The Internationalization of Corporate R&D: A Review of the Evidence and Some Policy Implications for Home Countries

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Abstract

A review of the existing evidence on the degree of internationalization of the innovative activities of multinational enterprises (MNEs) reveals three main trends. These are the continuing reliance of firms on the home country as a base for innovation, structural changes in MNEs toward more affiliate autonomy, and a small but growing presence of cross-border innovative activities in a group of nontraditional host countries. We argue that these trends pose two interrelated policy challenges for home countries. First, governments need to ensure that the national innovation system enables domestic MNEs to engage in global knowledge sourcing in a way that is complementary to their activities in the home base. Second, the continued importance of publicly funded R&D to corporate innovation implies that home countries, along with MNEs, need to be actively engaged in the standard setting processes in global markets in order to shape an appropriability regime that allows for the effective capture of economic gains from innovation.

KEY WORDS: multinational enterprises, R&D, internationalization, reverse knowledge transfer, standard setting

Introduction

Over the past three decades, advances in the transportation and communication technologies associated with globalization have enabled the spread of the value-creating activities of multinational enterprises (MNEs) on a global scale. Accompanying this process has been a more gradual evolution in the geography of the innovative activities of MNEs. Today, a considerable proportion of the value created by MNEs is the result of their cross-border knowledge-generating activities, whether through in-house research and development (R&D), or contractual network relationships for the development of new products and processes.

This article will systematically examine and synthesize the available evidence on the patterns of the internationalization of the knowledge-creating and knowledge-sourcing activities of MNEs. The evidence we review here suggests three main trends. First, that the internationalization of the innovative activities of MNEs has lagged behind that of their productive activities. This is the case even as the past decade has seen a notable increase in the internationalization of corporate R&D. Second, that within the internal network of the MNE, foreign affiliates have gained substantially more autonomy and now play a far more important role in the knowledge-creating activities of the MNE as a whole. This is because the foreign affiliates link the internal network of the MNE with the national or regional innovation systems within which they are embedded. Third, that following the emergence of new players in the global economy, the innovative activities of MNEs have become more geographically dispersed than has been the case before.

Similar
evidence for each of these trends can be found, for example, in Breznitz (2007) and Taylor (2009), and we contrast our findings with Cohen, Di Minin, Motoyama, and Palmberg (2009) and Dossani and Kenney (2009) in this issue, each of which find somewhat different degrees of internationalization.

Although there are a wide range of policy implications concerning the development of host country technological capabilities that arise from the internationalization of corporate R&D, in this discussion, our focus will be on two policy issues that are particularly germane to developed home countries, because these have been relatively underexplored in the literature. The first question is whether the increasing internationalization of R&D activities by MNEs is likely to lead to a hollowing out of the innovative base of the home country? The second issue arises from the fact that the appropriation of returns from innovation is strongly conditioned by the surrounding institutions related to intellectual property (IP) protection. To what extent are the changes we document here likely to result in divergent demands by some of the new players concerning the future development of these institutions in the global economy?

We begin by making a distinction between MNEs as vehicles for technology transfer and MNEs as generators of new technology. By engaging in foreign direct investment (FDI) and other forms of cross-border value-adding activity, multinational enterprises have been and continue to be important transferors of technology across borders. Such asset- or knowledge-exploiting investment, which might be undertaken for market-, resource-, or efficiency-seeking motivations, entails the transfer of technology from the home base of the MNE to the host country. Indeed, the imperfections in the market for technology are the primary reason why multinational firms would wish to internalize such transactions, and the act of internalization has been seen by some scholars as the raison d'être for the MNE itself (Buckley & Casson, 1976, 1985). Asset-exploiting investment of this kind has a long history, and its effects on the host country in terms of technology transfer and dissemination, the generation of spillovers, and the development of indigenous technological capability have been analyzed in a great number of studies.

Our focus here is on the second type of activity, the asset- or knowledge-seeking/augmenting investment by MNEs. Compared with asset-exploiting investment, asset-augmenting investment is a more recent phenomenon, and the cross-border innovative activities of MNEs have undergone considerable change over the past decade or so. These changes are primarily attributable to exogenous change caused by globalization, although by developing new forms of organization and coordination to manage dispersed knowledge, MNEs themselves have also contributed to this change process. The two primary changes we explore in this article are the increase in the number of countries and regions where world-class innovative activity can take place, and the increasing substitutability of the forms of governance that MNEs employ in their value-adding activities, and particularly the increasing use of market-based contractual alliances instead of equity-based relationships (Dunning, 2000).

The reasons for the changes in the organization of innovative activity extend beyond the scope of this article, but in general, globalization has served to reduce the costs of using market-based forms of exploiting and accessing knowledge, and therefore encouraged the use of contract research and contractual R&D...
development alliances, which had previously played little role in the innovative activities of MNEs. Furthermore, of the two ownership-based modes of engaging in innovative activities—greenfield investment and mergers and acquisitions (M&As)—there has been a notable increase in the use of M&As as a form of accessing both the markets, as well as the technological and organizational capabilities held by other firms.

This article is organized as follows. We begin by briefly examining the changing organization of affiliate R&D. We then move on to review the different types of evidence that indicate the extent to which MNEs are conducting their innovative activities abroad. In doing so, we pay particular attention to the changing composition of host countries and the emergence of new governance forms in the innovative activities of MNEs. In the second part of the article, we examine the impact of the internationalization of corporate R&D on the ability of the home country to reallocate and upgrade its existing technological competences, and to ensure that its MNEs are able to secure economic returns from their R&D investments.

**Organization of Affiliate R&D**

Cantwell and Piscitello (2000) identified three historical phases in the growth of firms in terms of their patterns of diversification and internationalization. In the early postwar period until the early 1970s, diversification and internationalization were alternative means of corporate growth, while the role played by affiliate R&D was mainly the adaptation of the products supplied by their parent companies to host market conditions. The second phase, from the late 1970s to the early 1980s, marked a shift in the technological paradigm (Freeman & Perez, 1988), as the potential of existing technologies to exploit scale and scope economies began to be exhausted, while asset-seeking investment had not yet taken off. In the third (and current) phase, which dates from the late 1980s, technological diversification is increasingly reflecting the growing interrelatedness between technologies, and previously disconnected efforts within firms are now being integrated into an interactive network, which help to create new competences. The increasing complementarity between competence accumulation, diversification, and internationalization is characteristic of the third phase.

