The Drivers of Foreign R&D Investment in China
and the new R&D Models.

Abstract
Many western firms are increasing the amount of direct investment in Research and Development (R&D) facilities in China. The surprising growth in R&D in China has led to the development of three new models of R&D. Two of these models can be viewed as variations or combinations of traditional models. However, one model is new in that it focuses solely on the Chinese market and can cause the change of worldwide R&D. These new models leverage China’s market and it's wealth of skilled researchers. Companies must be aware of these models to make the best use of their R&D investments. However, they should also be aware that some aspect of these models are feasible in China only due to its unique market and are not readily usable in other countries.
The Drivers of Foreign R&D Investment in China and the new R&D Models.

Introduction of R&D Investment in China

The portfolio of foreign direct investment (FDI) in China has been evolving over the past two decades. Inflows used to focus on labor-intensive industries during the 1980s and then moved towards capital-intensive ones during the early 1990s (Kraar 1994). Today, nearly 400 of the Fortune 500 firms have invested in over 2,000 projects in China (Wen 2002). The world’s famous manufacturers of electronics, computers, telecommunication equipment, power-generating equipment, and pharmaceuticals have extended their production networks to that country.

Even up to the late 1990’s, corporations were hesitant to develop Research and Development (R&D) in China due to questions of intellectual property rights and quality issues (Plafker and Wolff 1997). However, in recent years technology-intensive industries have focused on R&D and these activities have emerged as a bright spot for FDI in China. Motorola, Nokia, Siemens, IBM, Microsoft, GM, Samsung, Nortel, GE, JVC, Intel, P&G, DuPont, Ericsson, Matsushita, Mitsubishi, Lucent-Bell, and AT&T, to name a few, all have R&D facilities in China. Microsoft, for instance, invested $130 million to establish its research institute and Microsoft Asian Technology Center in China (Wang 1998). Motorola established eighteen R&D centers in China by the end of 2000. This included an initial $300 million investment and 1060 research personnel (Motorola 2002). So far, Beijing and Shanghai have attracted most of the R&D investment in China. In Beijing, foreign capital is invested mainly in such fields as computer technologies, software and telecommunications. In Shanghai the R&D focus in on the chemical industry, automotive systems and medicine. By the end of 2001, there were more than 120 foreign R&D centers in China, making China the second largest foreign R&D playground in Asia and the sixth largest one in the world (Wen 2002).

As can be seen, a great deal of research has focused on China and how global companies have moved much of their production capability to that country. However, this research has overlooked the growing amount of Research and Development (R&D) that these same firms have undertaken in China. In fact, China has seen the development of new models of R&D by foreign corporations. In general all three models focus on foreign market development as opposed for example to the two tiered home-base-augmenting site and home-base-exploiting site of (Kuemmerle 1997). Two of these models can be viewed as variations or combinations of traditional models.

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However, one model is new in that it focuses solely on the Chinese market and can cause the change of worldwide R&D. These new models leverage China’s market and it’s wealth of skilled researchers. Companies must be aware of these models to make the best use of their R&D investments. However, they should also be aware that some aspect of these models are feasible in China only due to its unique market and are not readily usable in other countries.

In the following sections, we outline the methodology that is used in this paper. We then discuss the drivers of R&D investment in China and the ways that those investments have created new R&D models in the Chinese markets. We then test these concepts with a Delphi study of experts in the area and conclude with implications for practitioners and researchers.

**Methodology**

“The research process…is a series of interlocking choices, in which we try simultaneously to maximize several conflicting desiderata. Viewed in that way, the research process is to be regarded not as a set of problems to be solved, but rather as a set of dilemmas to be lived with.” (Runkel and McGrath, 1972). This directly applies to any research concerning China at this time. The business environment is changing rapidly in China. Thus there is the need to identify changes in areas such as R&D which can aid businesses and researchers. However, because of the rapid rate of change, highly structured methodological research is faced with a host of problems. Because of that, we have adopted the empirical methods identified by Runkel and McGrath (1972).
Applying Runkel and McGrath’s methodology we seek to determine the changing ways in which firms are developing R&D within China. Since this is a new trend, not many people are aware of it. Thus large scale surveys (i.e. traditional empirical techniques) are not feasible. Because of this, we turn to surveillance techniques developed for technology forecasting; specifically Scanning, Monitoring and Tracking. These techniques have been used for some time in technology forecasting. In fact (Serapio and Dalton 1999) state that some researchers view U.S. R&D centers of foreign companies as ‘listening posts’ that focus on technology scanning. Thus these techniques have particular relevance to assessing current developments in China. Each of these techniques is detailed in (Vanston 1984) but in general they are:

- **Scanning** is “applied to broadly oriented surveillance activities which seek to identify, at an early time, developments in technical, economic, social, political, and ecological environments that may materially affect an organization”.

