Study on the relationship between the localisation of production, R&D and innovation activities

ANNEX 1: Literature review and conceptual framework

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1/ Introduction

1.1 Objectives and approach of the study

It has been observed that the EU maintains its leading position in inward and outward Foreign Direct Investment (FDI), but that it is losing some of its attractiveness as an FDI destination. Inflows from outside the EU are dominated by advanced economies (such as the US and Switzerland), but emerging economies are gaining relative weight. EU firms are the most important investors in the world. The major drivers behind the strong EU FDI inflows have been the European single market, the Euro and, in the case of west-east flows, cost advantages. Investments in the R&D and innovation process are pivotal for Europe's further industrial recovery and economic performance.

The main objective of the present study is to:

> **Understand the drivers behind a firm's decision on where to geographically locate production, and the influence of that decision on the geographical location of R&D and innovation activities.**

More specifically, underlying study examines:

1. Existing evidence on the drivers determining the choice of the production location by a firm and, in particular, the role of RDI in that decision.
2. Impact of the production location decision on the RDI activities, and in particular the level and the geographical location of RDI activities of the firm.
3. Consequences deriving from the decisions regarding the location of firm RDI, as well as the impact on RDI in the home economy and/or on access to markets.

1.2 Guide to the reader

Underlying report, which is presented as annex to the main report, provides the main insights stemming from the literature review on internationalisation and co-location between production and R&D and innovation. The literature review has led to the development of a conceptual framework and the formulation of a number of study assumptions, which were subsequently tested in the case studies.

In chapter 2 a theoretical review is provided, first on production location decisions, followed by R&D and innovation location decisions and the existing insights on co-location between production and R&D and innovation. In chapter 3, the conceptual framework along with the derived study assumptions is presented. A bibliography is provided in annex.

2/ Literature review on the (co-)location of production and RDI activities

2.1 Introduction

In understanding the determinants or drivers behind location decisions, there are largely two streams of literature originating from: 1) Economists (including economic geography), and 2) Organisation scholars. Economists mainly look at this problem from the perspective of "locational pulls", such as access to local technologies and know-how. From an organisation perspective, the focus is mainly on industry- and especially firm-specific (strategic) considerations, and cross functional interdependencies within the firms (Ketokivi, 2006[1]; Ketokivi, 2009[2]). Naturally, understanding managerial decision making is essential for understanding location decisions.

For companies that face global competition there is no simple answer to what is the optimal way of configuring one's business in relation to a value chain. A Danish study (Johansen et al.; 2012)[3] from University of Aalborg has identified at least four dimensions in the configuration options for a company, with 'costs' being one of the most decisive factors, which will be further explored during the proposed case studies. They and include:

1. The **organisation perspective**, some companies are characterised as footloose with a high degree of outsourcing, others as rooted companies with a low degree of outsourcing;
2. The **complexity of the company** and its markets from a narrow focus to a wide range of products, markets, processes;
3. The **competence** of a unit along the value chain from narrow to wide;
4. The perspective of **sourcing activities,** from costs to markets to knowledge.

Both production and services can be offshored. Literature agrees that production activities were among the first to be offshored, this in combination with distribution and sales (OECD, 2011[4]). For service activities, literature is not so uniform. Some argue that IT-enabled services were among the first to be offshored, later followed by innovation offshoring. Others argue that both types of services are offshored in parallel (Lewin et al. 2009[5]). Overall, R&D and decision-making activities have become increasingly (re)located internationally (OECD, 2011). Compared to before, the innovative activities of MNEs are more geographically dispersed (Dunning and Lundan, 2009[6]). There is also recent evidence pointing to growing relocation/offshoring of R&D to lower-income countries (OECD, 2011; Dossani and Kenny, 2007[7]). Due to the economic crisis though, overall international investments (in innovation) have decreased in the last years (OECD, 2011).

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1 Ketokivi (2006), "When does co-location of manufacturing and R&D matter?", ETLA Discussion Papers, 1051.

2 Ketokivi, M. and J. Ali-Yrkkö, (2009), "Unbundling R&D and manufacturing: Postindustrial Myth or Economic Reality?" Review of Policy research, 26, 1-2

3 Johansen et al. (2012), Dansk Produktion vaerdikaeder and Ferdows,

4 OECD (2011) "Attractiveness for Innovation: Location Factors for International Investment".

5 Lewin, A.Y, S. Massini and C. Peeters (2009). "Why are companies offshoring innovation? The emerging global race for talent". Journal of International Business Studies (2009), 40, 901-925.

6 Dunning, J.H. and S.M. Lundan (2009), "the internationalization of corporate R&D: A review of the evidence and some policy implications for home countries, Review of policy research, 26, 1-2, 13-33.

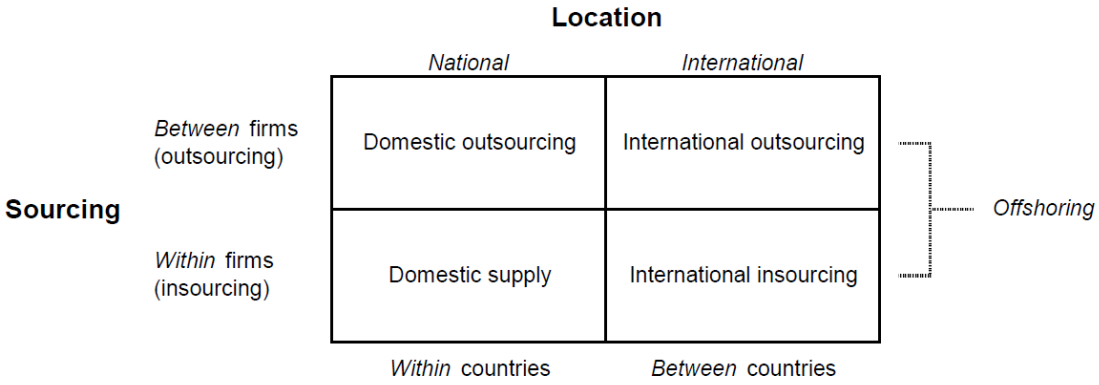
7 Dossani, R., & Kenney, M. 2007. The Next Wave of Globalization: Relocating Service Provision to India. *World Development*, 35(5): 772-791.

2.1.1 *Delocalisation strategies*

In the literature on production or RDI location decisions, we come across different terms and concepts often pointing to the same phenomenon. The term "offshoring" is often associated with "outsourcing", but the concepts are different. According to the OECD[8], "*outsourcing refers to the relocation of jobs and processes to external providers regardless of the provider's location, offshoring refers to the relocation of jobs and processes to any foreign country without distinguishing whether the provider is external or affiliated with the firm. Outsourcing may therefore include job relocations both within and between countries, whereas offshoring refers only to international relocations. The term offshore outsourcing therefore only covers the relocation of jobs or processes to an external and internationally located provider.*"

The figure below shows the different types of sourcing-location combinations that are possible. In this study, we are particularly interested in **offshoring,** either within (captive or insourcing) or outside the firm (outsourcing) and focusing on the international dimensions.

Figure 1: Illustrative matrix of insourcing, outsourcing and offshoring



Source: OECD, 2006

These offshoring activities can take different forms. Frequently they concern Foreign Direct Investments (FDI). There are three types of FDI (Peng, 2011[9]; Ekholm et al. 2003[10])

- **Horizontal FDI**: The company duplicates the activities of the home country in the host country at the same value chain with the main purpose of serving customers locally.
- **Vertical FDI (backward and forward**): The company moves upwards or downwards in different value chains in the host country. Different stages of the value chain are located in different countries.
- **Export-platform FDI**: The company investments (from a home country) in a host country, with the main goal of exporting it to and selling it in a third country.

8 OECD (2006), "Productivity Impacts of Offshoring and Outsourcing: A Review", by Karsten Bjerring Olsen, STI Working Paper

9 Peng, M.W. (2011). "Global Business". 2nd Edition, Mason, South Western, pp 635.

10 Ekholm, K., R. Forslid and J. Markusen (2003). "Export-platform foreign direct investment". London: Centre for Ecnomic Policy Research, International Trade, pp 36.

There are also different formats for FDI activities (Bitzenis, 2006[11]):

- "**Wholly owned subsidiary**: 100% ownership of assets by a company.
- **Joint venture**: a commitment, for more than a short duration, of funds, facilities and services by two or more legally separate interests to an enterprise involving doing business in common, the sharing of profits, the sharing of business risk and losses and longevity of cooperation.
- **Greenfield investments**: the establishment of an entirely new entity.
- **Brownfield investments**: the acquisition of an existing establishment, followed by the development of entirely new production facilities.
- **Other forms of acquisition**: direct acquisition or privatization of state-owned company, acquisition of majority holding or an acquisition stake.
- **Mergers and acquisitions**: the merger of two or more companies."

Foreign direct investment are applied for both production and RDI offshoring. For RDI activities abroad though, different formats often occur; contracts, cooperation projects etc.

Equally important as offshoring is **reshoring** or back-shoring, referring to the return of production that was previously offshored from the home country. When production offshoring or re-shoring is following by RDI offshoring or re-shoring, we may speak of the **co-location** of production and RDI. Decisions associated to offshoring, re-shoring, and/or co-location, will in this study be referred to as **location decisions**. We would like to indicate that in this study, location decisions concern two types:

- location decision to relocate (a part of) the activities in the home country to a host country
- location decision to invest in new activities in a host country (not in the home country)

2.1.2 The role of global value chains

Baldwin (2011)[12] describes two unbundling stages occurring in the process of globalisation. The first unbundling arose from advances in transportation and led to the acknowledgement that production and consumption do not need to take place at the same location. The second unbundling arose from the ICT revolution in the 1980's which led to advances in transmission of information. These transmission advances allowed that different manufacturing stages do not need to take place near each other. The result is that activities in the value chain are becoming more and more dispersed around the globe.

Location decisions depend largely on the peculiarities of the value chain(s) within which a company operates. As these value chains have become more global, the decision making processes have become more complex, and the role, and often location, of production and RDI have become more global as well. According to De Backer et al. (2013)[13], global value chains have deepened the process of globalisation at three levels.

First, there is **geographic** deepening which means that more countries and actors are involved in the value chain. There is also an increasing participation of emerging economies

[11] Bitzenis, A.P. (2006). "Foreign direct Investment and cross border transactions", In Globalization: Encyclopedia of Trade, Labour and Politics, Volume 1, edited by A.K. Vaidya.

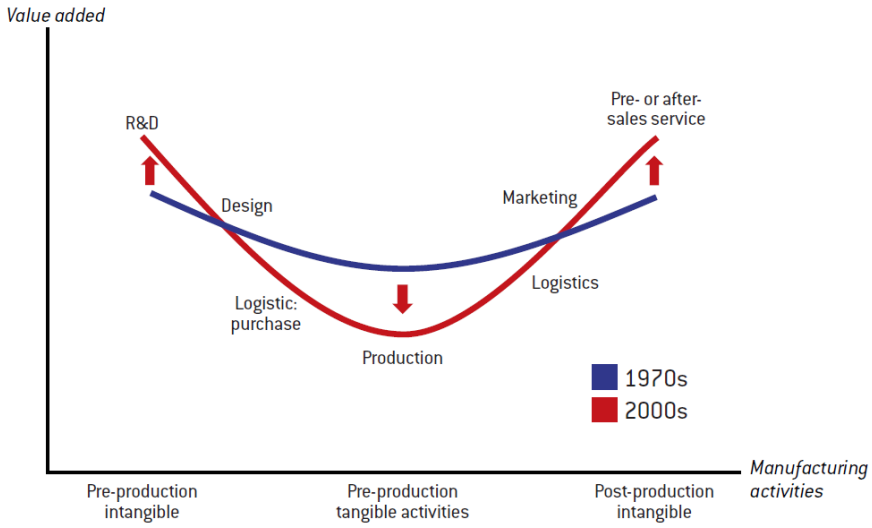
[12] Baldwin, R. (2011), "Trade and Industrialisation after Globalisation's Second Unbundling: How Building and Joining a Supply Chain are Different and Why it Matters"
Chapter in NBER book Globalization in an Age of Crisis: Multilateral Economic Cooperation in the Twenty-First Century (2014), Robert C. Feenstra and Alan M. Taylor, editors (p. 165 - 212)

[13] De Backer, K., S. Miroudot and A. Ragoussis (2013), "Manufacturing in global value chains", In Manufacturing in Europe's future, edited by R. Veugelers. (Breugel).

in these global value chains. Second, there is the **sectoral** deepening. Global value chains no longer only concern manufacturing but also increasingly encompass services. And third, there is **functional** deepening meaning that not only production and distribution but also R&D and innovation are included in the global dimension.

These functional changes are also observed by Veugelers (2013)[14] who indicates that there is a growing importance of the value of services related to production and manufacturing. The services specifically related to production can be subdivided in upstream service activities (such as R&D and design) and downstream service activities (such as marketing and after-sales services) (Defever, 2006[15]). The curve in Figure 2 shows the different phases in the production process and the value added that is created at each phase. In the 70's, this curve was rather flat, indicating that there was only slightly less value added created in the production and manufacturing stage than in the upstream and downstream service activities. More recently, this curve became more U-shaped. The value added of upstream and downstream services has increased while the value added of production itself has decreased. More specifically, this suggests that the value added of R&D has increased, just as the value added of pre- or after-sales services has, thereby adding importance to the geographical location of these activities.

Figure 2: The 'smile curve'



Source: Veugelers (2013)

Concerning the location of these activities, especially the upstream activities, there is some diversity in literature about the underlying rationale. Downstream activities (marketing) are often related to market characteristics (like size and demand), and should therefore be located near to the customers. Upstream activities (R&D) are often not related to market size and therefore it is argued that it is not necessary to locate these activities near the customer. But arguments do arise in favour of the location of upstream activities near the customers,

[14] Veugelers, R. (2013), "Trends, challenges and prospects for manufacturing in Europe", In Manufacturing in Europe's future, edited by R. Veugelers. (Breugel).

[15] Defever, F. (2006), "Funcational fragmentation and the location of multinational firms in the enlarged Europe", Regional Science and Urban Economics, 36, 658-677.

