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Evolution of globalised business R&D: Features, drivers, impacts

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Abstract

The globalisation of R&D activities has continued to grow as companies are increasingly trying to capture knowledge and market opportunities internationally. The rapid evolution of national economies and the ways to conduct knowledge-intensive businesses has brought researchers and analysts to pursue a deeper understanding of the globalisation of corporate R&D and the related driving factors and impacts.

This *Working Paper* provides an overview of the evolution of globalised business R&D activities and an outline of trends is provided with quantitative information from 2001 to 2009. Thus, the literature on the main drivers and impacts of the research process is reviewed and controversial arguments are discussed and reflected upon in the light of recent empirical observations. In particular, the drivers for firms to undertake R&D in their home country, to internationalise their R&D operations and to select a particular location for R&D implementation are analysed according to both the perspective of S&T supply side and for goods and services demand side. Furthermore, the impact of the internationalisation of business R&D is analysed for firms' host or home countries, with a particular focus on the effects on competitiveness and employment. The conclusions and policy implications from the main results of this work are presented in the last section of the document.

JEL Classification: F 21; F 23; L 16; O 32

Keywords: Research and Development [R&D], Business Enterprise Expenditure on R&D [BERD], internationalisation, innovation, investment gap, R&D policies

1 Introduction

The globalisation of research and innovation is no longer an emerging issue. It is now a booming and fast evolving phenomenon with a considerable impact, both positive and negative, on business, knowledge flow, national and local economies and thus also on the strategy and policy agendas. While the 'original Lisbon Agenda' might be seen as controversial, the importance of knowledge, innovation, and Research and Development [R&D] in Europe is not. In fact, Europe's economic and social future depends to a major extent on its ability to attract R&D (both inward flowing investment as well as that invested by European companies in Europe and elsewhere). Stating this implicitly assumes that the location of R&D and internationalisation does indeed matter.

In general, Multinational Enterprises [MNE] are constantly looking for the most favourable setting for their activities. This has always been true for the supply, production and distribution of goods along what has been called the value chain (see Kaplinsky, 2000; Fujita and Thisse, 2006; Roper *et al*., 2008). However, over the last decades, the international re-allocation of the value chain has increasingly shifted towards 'unbundling' activities that were previously vertically integrated and locally concentrated (see Hummels *et al*., 2001; Hanson *et al*., 2005; Helpman, 2006; Rugman *et al*., 2010). This trend has recently affected R&D and innovation, which were previously considered 'core activities' to be retained at a company's headquarters (see Grossman and Helpman, 1991; Florida, 1997; Chung and Yeaple, 2008).

This (accelerating) trend has been favoured by a number of different factors. These include (1) the nature of new technologies, which can be split into different stages, characterised by different enabling knowledge (e.g. 'open innovation' in terms of the software industry); (2) the increasing importance of R&D cooperation across firms (see Veugelers, 1997; Cassiman and Veugelers, 2002; Piga and Vivarelli, 2004), which means the merging of complementary R&D activities in firms and their divisions in different areas of the world is more likely and profitable; (3) the increasing availability of skilled labour in emerging economies like Brazil, Russia, India, and China [BRICs] and new member states in the EU (see Wood, 1994; Wood and Ridao-Cano, 1999; Meschi and Vivarelli, 2009).

In this sense, the amplitude of cross-border/overseas R&D operations has dramatically increased over the last two decades. Indeed, products involve a growing number of technologies and components, and are thus becoming increasingly reliant upon an expanding number of specialised fields of knowledge. Therefore, to remain competitive, firms must master innovations across a wide range of technology fields, and this often requires tapping into different centres of excellence around the world. Therefore, the internationalisation of R&D activities should be seen as a deliberate strategy for knowledge-seeking companies to try and profit from such globally dispersed knowledge reservoirs.

At the European level, the policy interest in the globalisation of R&D is accompanied by the underlying fear that increasingly moving R&D operations outside the EU (offshoring) might undermine efforts to become a competitive, knowledge-based society (i.e. the 'hollowing out' effects; see Criscuolo, 2009).[1] This Working Paper discusses the drivers and possible impacts of internationalised R&D activities in the light of the current policy debate, and aims to provide an overview of the available empirical evidence. It focuses on the trends, main drivers and the corresponding impact the internationalisation of corporate R&D may have. The potential impact of globalised R&D is assessed and what makes a location attractive for R&D is examined, i.e looking into firms' motivations for moving their R&D facilities abroad. To do this, the

[1] The fear is compounded by the suspicion that R&D capabilities being lost are in sectors which have been traditionally strong in the EU, such as the automotive, pharmaceutical and telecommunications sectors.

most updated and relevant knowledge on the subject presented at the 2nd European Conference on Corporate R&D (CONCORD 2010)[2] is reflected upon. However, emphasis is on reflecting empirical trends and the most recent contributions to the literature rather than on providing an exhaustive review of the literature on R&D globalisation, which can be found in Cincera et al. (2010) or Dachs et al. (2010), for example. This Working Paper is structured as follows: Section 2 briefly reflects on existing literature and outlines open research questions. Section 3 presents the main empirical trends for business R&D and internationalisation, with a discussion of the corresponding drivers in section 4. In section 5, the impact of internationalisation trends on the host or home country are considered. Conclusions and policy implications are presented in section 6.