- **Monitoring** “primarily watches developments outside the organization, such as research being done in competitive companies, universities, and government laboratories…Typical questions that might be addressed include: What is the present and potential significance of a new technology or trend? What is its present stage of development?...What are present constraints to development?” To do this techniques such as Delphi Studies are traditionally used.

- **Finally Tracking** involves a “concentrated effort to follow developments of major significance to the organization—competitive response to a new product or process; near-term introduction of new processes that will threaten present markets; major breakthroughs in which a organization needs to establish a position.”

Based on the guidelines outlined in figure 1 and using the Scanning and Monitoring techniques lead us to the methodology we will use for the rest of this paper. Specifically,

- The real world concerns the impact of foreign R&D investment in China and what are the business practices firms are applying to R&D in China.

- Scanning of the current R&D environment is done using historical data on R&D investments.
• Additional Scanning is done by case studies of current firms operating in China and doing initial Delphi Surveys of academics and industry leaders in China.
• This leads to observations and hypothesis concerning current practices in China.
• Monitoring and assessment of these hypotheses is then conducting by further Delphi surveys with the directors of the largest R&D facilities in China.

As an initial empirical assessment, we are well aware of the Fifth Rule of Dilemmatics: You can’t build flawless theory (Runkel and McGrath, 1972). The goal of this paper is to assess the current R&D practice in China through the use of the Scanning and Monitoring techniques. We then identify issues and develop a general framework which we believe require further Tracking by academics in order to provide future theory, support and direction for firms competing globally.

**What is driving the foreign R&D rush to China?**

The major driver of R&D activity has been China’s entrance into the WTO on November 12, 2001. This event triggered a huge investment of monetary and human R&D capital. From November 2001 to May 2002, one multinational company (MNC) after another announced the establishment or expansion of Chinese R&D centers. This can be seen in Table 1 (Summarized from People’s Daily, International Trade Daily, and China Daily).

<table>
<thead>
<tr>
<th>Company</th>
<th>Date of Announcement</th>
<th>Size of the New R&amp;D Center</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nokia</td>
<td>November, 2001</td>
<td>500 researchers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>It is the Nokia’s second R&amp;D center in China.</td>
</tr>
<tr>
<td>Motorola</td>
<td>November, 2001</td>
<td>It is the Motorola’s 19th R&amp;D center in China. In the next 5 years in China, Motorola will increase its researchers up to 5000 and invest 1.3 billion dollars in R&amp;D activities.</td>
</tr>
<tr>
<td>Microsoft</td>
<td>January, 2002</td>
<td>100 full-time researchers and several hundreds visiting researchers and engineering students.</td>
</tr>
<tr>
<td>Honda</td>
<td>January, 2002</td>
<td>$17 million investment</td>
</tr>
<tr>
<td>GE</td>
<td>February, 2002</td>
<td>400 researchers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>It is the third largest R&amp;D center of GE.</td>
</tr>
<tr>
<td>Honeywell</td>
<td>March, 2002</td>
<td>30 researchers</td>
</tr>
<tr>
<td>NEC</td>
<td>March, 2002</td>
<td>50 researchers (up to 500 researchers by 2005)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The size of this telecommunication R&amp;D center is only behind its counterpart in NEC’s headquarters.</td>
</tr>
<tr>
<td>Oracle</td>
<td>March, 2002</td>
<td>100 staff members</td>
</tr>
<tr>
<td></td>
<td></td>
<td>It will become Oracle’s strongest R&amp;D base outside the United States within five years.</td>
</tr>
<tr>
<td>Japan Koito</td>
<td>April, 2002</td>
<td>$12 million investment</td>
</tr>
<tr>
<td>Manufacturing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sun Microsystems</td>
<td>April, 2002</td>
<td>Sun will shift 10 per cent of its R&amp;D work to this Chinese center.</td>
</tr>
</tbody>
</table>
Table 1 Announcements of new R&D Centers in China from Nov, 2001 to May 2002

