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MNCs' Offshore R & D Mandates and Host Countries' Locational Advantages

A Comparison Between Taiwan and China

SHIN-HORNG CHEN, YUN-CHUNG CHEN, AND
PEI-CHANG WEN

Abstract Offshore R & D by multinational corporations (MNCs) has increasingly involved the developing world in East Asia, initially Taiwan and Korea but more recently China and India. However, the R & D mandates of foreign R & D facilities in this region tend not to follow the paths of evolutionary models. To explain this phenomenon, this article presents a conceptual framework, essentially based on Dunning's eclectic paradigm, with a strong flavor of the evolutionary approach to technology, but which, in some cases, also allows for leapfrogging competition. In terms of empirical work, the article also explores the relationship between MNCs' overseas R & D mandates and the locational advantage of the host country by conducting case studies on flagship MNCs' R & D facilities in the information technology sector on both sides of the Taiwan Strait. The results show some interesting contrasts across the Taiwan Strait that run counter to the evolutionary perspective. There are grounds to suggest that such contrasts have much to do with the locational advantages Taiwan and China each possess. Further implications are drawn to enrich the current understanding of R & D internationalization.

Keywords R & D internationalization, R & D mandate, locational advantages, MNC, leapfrogging

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Foreign direct investment (FDI) from the developed world has been a significant force in shaping the global industrial landscape, with its geographical flows being affected in part by the locational advantage of the host country.¹ The

so-called “Flying Geese Model,” coined by Japanese scholars, was used to describe this process in East Asia in a temporal and evolutionary manner. However, the rise of China and India has called into question the validity of the model. More importantly, FDI involves not only manufacturing and services but also corporate R & D value chains, giving rise to an increasingly significant trend of R & D internationalization by multinational corporations (MNCs).²

In addition, the outreach of MNCs’ R & D activities was initially geared to the developed countries, but this has more recently shifted towards the developing world.³ In particular, countries such as India⁴ and China⁵ have been documented as high-profile host countries for MNCs’ offshore R & D facilities. There is, however, a matching trend within the process of globalization that some countries in East Asia seek to attract the R & D facilities of MNCs. Nevertheless, not all FDI has equal value because many of the MNCs’ subsidiaries are footloose as “branch plants,” which can of course lead to the so-called “branch plant syndrome.”⁶ By contrast, MNCs’ subsidiaries with strong R & D mandates as well as strategic geographical or product range responsibilities tend to adhere more to the host economy and are hence considered to be highly desirable in terms of their impact on local wealth generation.

On balance, within the overall process of globalization, international economic development has much to do with the relocation of the value chain of MNCs and indigenous innovation.⁷ These two factors are, however, interrelated. Given the footloose nature of MNCs’ cross-border operations, it is deemed increasingly important for a host country to attract MNCs’ facilities with strategic mandates, such as R & D. Therefore, R & D internationalization has become a trend that is no longer confined to the developed world, since the less-advanced economies are becoming increasingly involved in this process. This gives rise to an important question as to the kind of locational advantage a country may have and may be able to develop in order to attract MNCs’ R & D activities.

More importantly, Taiwan’s quest for economic take-off started much earlier than China’s, which led to a well-developed information technology (IT) industry in Taiwan,⁸ the focal sector of the article. However, is it equally true in terms of R & D and innovation? China is a latecomer, but can we project its developmental trajectory according to Taiwan’s own experience? In addition, is China just a “low-cost manufacturing powerhouse” in the world? As a matter of fact, some researchers in the Western world have begun to address such questions as whether China (and India) can redefine the technological world order and whether China will become a regional, if not global, technological power.⁹ On

balance, the emergence of China, going hand in hand with the trend toward globalization, arguably may reshape the global technological landscape.

Against the backdrop sketched, this article intends to draw attention to such a trend and it sets out to explore the relationship between MNCs' overseas R & D mandates and the locational advantage of the host country by conducting case studies on flagship MNCs' R & D facilities in the IT sector on both sides of the Taiwan Strait. The results show interesting contrasts across the Taiwan Strait that run counter to the evolutionary perspective. There are grounds to suggest that such contrasts have much to do with the locational advantages Taiwan and China each possess. Further implications are drawn to enrich the current understanding of R & D internationalization.

R & D internationalization and locational advantages of host countries

R & D outreach of MNCs was initially geared to the developed countries, but the emphasis has more recently shifted toward the developing world.¹⁰ For example, while two-thirds of the R & D engaged overseas in 2000 by US-based MNCs (US\$13.2 billion out of US\$19.8 billion) took place in six countries—namely, the United Kingdom, Germany, Canada, Japan, France, and Sweden—certain emerging markets, mainly in Asia, have played an increasing role in overseas R & D directed by American MNCs.¹¹ In particular, such countries as India¹² and China¹³ have been documented as high-profile host countries for MNCs' offshore R & D facilities, despite their later developmental stage.¹⁴

The literature on R & D internationalization has proliferated over the past decade, focusing mainly on issues such as the current trends,¹⁵ organizational evolution,¹⁶ and MNCs' motives.¹⁷ More recent research has addressed the locational aspect of MNCs' R & D facilities, especially within a host country.¹⁸ However, the relevant literature remains largely based on the experiences of the developed countries.