2 Literature and open research questions

In general, there are two different perspectives on the 'internationalisation of R&D' in the scientific literature. Although the actual terms used may vary, the essence is the following:

The first, and traditionally dominant, perspective assumes that the main motive for the internationalisation of R&D is for companies to attempt to get higher returns from accumulated knowledge resources. However, when expanding into new markets abroad, this established knowledge may need to be adapted to local circumstances, and this may justify some investment in R&D. Thus, the internationalisation of R&D is mainly perceived as a result of internationalising sales and production, and the motive is primarily to adapt the company's existing knowledge base to the peculiar characteristics of foreign markets and locations.

In contrast, the second perspective looks at companies actively searching for relevant knowledge and creative environments all over the globe. Thus, the internationalisation of R&D activities should be seen as a strategy for companies to tap into such globally dispersed reservoirs of knowledge by establishing R&D activities there.

The reason for highlighting the difference between these two interpretations is that the resulting policy implications differ. In the first instance, the consequences of R&D internationalisation are fairly minor and perhaps slightly beneficial for the country of origin. For the second, however, there is a danger of hollowing out the national R&D system, since R&D resources flow to the most attractive locations worldwide (eventually leaving the home location 'deserted' of R&D). This has not gone unnoticed by policy makers, who in many cases have devoted resources to creating knowledge-based environments (e.g., science parks) in the hope that they may attract R&D and highly educated labour from other locations.

No doubt, in-house R&D conducted in the region or country of origin is often a fundamental basis for corresponding competitiveness. Nonetheless, there are new and fast evolving business practices, where the external sourcing of technological innovation plays a pivotal role, e.g. in so-called 'Open Innovation'[3]. Moreover, there are ever shorter technology life cycles, emerging technologies with the potential to disrupt market leaders' positions, soaring costs and risks associated with science based technology, greater dissemination of knowledge throughout the world, increased rivalry between companies in their product markets and the growing role of seed and venture capital to finance excellent business ideas, which all potentially influence a firms' decision to locate it's R&D internationally.

[2] For details see Conference website: http://iri.jrc.ec.europa.eu/concord-2010. The event took place on March 3-4, 2010, in Seville, Spain, and was organised by JRC-IPTS and the Spanish Centre for Development of Industrial Technology (CDTI) under the auspices of the Spanish Presidency of the EU Council. For results of the Conference see Moncada-Paternò-Castello and Voigt (2010).

[3] Chesbrough et al. (2006) defined open innovation as "the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively."

3 Trends in R&D investment and internationalisation

The internationalisation[4] of R&D – also referred to as the globalisation of R&D'[5] – refers to the distribution of company R&D operations among different countries and the cross-border flows of R&D-related resources such as knowledge, technologies, researchers, engineers and capital (investment and trade). Thus, the wording already appears to implicitly subsume a trend towards a further increase/acceleration of internationalisation in terms of R&D activities, to be substantiated by looking at the empirical evidence and pre-eminent trends. With regard to the latter, the following general observations can be made:

1) Cross-border research-related flows are an old phenomenon. These flows have traditionally been in the form of migrations of researchers and were discussed under the heading of 'brain drain'. However, the subject of interest here is the flow of investment and the question of where R&D-performing labour is thus to be located – instead of having the R&D-labour migrating in the search for its marginally most efficient use.

2) The crucial question for the internationalisation of R&D is whether the gains flowing to the host region (due to the spillover effects and accumulated tacit knowledge among local researchers carrying out R&D for foreign firms) are outweighed by the gains flowing to the investing firm back home (due to more efficient use of resources, and access to, and property rights over, the results of R&D performed abroad). This can only be answered on a case by case judgment and an empirical assessment of this is non-trivial.

3) Increasing the viscosity of the medium (e.g. legal, cultural) in which such flows of R&D-capital materialise may emerge is an option – not necessarily optimal – for both sides (the host country side and the side of the investing firms, and/or the countries in which these investing firms are based). For which side this would be more beneficial, depends on the factors mentioned above in point (2).

4) Being conversant in areas beyond the area of specialisation makes it easier to reap the benefits of such flows. For the host country, this is through spillovers or the accumulation of tacit knowledge in the host country R&D researchers; for the firm investing in R&D abroad, through new products and new market possibilities opening up due to research done in the host country.

5) According to Dominique Foray (Foray, 2009), the problem for Europe is not so much that firms move their R&D capacities abroad. In fact, they have good reasons to do so (proximity to foreign local markets, exposure to new ideas, access to intellectual resources, etc). The key problems are: (i) beneficial returns from knowledge may be hard to get, regardless of where it comes from; and (ii) the comparatively lower attractiveness of European markets and ideas (evidence of the latter according to OECD and UNCTAD data).

In general, it is quite difficult to measure corporate R&D activities, and specifically its internationalisation, since this information is sensitive, from a company perspective and is

[4] Internationalisation is generally defined as the mobility of goods and services (trade) and production factors (e.g. people and capital) across national borders,. The term is often used to describe a dynamic process of increasing cross-border flow and economic integration of a number of interconnected activities and actors, using formal and informal channels (see OECD 2005b).