<table>
<thead>
<tr>
<th>Company</th>
<th>Date</th>
<th>Announcement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hewlett-Packard</td>
<td>May, 2002</td>
<td>200 researchers (up to 2000 researchers in 5 years)</td>
</tr>
<tr>
<td>Ericsson</td>
<td>May, 2002</td>
<td>It is Ericsson’s 7th R&amp;D center in China</td>
</tr>
<tr>
<td>Dell</td>
<td>July, 2002</td>
<td>270 researchers initially, growing to 1,000 in the next few years.</td>
</tr>
</tbody>
</table>

To put this in perspective, table 2 provides the estimates of foreign R&D centers in China (1990-2002) from five different sources. Note the change in estimates of the People’s Daily from June to October 2002. This reflects amazing growth in FDI for Chinese R&D. But this brings up a question. What do foreign firms hope to gain from their R&D investment? No firm would expend a large amount of capital unless they truly expected a large return on their investment.

Table 2 Estimates of Foreign R&D Centers in China (1990-2002)

Traditionally, R&D has been considered as a method of gaining market share in a competitive global market (Franko 1989). However, different drivers can affect the size and type of R&D invested in a region (Kuemmerle 1999). So why have these firms determined that China is a good investment for R&D? For firms that invest in China, low cost is the primary motivator. This holds true even in the case of R&D (Zhao and Li 1997). Reducing R&D cycle time (and thus responding quickly to market developments) and reducing R&D costs are major motivators for R&D investment in China.

However the biggest drivers of R&D investment are access to local talent and the ability to develop products to meet local needs. These factors are in turn driven by the fact that China’s population represents both the
biggest potential market in the world as well as the biggest potential source of talent in the world. We can further structure these fundamental drivers of this into four groups based on data from (Xue and Wang 2001) who conducted an empirical analysis of the motives of 33 MNCs establishing R&D centers in China.

- **Lure of the huge Chinese market:** MNCs tailor their R&D to Chinese market needs (developing product for local market, localizing or modify products for local market, and adapting to local production process);
- **Market access:** MNCs use R&D as a powerful market access strategy to please the local governments (generating better public image or relationship);
- **Ready talent pool:** MNCs take advantage of local R&D human resources (hiring local talents, reducing R&D cycle time, and reducing R&D cost);
- **Ambition for the global market:** MNCs develop or test new technology in this huge market and then diffuse it to the world market (obtaining technologies developed locally).

**Driver one: the largest potential market in the world**

China provides a low-cost export platform for foreign companies as well as a very large and growing market. China’s advancement beyond the “design it abroad, make it in China, sell in abroad” cycle comes partly from its surging power as a market in its own right.

In 2002, China surpassed the U.S. to become the world’s largest market for cellular phones and beer (Powell 2002). It already was No. 1 in a diverse array of other product categories, including motorcycles, elevators, light bulbs, cotton, and television. By 2003, the world’s most populous nation is projected to surpass Japan to become the second-largest market, behind the U.S., for personal computers, and it is on its way to becoming the world’s largest high-tech market by 2015. Beyond that, there are expectations that China will develop into a leading buyer of commercial aircraft, automobiles and insurance (Lev 2002).

The acceleration of Chinese consumer demand means more sophisticated consumers that will require a wider range of products with higher quality and more diversified designs. Because of this, demand for improved quality-oriented and customer-oriented products continues to rise. In order to get a solid foothold in this largest potential market in the world, MNCs set up R&D facilities in China to meet local customers’ special demands or requirements. Market- or demand-driven considerations include factors that pull foreign R&D facilities into China for the purposes of
1) customizing/localizing the company’s products for the Chinese market  
2) developing new products for the local market  
3) supporting the parent company’s manufacturing, sales, or service facilities in China  

*Driver two: to pay the price for market access in China and to win government favor*

Another motive that MNCs occasionally mention is pressure by the Chinese government to establish R&D centers as a condition for foreign direct investment. The potential of China’s market is simply unparalleled, and the prospect of selling most anything to over one billion people, in one place, is irresistible for most companies. As such, the leverage of an enormous potential market allows Chinese officials to frequently play foreign competitors against one another in their bids for joint venture contracts and large-scale, government-funded infrastructure projects in China (Wang 1996). Thus, it is not surprising that technology transfers and R&D requirement are the price of doing business in China.

