The R&D Activities of Foreign Firms in the United States

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Introduction

In recent years, considerable attention has been paid in the literature to the process of globalization and the increasing extent of economic integration between advanced industrial countries. In part, these events have been facilitated and fashioned by the activities of multinational enterprises (MNEs) as they have sought to rationalize and coordinate their production in various locations (UN 1993). Initially, as firms engage in foreign direct investment (FDI), they tend to do so in comparatively low-value activities. If successful, these activities are followed by a forward and backward deepening along the value chain. Eventually, such vertical integration may embrace technologically sophisticated production and research and development (R&D) facilities; and there is considerable evidence (Casson 1991, Pearce 1989) that, over the last two decades, there has been a steady regionalization or globalization of high-value activities both from developed and developing countries. However, a particular feature of the increasing foreign ownership of domestic R&D activities in the advanced industrialised countries is that in recent years it has increasingly occurred through the acquisition of existing innovatory assets rather than the setting up of new, i.e., greenfield, R&D ventures. Moreover, such acquisitions have been prompted not so much by the desire of MNEs to exploit existing technological advantages but by a perceived need to protect these advantages or to acquire new ones. To this extent such FDI in R&D activity is best described as strategic asset seeking FDI. 1

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Especially interesting in this context is the recent rapid intensification of foreign-owned R&D activities in the United States. This is especially so, given the fact that, until the early 1970’s, the United States accounted for the great bulk of the world’s technological capacity. Moreover, to date, most of the literature on the internationalization of R&D has viewed the question from the perspective of the home country, or from that of home-based MNEs (Pearce 1989). Relatively little attention has been given to the significance of foreign owned R&D from the perspective of the host country. In view of this, the aim of this paper is to examine the following questions, based on the extent and industrial pattern of R&D undertaken by foreign MNEs in the United States:

1. What is the relationship between the internationalization of R&D and the internationalization of other forms of value-added activities of MNEs?
2. What is the relative significance of R&D activities of foreign owned corporations in the United States to all R&D activities of that country?
3. What motivates foreign MNEs to invest in U.S. R&D facilities? In particular, does such investment reflect the locational attractiveness of the United States for the exploitation of existing technological advantages of the investing corporations, or is it primarily perceived as a means of acquiring new advantages - particularly, those designed to protect or advance their global competitive position.

**Theoretical Framework**

Essentially, the competitive advantage of a firm or country derives from its having privileged access to assets which it is able to organize more efficiently than other firms or countries. Assets are defined as resources capable of generating a future income stream. They are essentially of two types. **Natural** assets embrace the fruits of the earth and the stock of untrained labor. **Created** assets are all other assets which are developed on the basis of natural assets. They may be tangible (e.g., the stock of physical or financial assets) or intangible (e.g., technological knowhow, trademarks, goodwill, organisational capability and institutional culture [Dunning 1993a]). When assets of either kind are available to all firms but are specific to a particular location, they are termed location-specific (L) assets or advantages. Where they are unique to particular firms, be they mobile or immobile over national boundaries, they are termed ownership-specific (O) assets or advantages (Dunning and Narula 1994).
By themselves, natural asset-type O advantages rarely lead to value-added activities. For the most part, in order to derive rent from such assets, firms must utilize them together with created assets. Firms from countries in the earlier stages of their economic development tend to derive their competitive advantages from the exploitation of location bound natural assets in which their home country has a comparative advantage. As a country’s comparative advantages evolve towards higher value-added activities, the importance of created assets in the portfolio of O advantages of its firms will increase (Narula 1993b). These same O advantages are likely to lead to the initial internationalization of firms - be it by exports or FDI. At the same time, the process of internationalization may yield its own O advantages. In particular, as the foreign production of firms becomes a more important component of its total production, so its access to created assets is likely to reflect not only the competitive advantages of its home country but also of those which are host to its affiliates. This is especially likely to be the case for technology-intensive firms. Not only are such firms prompted to internationalize their activities to capture new markets and to cover the increasing costs of R&D, but also to “scout” for new resources to tap into the benefits offered by the national systems of innovation in different countries (Dunning 1993a, Rugman 1993a, Narula 1993b).

For the most part, FDI by firms in the later stages of the production process is aimed at better exploiting its existing competitive advantages in conjunction with L advantages of the host country or countries. The nature of its O advantages may be technological, managerial, financial or organizational, while the character of the L advantages that it seeks to utilize may be some resource such as availability of some natural or created asset specific to the host location (e.g., the availability of raw materials, transport and communication networks), or may be market related (e.g., the level and structure of consumer demand). MNE activity may also be driven by the need to gain access to foreign product, production or marketing technology and/or organizational competence.

By contrast, in the case of internationalization of R&D activities, the aim of the investing company is more likely to be to develop new assets by utilising either the L advantages of the host country or by gaining access to the O advantages enjoyed by firms in that location. Indeed, it might be argued that the internationalization of R&D is one of the key examples of strategic asset-seeking FDI. Assume, for example, that a particular uninational firm largely derives its O-specific advantages from the efficient exploitation of its technological
assets, and has to compete with firms in the same industry which possess similar technological assets. Assume, too, that the technology of the industry is constantly being upgraded. Then it follows that, to maintain its competitive advantage, the firm must consistently seek to develop new technological assets. This it may do by generating assets by undertaking R&D activities at its own facilities. Alternatively, it may acquire these assets by buying an equity interest in a firm which already owns them. A third option for the firm is to collaborate (e.g., through a strategic alliance) with another firm to jointly develop the required assets. Since we are primarily concerned with R&D through the modality of FDI, we will not examine the development of technological assets through a non-equity collaboration separately in this paper, but as a subset of asset generation. 5

Types of R&D

The extent and form of MNE investment in foreign R&D facilities is likely to depend on the reasons for that involvement. For the purposes of the ensuing discussion, we shall classify R&D into four main categories.6 These are:

Type 1. Product, material or process adaptations or improvements. This type of R&D activity is intended to adapt and tailor products and/or processes to local supply and demand conditions. It may be undertaken to service either resource-seeking or market seeking foreign production. Overseas R&D facilities of this sort act as support laboratories to those of the parent company, and are essentially designed to more effectively exploit its global advantages. In essence, the subsidiary acts as a technology transfer unit (Ronstadt 1977, Hood and Young 1982). Minor product and process adaptations associated with a support laboratory do not always lead to the development of a new asset, especially where such improvements do not affect the nature of the product, but its market potential. Nonetheless, in practice, major product adaptations are often the accumulation of several minor product adaptations.

