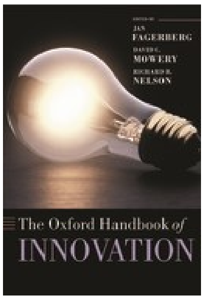

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CHAPTER

12 Globalization of Innovation: The Role of Multinational Enterprises

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Abstract

Economic globalization implies a growing interdependence of locations and economic units across countries and regions. Technological change and multinational enterprises (MNEs) are among the primary driving forces of this process. This article attempts to evaluate the changing extent and importance of MNEs as conduits for cross-border knowledge flows. MNEs affect the development and diffusion of innovations across national borders through a number of mechanisms, among which FDI (through which MNEs acquire existing assets abroad or set-up new wholly or majority owned activities in foreign markets) is only one. International knowledge flows also move through trade, licensing, cross-patenting activities, and international technological and scientific collaborations. These other modalities involve a wide variety of economic actors, but the MNE occupies a central role among these actors. This article emphasizes the MNE's multifaceted role in the more general process of the globalization of innovation.

Keywords: economic globalization, technological change, multinational enterprises, national borders, FDI

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12.1 Introduction

ECONOMIC globalization implies a growing interdependence of locations and economic units across countries and regions. Technological change and multinational enterprises (MNEs) are among the primary driving forces of this process. In this chapter we attempt to evaluate the changing extent and importance of MNEs as conduits for cross-border knowledge flows.

MNEs affect the development and diffusion of innovations across national borders through a number of mechanisms, among which FDI (through which MNEs acquire existing assets abroad or set-up new wholly or majority owned activities in foreign markets) is only one. International knowledge flows also move

p. 319 through trade, licensing, cross-patenting activities, and international technological ↳ and scientific collaborations. These other modalities involve a wide variety of economic actors, but the MNE occupies a central role among these actors. This chapter emphasizes the MNE's multifaceted role in the more general process of globalization of innovation.

12.2 Trends in the Internationalization of Innovative Activities

A useful taxonomy proposed by Archibugi and Michie (1995) identifies three main categories of the globalization of innovation (Table 12.1). Although a variety of economic actors undertake innovation and are engaged in its internationalization, the MNE is the only institution which by definition can carry out and control the global generation of innovation within its boundaries. We briefly discuss each of the three categories below.

12.2.1 The Cross-Border Commercialization of National Technology

The first category involves national and multinational firms as well as individuals engaged in the international commercialization of technology developed at "home." Key indicators of these activities are international trade flows and cross border patenting, both of which are responsible for growing levels of global transfer of technology.

The share of high-tech products (including electrical and electronic equipment, aerospace products, precision instruments, fine chemicals and pharmaceuticals) in world exports rose from 8 per cent in 1976 to 23 per cent in 2000. Exports of information and communications technology products showed the highest annual growth rate among all products in 1985–2000 (UNCTAD2002: 146–7). The rise in the share of world trade represented by R&D-intensive sectors suggests that the globalization of technology flows is increasing.[1]

Table 12.2 reveals a growth in the "internationalization" of patenting: the share of non-resident patenting
p. 320 in virtually all OECD economies has grown during the 1980s ↳ and early 1990s, and external patenting (i.e. patent applications of national inventors abroad) has also rapidly increased.

Table 12.1 A taxonomy of the globalization of innovation

Categories	Actors	Forms
International Exploitation of Nationally Produced Innovations	Profit-seeking (national and multinational) firms and individuals	Exports of innovative goods. Cession of licenses and patents. Foreign production of innovative goods internally designed and developed.
Global Generation of Innovations	MNEs	R&D and innovative activities both in the home and the host countries. Acquisitions of existing R&D laboratories or green-field R&D investment in host countries.
Global Techno-Scientific Collaborations	Universities and Public Research Centers	Joint scientific projects. Scientific exchanges, sabbatical years. International flows of students.
	National and Multinational Firms	Joint ventures for specific innovative projects. Productive agreements with exchange of technical information and/or equipment.

Source: elaboration on Archibugi and Michie 1995.

12.2.2 Technological and Scientific Collaborations

Domestic and international technical and scientific collaborations involve both private and public institutions, including national and multinational firms, universities and research centers. Since the 1970s, the use by industrial firms of "non-internal" options that include cooperation with competitors, suppliers, customers, and other external institutions (e.g. universities), which we denote as strategic technology
p. 321 partnering (STP), has grown. Available indicators of international STP ↳

p. 322 ↳

have a number of well-known drawbacks due to the quality of data available.[2] In spite of these drawbacks, there is a general agreement in the literature that global inter-firm alliances have become increasingly popular over the past two decades (Hagedoorn 2002; see also Ch. 3 by Powell and Grodal, this volume).[3] International STP has grown considerably in absolute terms, although its share of all STP has remained steady in the 1970s and 1980s, oscillating around 60 per cent of all agreements, while the share has declined in the 1990s to about 50 per cent (Hagedoorn 2002). There has also been a gradual shift in the types of agreements favored by firms over time, according to the MERIT-CATI database. The percentage of equity agreements in the total has declined from about 70 per cent to less than 10 per cent between the mid-1970s and the end of the 1990s. The increasing share of non-equity alliances may indicate growing use by MNEs of STPs as relatively rapid, short-term vehicles to gain access to non-domestic knowledge sources (see Section 12.5 for further discussion).