There is no better example of this than in the competition for China’s aviation market between the Boeing Company and the European Airbus consortium. The demand for air travel in China – both foreign and domestic travelers – is enormous and will surely require numerous Chinese purchases of foreign aircraft. Chinese officials are concerned about dependence on one aircraft manufacturer, Boeing, whose planes comprise approximately 80 per cent of all planes flying in China (279 out of 354 jetliners in 1997). They have increasingly alternated purchases of civilian aircraft between Boeing and Airbus as a way of developing independence as well as for political considerations. For example, in 1996, declining U.S.-China relations were linked to Airbus winning a $1.6 billion order to China (Wang 1996).

To dominate this attractive market, even though there is no official or published policy in China requiring technology transfers in the aerospace sector, “US-based aerospace firms have already agreed to onerous conditions in order to win access to the market in China by acceding to co-production deals and technology transfers” (Beckman 1996). Boeing and other US aviation manufacturers lobbied the Federal Aviation Administration (FAA) to sign a Joint Research and Development Project agreement with the General Administration of Civil Aviation of China (CAAC). Under this agreement, the FAA and the CAAC conducts joint R&D projects in aircraft safety and airworthiness assurance to include the exchange of information, joint testing and analysis, coordination of shared R&D activities, exchange of technical staff, and joint organization of symposia and conferences (FAA 2000).
Many MNCs believe that it is more important to establish a foothold in China than to make profits or even gain more than limited access to its market. Thus, if Chinese policies mandate a manufacturing joint venture or R&D in exchange for market access, many companies are ready to do so. Some R&D investment decisions were made to fulfill promises by MNCs to the Chinese government to “take root in the Chinese market and cooperate on a long-term basis.”

*Driver three: low-cost but high-quality talent pool*

No one doubts that the desire to take advantage of China’s low labor and infrastructure costs is an important motive of MNCs’ R&D strategy in China. In view of the relatively cheap cost structures in China (Figure 2), compared to western counterparts, and an increased supply of local talent, foreign investors find it both feasible and justifiable to develop certain technologies here, rather than to use technologies developed in their home country.

![Figure 2: Average Salary of Research/Engineer in Selected Countries](image)

*World Competitiveness Yearbook 1997, and (China 2000)*

The Chinese are well known for the importance they place on education, and many Chinese youths have displayed talent in scientific and technical fields, especially in the IT, chemical and biology industries. In IBM’s worldwide R&D centers, for instance, thirty per cent of the employees are of Chinese origin (Wei 2000). The U.S. Department
of Commerce’s International Trade Administration characterizes China’s software industry as “the only major source of competition to U.S. firms. Their products are of varying quality, and improve as the firms gain experience. The technical ability of the best Chinese engineers is first-rate” (Mataya and Huang 1995).

China’s “Open Door” policy has brought increasing numbers of students (mostly at the graduate level) to developed countries for training primarily in the scientific, engineering, and mathematics fields. Furthermore, the brain drain from China since 1989 is reversing, with more of these students finding their way back to work in emerging high-tech fields in China (Wen 2002) (Wingrove 1995). Currently, China has a total of 1,011 Universities which produced 417,000 science and technology majors in 1999. It boasts a sizeable engineering workforce, which is increasingly permeated by foreign R&D practices in China.

*Driver four: Much less expensive prospect to transfer a cutting-edge technology to a profitable, large economy scale product*

The most active foreign R&D investors in China come from the information technology (IT) and telecommunication sectors (Wen 2002). China’s severe lack of IT and telecommunications infrastructure is, in this case, an advantage. It is much less an expensive prospect to build a new wireless or fiber-optic telecommunications network throughout China than it would be if, as in other developed countries, a system were already in place that would require dismantling or replacement of old equipment. As a result, the lack of such an infrastructure actually allows China in many cases to “leapfrog” over old technologies to install cutting edge equipment (SIES 2002).

For example, only a decade or so ago, there was virtually no semiconductor industry in China. At that time domestic Chinese semiconductor manufacturing capabilities remained at 3.0-4.0 micron level, while the world level was at the 1.0 micron standard. However, China’s internal demand for semiconductors is enormous and growing quickly as more and more chips are needed to supply China’s own electronics, telecommunications, and computer markets. As a result, in 2000, China’s domestic semiconductor market was the second largest semiconductor market after the U.S. (Lev 2002). To meet this huge demand, the Chinese government decided to build 0.5 micron level fabrication plants rather than 1.0 micron. Because the cost of a fabrication plant is over $100 million and cutting edge technologies may be outdated in six months or a year, foreign semiconductor producers do not easily choose to rebuild a new plant at the 0.5 micron level. Thus, these companies enjoy setting up joint ventures with Chinese
semiconductor producers by providing technology and R&D support, and then export the high-tech products to their home countries and the world.