Type 2. Basic materials or product research. This may be undertaken for two main reasons. The first is that the inputs for research may be immobile, and the second is that there may be need for close interaction with the market to improve the product on a regular basis. This is similar to the Hood and Young (1982) classification of a locally integrated laboratory (LIL) and the Ronstadt classification of indigenous technology units. Such R&D activity usually represents the final stage of the indigenization of the value chain of resource-seeking or market-
seeking FDI, and are more research intensive than Type 1 in that they are geared toward substantial product improvements for local markets.

Type 3. Rationalised R&D. This type of R&D is analogous to efficiency-seeking foreign production. Rationalisation may be product or process based, and is normally designed to capture the economies of scale and scope, which may be associated with the presence of immobile inputs. However, Type 3 R&D differs from Type 2 R&D in that the research output may be exploited globally by the parent firm, rather than locally. Such R&D activities tend to give rise to rather more intra-firm trade in technology than either Type 1 or Type 2 R&D. They are also similar to what Hood and Young (1982) refer to as the internationally integrated laboratory (IIL) and Ronstadt’s global technology unit.

Type 4. Strategic asset seeking R&D. R&D activities of this type are aimed at monitoring or acquiring competitive advantages - particularly in the technology and information-intensive sectors - which are complementary to those already possessed by the MNE. Such R&D facilities are similar to the Ronstadt classification of corporate technology units which, as Lall (1979) has suggested, are designed not just to gain access to foreign immobile technological assets, but also to benefit from spillovers from other firms in the same industry arising from the clustering of innovatory activities. Much intra-Triad investment in science parks and regions of intensive innovatory activity is of this kind; the Japanese, in particular, have deliberately sought to access U.S. technology and scientific skills, by investing in R&D facilities in the United States (Herbert 1989).

Although the majority of overseas R&D activity by MNEs is of the first three types and tends to be sequential to the internationalization of lower value-added activities, it is the fourth type which has grown the most rapidly in the 1980s. This has important implications for the theory of international production, as unlike asset-exploiting FDI, the location of asset-developing FDI is not primarily guided by either cost or marketing considerations. Kogut and Chang (1991), for example, have pointed out that the presence of natural assets is not of pivotal importance in deciding the location of intra-Triad foreign direct investment, especially in those sectors and industries which are technology or capital intensive. R&D activities, which, by their nature, are knowledge-intensive, are an example of such FDI. Locational decisions are based on a different set of criteria than those applicable to other forms of FDI. Moreover, because the markets for R&D output is highly imperfect, such activity frequently needs to be
internalized if its benefit to the firm is to be fully realised. It follows then, that not only may internationalization of R&D precede rather than follow the internationalization of production but, in some cases, a firm may set up foreign R&D facilities even where it does not intend to produce, or where a market for its output does not exist. Though the internationalization of R&D may evolve as a result of the internationalization of production, this is not always the case; “supply-side” reasons play a distinct role in determining the location of R&D facilities.

Several researchers, notably Pearce and Singh (1992), Granstand et al. (1992) and Dunning (1992), have emphasized that the extent and pattern of internationalization of R&D varies according to country, industry and firm determinants, and may be analyzed in terms of the trade-off between “push” or “centrifugal” factors that encourage the decentralization of R&D and the “pull” or “centripetal” factors that favor the geographic centralization of R&D. Because the balance between these factors is likely to be different from that in the case of other forms of international production, it is not surprising that the pattern of the foreign R&D activities of firms is also likely to be different. Moreover the “depth” of R&D activity - by which we mean its created asset intensity - varies between the categories of R&D identified. It tends to be lowest in Type 1 and highest in Type 2 and 3 R&D. Similarly each kind of R&D has its own locational needs. Generally speaking, Type 3 R&D will be located in host countries where domestic firms have O advantages in the kinds of assets it seeks to develop, whereas for Type 1 and 2 R&D, the host country may have L advantages complementary to the assets the firm seeks to exploit and which it has already developed and exploited in another location. Nonetheless, Types 1, 2 and 3 R&D seem to follow a natural progression based on the age, growth and relative size of the international production of an MNE (Lall 1979), while Type 4 R&D is not necessarily a function of the existing FDI profile of a firm, and indeed may be independent of it. It is important to note that the Types 1, 2 and 4 can be undertaken simultaneously by a firm that has rationalized its international R&D activity. However, as noted earlier, rationalised R&D tends to be sequential to the rationalization of production, and is associated with large MNEs.8

However, it seems clear that as both uninational and multinational firms face more intensive competition due to the globalization of production, the need to sustain existing competitive advantages and acquire new ones obliges them to establish some kind of R&D presence in the main markets of their leading competitors. Some locations achieve a “critical
mass” of firms in a particular sector, leading to economies of agglomeration (Lall 1979, Casson 1991). There are several examples of such clustering of R&D activity, e.g., Silicon Valley in California, along the M4 between Slough and Swindon in the UK, and Tsukuba Science City in the Ibaragi prefecture of Japan, and in the Baden-Wurttemberg industrial district of Germany. The setting up of international R&D facilities to take advantage of economies of agglomeration can be done regardless of the extent of competitive advantage of the investing firm, and may occur with any of the four types of R&D described above. For instance, Type 4 R&D may be undertaken even where the MNE possesses only limited technological assets and simply wishes to set up a “listening post”, and to exploit a competitive advantage that the host country possesses relative to the home country. Although Type 4 R&D by MNEs is not a new phenomenon, its use has been greatly expanded in recent years, including by developing country firms in Europe and the United States.