In addition, alongside the issue of technology transfer, technology sourcing has also become an important issue in the R & D internationalization of firms.¹⁹ Within such a process, firms can build up a sustainable competitive advantage based on knowledge, leveraging and aligning both their internal and external networks on an international scale. This will arguably result in the reshaping of the structure of the global innovation system and the landscape of global technology, in which not only the MNCs with offshore R & D but also the host countries will be involved.

Relevant studies on this issue highlight some motives for MNCs' offshore R & D. A substantial part of the literature jointly suggests that the locational decisions of MNCs' offshore R & D are generally determined by the following four major factors. Firstly, MNCs may establish offshore R & D facilities for the purpose of getting close to their clients. The host country's industrial advantages can therefore be regarded as a driving force to anchor MNCs' offshore R & D units. In this regard, the accumulated production experiences and capabilities of a host country may serve as an important local condition in attracting MNCs' R & D facilities.²⁰

Secondly, MNCs may undertake offshore R & D in order to access new foreign technologies for the development of new products and technologies. Due to the dynamics of technology, some R & D-oriented firms, those based in Asia and Europe for example, have set up labs in the US to take advantage of "centers of excellence."²¹ More recently this has become increasingly applicable to the case of outreach in R & D from the developed countries to the developing countries.²²

Thirdly, it is regarded as being increasingly important for MNCs to relocate their R & D overseas in order to tap foreign R & D talents. Having examined locational choices for overseas R & D investment by MNCs based in the US and Japan, Kumar argued that a country with an abundant R & D labor force will enjoy a locational advantage in attracting MNCs' R & D investment.²³

Fourthly, the locational choice of MNCs' overseas R & D can be driven by the need to serve local markets. In an examination of the determinants of foreign affiliates' R & D investment in 16 OECD countries, Gao highlighted the market size of host countries as a critical factor.²⁴

On balance, the substantial body of the literature on R & D internationalization tends to approach this topic from the perspective of the MNCs themselves, with the central focus being placed on the MNCs' strategies and locational decision making in deploying offshore R & D, while neglecting the role played by the host country.

Since MNCs represent only half the R & D internationalization story, one can argue that while MNCs with offshore R & D facilities may be driven by different motives, what the host countries possess as the locational advantages should form the other side of the coin for R & D internationalization,²⁵ thus bringing about the interplay of the MNCs' offshore R & D and the host countries' national innovation system. For example, the incentives, goals, and characteristics of overseas R & D activities can be summarized in two broad categories: (1) market seeking or home-base exploiting, supporting the development of

new markets and foreign production sites; and (2) asset-seeking or home-base augmenting and pursuing science-based technologies and capabilities.²⁶ In the first category, MNCs aim to use and profit from proprietary knowledge overseas by transferring and adapting technologies for local markets, with an emphasis on product development expenditures. The second category targets the development of long-term innovative capabilities by taking advantage of novel or complementary knowledge located elsewhere, which is relatively new and driven by the demands of knowledge-based competition, particularly among OECD countries.²⁷ In either case, MNCs' offshore R & D facilities should interact with the host countries' innovation system in one way or another. The existing literature has revealed that this may have something to do with the mandate of MNCs' offshore R & D facilities. In particular, Westney argues that different types of MNCs' offshore R & D facilities, ranging from technology transfer units (TTUs), indigenous technology units, global technology units, and corporate technology units, have their own distinct types of linkages with the host economy.²⁸

For our empirical work, we adopt a framework developed elsewhere,²⁹ and which is essentially based on Dunning's 1993 eclectic paradigm, with a strong flavor of the evolutionary approach to technology,³⁰ but which, in some cases, also allows for leapfrogging competition. According to Dunning, where firms possess advantages of ownership and internalization and host countries enjoy locational advantages, international production may take place. In our view, Dunning's paradigm can be useful for analyzing the offshore R & D activities of multinationals if one interprets ownership, internalization, and locational advantages in the context of R & D, with these advantages being related mainly to the technological routines and trajectories of the firms and the host countries.³¹ In short, what a firm and an economy can do, or is about to do, is linked strongly to their routines and previous bases.

However, in some cases, where technologies are not characterized by incremental change, leapfrogging competition may arise, which may allow the firm or country concerned to bypass certain stages of the technological trajectory, or to jump straight into a new generation of technology. A typical example is the new industrial standard, time division-synchronous code division multiple access (TD-SCDMA), for third-generation (3G) mobile communications, which, despite the relatively low mobile phone penetration rate in mainland China, has been proposed by China and accepted by the International Telecommunications Union. Another example lies in the area

MNCs	Core technology World-class brand name	Systems integration capabilities Product planning capabilities Market access advantages Information & communication networks	
Taiwan			First-tier suppliers Innovation capabilities in certain areas and industrial segments
China			Production-related R & D and engineering support A larger pool of R & D personnel S & T system with a relatively larger emphasis on basic research Market potential

Figure 1 R & D-related advantages of MNCs in Taiwan and China in the Dunning eclectic paradigm context

Source: Adapted from Chen, "Taiwanese IT Firms' Offshore R & D in China and the Connection with the Global Innovation Network"

of software, because new learners can enter directly and learn the new version (or generation) of software without the need to go through previous versions. Those MNCs that are involved in offshore R & D may therefore shift some part of their R & D operations to a host country, according to the capabilities and/or potential of the latter, whilst capitalizing on the derived benefits by exploiting their own advantages of ownership and internalization. As a result of such analysis, we may be able to explain not only why R & D is internationalized, but also what types of R & D are undertaken in the host countries. Figure 1 itemizes some of the advantages that multinationals, Taiwan, and China may each possess in the context of the paradigm developed by Dunning.