These major drivers for R&D investment in China have increased foreign FDI significantly. However, with this increased investment, firms have struggled with the best way to make use of their investment. This has led to the development of various models of R&D structure. In the next sections, these models are discussed and compared to traditional R&D theory.

**International R&D Strategies: The Traditional Models**

There has been a great deal of research on R&D foreign direct investment (FDI). We will briefly touch on these, but for a more detailed review, see Pearce (1989), Cheng and Bolon, (1993), Kuemmerle (1997) and Serapiro and Dalton (1999). The five basic models are:

- **The International Product Life Cycle** was developed by Pearce (1989) and expanded by (Cantwell 1995) and (Niosi 1997) and reflects the tradition life cycle model of a product or firm. Originally, R&D is viewed as a support function of manufacturing facilities that are moved overseas during the final stages of the product life cycle. Of course as product life cycles have shortened, this view has been revised to reflect foreign R&D facilities role in accesses global technology sources and innovation which can be used throughout the corporation.

- **The Centralized vs. decentralized R&D** is similar to the Product Life cycle model in that it focuses on the growth process of a firm and reflects the realities of corporate structuring. (Pearce 1989) differentiated the causes that drive firms to centralize or decentralize R&D. (Cheng and Bolon 1993) expanded this in order to include factors internal and external to a company that push it to make FDI in R&D.

- **In the Theory of International Production**, (Dunning 1992) argued that firms viewed FDI in R&D as an opportunity to gain advantages to help them to support or improve their competitive positions. As such they focus on product line improvements, basic product research, cost minimization, or insights into foreign market capabilities.

- **Within the Complimentary assets framework**, Serapio (1999) extended the work of (Teece 1986) and argued that some firms will use foreign R&D in order access technology and capabilities from overseas that
compliment their own key assets. In addition, some firms use FDI in R&D to provide assets that are necessary for the success of their overseas operations. Thus the focus is on coordinating a global R&D network to complement all the firms’ competitive priorities.

- In the Home base exploiting vs. home base augmenting model, Kuemmerle (1997) generalized previous work to argue that FDI in R&D focuses on the ability to “seek to exploit advantages which were created at the firm’s homebase location and which the firm could not exploit in an equally profitable fashion through other means than direct investment' or to 'add new knowledge and skills to the firms home base in order to ensure the firm's long term survival and growth.”

**R&D Strategies in China: The New Models**

The prominence of FDI in technology intensive industries is manifested in China’s foreign trade. Exports of high and new technology products by foreign affiliates increased from $4.5 billion in 1996 to $29.8 billion in 2000 (Table 3). In fact, according to World Bank Data 18.6% of China’s manufactured exports are now considered high-tech (World Bank, 2002). This accounted for one-fourth of the total exports by foreign affiliates, and 81 per cent of the country’s total exports in high-technology products.

<table>
<thead>
<tr>
<th>Year</th>
<th>Total (Million dollars)</th>
<th>State-owned enterprises (Per cent)</th>
<th>Foreign affiliates (Per cent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>7681</td>
<td>39</td>
<td>59</td>
</tr>
<tr>
<td>1997</td>
<td>16310</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>1998</td>
<td>20251</td>
<td>25</td>
<td>74</td>
</tr>
<tr>
<td>1999</td>
<td>24704</td>
<td>23</td>
<td>76</td>
</tr>
<tr>
<td>2000</td>
<td>37040</td>
<td>18</td>
<td>81</td>
</tr>
</tbody>
</table>

*Table 3: Exports of High-Technology Products from China by Ownership of Production (source: UNCTD, World Investment Report, 2001).*

Of course, this represents exports and thus R&D focusing on the rest of the world market. However, figure 2 showed that one primary reason for R&D investment in China was the development of products for the local market. This is the dichotomy of R&D in China. Since China opened the door to foreign investment at the end of the 1970s, MNCs’ R&D strategies in China have generally fallen into two groups: establishing R&D centers focusing on the Chinese market, and establishing R&D centers to leverage Chinese resources but focusing on the world market.
**Model One: establishment of R&D centers focusing on the Chinese market**

Various researchers (Bartlett and Ghoshal 1990; Hakanson 1990) have shown that as local markets develop and become more sophisticated, R&D is extremely helpful in adapting existing products to local requirements.