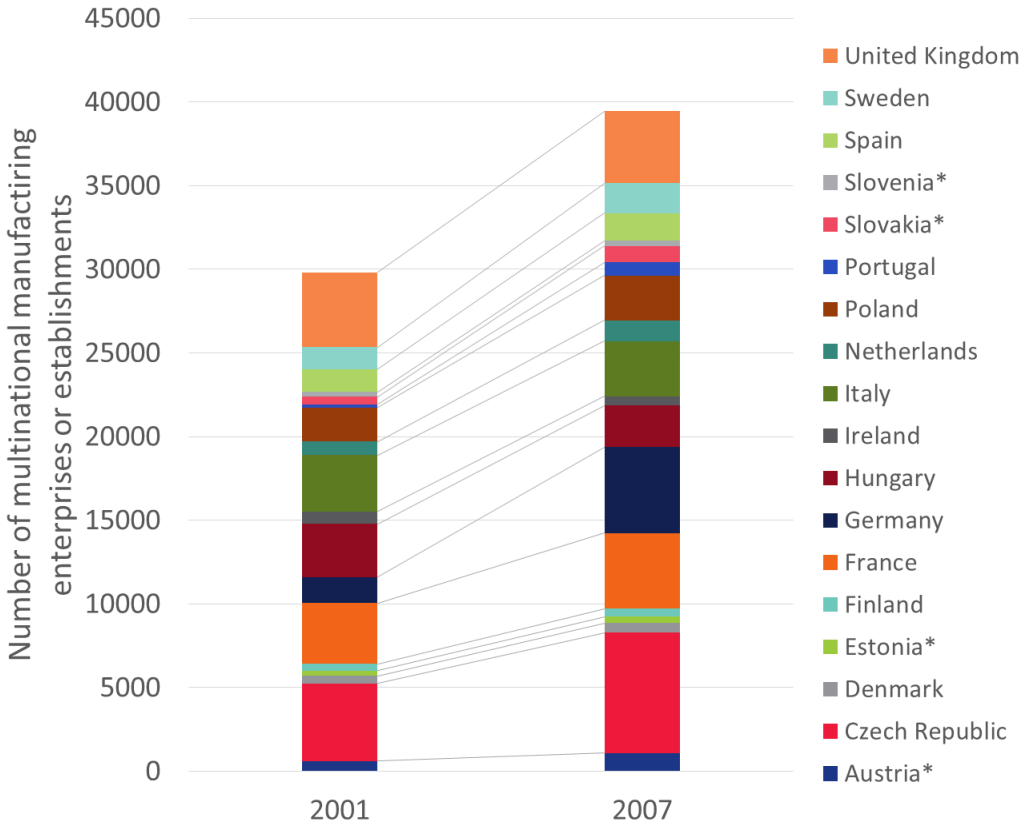
because the creation of new products or the adaption of goods to the local market requires some type of R&D (Defever, 2006). Overall, production and sales are more frequently geographically dispersed, while R&D activities are often more concentrated (Alcácer, 2006[16]). As we will discuss further on, a more detailed and fine-tuned analysis is needed.

In this literature review, an overview will be provided on the factors influencing production and RDI decisions, including the issue of co-location of RDI and production.

2.2 Production location decisions

The increasing globalisation of value chains and the dispersion of production facilities are reflected in the number of multinational manufacturing enterprises in Europe, which has increased considerably in from 2001 to 2007. The overall increase in the location of multinational enterprises is especially apparent in Germany, France and the Czech Republic.

Figure 3: Development in the number of multinational manufacturing enterprises or establishments in selected European countries



OECD (2010), "Activity of Multinationals in Manufacturing: Inward activity by investing country", OECD Statistics on Measuring Globalisation *(database)*

The following sections will look into the factors that come into play when multinational companies decide where to locate their production plants.

[16] Alcácer, J. (2006), "Location choices across the value chain: How activity and capability influence collocation", Management Science, 52, 10, 1457-1471.

2.2.1 *Drivers of production location decisions*

Thunen (1875) developed the economic framework of location theory. He focused primarily on agricultural location from a "least-cost" approach[17]. The initial focus on *cost* factors (transportation cost, labour cost, etc.) expanded when several authors proved the impact of critical *demand* factors (like the location of competitors, the proximity to consumer markets, etc.). One of the prime authors regarding demand factors was Laundhardt (1885) who shifted the theoretical focus from agriculture to the location of industry and demonstrated the importance of demand factors. August Losh (1939) integrated cost and demand factors into a collective approach when he presented a maximum-profit theory based on both cost and demand curves.[18] Currently there is an increased academic emphasis on the non-economic factors in the location of manufacturing facilities. This includes increased focus on *societal* factors (such as governance, corruption, general education level, and political stability, etc.) and their influence on facility location. A more recent trend in the literature is the inclusion of *environmental* factors affecting location decisions. Chen, Olhager, and Tang (2013) identify 98 recent articles concerning the impact of environmental issues such as waste treatment, recycling, pollution, renewable resources, etc. on firms' location decisions.[19]

The literature on production location decisions points to a multitude of quite different elements that affect location decisions. We have grouped these elements into four overall factors: Market considerations, (labour) costs, industrial ecosystem, and host country characteristics. This also includes a look at specific location factors in the case of back-shoring production facilities from abroad. After describing these general location factors, we look at sectorial differences in location decision and variations for different plant types.

Markets

Even though the literature on production location decisions examines a multitude of quite different factors, a coherent conclusion is that market considerations constitute the overall most important factor for production location decsions (e.g. UNCTAD 2009; Badri 2007; Defever 2006; Py & Camel 2009). In other words, when firms locate their production facilities they consider how a given location would affect their market potential.

As a location factor, markets can involve a variety of different considerations. For instance, the UNCTAD World Investment Prospects Survey (see Figure 6) points to both the size of local markets, access to international markets and growth of market as important factors. [20]

The UNCTAD Survey identifies 13 location factors, ranked below by their relative importance (see Figure 6 for details):

1. Size of local markets
2. Growth of market

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17 von Thünen, Johann Heinrich (1875), "Der isolairte Staat in Beziehung auf Landwirthschaft und Nationalökonomie"

18 Badri, Masood A. (2007), "Dimensions of Industrial Location Factors: Review and Exploration", Journal of Business and Public Affairs, 1(2), 1-26

19 Chen, L., et al., Manufacturing facility location and sustainability: A literature review and research agenda. Int. J. Production Economics (2013), http://dx.doi.org/10.1016/j.ijpe.2013.05.013

20 Brush, T. H., Maritan, C. A., & Karnani, A. (1999), "The plant location decision in multinational manufacturing firms: An empirical analysis of international business and manufacturing strategy perspectives", Production and operations management, 8(2), s. 109-132

3. Presence of suppliers and partners
4. Access to international/regional markets
5. Stable and business-friendly environment
6. Availability of skilled labour and talents
7. Cheap labour
8. Quality of infrastructure
9. Follow your competitors
10. Government effectiveness
11. Access to natural resources
12. Incentives
13. Access to capital markets (finance). [21]

At the heart of market considerations is proximity to key markets and customers. In other words, firms want to locate their production facilities near their key customers. Brush, Maritan and Karnani (1999) measure the impact of different factors in 209 responses from plant managers from 31 countries, representing 73 large multinational companies. They find that proximity to important markets and proximity to key customers are among the most important production location factors for all types of firms.[22]

Defever (2006) finds that the **external market potential** is the third most important factor for production location decisions, see Figure 5.[23] This is apparently not in line with the findings of other authors that point to markets as the key factor. The apparent divergence can be, at least partly, explained by the fact that R&D co-location, a factor internal to the company, takes first place as the most important factor, while the "sectoral count" (cf. the discussion of agglomeration factors further below) takes second place. Further explanation of the comparatively low ranking of "markets" as a location factor could be found in Defever's operationalization of the market potential as "*summation of country GDPs of all countries weighted by their distance to the location choice*". This definition measures the market potential at a national level. Thereby, these findings are not based on firms' individual decisions and the potential markets for the firms' products.

Costs

An important factor in production location decisions is **labour cost**. The wage level of employees constitutes a pull factor for the host country as lower labour costs attract production facilities. (Defever 2006; Py & Hatem 2009; UNCTAD 2009)

Looking at 11,000 location choices over a 5-year period, Defever (2006) concludes that unit wage cost is a significant factor for production location choices, see Figure 4.[24] Lower unit wage costs attract production facilities; the lower the unit wage cost, the higher probability to locate a given place, and vice versa. A high education level does not seem to be

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22 Brush, T. H., Maritan, C. A., & Karnani, A. (1999), "The plant location decision in multinational manufacturing firms: An empirical analysis of international business and manufacturing strategy perspectives", Production and operations management, 8(2), s. 109-132

23 Defever, F. (2006), "Functional fragmentation and the location of multinational firms in the enlarged Europe. Regional Science and Urban Economics", 36, 658-677

24 Defever, F. (2006), "Functional fragmentation and the location of multinational firms in the enlarged Europe. Regional Science and Urban Economics", 36, 658-677

necessary to attract manufacturing facilities[25]. In other words, labour costs are generally more important for production location decisions than the educational level. The findings of Py & Hatem (2009) support this conclusion; the general wage level pr. employee in the sector affects location decisions negatively while the educational level does not affect location decisions significantly[26]. The United Nations Conference on Trade and Development (UNCTAD) also identifies cheap labour as a significant location factor in their World Investment Prospect Survey 2009-2011[27] (see Figure 5 for exact figures).

Figure 4: Location choices and functional co-location: conditional logit model

Location factor	Logit coefficient
Unit wage cost	-0,66 ***
Education	-0,34 ***
Judicial quality	0,27 ***
GDP	0,03
External market potential	0,27 ***
Functional count	0,15 **
Sectoral count	0,95 ***
HQ co-location	-0,44 **
R&D co-location	1,12 ***
Production co-location	
Logistics co-location	0,1
Sales and marketing co-location	-0,2

Number of observations: 1,229
Significance level at 1%(***), 5%(**), and 10%(*)
Source: Defever (2006)
Note: A positive (green) logit-coefficient indicates a positive effect on location decisions, while red indicates a negative effect.

Labour cost can work as a pull factor for host countries. For instance, low-cost labour has proven to be one of the main drivers for outsourcing to emerging markets in Asia (Javalgi 2009; McCarthy & Anagnostou 2004; Ulrich & Ellison 2005)[28].

High labour cost can also work as a push factor, pushing facilities away from the home country. An example of this is the Mankiw and Swagel (2006) study of multinationals in the US that illustrates how the push factor decreases as the home country wage level diminishes: "*This means that as skilled workers at overseas affiliates become less costly, US multinationals use more labor in their US parent locations*"[29].
As we will see in the next paragraphs, rising wage costs in host countries can also be a significant factor in some companies' decisions to 'backshore' production.

[25] Defever (2006)
[26] Py, Loraine & Fabrice Hatem (2009), "Internationalisation et localization des services : une analyse sectorielle et fonctionnelle appliquée aux firmes multinationales en Europe", Économie et Statistique, 426
[27] UNCTAD (2009), "World Investment Prospects Survey 2009-2011", available at http://unctad.org/en/docs/diaeia20098_en.pdf
[28] Javalgi, Rajshekhar G.,Ashutosh Dixit & Robert F. Scherer (2009), "Outsourcing to emerging markets: Theoretical perspectives and policy implications, Journal of International Management, 15, 2009, 156–168
McCarthy, I., Anagnostou, A. (2004), "The impact of outsourcing on the transaction cost and boundaries of manufacturing", International Journal of Production Economics, 88, 61–71
Ulrich, K. & Ellison, D., (2005), "Beyond make-buy: internationalization and integration of design and production", Production and Operations Management, 14, 315–330
[29] Mankiw, N. Gregory & Philip Swagel (2006), "The politics and economics of offshore outsourcing", Journal of Monetary Economics, 53, 1026-1056

Agglomeration factors – the industrial eco-system

Market and cost considerations constitute respectively a supply and demand side factor in production location decisions. However, firms also consider the existing industrial structure in host countries. Already in 1929, Alfred Weber pointed to the importance of agglomeration forces in location decisions[30]. Several agglomeration forces can affect production location decisions. Agglomeration forces can emerge in an **industrial ecosystem** with suppliers, other plants in the same sector and facilities along the value chain.

Defever (2006) investigates the impact of agglomeration factors on production location decisions. He finds that headquarter location is not a significant factor for production location choices, see Figure 4.[31] In other words, production activities are characterised by a high degree of mobility since firms locate production facilities for other reasons than proximity to their headquarters.

The functional and sectorial count highlight two forms of agglomeration forces, respectively a concentration of facilities in the same part of the value chain and facilities within the same sector. The functional count sums up activities belonging to the same function but not to the same sector, and this agglomeration force only influences location decisions to a low degree. For production facilities this means that the existence of other production facilities does not necessarily attract new production facilities. The sectorial count specifies the number of foreign establishments (production plants) in the same sector as the investing firm. This factor influences location decisions to a high degree, where high numbers of other plants in the same sector improve the odds for firms to locate their production there. Co-location with R&D facilities is also a critical factor for the location of production facilities. The impact of locating near other sectorial facilities or own R&D facilities points to the importance of agglomeration forces. Defever (2006) does not find, however, that these agglomeration forces apply to production co-location with logistical facilities or with sales and marketing facilities[32]. However, Canel and Das (2002) point to the integration of marketing and manufacturing decisions. This involves a high level of coordination of the overall marketing strategies and the manufacturing strategies. Globalisation is forcing many companies to integrate location decisions and marketing strategies to gain a comparative advantage[33].

From a supply chain perspective, it is vital for firms to be able to deliver quickly, with high quality, and flexibility. Bhatnagar and Sohal (2005) identify three important factors that have a significant impact on supply chain competitiveness: location factors (like cost, infrastructure, proximity to markets, proximity to suppliers etc.), supply chain uncertainty, and manufacturing practices[34]. Grabis, Chandra, & Kampars (2012) prove this model useful by building a multi-objective facility location model accounting for these different factors

30 Weber, A. (1929), "Theory of the location of industries", C.J.Friedrich, Chicago: University of Chicago

31 Defever, F. (2006), "Functional fragmentation and the location of multinational firms in the enlarged Europe. Regional Science and Urban Economics", 36, 658-677

32 Defever (2006)

33 Canel, C., & Das, S. R. (2002), "Modeling global facility location decisions: integrating marketing and manufacturing decisions. Industrial Management and Data Systems", 102(2), 110-118

34 Bhatnagar, R., & Sohal, A. S. (2005). "Supply chain competitiveness: measuring the impact of location factors, uncertainty and manufacturing practices", Technovation, 25, 443-456

affecting decision-making[35]. The location factors mentioned are in line with the potential factors listed above (markets, costs, other agglomeration factors), but supply chain uncertainty is a new addition.

Supply chain uncertainty concerns firms' relations to potential suppliers. It involves the punctuality, accuracy, and quality of the deliveries from the supplier, as well as the length of the relationship with the supplier: the less uncertainty in supplier deliveries, the better[36]. Process uncertainty is also crucial, because firms want to avoid shutdowns that significantly affect operations. Finally, supply chain uncertainty involves a level of demand uncertainty. Firms want to forecast the demand for their goods and the size of their customer base accurately[37]. Supply chain uncertainty is linked to firms' relationship to individual suppliers. Therefore, it can be argued that it does not constitute a general factor for production location decisions. However, an efficient supply chain is an essential prerequisite for firms' competitiveness: firms do not place their companies solely based on supply chain uncertainty, but the possibility to create efficient supplier relationships are necessary for firms to locate at a given location. The need for an efficient supply chain is strongly related to the sectorial and functional count in Figure 4. It seems that firms seek an ecosystem with efficient suppliers and other plants within the same sector. The existence of production facilities from other sectors do not contribute to such an ecosystem, as the ecosystem has to be constituted of relevant partners from the same sector.

Meijboom and Vos (1997) point to the coordination aspects of activities in the value chain as a factor for location decisions. Firms consider the co-ordination aspects of how to integrate their production and distribution facilities, but they must also consider the configuration aspects of linking facilities along the value chain. The configuration aspect is driven by market pressures and the need for internationalisation, the latter entailing a need to compete on global markets. Therefore, the crucial question for decision on manufacturing investment is how to enhance products in order to win orders in the marketplace. This points to the importance of factors such as delivery speed and dependability, design, technical support and after-sales support. Even though these aspects not are part of production itself, they all influence location decisions on production facilities.[38]

Host country characteristics

Another significant group of factors that affect production location decisions are the **national and regional characteristics** of the host country. These factors are societal factors of potential host countries, covering a wide range of issues.