[5] The term 'globalisation' is used in this context when internationalisation has deepened to include a large number of countries worldwide and when the process has become increasingly detached from a particular home country or parent company.

often incomplete, hard to compare from one country to another, and appears after a considerable time lag (see Dunning and Narula, 1996; Serapio and Hayashi, 2004; Dunning and Lundan, 2009), if available at all.[6] For considering R&D internationalisation trends, however, one has to rely on indirect measures, which in turn may lead to comparability problems of the study results. Another important caveat to mention here is that available data do not often differentiate between flows from one EU country and another, or between one EU country and a non-EU country. Thus a separate study of intra-EU flows, as opposed to flows outside the EU, is difficult. In general, there is a need for better data and more systematic data collection (OECD, 2005b; Moncada-Paternò-Castello, 2010). Nevertheless, the main corporate R&D investment trends from the available sources is briefly summarised later.

3.1 Corporate R&D investment trends

Evidence from data covering the period 2002-2008 suggests that total R&D spending (public and private) as a percentage of GDP has remained largely unchanged in the EU and the US, while it has grown in countries like China and Japan (see Table 1). Similarly, R&D expenditure financed by the private sector has changed little in both the EU (converging to about 1.2% of GDP) and US (where, however, it is at a much higher level of around 2.0%). In contrast, in China, R&D financed by the business sector has increased significantly (from 0.6% to around 1.0% of GDP) and has accounted for most of the growth of China's total R&D intensity.

Table 1: Trends in R&D Expenditure as percentage of GDP (2002-2008)

		2002	2003	2004	2005	2006	2007	2008
EU-27		**1.87**	**1.86**	**1.83**	**1.82**	**1.85**	**1.85**	**1.92**
	of which business sector share is	1.2	1.18	1.16	1.15	1.17	1.18	1.21
US		**2.6**	**2.6**	**2.53**	**2.56**	**2.59**	**2.65**	**2.77**
	of which business sector share is	1.82	1.8	1.76	1.79	1.85	1.91	2.01
Japan		**3.17**	**3.2**	**3.17**	**3.32**	**3.4**	**3.44**	**:**
	of which business sector share is	2.36	2.4	2.38	2.54	2.63	2.68	:
China		**1.07**	**1.23**	**1.33**	**1.38**	**1.42**	**1.49**	**1.5**
	of which business sector share is	0.6	0.7	0.8	0.9	1.0	1.1	1.0

Source: Prepared from EUROSTAT (2011)[7], United Nations (2010)[8] and OECD (2010a) data
Note: Data for Japan's R&D in 2008 are not yet available.

Based on the R&D figures for the world's top R&D investors (according to their annual reports; see European Commission, 2010a)[9], more recent trends can be studied (2007-2009). Figure 1 suggests that companies headquartered in the EU have reduced R&D less than US firms during the recent economic crisis, which has affected R&D investment across the world. On the other hand, corporate R&D kept growing in Asian countries.

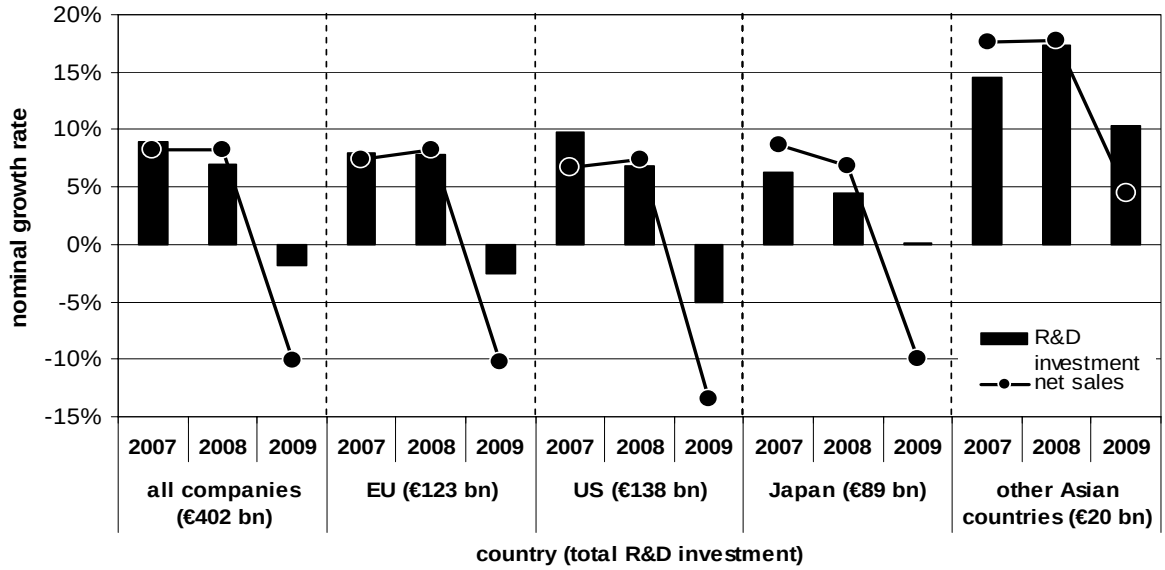
[6] Although there is still a need for better data sources, several efforts to gather systematic data are under way. See Moncada-Paternò-Castello (2010a) for a detailed discussion.