Table 12.2 Rates of growth of industrial R&D and patenting in the OECD countries

Countries	Average annual rates of change (per cent)							
	Industrial R&D (1)		Resident patents (2)		Non-resident patents (3)		External patents (4)	
	1970–80	1985–95	1970–80	1984–94	1970–80	1984–94	1970–80	1985–95
United States	2.0	1.3	−2.0	5.7	5.0	6.6	−0.6	15.6
Japan	6.1	5.4[e]	5.1	2.2	−0.8	5.1	5.5	8.3
Germany	4.9[a]	1.1	−0.7	1.4	0.8	4.6	1.7	8.0
France	3.7	3.2	−2.4	1.0	0.2	5.3	3.0	8.4
United Kingdom	3.0[b]	0.3[e]	−2.4	−0.4	0.8	4.8	−1.7	16.2
Italy	3.6	−0.5	n.a.	2.5[l]	n.a.	3.8	1.8	10.3
Netherlands	1.4	3.3[e]	−2.1	−1.5	1.5	6.8	0.1	14.1
Belgium	6.7[c]	1.7[f]	−3.0	−1.6	−0.1	7.7	0.5	13.4
Denmark	3.8	7.4[g]	1.7	3.0	−0.3	19.9	1.0	22.5
Spain	12.7	1.8[e]	−4.5	2.0	0.2	19.2	1.3	16.0
Ireland	5.2[c]	15.4	6.8	2.3	4.9	31.1	6.7	24.3
Portugal	4.6[d]	2.2[h]	−6.4	0.9	−0.5	37.2	−24.2	52.4
Greece	n.a.	−1.4[i]	−0.8	−13.4[m]	2.4	37.0	n.a.	21.5
Sweden	5.9[c]	0.2[g]	−0.5	0.0	2.5	7.1	3.0	14.2
Austria	9.8[a]	5.1[g]	0.3	−1.6	3.4	9.0	1.4	10.1
Finland	6.8[c]	5.1	4.7	2.7	0.7	13.4	5.7	23.1
Switzerland	0.8[a]	−0.5[l]	−3.1	−1.5	2.2	7.8	−1.3	5.5
Norway	7.3	1.3[g]	−2.7	0.9	−0.1	11.1	0.8	21.1

Australia	n.a.	8.9[e]	5.2	1.5	−2.0	7.5	6.7	21.7
Canada	5.5	4.9	−1.1	2.2	−2.1	4.5	−0.5	21.5
OECD weighted average	n.a.	n.a.	1.3	2.7	0.9	9.3	0.9	13.3

Notes: n.a. = not available

a 1970–81

b 1972–81

c 1971–81

d 1971–80

e 1985–94

f 1985–91

g 1985–93

h 1986–92

i 1986–93

(1) Million $US at 1995 PPP

l 1992–94

m 1984–93

(2) Resident patents: inventors in their home country

(3) Non-resident patents: foreign inventors in the country

(4) External patents: national inventors patenting abroad

Source: Archibugi and Iammarino (2002) based on OECD, MSTI, various years.

STP agreements appear to be most common in the domain of new materials, biotechnology and information technology, and largely involve Triad economies rather than developing economies. Developed-country firms participate in 99 per cent of the STP agreements in the MERIT-CATI dataset (Hagedoorn 2002). Although R&D and manufacturing outsourcing agreements with developing-country firms have expanded in number during the last two decades, the share of these firms in STP has remained around 5–6 per cent since the 1990s (Narula and Sadowski 2002). Seventy per cent of all STP since the 1960s have had at least one US partner, with collaborations between European and North American firms increasing from 18.5 to 25.2 per cent of overall technological alliances between the 1970s and the 1990s (Hagedoorn 2002).

12.2.3 The Role of MNEs in the Cross-Border Generation of Innovation

The globalization of innovation has been associated with growth in MNE activity and FDI since World War II. FDI stocks as a percentage of GDP[4] stood at 21.46 per cent in 2001, up from just 6.79 per cent in 1982 (Table 12.3). Furthermore, MNEs engage in considerable intra- and inter-firm trade (Table 12.3). The primary source of outbound FDI—almost 90 per cent of the total in 2001—continues to be the industrialized countries. The EU accounted for the largest share of outward FDI, with Netherlands, UK, France, and Germany accounting for fully 41.3 per cent of all outward FDI stock from the developed world. Around 68 per cent of inward FDI is also directed towards Triad countries. The developing economies' increase in the share of inward FDI during the period 1982–2001 is almost entirely due to a small group of developing countries, primarily the Asian NICs and China.

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Table 12.3 Selected indicators of FDI and international production, 1982–2001 ($US Billion at current prices and percentage values)

	1982	2001
FDI inflows	59	735
FDI outflows	28	621
FDI inward stock	734	6846
FDI outward stock	552	6582
Sales of foreign affiliates	2541	18517
Gross product of foreign affiliates	594	3495
Total assets of foreign affiliates	1959	24952
Exports of foreign affiliates	670	2600
Employment of foreign affiliates (thousands)	17987	53581
Inward FDI stocks to GDP ratio	6,79%	21,46%
Foreign affiliates' export to total exports	32,20%	34,99%

Source: UNCTAD, based on its FDI/TNC database and UNCTAD estimates.

The figures for R&D activity reflect similar patterns, since many of the largest firms engaged in FDI are key actors in the generation and diffusion of innovation. More than one-third of the top 100 MNEs are active in the most R&D-intensive industries, such as electronics and electrical equipment, pharmaceuticals, chemicals (UNCTAD 2002). Furthermore, large MNEs play a dominant role in the innovative activities of their home countries. For instance, Siemens, Bayer and Hoechst performed 18 per cent of the total manufacturing R&D expenditures in Germany in 1994 (Kumar, 1998). In 1997 three MNEs accounted for more than the 30 per cent of the overall UK R&D investment in manufacturing. These same MNEs also undertake a growing share of their total R&D activities outside their home countries.

Significant cross-national differences are also apparent in indicators of international R&D. The share of national R&D expenditures accounted for by non-domestic sources varies substantially within the industrialized and developing areas (see Table 12.4 for some details). The origins of international R&D investment flows also differ considerably among industrialized economies (Table 12.5). Cantwell (1995) suggests that countries such as Switzerland, UK, and the Netherlands, which have historically been home to large MNEs and that were long-time international investors in R&D, have greatly expanded their offshore R&D investments since World War II. Another group of countries (such as France and Germany) has
p. 324 relatively few large MNEs, and their outward R&D investments have grown more ↳ gradually during the last eighty years. A third group includes countries that were major investors in offshore R&D during the first fourteen years of the twentieth century. Offshore investment by these economies actually declined after
p. 325 1914 and returned to pre-World War I levels only recently. This group includes the United ↳ States, home of a number of MNEs which have a relatively low proportion of their R&D and patenting activity abroad.[5]

Table 12.4 R&D expenditure of foreign affiliates as a percentage of total R&D expenditures by all firms in selected host economies, 1998 or latest year

Country	Percentage of R & D
Canada	34.2
Finland (1999)	14.9
France	16.4
Japan	1.7
Netherlands	21.8
Spain (1999)	32.8
UK (1999)	31.2
US	14.9
Czech Republic (1999)	6.4
Hungary	78.5
India (1994)	1.6
Turkey	10.1

Source: UNCTAD (2002), table I.10.

