MANAGING FOREIGN R&D IN CHINA

Managers of international R&D and innovation in China relate the lessons they have learned: what works and what doesn’t.

Maximilian von Zedtwitz, Tadashi Ikeda, Li Gong, Richard Carpenter, Seppo Hämäläinen

OVERVIEW: China has become one of the most desired locations in which to do R&D. However, it has little innovation of its own, and intellectual property protection is weak. This raises questions: Is China R&D more hype than reality? Do cost advantages really outweigh the risk of losing technology to Chinese competitors? Lessons learned from managing R&D in China show that in order to avoid the typical pitfalls of managing R&D in a developing country, any China-based R&D must be part of an overall China strategy and must also be part of a global R&D effort.

KEY CONCEPTS: international R&D, emerging economies, management in China.

China is not your typical developing country—or is it? Those who have recently traveled to Beijing, Shanghai or Shenzhen have seen cities with Western-level infrastructure, Manhattan-like skylines, city-wide public transportation systems, and—last but not least—world-class R&D centers (1, 2). The best of the best in China come to these cities, are educated with knowledge and textbooks developed at the best universities, and are willing to work very long and very hard to succeed. Consequently, when visitors return to their home countries, they are always impressed, and sometimes a little frightened, by the energy and determination that pervade this country.

Despite its recent achievements, however, China is still a developing country by any standard. Even though it is a country of 1.3 billion people, in terms of GDP it is only about the size of the United Kingdom (2005 GDP US$2.2 trillion). China’s GDP has been growing nearly 10 percent per year since the early 1990s, with an average annual GDP per capita of US$1,710 (cf. average US$41,600). The industrialized world has a greater accu-

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Their article is jointly authored by all contributors. Some contributions are given in quotation style when they relate to a particular company or industry experience.
mulation of wealth and—fundamentally linked to this—significantly greater investments in science, technology and R&D. By far the greatest share of worldwide R&D is done in the United States, Europe and Japan, and most of the cross-border R&D investments go into other industrialized countries.

It is difficult enough to do R&D at home; global R&D is much more difficult because team members do not speak the same language, do not have the same cultural background, do not have access to the same infrastructure, and/or do not work in the same time zone. Thus, setting up R&D in China—a country which has only recently opened up to the West, where intellectual property rights are harder to enforce, whose scientists and engineers speak Chinese predominantly, where expertise in modern technology is limited, and whose culture is often described as “the most different” from the West—brings about a special set of challenges.

**Foreign China R&D Still at Early Stage**

According to official numbers (collected by the Chinese Ministry of Science and Technology), by late 2005 foreign companies had established about 750 R&D centers, mostly in the telecommunications, IT and manufacturing sectors. How significant is this in terms of global R&D?

CNY197 billion, or 1.23 percent of China’s GDP, was invested in R&D in China in 2004. Of the expenditure, 66.8 percent was spent by enterprises, with three-quarters of that amount by large and medium-size companies. Of this, 23.1 percent was invested by foreign companies, including those from Hong Kong, Macau, Taiwan (together 8.1 percent) and other countries (15.0 percent). In other words, R&D spending by large and medium-size foreign companies contributed about 11.5 percent of the total enterprise R&D spending in China.

This is roughly comparable to what foreign companies spend on R&D in the U.S. (15 percent). However, 11.5 percent of CNY197 billion is CNY22.6 billion, or about US$2.7 billion—hardly impressive given that a Microsoft or Pfizer alone spends more than US$8 billion every year (3).

To cross-check this calculation, let us multiply the 750 R&D labs by an estimated 50 researchers per lab (most labs are actually much smaller and only a few number into the hundreds), multiply the result by an average annual salary of US$40,000 per researcher (about one-third of U.S. levels) and multiply this by 2 (as salaries, on average over most industries, account for about 50 percent of R&D costs). As a result, we arrive at US$3 billion estimated annual R&D investment in China.

Foreign R&D spending in China is thus still small, but rising with the influx of more foreign direct investment (about US$1 billion per week), the national 10 percent annual GDP growth rate, and the individual expansion of foreign R&D centers in China in size and numbers (see Figure 1). Nevertheless, foreign R&D in China is still in a nascent stage.