[7] EUROSTAT – Online Database on Science, Technology & Innovation – (2011) http://epp.eurostat.ec.europa.eu/portal/page/portal/science_technology_innovation/data/database

[8] United Nations (2010) - Encyclopaedia of the Nations, Data on Research and Development Expenditure (% of GDP) - World Development Indicators; available online at: http://www.nationsencyclopedia.com/WorldStats/WDI-tech-research-expenditure.html

[9] See Moncada-Paterno-Castello *et al.* (2010) for a discussion about differences and complementarities between data presented in the *EU Industrial R&D Investment Scoreboard* and BERD data (business expenditure on R&D) collected by national statistical agencies and published by OECD and EUROSTAT.

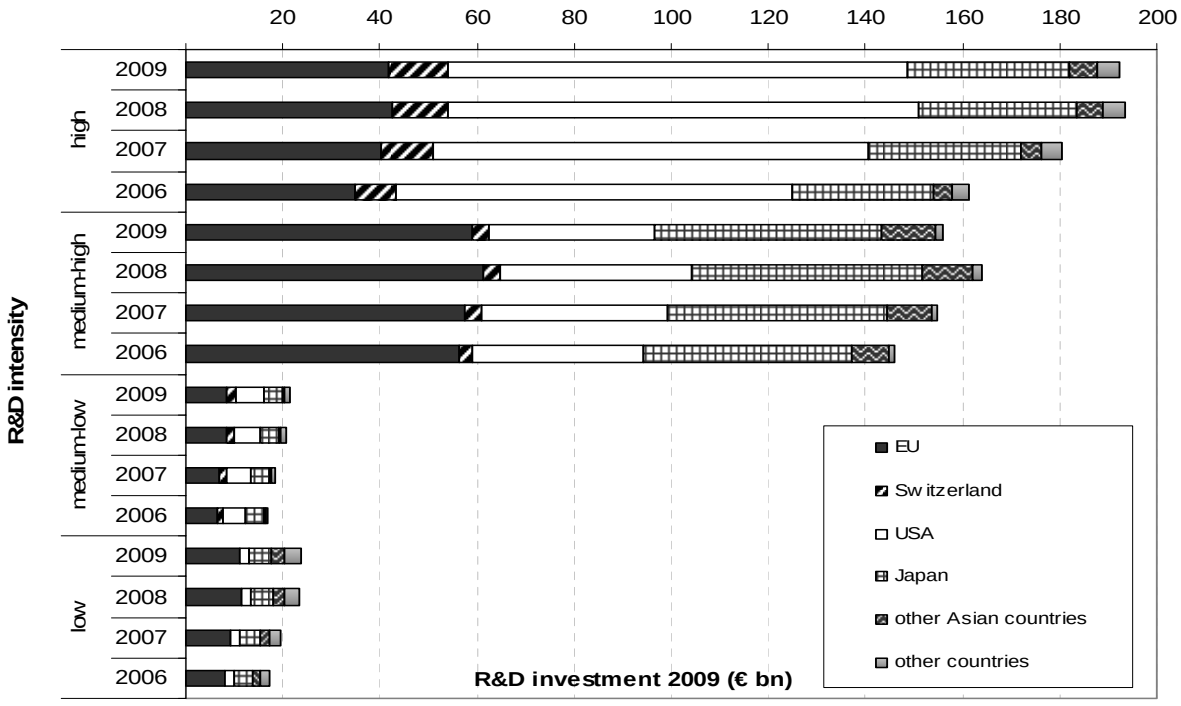
Figure 1: Trends in corporate R&D investment



Source: European Commission (2010a): The 2010 EU Industrial R&D Investment Scoreboard.

Furthermore, as illustrated by Figure 2, companies from Asian countries are challenging the position of the EU and the US, especially in high-tech sectors. This provides a reason to look into internationalisation trends and to devote some consideration to the offshoring of R&D, with a special emphasis on the emerging Asian countries (section 2.2).