A variety of studies undertaken in the 1980s revealed that the great majority of R&D undertaken by the foreign affiliates of MNEs was directed to the adaptation of particular products, processes, or functions and procedures of the firm, rather than to basic or fundamental research (e.g., Casson, 1991; Pearce, 1990; Pearce & Singh, 1992). While this is still often the case today, the growing importance of affiliate activity that is directed at generating new knowledge and competencies for the MNE as a whole, rather than applying and exploiting its existing knowledge, has increased since the 1990s (Cantwell & Mudambi, 2005; Kuemmerle, 1999).

Assuming that the MNE wishes to add to its stock of knowledge by undertaking in-house R&D rather than through contractual means (e.g., through R&D alliances), or by acquiring licenses and patents, it faces the question of how best its innovative activities should be organized. This involves essentially two choices,
one concerning the extent of decentralization, and the other concerning the strategic role of the affiliates, and the scope and content of their mandate.

There are powerful reasons favoring both the centralization and decentralization of R&D. Those favoring centralization include the desire to gain and exploit economies of scale in R&D, the availability and quality of supporting institutions and agglomerative economies in the home country, and the possible benefits gained from colocation with production units and supplier firms. The most powerful motive for decentralizing R&D is the desire to exploit the pool of research talents of another country by “tapping into” the institutions that make up the national or regional innovation system. The localized knowledge may be necessary for adapting the product or service to local tastes. Alternatively, it may reflect the host country’s comparative advantage in certain types of research and resources, and the cost and availability of inputs needed to effectively pursue it.

Within these parameters, MNEs may pursue various strategies toward the international organization of their research activities. Bartlett and Ghoshal (1988) delineated the innovatory activities of MNEs according to where the R&D is undertaken and for what purpose. Thus, they defined local-for-local R&D activities as those in which a particular national affiliate of the MNE creates and complements innovations entirely at a national level. Where these innovations are found to be applicable in multiple locations, they become local-for-global activities. By contrast, a center-for-global innovatory strategy is one in which a central R&D laboratory creates a product, process, or system for worldwide use, while global-for-global innovations are those created by pooling the resources and capabilities of many different R&D units to help solve a worldwide problem (Nohria & Ghoshal, 1997).

The increasing autonomy of MNE affiliates has been documented in a number of studies. The first group dates back to studies of Canadian affiliates in the 1970s, which examined whether affiliates that were assigned a world product mandate (WPM) with respect to product development or marketing responsibilities could prevent the “hollowing out” of Canadian affiliates (Rugman & Bennett, 1982; White & Poynter, 1984). Other scholars that have examined foreign affiliates with product mandates include Papanastassiou and Pearce (1994), who focused particularly on their export-orientation and the development of their R&D capabilities. They identified three types of affiliates. The first was the truncated miniature replica affiliate, which they defined as an import-substituting affiliate that produces and sells locally the established products of the MNE. The second type of affiliate was the rationalized product subsidiary, which is involved in the production of intermediate goods. The third type of affiliate they considered was the world or regional product mandate (WPM/RPM) affiliate.

While entrepreneurial affiliates are increasingly likely to develop capabilities that allow the MNE to enhance its stock of technological assets, their strategic role also creates tension between affiliate autonomy and centralized control within the MNE. Consequently, the further internationalization of R&D activities depends in large part on the trade-off between the benefits derived from decentralized R&D (including colocation with production), and the increasing costs of coordination and integration.
Evidence on the Internationalization of Corporate R&D

The available empirical evidence on the internationalization of R&D consists of three types of data, namely that on patenting by foreign affiliates, the geographical distribution of the R&D expenditures of MNEs, and survey-based evidence on the question of R&D location. We briefly review all three here.

**Patenting**

The historical data spanning from 1920 to 1990 presented by Cantwell (1995) show that the internationalization of R&D was significant for some home countries such as the UK and Sweden as early as the 1920s and 1930s. For example, between 1920 and 1939, 37 percent of U.S. patents of Swedish firms in the mechanical sector was attributable to R&D activities in their foreign affiliates, while 42 percent of U.S. patents in the chemical sector assigned to UK firms was attributable to research located abroad. Following the Second World War, Swedish firms did not regain their former share until the late 1980s, while for the UK, the share grew quite steadily to reach 51 percent in 1987–90. Switzerland also began to increase its share in several sectors in the late 1960s to reach 43 percent in 1987–90. The share of German and French firms also grew, but only to around 18 percent. By contrast, the share of U.S. patents accounted for by the foreign activities of U.S. MNEs was relatively more modest, growing from 3 percent in 1920–24 to only 9 percent in 1987–90.

The latest data on the 169,000 patents granted in the United States in 2003 indicates that the share granted to foreign firms was 48 percent (National Science Board, 2006). This share has remained quite stable since 1980, although there has been some fluctuation from year to year. Reflecting the differences in the relative prominence of particular industry sectors between countries, the patent classes in which patents are sought differ considerably between U.S. firms and the leading foreign firms seeking U.S. patents.

In the period 1963–2001, Japan, Germany, France, and the UK accounted for 72 percent of all U.S. patents awarded to foreigners (National Science Board, 2004). However, by 2003, the top countries to patent in the United States were Japan and Germany, followed by Taiwan, South Korea, the UK, Canada, and France. Japan still had by far the largest, although declining, share of the patents awarded to foreigners, accounting for 40 percent, followed by Germany with a 12 percent share (National Science Board, 2006). Inventors from China, which had filed only 111 patent applications in 1990, reached 1,034 applications by 2003. Similar increases were also registered from other countries that had made strong investments in science and technology, namely India, Israel, and Finland (National Science Board). Furthermore, for the majority of the developing countries applying for U.S. patents in 2001–03, a high proportion—63 percent in the case of China and 40 percent in India—was due to patents assigned to foreign MNEs. However, for the two leading developing countries registering U.S. patents, namely Taiwan and South Korea, the proportion was only 4 percent (UNCTAD, 2005, p. 135).
In 1981, the share of industrial R&D financed by foreign sources was below 10 percent for all of the OECD countries (National Science Board, 2004). According to recent OECD data, in 2005, foreign funding accounted for as much as 26 percent of industrial R&D in Austria, 23 percent in the UK, 18 percent in Hungary, and 15 percent in Canada. By contrast, it accounted for as little as 0.4 percent in Japan, 0.9 percent in South Korea, and 1 percent in Finland, reflecting the low levels of inward FDI in all three countries.