**Why Set Up R&D in China?**

The goal of many companies is to create global, interdependent, competence-based organizations that build external capability and then leverage it where it can be most effective in developing innovation. This usually requires long-term commitment to developing business in that country. Putting R&D resources on the ground locally must be a key part of that commitment in China. Several reasons to do this are enumerated in Table 1: access to local markets, to local expertise, cost advantages, new production systems, business politics, and maintaining proximity to customers, as follows.

1. China’s large population and evolving consumer habits, practices and market trends require a strong local presence. Understanding and respecting cultural differences and values is key to becoming a successful organization in any country, and developing products and technologies for Chinese customers is crucial in many industries. Says co-author Seppo Hämäläinen of Nokia: “China is the world’s largest mobile market by subscribers and the most dynamic one. It is estimated that nearly one-quarter of new subscribers in the world are from China. China is a strategic country for Nokia and one of the biggest markets now.”

2. China is very strong in science, technology and human talent (particularly Beijing and Shanghai, as illustrated in Figure 2), and companies wish to integrate this into their businesses. Nearly 750,000 scientists and engineers graduate from Chinese universities every year, second
Figure 1.—Number of R&D labs set up in China annually, based on 313 confirmed establishment dates collected through mid-2006.

only to the United States. One-third of Chinese university graduates have degrees in engineering, and another 16 percent graduate in natural sciences or medicine. Since 1998, China has doubled its national share of annual R&D spending to about 1.23 percent of GDP. China is clearly willing to invest in building a foundation of people trained to compete internationally (4).

3. In general, the average salary of Chinese engineers is still quite low. At Tsinghua University, considered by many as the “MIT of China,” engineering graduates can expect to make about 4,000 CNY (about US$500) a month in their first job. When working for foreign firms, Chinese R&D engineers earn on average about one-third of what their peers make in the U.S. or Western Europe. With salaries accounting for 40–60 percent of a typical R&D budget, the attraction of being able to employ more than twice the number of university-educated engineers in China is huge.

In deciding to build up R&D in China, however, the personnel cost advantage should be only one consideration, and balanced by an understanding of other related factors:

- When comparing average salaries in China with the West, we must recognize that many of the China-based labs are new and hence staffed with young scientists who tend to earn much less than their more senior colleagues. In the West, R&D labs hire older engineers too, and they have matured with respect to a senior management and science structure that adds high-salaried people to the upper part of the pyramid. Thus, as Chinese labs grow older, the average salary of its employees will increase as well.

- There is a greater need to compensate for educational shortcomings (e.g., in project management, teamwork and English language).

- High turnover rates are a risk, and will result in additional search and replacement costs.

- Misunderstanding of expectations and weakness in quality can lead to greater involvement of senior managers in R&D, i.e., micromanagement, which ultimately reduces R&D performance.

- Much of the infrastructure, such as computers and real estate, is just as expensive as it is in developed countries, and hence no cost advantage can be gained in this area.

Investments in R&D in China should therefore never be solely cost-related, and should always include some or all of the other reasons mentioned here.
4. China has become a major source and developer of materials and technologies that are becoming more important to overall business and future growth. Many companies have established production bases in China to make use of its extensive manufacturing capabilities. For instance, more than 80 percent of all television sets worldwide are said to be manufactured in Guangzhou, a province in the south of China. In pharmaceuticals, China is expected to quadruple its sales from US$6 billion in 2002 to US$24 billion in 2010, effectively making it the fifth-largest pharma market after the U.S., Japan, Germany, and France. China also invests in infrastructure and construction. Between 2006 and 2010, it will add more than 24,000 km of expressways to reach about 65,000 km, and at least another 20,000 km until 2020. In 1988, China had no expressways at all; the U.S. had about 90,000 km in 2005. R&D is set up in the main hot-spots of China to take advantage of these production systems in scope and scale.

5. Companies establish R&D in China for business, political and strategic reasons. A significant investment in local R&D helps build relationships with the local or national government, which in turn facilitates business-related deals. As “friends of China,” it is often those with an R&D presence who get the favorable nod from the inside of powerful ministries. However, it is usually the central government in Beijing that encourages foreign R&D investments more than the provincial or municipal governments, whose interest is not primarily in global science and technology but rather in local tax revenue and employment, thus clearly favoring investments in more labor-intensive manufacturing facilities. Still, a foreign R&D lab makes local officials look better. Foreign companies thus assign networking and representative roles to their R&D centers in China, and in some cases these political responsibilities are more important than the actual R&D work done there.