Figure 2: EU R&D performance compared to main competitors



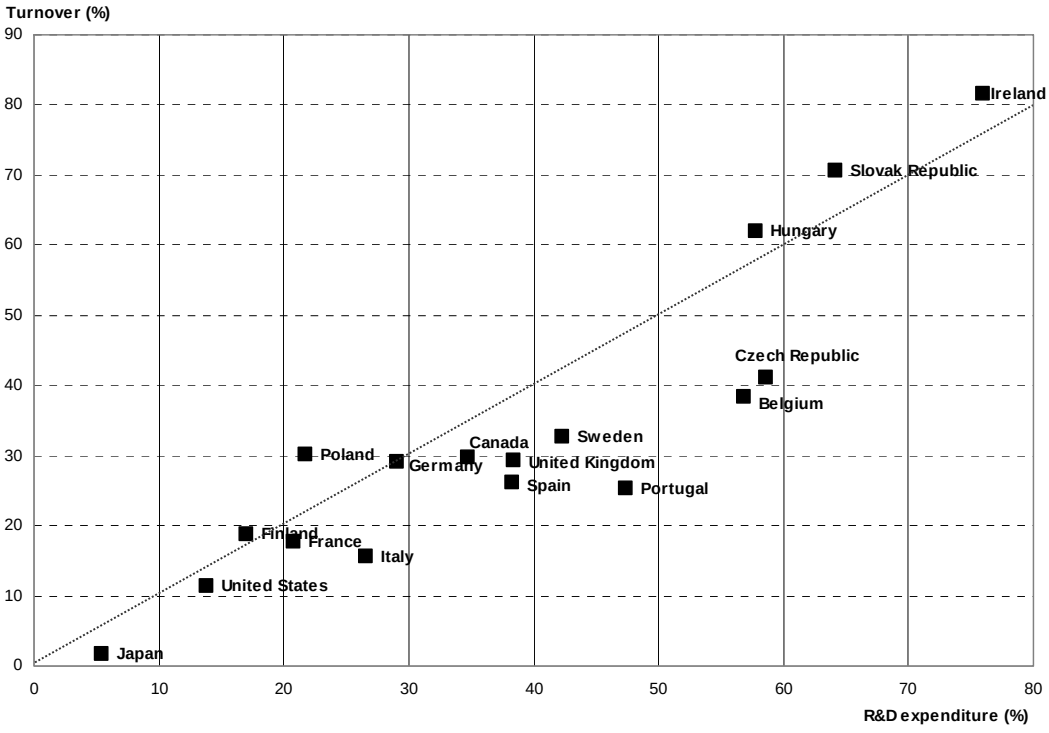
Source: European Commission (2010a) - The 2010 EU Industrial R&D Investment Scoreboard.

Note: The classification of low, medium-low/high, and high R&D intensity follows the terminology introduced by OECD, with thresholds of <2% for low and >5% for high-R&D intensity manufacturing industries (R&D intensity measured as a percentage of R&D spending in terms of value added or sales). For a discussion, see Hatzichronoglou, 1997, for example.

3.2 Internationalisation of R&D

Among the reasons for companies performing R&D and innovation abroad may be to adapt their products to host country markets, to absorb new knowledge or to benefit from cost-efficient and/or good-quality local R&D and an innovation base.[10] There are also numerous partial hypotheses to explain specific aspects of internationalisation rooted in different 'sub-disciplines' of economics, such as industrial organisation, management sciences, evolutionary economics and economic geography or finance (see Dunning 2000). Hence, the reasons for internationalising company R&D are as diverse and difficult to identify as the corresponding aggregate trends. For instance, the OECD analyses 'R&D expenditures by foreign affiliates of MNE in the host market'. Considered in absolute numbers, this indicator measures the amount of R&D spent in a particular host country by affiliates of (foreign) MNEs. Thus, the higher this number, the more foreign R&D is undertaken in a host country. Moreover, R&D expenditure of foreign affiliates considered as a share of total industry R&D provides a relative measure of internationalisation and, in fact, varies significantly among countries. For instance, it is below 5% in Japan and above 70% in Ireland, see Figure 2.

Figure 3: Share of total R&D and turnover of affiliates under foreign control, 2006



Source: Prepared from OECD (2009): Science, Technology and Industry Scoreboard 2009.

[10] There are three main theoretical strands to explain international corporate investment: First, the classical theory of international trade stresses the factor endowment of an economy, and implies that a firm's investment follows the comparative advantages of different locations (see Mundell, 1957). Second, according to the 'New Trade Theory', firms exhibit specific capabilities (technology, marketing, etc) that can be successfully exploited at home, as well as abroad, independently from the economic attractiveness of different countries (see, for instance, Helpman, 1984 and Ethier, 1986). Third, the transaction cost theory hypothesises that a firm tends to engage in FDI whenever the total costs of internationalising a certain undertaking are lower than those arising from doing it at home (Buckley and Casson, 1985).

In fact, in most countries the share of foreign affiliates in total R&D manufacturing expenditure compared to their share in total manufacturing turnover is higher (OECD, 2009), which suggests that research is nowadays more internationalised than production. Furthermore, based on patent data, the OECD (2007) reports that most economies became strongly involved in cross-border inventive activity. However, as illustrated in Table 2, the percentage R&D undertaken by foreign affiliates is not linear in the seven countries and four years considered: it has decreased in France, Sweden and the UK[11]; is almost constant in Germany, Italy and USA; and has increased in Japan.

Table 2: R&D expenditure of foreign affiliates as a percentage of total corporate R&D
(selected economies and years)

COUNTRY / YEAR	**2001**	**2003**	**2005**	**2007**
France	21.5	22.6	23.5	19.6
Germany	24.8	26.7	27.8	26.2
Italy	33.0	26.3	25.2	27.4
Sweden	40.7	44.7	42.3	35.5
UK	42.8	44.6	39.1	37.5
US	13.1	14.8	13.8	14.8
Japan	3.4	4.3	5.1	5.1

Source: Prepared from OECD (2010b): Main Science and Technology Indicators, Vol. 2010, 22/07/2010.