The share of R&D performed by foreign affiliates as a share of the total R&D performed in the host country is generally higher than the proportion of such activity that is funded from outside of the host country. The share of affiliate R&D can be as high as 60–72 percent (in 2004) for countries such as Singapore, Hungary, and Ireland that are host to a large number of foreign affiliates, while having relatively low levels of indigenous R&D. It is also quite high (35–45 percent) in countries like Canada, the UK, and Sweden, where the R&D performed by indigenous firms is more notable. Indeed, in countries like the Netherlands, Sweden, and the Czech Republic, the share of foreign affiliates in host country R&D has generally been higher than the affiliate share in value-added, employee compensation, or gross fixed-capital formation. In 2004, more than 16 percent of the industrial R&D within the OECD was performed by affiliates, as compared with 12 percent in 1993 (OECD, 2006).

The most detailed data available on the innovatory activities of foreign affiliates is that based on the comprehensive enterprise surveys conducted by the Bureau of Economic Analysis on the activities of foreign affiliates in the United States, and on the foreign activities of U.S. MNEs abroad. These indicate that between 1994 and 2000, the share in total industrial R&D in the United States accounted for by foreign affiliates ranged from 11 to 13 percent (National Science Board, 2004). In 2002, R&D performed by foreign affiliates in the United States amounted to $27.5 billion, accounting for 14 percent of total U.S. industrial R&D performance (National Science Board, 2006). Manufacturing accounted for three-quarters of affiliate R&D, which was mostly concentrated in three industries, namely chemicals and pharmaceuticals, computer and electronic products, and transportation equipment. Seven countries, viz., Germany, the UK, Switzerland, Japan, Canada, France, and the Netherlands accounted for about 90 percent of the R&D performed by foreign affiliates in the United States. By 2004, the R&D expenditures of nonbank majority-owned affiliates had increased to $29.9 billion (Anderson & Zeile, 2006).

The picture is very similar when one looks at the innovative activities of U.S. MNEs abroad. For more than two decades, some two-thirds of the R&D performed by U.S. firms outside of their home country was located in only six countries, namely the UK, Germany, Canada, Japan, France, and Sweden. The same industrial sectors that accounted for most of the R&D investment in the United States were also responsible for most of the R&D performed overseas by the affiliates of U.S. MNEs. In 2000, the proportion of R&D performed abroad by the foreign affiliates of U.S. MNEs was 15 percent. However, this figure was still notably lower than the equivalent foreign proportion of MNE employment (26 percent), sales (28 percent), and value added (22 percent), but considerably higher than the 7 percent...
of R&D undertaken outside the United States in 1982 (National Science Board, 2004). By 2004, the proportion of R&D performed by the majority-owned foreign affiliates of U.S. MNEs had reached 15 percent (Yorgason, 2007).17

For more than two decades, some two-thirds of the R&D performed by U.S. firms outside of their home country was located in only six countries, namely the UK, Germany, Canada, Japan, France, and Sweden. Even in 2004, nearly one half of affiliate R&D expenditures were accounted for by UK, Germany, and Canada (Yorgason, 2007). Between 1994 and 2002, the R&D spending of the foreign affiliates grew at a faster rate (7.5 percent per annum) than the spending of their U.S. parents (5.3 percent), and an increasing share of innovatory activities was beginning to be directed to smaller host countries and to some developing countries (National Science Board, 2006).

For example, U.S. R&D performed in nontraditional markets, namely Singapore, Israel, Ireland, China, Hong Kong, Mexico, Brazil, Malaysia, Taiwan, and South Korea, accounted for just $1.3 billion or 11 percent of the R&D expenditures of U.S. foreign affiliates in 1994. This had grown to $3.5 billion, or 18 percent of affiliate R&D expenditures, by the year 2000 (measured in current dollars). Even more notable is the fact that R&D expenditures in this group increased by an average annual rate of 15.9 percent (in real terms), as compared with a 6.9 percent growth for the aggregate of all host countries (National Science Board, 2004). By 2004, more than 100 MNEs had set up R&D facilities in India, while as many as 700 had set up such facilities in China (Reddy, 2000; UNCTAD, 2005, p. 141).

For developed countries, estimates compiled by UNCTAD (2005, p. 125) indicate that the share of foreign affiliates in host country R&D grew from 11 percent in 1996 to 16 percent in 2002, while the share of developing countries rose from just 2 percent to 18 percent in the same period. Much of this trend, particularly within the Triad, is the consequence of extensive M&A activity in several research-intensive fields, including pharmaceuticals, biotechnology, and information technology in the 1990s.

**Survey-Based Evidence**

The third main source of data on the internationalization of the R&D activities of MNEs is gained through smaller enterprise surveys. As was shown in the previous section, only the United States records data on the foreign R&D activities of their MNEs, as well as that of foreign affiliates in the United States as part of comprehensive enterprise surveys. For other countries, we have to rely on evidence based on smaller surveys conducted by academic researchers and occasional or less comprehensive official surveys.