Brush, Maritan and Karnani (1999) state that production location decisions are determined by network nodes, access to factors of production, and national and regional characteristics[39].

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35 Grabis, J., Chandra, C., & Kampars, J. (2012). "Use of distributed data sources in facility location", Computers & Industrial Engineering, 63, 855-863.

36 Bhatnagar & Sohal (2005)

37 Bhatnagar & Sohal (2005)

38 Meijboom, B., & Vos, B. (1997), "International manufacturing and location decisions: balancing configuration and co-ordination aspects. International Journal of Operations & Production Management", 17(8), 790-805

39 Brush, T. H., Maritan, C. A., & Karnani, A. (1999), "The plant location decision in multinational manufacturing firms: An empirical analysis of international business and manufacturing strategy perspectives", Production and operations management, 8(2), 109-132

Network nodes	Access to factors of production	National and regional characteristics
Proximity to important markets, key customers, key suppliers, and other facilities	Access to raw materials, energy, capital, local technology, skilled labour, low cost labour	Access to protected markets Tax conditions Regional trade barriers Government subsidies Exchange rate risk Language, culture, politics Advanced infrastructure Labour practices and regulation Environmental regulation

These national and regional characteristics include a wide range of issues, such as tax conditions, government subsidies, advanced infrastructure, environmental regulation and labour practices and regulation.

Tax conditions is one of the important factors that can act both as a pull and a push factor. While lower overall tax levels or even specific tax incentives to attract FDI to potential host countries can act as a pull factor, higher taxation levels in the parent country is a push factor.
Barrios et al. (2006) examine the effects of host and additional parent country taxation on the location decisions of multinational firms. Based on panel data on the structure of multinational firms in 33 European countries over the period 1999–2003, they conclude that "*additional parent country corporate taxation of foreign resources has an independent, strongly negative effect on the probability of foreign subsidiary location in potential host countries, despite the fact that parent country taxation can generally be deferred until income is repatriated*"[40]. This means that if a parent country taxes firms abroad, this reduces the inducement for firms to locate abroad in a new host country.

Already in 2000, Dunning (2000) emphasised the increasing importance of national characteristics. He underlines how nation states have become more dependent on cross-border activities (and even though Dunning writes at the turn of the millennium, this development has continued, cf. e.g. Figure 3). The institutional framework of the states increasingly influences these activities. Therefore, states are becoming increasingly aware of their economic and social infrastructure in order to attract multinational enterprises[41]. In the recent years, there has been a massive focus in societal factors in the literature. Chen et. al (2013) identifies more than 40 recent articles concerning different societal aspects of location decisions[42].

Backshoring

A recent trend in firms' production locations is **backshoring** (sometimes referred to as "reverse on-shoring" or "re-shoring"). Backshoring refers to the return of production that was previously offshored from the home country. A 2009 study from Kinkel and Maloca

[40] Barrios, S., Huizinga, H., Laeven, L., & Nicodème, G. (2006), "International taxation and multinational firm location decisions", Journal of Public Economics, 96, s. 946-958
[41] Dunning, J. H. (2000), "The eclectic paradigm as an envelope for economic and business theories of MNE activity", International Business Review, 9, 163–190
[42] Chen, L., et al., Manufacturing facility location and sustainability: A literature review and research agenda. Int. J. Production Economics (2013), http://dx.doi.org/10.1016/j.ijpe.2013.05.013

estimated that between a fourth and a sixth of German firms that had previously offshored, had moved the production back in.[43] Backshoring takes place if the desired effects of offshoring do not materialise and firms decide to reverse the outsourcing process.[44] A PRTM study on the automobile industry revealed a tendency for backshoring in the economic downturn after 2007 but it has not been fully covered whether this is an overall industrial crisis strategy[45]. While off-shoring has been subject to significant academic attention, the area of backshoring has not yet been researched widely.[46] However, the emerging literature points to some critical factors for backshoring[47]:

- *Increased local costs:* The production costs in the host country can increase. For instance, wages in China have increased by 20 percent a year over the last five years.[48]
- *Quality:* An unfulfilling quality of the final products can lead firms to backshoring.[49]
- *Loss of operational flexibility:* Outsourcing production can reduce firms' operational flexibility. Firms backshore production to retain this flexibility.[50]
- *Increased coordination and control costs:* When firms outsource production it increases the need for coordination and control activities.[51]
- *Need for skilled labour:* There is a need for skilled labour in the host country, especially the skills for internal auditors are gaining importance.[52]
- *Market expectations:* As described earlier, proximity to markets is an essential factor in production location decisions. But markets do not always evolve as expected. If the host country market decreases or increases to a smaller degree than expected, this reduces firms' incentive to locate there.[53]

2.2.2 Sectorial differences in production location

The United Nations Conference on Trade and Development (UNCTAD) analyses sectorial differences in location factors in their World Investment Prospect Survey. Some sectorial differences emerge; Pharmaceuticals are more likely to follow their competitors and emphasise access to international markets in their location decisions, while the food industry

43 Kinkel, S. & Maloca, S. (2009), "Drivers and antecedents of manufacturing offshoring and backshoring - A German perspective", Journal of Purchasing & Supply Management, 15(3), 154-165

44 Leibl, P., R. Morefield, & R. Pfeiffer (2013), "A study of the effects of backshoring in the EU", draft for the 13th international conference of American Society of Business and Behaviroal Sciences

45 Drauz, Ralf (2014), "Re-insourcing as a manufacturing-strategic option during a crisis—Cases from the automobile industry", Journal of Business Research, 67, 346-353

46 Drauz, Ralf (2014), "Re-insourcing as a manufacturing-strategic option during a crisis—Cases from the automobile industry", Journal of Business Research, 67, 346-353

47 Arlbjørn, J.S., T. Lüthje, O.S. Mikkelsen. J. Schlichter, L. Thoms (2013), "Danske producenters udflytning og hjemtagning af produktion", Copenhagen, Krak Fondens Byforsknings

48 Shih, W. (2013), "The Resurgence of Manufacturing in America", Inside Supply Management, June/July, 2013, 30-33

49 Kinkel, S. (2012), "Trends in production relocation and backshoring activities: Changing patterns in the course of the global economic crisis", International Journal of Operations & Production Management, 32(6), 696-720.

50 Kinkel, S. & Maloca, S. (2009), "Drivers and antecedents of manufacturing offshoring and backshoring - A German perspective", Journal of Purchasing & Supply Management, 15(3), 154-165

51 Meijboom, B., & Vos, B. (1997), "International manufacturing and location decisions: balancing configuration and co-ordination aspects. International Journal of Operations & Production Management", 17(8), 790-805
Kinkel, S. & Maloca, S. (2009), "Drivers and antecedents of manufacturing offshoring and backshoring - A German perspective", Journal of Purchasing & Supply Management, 15(3), 154-165

52 Leibl, P., R. Morefield, & R. Pfeiffer (2013), "A study of the effects of backshoring in the EU", draft for the 13th international conference of American Society of Business and Behaviroal Sciences

53 Kinkel, S. (2012), "Trends in production relocation and backshoring activities: Changing patterns in the course of the global economic crisis", International Journal of Operations & Production Management, 32(6), 696-720

places a higher weight on the presence of partners and suppliers. Despite sectorial differences, the overall picture is that market considerations are decisive for location decisions. Market considerations include the size of local markets, access to international markets and growth of market.

Figure 5: Sectorial differences in location factors

	Presence of suppliers and partners	Follow your competitors	Availibility of skilled labour and talents	Cheap labour	Size of local markets	Access to internatianel / regional markets	Growth of market	Access to natural resources	Access to capital markets (finance)	Government effectiveness	Incentives	Quality of infrastructure	Stable and business-friendly environment
Manufacturing	**10.1**	**5.0**	**8.1**	**6.5**	**17.5**	**10.0**	**15.8**	**3.4**	**2.4**	**4.0**	**2.9**	**6.1**	**8.1**
Chemicals and chemical products	9.5	2.9	5.1	5.5	18.2	12.4	18.6	6.2	0.7	4.4	1.5	5.1	9.9
Electrical and electronic equipment	10.9	6.3	8.9	7.6	17.1	10.9	19.1	1.0	2.0	2.6	2.6	5.3	5.9
Food, beverages and tobacco	12.6	7.3	6.6	4.6	18.5	9.9	16.6	0.7	6.6	2.6	2.6	4.6	6.6
Motor vehicles and transportation equipment	9.8	7.0	6.0	7.4	17.7	8.8	12.6	2.8	2.8	3.7	6.5	7.4	7.4
Other heavy industry	9.5	2.5	6.9	7.9	16.7	8.8	13.9	8.8	2.5	5.4	0.9	6.3	9.8
Other manufacturing	8.8	8.8	8.8	7.7	17.6	6.6	6.6	-	4.4	8.8	3.3	7.7	11.0
Pharmaceuticals	9.6	9.6	9.6	2.7	17.8	15.1	16.4	-	2.7	6.8	1.4	4.1	4.1
Professional equipment goods	10.2	3.3	13.5	5.8	17.5	8.8	16.8	1.1	0.7	2.2	4.4	7.7	8.0

Source: Data from UNCTADs World Investment Prospects Survey 2009-2011[54]*.*
The figure shows the percentage of companies in a particular sector that consider a location factor the most important.

2.2.3 Location differences

Brush, Maritan and Karnani (1999) measure the impact of these different factors in 209 responses from plant managers from 31 countries, representing 73 large multinational companies. They categorise plants by two dimensions: 1) location relative to headquarters and 2) degree of integration. The first dimension indicates whether the plant is located in the same country as the firm's headquarters. The degree of integration specifies whether the plant is independent or integrated with other plants in the firm. Integration with other plants concerns material flows and knowledge flows between the plants.[55] The plant managers reported what would be important for them if they had to make a location decision (i.e. they were not necessarily facing a concrete location decision at the time).

[54] UNCTAD (2009), "World Investment Prospects Survey 2009-2011", available at http://unctad.org/en/docs/diaeia20098_en.pdf

[55] Brush, T. H., Maritan, C. A., & Karnani, A. (1999), "The plant location decision in multinational manufacturing firms: An empirical analysis of international business and manufacturing strategy perspectives", Production and operations management, 8(2), 109-132

Figure 6: Importance of location factors – if the decision was made at the time of the study

		Integrated Domestic	Independent Domestic	Integrated Foreign	Independent Foreign
Proximity to network nodes	Proximity to important markets	3,22	3,15	3,54	3,94
	Proximity to key customers	3,08	3,05	3,22	3,81
	Proximity to key suppliers	3,11	2,87	2,64	2,69
	Proximity to other facilities	2,92	2,48	2,32	2,34
Factor costs	Factor costs Access to raw materials	2,78	2,6	2,61	2,56
	Access to low cost labor	2,97	2,73	3,19	2,78
	Access to skilled labor	3,73	3,4	3,48	3,25
	Access to energy	3,41	2,77	2,97	2,34
	Access to capital	1,78	1,6	2,29	1,59
	Access to local technology	2,35	2,37	2,48	1,97
	Access to protected markets	1,65	1,35	1,9	1,4
National or regional characteristics	Tax conditions	2,86	3,02	3,25	2,06
	Regional trade barriers	1,57	1,39	2,03	1,88
	Government subsidies	2	2,1	2,97	1,84
	Language, culture, politics	2,32	2,11	3,45	2,25
	Advanced infrastructure	3,46	3,5	3,83	3,25
	Labor practices and regulation	3,16	3,08	3,45	2,66
	Environmental regulation	3,27	3,05	3,12	2,81
	Exchange rate risk	1,38	1,65	2,51	2,13

Source: Brush, Maritan & Karnani (1999). Note: Measured on a scale from 0 to 5, with 0 not being influenced at all, and 5 being influenced to a very large extent

There is a noteworthy difference between decisive factors for domestic and foreign plants. Two critical location factors for foreign plants (both integrated and independent) are '**Proximity to important markets'** and **'Proximity to key customers'**. These factors are especially critical for the location of independent foreign plants. For integrated foreign plants, the **national or regional characteristics** (tax conditions, government subsidies, advanced infrastructure, environmental regulation and labour practices and regulation) are decisive factors. The integrated foreign plants also place higher weight than others do on 'access to low cost labour', and they value 'access to skilled labour'. A very critical factor for the location of foreign plants is market considerations. For independent foreign plants, proximity to important markets and key customers stands out as the prime location factors. Markets considerations are still important for the location of integrated foreign plants, but national or regional factors are of equal importance concerning the location of integrated foreign plants.

Brush, Maritan & Karnani (1999) also compare location factors underlying previous location decisions and if the location decision was made 'now' (at the time of the study). This makes it possible to see the difference between determinants for actual location decisions made previously and for the hypothetical situation of having to make a decision 'now', which would include experiences from previous decisions. A positive difference indicates that the panel ranges a factor higher in the hypothetical situation than in actual decisions.

Figure 7: Differences in the importance of location factors between hypothetical and actual decisions

		Integrated Domestic	Independent Domestic	Integrated Foreign	Independent Foreign
Proximity to network nodes	Proximity to important markets	0,22	0,42	-0,3	-0,19
	Proximity to key customers	0,37	0,32	-0,23	0,08
	Proximity to key suppliers	0,34	0,5	0,12	0,32
	Proximity to other facilities	0,18	0,13	0,32	0,27
Factor costs	Factor costs Access to raw materials	0,07	0,81	0,13	0,43
	Access to low cost labor	0,31	0,58	0,32	0,25
	Access to skilled labor	0,39	0,33	0,13	0,48
	Access to energy	0,47	0,52	0,13	0,04
	Access to capital	0,21	0,43	0,1	0,69
	Access to local technology	0,75	0,72	0,58	0,87
	Access to protected markets	0,48	0,67	0,42	-0,13
National or regional characteristics	Tax conditions	0,75	1,47	0,64	0,33
	Regional trade barriers	0,94	0,74	0,61	0,58
	Government subsidies	1	1,09	0,36	0,64
	Language, culture, politics	0,86	1,03	0,39	0,05
	Advanced infrastructure	0,72	0,67	0,28	0,32
	Labor practices and regulation	0,85	0,93	0,48	0,66
	Environmental regulation	1,41	1,53	1,06	1,41
	Exchange rate risk	0,75	1,19	0,41	0,96

Source: Own calculations based on Brush, T. H., Maritan, C. A., & Karnani, A. (1999)

Tax conditions, Regional trade barriers, and Environmental regulation are the factors with the highest increase in importance for integrated foreign firms. There are two possible interpretations, either these factors have gained importance over time, or firms place higher weight on these location factors in hypothetical settings than in real-life situations.

2.2.4 Impact of offshoring on home and host countries

Production offshoring gives rise to different **challenges and risks** for the home country. Offshoring can lead to higher wage dispersion, i.e. that unskilled workers' wage level decreases and their wage share in the total wage bill decreases as well.[56] Offshoring of production activities also has an immediate impact on jobs in the home country.[57] However, production offshoring can also give some **opportunities** for the home country in terms of the creation of complementary jobs, in general management, logistics etc., to support the international production activities. Home country firms can strengthen their price competitiveness by offshoring production to lower-wage production locations. This can create large revenues for home country firms which benefit the home country. Production offshoring impacts the host country **positively**, creating immediate jobs.[58] As shown in section 2.4, production and R&D location decisions are inter-related. Therefore, the location of production facilities in a host country can improve the chances to attract R&D facilities.