In our opinion, the ownership advantages of MNCs generally lie in their core technology and world-class brand names. Their core technologies allow them to set the agenda, at an international level, and to influence the way in which technology will progress, whilst their world-class brand names enable them to gain direct access to customers and marketplaces, which in turn facilitates their initiation of concepts for product development and the means of further exploiting market potential elsewhere.

The internalization advantages of MNCs may include systems integration capabilities, product planning capabilities, market access advantages, and

information and communication networks. In particular, with systems integration capabilities and information and communication networks at their disposal, they may be able to deploy core and noncore R & D across boundaries, whilst maintaining control over the profits generated during the whole process. Likewise, the possession of product planning capabilities and market access advantages means that MNCs have control over the two ends of the “smiling curve,” and hence, have the final say in the benefits derived from the entire value chain they face.

With regard to Taiwan as a location for offshore R & D by MNCs, we have to refer to the way in which economic development has evolved on the island, since it is a well-known typical example of the export-oriented industrialization paradigm. Although this goes hand in hand with the process of migration from labor-intensive sectors toward high-technology and capital-intensive industries, Taiwan's major sectors are characterized by their vertical disintegration and the pursuit of original equipment manufacturing/original design manufacturing (OEM/ODM) contracts for brand marketers, without direct access to the final market. In terms of R & D, local firms may, in general, lack systems integration capabilities and the ability to take the initiative in product and technology development; however, some of the industrial players may be positioned as “first-tier suppliers,” possessing innovation capabilities in certain areas and industrial segments, which could be considered as Taiwan's main locational advantage in offshore R & D. In addition, the last decade witnessed a wave of R & D investment in China both from MNCs and from Taiwan-based firms. Therefore, Figure 1 goes a step further to analyze the case where Taiwan-based firms engage in R & D investment in China.

It is generally perceived that firms based in Taiwan undertake more “D” than “R” and that they lack systems integration capabilities. As a result, commercialization capabilities of the subsystem in certain areas may be viewed as their R & D ownership advantages. However, their networking relationships with brand marketers may be considered as their internalization advantage on two counts. Firstly, although China is emerging as a major electronics manufacturing base, approximately two-thirds of Chinese exports are attributable to Taiwan-based firms. Elsewhere, we have argued that the restructuring of the global electronics industry has led to the formation of the global production network in which Taiwan-based firms have begun to shoulder functions such as coordination of cross-border supply chains and logistics, acting as integrated service providers, and hence an essential node in the global value chain.³² As a result, many world-class

brand marketers may be “anchored” to Taiwan’s economy, especially in terms of order placement. Secondly, in the process of outreaching, Taiwan-based firms have scaled down their local operations and they have handed over parts, or all, of their manufacturing functions to offshore sites, leading in varying degrees to the de-linking of manufacturing and R & D. As long as their networking relationships with brand marketers are secure, the Taiwan-based firms remain in the driver’s seat in terms of profit distribution within internal organizations and coordination of R & D and manufacturing. An additional internalization advantage that may be enjoyed by Taiwan is ethnic links with China, particularly as compared to MNCs; if Taiwan-based firms undertake offshore R & D in China, the similarities in language and culture between Taiwan and China may facilitate knowledge communication and absorption between the two parties.

It then comes down to the question of what locational advantages China may have that are capable of attracting MNCs’ offshore R & D. A large pool of R & D personnel and market potential may be two obvious advantages, but when discussing market potential, we have to take into account the possibility of leapfrogging development, since some proportion of the Chinese population may wish to consume state-of-the-art products. In addition, the Chinese science and technology system formerly placed relatively greater emphasis on basic research, partly because of the defense race in the Cold War period. Moreover, as China is emerging as an international manufacturing base, it may be in the process of accumulating production-related R & D and engineering support, which will also subsequently become a locational advantage.

The essence of the framework described is that R & D globalization may be better understood in a “multilateral” rather than simply a “bilateral” context. This means that R & D undertaken by the three parties in the individual locations may to some extent interact, resulting in complex networking relationships. In addition, for a country to leapfrog, a few conditions need to be met. First, the country needs to have a sound science base and/or vigorous creativity, or more broadly intangible assets, based on which the country may be able to make breakthroughs in emerging technologies. Second, some proportion of the country’s population should be able to and may also wish to consume state-of-the-art products so that market demand in the country may serve to drive new technological innovation. The third, though not necessary, condition is that the relevant industry in the country should be well equipped with capabilities along the value chain based on which new technological innovation supported by indigenous initiatives can be commercialized.

Foreign IT R & D on both sides of the Taiwan Strait

Although the important role played by FDI in Taiwan's economic development has been well documented, it is seldom realized that to some degree, some of the MNCs in Taiwan have also invested in R & D. From the dataset provided by the Investment Commission of the Ministry of Economic Affairs, our calculations show that R & D intensity (R & D/sales) for foreign-owned subsidiaries in Taiwan's manufacturing sector has increased from 1.52 percent in 2002 to 1.94 percent in 2003;³³ which perhaps indicates that Taiwan's mandate has significantly improved in terms of MNCs' regional or global innovation networks.