The Internationalization of R&D

The evidence on the internationalization of the R&D activities of MNEs suggests that, while there is some evidence of a convergence of these activities among the leading industrial nations, the majority of the R&D undertaken by MNEs of these countries is concentrated in their home country (Casson [ed.] 1991, Freeman and Hagedoorn 1992, Dunning 1992, Pearce and Singh 1992, Papanastassiou and Pearce 1993b, Patel and Pavitt 1991). As Table 1 illustrates, although the share of patents granted to the world’s largest firms originating from foreign R&D has only increased only marginally from 10.3 percent in the period 1969-72 to 11.2 percent in 1987-90, there were important country-specific differences. For example, while the share of patenting activities undertaken by the overseas subsidiaries of large Japanese firms has actually fallen despite a fast growth rate of its overseas production activities, French and German firms which have also markedly expanded their foreign operations since the 1970s have clearly moved towards internationalising their R&D activities.

***TABLE 1 HERE***

Several recent studies have also illustrated that, while the internationalization of asset exploitation (i.e., production) has sharply increased over the past two decades, the internationalization of R&D activities is a more subdued affair and is limited to a few industries and countries. For instance, even in a high R&D-intensive sector like pharmaceuticals where
production is highly internationalized, the share of patents accounted for by foreign-based R&D activities of the world’s largest firms between 1985 and 1990 was only 16.7 percent, of which only 1.7 percent was located outside the Triad (Patel 1993). Even within the Triad, where most of the growth in international production has occurred, there has not been a significant decentralization of R&D. For example, in a study of the R&D activities of the largest industrial enterprises in the world, Pearce and Singh (1992) found that 44 percent of the parent companies reported they had no overseas R&D expenditure, and another 13 percent reported that overseas R&D accounted for less than 5 percent of their total R&D expenditures. Figures such as these provide some support to the argument that techno-globalism in asset-development is not occurring (Archibugi and Michie 1993). On the other hand, studies such as those of Lall (1979), Pearce (1989), Hakanson and Nobel (1993a, 1993b) also suggest the degree of internationalization of production by a firm is a significant determinant of decentralization of R&D. The implication seems to be that the internationalization of R&D activities lags that of international production, and that the globalization of R&D is at a nascent stage. Certainly, the Pearce and Singh (1992) study would seem to confirm this: 66 percent of their respondents, when asked to evaluate the possible changes in the international location of R&D in their company responded that they expected to place increased emphasis on a globally integrated R&D network, whereas 20 percent felt that they might make more use of centralized R&D activity.

**The Growth of R&D in the United States: Why?**

Let us now examine the argument of the previous sections in the context of the United States. Over the past two decades or so it has become not just the major exporter of R&D activity, but a primary host country for the R&D activity of foreign-based MNEs. In fact, by the early 1980’s, R&D expenditures by foreign firms in the United States exceeded those of U.S. MNEs in other countries, since when the gap between the two has continued to widen. By 1989 for example, foreign MNEs in the US spent $9.2 billion on R&D in the United States, while the foreign affiliates of U.S. firms spent $6.5 billion on R&D. The propensity of the United States to be a net importer of FDI in R&D is, in fact, much more pronounced than her international direct investment position would suggest: in 1989, the sales of all foreign affiliates of U.S. MNEs amounted to $1,015 billion, only slightly less than those of the affiliates of foreign firms in the United States of $1,056 billion.
What then explains the recent growth of R&D activity by foreign MNEs in the United States? Which industries attract this activity? How important is it relative that of U.S. firms? What is the motivation of this activity in light of our discussion thus far?

We would suggest that there are three primary factors that explain the growth of R&D activities of foreign MNEs in the United States. These are first, the characteristics of the U.S. market; second the convergence in the productivity levels and economic structures of the leading advanced industrialised economies; and, third, the increasing internationalization of production by firms from these countries. Figure 1 shows that direct investment activities by foreign MNEs in the United States had, until the early 1970’s, been a subdued phenomenon, due largely to the technological and economic hegemony built up by the United States during and immediately after the Second World War.

**FIGURE 1 HERE**

In these years, U.S. firms, by and large dominated world markets, and particularly in R&D-intensive industries. Even foreign MNEs found it difficult to compete with the subsidiaries of U.S. MNEs in their respective home countries. Until the mid 1970’s, U.S. direct investment abroad accounted for around half the world’s stock of outward direct investment and for over three-fifth’s of the R&D expenditure of the leading industrial countries (Dunning 1993c). Yet, despite the fact that the United States offered the largest and most sophisticated consumer market in the world, the share of the world’s inward direct investment stock directed towards the United States was only 9.9 percent in 1973. Most of the FDI activities in the United States by foreign firms at that time were of a trade-supportive character since foreign firms supplied the U.S. market through exports either from their home countries or other lower-wage locations. A limited amount of inbound MNE activity was also aimed at acquiring U.S. assets - particularly by U.K. firms anxious to regain a stake in the U.S. market after the second world war.12 As one might expect, the R&D activities associated with trade-supportive FDI was primarily of type 1 and, given the low R&D intensity of trade-supportive investments the expenditures of MNE R&D were also low.