Data compiled on the world’s largest industrial companies showed that in 1982, about 30 percent of their production was undertaken outside their national boundaries, while only about 12 percent of their innovatory activities were (Dunning & Pearce, 1985). These data were largely corroborated by a 1989 field study of the geographical distribution of the innovatory activities of 167 of the world’s largest industrial enterprises (Pearce & Singh, 1992). The survey found that although 44 percent of these companies undertook no foreign R&D, 21 percent allocated more than one-fifth of their global R&D budget to their overseas activities. The
propensity to engage in foreign R&D was most pronounced in the case of food, drink, and pharmaceutical MNEs, and among those of European origin. Most of the foreign R&D units were relatively new, 42 percent having been set up after 1980. About two-thirds of R&D facilities established since 1980 had been located in foreign countries, compared with only one-third of those set up prior to 1980.

More recent survey-based evidence on the increasing propensity of large MNEs to source technological assets abroad indicates that in the case of some European firms, especially in the pharmaceuticals, food, drink, and tobacco sectors, foreign R&D expenditure exceeded that undertaken in the home country (Dunning & Lundan, 1998). The average share of foreign R&D across the 85 large MNEs in the sample was 21 percent. Among the leading European MNEs, firms such as SKF, Pilkington, Hoechst, BAT, Nestlé, and Philips, and among U.S. and Canadian MNEs, firms such as Amoco (now part of BP), Goodyear, and Alcan, all conducted more than 40 percent of their R&D abroad in 1993.

In their review of the empirical evidence, Niosi and Godin (1999) concluded that large firms from small countries like Belgium, Canada, the Netherlands, Sweden, and Switzerland tended to record the highest share of their global R&D from their foreign affiliates. Firms from the UK also tended to conduct a significant proportion of their R&D activities abroad, while Italian and Japanese firms conducted a large share of their innovation at home. American, French, and German MNEs typically fell somewhere in between. This general pattern was also confirmed by the evidence reviewed in a report by UNCTAD in 2005, although the share of foreign R&D conducted by German MNEs had grown substantially, from 2,000 employees in foreign R&D affiliates in 1996 to 11,000 in 2003 (UNCTAD, 2005, p. 124).

Relatively comprehensive Swedish data presented by Fors (1998) indicates that in 1994, foreign R&D accounted for 25 percent in all sectors, 29 percent in chemicals, 63 percent in nonelectric machinery, and 25 percent in electric machinery. At that time, 65 percent of the research of Swedish MNEs was conducted in Europe. This compares with data from 1970, when foreign R&D accounted for 9 percent in all sectors, 10 percent in the chemical sector, 14 percent in nonelectric machinery and 12 percent in electric machinery, and 75 percent of the foreign R&D of Swedish firms took place in Europe. However, there was a considerable increase in the share of foreign R&D expenditure of Swedish MNEs in the latter half of the 1990s, so that by 1999, the ratio had nearly doubled to 42 percent, remaining at 43 percent in 2003 (UNCTAD, 2005, p. 123).

Similar developments also took place in Finland, where the foreign R&D expenditures of Finnish firms grew rapidly in the late 1990s, mostly as a result of M&A activity, reaching a high of 45 percent in 2001 (Ali-Yrkkö & Palmberg, 2006b, p. 14). Based on in-depth interviews with 17 chief technology officers of large Finnish MNEs, Ali-Yrkkö and Palmberg (2006a) concluded that proximity to customers and the availability of skilled engineers were the primary factors in influencing their R&D location. While the former increasingly favored locating some R&D offshore, the latter was seen as reflecting Finland’s strengths as a location for R&D, with a supply of highly skilled engineers and a well-functioning national innovation system (NIS).

For Japan, which historically has had very low levels of foreign R&D, Granstrand (1999) reports a percentage of R&D conducted abroad in 1987 of 1.6 percent, and
as high as 5 percent in 1991 for a sample of 24 large Japanese MNEs in the chemical, electric, and mechanical industries. Other estimates presented by Kumar (2001) using MITI data indicate that between 1989 and 1997, the R&D expenditures of foreign affiliates of Japanese firms grew from 1.4 to 2.3 percent of the R&D expenditures of their parent group. Latest estimates from UNCTAD (2005, p. 123) indicate that the share of foreign affiliate R&D by Japanese MNEs had also increased in the late 1990s, and reached 4 percent by 2002.

Finally, we would mention the results of two recent international surveys, which sought to evaluate the factors important to the choice of location of international R&D facilities. The first involved a sample of 95 MNEs drawn from the top 500 R&D spending firms in Europe (European Commission, 2006). The most important locational factors identified in this survey were the availability of researchers, access to specialized R&D, market access, and a predictable IP rights framework. The cost of research personnel was among the least important factors, and in two-thirds of the cases, the home country was considered to be the most attractive R&D location. The United States was clearly the preferred location outside of the EU, followed by China and India.

The second survey involved a sample of 203 MNEs mostly from the United States and Europe (Thursby & Thursby, 2006). The questions were posed in terms of R&D employment (rather than expenditures) to minimize inaccuracies and problems due to currency translation. When considering the siting of a new R&D facility, 70 percent of the respondents envisaged an expansion rather than the relocation of existing facilities. The factors most important for location choice were the quality of R&D personnel and output markets, high IP protection, and university collaboration. By contrast, tax breaks and lower costs of R&D personnel were ranked near the bottom, also in the case of developing countries (China and India). Both surveys thus underlined the importance of IP protection to the location decisions concerning the R&D activities of MNEs. At the same time, both surveys highlighted the importance of the (potential) output market, which in the case of China and India has served to counterbalance some of the firms’ concerns regarding IP enforcement.

**External Technology Sourcing by Multinational Enterprises**

Having reviewed the evidence concerning the internationalization of corporate R&D, we will briefly discuss the motivations and evidence for the use of external forms of technology sourcing and development by MNEs. In doing so, we shall concentrate particularly on the role of cross-border R&D alliances and acquisitions. The impact of other forms of external knowledge sourcing, such as knowledge spillovers from innovative clusters abroad, will not be considered here, as their magnitude and impact is likely to be small in comparison with contractual technology sourcing.

The majority of technology alliances is contractual, and specify where and by whom specific research is to be carried out. Technology alliances can thus be seen as a form of relational contracting for the development of new knowledge, which differs from other forms of contractual outsourcing in that the precise characteristics of the output are not known beforehand. As such, alliance agreements would
be expected to influence the location and extent of innovative activity, and their collective impact should be reflected in the statistics over time, both in terms of the share of corporate R&D-conducted abroad, as well as in terms of the share of R&D funded by MNE affiliates.