In summary

[56] Lipsey, Robert E (2004), "Home- and Host-Country Effects of Foreign Direct Investment", available at http://www.nber.org/chapters/c9543.pdf

[57] Rajshekhar, G. J., A. Dixit & R. F. Scherer (2009), "Outsourcing to emerging markets: Theoretical perspectives and policy implications", Journal of International Management, 15(2), 156–168

[58] Farrel, D. (2005), "Offshoring: value creation through economic change", Journal of Management Studies, 42 (3), 675–682

The literature on production location decisions points to a multitude of quite different elements that affect location decisions. Therefore, studies on location decisions examine different factors. However, a number of factors appear as crucial across all studies:

- Market considerations are an essential determinant for location decisions, since companies value the proximity to important markets in their location decisions.
- Labour costs (unit wage cost), impact location decisions as well. Location decisions are different for independent and integrated plants.
- The value of being near an ecosystem of dependable suppliers, other plants in the same sector and facilities along the value chain stand out as agglomeration forces that influence production location decisions.
- The location of production is not that dependent on the placement of other facilities like corporate headquarters, sales/logistics, etc. Hence, there is a high degree of freedom in where to locate production facilities in relation to these types of value chain activities. However, R&D co-location is important for production facility locations.
- Host country characteristics such as tax conditions, government subsidies, advanced infrastructure, environmental regulation and labour practices and regulation are decisive factors as well. Integrated plants weigh national characteristics higher than independent plants.

2.3 RDI location decisions

2.3.1 Patterns of R&D internationalisation

The phenomenon of R&D internationalisation is more of a recent one. In particular, R&D and the accumulation of knowledge were long regarded as activities that are bound to the home countries of MNEs. In their seminal paper on R&D in large MNEs, Patel and Pavitt (1999)[59] concluded that the production of technology was concentrated in the home countries of MNEs and therefore remained 'far from globalized'. Hence until the 1990s, R&D was still 'an important case of non-globalization' (Patel and Pavitt, 1999).

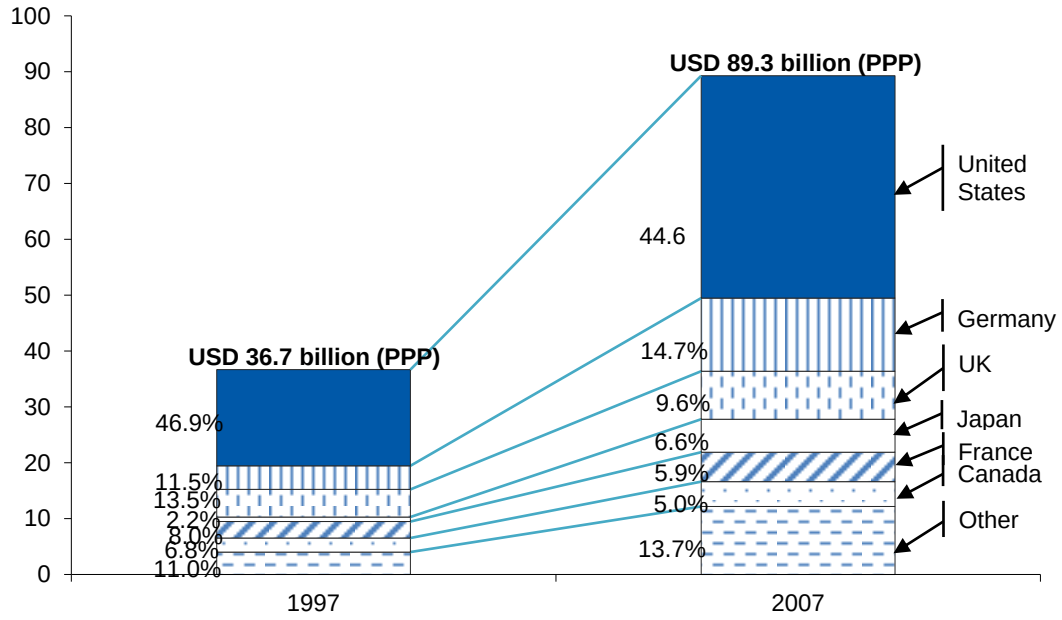
However, during the last two decades, the internationalisation of business R&D activities has accelerated strikingly. In particular, between 1995 and 2003, R&D expenditure of foreign affiliates increased twice as fast as their turnover or their host countries' aggregate imports, which renders R&D activities of foreign affiliates one of the most dynamic elements of the process of globalisation (OECD 2008a).[60] Until recently, the main actors and recipients of cross-border R&D expenditure were developed countries. Lately, however, some new players emerged: especially in Asia, emerging economies like China or India became attractive host countries of R&D internationalisation activities, but other developing countries also increasingly engaged in the relocation of R&D activities abroad. All these recent developments notwithstanding, the major part of international R&D still takes place between the triad area, comprising the US, the EU and Japan (OECD 2008b).[61]

[59] Patel, P., and K. Pavitt (1999), "Global Corporations and National Systems of Innovation: Who Dominates Whom?", in Archibugi, D., J. Howells, and J. Michie, "Innovation Policy in a Global Economy", Cambridge, Cambridge University Press, 94-119

[60] OECD (2008a), "The Internationalisation of Business R&D: Evidence, Impacts and Implications", Paris, Organisation for Economic Co-operation and Development

[61] OECD (2008b), "Open Innovation in Global Networks", Paris, Organisation for Economic Co-operation and Development

Figure 8: Trends in the share of R&D expenditure under foreign control in the manufacturing sector in selected OECD countries between 1997 and 2007 (in Billions USD, PPP)



Source: OECD (2010); based on OECD, AFA database and OECD estimates, January 2010
Note: Other OECD comprises the Czech Republic, Finland, Hungary, Ireland, the Netherlands, Poland, Spain and Sweden. Data were partially estimated.

Trends in the share of R&D expenditure under foreign control in the manufacturing sector in selected OECD countries between 1997 and 2007 are depicted in the figure above. It highlights that in 1997, R&D expenditures in the OECD were around USD 36.7 billion (in purchasing power parity (PPP), with the US accounting for 46.9% of total R&D expenditure of foreign affiliates, followed by the UK (13.5%), Germany (11.5%), France (8%), Canada (6.8%) and Japan (2.2%). Between 1997 and 2007, R&D expenditure of foreign affiliates in the OECD more than doubled (from USD 36.7 in 1997 to USD 89.3 in 2007 (in PPP)). However, the remarkable increase in overall R&D expenditure of foreign affiliates in the OECD was accompanied by considerable changes in the countries' relative shares. The US share of R&D dropped slightly, however the US still continued to attract almost 45% of total foreign R&D expenditure in the OECD in 2007. While Germany and Japan were able to increase their shares, others (like the US, the UK, France or Canada) saw their shares decline.

2.3.2 Drivers of R&D location decision

The oldest literature on the internationalisation of R&D dates back to the end of the 1960s and the beginning of the 1970s (e.g. Dunning 1958; Brash 1966; Safarian 1966).[62] Only few

[62] Dunning, J. (1958), "American Investment in British Manufacturing Industry", London, Allen and Unwin
Brash, D.T. (1966), "American Investment in Australian Industry", Cambridge, Mass, Harvard University Press

articles and surveys emerged in the 1970s (e.g. Creamer 1976; Ronstadt 1977; Lall 1979)[63] and in the 1980s (Behrman and Fischer 1980)[64]. Since the early 1990s, as more and better data has become available, a rapidly growing body of literature emerged which stresses that the internationalisation of R&D is quickly gaining momentum (e.g. OECD 2005; UNCTAD 2005; OECD 2008a; OECD 2008b; OECD 2008c).[65]

Studies on the R&D location decision differ widely in terms of the level and type of analysis, the period or countries covered or the specific variables tested, which makes comparisons very difficult. However, despite apparent differences, some coherent conclusions can be drawn from this rich body of literature. Specifically, **the size of the market** is identified as one key location factor of R&D activities (e.g. Kumar 2001; Athukorala and Kohpaiboon 2010; Dachs and Pyka 2010).[66] Frequently, R&D activities of MNEs accompany and support production activities by adapting products and production processes to local demand patterns or consumer preferences. These costs of adaptive R&D can more easily be recovered in larger markets with stronger demand and consequently larger revenues.

Similarly, a location factor that is of crucial importance is a **skilled workforce and the quality of education systems** (Thursby and Thursby 2006; Kinkel and Maloca 2008; European Commission 2010).[67] In particular, in the face of skills shortages and a growing demand for engineers and scientists in the home country, firms frequently go abroad with their R&D. For instance, Lewin et al. (2009)[68] demonstrate that a shortage of highly skilled science and engineering talent in the US explains the relocation of product development to other parts of the world while Hedge and Hicks (2008)[69] stress that innovative activities of overseas US subsidiaries are strongly related to the scientific and engineering capabilities of the host countries. Similar pull-effects of human capital are identified by Erken and Kleijn (2010) who show that strong human resources in science and technology in the host country are strong location factors for international R&D activities or by Ernst (2006)[70] who relates

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Safarian, A.E. (1966), "Foreign Ownership of Canadian Industry", Toronto, McGraw Hill

63 Creamer, D.B. (1976), "Overseas Research and Development by the US Multinationals", The Conference Board, New York.
Ronstadt, R.C. (1977), "Research and Development Abroad by U.S. Multinationals", New York, Praeger Publishers.
Lall, S. (1979), "The International Allocation of Research Activity by US Multinationals", Oxford Bulletin of Economics and Statistics, 41(4), 313-331

64 Behrman, J.N., and W.A. Fischer (1980), "Overseas R&D Activities of Transnational Companies", Cambridge, Mass, Oelgesclagert, Gunn & Hein

65 OECD ,2005, Measuring Globalisation: OECD Economic Globalisation Indicators, Paris, Organisation for Economic Co-operation and Development.
UNCTAD (2005), "World Investment Report 2005: Transnational Corporations and the Internationalization of R&D", United Nations, New York and Geneva
OECD (2008c), Recent trends in the internationalisation of R&D in the enterprise sector, DSTI/EAS/IND/SWP (2006)1/Final. Organisation for Economic Co-operation and Development, Paris.

66 Athukorala, P.-C., and A. Kohpaiboon (2010), "Globalization of R&D by US-based multinational enterprises", Research Policy, 39, 1335-1347
Dachs, B., and A. Pyka (2010), "What drives the Internationalisation of Innovation? Evidence from European Patent Data", Economics of Innovation and New Technology, 19(1), 71-86

67 Thursby, J., and M. Thursby (2006), "Here or There? A Survey of Factors in Multinational R&D Location", National Academies Press, Washington DC
European Commission (DG Research and Innovation, JRC-IPTS) (2010), "Monitoring Industrial Research: The 2009 EU Survey on R&D Investment Business Trends", European Communities, Luxembourg

68 Lewin, A.Y., S. Massini, and C. Peeters (2009), "Why are companies offshoring innovation? The emerging global race for talent", Journal of International Business Studies, 40(6), 901-925

69 Hedge, D., and D. Hicks (2008), "The maturation of global corporate R&D: Evidence from the activity of U.S. foreign subsidiaries", Research Policy, 37(3), 390–406

70 Ernst, D. (2006), "Innovation Offshoring – Asia's Emerging Role in Global Innovation Networks", East-West Center Report Nr. 10, Honolulu

the success of India and other Asian countries in attracting foreign R&D to their expanding pool of graduates in science and technology.

The possibility to benefit from sizeable **knowledge spillover effects** is another factor of crucial importance for the location decision of R&D activities. In particular, firms which want to utilise localised knowledge spillovers have to be present where they occur. Hence, R&D activities may be relocated to host countries whose technological specialisation or leadership is of particular interest for the learning potentials it offers to technologically lagging firms and the knowledge transfers it enables. Kumar (2001) highlights that the scale of national technological efforts in the host country is a crucial determinant of the location decision of R&D of US and Japanese affiliates. Erken and Kleijn (2010) demonstrate for a set of 13 OECD countries that inward R&D expenditure of foreign affiliates is strongly attracted by the stock of private knowledge of the host country and the potential for knowledge spillovers it offers. They estimate that - in the long run - 1% additional private R&D expenditure (as percentage of GDP) is associated with an increase in R&D investments of foreign affiliates (as a ratio of GDP) of 0.56%. In contrast, no significant effect is found for public R&D expenditure (as percentage of GDP). Cantwell and Piscitello (2002)[71] point at the role of geographic concentration of innovative activities for the prevalence and size of knowledge spillovers and show that the presence of technology clusters fosters the generation of new knowledge and technology (in terms of the number of patents granted to foreign-owned firms). Additionally, spillovers as a determinant for R&D location decisions point to the importance of the quality of university research as a driver of R&D internationalisation at the country level (Belderbos et al. 2009; Dachs and Pyka 2010).[72]

In contrast, the **labour costs of R&D personnel** are found to have an ambiguous role for the location decision of R&D. For instance, Kumar (2001), Kinkel and Maloca (2008) and Athukorala and Kohpaiboon (2010) find a positive effect between labour costs and R&D offshoring. Kumar (2001) demonstrates that the lower relative cost of qualified R&D personnel in the host country is attractive for R&D efforts of US and Japanese affiliates. Kinkel and Maloca (2008) emphasise that lower costs of qualified personnel is the second most important reason of German firms to relocate their R&D activities abroad. And Athukorala and Kohpaiboon (2010) highlight that a lower wage rate of technical personnel is conducive to R&D efforts of MNEs. In contrast, Cornet and Rensman (2001)[73] find that cost factors (like e.g. costs of R&D personnel) seem to be less important location factors of R&D activities. However, cost differences appear to gain importance when firms consider to locate R&D and innovation activities in emerging economies, or when firms have to choose between two similarly attractive locations (Booz Allen Hamilton and INSEAD 2006[74]; Thursby and Thursby 2006; Cincera et al. 2009[75]).

In a similar vein, empirical evidence on the role of **geographical proximity** between host and home country for the location decision of R&D is mixed and inconclusive. Generally, a

[71] Cantwell, J., and L. Piscitello (2002), "The location of technological activities of MNCs in European regions: The role of spillovers and local competencies", Journal of International Management, 8, 69–96

[72] Belderbos, R., B. Leten, and S. Suzuki (2009), "Does Excellence in Scientific Research attract foreign R&D?", UNU-Merit Working Paper, UNU-MERIT, Maastricht

[73] Cornet, M. and M. Rensman, 2001, The Location of R&D in the Netherlands: Trends, Determinants and Policy, CPD Document 14.