By the early 1970’s, the economies of both the EC and Japan had begun to catch up with that of the United States. At the same time, European and Japanese MNEs were not only evolving distinctive O-specific advantages, but they were increasingly exploiting these from foreign production outlets (Cantwell and Sanna Randaccio 1990). As Figure 1 illustrates, by
the mid 1970’s, MNE activity in the US - first by European and later by Japanese companies - began to grow at a phenomenal rate. Between 1974 and 1980, the stock of FDI in the US grew at an average annual rate of 22 percent, compared with a rate of 6.3 percent between 1950 and 1966 and 13.6 percent between 1966 and 1974 (Rutter 1992). In part, this increase in inbound investment reflected the sudden improvement in the L advantages due to the devaluation and float of the dollar in 1971, which made U.S. production activities more attractive to foreign firms than they had been previously. But, as pointed out in Dunning (1993b) and Dunning and Narula (1994), there were also long-term forces at work. These included not only an improvement in the competitiveness of European and Japanese firms, but a greater incentive to exploit these advantages in the United States via FDI rather than exports. Needless to say, given the importance of the United States as a large and technologically sophisticated market, many of the MNEs that hitherto served the US through exports did move production to the United States, and, as might be expected with such sequential investment, upgraded their R&D facilities to Type 2. As the production facilities of many of these MNEs became well-established in the US, and as these MNEs themselves began to rationalize their operations, their R&D activities gradually evolved toward Type 3 R&D facilities.

At the same time, given the market size of the United States and its traditional leadership in high technology, high value-added activity, clusters of firms have continued to develop in particular locations that are in high-technology, scale-intensive industries such as electronics and bio-technology. Much of the growth of R&D in these sectors was initially caused by the presence of manufacturing facilities and their suppliers, but as a critical mass of innovatory activity has developed, an increasing number of foreign firms have set up R&D facilities in these places to seek the economies of agglomeration. Classic examples include a wave of foreign investment transactions in Silicon Valley in the mid-1980s (Teece 1992); and an increasing concentration of cutting-edge innovatory activity in the consumer electronics sector along Route 1 in New Jersey (Dunning 1993a).

**How Important is Foreign MNE R&D Activity to the US Economy?**

Table 2 sets out the growth of R&D expenditures of foreign MNEs in the United States relative to that of all firms (including foreign affiliates) in the United States. This table reveals
that the share of R&D expenditure of foreign affiliates as a percentage of total US business R&D expenditures has increased quite dramatically from 4.8 percent in 1977 to 15.8 percent in 1990. This compares with an increase in the share of stock of all inward investment in the United States to the U.S. GDP of 4.7 percent in 1980 to 7.9 percent in 1990 (Dunning 1993b). The table also shows that the growth of foreign owned R&D expenditures was greatest during the late 1970’s: between 1977 and 1982 for example, it grew in real terms at an annual average rate of 22.5 percent - almost three times faster than the growth of privately-funded U.S. industrial R&D activity. While there was some slowing of FDI financed R&D growth in the latter part of the 1980’s, there was an even sharper decline in the growth of the R&D of U.S. firms. Between 1980 and 1985, for example, the real annual expenditure on R&D by foreign owned firms rose by a factor of 2.08, compared with that of all U.S. firms of 1.45 times; the corresponding multiples for the 1985 -90 period were 1.85 and 1.08.

***TABLE 2 HERE***

Much of the expansion in FDI activity in the 1980s occurred through the acquisition of existing U.S. firms by foreign MNEs, rather than through greenfield investments or the growth of existing MNE operations. Almost four-fifth of the total investment outlays to acquire or establish U.S. operations between 1980 and 1990 by foreign direct investors was through the purchase of existing U.S. businesses. Much of the initial growth in M&A activity was by European and Canadian firms - in 1980, the UK, Dutch, Canadian and German firms accounted for 72.3 percent of the acquisitions and Japan only 5.8%, but by 1989, Japanese firms accounted for 18.2 percent of all M&A investment outlays by foreign firms in the United States. European firms have invested heavily in the manufacturing sector - in 1990, 48.2 percent of European FDI was in manufacturing, compared to only 20.9 percent of Japanese FDI.¹³

However, it is dangerous to read too much into these figures, as the manufacturing sector attracted less than half of the new investment outlays by foreign firms in the United States in the 1980s. Furthermore, what growth there was in manufacturing investment was directed to just a few industries. U.S. Department of Commerce data reveal that food products, chemicals, electrical and electronic equipment, printing and publishing, and stone, glass and clay products were the largest recipients of new investment outlays; and these were funded primarily by their parent companies rather than from U.S.-based sources.
The share of U.S. R&D expenditures accounted for by foreign firms has also been seen to grow in almost all industrial sectors. In 1977, the pharmaceutical and petroleum industries were the only two sectors in which foreign firms accounted for more than 10 percent of total U.S. R&D - 15.7 percent and 11.8 percent respectively, with the lowest participation shares being in electrical equipment (1.7%), instruments (1%) and transportation (0.1%). By 1990, the R&D activities of foreign affiliates were distributed more evenly across industries, accounting for more than 20 percent of all US R&D expenditures in 4 sectors (petroleum, industrial chemicals, pharmaceuticals and primary metals), and more than 10 percent in another 4 (food products, fabricated metal products, other non-electrical machinery, and electrical equipment). The lowest participation ratios of foreign firms were instruments (7%), computers (6.5%), and transportation equipment (1.6%), while the highest participation ratios were in pharmaceuticals and industrial chemicals in which 42.9 percent and 38.3 percent of U.S. business R&D was conducted by foreign owned firms.

**Country Distribution of FDI R&D**

In 1977, four countries accounted for about 70 percent of all expenditures on R&D by foreign affiliates in the United States. Switzerland led with 25.8 percent, followed by the Netherlands (20.3%), the UK (16.6%) and Germany (10.8%). By 1990, the distribution of the leading spenders had changed. Canadian affiliates were then responsible for 16.9 percent of the total R&D expenditures by foreign firms. The UK accounted for 16.4 percent, German affiliates for 15.3 percent, Swiss affiliates for 14.5 percent and Japanese affiliates for 11.3 percent. However, the four largest in terms of sales in 1977, were Japan (26.2%), the UK (16.2%), France (11.7%) and The Netherlands (10.5%). By 1990, the four largest home countries of foreign firms in the US sales were Japan (27.1%), UK (16.4%), Canada (10.7%) and Germany (9.23%) while the four largest spenders in R&D activity in the US were the UK (17.4%), Canada (16.9%), Germany (15.3%) and Switzerland (13.5%). Further details are set out in Table 3 and 4.