Some indication of the increasing importance of external knowledge sourcing can be gauged from the fact that in 2003, the ratio of contract research to in-house R&D was 5.6 percent for all U.S. industries, which marked a notable increase from 3.7 percent in 1993. Furthermore, these figures only provide a partial view, as they are limited to contract research performed in the U.S. (National Science Board, 2006). A recent survey of 95 R&D-intensive MNEs in Europe indicated that nine out of ten respondents outsourced some of their R&D activities, with an average of 15 percent of their R&D being performed by other firms (European Commission, 2006).

Although contractual R&D alliances normally have a limited time horizon due to their project-based organization, they appear to require a relatively strong commitment of resources by the companies involved and a corresponding level of interorganizational interdependence during the joint project. In high-technology industries such as biotechnology, pharmaceuticals, and information technology, contractual arrangements are frequently focused on in-depth research activities, while in other industries, such partnerships will tend to focus more on the development and engineering of new products or processes.

While in 1980, joint ventures and contractual alliances accounted for roughly half each of annual alliance formation, by 1998, contractual alliances accounted for about 90 percent on the annual alliances, and since the mid-1990s, this trend has remained constant (Hagedoorn & Lundan, 2001). Indeed, the growth in newly made R&D partnerships since the early 1980s was largely caused by an overwhelming increase in the absolute numbers of contractual partnerships.

From 1980 to 1998, the share of high-technology industries in all newly established R&D partnerships increased from about 50 percent to over 80 percent. During the same period, the share of medium-technology industries in these new R&D partnerships decreased sharply from about 40 percent to less than 20 percent (Hagedoorn & Lundan, 2001). Thus, in addition to contributing to the explosive growth of contractual forms of alliances, high-technology alliances in sectors like biotechnology, information technology, and new materials have accounted for the vast majority of newly formed alliances over the past decade. Indeed, biotechnology alliances alone accounted for 63 percent of all alliances in 2002, and 53 percent in 2003 (National Science Board, 2006).

As a proportion of all alliances, international alliances declined from about 70 percent during the first years of the 1980s to about 60 percent of all alliances in the early 1990s (Hagedoorn & Lundan, 2001). By the late 1990s, the share of international partnerships was below 50 percent of all new R&D partnerships, although it should be noted that this share is of a total number of new alliances, which was then more than twice as high as it was in 1980. Alliances between U.S. and European firms have generally accounted for 20–30 percent of the total, while alliances between U.S. and Japanese firms have declined from a high of around 20 percent in the early 1980s, to less than 10 percent in the early 2000s (National Science Board, 2006).
The intensification of competition on account of globalization and the increasing complexity of modern technology have resulted in a need to speed up the innovative process, and, consequently, to an escalation of the costs of R&D for firms. In addition to employing a variety of nonequity means to share the risks and costs of R&D, MNEs have also engaged in a large number of cross-border M&As—mainly intra-Triad—in an effort to promote and augment their competitive advantages (Lundan & Hagedoorn, 2001; UNCTAD, 2000).

Research by Hagedoorn and Duysters (2002) indicates that mergers and acquisitions are still frequently preferred to alliances, where the object of the acquiring firm is to upgrade its core ownership-specific advantages. They also found that experience with one or the other mode influences the choice between acquisitions and alliances. However, in high-technology sectors, firms preferred alliances to acquisitions, while in low-technology sectors, the opposite was true. While in absolute terms, high-technology firms engaged in many M&As, they undertook even more alliances. This was driven by the rapid rate of technological development in high-technology sectors, along with the constraints to equity acquisition posed by time, money, and the availability of suitable targets.

While the motivation for undertaking both mergers and alliances is often related to the possibility for learning and knowledge transfer, the two modes carry distinct benefits and costs. Indeed, research by Hagedoorn and Sadowski (1999) confirms that technology alliances do not appear to be a gateway to mergers, as of the nearly 13,000 instances of alliance formation in their database, only less than 3 percent were converted into mergers over a three-year period. According to their evidence, not only are conversions from alliances to mergers rare, but they are seemingly random, as neither size nor country of origin had a significant impact on the rate of conversion.

In contrast to the 1980s, when cooperative R&D activity, particularly by Japanese firms, was seen in the context of a “learning race” between the partners, the more recent evidence would seem to suggest that acquisitions and partnering should be seen instead as complementary means of enabling technological specialization between firms (Zeng & Hennart, 2002).

Policy Implications for Home Countries

We now return to the two policy questions introduced in the beginning of this article. The first of these is concerned with the possible “hollowing out” of the innovative base of the home country as a result of the internationalization of the innovative activities of its MNEs. On this question, there is an emerging literature that suggests that in spite of the cost savings that can be realized, there are likely to be knowledge-intensive activities that are not so footloose, and where proximity might continue to play a more important role than perhaps has been presumed in the past. This is likely to be the case, for instance, where innovative activities require colocation with customers, the firm’s own productive activities, or competitors’ R&D facilities. In addition to the “stickiness” of some types of innovative activities, some of the R&D conducted abroad might also be complementary to that conducted at home, although, as yet, there is little evidence available to assess the empirical significance of this possibility.
Historically, the activities that enabled the MNE to modify its products and processes to suit the conditions and tastes in host country markets were the first and most important purpose for giving affiliates responsibility for local R&D. Such R&D was typically development oriented, and had little connection to the research that was directed at developing new products and processes. The presence of important customers and/or a large host country market were necessary to justify the costs of a firm’s own R&D facility of this type. With the globalization of production and sales and the emergence of new host countries on the global market, the relative increase in the movement of key customers is likely to contribute to the increasing relocation of this type of R&D activity.