Elsewhere, we have been able to characterize, with statistical robustness, those foreign R & D subsidiaries with a higher R & D intensity in Taiwan.³⁴ Among other findings, we found that those foreign-owned firms in Taiwan with a higher export propensity tended to be more R & D intensive. As an economy characterized by international competitiveness and export orientation, Taiwan may be able to act as a host for some MNCs in order to capitalize on its comparative advantages to serve the international market.

Foreign-owned subsidiaries with higher R & D intensity are also found to be characterized by a greater degree of localization in terms of their sourcing of both production materials and capital goods. To interpret this finding, we can refer to Westney's argument that if their ties with the local scientific and technical community are gaining strength (and probably, therefore, greater R & D intensity) MNCs' offshore R & D units are given higher hierarchical mandates.³⁵

In addition, we find that where Taiwan's industrial sectors have a larger pool of R & D employees, their constituent foreign affiliates tend to be more R & D intensive. On the one hand, this seems to imply that the R & D efforts of foreign affiliates in Taiwan are driven by a local technology pool. On the other hand, assuming that a larger pool of R & D employees in a sector implies that its local firms are more technology aggressive, one can argue that indigenous R & D efforts serve as a complement to, rather than a substitute for, the R & D activities of foreign affiliates.

More than that, the government in Taiwan has orchestrated a plan to encourage MNCs to establish R & D centers on the island, which since its implementation in 2002 has met with some success. In Taiwan there are so far some 30 R & D centers, belonging to MNCs, which have been established or promised. Of note is the fact that these R & D centers are related mainly to the current strength of Taiwan's industrial development, with the lion's

share being focused on the broadly defined IT area and showing a strong intention of collaborating with the local firms.

Recently a notable aspect of R & D globalization is the rising significance of China and India as the location for MNCs' offshore R & D. According to a survey of the host countries of MNCs' offshore R & D facilities, China's ranking (in terms of the percentage of the surveyed firms with offshore R & D in a particular country) is as high as third for 2004, second only to the US and UK. The same survey also revealed that for the period 2005–2009, China would top all of the countries, becoming the hot spot of the MNCs' offshore R & D facilities worldwide.

In fact, several studies have documented from the early 1990s onward a significantly rising trend of R & D by MNCs in China.³⁶ High-profile examples include quite a number of MNCs in the IT sector, such as IBM, Microsoft, Motorola, Intel, and Nokia. Data gathered by the US government reveals that US-based MNCs spent US\$506 million on R & D in China in 2000, which was surpassed only by Singapore and Israel in Asia (excluding Japan). Data gathered by the Department of Commerce goes further to show a dramatic increase in the US-based firms' R & D investment in China, with the ratio of R & D expenditure to gross products rising from 1.7 percent in 1998 to 8.1 percent in 1999 and further to 9.2 percent in 2000, significantly increasing its rank as a host of US-owned overseas R & D, from 30th position in 1994 to 11th in 2000.

In particular, Walsh has reported that R & D by high-tech MNCs in China seems to have evolved in three distinct stages.³⁷ The initial stage is described by Walsh as "exploratory and strategic partnerships" (early and mid-1990s), motivated by a primary purpose to enter and exploit the Chinese market by forming strategic alliances with the local firms. As such, the MNC's R & D at this stage can be characterized as "show R & D activity." From the mid- to late 1990s came the stage termed "expansion of R & D," which witnessed the proliferation of MNCs' R & D facilities in China. This was driven mainly by the boom in the local IT market, China's imminent accession to the WTO, and the governmental policy encouraging firms to "Go West." The third stage, starting from late 1990s onward and termed as consolidation of R & D, is marked by a more considered, strategic approach to R & D investment by MNCs in China. According to Walsh,³⁸ driven by increasing pressures on high-tech industry and the growing global competition for international R & D, a number of MNCs are shifting their R & D in China toward more advanced R & D activities, while consolidating their overall number of research-related programs.

Having touched upon foreign R & D investment on both sides of the Taiwan Strait, the following section turns to a close examination of four major MNCs in the IT industry in China and Taiwan: Motorola, Microsoft, IBM, and Hewlett-Packard (HP).

Motorola

Motorola is a global major player in mobile communications. After more than 30 years' evolution, the firm's global R & D network has developed into a "dispersed research and dispersed development model,"³⁹ with a hierarchical structure of research labs, global software groups, and development centers. With its R & D headquarters in Schaumburg in Illinois, Motorola began to disperse its R & D to some of the advanced countries in West Europe before the 1980s. After that, the company further extended its global R & D network to the second layer, located in such countries as India, Israel, Ireland, and Canada, and more recently to East Asia because of the rising capabilities in mobile communications in the region.