Given the general trend of growing business R&D expenditure over the period considered (EUROSTAT)[12], companies appear to have invested in R&D elsewhere; possibly in China and India. However, despite the apparent increasing internationalisation of corporate R&D, it is still unclear whether this is better for the company's home or host country. The relocation of indigenous firms' R&D centres may restrict technological opportunities in the domestic market (Archibugi and Iammarino, 1999). It may also involve a loss of technological capabilities for the home country or, at least, signal that the home country is insufficiently attractive to innovative MNEs (Doz, 2005; Sachwald, 2005). Moreover, the share of foreign affiliates in R&D also reflects the size of their R&D relative to that of domestic firms; and when approximating the R&D internationalisation by shares of foreign funding and international engagements, it is worth mentioning that not all countries are exposed to the globalisation of R&D to the same degree.

The relative importance of R&D expenditure abroad may thus be less due to 'green field' R&D investment strategies than 'brown field' ones, resulting from a process of mergers and acquisitions (Shrader *et al.,* 2009; Smith, 2010). For instance, a study of major French multinationals revealed that in most cases their existing foreign R&D department appears to be as a result of a takeover (Ministère de l'éducation nationale, 2004); the R&D centre was created *ex-novo* in only 25% of cases. There are, however, sectoral differences. In R&D-intensive sectors like ICTs, electronics and chemicals & pharmaceuticals, the option to create an R&D centre from scratch was more frequently chosen than for machinery & electrical goods, for example (see Fleetwood and Molleryd, 2009; Takatani *et al*., 2009).

To provide a comprehensive picture of corporate R&D investment flow and volume and related dynamics, it appears to be important to take a closer look at the locations where R&D are carried out, and why and to what extent this is changing. A survey by the Economist Intelligence Unit (EIU, 2004) revealed that, when managers were asked where they would

[11] In fact, for these three countries an increase then a decrease below the initial level is reported, indicating a U-shaped development.

[12] EUROSTAT – Online Database on Science, Technology & Innovation – (2011) http://epp.eurostat.ec.europa.eu/portal/page/portal/science_technology_innovation/data/database

spend most on R&D in the next three years, two emerging countries stood out: China and India (39% and 28%, respectively).[13] In fact, China and India are emerging as major competitors to the EU in terms of R&D growth. Furthermore, an UNCTAD (2005a) survey of the largest R&D spenders among multinational enterprises revealed that China was the third largest global destination, behind the US and UK; and India was sixth. Out of the 885 R&D-oriented green field foreign direct investment (FDI) projects announced in the Asian region, 723 were in China and India. The survey also indicated that 25% of current foreign global R&D offshoring was going to India. India was also considered an attractive potential R&D location for about 30% of respondents for the following period, 2005 – 2009.

In general, the globalisation of business R&D is expected to continue in the years to come. According to a recent global survey of the Economist Intelligence Unit, the proportion of large firms with at least some of their R&D overseas was 65% in 2006 and is expected to rise to 84% by 2010 (EIU, 2007).[14] The globalisation of R&D will continue in 2011 and beyond, as companies continue to decentralise their R&D by building new R&D facilities in offshore locations, as pointed out by a recent global research community survey (Battelle Institute, 2010). These changes are mostly at the expense of the organisation's home R&D infrastructure. Moreover, a few companies in China and India are also starting to globalise their R&D activities.

Looking at the EU, the share of R&D conducted outside Europe has increased slowly but steadily during the last few years, while R&D investment by these firms in the EU is assumed to drop to 68% in 2012, compared to 78% in 2005, according to a recent survey of R&D-intensive European-based companies, carried out by the European Commission (2010b). On average, the surveyed companies carry out a quarter of their R&D outside the EU. The largest share of foreign R&D investment is in the US and Canada (around 12%), followed by India (3.1%), China (2.4%), other European countries (2.1%), Japan (1.9%) and the rest of the world.

In short, the R&D environment has changed as a result of various factors. These include developing global markets; closer links between R&D and the creation of new products, services, and markets; and, the opportunities offered by advances in ICT. Industry has responded by outsourcing R&D both nationally and internationally, by opening R&D operations abroad, forming strategic technology alliances with overseas partners and divesting or acquiring strategic technology units. Meanwhile, R&D appears more internationalised than production (OECD, 2009), and foreign R&D tends to be an increasingly common strategy for MNEs, thus forming global research networks (von Zedtwitz and Gassmann, 2002). Evidence suggests that most R&D internationalisation still takes place within the US, Europe and Japan (OECD, 2005c, UNCTAD, 2004, 2005b), with the emerging markets attracting an increasing share of overseas MNEs' R&D outlay. In general, the sectors with the most highly internationalised R&D are the high-tech ones, especially the pharmaceutical industry. However, the decisions regarding where to carry out corporate R&D activities, how to diversify and by how much are still mainly company-specific. However, what are firms looking for when they decide to relocate or set up their R&D operations abroad? These drivers are investigated in the next section.

[13] US were second (29%) in this ranking after China, UK fourth (24 %), then Germany, Brazil, and Japan (19%, 11% and 10%, respectively).

[14] At the same time, it is expected that large enterprises will continue restructuring and rationalizing their global innovation networks.