By contrast, R&D on basic materials and product development, which forms the technological core of the firm, has traditionally relied on local innovative conditions and the institutions comprising the NIS of the home country. Indeed, there is evidence to suggest that NISs are particularly geared to assisting large indigenous firms in the dominant industrial sectors, particularly in the case of relatively small countries. Although potential host countries have sought to overcome some of the costs of R&D relocation by providing incentives to foreign investors, the institutional conditions in the home country, including the institutions that comprise the NIS, and the cultural and social proximity of the key players, are likely to result in substantially lower transaction and/or coordination costs being achieved by keeping these types of R&D activities in the home country.

Another factor influencing the location of this type of R&D has to do with the benefits that are gained from the colocation of production with R&D. Whether colocation continues to be preferred in the contemporary global economy, when value chains are broken up, and much of production is carried out contractually, is difficult to judge due to the paucity of empirical evidence. However, some recent survey-based evidence presented by Ketokivi and Ali-Yrkkö (2009) on Finnish firms suggests that the need for colocation is likely to be positively associated with product or process complexity.

The third type of R&D is at the heart of the discussion on offshoring, as it concerns efficiency seeking within the R&D function, or in other words, the utilization of a cost advantage in R&D, such as that enjoyed by Indian software engineers over American ones. There are considerable benefits to engaging in R&D activities of this kind, but the offshoring potential is limited by the ability of the firm to effectively transfer the knowledge from the offshored activities and to make use of it within the firm. There is increasing evidence to suggest that this is not a trivial problem and that the totality of transaction costs related to the transfer of knowledge-intensive assets, also within the firm, may be quite substantial. Ceteris paribus, this will favor the home country location over offshored R&D activities at low to moderate levels of cost advantage. Put somewhat differently, of all the R&D conducted by the firm, only some of it is likely to be of a kind where the interdependencies can be successfully managed at a distance.

The final category of R&D is that which is aimed at the acquisition of new capabilities and knowledge-based assets. Like the first type of R&D related to product modifications, the asset acquiring R&D is also an “old” form of international R&D activity, as science and technology centers have attracted investment, particularly from Europe to the United States, since the 1920s and 1930s. What is
different about the contemporary global economy is thus not so much the type of activity, but the fact that there are more locations where cutting-edge scientific activity can take place.

This capability-acquiring R&D is often directed at regional or local clusters of innovation, which in the science-based industries are often linked to public or private research centers, and where agglomeration by other firms from the same sector generates localized knowledge spillovers in the area. As a physical presence in such clusters is generally the only means whereby access to local knowledge is obtained, and whereby any spillovers can be appropriated, the location specificity of such activity is extremely high and necessitates investments away from the home country.

Overall, there are likely to be some divergences of interest between home and host countries as to the technological impact of MNE activity. To the host country, the opportunity cost of obtaining technology via inward direct investment is the cost of obtaining it by other routes or by the internal generation of that technology. To the home country, the cost is essentially the impact—beneficial or otherwise—which the outward MNE activity might make to its global competitive position. At the same time, however understandable it may be that countries wish to advance their technological prowess, and however much one might judge the success of inward and outward direct investment in these terms, all countries cannot expect to be technologically competent in all sectors.

The principle of comparative dynamic advantage is no less applicable in explaining the international allocation of R&D than it is in explaining the trade in final goods and services (UNCTAD, 2005). Unless it is prepared to sacrifice economic welfare for other goals, no country—even large industrialized countries—can expect to be entirely self-sufficient in its technological capabilities. So the role of the MNE must be judged not only in the light of the effect it has on the generation of new knowledge-intensive assets, but also on the allocation of these assets, and this, in turn, on the long-term economic interests of the country concerned. Indeed, it is possible to conceive of an MNE doing its home country a service by relocating some of its R&D elsewhere, whenever this opens the door to more productive R&D—or, for that matter, more productive non-R&D activities—in that country.

The changes we have outlined in this article, including the greater number of locations where innovative activities can be performed, and the growth in different forms of contractual activity, have served to reinforce the allocative role of MNEs in the restructuring of the technological capabilities of their home countries. At the same time, the innovative activities MNEs perform abroad provide a potentially important channel for reverse technology transfer back to the home country, whether in the form of a direct (intrafirm) transfer or via spillovers. In this way, such activities also contribute to the domestic technology base and influence the capacity of the home country to generate new technologies.

Consequently, home country governments have an important role to play by fostering institutions that support the development of the management and organizational skills of asset-acquiring firms so that they can effectively integrate the newly acquired technologies with their own strategies and operations. On one level, this is an issue of absorptive capacity or the requisite level of technological sophistication that allows for further learning to take place. However, we would argue that successful reverse technology transfer from abroad is also an issue of the
informal institutions or the values and norms that support entrepreneurship and encourage experimentation in the home country (Cantwell, Dunning, & Lundan, 2008; Dunning & Lundan, 2008a). While the former is likely to pose an obstacle particularly in the context of developing countries that suffer from deficiencies in their human resource development, the latter might impede technological upgrading even in advanced economies.

The second policy concern for home countries arises from the fact that particularly in the technologically advanced countries, the appropriation of returns from innovation is strongly conditioned by the surrounding institutions, especially in the area of IP protection (Granstrand, 2005; Teece, 1992, 2006). To what extent is the internationalization of corporate R&D likely to shape the future development of these institutions? We think that the expanding membership of the “club” of countries where innovative activity takes place has potentially important implications for the development of the regimes under which technological standards are formed and where the rules concerning IP are agreed upon.

To the extent that some of the emerging powers, notably China, have exhibited different priorities in relation to the enforcement of IP rights, or like India, have embraced a different philosophy as regards the desirability of IP protection in the case of pharmaceutical innovation, they present a competing vision of what ought to constitute the rewards for innovation in the global economy. At the same time, the interests of the established IP holders are likely to be divergent from those desiring to catch up, and sometimes it can even be in the interest of the incumbent firms to promote an open IP regime in one domain while defending a closed one in another (Pisano & Teece, 2007).