China

Since its first entry into China in 1987, Motorola has grown into the largest foreign investor in terms of not only capital formation but also R & D investment. In fact, Motorola has a complex R & D network within China, with about 15 R & D facilities in such major cities as Beijing, Tianjin, Shanghai, and Nanjing. In 1993, Motorola set up its first R & D center in China—Global Software Group China Center—which coincidentally is also China's first multinational R & D center. In addition, Motorola China Research and Development Institute (hereafter Motorola Institute) was established in Beijing in 1999, demonstrating Motorola's commitment to R & D and collaboration with technology partners in China. Right now Motorola Institute has grown into the biggest multinational R & D institute in China with over 1,500 R & D staff and 15 R & D centers, ranging from research labs, global software groups to development centers. In particular, the software capability of Motorola Institute has been verified as "capability maturity model integration" (CMMI) level five.

Motorola Institute was established to capitalize on China's booming domestic market and rich talent pool; by the same token, China's competency in the

telecommunications industry would be enhanced. Motorola's R & D focuses on the following areas: advanced materials research, software development, personal communications product design and development, product development of auto electronics products, man-machine interaction technologies in future hardware and software applications, batteries, and other accessories for portable electronic devices, and so on. However, according to a high-ranking official in Motorola China Research Lab, about 87 percent of their R & D expenditures are related to software.⁴⁰ In addition, Motorola Institute has formed complex external R & D networks, in collaboration with not only China's major industrial players but also some of its leading universities.

Taiwan

In response to the Taiwanese government's initiative, Motorola set up a Motorola Taiwan Product Development Center in 2004. This was also related to the company's role as a leading procurer in Taiwan for mobile devices. As a result, the center's mandate concerns mobile devices, working on such areas as handsets, semiconductors, and the energy system, in which the Taiwanese suppliers have competitive advantages.

In essence, Motorola Taiwan Product Development Center functions as a bridge for the company to work closely with its major original design manufacturing partners in Taiwan by providing a reference platform for mobile devices and assisting in the development of new products in a time-to-market manner.

Microsoft

Microsoft is a global giant in software. The company has set up five research labs around the globe, mainly in the US (Redman, San Francisco, Mountain View) and the UK (Cambridge). The Microsoft Research Lab in Beijing was established in 1998, and it is now called Microsoft Research Asia. It conducts basic research in a number of fields, being the company's first research lab in the developing world and acting as Microsoft's regional research center in Asia. In addition, Microsoft Research India was established in Bangalore in January 2005, and is mandated to conduct cutting-edge basic and applied research in multiple fields in computing, information technology, and related areas.

China

Microsoft Research Asia is Microsoft's fundamental research arm in Asia Pacific, conducting fundamental curiosity-driven research that is related to Microsoft's long-term vision and strategy. Its research agenda covers a few areas, including a next-generation user interface, next-generation multimedia technologies, digital entertainment, wireless and ubiquitous networking technologies, and web search and data mining. Microsoft Research Asia has grown into an accomplished research lab with more than 180 researchers and an output of over 1,200 published papers. Since 1998, Microsoft Research Asia has developed extensive university relations in China and in the region, examples of which include theme-based projects, joint research labs, joint research funding, and Chinese government-accredited postdoctoral stations.

In addition, in 2005, Microsoft Research Asia and MSN Search have teamed up to create a Search Technology Center in Beijing. The center is dedicated to "advancing the state-of-the-art in search technology and delivering a more intelligent and powerful search experience to MSN users around the world."⁴¹ One of its missions is to accelerate innovations by seamlessly combining research and development in Microsoft Research Asia, bridging fundamental research and product development.

Taiwan

Apart from the research labs, Microsoft also deploys a global network of technology centers. They are located mainly in the US, the UK, Germany, and Japan. The Microsoft Technology Center in Taiwan has been recently established in response to the government's initiatives.

By providing the company's XML web service and .Net technologies, the Microsoft Technology Center aims to assist in advancing a vibrant (mainly embedded) software development industry in Taiwan, via joint business development and engagement, and to provide a portal for academia and business to combine skills and knowledge. To achieve these aims, the center—supported by the company's technology centers in the US and Europe—has teamed up with not only independent software vendors but also some local research institutes and universities. In particular, Microsoft has undertaken a high impact project which involves the Institute for Information Industry, a local research institute dedicated to the software and IT industries.

Though positioned as a technology transfer unit, an outcome of its cooperation with local partners, the Microsoft Technology Center has generated some intelligent property outputs adopted by its headquarters. As a result, with permission from the government and support from headquarters, the Microsoft Technology Center has extended its mandates by establishing a Windows Media Engineering Center in order to facilitate the development of the digital home industry in Taiwan.

IBM

IBM is not only a global IT giant, but it has also successfully evolved into a service-oriented company. Thanks in part to this, the organization of the company's global R & D network has evolved from central funding, dating back to the 1970s, to collaborative teams in the 1980s, and to research in the marketplace after the 1990s in order to gain market insights.

IBM has set up eight research labs around the globe, mainly in the developed countries, though two of them are located in China (Beijing) and India (New Delhi). In particular, the IBM China Research Lab is mandated to function as a watch port and to conduct exploratory research mainly on e-banking because of the sheer volume of e-banking in China. In addition, the company maintains some 27 product development centers worldwide. Those in Asia include Beijing and Shanghai in China, Yamato in Japan, Seoul in Korea, Taipei in Taiwan, and Bangalore in India.