4 Driving factors for corporate R&D internationalisation

The reasons for firms expanding their R&D activities abroad are comprehensively discussed in the literature (outlined above).[15] In general, they can be grouped into two main categories: (1) the exploitation of assets from the parent firm and (2) the acquisition or improvement of assets by exploiting the advantages of the host country. In the first case, the internationalisation of R&D transfers technology to foreign subsidiaries, where the technological assets developed in the home country are exploited, usually after some adaptation to the characteristics of foreign markets (Bartlett and Ghoshal, 1990; Berry and Sakakibara, 2008). In the second case, multinationals invest in R&D abroad to acquire resources, which are only available in foreign locations, and to increase their stock of knowledge (Florida, 1997).

Looking deeper at the drivers for locating corporate R&D, Thursby and Thursby (2006) describe four main factors: output market potential, quality of R&D personnel, university collaboration and intellectual property protection. Furthermore, for companies locating in emerging economies, the growth potential of the local market and the quality of R&D personnel appear to be very important. For companies locating in developed countries, the quality of R&D personnel and intellectual property protection are more important. Examples of other relevant institutional factors are public support for R&D, technological infrastructure quality and framework conditions, such as macroeconomic ones and political stability. Finally, proximity to a certain (important) market is commonly seen as crucial when making a decision about outsourcing corporate R&D. This is why countries with large and affluent markets (such as the US) continue to be a magnet for foreign R&D investment. The logic being that the closer R&D is to the customer, the more customer-tailored the products will be and the larger the market share they can capture.

Moreover, management attitude to R&D internationalisation depends on the different phases of a R&D project. In fact, when a company decides to internationalise, it often makes a distinction between *research* and *development* activities, with different locations being chosen (see Zedtwitz and Gassmann, 2002; Gulbrandsen and Godoe, 2008).[16] Development helps to turn attention to the managerial perspective of internationalising corporate R&D activities, namely company strategy. This in turn characterises the typology of sites according to the two main company motives for internationalising as outlined above: accessing either local markets or critical local scientific knowledge (see Zedtwitz and Gassmann, 2002, for example). Similarly, Richtnér and Rognes (2008) identified four main factors influencing the location and organisation of R&D: (1) corporate growth & positioning; (2) knowledge sourcing; (3) R&D management & flexibility and (4) communication & problem solving. These strategic drivers resemble the more general ones discussed at the beginning of this section, i.e. market-pull and technology-push factors. In contrast with the above, there are also a number of other reasons for firms not internationalising R&D, such as lower economies of scale due to distributing R&D across dispersed units; the disadvantage of being an outsider in the host country's innovation system; increased obstacles in the internal knowledge transfer due to inter-unit geographical and technological distance; the leakage of key technology to foreign competitors; and the costs of coordinating R&D across multiple countries (OECD. 2005a, Economist, 2004b).

[15] See e.g. Kumar (2001) and Narula (2002) for overviews. For discussing the characteristics of several individual motives for internationalising R&D activities see Hollenstein (2009).

[16] "…We really don't want to move, but..." (Gulbrandsen and Godoe, 2008)

Table 3 provides an overview of the main factors for a company deciding about locating R&D activities at home or abroad.

Table 3: Reasons for investing in R&D at home and abroad and for selecting a particular R&D location

	Factors from the S&T supply perspective	Factors from the goods & services demand perspective
Reasons for R&D investment at home	• Historical capabilities of the home country • Economies of scale • Firm is an insider in the innovation system • Fewer problems of internal knowledge transfer due to geographical proximity • Lesser co-ordination costs • Greater control of knowledge leaks to competitors	• Leading home market
Reasons for internationalising R&D	• Centres of excellence abroad • Spillovers from other firms operating in the area • Access to high-quality science and engineering talent • Better cost-efficiency for some activities • R&D as a determinant of competitive advantage • R&D asset exploiting and/or augmenting	• Adaptation to local markets • Existence of leading markets abroad
Reasons for selecting a particular R&D location	• Availability of high-quality personnel • Quality of education • Centres of excellence • Technological strengths • Quality of research-industry relations • Cost efficiency of qualified R&D activities • Presence of other foreign firms • High business R&D intensity/R&D stocks • Favourable framework conditions	• Large local market (size, purchasing power) • Leading market • Market where innovations can be introduced with ease and support • Strong intellectual property legislation

Source: Prepared from Sachwald (2005), Economist (2004b), Jones and Teegan (2003), and OECD (2005a). Patel and Vega, 1999; Le Bas and Sierra, 2002; Griliches, 1998; Mansfield, 1965; Scherer, 1965; Dunning and Narula, 1996; Kuemmerle, 1997; UNCTAD, 2005a; European Commission, 2010b.

An alternative model illustrating how MNEs organise global R&D is provided by Chiesa and Manzini (2009). A distinction is made between different types of R&D units, categories of global R&D structures and the different phases of a R&D project (Chiesa 2000): a) The '*centre of excellence'* structure, where one centre is assigned a global mandate for a certain technology/product/process area to increase R&D efficiency by concentrating the needed resources in one location; b) The '*supported specialisation'* structure, where the main resources of a technology/product/process area are still concentrated in one location but over a number of small units dispersed worldwide to supply the local markets; c) The '*network'* structure, which consists of a network of dispersed centres in different countries working in the same technology/product/process which are free to undertake their own R&D initiatives and allocate resources to locally developed projects; d) The *specialised contributors,* where each unit is specialised in one or a few disciplines and contributes by developing a piece of the R&D work with an 'integrator' R&D centre having overall management and control.