Of particular interest in this context are instances where the promotion of one type of appropriability regime receives direct or indirect support from the home government of the MNE. Here, we might think, for example, of the role played by U.S. pharmaceutical firms, led by Pfizer, in introducing the Trade-Related Aspects of Intellectual Property Rights (TRIPs) agreement to the Uruguay round of negotiations (Ramamurti, 2005). Alternatively, we might think of the range of technology standards introduced by the Chinese government over the past decade. These include, for example, the third generation mobile communications standard TD-SCDMA, and the WAPI security standard for wireless internet, that are embodied in the products made by leading Chinese firms such as Huawei (Bach, Newman, & Weber, 2006).

The process of standardization that underpins the increasing modularization of technology implies that there is a great deal at stake for the MNEs and their home countries in their efforts to influence the standard-setting process. We believe that the increasing number of players involved is likely to lead to a reconfiguration of the politics surrounding the formation of standards at the national and supranational levels. In this process, the role of MNEs becomes pivotal not just as technology transferors or developers, but also as entities that can shape the institutional fabric in their home and host countries (Dunning & Lundan, 2008a, 2009).

Finally, we might mention a related and potentially contentious issue concerning the use of M&As as a means to acquire technological capabilities. Over the past decade or so, M&As involving marketing and distribution activities, production capacity, and innovative capabilities, have become an important element of
cross-border value-adding activity (UNCTAD, 2000, 2007). The ability of foreign firms to use M&As to access the NIS of the host country and thus gain an insider status in the market, offers a notable advantage to the investing firm while also posing a potential threat from the point of view of the host country. Although such incoming investment does not need to be in conflict with the goals of advanced host countries that want to see their science and technology base exploited as fully as possible, as the internationalization of R&D continues to deepen, the political dimensions of these activities are likely to become more prominent.

Although the developed countries have acted as the champions of the liberal market policies that have facilitated the process of globalization, one can point to several recent examples which seem to indicate a more protectionist stance toward inward investment, particularly with respect to investment that is seen to be driven by the developmental objectives of a state, rather than by market competition (Sauvant, 2006). The best-known examples here involve the failed acquisition of Unocal in the United States by the Chinese oil company CNOOC, and the Dubai Ports World takeover of the British firm P&O, which operates ports in the United States. Both cases came under review by the Committee on Foreign Investment in the United States (CFIUS) for concerns related to national security, although the security aspect particularly in the CNOOC case was not readily apparent (Graham & Marchick, 2006). In India, an attempt by the Chinese firm Huawei to set up a telecommunications manufacturing affiliate was also blocked by the government on national security grounds (UNCTAD, 2006). In 2008, in response to the growing engagement of sovereign wealth funds in cross-border investment, Germany confirmed its intention to establish a review body modeled after CFIUS to screen inward investment, while the EU has also proposed a community-wide accord on the same issue.29

It is still too early to tell what the substantive impact of such developments is likely to be on the climate for inward investment and specifically on the internationalization of the innovative activities of MNEs. However, as the exploitation and development of knowledge-based assets is critical to economic performance, any restrictions on the ability of MNEs to organize their innovative activities in line with comparative advantage would be likely to restrict the rate of technological development and economic growth.

Conclusions

This article has reviewed and synthesized the existing evidence on the extent to which the knowledge-creating activities of MNEs have become more internationalized over the past three decades. As there are multiple ways in which MNEs both develop and source knowledge from abroad, and considerable variation across industries in the extent to which innovative activities are linked to the science and technology base in the host countries, no single measure can fully capture the extent and forms of the internationalization of corporate innovative activities. Cross-border knowledge generation can be the result of the R&D conducted by the MNE’s own affiliates, the acquisition of foreign research facilities, R&D performed under contract, or development work carried out in informal open networks. To make use of these sources of innovation, MNEs have evolved toward structures that
give more autonomy to foreign affiliates. However, in spite of these developments, much of the innovative activity of MNEs still takes place in the home country. Furthermore, the internationalization of corporate R&D has been primarily directed to the traditional host countries, although the growth in the share of the emerging economies over the past decade has been notable.

What then are the policy implications arising from these developments? From the perspective of the home country concerned with its attractiveness as a location for innovative activities, we noted that just as in the case of productive activities, at least some of the cross-border innovative activities of MNEs are likely to be of a kind that is complementary to the activities being carried out in the home base. As a consequence, the increasing internationalization of different types of innovative activities by MNEs is likely to have both positive and negative effects on the home country. The balance of these is likely to depend on the ability of the home country governments to foster the reallocation of resources in line with changing comparative advantage while acknowledging that the technological profiles of countries (or firms) do not change very quickly, and any new division of labor is as likely to reinforce old competencies than it is to introduce new ones. While the past investments made to develop the NIS can form a basis for the development of sustainable advantages, they also create path dependencies, which can become a source of inflexibility in the face of rapid technological change. In the worst-case scenario, such rigidities might prompt MNEs to move the bulk of their innovative capacity outside of the home country, although so far, there is little in the available evidence to suggest that this has taken place.

The second major implication of the internationalization of the corporate research base is that home countries need to seek new ways to influence decision making in the various fora where the appropriability regimes surrounding innovation are formed. To the extent that much of the innovative activity of MNEs has coevolved within the context of the home country NIS, even in the absence of any active promotion by the government, it has generally been in the interest of the MNEs to advance the home country standards in the global marketplace. However, if and when new contenders enter the market, possibly advancing standards that are being promoted in a strategic manner by their home governments, the outcome of the standard-setting process becomes more difficult to predict.

Without wanting to overstate the case, we think that it is precisely because some types of innovative activities have been shown to be quite “sticky,” and tied to the home base that the domain of global market standards is likely to become an even more contested terrain. If innovation were truly global, the interests of technology developers in different parts of the world should be relatively easy to reconcile. However, because corporate innovation still rests in large part on public investments in science and technology, state interests in the promotion of proprietary technology standards and in controlling other aspects of the appropriability regime are likely to remain significant.

Notes

1 This research is a part of the collaborative research program of BRIE, The Berkeley Roundtable on the International Economy (University of California, Berkeley), and ETLA, The Research Institute of the Finnish Economy (Helsinki, Finland).
2 The contemporary MNE is not simply defined by the extent of the value-added activities it owns and/or controls, but it is better conceived of as an organizing entity that coordinates a system or a network of both inter- and intrafirm relationships. Some of these relationships are equity based, some are contractual, while others might be purely cooperative (Dhanaraj & Parkhe, 2006; Doz, Santos, & Williamson, 2001; Dunning & Lundan, 2008b).