Table 12.5 Shares of US patenting of largest nationally owned industrial firms due to research located abroad, 1920–1990 (%)

	1920–1939	1940–1968	1969–1990
US	6.81	3.57	6.82
Europe	12.03	26.65	27.13
UK	27.71	41.95	43.17
Germany	4.03	8.68	13.72
Italy	29.03	24.76	14.24
France	3.35	8.19	9.55
Sweden	31.04	13.18	25.51
Netherlands	15.57	29.51	52.97

Source: Cantwell (1995).

On average, firms from EU countries obtain a larger share of patents from their foreign subsidiaries than is true of US or Japanese companies (Table 12.6). During the 1969–95 period, the share of total patents of EU firms attributable to foreign affiliates grew from 26.3 to 32.5 per cent. European firms tend to concentrate a considerable share of their international R&D activities in the US (over 50 per cent of their foreign R&D investment on average, with German, British, and Swiss firms showing the highest concentration of their foreign activities in the United States). The foreign patenting activity of US firms also increased during this period, but remained below 10 per cent.[6] Although US foreign R&D activities are relatively low compared to EU firms, they are much larger than Japanese companies, whose offshore patenting declined from 2.1 per cent in 1969–77 to approximately 1 per cent of their total patenting activity in 1987–95.

Overall, MNEs have increasingly internationalized their innovative activities, with a few relevant exceptions (most notably, Japanese MNEs). The importance of R&D activities of foreign affiliates has grown in most host economies over the 1990s. R&D by foreign firms is especially high in the UK, Ireland, Spain, Hungary, and Canada, and lowest in Japan, with other countries (including the US, France, and Sweden) in intermediate positions. Nevertheless, most R&D and patenting activities are still largely concentrated in the MNEs' home countries, and in a few host countries. Well over 90 per cent of the R&D expenditures of most p. 326 MNEs is located ↳ within the Triad.[7] While there are significant differences in the international dispersion of innovative activity across industries, firms have generally not internationalized their innovative activity at the same rate as their production activities. Exceptions to this rule are MNEs originating from small economies, such as Belgium, the Netherlands, and Switzerland. A large proportion of even the most internationalized MNEs concentrate at home their more "strategic" activities, such as R&D and headquarters functions (Benito et al. 2003).

Table 12.6 Share of US patents of the world's largest firms attributable to research in foreign locations by main area of origin of parent firms, 1969–1995 (%)

Nationality of parent firm	1969–77	1978–86	1987–95
US	5.4	6.9	8.3
Japan	2.1	1.2	1.0
European countries[a]	26.3	25.6	32.5
Total all countries[b]	10.3	10.7	11.3
Total all countries excluding Japan	11.1	13.0	16.2

Notes:

a Germany, UK, Italy, France, Netherlands, Belgium, Luxembourg, Switzerland, Sweden, Denmark, Ireland, Spain, Portugal, Greece, Austria, Norway, Finland.

b Total includes all the 784 world's largest firms recorded by the University of Reading database, base year 1984.

Source: Cantwell and Janne (2000).

This relatively low—but increasing—degree of internationalization is associated *inter alia* with the complex nature of systems of innovation, and the embeddedness of the MNE's activities in the home environment (see e.g. Narula 2002*a*), the need for internal cohesion within the MNE (Blanc and Sierra 1999, Zanfei 2000), and the high quality of local infrastructures and appropriability regimes that R&D activities tend to require. These factors, together with the difficulties of managing complex technological portfolios, imply that the internationalization of innovation occurs at a slower pace than the internationalization of production.

12.3 Overseas Innovative Activities of MNEs: Theoretical and Empirical Issues

The extensive literature on international R&D investment highlights two broad firm-level motives. First, firms internationalize their R&D to improve the way in which existing assets are utilized. That is, firms seek to promote the use of their technological assets in conjunction with, or in response to, specific foreign locational conditions. This has been dubbed as asset-exploiting R&D (Dunning and Narula 1995) or home-base exploiting (HBE) activity[8] (Kuemmerle 1996). For example, some modification in these firms' products or processes may be necessary to make them competitive in the relevant foreign market. This type of offshore R&D investment typically is based on the technological advantages of the source firm, which in turn reflect those of its home country.

Asset-exploiting strategies correspond to traditional views of the organization of innovative activities and foreign direct investment, many of which were rooted in the "product life cycle" theory of such investment. Referring mainly to US-based multinationals, Vernon (1966), Kindleberger (1969), and Stopford and Wells
p. 327 (1972) suggested that an MNE's foreign subsidiary replicated the parent's non-strategic ↳ activities abroad, with strategic decisions—including R&D and innovation—being rigidly centralized in the home country. Vernon emphasized that coordinating international innovative activities was too costly, due to the

difficulties of collecting and controlling relevant information across national borders. The R&D activities of foreign subsidiaries were limited largely to the adoption and diffusion of centrally created technology.

The second broad motive for offshore R&D investment is strategic assetaugmenting activity (Dunning and Narula 1995), also known as home-base augmenting (HBA) activity (Kuemmerle 1996). Firms use these types of R&D investments to improve existing assets or to acquire (and internalize) or create completely new technological assets through foreign-located R&D. The assumption in such cases is that the foreign location provides access to *complementary* location-specific advantages that are less available in its primary or "home" base (Ietto-Gillies 2001). In many cases, the strategic assets sought by the investing firm are associated with the presence of other firms. A location which is home to a major competitor may attract asset-augmenting investments by other firms in the same or in other related industries (see Cantwell in this volume on the implications of these patterns of FDI for the competitiveness of host countries). Asset-augmenting motives and technology sourcing have been partially incorporated in formal models of the FDI decision.[9]

The asset-augmenting perspective, which considers local contexts more as sources of competencies and of technological opportunities, and less as constraints to the action of MNEs, marks a fundamental departure from the conventional wisdom. In a seminal contribution, Hedlund (1986: 20–1) caught the essence of this new way of conceptualizing the role of local contexts: "The main idea is that the foundations of competitive advantage no longer reside in any one country, but in many. New ideas and products may come up in many different countries and later be exploited on a global scale." (See Kogut 1989 for a similar view.)