***TABLE 3 and 4 HERE***

In interpreting these data some caution is needed. Firstly, percentage shares taken by themselves may be misleading, especially where the initial sales or R&D expenditures are low. To give just one example, the large jump in the share of Canada between 1980 and 1982 is due
to the purchase of a large share of Dupont by Seagrams, and does not represent control but, since it satisfies the 10 percent equity requirement, it is classified as a FDI in the United States.

At the same time, the data reveal several interesting trends. First, as shown by four last columns in Tables 3 and 4, the growth rate of U.S. based R&D expenditures of foreign affiliates from all countries has clearly outstripped that of the sales of such affiliates, even when considered in constant dollars, and has done so for all periods between 1977 and 1990. Second, excepting the UK, the share of R&D expenditures accounted for by the “traditional” home countries of Europe (such as Switzerland and The Netherlands) has fallen, as MNEs of other nationalities (such as Germany, Japan and Sweden) have begun to internationalize their R&D activities. Especially interesting is the dramatic growth of the share of firms from Japan and the newly industrialising countries of the Asia Pacific region, while that of Australian and New Zealand firms has declined in importance.

Unfortunately, the data do not allow us to test this convergence hypothesis more rigorously. Although the casual evidence does suggest that while the convergence argument is persuasive in explaining the phenomenon of growth of MNE R&D in the United States, there are undoubtedly other factors at work. A case in point is that of Canadian MNEs which have continued to relocate an increasing extent of R&D to the United States. Pearce (1989) notes that, in the 1980s, Canadian MNEs had a tendency to relocate not just their production but their other value-adding activities to their largest market; and, with the conclusion of the US-Canada free trade agreement and NAFTA, this trend has almost certainly been exacerbated.

***TABLE 5 HERE***

How R&D-Intensive is FDI in the United States?

Trends by home country

We now turn to consider the R&D intensity of FDI in the United States and how it has changed over the years. To what extent is any change in such intensity a result of the growth of its sales - i.e., is the growth of R&D intensity sequential to the growth of sales of foreign affiliates in the United States? As we have argued earlier, if an MNE expands its U.S. production, it is reasonable to expect that at least some growth in R&D activity will occur - at least of Type 1, if not of Types 2 and 3.
Table 5 sets out some details of the average R&D intensities of MNEs from the major host countries. R&D intensity is defined as the proportion of R&D expenditure to total sales. The table reveals that, on average, the R&D intensity of foreign affiliates has doubled over the 1980s. Again however, there are significant country differences. In the case of Canadian MNEs, apart from the sudden rise in the R&D intensity due to the Dupont deal, the R&D intensity stayed more or less constant over the period under discussion. *Inter alia*, this suggests that Canadian FDI is primarily of the market- or resource-seeking, i.e., of the asset-exploiting variety. The most significant growth in R&D intensity has been associated with French, Swedish, Japanese and Asia-Pacific MNEs, while Germany, UK, and Swiss foreign affiliates have experienced only modest increases in their R&D intensity. Interestingly, the Netherlands’ MNEs have shown no growth in their R&D intensity during the entire period.

Taken together with the data on new investment - and particularly that likely to be associated with M&A activity - the R&D expenditure figures suggest that the increase in FDI by French, Japanese, NICs, Swedish, German and British companies may, at least to some extent, be accounted for by growth in Type 4 R&D, i.e., strategic asset-seeking FDI. However, such a high level of aggregation of data cannot take us much further; and the following section examines the evidence in greater industrial detail.

Table 5 also reveals that, despite the increase in the R&D intensity of foreign affiliates of most countries, with the exception of Swiss-owned firms, their aggregate R&D intensities are less than half of that of all U.S. firms in 1990.15

***TABLE 6 HERE***

To what extent is the growth of foreign-owned R&D explainable by factors associated with the growth of U.S. R&D in general? It might be that R&D by all firms operating in the United States show a similar trend due to U.S.-specific characteristics, such as policy incentives or similar stimuli to R&D. Table 6 provides confirmation that the real growth rate of non-defense U.S. R&D expenditures is very much lower than its equivalent growth rate of foreign owned R&D in the United States. What next of the suggestion that the growth of R&D expenditures of MNEs in the United States is associated with the growth and convergence of innovative activity among the other major industrial countries? Here the hypothesis is that growth of MNE R&D in the United States may be related to domestic R&D growth in its home country. Table 6 also gives details of the growth of real domestic R&D expenditures of some
major home countries. Once again, there seems to be no clear evidence that this might be the case. For all the countries in our sample, the growth of the R&D expenditures by foreign affiliates in the United States is much greater than the growth of all R&D activities in the home countries of their parent companies.

Industrial distribution

Tables 7 and 8 provide details of the industrial distribution of foreign-owned R&D and that of the total sales of foreign affiliates for several years, and also the real annual growth rates over several periods. An interesting feature illustrated by the data presented in these tables is the steadily increasing share of both R&D and sales accounted for by manufacturing industries. This suggests that foreign affiliates in the United States have, over the past decade or so, had become steadily more competitive vis-à-vis their domestic counterparts, and have expanded into market-seeking investments. Table 7 and 8 also show that foreign-owned R&D expenditures in manufacturing have overall been growing faster than have the sales of these firms. This suggests that the production of these firms are being directed towards higher value-added activities, and that their subsidiaries are moving away from a trade-supportive role to a market-seeking one. Concurrently, their R&D activities have begun to move towards Type 2 and Type 3, away from Type 1.