3 For example, a large MNE like Siemens that spends about 7 percent of its sales on R&D had nearly half of its 45,000 R&D employees working outside of Germany in 2004. Of these, already 6 percent were located in the emerging countries of Brazil, China, India, Malaysia, Mexico, and South Africa (UNCTAD, 2005, p. 124).

4 The literature on linkages and spillovers is reviewed by, for example, Dunning and Lundan (2008b) and Blomström, Globerman, and Kokko (2000).

5 By globalization, we mean the increasing interconnectedness of markets that has been brought about by successive innovations in communication and transportation technology, coupled with a supportive policy environment. Internationalization, by contrast, refers to a strategy of increasing cross-border activities by firms.

6 See also Fai (2003) on the historical evolution of corporate technological competencies.

7 Additionally, Cantwell and Vertova (2004) show that since the mid-1960s, despite considerable overall increase in technological activity, there has been a tendency for countries to increasingly concentrate their technological activities. Thus, MNEs and their affiliates seem to retain their own profiles and to complement the national profiles of technological specialization of host countries, rather than change them toward greater diversity.

8 Indeed, as Cohen and Levinthal (1989) have argued, firms would have little incentive to carry out any basic research, if it were not for the need to build absorptive capacity that enables the firm to utilize publicly available research results in their own R&D endeavors.

9 Leiponen and Helfat (2006) found that decentralized innovation was positively related to innovation success in a representative sample of Finnish firms, but that the beneficial effects were associated with imitative innovations, rather than novel (new to the market) forms of innovation.

10 Rugman and Bennett (1982, p. 58) defined a WPM as a “charter to develop, produce and market a new product line worldwide.”

11 See also Florida (1997) and Pearce (1999).

12 See, for example, Zanfei (2000), for a review of the literature on the innovative activities of MNE affiliates and the tension between affiliate autonomy and centralized control. See also the various contributions in Lundan (2002).

13 The first two sections draw on chapters 11 and 12 in Dunning and Lundan (2008b).

14 Data on U.S. patenting is a useful metric due to the availability of long-term data, and the leading position of U.S. firms in the new technologies of the second industrial revolution, including the development and commercialization of electric power and the automobile (see, e.g., Chandler, 1990; Hausman, Hertner, & Wilkins, 2007). Prior to the 1920s, there were no industrial firms with R&D departments in the modern sense.

15 See also Patel and Pavitt (1991).

16 However, as indicators of technological capability, patent data have some well-known drawbacks. See for example Griliches (1990). The OECD database on Triadic patent families was developed to address the issue of significant and insignificant patents by focusing on a subset of inventions for which patent protection was sought in the three important markets of the United States, Europe, and Japan. Using the classification of Triadic patent families, United States and Japan were still clearly in the lead (in 2003) along with Germany, followed at a considerable distance by France and the UK.

17 In absolute terms, the R&D performed abroad by U.S. affiliates amounted to $21.2 billion in 2002, accounting for 11 percent of the industrial R&D in the United States (National Science Board, 2006).

18 See also Serapio and Dalton (1999) on R&D conducted by foreign affiliates in the United States.

19 This is sometimes referred to as open innovation, and may also involve non-R&D innovation, such as user innovation. See for example Doz and others (2001), Chesbrough (2003), and von Hippel (2005).

20 While 81 percent of high technology alliances in 1998 were contractual, only 52 percent of medium technology and 62 percent of low technology were.

21 See also Håkanson (1995) on the managerial, sociocultural, technical, and procedural integration challenges encountered by MNEs when they acquire knowledge-intensive assets, such as R&D facilities.
22 For example, in Norway, Narula (2002) found that the smaller entrepreneurial firms in nontraditional sectors had been more active in relocating their innovative activities abroad, whereas those indigenous firms best served by the NIS were understandably more reluctant to do so. In Finland, there is little question that the NIS has served the needs of Nokia and vice versa.

23 In general, transaction costs in the home country are likely to be lower because of higher levels of trust, which is facilitated by the possibility of face-to-face contact and a lower cultural distance. The dense social networks, which are particularly characteristic of small home countries, also allow firms to obtain better information concerning their network partners, which reduces the need to rely on trust when conducting transactions.

24 This comparison assumes that when wages are adjusted for productivity, there are no major quality differentials between the two groups. It is reasonable to assume, however, that the availability of this type of science and technology personnel is likely to be much more limited than that suggested by the raw numbers of university graduates in some of the emerging markets (Gereffi & Wadhwa, 2005).

25 This is reflected, for example, in the knowledge-based theory of Kogut and Zander (1993, 1996), which emphasizes the importance of organizational identity and motivation in knowledge transfer, and in the work of Szulanski (1996) on internal “stickiness” in the transfer of information.

26 Successful “organic” clusters tend to induce further agglomeration in the same area, until some threshold of crowding or congestion is reached. This might occur, for example, when the unwanted leakage of knowledge is likely to exceed or equal the ability of the firm to appropriate any local spillovers (Shaver & Flyer, 2000).

27 Additionally, at least three developing home countries, namely, China, Malaysia, and Singapore, have put in place policies that explicitly encourage outward FDI for the purposes of asset exploitation, as well as asset augmentation (UNCTAD, 2006, p. 163).

28 In fact, the initial acquisition of technological competences in many emerging countries (e.g., South Korea, Singapore, and China) depended on indigenous investment, followed by trade, subcontracting, and licensing relationships rather than foreign investment. Since the early 1980s, the rapid growth of arm’s length markets for IP has broadened the opportunities of the emerging players to also take part in the cross-border interfirm business networks for knowledge exchange (Athreye & Cantwell, 2007).


30 It is also possible that due to technological or market changes, the NIS may become less attractive from the viewpoint of domestic MNEs, but more attractive from that of some foreign MNEs. However, this presumes that other factors necessary for attracting such investment are also in place.

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