There are several reasons why such asset-augmenting R&D activities are hard to achieve through means other than FDI. Some of these reasons are associated with the nature of technology. When the knowledge relevant for innovative activities is clustered in a certain geographical area and is "sticky," foreign affiliates engage in asset-augmenting activities in these areas in order to benefit from the external economies and knowledge spillovers generated by the concentration of production and innovation activities in the relevant clusters. The tacit nature of technology implies that even where knowledge is available through markets, it may still require modification to be efficiently integrated within the acquiring firm's portfolio of technologies. The tacit nature of knowledge associated with production and innovation activity in these sectors also means that "physical" or geographical proximity may be important for accessing and absorbing it (Blanc and Sierra 1999). The marginal cost of transmitting codified knowledge across geographic space
p. 328 does not depend on distance, but the marginal cost of transmitting, accessing, and ↳ absorbing tacit knowledge increases with distance. This leads to the clustering of innovation activities, especially in the early stages of an industry life cycle where tacit knowledge plays an important role (Audretsch and Feldman 1996).

In general, asset-exploiting activities are primarily associated with demanddriven innovative activities (e.g. localization of the parent-firm products for a specific offshore market). Asset-augmenting activities, on the other hand, are primarily undertaken with the intention to acquire and internalize technological spillovers that are host location-specific. Asset-exploiting activity, broadly speaking, represents an extension of R&D work undertaken at home, while assetaugmenting activity represents a diversification into new scientific problems, issues or areas.

An extensive literature has suggested that asset-augmenting internationalization of R&D has become more significant during the past two decades as a result of several factors that include: (*a*) the increasing costs and complexity of technological development, leading to a growing need to expand technology sourcing and interaction with different and geographically dispersed actors endowed with complementary bits of knowledge; (*b*) the faster pace of innovative activities in a number of industries, spurring firms to search for application opportunities which are mainly location-specific; (*c*) growing pressures from host governments, which have led MNEs to increase the interaction with local partners as key conditions to gain access to foreign markets.

Although the conceptual differences between these two motives for offshore R&D investment are clear, indicators of the importance of these two motives are scarce. Until recently, most empirical studies of international R&D investment (Mansfield et al. 1979; Lall 1979; Warrant 1991) reflected the view that the role played by foreign R&D units was determined by market or demand-side factors, i.e., asset-exploiting motives were assumed. More recent empirical work, however, has focused on assetaugmenting motives for R&D investments. Detailed analyses carried out by Miller (1994), Odagiri and Yasuda (1996), and Florida (1997) argue that technology sourcing strategies play an important role in a number of manufacturing industries in North America, Europe and Asia.[10] Some studies find that "market-oriented" R&D units established for asset-exploiting motives have evolved into asset-augmenting ones (Rondstadt (1978). But other foreign R&D units experience no major shift in their characters (Kuemmerle 1999).

Several studies have used multivariate techniques to identify the relative importance of asset-augmenting vs. asset-exploiting motives for offshore R&D investment. Using patent citations Almeida (1996) found that foreign firms in the semiconductor industry not only learnt more from local sources, but they did so to a greater extent than their domestic counterparts. This study also found that, with the significant exception of subsidiaries of Japanese MNEs, foreign firms locate their technological activities overseas in areas where
p. 329 these firms exhibited a home country disadvantage ↳ (measured in terms of 'Revealed Technological Advantages' (RTA)). Using a similar methodology, Cantwell and Noonan (2002) showed that MNE subsidiaries located in Germany between 1975 and 1995 sourced a relatively high proportion of knowledge (especially new, cutting-edge technology) from this host country.

Data such as this lend support to the idea that foreign owned technological activities undertaken in Germany are often asset-augmenting. However, Patel and Vega (1999) obtained different results from their study of US patenting activities in high technology fields. By comparing the RTA of the MNE at home and the host location, they showed that a majority of firms undertook foreign innovative activities in the technological fields in which they were strong at home. They interpreted this as evidence that asset exploiting motives, i.e. adapting products and processes for foreign markets and providing technical support to offshore manufacturing plants, remained dominant in MNEs' foreign innovative activities. Their findings were supported by an extensive interview-based survey carried out by Pearce (1999). Employing a methodology similar to that of Patel and Vega, Le Bas and Sierra (2002) confirmed that MNEs rarely internationalize R&D to compensate for technological weaknesses at home. However, their research also showed that the lion's share of these investments went to technologically advanced locations, indicating that asset augmenting is very important and can coexist with asset exploiting in many cases. This may be interpreted as signalling the formation of global "centers of excellence" in specific technological fields (see Box 12.1 for details on the methodology used to measure alternative international R&D strategies).

Box 12.1 Asset exploiting, asset augmenting or both?

In one of the most extensive empirical exercises to date, Le Bas and Sierra (2002) studied the R&D investment strategies of the 345 MNEs with the greatest patenting activity in Europe between 1988 and1996. These companies, which accounted for about one half of total patenting through the European Patent Office (EPO) over this period, were predominantly of US, European, or Japanese origin.

To measure the technological strength of companies and locations, the authors used a patent-based indicator ("Relative Technolological Advantage," RTA). For a company, HomeRTA is defined as the firm's share of total European patents in a particular technological field relative to its overall share of all European patents. Patents from foreign affiliates of the firm (filed from outside the country in question) were excluded from the calculation. For a location (country) in which a given firm has invested, HostRTA is defined as the host country's share of all European patenting in that field, divided by its share of all European patents in all fields. In all cases an RTA> 1 signals a relative advantage of the country (firm). Based on these definitions, four different R&D strategies may be identified:

Corporate technological activities in the home country	**Technological activities in the host country**	
	Weak	**Strong**
Weak	Type 1: market-seeking HomeRTA < 1 HostRTA < 1 (Technology is not a driver of FDI) (10%)	Type 2: technology-seeking HomeRTA < 1 HostRTA > 1 (13%)
Strong	Type 3: asset-exploiting HomeRTA > 1 HostRTA < 1 (Efficiency-oriented FDI in R&D) (30%)	Type 4: asset-augmenting> HomeRTA > 1 HostRTA > 1 (Learning-oriented FDI in R&D) (47%)

Source: adapted from Patel and Vega (1999, p. 152) and from Le Bas and Sierra (2002 p. 606).