[74] Booz Allen Hamilton, and INSEAD (2006), "Innovation: Is Global the Way Forward?", Paris

[75] Cincera, M., C. Cozza, and A. Tübke (2009), "The main drivers for the internationalization of R&D activities by EU MNEs", Draft for the 4th Annual Conference of GARNET Network, IFAD, 11-13 November 2009, Rome

potential negative distance effect is often explained by additional co-ordination cost, the cost of transferring knowledge over distance, and a loss of economies of scale and scope when R&D becomes more decentralized (von Zedtwitz and Gassmann 2002; Gersbach and Schmutzler 2006; Sanna-Randaccio and Veugelers 2007).[76]

Additionally, it may also be explained by **cultural, social and institutional factors** since foreign firms have to master additional institutional and cultural barriers in their host countries like a lack of market knowledge and understanding of customer demands, but also a lower degree of embeddedness in informal networks in the host country. In this respect, results by Guellec and van Pottelsberghe de la Potterie (2001)[77], Dachs and Pyka (2010) demonstrate that geographical proximity between host and home country is conducive to cross-border R&D investments, while Belderbos et al. (2009) show that the probability to conduct R&D abroad increases with geographic proximity. In contrast, Castellani et al. (2011)[78] emphasize that once social, cultural and institutional factors like shared language or membership in the same regional trade agreement are accounted for, the location of R&D labs abroad is independent of geographic distance and therefore equally likely to be found close by or farther away. Similarly, Athukorala and Kohpaiboon (2010) also fail to find a significant effect of distance on the R&D intensity of US MNEs.

Finally, **public policy** also shapes the attractiveness of regions or countries for overseas R&D activities. There is consensus in the literature of policy measures in the field of R&D internationalisation that governments that want to attract R&D of foreign MNEs should focus on the economic fundamentals rather than grant special incentives to foreign-owned firms. Governments should provide a healthy business environment, political stability, good public infrastructure, reasonable tax rates, and a stable legal system including the protection of intellectual property rights (see e.g. Cantwell and Mudambi 2000; Kumar 2001; Cantwell and Piscitello 2002; Thursby and Thursby 2006; Kinkel and Maloca 2008; European Commission 2010).[79]

In addition, **science, technology and innovation (STI) policy measures** like public subsidies for R&D performing firms, measures to foster co-operation between firms and universities or measures to foster university education can significantly shape locational advantages and influence internationalisation decisions of firms in R&D (Steinmueller 2010).[80] Again, there is consensus in the literature that special incentives to foreign-owned firms are not an appropriate instrument to attract R&D of foreign-owned firms (e.g. Cantwell and Mudambi 2000; Kumar 2001; Cantwell and Piscitello 2002; Thursby and Thursby 2006; Kinkel and Maloca 2008; European Commission 2010). However, the literature also

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76 Von Zedtwitz, M., and O. Gassmann (2002), "Market versus Technology Drive in R&D Internationalization: Four different Patterns of Managing Research and Development", Research Policy, 31(4), 569-558
Gersbach, H., and A. Schmutzler (2006), "Foreign Direct Investment and R&D Offshoring", Socioeconomic Institute University of Zurich Working Paper 0606, Zürich
Sanna-Randaccio, F., and R. Veugelers (2007), "Multinational knowledge spillovers with decentralised R&D: a game-theoretic approach", Journal of International Business Studies, 38(1), 47-63

77 Guellec, D., and B. van Pottelsberghe de la Potterie (2001), "The Internationalisation of Technology Analysed with Patent Data", Research Policy, 30(8), 1253-1266

78 Castellani, D., A. J. Palmero, and A. Zanfei (2011), "The Gravity of R&D FDI."WorkingPapers Series in Economics, Mathematics and Statistics WP-EMS No. 2011/06, Facoltà di Economia, Università degli Studi di Urbino "Carlo Bo", Urbino

79 Cantwell, J., and R. Mudambi (2000), "The location of MNE R&D activity; the role of investment incentives", Management International Review, 40(1), 127-148

80 Steinmueller, W.E. (2010), "Economics of Technology Policy", in Hall, B.A. and N. Rosenberg, Handbook of Economics of Innovation, Amsterdam, Elsevier, 1182-1218

emphasises that public support for R&D can create important additionalities and can help leverage R&D efforts of firms, including foreign-owned firms.

In addition to country-level determinants of R&D internationalisation decisions of MNEs, specific characteristics of industries matter and shape observable inter-industry differences in the degree of internationalisation of R&D efforts. Firstly, a high **degree of tacitness** of the knowledge-base of a sector is obstructive to the internationalisation of R&D as abstract concepts are difficult to articulate explicitly and to transfer between people (Cowan et al. 2000).[81] Secondly, a high **degree of cumulativeness** (i.e. a large and strong available knowledge base) of the knowledge-base of a sector is obstructive to the internationalisation of R&D as high degree of cumulativeness may require a high degree of specialisation in R&D, which favours centralized R&D. Cumulativeness may also promote R&D centralisation when strong learning effects lead to increasing returns to scale in R&D, or when the R&D process includes economies of scope and effects from cross-fertilisation. Cumulativeness is found to be high in chemicals, pharmaceuticals, telecommunications and electronics, and low in mechanical engineering, food, clothing, or civil engineering (Malerba and Orsenigo 1996; Marsili 2001).[82] However, Ramirez (2014) highlights that R&D outsourcing among top European and US pharmaceutical firms which is increasingly concentrated in a few world clusters has been on the increase.[83] Thirdly, a **low degree of appropriability** (i.e. the degree to which an innovation can be protected from imitation) is also obstructive to the relocation of R&D abroad since, given their rather weak means to prevent involuntary knowledge spillovers and leakages, firms in sectors with a low degree of appropriability may be reluctant to internationalise R&D. Finally, a **firm's network of external relations with suppliers, clients, universities or public authorities** (Marsili 2001; Malerba 2002)[84] also matter. For instance, firms in the automotive of the electronics industry are closely connected to suppliers and customers through international production networks. Suppliers in these sectors may be forced to internationalise their R&D to have development capabilities in proximity to key clients. For instance, Erken and Kleijn (2010) show that industries that are characterised by higher R&D efforts also attract more R&D from abroad or that in high-technology industries such as chemicals or the electrical and optical equipment industry, human capital is of higher importance than in other industries while, in contrast, the stock of R&D capital is an important R&D location factor in all industries.

2.3.3 Sectoral differences in R&D location

Empirical evidence points at strong inter-industry differences in the patterns and the degree of the internationalisation of R&D efforts. Erken and Kleijn (2010)[85] use the OECD AFA statistics between 1995 and 2004 to study characteristics of industries receiving R&D from

81 Cowan, R., P.A. David, and D. Foray (2000), "The Explicit Economics of Knowledge Codification and Tacitness", Industrial and Corporate Change, 9(2), 211-253

82 Malerba, F., and L. Orsenigo (1996), "Schumpeterian Patterns of Innovation are technology-specific", Research Policy, 25, 451-478
Marsili, O. (2001), "The Anatomy and Evolution of Industries: Technological Change and Industrial Dynamics", Cheltenham, UK and Northampton, MA, USA, Edward Elgar

83 Ramirez, P., (2014), "Outsourcing and Offshoring of R&D in the Pharmaceutical Industry: Evidence and Policy Implications from a Global Value Chain Analysis", Paper presented at the 3rd IRIMA Workshop on the Internationalisation of Corporate R&D and Innovation, Brussels, June 5, 2014

84 Malerba, F. (2002), "Sectoral Systems of Innovation and Production", Research Policy, 31(2), 247-264

85 Erken, H. and M. Kleijn, 2010, Location factors of of international R&D activities: An econometric approach, Economics and Innovation, 19(3), 203-233

abroad. They highlight that in OECD countries, chemicals, the radio, TV and communication equipment industry, the office machinery industry, the medical instruments industry and the transport equipment industry were characterised by the highest average R&D expenditure of foreign affiliates (as a percentage of value added). With below 0.2%, the majority of service-related industries have the lowest R&D expenditure of foreign affiliates (as a percentage of value added). Moreover, a study by the OECD (2010)[86] demonstrates that in 2007 the degree of internationalisation of R&D activities observable at the industry-level differed across the three major global players in R&D internationalisation. In Japan, R&D investment of foreign affiliates was strongly concentrated in one industry only: with almost 70%, the share of foreign R&D investment (in total) was the highest in the motor vehicles industry, followed by pharmaceuticals (with almost 20%) and the office, accounting and computing machinery industry (with less than 5%). In contrast, in both the US and the EU, R&D investment of foreign affiliates is less concentrated. In the US, the share of foreign R&D investment was highest in pharmaceuticals (with almost 40%), followed by the transport equipment industry (with around 15%) and the radio, TV and communication equipment industry (with almost 10%). In the EU, the share of foreign R&D investment was highest in pharmaceuticals (with around 20%), followed by the motor vehicles industry (with almost 15%) and the radio, TV and communication equipment industry (with almost 10%)[87]. Moreover, empirical evidence is mounting that industries are subject to quite different internationalisation trends. For instance, Kinkel and Maloca (2008)[88] show for the German manufacturing sector that between 2004 and 2006, firms in the chemical industry and in vehicle manufacturing (plus suppliers) internationalised their R&D activities the most, followed by the medical engineering, the process measuring and control technology, the optical industry and the mechanical engineering industry. On the contrary, firms in the metal production industry and the paper, publishing and printing industry internationalised their R&D activities the least. Finally, Kumar (2001)[89] suggests that MNEs pursue different R&D internationalisation strategies: while US MNEs also conduct more R&D abroad in more R&D intensive industries, Japanese MNEs in more technology intensive sectors retain their R&D efforts at home and only move abroad in relatively simple technology sectors.

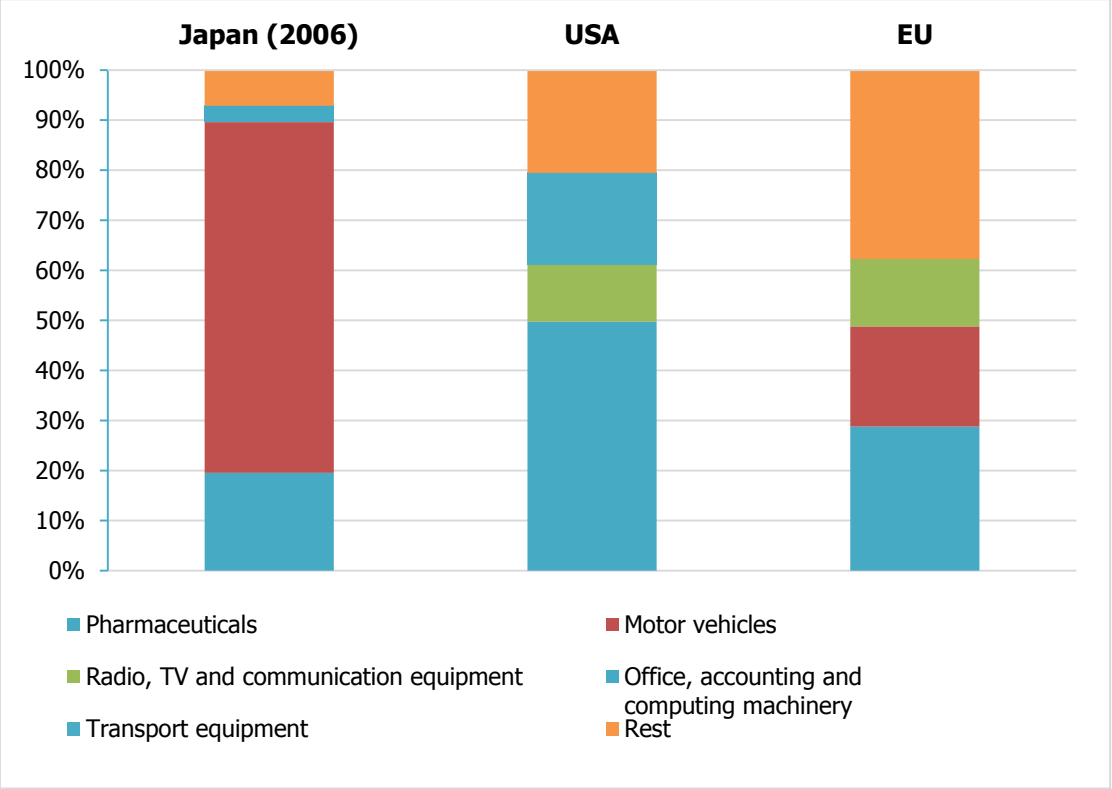
[86] OECD (2010), "Measuring Globalisation: OECD Economic Globalisation Indicators 2010", Paris, Organisation for Economic Co-operation and Development

[87] These numbers should also include intra-EU R&D investments as the OECD used "R&D expenditures of affiliates under foreign control by main industrial sectors, 2007 - In millions of PPP USD and percentages of total", which does not discriminate between EU and non-EU origin of inward BERD.

[88] Kinkel, S., and S. Maloca (2008), „FuE-Verlagerungen in Ausland - Ausverkauf deutscher Entwicklungskompetenz?", Fraunhofer ISI, Karlsruhe

[89] Kumar, N. (2001), "Determinants of Location of Overseas R&D Activity of Multinational Enterprises: The Case of US and Japanese Corporations", Research Policy, 30(1), 159-174

Figure 9: R&D expenditures of affiliates under foreign control by main industrial sectors, 2007 (in percentages of total)



Source: OECD (2010); based on OECD, AFA database and OECD estimates, January 2010
Note: Rest in the EU comprises: Non-electrical machinery (8.1%), Aircraft and spacecraft (8.1%), Chemicals – less pharmaceuticals (6.2%) and Scientific instruments (4.4%).

2.3.4 Outsourcing of RDI activities

Moreover, R&D outsourcing has increasingly become an important strategy of companies to get access to distinctive capabilities of specialised providers, gain efficiencies and enter new or growing markets. Such partnerships are organised in different contract forms, like alliances or research cooperation with different partners, e.g. suppliers, clients, competitors or research institutes.

In general, empirical evidence seems to suggest that firms simultaneously cooperate with several types of partners to carry out their innovation activities (Badillo and Moreno 2012).[90] However, firms appear to more often cooperate on R&D projects with other private firms than with public research institutes (see e.g. Polt et. al. 2001).[91]

Empirical evidence on the determinants of R&D cooperation is also quickly mounting, demonstrating that, generally, incoming spillovers are important determinants of R&D

[90] Badillo, E. and R. Moreno (2012), "What Drives the Choice of Partners in R&D Cooperation? Heterogeneity across Sectors", IREA Working Paper 2012/13, Regional Quantitative Analysis Research Group Working Paper 2012/06.

[91] Polt W., H. Gassler, A. Schibany, C. Rammer, N. Valentinelli and D. Schartinger (2001), "Benchmarking Industry-Science Relations – The Role of Framework Conditions", Final Report. European Commission, Firm DG, Benchmarking Coordination office.

cooperation (e.g. Ramirez, 2014) [92]. Additionally, R&D cooperation is not independent of specific firm characteristics. For instance, R&D cooperation is more likely among more technologically advanced firms with stronger absorptive capacities (Bayona et al. 2001; Lopez 2008; Arranz and Arroyave, 2008)[93] or among firms which can more effectively appropriate returns from their innovative activities through strategic protection (Cassiman and Veugelers 2002; Lauterbach and Benavente 2009). Moreover, studies usually find that larger firms are more likely to engage in R&D cooperation (Cassiman and Veugelers 2002, Bayona et al. 2001, Arranz and Arroyabe 2008 or López 2008 among others).