6. Finally, one reason unrelated to costs but particularly relevant to small and medium-size enterprises (SMEs) that supply multinationals (MNCs) is to maintain proximity to their global customers. Many MNCs have set up manufacturing in China and expect their suppliers to provide on-site technical service and development. Those SMEs unwilling to invest in development teams in China may risk losing their status as the preferred supplier not only to the operation in China but elsewhere. Thus, SMEs are pressured to follow the Fortune 500 companies with their own product development and technical service groups to China.

**Toughest Challenges**

For nearly 25 years, China has received a large amount of inward technology transfer, effectively making “technology for market access” an official policy for foreign direct investment. A poor intellectual property (IP) system has made dissemination of technology easier than
its protection. Many Chinese engineers are lured away by rising Chinese high-tech companies, or they start their own firms to compete directly with multinationals or to supply them with components. As a result, China may not be the ideal location for cutting-edge R&D. How does one manage R&D in such an environment?

China is not the first country to import technology en masse under weak IP protection regimes. Switzerland, for example, did the same in the late 1800s to build up a chemical industry, as did the U.S. in the mid-1800s to bring in British and Continental engineering technology. In the case of China today, however, multinational companies are affected the most. Table 2 shows the patenting behavior of Chinese inventors and foreign multinationals. Foreigners obtain about 63 percent of all granted patents, while Chinese inventors get by far the lion’s share of utility model and design patents. This is not necessarily indicative of actual R&D performance, but much more of China’s first-to-file rule. In order to protect technology claims, foreign multinationals also reap the benefits of patents already granted in the U.S., Japan and Europe, while some Chinese companies also apply for patents based on foreign technologies whose owners do not seek protection in China. Unlike invention applications, utility model and design applications are given only a preliminary technical examination.

China’s IP law is actually quite modern, and in the larger cities increasingly well-enforced. However, many counterfeiters are outside those metropolitan areas and in central China, where IP enforcement is still weak.

MNCs deal with the situation as best they can and to the extent needed. Pharmaceutical companies have been cautious in moving R&D to China for this very reason, while engineering companies seem to be less affected. At the company level, MNCs are employing various techniques and strategies to protect their IP rights. With proper training, it is not difficult to have employees recognize the value of IP and the importance of protecting it for the company they work for. Moreover, certain technologies have entry barriers (technical, business or otherwise) so high that it is not easy for someone to utilize a stolen piece of code or design to achieve competitiveness.

Observe co-author Li Gong, of MSN Microsoft China, “With respect to IP protection, China does not have a high reputation. However, at an individual level, people are fundamentally sound. . . . This is not to say that employers can let down their guard.”

Besides IP violations, the other major challenge is to manage R&D staff. Simply put, the toughest challenge for R&D in China today is “capability building”: recruiting, training, developing, and then retaining top talent while building sustained technical capability. This begins with recruiting: outside of the top ten Chinese research institutes and universities, most Chinese research organizations are still years behind Western standards, and thus are not only unattractive research partners but also poor training grounds for future MNC R&D engineers. MNCs—and most Chinese high-tech companies—focus on recruiting from the likes of Tsinghua, Beijing and Fudan universities, or the Chinese Academies of Sciences and Engineering. MNCs are not only competing with one another but also with European and American universities, which select the best and brightest of each class for Ph.D. courses abroad.

Hence, despite the huge annual number of graduates in China, it is sometimes difficult to find good talent, especially in research. There will be dozens or even hundreds of job applications for an open position, but there will be

<table>
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<tr>
<th>Patent Applications</th>
<th>Patents Granted</th>
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<tr>
<td></td>
<td>Total</td>
</tr>
<tr>
<td>All</td>
<td>353,807</td>
</tr>
<tr>
<td>Invention</td>
<td>130,133</td>
</tr>
<tr>
<td>Utility Model</td>
<td>112,825</td>
</tr>
<tr>
<td>Design</td>
<td>110,849</td>
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Source: SIPO-China’s State Intellectual Property Office

May—June 2007
no time to interview all of them, as resumes (in China) are not reliable indicators of skills. Microsoft (and other companies) run additional entrance examinations just to pre-qualify applicants for interviews.

Once hired, further training is needed for the new scientists to be brought up to the equivalent skill level of those in Western countries. One of the biggest challenges is to bridge the cultural gap between U.S. and China employees, in both directions. There are difficulties in communication between Chinese and foreign staff due to language and cultural differences, and attitude of foreign colleagues toward Chinese researchers due to lack of trust. Both need to adapt to the ways of work and life of the other party.