***TABLE 7,8,9 HERE***

Again however, given their aggregate nature, these figures should be treated with great caution. In terms of industrial distribution, the chemical industry has been responsible for the greatest share of R&D expenditure which has remained relatively constant over time - it accounted for 51.8 percent of all MNE R&D in 1977 and 45.5 percent in 1990. Indeed, in 1989, MNE R&D expenditures in industrial chemicals and pharmaceuticals accounted for 57.2 percent and 34.1 percent of all U.S. non-federally funded industrial R&D in those two subsectors. It is interesting to note that, in both these subsectors, the United States does not possess a technological advantage, vis-à-vis the home countries of the major investing firms such as the UK, Germany and Switzerland (Cantwell 1991). Indeed, these are the only sectors in which the R&D intensity of MNEs in the United States is higher than the R&D intensity of all firms in the United States (Table 9). A recent OECD (1992) report suggests that foreign firms were responsible for 34 percent of the sales in the chemicals sector in 1989.
Apart from the chemical sector, the sales of foreign manufacturing affiliates grew fastest in the electrical equipment, primary and fabricated metal industries and transportation sectors in the 1980s. On the other hand, Table 9 reveals that the R&D intensities in these sectors have been much lower than that of all U.S. firms; and, with the exception of the electrical equipment sector, have shown no sign of catching up, despite an initial high growth period in the late 1970’s and early 1980’s. Possibly the main reason for this fact is that much of the growth of sales in these sectors has been in fairly low value activity, especially by Japanese MNEs. The electrical equipment and instruments sectors have shown the greatest increase in their R&D intensity; and in the case of the former, the R&D intensity of foreign-owned firms has caught up with that of indigenous competitors. This deepening of the value chain of foreign-owned affiliates partly reflects the growing maturity of greenfield investments (and particularly those of Japanese origin\textsuperscript{16}), and partly the acquisition of U.S. owned assets by foreign MNEs.

**Testing some Explanations**

We now turn to examine a number of explanations for the pattern and growth of R&D expenditures in the United States by foreign-owned firms. In particular we explore the validity of some simple hypotheses. The small sample sizes associated with the data on foreign-owned R&D activity, both in terms of industrial breakdown as well as in the number of years for which comparable data is available, precludes any sophisticated statistical testing of these hypotheses. The hypotheses proposed here are complementary in several respects:

**Hypothesis 1.** Foreign MNEs invest in U.S. R&D facilities in order to strengthen their global competitive position; and they would favor sectors in which the host country (i.e., the United States) has a relative competitive advantage in innovative activity.

**Hypothesis 2.** Foreign MNEs invest in U.S. R&D facilities in order to support their U.S. production facilities, and would favor sectors in which the United States has location advantages. In other words, their investment in R&D facilities will reflect the strength of the competitive advantage of their parent companies.

Our dependent variable is the share of U.S. R&D activities accounted for by foreign firms (SHRD). We seek to examine the correlation between SHRD and two independent variables individually - revealed technological advantage (RTA)\textsuperscript{17} and revealed comparative
advantage (RCA) of the United States, for two periods, 1977 and 1990, and 11 sectors. RCA provides a measure of the attractiveness of the L advantages of the United States from the point of view of production (asset-exploiting FDI), indicating the overall competitiveness of the United States vis-à-vis its major trading partners. If SHRD and RCA prove to be positively correlated, it would provide support for Hypothesis 1, that is, suggesting that investment in R&D was asset-seeking in nature. However, if the correlation provided a negative result, it would suggest that foreign MNEs invest in U.S. R&D facilities not to strengthen their competitive position by taking advantage of U.S. competitive advantages, but to exploit existing competitive advantages associated with their parent companies (i.e., R&D supportive of asset-exploiting investment), thereby supporting Hypothesis 2.

However, RTA is a more specific measure of the L advantages associated with high value-added activities, or in other words, its competitiveness as a center of innovation. In the case of a negative correlation between RTA and SHRD, this would also suggest support for Hypothesis 2, that is, that the R&D activities of foreign firms were directed towards those sectors where the United States had a revealed disadvantage as a center for innovation, and that these firms were simply seeking to exploit other L advantages associated with the United States in conjunction with the O advantages of their parent companies, while a positive correlation would suggest that the R&D activities of foreign firms was directed towards industries in which the United States was competitive as a center of innovation.

We wish to highlight two limitations of this analysis: the propensity for foreign firms to invest in U.S. R&D facilities is determined not just by the host country-specific characteristics relative to its major competitors, as we have assumed in the analysis conducted here. Firstly, the propensity to engage in FDI is affected by the competitive advantages of the host country relative to the home country, i.e., on a bilateral basis. Secondly, as MNEs become globalized in their value added activity, their O advantages become increasingly firm-specific rather than country-specific (Narula 1993b). Data limitations prevent us from exploring these issues within the scope of the present paper.

However, it is important to note that the propensity of foreign firms to engage in both R&D and in other value-added activities in the United States varies across industries. Certain sectors are less amenable to internationalization than others. Research (described in Dunning 1993) suggests that the technology-intensive sectors are among the most internationalized in
their production. It is thus not unreasonable to infer that SHRD will tend to be greater in sectors in which the share of foreign to global sales or assets is highest.

**Hypothesis 3.** The degree of multinationalization of production by MNEs, as measured by the share of foreign production in particular sectors by the largest MNEs (CONC), is positively correlated with the share of U.S. R&D expenditures accounted for by foreign firms (SHRD).

The implication of a positive correlation for Hypothesis 3 is that foreign-owned R&D activities in the United States take the form of a deepening of production activities, and that the growth of R&D activities in the United States by foreign firms follows in the wake of production; while a negative correlation would suggest that the R&D activities of foreign firms are in different sectors than those in which lower value-added activities of these firms would ordinarily have been - that is, R&D activities of foreign firms is not necessarily sequential to the growth of their U.S. production activities, and may indeed be asset-seeking in nature, rather than asset-exploiting.