The numbers in brackets indicate the frequency of the strategy in question for the sample of firms considered. As is evident from the table, Le Bas and Sierra found that the great majority of MNEs located their activities abroad in technological areas or fields for which they were strong at home (strategies 3 and 4). However, the most frequent strategy is clearly number 4, in which case not only the firm but also the host country has a relative technological advantage (HostRTA > 1). This may indicate the formation of "centers of excellence" in which strong domestic research environments function as global attractors.

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12.4 Forces Supporting Concentration and Dispersion of R&D

The literature on the location of R&D activities views the location of MNEs' innovative activities as affected by centrifugal and centripetal forces that determine whether the MNE centralizes (in the home location) or internationalizes to create additional centers abroad. But all too often, this dichotomy—while substantially correct—presumes that the MNE has a single center in the first place. In order to allow for the possibility that the MNE may have multiple home bases or several locations of R&D concentration rather than a single "hub", this section uses the terms "concentration" and "dispersion."

p. 331 We can single out at least four broad sets of factors affecting the concentration *and* dispersion of innovative activities. These forces are active at both the macro-level of countries, regions and systems of firms involved in the globalization of innovation; and the micro-level of individual firms and of their internal networks of innovative activities across national borders.

12.4.1 The Costs of Integrating Activities in Local Contexts

When firms engage in R&D in a foreign location to avail themselves of complementary assets that are location-specific (including those that are specific to local firms or institutions), they seek to internalize several aspects of the systems of innovation of the host location. Developing and maintaining strong linkages with external networks of local counterparts is expensive and time consuming. Networks of government-funding institutions, suppliers, university professors, private research teams, informal networks of like-minded researchers take considerable effort to create, but once developed, links with these entities or networks are less costly to maintain. Even where the host location is potentially superior to the home location, the high costs of becoming familiar with and integrating into a new location may be prohibitive. Firms are constrained by resource limitations, and some minimum threshold size of R&D activities exists in every distinct location. As such, maintaining more than one facility with a "critical mass" of researchers requires that the new (host) location offer significantly superior spillover opportunities, or provide access to complementary resources that are unavailable elsewhere and cannot be acquired by less costly means more efficiently.[11]

12.4.2 Local Technological Opportunities and Constraints

The high costs of integration into a host location's systems of innovation—in contrast to the low marginal cost of maintaining its embeddedness in its home location's innovation system—may increase the fixed costs firms have to overcome in order to expand internationally (Narula 2003). However, these costs must be tempered by other supply-side considerations. For example, development of the technologies in question may benefit from diversity and heterogeneity in the knowledge base, which might come from competitors, from interaction with customers and from other complementary technologies in the offshore site. A single national innovation system, especially in a small country, may be unable to offer the full range of interrelated technological assets required for this diversification strategy (see Box 12.2 on the interactions between innovation systems and R&D internationalization strategies).

Where local technological opportunities are sufficiently high, asset-augmenting activities are likely. Capturing foreign opportunities may require that a firm develop proximity to local "technology leaders" (see Ch. 20 by Cantwell, this volume) whose competences are rooted in the offshore system of innovation.[12]

p. 332 Whenever products ↳

p. 333 ↳

are multi-technology-based, one firm may be marginally ahead in one technology, and its competitor in another; but on a macro-level, both may be associated with "powerful" innovation systems (Criscuolo et al. 2005). Thus, technology leadership can change rapidly. This is another reason why firms often engage in both assetaugmenting and asset-exploiting activities simultaneously.[13]

Box 12.2 How innovation systems affect the internationalization of R&D

Innovation systems are built upon a relationship of trust, iteration, and interaction between firms and the knowledge infrastructure, within the framework of institutions based on experience of and familiarity with each other over relatively long periods of time. In engaging in foreign operations in new locations, firms which already face opportunities and constraints created by their home innovations systems gradually become embedded in the host environment. The self-reinforcing interaction between firms and infrastructure perpetuates the use of a specific technology or technologies, or production of specific products, and/or through specific processes. Increased specialization often results in a systemic lock-in. Institutions develop that support and reinforce the interwoven relationship between firms and the knowledge infrastructure through positive feedback, resulting in positive lock-in. When innovation systems cannot respond to a technological discontinuity, or a radical innovation that has occurred elsewhere, there is a mismatch between what home locations can provide and what firms require, this is known as sub-optimal lock-in (Narula 2002*a*).

In general, national innovation systems and industrial and technological specialization of countries change only very gradually, and—especially in newer, rapidly evolving sectors—much more slowly than the technological needs of firms. In other words, there may be systemic inertia. Firms have three options open to them (Narula 2002*a*). Firms may seek either to import and acquire the technology they need from abroad, or venture abroad and seek to internalize aspects of other countries' innovation systems, thereby utilizing an “exit” strategy. Of course, firms rarely exit completely, preferring often to maintain both domestic and foreign presence simultaneously. There are costs associated with an exit strategy. On the one hand, they would weaken their contact with their home market and by so doing they might reduce their ability to absorb external knowledge. On the other hand, it must suffer the costs of entry in another location (in terms of effort, capital, and time), and firms may minimize this through a cooperative strategy with a local firm. Developing alternative linkages and becoming embedded in a non-domestic innovation system takes considerable time and effort.

They can also use a “voice” strategy which is to seek to modify the home-country innovation system. For instance, establishing a collective R&D facility, or by political lobbying. Firms are inclined towards voice strategies, because it may have lower costs, especially where demand forces are not powerful, or where the weakness of the innovation system is only a small part of their overall portfolio. But voice strategies have costs, and may not be realistic for SMEs, which have limited resources and political clout. Such firms usually cannot afford an “exit” strategy either, and end up utilizing a “loyalty” strategy, relying instead on institutions to evolve, or seeking to free-ride on the voice strategy of industry collectives, or larger firms.

12.4.3 Firm Size and Market Structure

An important factor affecting internationalization is the size of the firm. The expansion of R&D activities—both at home and in overseas locations—requires considerable resources of capital and management expertise that smaller firms often lack. *Ceteris paribus*, large firms have more money and resources to use in overseas activity. As they have higher R&D budgets at home, they are also more likely to have the absorptive capacity to set up linkages with both foreign and domestic science bases. R&D is a costly and slow affair, and overseas R&D facilities are an expensive and risky option that is hard to justify for SMEs. Indeed, Belderbos (2001) finds that there is a non-linear relationship between firm size and overseas R&D, with medium-sized Japanese firms showing a higher propensity (in relative terms) to internationalize R&D than small- or large-sized firms. Many small firms operate as part of a domestic supplier network for larger firms, and are thus also bound to their home location (or the location of their main customers) (Narula 2002*b*). Internationalization of supplier firms often occurs in tandem with the internationalization of their primary customer, especially where the customer dominates their market. This motive was apparent in the investment by Japanese automobile firms' supplier firms in US and European production facilities during the 1980s and early 1990s (Florida 1997).