China

Starting as a small R & D site, IBM China Research Lab has grown into IBM's global research network, now staffed by more than 200 researchers. Its research agenda focuses on software and global business service consulting, with a specific aim to conduct research centered around customers' needs. Alongside IBM China Research Lab, the company also set up a China Software Localization Center and an Industry Innovation Center in Beijing, with both of them focusing on the downstream and tailor-made part of the R & D process.

IBM's R & D commitment in China has much to do with the progress of the company's business relationship with China, which has evolved from "investment to learn," via "investment to grow in China," "towards investment to grow for China and leveraging China's strength."⁴² According to a

senior staff member of IBM China Research Lab, China's strength lies mainly in its "unique workload with broad applicability," especially regarding services and e-commerce, which may enable IBM to develop new software, technologies, and services as the mainstream in the future.⁴³ IBM China Research Lab is in fact conducting a research program on demand innovation services, which is the first of its kind worldwide.

Taiwan

Motivated in part by the government's initiative, IBM has established the IBM xSeries Taiwan R & D Center. The center is mandated as the "mission lab" for IBM's low-end (xSeries) servers, the only server R & D center outside the US. The American R & D headquarters in Raleigh, together with R & D facilities in Kirkland and Austin, are in charge of high-end servers (pSeries, iSeries, and zSeries). As compared to a "job shop," a mission lab is positioned to shoulder the entire R & D process (ranging from the concept phase, planning phase, development phase, qualification phase, and launching phase to the life-cycle phase) for its product mandates. Hence, the IBM xSeries Taiwan R & D Center has been given the full support of its headquarters which sent eight senior experts from Raleigh on a long-term basis and the Taiwan R & D center has been given a mandate to set its own research agenda.

Taiwan outcompeted China and India in terms of IBM's locational decision for the xSeries R & D Center mainly because of the local IT industry's strengths in terms of product development and rapid-response capability. Therefore, ever since day one, the IBM xSeries Taiwan R & D Center has been closely collaborating with the local IT industry, which is regarded as IBM's first-tier supplier. Their cooperation has taken the form of "collaborative design" and covers the whole process, ranging from the engineering sample, design valuation test, engineering valuation test, and production valuation test. Such collaboration, though existing for quite a long time, used to take place across the Pacific Ocean. By relocating the xSeries R & D center from Raleigh to Taipei, IBM, together with its suppliers in Taiwan, has managed to shorten the R & D cycle time from 7–11 months to 5–9 months. In addition, partly because of the center's positive outputs, IBM has given serious thought to equipping the center with product mandates for higher-end servers (pSeries and iSeries).

Hewlett-Packard (HP)

HP is a global leader in the IT industry. Its corporate organization is divided into three strategic business units—the Personal Systems Group, the Imaging and Printing Group, and the Technology Solutions Group—together with HP Labs. Its merger with Compaq in 2002 has made the company a leader in the PC industry.

HP has a global network of six research labs around the world, mainly in the developed world (Palo Alto in the US, Bristol in the UK, Tokyo in Japan, and Haifa in Israel), and two others located in Bangalore, India and Beijing, China. Initially, the company's research network was concentrated in the US and the UK, but it began to extend its reach to Japan in 1990, India in 2002, and China in 2005. The company's research lab in India is mandated to conduct research on ICT mainly for potential users in the developing world.

China

Established in 1985, HP China has become the company's largest subsidiary in the Asia Pacific region. In 2002 HP set up a software R & D center in Shanghai, which is now staffed by more than 200 software experts and is planned to scale up to 1,500 R & D personnel in the next few years. This R & D center serves two purposes: one is to be part of HP's global R & D network, and the other is to provide total solution to serve the local needs in China. In addition, HP Laboratories China was launched in November 2005, with a mandate "to strengthen the partnership between HP and China's premier research institutions and major industrial customers."⁴⁴ As a result, HP Laboratories China has formed a number of R & D links with local universities and research institutes. In fact, according to news released by the company, HP Laboratories China is developing a research program aligned with HP Labs' worldwide research and partnering with Chinese research institutions and major industrial customers. A part of that program is expanding collaborations with universities under the research it established in 2005 with the Chinese Ministry of Education.

Taiwan

For years, HP has been the largest foreign procurer in Taiwan for IT products made by the Taiwan-based firms. Thanks in part to this, HP's subsidiary, together with its major local suppliers in Taiwan, has been heavily involved

Table 1 A comparison of the flagship MNCs' R & D across the Strait

<i>Dimensions</i>	<i>Relative focus</i>	
	<i>China</i>	<i>Taiwan</i>
Software or hardware	Software	Hardware
Focus of R & D	Upstream R & technology	Downstream D
Local technological linkages	Institutes of higher education	Local suppliers
Position of the parent's global R & D network	Research lab	Product development center
Market targeted	Domestic market	International market
Scale by headcounts	Larger	Smaller

in e-commerce initiatives sponsored by the government, ranging from online global logistics to online joint product development.

In 2002, HP set up an HP Product Development Center in Taiwan, which was not only relocated from Singapore but also given a broader geographical mandate to serve the global market. In addition, the center serves to perform product development in four areas, including desktop computers, notebook computers, servers, and hand-held devices, in which the Taiwanese suppliers have well-established capabilities in original design manufacturing. According to its staff,⁴⁵ the HP Product Development Center has come into existence for the following reasons: (1) proximity to suppliers; (2) access to supply side knowledge; and (3) to gain support for its development efforts.