Table 10 summarizes the results of the rank correlations. Given the small sample size and the aggregate nature of the industrial sectors, these results are extremely tentative in nature. The sign of the correlation between RCA and SHRD in both periods is negative, and are almost identical in value and significant at the 5 percent level for 1990. This would suggest that R&D activities of foreign firms as a share of all R&D in the United States tends to be highest in those sectors where the competitive advantages of the United States are low, relative to its competitors. This then supports Hypothesis 2 and rejects Hypothesis 1 for both periods. Given the relatively high value for both periods, and the fact that while SHRD has grown for all industries over that period, while RCA has declined or stayed constant for all industries except primary metals and petroleum, we must conclude that the L advantages associated with U.S. based production have declined, and that the growth of R&D by foreign firms is primarily geared at exploiting competitive advantages associated with their parent companies. Such a result may be considered to be counter-intuitive, since declining L advantages, should, ceteris paribus, lead to declining foreign participation in U.S. industry. However, RCA does not measure a very important “exogenous” L advantage associated with the US- that of its market size.19

**TABLE 10 HERE**
The signs for RTA when correlated against SHRD in both periods are negative, and although the results are insignificant, they do provide some support to Hypothesis 2. Although the negative signs suggest that the high share of U.S. R&D activities accounted for by foreign firms are associated with the high competitive advantages of their parent companies, the fact that the value of the correlation has declined between 1977 and 1990, and that the RTA of the United States has improved or stayed constant in 8 of the 11 industries suggests that at least some of the increase in the share of foreign firms of total U.S. R&D activity may have been associated with the L advantages of the United States as a center of innovation. In other words, not all the growth of SHRD can be said to be associated with asset-exploiting FDI. However, the low values of the correlation in the case of RTA suggests that this varies across industries, and that, given the small sample size and the high extent of industrial aggregation, the results must be regarded as inconclusive.

The correlation coefficients between CONC and SHRD provide some further support to this argument: As can be seen from Table 10, the results for both years are positive, but not significant. This suggests that MNEs in industries which are more highly internationalized have a higher share of U.S. R&D activities controlled by foreign firms. However, the decline in the value of the correlation indicate that over time, the R&D activities of these firms have become more evenly distributed across industries, and that investment in R&D facilities is being directed towards sectors in which production has not traditionally been internationalized. Taken together with the RTA correlations, they suggest that the growth in R&D activities of foreign firms in the United States has been associated with both asset-seeking and asset-exploiting types of investment, something that might very well be expected as the international value-added activities of MNEs become increasingly integrated (UN 1993).

Although the data examined here are of a tentative and general nature, they do point to the continuing dominance of R&D activities of Types 1, 2 and 3 among foreign MNEs located in the US; and these, as we have already argued, are primarily geared to exploiting the existing assets of the investing companies, or those associated with the multinationality of such. However, these data also indicate that while the extent of strategic asset-seeking R&D by the US subsidiaries is not as yet of major consequence, there is some evidence to suggest that this is a growing trend. A greater industrial dissagregagation of the data is needed if we are to properly examine this small but growing phenomenon. For instance, three of the sectors in
which the United States has attracted considerable amount of foreign investment in R&D, that is, computers, semiconductors and bio-technology, are those in which the United States continues to enjoy a comparative and technological advantage. However, as Wortmann (1990) and Mowery and Teece (1993) point out, R&D investment in these sectors, especially by large European and Japanese MNEs, is often in high technology start-up firms, or in basic research laboratories. Such investments, although highly R&D intensive in themselves, when aggregated with the relatively large production activities of other U.S. affiliates of foreign MNEs, conceal the significance of these R&D investments. Another limitation of this analysis is that the use of R&D expenditures as a proxy for assets does not allow us to measure the technological or economic significance of R&D activities, since adaptive research may be more expensive than research of a more fundamental or basic nature.

However, it is important to note that, apart from the limitations due to the aggregate nature of these data, we have only examined the R&D activities financed by foreign direct investment. This caveat is an important one, in that there have been a growing extent of inter-firm R&D pacts and other forms of strategic alliances, especially in new technologies. Hagedoorn (1993), for example, estimates that 41.8 percent of of strategic technology alliances in core technologies worldwide took the form of R&D pacts between 1980 and 1989, compared to 16.3 percent through minority direct investment, and 29.2 percent through R&D joint ventures.

Conclusions

The data presented in this paper reveal that not only is the R&D intensity of foreign owned production in the United States increasing, but it is generally doing so at a faster rate than that of indigenous firms. The conclusions of the analyses conducted above are partly consistent with the hypothesis that non-U.S. MNEs are improving their competitive position (i.e., O-specific advantages) relative to U.S. firms in global markets, and, in doing so, are increasing their share of U.S.-based higher value-added activities. To a lesser extent, they are also supportive of the proposition that foreign enterprises are acquiring existing U.S. R&D facilities to protect and enhance their regional and global competitive positions.

Taken together with the data on outward investment in R&D facilities by U.S. MNE and of intra-Triad MNE activity by non-U.S. firms, we are persuaded that the growing R&D intensity of FDI in the United States is part of a global phenomena. These phenomena
essentially reflect the perceived need of leading MNEs in the technology-intensive sectors to establish an R&D-acquiring presence in the leading industrial markets of the world, and also to deepen their value-added activities in those locations that offer the most favorable complementary assets to the regional or global exploitation of the innovatory advantages they possess.

The geographical distribution of R&D activities by MNEs tends to be more concentrated than that of other forms of FDI. The evidence from the United States which is backed up from that in Europe and Japan (OECD 1992) suggests that MNEs have facilitated the convergence in the deployment of R&D expenditures - at least within the industrial nations of the world. At the same time, by their acquisition strategies in the United States and Europe, MNEs from developing countries are seeking to diversify the location of their R&D activity; and in so doing are assisting their own economies to upgrade their indigenous resources and capabilities, without surrendering them to foreign control.