Industry-specific factors also encourage or discourage the locational concentration of innovative activities. The industrial structure of countries is path dependent, and technological specialization changes only gradually over time (Cantwell 1989; Zander 1995). At one extreme, mature technologies evolve slowly and demonstrate minor but consistent innovations over time. The technology is to a great extent codifiable, widely disseminated, and the property rights well defined. Under these circumstances, constant and close interaction with customers is not an important determinant of R&D: profits of firms depend on the costs of inputs, and proximity to the source of these inputs is often more significant than that of customers. At the other extreme, rapid technological change in "newer" technologies or engineering industries may require closer interaction between production and R&D (Lall 1979), or between users and producers of technology. In some circumstances both new technology and applications environments have a high tacit, uncodified
p. 334
element, requiring extensive interaction during new product development, design, and ↳ testing. This factor may account for the frequent establishment of both manufacturing and R&D plants close to applications abilities in foreign telecommunications markets (Ernst 1997). In other industries, however, a large variety of international linkages are required for R&D and innovation, as appears to be particularly the case of biotechnology (Arora and Gambardella 1990).

12.4.4 Organizational Issues

Another micro-level determinant is associated with the difficulties of managing cross-border R&D activities. It is not sufficient for the foreign affiliate to internalize spillovers if it cannot make these available to the rest of the MNE (Blanc and Sierra 1999). A dispersion of R&D activities across the globe requires extensive coordination between them, and particularly with headquarters, if they are to function efficiently. This acts as a centripetal force on R&D, and accounts for a tendency of firms to locate R&D (or at least the most strategically significant elements) closer to headquarters.

Complex linkages, both within the firm, and between external networks and internal networks, require complex coordination if they are to provide optimal benefits (Zanfei 2000). Such coordination may require expertise, managerial and financial resources that are most likely available to larger firms with more experience in transnational activity (Castellani and Zanfei 2004). Large firms tend to engage in both asset-augmenting and asset-exploiting activities. Indeed, large MNEs may have several semi-autonomous sister affiliates in the same location that operate in similar technological areas. Lastly, MNEs tend to engage in production activities (whether in the same or another physical facility) in the host location, and this prompts a certain level of asset-exploiting activity. Thus, an MNE in a given location may seek to internalize spillovers from non-related firms and to exploit intrafirm knowledge transfers within the same multinational group (Criscuolo et al. 2005).

12.5 Innovation through International Strategic Technology Partnering

The previous sections have discussed the growing international dimension of R&D, concentrating on the intra-MNE aspect of this development. However, not all innovatory activity is undertaken within
p. 335 hierarchies; during the last two decades, ↳ "non-internal" R&D activities that rely on interfirm cooperative agreements have grown rapidly in number.

Fully examining the role of (international) networks in the generation and diffusion of innovation is beyond the scope of this chapter (see Powell and Grodal, Ch. 3 in this volume, for a more comprehensive discussion). A key issue for this discussion is whether and to what extent there is substitution or complementarity between internal innovative activities and technological collaborations on a global scale.

In some circumstances, international STP may substitute for internal innovative activities. One such circumstance is that of R&D alliances aiming to enter foreign markets protected by non-tariff barriers, as is the case for environmental regulations in the chemical industry. Nonetheless, there are limits to how much a firm can substitute STP for in-house R&D, and by extension, international STP for overseas R&D facilities.[14] STP tends to develop in areas in which partner companies share complementary capabilities, and these alliances create a greater degree of interaction between the partners' respective paths of learning and innovation (Mowery et al. 1998; Cantwell and Colombo 2000; Santangelo 2000).

One way to look at this issue is to tackle the problem of firm size, technological capabilities, and collaborations. Participation in STPs tends to be correlated with firm size in technology-intensive sectors. In these sectors, cooperation is a way to keep up with the technological frontier: by associating complementary resources and competencies, it makes it possible to explore and exploit new technological opportunities. But smaller technology-based MNEs also are involved in such agreements, and their growing significance raises numerous conundrums (Narula 2002*b*; see also Ch. 5 by Lam, and Ch. 3 by Powell and Grodal, this volume). Firms—regardless of size—must maintain a growing breadth of technological competences, and this may require participation in international internal and external networks. SMEs need to rely on non-internal sources, as they often experience wider gaps in terms of competencies and development abilities than their larger counterparts (Zanfei 1994) but must be more skilful at managing their portfolio of technological assets, because they have limited resources (Narula 2002*b*). Indeed, the costs of managing a web of cross-border agreements highlight the importance of transaction-type ownership advantages for the MNE. This complementarity between firm size, technological capabilities and the development of innovation networks is consistent with some of the trends highlighted in Section 12.2.2. In particular, the geographical concentration of STP activity within the Triad reflects *inter alia* the fact that firms from these areas tend to be larger and account for a major share of R&D activity.

The issue of complementarity or substitution between the internal and non-internal innovative activities of MNEs can also be examined by looking at the interdependencies between multinational expansion and international STP. Drawing on the transaction-cost literature, several works on international market entry
p. 336 strategies argue that multinational experience may lower the risks faced by an MNE ↳ in entering a new foreign market. In the absence of multinational experience, cooperative ventures may be more effective market entry tools than hierarchical control strategies. As MNEs accumulate greater experience in foreign markets, the information-gathering and risk-sharing advantages of collaboration will decline. As a result, the organizational costs of cooperation, in terms of shirking and conflicts of interest between partners, will

exceed the benefits of this strategy for experienced MNEs (e.g. Gomez-Casseres 1989; Hennart and Larimo 1998). In summary, multinational experience is supposed to impact negatively on collaborative ventures and positively on equity-based, commitment-intensive linkages. This view is largely—but not exclusively—consistent with the argument that multinational experience helps facilitate the exploitation of MNEs' assets in foreign markets. That is, MNEs respond to uncertainty in host economies by utilizing their own assets as a means to penetrate these markets. Such a view regards STP as a second-best option.