A comparison of the cases

The cases discussed in the previous section tend to suggest some interesting patterns of contrast between Taiwan and China, especially in relative terms, which is summarized in Table 1.

First of all, in terms of the dimension of software vs. hardware, the MNCs' R & D centers in China tend to focus more on software, while their counterparts in Taiwan focus on hardware. On the one hand, this may have something to do with Taiwan's well-established strengths in IT hardware, especially in terms of original equipment manufacturing/original design manufacturing contract work. By setting up their R & D centers in Taiwan, these MNCs may benefit from proximity to their first-tier suppliers and the latter's component technology. As a senior staff member of an IT brand marketer put it, "when the majority of products are already being manufactured in

Asia, our R & D center in Taiwan allows R & D engineers to get even closer to the center of action and better able to achieve our ability to respond rapidly.”⁴⁶ On the other hand, a feature of software per se is its leapfrogging potential, in terms of the supply side. China may even go further to provide the MNCs with an abundant supply of the R & D personnel in software, enabling the latter’s R & D centers in China to focus more on software. In fact, according to a high-ranking official in Motorola China Research Lab, about 87 percent of their R & D expenditures are related to software and its software capabilities have been verified as capability maturity model integration level five.⁴⁷

In addition, in terms of their local R & D linkages, the MNCs’ R & D centers in China show a strong tendency to forge linkages with the local research community, while their counterparts in Taiwan tend to collaborate with the local firms, their suppliers in particular. This may have something to do with the way the MNCs view the locational advantages of the host countries and position their respective offshore R & D units within their global R & D networks.

Above all, the four cases examined tend to suggest that the MNCs’ R & D centers in Taiwan are all mandated as product development centers, while their counterparts in China tend to function as research labs, in a couple of cases along with product development centers. This may have something to do with the features of Taiwan’s national innovation system in terms of the IT industry.⁴⁸ From the perspective of the evolutionary approach to technology,⁴⁹ what a firm and an economy can do, or is about to do, is linked strongly to their routines and previous bases.⁵⁰ It can be argued that the mainstream of Taiwan’s industrial technological innovation currently lies mainly in the central part of the smiling curve, which ranges from incremental technological changes to defensive patents. In addition, it is generally perceived that the IT community in Taiwan undertakes more “D” than “R.” The MNCs may therefore feel more comfortable in capitalizing on the strengths of Taiwan’s national innovation system by establishing product development centers.

In contrast, while China is behind Taiwan on the ladder of economic development, there may exist in China the possibility of leapfrogging development, which may allow the firm or the country concerned to bypass certain stages of the technological trajectory, or jump straight into a new generation of technology. Apart from having a large pool of R & D personnel and market potential, China’s science and technology system formerly placed relatively greater emphasis on basic research, partly because of the arms race during the Cold War period. In addition, China’s economic development has reached the stage where some proportion of the Chinese population may be

able to and also wish to consume state-of-the-art products. This may equip China with leapfrogging potential on the demand side. Therefore, it makes sense for some of the MNCs to set up research labs in China and to conduct more advanced R & D activities, although the bulk of foreign R & D in China may be related to adaptive R & D.⁵¹

Moreover, based upon the preceding discussions, we would like to put forward a holistic view of the possible R & D portfolio of flagship MNCs on both sides of the Taiwan Strait, as shown in Figure 2. In essence, based on the heritage of industrialization, Taiwan has been able to capitalize on its first-tier supplier advantage as a means of attracting a few MNCs to set up their offshore R & D facilities on the island. As a result, those MNCs have tended to conduct certain types of R & D in Taiwan, ranging from medium-term product/process applied development, short-term innovation, and prototype development to significant adaptation and improvement to existing technologies. By contrast, to quite an extent, while the bulk of foreign R & D in China may be related to adaptive R & D,⁵² some, if not many, of the MNCs are conducting strategic R & D in China, such as blue sky or basic research and medium-term product/process research.

It now comes down to the question of what such an R & D portfolio across the Taiwan Strait means for the prospects of Taiwan and China, respectively. To answer this question we can refer to the well-established argument in economic geography that location does not necessarily make sense, if linkages do not exist.⁵³ Research is the upstream part of the R & D process, while development belongs to the downstream part. Some might get an impression that research conducted by the MNCs may mean more to the host country than development does. Such an impression may be an oversimplification. Instead, we would like to argue that development conducted by the MNCs in Taiwan often entails close interactions with the indigenous firms and hence could bring benefits to the local economy in an immediate and direct way. By contrast, with regard to research conducted by the MNCs in China, it has to take time, not to mention the risk involved, for results from research to bear commercial fruit. However, where research involves emerging technologies and/or industries, it is possible that R & D conducted in China can redefine the technological order across the Taiwan Strait, if not the world. This will become more likely if R & D conducted by MNCs in China eventually goes through the commercialization process by working together with China's indigenous value chain, giving rise to leapfrogging development in China.