Additionally, evidence is mounting that determinants of R&D cooperation differ across types of R&D cooperation. Evidence points at different effects of incoming spillovers by type of cooperation partner: The strongest impact seems to stem from cooperation with universities (and consultants) while cooperation with suppliers, customers or competitors gives rise to smaller incoming spillovers (Cassiman and Veugelers 2002; Lauterbach and Benavente 2009).[94] However, the effects of firm size are more mixed. Belderbos et al. (2004)[95] show that firm size is always associated with a higher likelihood of R&D cooperation, irrespective of type of cooperation partner considered, but also emphasise that the size-effect is strongest for institutional cooperation. This is in contrast to findings by Bayona et al. (2003) which highlight that vertical cooperation is more likely among smaller firms while horizontal cooperation appears to be independent of firm size. In addition, the literature suggests that strong absorptive capacities appear to be important for supplier, customer or institutional cooperation, while, on the contrary, competitor cooperation is more likely in the case of weak absorptive capacities. Hence, in the face of higher risks of information leakages, R&D cooperation with competitors are less likely for firms with strong absorptive capacities (Belderbos et al. 2004, Miotti and Sachwald 2003[96]). On the contrary, the cooperative behaviour of foreign MNCs has attracted little attention in the literature so far. Notable exceptions are Belderbos et al. (2004) or Gussoni (2009)[97]. In this respect, Belderbos et al. (2004) find that belonging to a foreign group decreases the probability of cooperation with competitors but does not affect the probability of cooperation with suppliers, customers and universities. However, Gussoni (2009) highlights that irrespective of type of cooperation considered, foreign multinational companies always exhibit a lower propensity to cooperate in R&D than domestic firms.

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92 Ramirez, P., (2014), "Outsourcing and Offshoring of R&D in the Pharmaceutical Industry: Evidence and Policy Implications from a Global Value Chain Analysis", Paper presented at the 3rd IRIMA Workshop on the Internationalisation of Corporate R&D and Innovation, Brussels, June 5, 2014

93 Bayona, C., T. Garcia-Marco and E. Huerta (2001), "Firms' motivations for cooperative R&D: an empirical analysis of Spanish firms", Research Policy, 30, 1289-1307.
López, A. (2008), "Determinants for R&D Cooperation: Evidence from Spanish Manufacturing Firms", International Journal of Industrial Organization, 26(1), 113-136.
Arranz, N. and J.C.F. Arroyabe (2008), "The choice of partners in R&D cooperation: An empirical analysis of Spanish firms", Technovation, 28, 88-100.

94 Lauterbach, R. and J.M. Benavente (2009), "R&D Cooperation Determinants, Evidence from Chilean Firms", mimeo.
Cassiman, B. and R. Veugelers, 2002, R&D cooperation and spillovers: Some empirical evidence from Belgium. American Economic Review 92(4), 1169-1184.

95 Belderbos, R., M.A. Carree, B. Diederen, B. Lokshin and R. Veugelers (2004), "Heterogeneity in R&D co-operation strategies", International Journal of Industrial Organization, 22, 1237-1263.

96 Miotti, L. and F. Sachwald (2003), "Co-operative R&D: why and with whom? An integrated framework of analysis", Research Policy, 32, 1481-1499.

97 Gussoni, M. (2009), "Cooperation Strategies and Knowledge Spillovers, Evidence from the Fourth Italian Community Innovation Survey", DSE, Università di Pisa Working Paper.

Finally, a growing body of literature also suggests that the choice of cooperation partner is pivotal to innovation outcome. In this respect, given their superior science research capabilities, cooperative R&D efforts with public institutions, universities or research institutes are found to be beneficial for the development of new products (Belderbos et al. 2004; Aschhoff and Schmidt 2006[98]). In contrast, findings are less clear-cut for R&D cooperation with either customers and suppliers or rivals.

2.3.5 Impacts on host and home countries

As for impacts of the internationalisation of RDI on host and home countries, the literature has identified various potential challenges and opportunities for host and home countries from the internationalisation of RDI (see Table 1 for an overview).

Table 1: Potential opportunities and challenges for national innovation systems from the internationalisation of RDI

	Opportunities	Challenges and Risks
Host country	• Increases in aggregate R&D and innovation expenditure • Knowledge diffusion to the host economy • Increase in the demand for skilled personnel • Structural change and agglomeration effects	• Loss of control over domestic innovation capacity and commercialisation • Less strategic research, less radical innovations, more adapting • Separation of R&D and production • Competition with domestically owned firms for resources ('Crowding out')
Home Country	• Improved overall R&D efficiency • Reverse technology transfer • Market expansion effects • Exploitation of foreign knowledge at home	• Loss of jobs due to relocation • 'Hollowing out' of domestic R&D and innovation activities • Technology leakage and involuntary knowledge diffusion

Source: Adapted from Sheehan (2004), UNCTAD (2005), Veugelers (2005)[99]

2.3.5.1 Impacts on host countries

In particular, host countries can **benefit** considerably from the R&D activities of foreign-owned firms. Firstly, R&D expenditure of foreign-owned firms may *increase aggregate R&D and innovation expenditure of the host country*. In particular, in many countries, R&D expenditure of MNEs constitutes a non-negligible share of gross R&D expenditure (Lonmo and Anderson 2003; Costa and Filippov 2008).[100] Moreover, affiliates of MNEs may enjoy access to internal funds and can therefore more easily finance R&D activities while in

98 Aschhoff, B. and T. Schmidt (2006), "Empirical evidence on the success of R&D cooperation: Happy together?", ZEW Discussion Paper No. 06-59.

99 Sheehan, J. 2004. "Globalisation of R&D: Trends, Drivers and Policy Implications", Paper presented at the IST 2004, Den Haag
Veugelers, R. (2005), "Internationalisation of R&D: Trends, Issues and Implications for S&T policies", Background report for the OECD Forum on the internationalization of R&D, Organisation for Economic Co-operation and Development, Brussels

100 Lonmo, C., and F. Anderson (2003), "A Comparison of International R&D Performance: An Analysis of Countries that Have Significantly Increased Their GERD/GDP Ratios during the Period 1989-1999", Statistics Canada 88F0006XIE2003001, Ottawa
Costa, I., and S. Filippov (2008), "Foreign-owned subsidiaries: a neglected nexus between foreign direct investment, industrial and innovation policies", Science and Public Policy, 35(6), 379-390

response to the threat of market entry by R&D intensive MNEs domestically owned firms may expand own R&D activities (Aghion et al. 2009).[101]

Secondly, inward R&D expenditure may give rise to substantial *information and knowledge spillovers*, with domestic firms, universities or research centres as potential recipients and beneficiaries. However, empirical evidence on the size and effects of spillovers are mixed: diverse meta-studies (Görg and Greenaway 2004; Mayer and Sinani 2009; Havránek and Iršová 2010)[102] as well as literature surveys find no clear relationship between the presence of foreign-owned firms and the performance of domestically owned firms. In contrast, empirical evidence is clearer and more consistent at the more aggregate level: substantial spillover effects from foreign R&D stocks and the presence of foreign-owned firms are found at the sectoral level (Keller and Yeaple 2009; Coe et al. 2009).[103]

Thirdly, foreign-owned firms may *boost the demand for skilled personnel including R&D staff*. Given the attractive international career perspectives and significantly higher wages they offer, MNEs are attractive employers (Lipsey 2002)[104] whose R&D activities may generate additional demand for researchers and technical staff.

Finally, inward R&D and the presence of foreign-owned firms may lead to *structural change and agglomeration effects*. In particular, since foreign-owned firms predominantly operate in technology intensive industries, their market entry and subsequent growth first of all moves the industrial structure of a country towards higher technology intensity and secondly their demand for inputs promotes the growth of domestic technology-intensive suppliers. The latter effect may also lead to the emergence of clusters and other agglomerations in the host country (Young et al. 1994; Bellandi 2001; Pavlínek 2004).[105]

In contrast, R&D activities of foreign-owned firms may also have **negative consequences** for the host country. Firstly, host countries run the risk of losing control over their indigenous innovation capacity. Secondly, if foreign-owned firms predominantly pursue adaptive innovation activities, fewer radical innovations may result. Thirdly, multinational firms may decide to separate research and production so that their R&D activities may produce fewer jobs in the host country than in the case of a domestic firm. In particular, MNEs may find it useful to develop products in one country and manufacture them in another country where conditions for production appear more favourable. Hence, any measures to promote R&D

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101 Aghion, P., R. Blundell, R. Griffith, P. Howitt, and S. Prantl (2009), "The effects of entry on incumbent innovation and productivity", Review of Economics and Statistics, 91(1), 20-32

102 Görg, H., and D. Greenaway (2004), "Much Ado about Nothing? Do Domestic Firms Really Benefit from Foreign Direct Investment?", The World Bank Research Observer, 19(2), 171-197
Mayer, K.E., and E. Sinani (2009), "When and Where Does Foreign Direct Investment Generate Positive Spillovers? A Meta-Analysis", Journal of International Business Studies, 40(7), 1075-1094
Havránek, T., and Z. Iršová (2010), "Which Foreigners Are Worth Wooing? A Meta-Analysis of Vertical Spillovers from FDI", Czech National Bank Working paper, Prague

103 Keller, W., and S.R. Yeaple (2009), "Multinational Enterprises, International Trade, and Productivity Growth: Firm-Level Evidence from the United States", Review of Economics and Statistics, 91(4), 821-831
Coe, D.T., E. Helpman, and A.W. Hoffmaister (2009), "International R&D spillovers and institutions", European Economic Review 53(7), 723-741

104 Lipsey, R.E. (2002), "Home and Host Country Effects of FDI", NBER Working Paper 9293, Cambridge, MA
Bailey, D., and N.L. Driffield (2007), "Industrial Policy, FDI and Employment: Still 'Missing a Strategy'", Journal for Industry, Competition and Trade, 7(3-4), 189-211

105 Young, S., N. Hood, and E. Peters (1994), "Multinational Enterprises and Regional Economic Development", Regional Studies, 28(7), 657-677
Pavlínek, P. (2004), "Regional Development Implications of Foreign Direct Investment in Central Europe", European Urban and Regional Studies, 11(1), 47-70

and product development may generate few jobs and provide only a weak stimulus to growth. However, as of now, no empirical study appears to have examined the employment effects from the separation of R&D and production.

Finally, the increased presence of foreign-owned firms may also increase the competition with domestic firms for skilled personnel, which may crowd out R&D activities of domestic firms. In the short run, when there is unemployment among scientists, engineers and technicians, additional demand of foreign-owned firms for researchers is beneficial as it helps mitigate the unemployment problem. However, if the supply for researchers is inelastic and foreign-owned and domestic firms compete for qualified staff, negative effects may materialise (Figini and Görg 1999; Driffield and Taylor 2000).[106] However, the long-run employment effects seem positive: as illustrated by Barry (2004)[107], stronger demand for high-skilled labour due to market entry of foreign-owned firms and structural change may foster academic training and increase the number of graduates in science and technology. The resulting higher skill intensity in the economy may then foster locational advantages and further improve the country's attractiveness for inward investment.

2.3.5.2 Impacts on home countries

The internationalisation of R&D also has consequences for the home countries of foreign-owned firms. In particular, home countries may **benefit** from *reverse knowledge transfer* when overseas R&D efforts bring new knowledge into the home country (Fors 1997; AlAzzawi 2004; Feinberg and Gupta 2004; Rabbiosi 2005; Todo and Shimizutani 2005; Ambos and Schlegelmilch 2006; Piscitello and Rabbiosi 2006; Narula and Michel 2009; Rabbiosi 2009).[108] These reverse knowledge transfers increase the home country's overall technological capacity and can be exploited to develop new products or processes and therefore help to spur growth and employment in the home country. Hence, R&D activities of foreign-affiliates help strengthen the growth perspectives of the parent company in the home country (Rammer and Schmiele 2008).[109] However, the degree to which these benefits from reverse knowledge transfer occur is contingent upon a number of factors: i) the exact

[106] Figini, P., and H. Görg (1999), "Multinational companies and wage inequality in the host country: The case of Ireland", Review of World Economics, 135(4), 594-612

[107] Barry, F. (2004), "FDI and the Host Economy: a Case Study of Ireland", in Barba Navaretti, G. and A.J. Venables, "Multinational Firms in the World Economy", Princeton and Oxford, Princeton University Press, 187-215

[108] Fors, G. (1997), "Utilization of R&D Results in the Home and Foreign Plants of Multinationals", Journal of Industrial Economics, 45(3), 341-358
AlAzzawi, S. (2004), "Foreign Direct Investment and Knowledge Flows: Evidence from Patent Citations", mimeo. University of Davis, Davis
Feinberg, S. E. and A. K. Gupta (2004), "Knowledge spillovers and the assignment of R&D responsibilities to foreign subsidiaries", Strategic Management Journal, 25(8-9), 823-845
Rabbiosi, L. (2005), "The evolution of reverse knowledge transfer within multinational corporations", Paper presented at the Triple Helix 5, Torino
Todo, Y., and S. Shimizutani (2005), "Overseas R&D Activities by Multinational Enterprises: Evidence from Japanese Firm-Level Data", Hi-Stat Discussion Paper Series no. 05-91, Institute of Economic Research, Hitotsubashi University, Tokio
Ambos, B., and B.B. Schlegelmilch (2006), "Learning from foreign subsidiaries: An empirical investigation of headquarters' benefits from reverse knowledge transfers", International Business Review, 15(3), 294-312
Piscitello, L., and L. Rabbiosi (2006), "How does Knowledge Transfer from Foreign Subsidiaries affect Parent Companies' Innovative Capacity?", Druid Working Paper No. 06-22, Copenhagen
Narula, R., and J. Michel (2009), "Reverse knowledge transfer and its implications for European policy", UNU-MERIT Working Paper, Maastricht
Rabbiosi, L. (2009), "The impact of reverse knowledge transfer on the parent company's innovativeness: Which role for organizational mechanisms and subsidiary's characteristics?", in Piscitello, L. and G. Santangelo, "Multinationals and local competitiveness", Milan, Edizioni Franco Angeli, 167-195

[109] Rammer, C., and A. Schmiele (2008), "Globalisation of Innovation in SMEs: Why They Go Abroad and What They Bring Back", Applied Economics Quarterly, 59(Supplement), 173-206

motives for overseas R&D activities of domestic firms, ii) the degree of complementarity between overseas and home activities (Arvanitis and Hollenstein 2009)[110], iii) the absorptive capacities of the parent company, and iv) additional firm characteristics of the parent (Schmiele 2009).[111] Moreover, there seems to be a positive relationship between internationalisation and the returns from R&D at home (Añón Higón and Manjón Antolín 2009; Criscuolo and Martin 2009).[112]

Finally, the internationalisation of R&D also entails potential **challenges** for the home country. Firms may substitute domestic RDI activities for RDI activities abroad which may result in a *hollowing out of the domestic innovation capacity*, a *loss of jobs* in R&D, and a downward pressure on wages of R&D personnel in the home country. However, empirical evidence on the negative effects from overseas R&D is rather scarce.