Particular concepts of this idea are incorporated into the complementary assets R&D model. One of the traditional models of foreign R&D was established by (Kuemmerle 1997). He argued that all foreign R&D sites fall into one of two categories. The home-base-augmenting laboratory site’s objective is to absorb knowledge from the local scientific community, create new knowledge, and transfer it to the company’s home R&D facility. In the home-base-exploiting laboratory site, the objective is to commercialize knowledge by transferring it from the company’s home base to the laboratory site abroad. From there it will be used in local manufacturing and marketing.

**Case Study: Matsushita**

Even though Matsushita has been in the Chinese market for twenty years, there are only around 1000 technicians in China while its total Chinese employee base is over 30,000. In Matsushita’s former supply chain model, all important parts were designed and produced in Japan. China’s subsidiaries only took the pure assembly tasks. However, the Japanese designers design the products based on their understanding of Japanese manufacturing demands. For example, Japanese designers would like to increase equipment costs rather than to increase labor costs because of Japan’s dependence on automation. But in China the labor cost is much lower than in Japan. So the original Japanese design only increases costs in China’s factories. On the other hand, Japanese designers do not know Chinese customers’ demands very well. For example, Japanese customers want microwave ovens with a barbecue function, but Chinese customers rarely want (or have even tried) barbecue.

In February 2001, Mr. Yoichi Morishita, the Chairman of Matsushita announced that Matsushita had decided to establish a new “brain” – Matsushita Electric R&D center (China) in Beijing. This center would be the second largest one among Matsushita’s sixteen R&D centers around the world (the largest one is in Matsushita’s headquarters). He said that it was too difficult to explain everything about China to Japanese designers. In order to make use of China’s special competitive advantages and to truly meet Chinese customers’ demands, Matsushita decided to focus its Chinese R&D issues with Chinese researchers and engineers. “We have definitely made up our
mind to rebuild our supply chain in China from the very beginning point – the design paper.” Mr. Morishita said (Panasonic 2001).

**Model Two: establishment of R&D centers focusing on the world market**

Researchers have shown that in many cases foreign investment in R&D may be driven by the need to augment its own knowledge base on a particular technology or capability (Cantwell 1989) (Florida 1997) (Howells 1990) (Kogut and Chang 1991) (Kuemmerle 1999). The reason is that non direct, or “spillover” effects can have direct impact on current operations and products.

**Case Study: Procter & Gamble**

Nabil Y. Sakkab is R&D Vice President of the Global Fabric & Home Care division of Procter & Gamble. He has stated that Procter & Gamble did not place R&D facilities in China because of less-expensive labor costs. Specifically, the salary gap for Ph.D.s is actually narrowing for countries with rapidly developing economies. The real value of R&D in China is the perspective it forces on the work. By developing products specifically for the Chinese market, it is easier to export those to other markets world wide. As an example, hair products such as shampoo are being developed for the Chinese market and the specific characteristics of Chinese hair. These products are developed specifically for the second largest consumer market in the world, but can be easily exported to other Asian markets. It is his belief that products which satisfy the requirements of the most difficult consumer environments are likely to work anywhere in the world.

**Model Three: leveraging the Chinese market to change worldwide R&D.**

Within particular areas such as electronics, it is necessary to develop worldwide standards. Thus there are various international standards bodies whose standards direct future product development. In this area, China is having a distinct impact which is changing the face of world-wide R&D for wireless communications. This impact provides the basis for a new model of R&D.

China is regarded as the growth engine of the world wireless industry (Wrolstad 2002). Especially in the case of the harmonization and formulation of the 3G (third generation) wireless systems communication standards, China plays an important role. Even though almost every major wireless player is developing 3G systems, there is
still not a well-accepted 3G technical world standard. With the largest wireless market, China’s vote will decide the future development of the 3G industry. Thus, it is not surprising to see that all major wireless MNCs have transferred their 3G R&D to China where the final product will be heavily consumed. They believe that it is better to perform the R&D there than to guess at home.

**Case Study: Wireless 3G Standards**

In the US, Europe, Japan and South Korea third generation wireless networks are being built using two basis technologies; WCDMA and CDMA2000. Both of these standards are variances of Code Division Multiple Access (CDMA) and were developed for practical reasons. For example, WCDMA is the European 3G technology and was designed as an upgrade of the existing GSM network. However, China has developed a third version of the CDMA technique called TD-SCDMA. In January 2003, T3G Technology Co. was started by Datang Telecom, South Korean electronics giant Samsung and Dutch company Royal Philips Electronics which will develop the chips for the new technology. The goal is to develop chips that run on this standard and licensing the technology to other companies.