It is regrettable that there are little systematic data on the R&D activities of foreign MNEs in Europe and Japan; but, in principle, we would expect the trends and patterns to be broadly similar to those described here. This is because the global economy is forcing a gradual dispersal of high value activity among the larger industrial regions or areas; and in order for the leading industrial enterprises to contribute towards and to benefit fully from this trend, they need to have a innovatory presence in each of the main centers of R&D excellence. To this extent, the Knickerbocker thesis of the 1960’s (Knickerbocker 1973) that firms invest in production facilities abroad as part of a “follow my leader” strategy to protect their regional and global market positions, makes a great deal of sense in explaining what is now prompting the geographical restructuring of R&D activities by MNEs.

The history of the past half century has shown that a gradual evolution in the trade and FDI patterns of the major economic powers. A foremost feature of this evolution has been the relatively faster growth of both intra-industry trade and intra-industry FDI. But it is only since the late 1970’s that one has seen a marked increase in intra-industry FDI in R&D activities. Nevertheless, it is important to note that the growth of international R&D activities over the past two decades by MNEs seeking to acquire assets has increasingly been undertaken through strategic technology alliances. However, this mode of undertaking overseas R&D represents not so much an alternative to R&D through FDI, as a complement to it.
Insofar as the forces leading to the deepening of the value-added of international production viz, technological advances, the liberalisation of markets and economic integration, seem likely to continue in the 1990s, it may be reasonable to expect both the geographical ownership of R&D activity to become more dispersed, and the percentage of that activity undertaken by the foreign subsidiaries of MNEs to grow. We would also expect that the type of R&D financed by FDI will veer towards the efficiency and strategic asset seeking kind as MNEs increasingly view the organisation and location of their innovatory activities as part and parcel of a regional or globally integrated production system (UN 1993). So far, only a handful of companies, e.g., IBM, Ciba Geigy, Bayer and ICI are pursuing this approach, but many others are currently revamping the structure of their R&D systems (Perrino and Tipping 1989).

The United States, in particular, is likely to prove an increasingly attractive location for the innovatory activities of foreign-based firms as it offers some of the best technological infrastructure and opportunities in the world. At the same time, it is to be expected that U.S. MNEs will engage in more strategic asset-seeking R&D activity, especially in the EC and Japan as these regions upgrade their own technological capabilities. Economic integration in Asia and the Pacific and the Americas may also be expected to lead to an increase in Type 3 R&D by MNEs, as well as technological strategic alliances. In short, the 1990s should bring both an increase in the cross-border integration of innovatory activities, and an intensification of the R&D component of intra-industry trade and FDI.
Notes

1. As described in some detail in Dunning (1993).
2. For example, in 1940, some 80 percent of the patents registered in the United States were accounted for by U.S.-based firms.
3. Exceptions include that of R&D activities in Canada and Germany. See for example Alexander (1983) and Dorrenbacher and Wortmann (1991) and Wortmann (1990).
6. This typology is similar to that of Hood and Young (1982) and Ronstadt (1977). For a review of the alternative classifications, see Pearce (1989).
7. As was first demonstrated by Ronstadt (1977).
8. This point is best illustrated in Westney (1993).
9. Inter alia this reflects the relatively faster growth of domestic R&D by Japanese firms vis-à-vis their main foreign competitors.
10. NSF data on R&D includes petroleum refining and extraction as a manufacturing sector, while Department of Commerce data on MNEs in the United States have considered it separately. We have tried to follow the Department of Commerce classification but, as might be expected, this presents certain difficulties in comparing the data. However, although petroleum is not included in manufacturing, it is not included as a non-manufacturing sector either. Non-manufacturing is taken to include wholesale and retail trading, services, mining, finance and real estate.
12. Many of the U.S. assets of UK companies had been sold during 1939-50 period to help pay for Britain’s Second World War debt.
15. It should be noted that our R&D intensities calculated for MNEs may be much lower given that we have used total sales instead of manufacturing sales, even though R&D is primarily associated with manufacturing and petroleum. The figures for total U.S. R&D intensities used throughout this paper are not strictly comparable as they are based on the manufacturing sector, and are used here for illustrative purposes. However, we are constrained by the availability of data.
16. As for example shown by the greater local content to total sales ratio of Japanese affiliates in the auto and electrical equipment sectors during the latter half of the 1980s.
17. RCA is defined as follows:

\[ \text{RCA}_{ij}(X) = \frac{X_{ij}}{\sum_j X_{ij}} / \left( \frac{\sum_i X_{ij}}{\sum_i \sum_j X_{ij}} \right) \]
The revealed comparative advantage for an industry $i$ for a country $j$ is denoted by $RCA_{ij}(X)$, while the value of exports of industry $i$ from country $j$ is denoted by $X_{ij}$. A value greater than one indicates that a country is advantaged in that industry, and less than one the country is disadvantaged in the sector in question. We have calculated RCA relative to the major economic partners of the United States: UK, France, Germany, Japan, Sweden, Norway, Denmark, Netherlands, Belgium, Italy, Switzerland and Canada. We are grateful to Bart Verspagen of MERIT for providing us with the data for this section.

18. RTA is defined as follows:
$$RTA_{ij} = \left( P_{ij} / \sum_j P_{ij} \right) / \left( \sum_i P_{ij} / \sum_i \sum_j P_{ij} \right)$$
The revealed comparative advantage for an industry $i$ for a country $j$ is denoted by $RTA_{ij}$, while the value of patents of industry $i$ from country $j$ is denoted by $P_{ij}$. A value greater than one indicates that a country is advantaged in that industry, and less than one the country is disadvantaged in the sector in question.

19 See Narula (1993b).
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