, given the increasing demand on automotive specialists, there is still an insufficient number of qualified automotive engineers when compared to the international standard.

■ R&D cooperation as an option

The management of SiemensVDO is aware that the mentioned obstacles set limitations on direct investment in R&D activities. Therefore the form of cooperation is considered as an alternative means of reliance in order to ensure competitive advantages. What is notable is that most of the domestic automotive companies are not able to provide technological benefit to SiemensVDO through the cooperation. Within the automotive industry, cooperation in China will mainly give advantages with respect to reducing time of development; joint use of resources and facilities, regional market knowledge, and creating market barriers to entry.

In our case there are two kinds of potential cooperation partners: universities and automotive companies along the supply chain. In the SiemensVDO case, universities are preferable as cooperation partners primarily for two reasons: first, the contact with a university will be seen as a good source of qualified automotive engineers. Second, universities could have certain testing facilities, which are

crucial for product development, such as an engine testing facility. Both reasons are resource based. SiemensVDO has a strong exchange and cooperation agreement with the automotive faculty of Changchun University of Science and Technology.

Another kind of potential cooperation partner is Chinese automotive firms along the supply chain (vertical integration). They can help to attract customers and to build long term business relationships with key customers in order to create market entry barriers. According to the interviewed experts, competitors will definitely not be considered as cooperation partners due to apprehension of unwanted technology transfer.

Two kinds of significant environmental uncertainties are confronting R&D cooperation in China at this time. First, due to the insufficient legislation (especially intellectual property rights) and a strong protectionism of regional governments, there are uncertainties concerning the fairness of this cooperation. Most of the potential cooperation partners are state owned enterprises (SOEs) and spin-offs of former SOEs. However local governments are in most instances an important stakeholder. Unwanted and non-transparent knowledge/technology transfer could be carried out within this network, something that is not obvious to an outsider.

Second, China sees Europe as a role model with regard to industry norms and regulations. China ambitiously follows the European automotive norms (e.g. emission norms (EURO III, IV), airbag obligation, tire pressure control, brake power control). The validity of the norms for automotive products will be left up to the government. As a further uncertainty issue, cooperation decisions must be well thought out and carried through.

8. Managerial implications

In our interviews, the human resource challenge was strongly emphasized. Local R&D talent is inexpensive and qualified in China. Yet due to the cultural gap and language problems, huge potential remains untapped. As

previously outlined, foreign R&D activities are mainly set up because of input or performance oriented potentials. From a competence based view this can be described by the absorptive capacity (see Levinthal & Cohen, 1990) and multiplicative capacity of the R&D unit. Both determine a firm's capability to link its peripheral units to the external environment: A higher absorptive capacity results in a better knowledge sourcing capability from local community, while a higher multiplicative capacity improve the firm's capability to efficiently link the output of the peripheral unit to global TNC's operations (R&D effectiveness and efficiency, technology transfer).

In order to fulfill the two basic functions of an R&D unit, to absorb local skills and knowledge and to multiply the output to the TNC's operations, human linkages are required. We identified two major bridges for foreign R&D in China: expatriates and global Chinese (see figure 1).

Expatriates build up the R&D unit, establish the management system and corporate processes as well as develop the linkages to the corporate operations, (i.e. corporate R&D, local sourcing, corporate marketing and regional product management). One of the major drawbacks of using expatriates is the high cost. At Schindler, the costs of an expatriate R&D manager can be five times higher than their costs in Switzerland (due to personal services, adequate housing, international school for expatriates' children, memberships in several clubs, accommodation, car etc.). On the other hand, after four years experience, Schindler had made positive experience with global Chinese who have spent a certain amount of time in workplaces abroad. They are efficient leveragers and can be also built up by systematic job rotations (e.g., by Siemens, IBM). Absorptive and multiplicative capacity will increase with by using these human bridges. U.S. based TNCs in particular can take advantage of global Chinese, due to the huge overseas Chinese community in the U.S.. Once more, one should not ignore the potential conflicts between global Chinese and locals. Hence, more management challenges are present for cross-cultural teamwork than many foreign R&D managers initially assume.

Figure 1: Expatriates and global Chinese increase the absorptive and multiplicative capacity of foreign local R&D units in China.

Concerning the issue of the cultural gap, a comprehensive training program enables expatriates to understand the Chinese environment, to develop awareness of cultural differences, and to facilitate their intercultural communication skills. Many proven Western management styles will not succeed in China due to cultural differences. As Walsh (2003) stated, many Western managers intend to change Chinese work habits and attitudes to more closely conform to Western business models and styles, while Chinese staff seems keen to learn these methods and to change their performance accordingly. Yet the strong influence of Chinese culture and mentality still affect their way of thinking and approach to innovation. To be successful, foreign managers will have to identify and adapt these challenges to their advantage.

It was also found that strategic co-operations with reputable universities and official research institutes can help TNCs' R&D activities in different aspects: First, Chinese universities and research institutes are sources of top-class local talents. Second, they do have important and advanced facilities which could allow reducing R&D investment through partnering. Third, since most of the universities and research institutes have close connections with government or Chinese ministries, to join up with them could mean access to the important official 'Guan-Xi' and competitive benefits less bureaucracy and access to information concerning official lines of policy. Uncontrolled technology transfer may be the cost for having these competitive positions in certain partnerships.

Other managerial recommendations from the interviews include: A consistent management information system which is as global as possible as local as necessary to help increase the capacity of the R&D unit. This includes a global standardized stage-gate-process to enable transnational R&D, but local freedom in the creative early innovation phases. A politically sensitive "match maker" who knows the political rules and open doors could further increase the absorptive capacity. One possible scenario has the party secretary of the company serving as a mediator between foreign investors and the government.

9. Conclusion

The emergence of foreign R&D activity in China is a recent phenomenon and has rapidly increased since the mid-nineties. This trend will carry on into the future. According to our interview partners, the number of R&D sites in China could exceed 300 by 2006, based on the assumption that China continues its economic and societal transformation, and the enduring trends continue in R&D internationalization in the triad regions.

With this contribution, the authors hope they have added to the understanding of the drivers and barriers of foreign R&D activities in China. Input- and output-oriented, and business-ecological motivations TNCs' R&D endeavors in China. The more advantages created by local R&D activities in China, the greater the challenges of managing on-site R&D for TNCs. The major barriers such as complexity in human resource management, bureaucracy, uncertainty in legal changes and low confidence in the protection of intellectual property rights will

also last for at least the medium term. We believe that the success of foreign R&D endeavors in China depends strongly on a realistic estimation of its advantages on the one hand, and on the awareness and the proper handling of identified barriers. TNCs intending to establish R&D sites in China should cautiously set local R&D activities in accordance with their internal strategy of R&D internationalization and more importantly with their long term purpose in the country. Future research in the field of foreign R&D activities in China may emphasize the evaluation of best practice of overcoming obstacles in managing foreign R&D in China.

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