A second body of literature focuses mainly on the evolution of high technology industries, and highlights an important motive for interfirm linkages, i.e. the need to explore and rapidly exploit new opportunities, either new businesses or new technological developments. From this perspective, strategic alliances provide "an attractive organisational form for an environment characterised by rapid innovation and geographical dispersion in the sources of know how" (Teece 1992: 20). As the relevant knowledge sources are dispersed globally in a number of industries, this perspective explains the formation of some types of international STP agreements. From this perspective, multinational experience—which is associated with the establishment and activity of foreign subsidiaries over time—may increase a firm's capacity to search for and absorb external knowledge (Cantwell 1995; Castellani and Zanfei 2004). This view is consistent with a number of studies on high technology industries which highlight the mutually reinforcing nature of intra- and interfirm networks. Multinational experience thus may expand a firm's exploration potential and hence expand its use of international STP.[15]

Some of the trends in the development of STP highlighted in section 12.2.2 seem to be consistent with the view that firms with multinational experience are more likely to use alliances as an exploratory strategy. As we have shown, the fraction of *non equity* STPs is growing, particularly in high technology industries. This trend may constitute evidence of the fact that low commitment intensive agreements are more effective as a mechanism to gain timely and extensive access to rapidly evolving technology across borders. From this perspective, STP may represent a "first-best" option to MNEs (Narula 2003), especially where innovative activities are concerned. In other words, firms do not necessarily resort to these strategies because they cannot have access to more effective and more profitable channels of technology transfer (as uncertainty is too high or institutional barriers constrain "internal" strategies). Instead, STPs, especially non equity agreements, are more flexible and more apt for knowledge development and learning.

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12.6 Conclusions and Policy Issues

This chapter has discussed the internationalization of innovative activities, and highlighted that it has been driven by a myriad of factors. One of the most recurrent among these factors is the need to respond to different demand and market conditions across locations, and the need for the firms to respond effectively to these by adapting their existing product and process technologies through foreign-located R&D.

Nevertheless, supply factors and the need to gain access to local competencies have become an increasingly important motivation to engage in asset-augmenting R&D abroad. This is due, *inter alia*, to the growing tendency for multi-technology products, and to the fact that patterns of technological specialization are distinct across countries, despite the economic and technological convergence associated with economic globalization.

As a result, there is a growing mismatch between what home locations can provide and what firms require. In general, innovation systems and the industrial and technological specialization of countries change only very gradually, and—especially in newer, rapidly evolving sectors—much more slowly than the technological needs of firms. Firms must seek either to import and acquire the technology they need from abroad, or venture abroad and seek to internalize aspects of other countries' innovation systems. A third option, lobbying for modification of the home-country innovation system, is expensive and difficult

(Narula 2002*a*). Thus, in addition to proximity to markets and production units, firms venture abroad to seek new sources of knowledge, which are associated with the innovation system of the host region. The interdependence of markets and the cross-fertilization of technologies—whether through arm's-length means, cooperative agreements, or equity based affiliates—means that that few countries have truly "national" systems. Of course, some innovation systems are more "national" than others, and the term is indicative rather than definitive (see also Ch. 7 by Edquist and Ch. 14 by Malerba in this volume for a discussion). Furthermore, firms need a broader portfolio of technological competences than they did in the past.

The internationalization of R&D raises crucial welfare issues, since it provides opportunities for spillovers between the MNE and its host economy, and in certain circumstances between the MNE affiliate and its home country. There has been some concern in the US with the potential loss of competitiveness of domestic firms and with the impoverishment of the "national knowledge base" which would be associated with the increasing local R&D presence of foreign-owned MNEs (e.g., Dalton et al. 1999). In other countries and areas of the world, the perception is very different, as a local presence of foreign R&D and value-added activities is expected to contribute to the upgrading of national technology systems. A few empirical studies
p. 338 seem to provide sound evidence on the existence of positive spillovers of multinational ↳ presence in some emerging economies such as Korea, Taiwan, and Singapore (Hobday 2000; Lim 1999), and some EU member states (Barry and Strobl 2002; Castellani and Zanfei 2003). However the evidence in the case of most developing countries does not point to significant spillovers (see Harrison 1999). Indeed, according to a recent survey on econometric studies of productivity spillovers from FDI, the number of studies in which negative or non-significant results are obtained is approximately as high as cases where positive spillovers were observed (Gorg and Strobl 2001). This suggests a cautious approach to this issue, and calls for a refinement of analytical tools (see Box 12.3). There is a need to develop more appropriate measures of technological spillovers, which are not properly captured by performance indicators like productivity. The channels through which spillovers occur also need to be examined more carefully, if FDI-related spillovers are to be explicitly used as means for technological upgrading.

Another position in this policy debate argues that the internationalization of R&D may lead to a "hollowing out" of the home country's innovatory capacity when the domestic innovation system does not meet the
p. 339 needs of firms in certain industries. ↳ Although there is currently little evidence to support or refute the hollowing out hypothesis, this has been raised by policy makers in several countries, and represents an important area for future research. The consequences of a potential hollowing out may be especially significant in small open economies that are specialized around a few products, and/or concentrated around a few large firms. Another related and potentially important area for future research is the need to distinguish between hollowing-out as a symptom of sub-optimal lock-in and the internationalization of innovation to supplement domestic supply limitations (Narula 2003). After all, no country can provide world-class competences in all technological fields. Even the largest, most technologically advanced countries cannot provide strong innovation systems to all their industries, and world-class competences in all technological fields. Some countries regard imported technologies as a sign of national weakness, and have sought to maintain and develop in-country competences, often regardless of the cost (Narula 2002*a*). Relying largely on in-country competences may however lead to a sub-optimal strategy, especially in this age of multi-technology products. In fact, the cross-border flow of ideas is fundamental to firms, and this imperative has increased with growing cross-border competition, and international production.