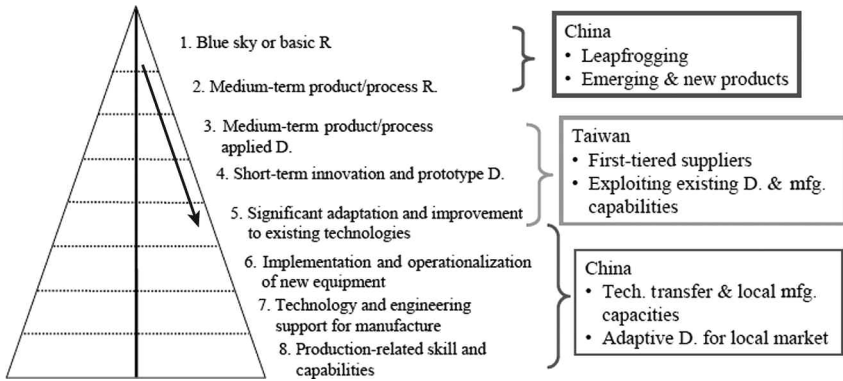


Figure 2 Possible R & D portfolio of flagship MNCs across the Taiwan Strait

In fact, China's progress in leapfrogging is not just about achievements in attracting MNCs' R & D facilities, it also concerns industrial standards and global outreach in terms of outward investment and mergers and acquisitions. Taking industrial standards as an example, these have been placed at the top of the policy agenda in China to acquire autonomous intellectual property rights by establishing own industrial standards. Typical examples include time division-synchronous code division multiple access (TD-SCDMA) for third-generation mobile communications, digital TV, and the Linux-based operating systems. In all these cases, China intends to explore its leapfrogging potential by eventually competing with the global leaders. While it is too early to judge whether or not China will succeed in generating an influential industrial standard with commercial success, especially outside China, it is fair to say that, through policies aimed at developing industrial standards, China has managed to substantially restructure its innovation system in a few specific sectors. For example, since TD-SCDMA has been recognized by the International Telecommunications Union as one of the industrial standards for third-generation mobile communications, China has managed to receive endorsements from a few global flagship firms, such as Siemens, Nortel, TI, and Philips. Together with these flagship firms, a wide spectrum of the value chain for mobile communications has already taken root in China.

Conclusions

Locational advantage of the host country has been used as a concept to interpret FDI,⁵⁴ and more recently offshore R & D.⁵⁵ However, to our knowledge,

little research has been done to capture differences in offshore R & D mandates by referring to this concept. Set against this, we have managed to show that it can be determined—through both conceptualization and evidence—that locational advantage is useful to interpret the geographical pattern of R & D portfolio of MNCs across the Taiwan Strait.

The foreign R & D centers in Taiwan examined, though different in terms of their R & D mandates, tend to work closely with the local IT industry in their R & D efforts. This may have something to do with the position of Taiwan's IT industry within the global production and innovation network. In the case of HP, IBM, and Motorola, the major players in Taiwan's IT industry can be regarded as these companies' first-tier suppliers and/or ODM partners, especially with regard to components and barebones. As brand marketers have become corporations that are hollowing out, collaborative research and design between the brand marketers and first-tier suppliers have increasingly come to the fore, which may have been facilitated by the geographical proximity between the two parties' knowledge bases. As for the Microsoft Technology Center, Microsoft provides essential platform technologies to the local IT industry, based on which the latter may develop new products for the international as well as domestic markets. However, the role played by the offshore R & D facilities in this case has gone beyond the traditional technology transfer units, which tend to perform adaptive R & D to meet local needs, but is by nature in line with the prevailing collaborative research and design model. In fact, some of their intelligent property outputs have been adopted by the R & D headquarters.

More importantly, the emergence of China is, in some aspects, characterized by leapfrogging, which may entail a structural shift of innovation across the Taiwan Strait. Christensen et al. have argued that such countries as China and India may bring about "the great disruption" and that "technologies emerging from these countries (China and India) may have profound but unpredictable implications for the rich world's markets."⁵⁶ On the technological side, this article has shown that by taking advantage of its leapfrogging potential, China outperforms Taiwan in attracting MNCs' offshore R & D facilities, which tend to be given a higher R & D mandate. This may eventually lead to a structural shift in innovation across the Taiwan Strait.

The picture portrayed seems to suggest that new patterns and flavors have surged from the current trend towards R & D globalization, including R & D offshoring, technology sourcing, offshore collaboration,⁵⁷ particularly

regarding developing host countries. In this way, MNCs' offshore R & D mandates have increasingly gone beyond the traditional pattern of technology transfer and adaptive R & D in developing host countries. Both R & D offshoring and technology sourcing often involve software, basic research, and even new market insights. However, from the perspective of the host country, this may lead to the possibility of "enclave," due to the absence of local linkages. Offshore collaboration, on the other hand, tends to take the form of interorganizational, cross-border collaboration for innovation, facilitated by modularization of product. In this way, the MNCs may be able to capitalize on the local countries' "external economies," in terms of industrial networking.

It follows that certain rules of the game for R & D and innovation may have begun to change, at least in relative terms. First of all, certain types of R & D internationalization may involve de-linking of R & D and manufacturing in terms of location, unlike the case of technology transfer and adaptive R & D. Such a situation implies that MNCs' offshore R & D may not necessarily lead to the creation of a new industrial segment for the host country, hence generating limited spillover effects. Secondly, some developing countries have increasingly become a source of R & D and innovation, not just a technology recipient and late-adopter. Following this, players in the developing world may serve as a partner of collective innovation, with their involvement at the early stage of the product life cycle.

Notes

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