China employees must learn to take initiatives and innovate. This involves developing the appropriate market and business sense. U.S. employees, especially the senior managers, must learn how to build teams in a “foreign” environment, manage employees remotely, and be sensitive to local characteristics. Without such knowledge, or at least acknowledging the lack of such knowledge (and the need to learn), Western managers are at high risk of failure and may not even know it.

In fact, many R&D centers in China are now moving toward being managed by a team of two directors: one foreign expatriate and one local Chinese. The foreign director provides the link to the parent company and relays the corporate mission and culture to the local unit. He/she may be “our man in China” for HQ, but in actuality he should be “our man in HQ” for the Chinese team. His vision and understanding of what needs to be done has a profound impact on the local culture and R&D organization. The local Chinese team depends on him to represent it at the global level (see Figure 3).

The Chinese director acts as a chief operating officer (COO), someone who deals with day-to-day matters and defines goals and processes in the R&D center. Having spent time abroad, he can interpret between the foreign and the local Chinese culture. As a Chinese, he serves as a living example that local Chinese can also climb to senior positions. This gives him the necessary credibility with line managers and key engineers, who depend on him. In turn, he can ensure that their concerns and expectations are met, as he—a Chinese—understands where they are coming from and what they need, even without them having to state it explicitly.

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![Figure 3](image_url)

**Figure 3.**—How to run a R&D unit in China: An expatriate hands-off R&D director teams up with a local Chinese executive head of R&D: line managers should be recruited from within the projects to establish career tracks fast.
The promotion of senior Chinese engineers and managers into top positions often hits a glass ceiling, which needs to be removed by the foreign top management in order to be credible with respect to global career promises. Says co-author Tadashi Ikeda, of R&D Hitachi, Shanghai, “At Hitachi, we are actively employing local talent as well as those with overseas experience. It is corporate policy to foster R&D leaders from within the talent pool of local staff, and we do not intend to make any direct senior appointments from outside this pool. Also, we are investing heavily in the education of our young and talented local researchers to gain an international competitive edge.”

Although the standard of pay remains low compared to Japan, Europe or North America, it is increasing at a remarkably high rate. Good performers can, and do, expect to double their salaries every three years. For foreign companies in China, the imperative is to maintain or even raise cost performance, as the competitiveness of local researchers must increase faster than R&D costs. Chinese companies suffer from this salary spiral as well, because they are not used to paying such high salaries for engineers in addition to the premiums needed to lure them away from foreign MNCs offering an international perspective and environment.

Further, competition is tight; many foreign and domestic companies wish to hire the same people. Chinese researchers and engineers are eager to learn and grow in order to advance their careers. The researchers are not ready to remain in R&D positions for long, but expect to move into managerial positions quickly. The costs and risks of switching jobs are perceived to be low by researchers; thus, the decision to go work for a competitor sometimes hinges on a difference of only a few hundred dollars. As a result, the circulation and turnover of people is fast.

Foreign R&D labs suffer from this high engineering turnover rate, especially when engineers leave before they have returned the investment made in their training and in-house education. In some industries, it may take two years or more before a newly hired engineer or scientist becomes independently productive (or provides net value to a firm). In software development, this may be only a few weeks. But once an employee reaches this turning point (i.e., where he/she returns more to the company than what the company has invested in terms of salary, overhead costs, etc.), it will still take time before the employee has worked off the accumulated investment made in training, managerial guidance and salary since the start of employment (see Figure 4).

In China, by the time such a break-even point is reached, many engineers have left the company for another Western firm, re-starting the training, learning and adaptation there, or they have taken their experience to a local Chinese competitor. Thus, engineers trained by Volkswagen, for example, are sought-after employees by, for example, DaimlerChrysler or Audi, as they may have received training in a foreign language (e.g., German or English), as well as foreign engineering or business processes. In the worst case, foreign R&D units serve as training centers for Chinese engineers who move on before the investment in them has been recouped. In Table 3 we summarize several ways to minimize turnover on the basis of our own experience.