The TD-SCDMA Industry Alliance is headed by Datang Telecom. Hua Yang, the secretary general of the TD-SCDMA alliance is clear about the strategy. “If we use an overseas standard, then the technology is controlled by foreign manufacturers. If China has its own standard, then the domestic enterprises can master the technology by themselves, so they can be at the same competitive level with overseas manufacturers” (Goodman 2003). Johan Pross, chief executive of T3G Technology Co. states that “This is China saying we have to build our own intellectual property….In China, you can be sure that the government will promote it [TD-SCDMA] based upon the fact that it is a homegrown technology and they have invested substantial money in their own standard” (Goodman 2003).

**Assessment and Monitoring of the New Models**

To gauge the accuracy of our three models we conducted Delphi surveys. Since the early 1950’s when the Rand corporation performed the first Delphi survey for the US Air Force, hundreds of government, industrial and private Delphi surveys have been conducted world wide (Vanston 1984). While there are variations, the basic concept includes original input of opinion by experts; idea feedback procedures and a standardized display of results. Of course, each participant’s comments remain anonymous to all other participants. As an initial assessment we
surveyed various academics within China and those outside China whose research focuses on China concerning models of R&D research currently being practiced within China. There was agreement that most R&D conducted in China were variants or combinations of existing models and that there was growing emphasis on R&D solely for the Chinese market.

In order to test model three, however, we surveyed the directors of ten of the largest R&D facilities in China to see if they agreed that a new model of R&D was being seen focusing solely on the Chinese market. We used the example of the development of different wireless standards by the Chinese government and asked if they believed this heralded a new model of R&D. The ten R&D directors contacted were from GE, Microsoft, Kodak, Nokia, IBM, Ericsson, Samsung, Lucent, NEC and Sony. Of these four responded. Three agreed unconditionally that we were correct in our assessment of a new R&D model. One offered a conditional acceptance. In order to be true to the Delphi method, we recreate the response.

- I see that there will be in China more and more foreign owned companies’ R&D focusing PRIMARILY to meet Chinese market needs, which differ sometimes from the global market needs. However, I do not sign the development of new cellular phone standards as an example here. The need with standards are toward really international ones, not creating isolated standards only used in China, and (especially telecommunication field in my mind) the technical/economical/political/legal/cultural readiness to develop new truly global standards is still a very much lacked skill in China (cf. even the Japanese have not mastered this, although they played an important role in selecting WCDMA). The change of the rest world is happening, but the change is happening whether China is present or not. China’s presence is mainly “fine tuning” the change, not the source for the change. An example from telecommunication standard, whether China is applying its "own standard" (TD-SCDMA) in China will not effect the word selection at all. It may have role (if will be selected in China), but this role is merely a complimentary one. Within 4G the direction will be effected by China, but China is not in a position to dominate the direction of the other world. As a whole, I see China to be more and more integrated to the outer world without being dominating there, but having a certain gradually growing weight of influence.”

Note that even with this one conditional acceptance; there is still agreement that more R&D will be conducted focused primarily on the Chinese market and that China will have a growing weight of influence with regards to international standards and thus the R&D behind those standards. The key issue is how great an impact this growing
Implications

Implications for Models One and Two

It can be argued that Models One and Two are extensions of traditional theory. For example, model one can be viewed as an extension of Kuemmerle’s work. According to Kuemmerle, home base exploiting FDI in R&D focuses primarily on (1) local adaptation of products, (2) creation of peripheral products, and (3) local adaptation of processes. In the example of Matsushita, they have adapted their products and production process to the Chinese markets.

Likewise Model Two can be viewed as a variation of Serapio’s complementary asset model. In this model, he argues that firms used foreign R&D to provide complimentary assets that are essential to the success of their overseas manufacturing or sales operations. “Overseas transplanted production and sales operations often require adaptive development efforts; the product often has to be redesigned and reengineered. In such cases the company needs to compliment its overseas manufacturing and sales presence with an R&D presence in the local market” (Serapio and Dalton 1999).