In summary

- While R&D was still 'an important case of non-globalization' in the 1990s, the internationalisation of business R&D activities has accelerated radically over the past two decades. The main part of the R&D internationalization takes place between the US, the EU and Japan. However, China, India and other developing countries increasingly take part in this development.
- The size of the market is a key location factor for R&D activities. This applies in particular to R&D conducted abroad that aims at supporting production activities by adapting products and production processes to local demand patterns or consumer preferences.
- A skilled workforce may act as a push and pull factor. A lack of key skills in the home country results in firms conducting more R&D abroad. Similarly, human capital is a decisive location factor pulling R&D into the host country. Differences in labour costs are not a key factor determining R&D localisation decision but they have recently gained in importance with the internationalisation of R&D taking place also in emerging economies.
- The possibility to benefit from knowledge spillovers is often an essential factor for the location decisions of technologically lagging firms. They will locate close to clusters of firms with interesting technological specialisations or leadership in relevant areas.
- A high degree of tacitness of the knowledge-base of a firm hampers the internationalisation of R&D. Related to that, a low degree of appropriability is obstructive to the relocation and dispersion of R&D given the higher likelihood of involuntary knowledge spillovers and leakages.
- If the knowledge-base is highly cumulative, as found in chemicals, pharmaceuticals, telecommunications and electronics, centralized R&D is favoured.

[110] Arvanitis, S., and H. Hollenstein (2009), "How Do Different Motives for R&D Investment in Foreign Locations Affect Domestic Firm Performance? An Analysis Based on Swiss Panel Micro Data", Paper presented at the CONCORD 2010 Conference, Zürich

[111] Schmiele, A. (2009), "Drivers for International Innovation Activities in Developed and Emerging Countries", ZEW Discussion Paper No. 09-064, Mannheim

[112] Añón Higón, D., and M. Manjón Antolín (2009), "Internationalization, R&D and Productivity: Evidence for Great Britain", Paper presented at the CONCORD 2010 Conference, Seville
Criscuolo, C., and R. Martin (2009), "Multinationals and U.S. Productivity Leadership: Evidence from Great Britain", Review of Economics and Statistics, 91(2), 263-281

- While firms simultaneously cooperate with several types of partners to carry out their innovation activities they more often cooperate with other private firms than with public research institutes.
- Incoming spillovers are important determinants of R&D cooperation and differ by type of cooperation partner: the strongest impact stems from cooperation with universities.
- R&D cooperation is more likely among (i) more technologically advanced firms with stronger absorptive capacities, (ii) firms which can more effectively appropriate returns from their innovative activities and (iii) larger firms. However, effects differ by type of R&D cooperation.
- The choice of cooperation partner is pivotal to innovation outcome: Cooperative R&D efforts with public institutions, universities or research institutes are beneficial for the development of new products.
- The host country profits from R&D internationalization through increased innovation expenditures and knowledge spillovers to domestic firms. Increased innovation will also boost the demand for skilled personnel including R&D staff. The presence of foreign-owned firms may lead to structural change and agglomeration effects. If MNEs conduct mostly adaptive R&D, less (indigenous) radical innovations can be a result.
- The home country benefits from reverse knowledge spillovers and new products or processes developed abroad can also spur growth and employment in the home country. However, R&D internationalization can also lead to a reduction of innovation capabilities in the home country and put downward pressure on wages of the R&D personnel.

2.4 Interrelation between production and RDI location decisions

2.4.1 Drivers of 'production – RDI' co-location decisions

Kenney and Florida (1994)[113] investigated the organisation and geography of Japanese R&D of Japanese electronics and biotechnology firms. They used a mail survey (54 observations) and personal interviews (23) with R&D managers. Results indicated some significant location flexibility of basic research. This was, however, not the case for applied research and production engineering for which the result suggested that close proximity to manufacturing is required. Other studies for Japan confirm this result of co-location of R&D and production (i.a. Aoki, 1990[114]; Imai, 1991[115]; Nonoka, 1992[116]; Mariani, 2002[117]). Ambos (2005)[118] found similar results for German MNCs when investigating FDI in industrial R&D. There is a tendency for German MNCs to "*cluster R&D in close proximity to offshore production facilities*". On the contrary, Pearce (1989)[119] and Håkanson and Nobel (1993)[120] found for

[113] Kenney, M. and R. Florida (1994). The organization and geography of Japanese R&D: results from a survey of Japanese electronics and biotechnology firms. Research Policy, 23, pp. 305-323.
[114] Aoki, M., (1990), Towards an economic model of Japanese firms. Journal of Economic Literature 28, 1–27.
[115] Imai, 1991,
[116] Nonaka, I., (1992), The knowledge creating company. Harvard Business Review 74 (6), 96–104.
[117] Mariani, M., (2002), Next to production or to technological clusters? The economics and management of R&D location, Journal of Management and Governance, 6, 131-152.
[118] Ambos, B. (2005), ", Foreign direct investment in industrial research and development: A study of German MNC", Research Policy 34, pp 395-410
[119] Pearce, R.D., (1989), The Internationalization of Research and Development by Multinational Enterprises. MacMillan, London.

respectively British and Swedish MNEs that production and R&D are not co-located. With **"co-location" we refer to production and R&D being carried out in the same location.**

As already discussed above, market and sectoral characteristics play an important role also in co-location decisions. Kahn et al. (1997)[121] analyse the relationship between co-location, integration, performance and satisfaction using a survey of department managers in member companies of the electronic industries association. R&D and manufacturing are co-located in 75% of the cases. No effect on functional integration (close collaboration) is found as co-location does not facilitate communication between R&D and manufacturing. Also between co-location and performance, no effect is found.

Based on theoretical considerations and insights gained from two cases studies, Ketokivi (2006) maps the interdependencies between R&D and manufacturing. Both *industry- and firm-specific considerations* need to be taken into account when deciding on co-location. Causal hypotheses formulated with respect to co-location as indicated in the interdependencies framework of R&D and manufacturing (Ketokivi, 2006) are:

- High product and process complexity is strongly linked to co-location;
- Reciprocal interdependence is strongly linked to co-location;
- Increasing manufacturing uncertainty is strongly linked to co-location;
- High industry clock speed (i.e. high rate of new product introductions) is strongly linked to co-location;
- The absence of other integrative mechanisms (such as intensive distance 'virtual' collaboration) is strongly linked to co-location;
- The link between R&D intensity and co-location is ambiguous.

He emphasises, however, that these causal effects should be considered as working hypotheses and should be interpreted as dependencies In addition, all dimensions should be considered as interrelated with each other.

Ketokivi and Ali-Yrkkö (2009) perform an empirical analysis in order to test most of the hypotheses formulated in the interdependencies framework concerning product and process complexity, clock speed and R&D intensity. A sample of 241 manufacturing firms incorporated in Finland was used. Results from the empirical analysis confirm that *high product and process complexity and a high rate of new product introduction (clock speed) is strongly linked to co-location*. No empirical evidence is found for a link between R&D intensity and co-location.

Similar to Ketokivi and Ali-Yrkkö (2009), Simon et al. (2008) indicate the importance of the complexity of the production process as a determinant of co-location. While Ketokivi and Ali-Yrkkö (2009) did not find evidence for the importance of R&D intensity in the co-location process, Simon et al. (2008) find that more innovativeness, measured as R&D intensity in percentage of revenues, requires more extensive collaboration of R&D and production. Figure 9 illustrates this correlation between product innovation, the complexity of the production process and R&D integration. Science-intensity of the firm and sector is also indicated by Mariani (2002) as an important factor in the co-location process. An increase in firm and sector science-intensity and technological characteristics of the region, on the

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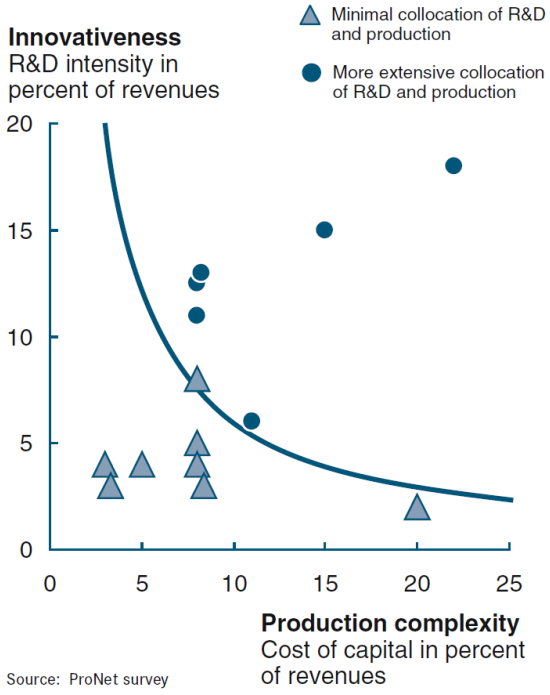
120 Håkanson, L., Nobel, R., (1993), Determinants of foreign R&D in Swedish MNCs. Research Policy 22, 397–411.

121 Kahn, K.B. and E. F. McDonough, III (1997), "An empirical study of the relationship among co-location, integration, performance and satisfaction" Journal of product innovation management, 14, pp. 161-178.

contrary, seems to decrease the link between R&D and production. The different modes of investment are also linked to co-location.

Figure 9: Drivers of R&D co-location



Source: Simon, S., Näher, U. and M.D. Lauritzen (2008)

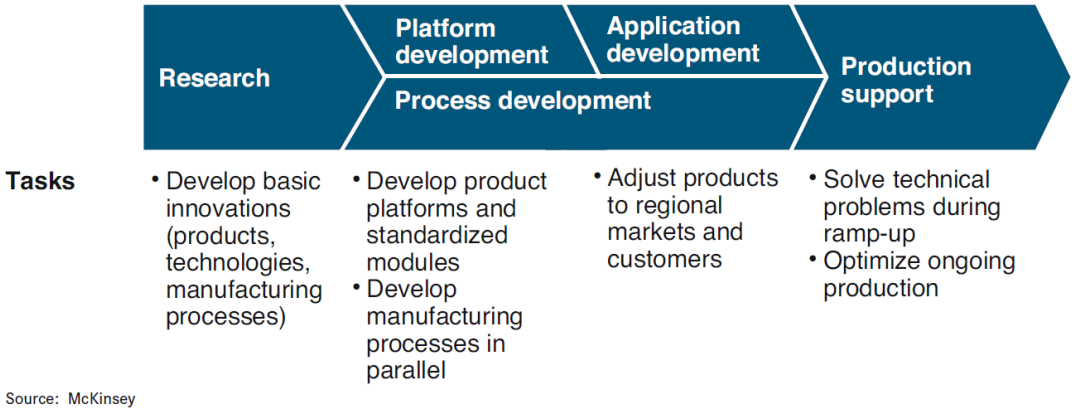
As already discussed in the sections above, Defever (2006) analyses the location choices of non-European MNEs for different stages in the value chain in the EU. Firm data on 11,000 locations for 23 countries over the period 1997-2002 are used. In his analysis he distinguished between two forms of agglomeration as possible determinants of the location decision, 1) Sectoral (activities belonging to the same sector are located in a specific country), and 2) Functional (activities belonging to the same function but not to the same sector are taking place in the same location). Results indicate that the location of service activities appears to be more affected by functional factors than by sectoral factors.

2.4.2 Disentangling "R"esearch from "D"evelopment

In literature a further distinction is made between the different activities/types of R&D. This is important in order to be more precise in the discussion on R&D location decision, which may affect R&D as a total overall function, or just a sub-activity. The location of "Research" can be different than the location of "Development". Depending on the type of production (routine versus non-routine), development can be more or less closely (also physically) connected to production.

Simon et al. (2008)[122] distinguish between five phases in the R&D process: research, platform development, application development, process development and production support (see Figure 10).

Figure 10: Five phases in the R&D process



Source: Simon, S., Näher, U. and M.D. Lauritzen (2008)

There is a difference in the need for locating the different phases of the R&D process in proximity to the market or production. Basic research activities often occur at central research facilities whereas application development processes which require more market-specific insights may be more closely integrated with the production/R&D networks of key customers. More specifically, according to Simon et al. (2008) the following options can be described:

1) **Independent networks with minimal co-location**, where only a few R&D employees are based permanently at the production location, which is possible in the case of mature products that are already manufactured at other locations.

2) **Co-location of process development** concerns developing production processes at the site itself. This is adequate when processes need adaptation to local circumstances or need substantial development support during operation. Often the case when production is relocated as a result of cost management.

3) **Relocation of application development**, where application development is transferred. This is often used when products need to be customer tailored and can be combined with the previous option. New expanding markets often require the local presence of a production development capability in close proximity to local customers.

4) **Relocation of platform development,** here product platform development is also relocated. This is important when the market needs completely different product

[122] Simon, S., Näher, U. and M.D. Lauritzen (2008), "R&D: Aligning the interface with production" in Global Production edited by Prof. Dr.-Ing. Eberhard Abele, Dr.-Ing. Tobias Meyer, Dr. rer. nat. Ulrich Näher, Dr.-Ing. Gernot Strube, Richard Sykes

architectures, such as a low-cost product platform; this is often the case in new emerging markets (like China and India), which a company is fully committed to develop.

5) **Full co-location** where all R&D phases take place at the production site. According to Simon et al. (2008), companies only go to full co-location at long established locations that serve as a knowledge centre for an entire sector. Full relocation of R&D suggests that an entire industry locus has shifted. The authors continue by sketching three different scenarios:
    - Leadership role of the regional market: a new market can develop dominance over the standards of an entire industry.
    - Specific customer issues: customer constraints or requirements of a technical or regulatory nature may call for entirely new solutions.
    - Extremely research intensive products: here the products require a continuous and close communication between R&D and production. Examples are photonics products which are highly innovative and one-off made-to-order items.

The creation of R&D independent plants is often supported by a lead factory which carries out central development of production technologies as well as transfer to other branches.

Not only different activities can be selected within development, but also different activities can be distinguished within research. According to Kenney and Florida (1994), **basic research** has some significant location flexibility whereas for **applied research** and production engineering close proximity to manufacturing is required.

Second, there are also different types of R&D. In their study on the attractiveness for innovation, the OECD (2011) makes a distinction between **adaptive R&D** and more **innovative R&D**.

- *Location decisions for more adaptive R&D facilities are primarily demand-oriented and hence related to market proximity, as it is important to be close to 'lead users' and to adapt products and processes to local conditions.*
- *Location factors for more innovative R&D investments are more supply-driven, consistent with the motivation of technology/knowledge sourcing: the host country's technological infrastructure, the presence of other firms and institutions that may create benefits which investing firms can absorb, access to trained personnel, established links with universities or government institutions, the existence of appropriate infrastructure for specific kinds of research, etc.*

The labour costs for R&D personnel appeared to be of limited importance in the past, but more recently there are some observations of increasing importance, especially in the emerging economies (OECD, 2011), see also the literature discussion on R&D location decisions.

2.4.3 Sectoral differences in co-location decisions

"*Almost all governments currently target international investments in high-technology industries (reflecting an innovation industry approach) and in innovation and R&D (reflecting an innovation business function approach) as these investments are generally believed to bring greater benefits to host countries* (OECD, 2011)".

Some common industries which are popular for international investments are electronics-telecommunications, equipment, pharmaceuticals, aerospace, automobile (manufacturing) and business services and telecommunications (services). This coincides with the earlier discussion of the sectorial deepening where global value chains no longer concern only manufacturing but also increasingly services.

MNEs participate actively in global value chains whereas the participation of SMEs is more limited (De Backer et al., 2013). The type of value chain applied by MNEs is often related to their sector of activity. De Backer et al. (2013) make a distinction between 'buyer driven' chains and 'producer driven' chains.