Box 12.3 Host country effects: technology gaps, technological upgrading, and absorptive capacity

One of the strongest and most popular arguments in favor of inward investment as a vehicle for local technological upgrading is that foreign firms usually outperform domestic ones (see Bellak 2002 for a review on empirical evidence on this aspect). The underlying policy issue is whether or not foreign presence can generate technological opportunities for the local economy. There is a clear connection here to the literature on technology gaps and catching up (Godinho and Fagerberg, Ch. 19 in this volume). On the one hand, some works suggest that the larger the productivity gap between host country firms and foreign-owned firms, the larger the potential for technology transfer and for productivity spillovers to the former. This assumption, can be derived from the original idea put forward by Findlay (1978), who formalized technological progress in relatively "backward" regions as an increasing function of the distance between their own level of technology and that of the "advanced regions," and of the degree to which they are open to direct foreign investment.

On the other hand, scholars have argued that the lower the technological gap between domestic and foreign firms, the higher the absorptive capacity of the former, and thus the higher the expected benefits in terms of technology transfer to domestic firms. It is worth noting that the role of absorptive capacity is also implicitly recognized in the catching up tradition, when it is acknowledged that a sort of lower bound of local technological capabilities exists, below which foreign investment cannot be expected to have any positive effects on host economies.[16] The "technological accumulation hypothesis" goes beyond this simplistic view of absorptive capacity and places a new emphasis on the ability to absorb and utilize foreign technology as a necessary condition for spillovers to take place.

Notes

1. Both changes in the composition of world trade, and sectoral correlations between R&D intensity and internationalization should be considered with caution since definitions of industries change over time (see Von Tunzelman and Acha, Ch. 15 in this volume).

2. For instance, press releases are often used to construct data-sets, and these are not always factual, sometimes reflecting the public relations objectives of the firms; the coverage of large firms is higher than for smaller firms; STP failures are not reported as accurately (or as often) as STP formation; large databases are hard to update and are frequently subject to changes in the methodology of data collection over time.

3. STP refers to interfirm cooperative agreements where R&D is at least part of the collaborative effort, and which are intended to affect the long-term product-market positioning of at least one partner.

4. Strictly speaking, the two numbers are not comparable, because GDP is a flow figure. Nonetheless, it is generally accepted that FDI stock is a monotonic function of value added, so the change in this ratio gives a general idea of how the significance of FDI activities has changed.

5. Paradoxically, perhaps, this group also includes Swedish MNEs, whose much higher shares of offshore R&D and patenting throughout the twentieth century, nevertheless, display a sharp drop after 1940 and a recovery by 1969–90 to a share that is lower than that of 1920–39.

p. 340 6. Although the degree of R&D internationalization of US firms is below average, it more than doubled between the mid-1960s and the end of the 1980s (Creamer 1976; Pearce 1990).

7. Even where MNEs do engage in R&D in developing countries (e.g. industries where demand considerations and regional variations are especially significant, such as food products and consumer goods), these tend to agglomerate in just a few

locations such as China, India, Malaysia, Brazil, South Africa, and the Asian NICs.

8. Although “home-base exploiting” (HBE), and “home-base augmenting” (HBA) (which we define later) have become dominant in the literature, this terminology is less accurate than “asset exploiting” and “asset augmenting”. HBA and HBE hold to a very traditional view of the MNE as centered in a dominant home base. In fact, by emphasizing the role of home bases, the HBA–HBE jargon cannot be easily made consistent with the possibility that firms are evolving towards network structures, hence reducing the importance of a single home and, by the same token, expanding the number of countries wherein the firm ends up being based. This chapter takes the view that being accurate is more important than being fashionable, and avoids using the HBE–HBA terminology except where necessary for historic accuracy.

9. Fosfuri and Motta (1999) and Siotis (1999) show that a technological laggard may choose to enter a foreign market by FDI because there are positive spillover effects associated with locational proximity to a technological leader in the foreign country. Where the beneficial knowledge spillover effect is sufficiently strong, Fosfuri and Motta show that it may even pay the laggard firm to run its foreign subsidiary at a loss to incorporate the benefits of advanced technology in all the markets in which it operates.

10. Miller (1994: 37) studied the factors affecting the location of R&D facilities of twenty automobile firms in North America, Europe, and Asia, and found that an important motivation is to establish “surveillance outposts” to follow competitors' engineering and styling activities. In their study of 254 Japanese manufacturing firms, Odagiri and Yasuda (1996: 1074) note that R&D units are often set up in Europe and in the US to be kept informed of the latest technological developments. Similar results are obtained by Florida (1997: 90) analyzing 186 foreign affiliated laboratories in the US.

11. With few exceptions (e.g. Narula 2002*a*), the costs and inertia of offshore R&D networks is a topic which has not as yet been properly explored and represents an important area for further research.

12. Technology leaders are not always synonymous with industry leaders: firms—particularly in technology intensive sectors —increasingly need to have multiple technological competences (see e.g. Granstrand 1998; Granstrand et al. 1997).

13. This is another area which has not as yet been fully studied (for an exception, see Zander 1999) and represents an important area for further research.

14. The attempt to understand the reasons behind a firm's choice between non-internal and internal technological development is not new. The work of Teece (1986) presents a pioneering analysis of this issue, which builds on Abernathy and Utterback (1978), Dosi (1982) among others. See also further developments by Pisano (1990), Henderson and Clark (1990), Nagarajan and Mitchell (1998), Veugelers and Cassiman (1999), Gambardella and Torrisi (1998), Nooteboom (1999), Narula (2001) and Brusoni et al. (2001).

15. Castellani and Zanfei (2004) have tried to provide some empirical basis to this view with reference to the electronics industry. They measure what they call “specific experience” in terms of the number of subsidiaries a MNE has established p. 341 in a given country, which in ↳ their view would reduce uncertainty about the foreign market. Controlling for a number of sources of heterogeneity, they show that this factor is positively correlated with the creation of new subsidiaries and of equity agreements. By contrast, what they call “variety experience,” reflecting the heterogeneity and geographical dispersion of markets where aMNE is active, should increase the firm's exploratory capacity. They find that, in the examined industry, variety experience has a positive and significant impact on non equity technical alliances.

16. As Findlay (1978: 2–3) notes: “Stone age communities suddenly confronted with modern industrial civilisation can only disintegrate or produce irrational responses … Where the difference is less than some critical minimum, admittedly difficult to define operationally, the hypothesis does seem attractive and worth consideration.” Findlay also observes that the educational level of the domestic labour force, which is a good proxy for what is currently named country's “absorptive capacity,” might also affect, *inter alia*, the rate at which the backward region improves its technological efficiency (Findlay 1978: 5–6).

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