However, for both of these extensions, business people should understand that R&D management in China has to integrate both Western theory and Chinese culture (Sirp, Gan et al. 1998). Specifically, they noted that there “are aspects of R&D management for which there is little suitable management theory as yet.” What has apparently been happening is an extension of traditional theory. Specifically, firms have used local R&D to adapt their products to the local conditions. Due to the size of the Chinese market and its inherent differences from other markets, this model has now been expanded into a foreign-base exploiting model. The specific needs and drivers for this new model were addressed at the IRI CTO Forum held in Beijing on September 25-28, 2000. There, Bruce Lyne, the chair of IRI’s International Committee discussed the acceleration of R&D and innovation in China. He noted that the prime motivation for the 27 IRI companies at the meeting was the need to get closer to the customers of the worlds second largest and fastest growing consumer market. Most of the firms agree that selling foreign products without concern for the realities of the Chinese market was bound to fail. The products had to be developed specifically for the Chinese market. To support this, good working relationships with Chinese authorities
is also important. This is known as guanxi, which literally means relationships. Guanxi can also be viewed as “friendship with implications of continued exchange of favors” (Pye 1992). Companies conducting business in China must understand that different business logic applies in China as opposed to Europe and the US. Unless a company understands the Chinese business logic used to reach decisions, nothing can be accomplished (Park and Luo 2001). The establishment of an R&D Center in China is considered evidence of the companies’ long-term focus in China. Thus R&D facilities in China allow for better long term relationships as well as providing a base for developing products purely for the Chinese market.

Implications for Model Three

On one hand model three can be viewed as an extreme extension of model two. However, we believe that the leverage of the potential size of the Chinese market and the political leverage of the Chinese government is causing a new model to be defined. This model can impact worldwide technical investments and R&D. Businesses must be aware of this change so that they can best apply it to their own R&D decisions. In addition to the case of the cellular phone industry already presented, China is also developing its own standards for HDTV. It has also announced a new standard for video called Enhanced Video Disc (EVD) and has been formally adopted by the Chinese Ministry of Information Industries (MII) and the Standardization Administration of China (SAC). EVD is being pitched straight at DVD. All DVDs sold in China will have to use this format. As such it will “attach the market share of DVD” (Smith 2003). We contacted a member of the World Wide Web Consortium (W3C) and the Internet Engineering Task Force (IETF) who agreed to speak anonymously. He stated that it is the belief of W3C and IETF members that China will continue to tweak technical formats in order to protect their own industry and force outside companies to manufacturing products on Chinese terms.

Practitioners and researchers should understand that we are seeing the development of a model that cannot be generally applied. This is because of the conflux various factors. These include the huge potential market size and technical capabilities of China. Another confounding factor is the interaction of the Chinese market into these issues. Thus this model cannot be applied traditional markets such as Greece, Argentina or even Australia, for that matter. However, this is not to say that is of isolated importance. One market that does have the potential to apply this R&D model is that of India. India has a similar market size and technical capability. In fact one recent report stated that India must “import either Chinese products or the Chinese model” of business (Economist 2003).
Conclusions

China currently represents the world’s largest potential market for a host of goods and services. Because of this foreign firms have been making great efforts to enter this market. This large degree of FDI has had effects in both directions. On one hand, western influences have caused China to adapt its R&D structures after western models (Sirp, Gan et al. 1998). However, China’s distinctive market has had effects on the companies that have entered there. Specifically, as predicted by (Sirp, Gan et al. 1998) we see that these companies have developed new methods of using R&D facilities to better make use of China’s strengths.

On one hand there are variations of traditional models to better apply them to the Chinese marketplace. In model one firms site R&D facilities in China in order to develop specific products for the Chinese market alone. This allows firms to not only take advantage or China’s huge market but also to develop production methods that make use of China’s low cost labor.

In the second model, R&D sites in China are used to develop products for external, world wide consumption. Products that may have been developed under the ideas of model one, can now be exported worldwide. While this can be seen as a variant of previous R&D models, if highly leveraged, we reach model three.

In model three, the focus on the large Chinese market cause international R&D to be changed. The 3G wireless standards are a case in point. As global markets continue to become intertwined, China (with its singularly huge market), will have much greater leverage on determining world standards.

It should be noted that while all these models are viable only because of the combination of China’s huge market potential and its huge knowledge resource potential. It is doubtful that the third model in particular can be easily duplicated in other markets except possibly India. As discussed earlier, the goal of this paper is to develop models of current R&D practice in China by performing the Scanning and Monitoring techniques. However, now that they have been developed and observed, further Tracking and research by academics is in order to provide future support and direction for firms competing globally.
Bibliography