Large retailers and highly successful brand merchandisers are often positioned in the **'buyer driven' value chain**. Their main activities are into marketing and sales as the products are often rather simple and production of these products does not require a lot of capital or skilled workers. They mainly source products and do not perform own production activities.

Companies in high-tech sectors on the other hand are more frequently part of a **'producer driven' chain** (e.g. semiconductor, electronics, automotive and pharmaceuticals). "*These industries rely on technology and R&D, …, they control the design of products as well as most of the assembly, which takes place in a number of countries. Technology (including design) and production expertise are core competencies that are largely developed in-house in the lead firms or in affiliates and captive suppliers that can be prevented from sharing technology with competitors*" (De Backer et al. 2013).

Important sectors to consider for analysing the offshoring of production and/or R&D activities are thus semiconductors, electronics, automotive and pharmaceuticals. Ketokivi (2006) performs two case studies in high tech electronics and in pharmaceuticals in order to map the interdependencies between production and R&D. He indicates that three types of pharmaceutical industries can be distinguished. The competitive advantages of the (1) cost-competitiveness-driven and (2) research-intensive patent-protected pharmaceuticals are known and the functional interdependencies are also fairly known. The sources of competitive advantage for the (3) new pharmaceutical industry (gene technology, advanced biotechnology, nanotechnology) are still largely unknown. The functional independencies are also unknown but as this third type of pharmaceutical industry is the fast growing one, Ketokivi considers it certainly worthwhile to try to frame the functional interdependencies which coincide with the (de)location decision. Concerning the high-tech electronics sector, Ketokivi (2006) finds that co-location of manufacturing and R&D is mainly due to the reciprocal interdependence between the two activities and not or to a lesser extent due to the rate of change and the unpredictability of this industry as often argued. It seems that each sector will have its own characteristics driving location strategy and associated decisions.

2.4.4 Impacts on home country and RDI performance

There is some empirical evidence that, in the long run, the relationship between foreign and domestic activity is complementary. Literature often focusses on employment, production and exports (Lipsey, 2002[123]; Barba Navaretti and Falzoni, 2004[124], Crinò, 2009[125] and Falk

[123] Lipsey, R.E. (2002); "Home and host country effects of FDI", NBER working paper, 9293, Cambridge MA.

and Walfmayr, 2010[126]), for which the overall effects appear relatively small (Dachs and Ebensberger, 2013)[127]. Home and host-country effects on innovation and technology are less often discussed. With respect to the effect of offshoring production on the home country RDI, Dachs and Ebensberger (2013) identified in the literature the following mechanisms:

- If offshore production complements production at home (e.g. open up new markets) additional demand for production at home may occur. Also demand for headquarter activities (e.g. R&D, design, innovation activities etc.) may increase. In case of substitution through offshore production, home employment and production may decline.
- Offshore of production may lead to a change in **specialisation** (internal division of labour between the different parts of the firm) in the home country. In the home country, more capital-, technology-, and skill-intensive types of economic activity may be demanded. The headquarter might also need to provide more supervising, coordinating and other value added support activities.
- **Transfers** from the foreign affiliates can be beneficial for the home county e.g. technology transfer from overseas R&D activities (D'agostino et al. 2013[128]).

Dachs and Ebersberger (2013) used a dataset of more than 3000 manufacturing firms located in seven European countries in order to analyse the effects of **production offshoring** on RDI of the firm in the home country. More specifically, the focus is on process innovation and investment in new production technologies. The results of the analysis indicate that production offshoring **does not have a negative effect on innovation and technological capabilities in the home country**. Spending on R&D, product design and new production technologies in the home country even appears to be significantly higher for offshoring companies than for non-offshoring ones.

In summary

- The process of globalisation has led, and continues to lead, to an increasing 'unbundling' of a company's activities. This unbundling, triggered by advances in transportation and ICT, allowed for different activities like production and R&D to be spread over different locations. As part of this process, R&D and decision making activities are increasingly delocalised.
- In general, literature on the interrelation between R&D and production decisions and the effect or production offshoring on the location of R&D is inconclusive. Different industry- and firm-specific considerations need to be taken into account.
- High product and process complexity and a high rate of new product introduction (a market that demands this) are strongly linked to co-location of R&D and production activities.
- There is evidence that highly science intensive firms and highly innovative firms require a more intensive collaboration between production and R&D. On the other hand, if a region

124 Barba Navaretti, G. and A.M. Falzoni (2004), "Home country effects of foreign direct investment. In G. Barba Navaretti and 1.J. Venables (eds.), Multinational firms in the world economy, 217-239. Princeton and Oxford: Princeton University Press.

125 Crinò, R. (2009), "Offshoring, multinationals and labor market: A review of the empricial literature. Journal of Economic Surveys, 23,2, 197-249.

126 Falk, M. and Y. Wolfmayer (2010), "the extent, characteristics and impacts of FDI and multinational activities. A firm level analysis. Vienna: FIW research reports, 06.

127 Dachs, B. and B. Ebersberger (2013), "The effects of production offshoring on R&D and innovation in the home country, FIW-research reports 2013/14

128 D'Agostino, L.M., K. Laursen and G.D. Santangelo (2013), "the impact of R&D offshoring on the home knowledge production of OECD investing regions", Journal of Economic Geography, 13,1, 145-175

or a sector becomes more science intensive, the link between R&D and production becomes weaker as the knowledge required can be locally insourced. Product complexity and innovativeness to a certain extent thus drive 'co-location'.

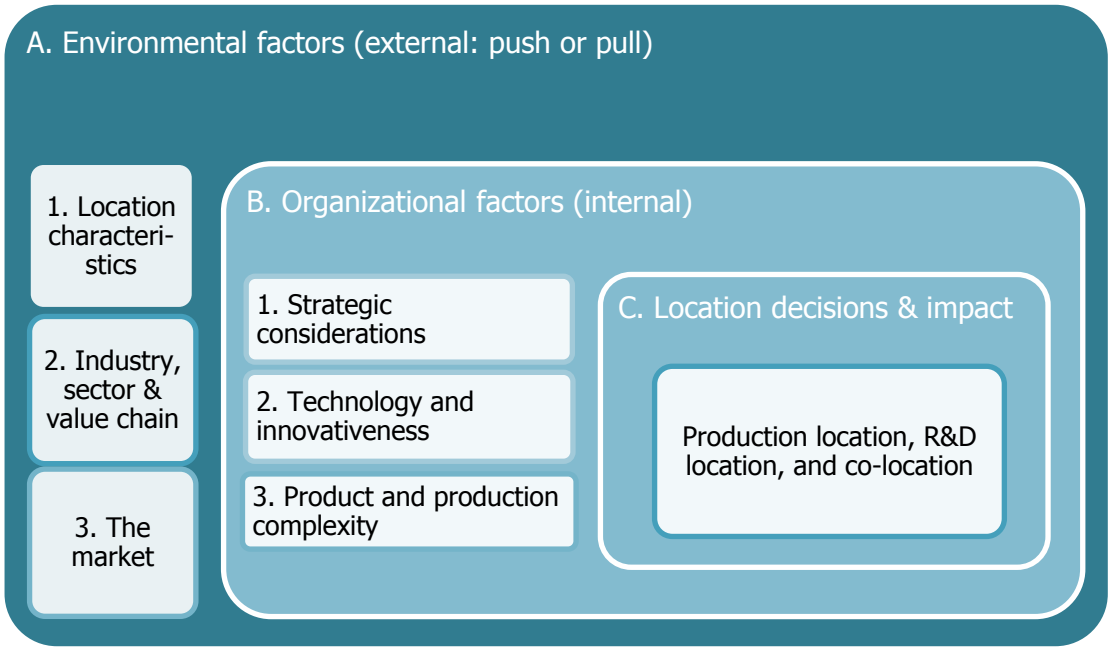
- The discussion on R&D co-location is benefited by a more detailed view on and a distinction between the different R&D activities (research, platform development, application development, process development and production support; distinction between basic and applied research; adaptive versus innovative R&D). Based on this distinction, different options of co-location can be distinguished.
- Recent research shows that production offshoring does not have negative effect on innovation and technological capabilities in the home country. Spending on R&D, product design and new production technologies in the home country even appears to be significantly higher for offshoring companies than for non-offshoring ones.

3/ Towards an integrated framework for the case studies

3.1 Integrated framework of location 'driving' forces

On the basis of the previous review, an integrated framework on location, and in particular the RDI and production co-location problem, has been developed. This perspective is visualised in the figure below.

Figure 11: Location and co-location decisions: an integrated framework



Source: the authors

The framework consists of the various building blocks that are important to consider when exploring and understanding the location decisions of the case-companies. In what follows, we briefly discuss the various building blocks and their interrelation. In addition, in the context of this conceptual framework, a set of key assumptions are derived. They will be addressed in this study through more detailed questions in the case studies (see chapter 5). It should be mentioned that in view of the number of case studies foreseen (10), these assumptions cannot be tested scientifically and/or systematically. Nevertheless, the importance of formulating them lays in the guidance of the case study discussions.

3.2 Discussion of integrated framework and formulation of assumptions

Location decisions are taken in a broad **environmental context**, often outside the sphere of control of the company. This environmental context includes location-, industry-, and market specific factors. Usually, organisations will seek to adapt to these factors by matching the organisational characteristics to the environmental context. Important to note is that environmental factors can both work as pull or push factors, i.e. they may pull companies to

a certain location or push them away from a certain location. The **organisational characteristics** contain strategic, technology and innovation, and product aspects, and are usually under the sphere of management control. The matching or adaptation process, finally, leads to a set of decisions with respect to the location of production and RDI (including the possibility of co-locating production and RDI).

A1. Environmental factors: location characteristics

They concern **cost factors** like transportation cost, labour costs, raw materials, taxation structure, R&D and other types of subsidies. Cost factors should be considered together with the issue of 'access' to e.g. raw materials, energy and (human) capital. Second, **national or regional characteristics**, like environmental and social aspects, such as political governance, political situation, corruption, general education level (skilled workforce), scientific and technological strengths, and political stability, but also trade barriers play a role of importance as well. **Societal factors**, such as environmental issues like regulation with respect to waste treatment, recycling, pollution, renewable resources, etc. will play a role of importance in certain sectors as well and need to be touched upon during the case studies.

Assumptions A1: Location factors can work both as push and pull factors for RDI and/or production location decisions:

- *National/regional and cost factors are decreasing in importance in RDI and production co-location decision making.*
- *Societal factors (like environmental) are increasing in importance in RDI and production co-location decision making.*

A2. Environmental factors: industry, sector and value chain

A second group of factors, concerns the **industry** and **sector characteristics** and in particular the characteristics of the overall **value chain**. The value of being near an ecosystem of dependable suppliers or other plants in the same sector and facilities along the value chain, do influence production location decisions (in the case of SMEs e.g. the location decision may be linked to the power relationship with a large firm). Firms consider the co-ordination aspects of how to integrate their production and distribution facilities, but they must also consider the configuration aspects of linking facilities along the value chain. It is thus important to understand the industry characteristics and dynamics and link these to the location decisions of a company.

Assumptions A2: Industry, sector and value chain characteristics/development are crucial in RDI and production co-location decisions.

- *The position in the value chain (upstream, downstream, strategic segment) is important for the location decision. Power relationships between segments within the value chain can induce delocalisation decisions (e.g. SMEs as suppliers of large companies can base their location decisions on movements of large companies).*
- *High international exposure (i.e. an industrial segment embedded in a strongly globalized value chain) will cause an industrial activity to be more sensitive to delocalization, even though strong international exposure does not necessarily mean that a segment is not strongly anchored in a region.*
- *The strength or weakness of production and RDI is of major important for a company's location decision.*

A3. Environmental factors: markets

Despite sectorial differences, **market considerations** are in general decisive for location decisions. This concerns decisions on where to realise innovations through production and process market introduction on the basis of market size and growth potential. Literature shows that companies value the proximity to important markets and key customers in their location decisions. Subsequently, the market penetration strategy of the company is decisive for the extent to which local presence is necessary. Market size characteristics increasingly play a role in the location decisions for research and/or development activities.

Assumptions A3: Market characteristics (market growth pace, demand patterns etc.) are decisive for production but also for R and/or D and innovation location decisions (proximity matters).

- *National or regional characteristics like governance, public policy, scientific and scientific/technological capabilities (pull factors) are subordinate to market considerations in both production and RDI (co-)location decisions*
- *For Research, Development and Innovation location decisions, cost factors are in general subordinate to market considerations, especially when looking at later stages of the innovation process.*

B1. Organisational factors: strategy

A company's overall strategy with respect to market entry and growth (linked to hypotheses A1, 2 and 3), product/market combinations, production organisation (e.g. through lead factories or not), distribution and services etc. is obviously decisive for the location decisions of RDI and production. Understanding the key strategic considerations and longer term vision of a company, allows to better understanding location decisions.

Assumption B1: A company's overall strategy is decisive for the location decisions of RDI and production.

B2. Organisational factors: technology and innovativeness

Highly **science & technology intensive firms**, and highly innovative firms, require a more intensive collaboration between production and RDI and a more pro-active strategy towards knowledge and technology sourcing. RDI location decisions are strongly linked to the stock of knowledge available in the host country (versus the home country). Moreover, if the host country or region becomes more science and technology intensive, there is less of a need to co-locate company R&D facilities as the knowledge required can be locally insourced (from the perspective of access to knowledge). At the same time if knowledge insourcing in the home country's ecosystem does not match the needs, companies will look other strong ecosystems outside the home country. In other words, available knowledge stocks in the home versus a potential host country are an important factor in R&D location decisions. The following assumption will be explored.

Assumption B2: For R&D intensive firms, location decisions depend largely on the knowledge available in the ecosystem (the knowledge available in a home versus host ecosystem).

B3. Organisational factors: product & production complexity

Here one has to consider the **product and production process complexity** and the need for innovation. High product and process complexity, and a high rate of new product introduction (clock speed), have a strong influence on the location of R and/or D and

production. Similarly, in new complex markets that require a high degree of customisation, proximity but also local R and/or D capabilities play a role as well.

Hypothesis B3: Co-location of R and/or D and production is largely driven by the intrinsic nature or a product (and mainly the complexity thereof).

C. Location decisions & impact

The result of the interaction between the previous driving forces, are decisions with respect to production and R and/or D and innovation. With respect to production decisions, it is important to understand how a particular plant fits in the **overall network of production facilities**, also geographically. On the RDI side, it will be equally important to distinguish between the **different R&D activities** (research, platform development, application development, process development and production support; distinction between basic and applied research; adaptive versus innovative R&D) when considering location or co-location decisions.

Hypothesis C1: It is not 'a natural thing' that production offshoring is followed by R and/or D offshoring. Furthermore, delocalisation is a dynamic and multifaceted concept that should be considered from the perspective of a firms overall production and RDI portfolio.

Finally, once the production and RDI location decisions and their interrelation are understood, the next step is to investigate the impact of these decisions, first of all on the company level (turnover, employment, revenues etc.), secondly and by aggregating, on the regional and national level both in the home and the host country. Recent literature increasingly shows that offshoring is not necessarily bad for the home country.

Hypothesis C2: Production and/or RDI offshoring do not necessarily have a negative impact on the company's activities in the home country.

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