### Global Impact of R&D in China

Most foreign R&D labs have been established in China only recently and require more time to mature organizationally and produce truly innovative results. There are two camps of thought in this respect. The first camp believes that China will not be able to shed its status as a developing country and that the lack of creativity and initiative is hard-wired into the current generation. This camp argues that it took Japan and Korea many decades to develop leading-edge technologies even in only a limited number of areas. The second camp is more optimistic and believes that China’s overall energy and dynamism will also put its R&D on a fast track.

The likelihood of investing in R&D in China will depend on which line of thought is taken. The real questions, however, are not “if” but “when” will China become the right host for a given company’s R&D, and when can we expect to see the first modern products introduced worldwide based on truly Chinese innovations?

It is the authors’ opinion that major breakthroughs from China are just a matter of time. Small breakthroughs are already on the way, especially in the wireless sector. For example, individualized ring tones were first widely deployed in China with great popularity, and this feature is now available in the U.S. via T-Mobile. What is notably lacking today is truly disruptive Chinese-innovated technology. The (Chinese) inventions of
movable type, gunpowder, compass, and paper were made hundreds if not thousands of years ago, and it took centuries for them to be accepted outside (and even inside) China. But China is investing heavily in science and technology again. If anyone can have a great innovative idea—and the role of MNCs is to find these ideas efficiently—then it might be a smart bet to locate R&D centers in China to create crystallization points for these scientists and other technically trained people.

Successful R&D does not have to result in Nobel prizes or breakthrough inventions all the time. More often, what is important is the incremental but steady progress that builds sustainable competitive advantage. Collaborating with customers’ R&D (e.g., telecom carriers) and marketing people, and adopting Chinese leaders for the China market will surely result in more productive R&D. For instance, co-author Richard Carpenter, of Procter & Gamble in Beijing, says, “P&G’s R&D organization has been in China for more than ten years and has already become a key source of low-cost innovation for the company both locally and globally, not only in China. P&G has reapplied learnings and technologies from China to other developing and even developed markets. Its China R&D center leads global thinking on low-cost innovation strategies and solutions.”

The length of time it takes for R&D to produce results also depends on the nature of the work. For instance, at the previous company of one of the authors, Sun Microsystems, it was possible to assemble a team of Chinese engineers within a short time span and deliver high-quality products on schedule at a much lower cost. Such achievement demonstrates not only that Chinese engineers can individually accomplish much in the right foreign-style environment, but also that they can achieve similar results as a group while situated in China.

China has the potential, therefore, to be not only a source of radically new technologies, but also a low-cost innovator (rather than just a low-cost labor country) by developing products and services that are still profitable at the much narrower margins commonplace in China.

Lessons Learned

Some say that China changes so fast that whatever you learned five years ago is likely no longer valid today. Some of the key lessons learned from the authors’ 30-odd years of accumulated experience of managing R&D in China are summarized below.

1. To benefit from China, one must be there. To realize China’s potential and opportunities, it is crucial to be a part of it, grow with it, give back to receive, and most importantly be there when it happens. China is changing rapidly. What is supposed to be a “Chinese standard” is actually a “moving target.” Whatever China is today, it will be different tomorrow. To succeed, one has to be continually vigilant in identifying first-mover opportunities while also anticipating future implications. A local organization and local technical capability need to be built. This requires a long-term organizational commitment that not every company is prepared to make. It also requires significant persistence and tenacity to carry it all the way.

2. Cost should not be the driving motivation to locate in China, although it may be one consideration. Although R&D salaries in China are only about a third of those in the West, management challenges related to personnel turnover, training, communication barriers, and Chinese

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**Table 3.—How to Keep R&D Turnover Low (Authors’ Experience)**

<table>
<thead>
<tr>
<th>Problem</th>
<th>Solutions</th>
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<tbody>
<tr>
<td>High career ambitions not met.</td>
<td>• Instill perception of career advancement and save face, with “phantom” promotions.</td>
</tr>
<tr>
<td>Work is not inspiring enough.</td>
<td>• Set examples by appointing top-level Chinese managers from inside the R&amp;D center.</td>
</tr>
<tr>
<td>Poor communication.</td>
<td>• Assign “sexy” projects or work that is relevant to China.</td>
</tr>
<tr>
<td>Salary perceived too low.</td>
<td>• A senior Chinese manager better understands needs and wants.</td>
</tr>
<tr>
<td></td>
<td>• Move to less “distractions” location, e.g., city other than Beijing, Shanghai.</td>
</tr>
<tr>
<td></td>
<td>• Offer international assignments.</td>
</tr>
<tr>
<td></td>
<td>• Build/maintain non-monetary attraction, e.g., leverage company brand, or integrate staff into global teams.</td>
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<tr>
<td></td>
<td>• Hire female engineers: they value better work climate over incremental salary advantages elsewhere.</td>
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culture mean that the China lab cannot be used as a flexible and easily expandable resource pool. It is important to remember that most Chinese employees have never left China and many have never even flown on an airplane!

A well articulated strategy is important—one that explains the purpose for an R&D unit in China. The local R&D effort should be well-linked to the global R&D strategy. Otherwise, the China team will not be perceived to have the credibility needed to achieve equal footing with the rest of the R&D organization. Ideally, the R&D center will work on China-related topics (e.g., traditional Chinese medicine, Chinese character handwriting recognition, etc.) to ensure that the local R&D staff feels that their work leads to solutions relevant for China. Engineers actually like to work on things that make their family and friends lead better lives. It is a lot more motivating to know that one is not just working for a foreign multinational on “foreign problems” but also on a project that will contribute back to one’s home society. This principle works in product localization as well as basic research. It gives people the necessary motivation to work long hours and still stay with you despite seemingly more lucrative jobs with competitors.

At the same time, the problems to work on should be “tough” ones, that is, problems that are difficult to crack elsewhere, including your home-based R&D center. The China R&D team will gain “face” by working on a tough challenge—so tough that even the R&D experts back in California, New Jersey, the UK or elsewhere have been unable to solve it.

Perpetuating the “China is low-cost” message is not only untrue in R&D but also highly demotivating for local R&D staff. No one likes to give his best ideas and put in long working hours to a foreign company that openly considers him cheap labor. Rather, Chinese engineers need to understand that they are the only engineers who can do it, and the incentives of winning respect, international reputation, and sense of accomplishment and fulfillment will outweigh a slightly bigger paycheck.

3. Invest in China R&D and delegate R&D decision making to the China country level whenever possible. Do not alienate local R&D directors and staff with rules, regulations and requests that will only result in meaningless responses. What works for an R&D center in Houston may not work for an R&D center in Nanjing. Give local directors reasonable leeway in making operational decisions, and assess them based on long-term results. Be prepared to train Chinese engineers. They are diligent, but they may also need to be equipped with new methods to best utilize their skills, and they need to be informed. Chinese employees will follow your company standards—in IP rights, information security, etc. People are willing to learn and follow rules if they are made aware of them. This will also help you to treat Chinese employees as trusted partners instead of suspicious hired hands.

4. Take time to understand the way China works best instead of attempting to export U.S. or Western practices every time. Let them work for you rather than work against them. This means you will have to stay informed about China and about your R&D units there. Establish reliable feedback channels so that problems at remote sites can be heard and dealt with in a timely and fair manner. Consolidate reporting locally to form a bigger pyramid that can offer better career paths. It also means, however, that you keep people informed. The traditional understanding of a directive is that if it is not repeated every couple of weeks, it is not applicable any more. Your engineers need to be reminded of your values and goals.

Looking Ahead

In the absence of major political or economic disruptions, the authors believe it is inevitable that China will sooner or later become an important source of technology. More technology will be transferred to China, but improvements in IPR enforcement and management of local R&D labs will make it easier for high-tech companies to benefit from R&D in China. But besides high-tech MNCs, other companies are also considering tapping into China with R&D. We expect that most of the new R&D investment will be made by mid-tech companies, which have been increasing business in Asia today (such as construction, steel, food, and chemical companies), pharmaceutical and biotech companies (which have been reluctant to enter China with R&D for IPR reasons and have so far used it only as a basis for clinical trials), and SMEs (which will continue to follow MNCs and other customers).

To repeat, our most important insight is that any significant R&D move to China by foreign companies should not be triggered by cost-saving considerations but by a sound overall China strategy which itself is part of a coordinated global strategy, enabling and providing the China R&D team with incentive to achieve and contribute on an equal footing with a company’s other overseas R&D teams.

References and Notes

3. OECD Science, Technology and Industry Outlook 2006 (OECD: Paris) estimates that China has become the world’s second largest R&D spender, measured in purchasing power parity (PPP) terms. However, PPP may not be appropriate for assessing R&D expenditures and investment, as our cost calculations in this article illustrate. Consequently, we use the more traditional foreign exchange rate conversion.