Managing these geographically dispersed R&D efforts is especially challenging in technology-intensive ventures that involve complex work, risks, and non-linear development processes (Thamhain, 2009). In particular, knowledge flows can be directed either by an '*asset exploiting'* or *'asset augmenting'* attitude (Narula and Zanfei, 2005; OECD, 2005a; Dunning, 2009). If the first attitude dominates the mother firm's management strategy, knowledge tends to flow *from* the parent home's R&D centre *to* foreign based facilities. If the second attitude dominates, knowledge tends to flow *from* the foreign R&D centre *to* the central home R&D centre (Audretsch and Feldman, 1996; Hegde and Hicks, 2008).

Other researchers pointed towards sector specifics in this regard, suggesting that asset exploiting is one of the most widely implemented strategies in electronics and metals, while

asset augmenting is more prominent among chemicals, pharmaceuticals, mining, food, and materials (Patel and Vega, 1999). More significantly, there has been a shift from believing that asset-exploiting motives were dominant to acknowledging the role of asset-augmenting motives. In a study of patent applications to the European Patent Office, Le Bas and Sierra (2002) found that the asset-augmenting strategy was more prevalent overall. Generally speaking, over the last twenty years, international R&D have been characterised by an increasing trend towards asset-augmenting activities.

However, while a trend towards more asset-augmenting activities is noticeable, asset-exploiting motivations still remain important. There is empirical evidence that firms' offshore activities are strong at home (i.e. they have revealed significant technological advantages). This would give support to the idea that they are conducting asset-exploiting activities, namely adapting products and processes to foreign markets and lending technical support to offshore manufacturing plants. There is also evidence that MNEs are rarely internationalising R&D to compensate for technological weaknesses at home.[17] Le Bas and Sierra (2002) showed that R&D offshoring usually takes place in locations which are strong in technologies where the parent firm has an advantage. In such instances, the fact that the parent company is exploiting its technological advantages suggests asset-exploiting motives, but the fact that the host country is strong in technology points towards asset-augmenting motives. Both motives, therefore, coexist.

Figure 4a/b (see Annex) illustrates the key decision factors for EU companies considering carrying out R&D (European Commission, 2010b)[18]. Accordingly, the determinants for locating R&D are fairly consistent, irrespective of whether they are local or international investments. However, the drivers for companies mainly attracted by foreign countries (the white bars in Figure 4b) show some peculiarities. 'Asset augmenting' determinants turn out to be dominant. Indeed, access to specialised knowledge, the availability of researchers and the legal framework rank at the top of the motives for R&D outsourcing. In contrast, 'asset exploiting' motives, such as access to market, cheap labour costs of researchers[19] and the proximity to suppliers, appear to play a secondary role as drivers of R&D location abroad. This evidence from European top investors is consistent with the general trend, discussed above, that R&D globalisation is increasingly driven by an 'asset augmenting' attitude.

To summarise, each of the approaches discussed above has its own economic, organisational and operational implications, and neither of them can be considered as the ideal approach for staying ahead of the competition in science and technology fields (Heidenreich et al., 2010).

Regarding the possible impacts of corporate R&D internationalisation, many aspects in both the private and public sphere can be investigated (Dunning and Lundan, 2009; Moncada-Paternò-Castello and Voigt, 2010; Moncada-Paternò-Castello *et al.,* 2011). The following section discusses possible effects on corporate performance.

[17] The trend towards more technology sourcing implies changes in the governance of innovation in MNEs, with important implications for the role of subsidiaries in recognising and exploiting the potential for innovation (Papanastassiou and Pearce, 1998; Pearce, 1999). While decentralised and autonomous R&D subsidiaries may be more flexible and responsive to local market needs, the resulting international R&D structures have in some cases become difficult to manage (Gerybadze and Reger, 1999).

[18] The Figure is based on a survey conducted by the JRC-IPTS in 2009 and refers to a random sample of 184 European top R&D investors. For further details see European Commission (2010b).

[19] It is worth noting that a number of sources suggest that cheap research labour costs are relatively unimportant in a decision to set up or relocate R&D activities in foreign countries (Jones and Teegan, 2003; Papanastassiou, 1997; Voelker and Stead, 1999; Economist (EIU), 2004).

5 Impact of corporate R&D internationalisation

In general, corporate R&D internationalisation may bring substantial benefits, for instance, higher cost efficiency in the innovation process, leveraged ability to learn about innovation conducted by other companies/institutions, earlier commercialisation and a positive impact on the innovation capacity of the firm. In fact, the internationalisation of R&D activities, involving setting up research facilities abroad, helps firms to access complementary expertise and be closer to markets where the fruits of their R&D can be exploited. Similarly, foreign R&D activities may provide access to foreign technologies and can therefore provide a channel for transferring knowledge back to the home country (Miravete and Pernias, 2006).

An interesting approach in this regard is the 'Open Innovation' concept, where a firm finds creative ways to motivate outsiders to supply an ongoing stream of external innovations (West and Gallagher, 2006). The internationalised R&D activities can turn out to be central drivers for firms adopting 'Open Innovation' management tools (Saiyd and Gocaerts, 2009). In fact, companies can gain valuable input from geographically disperse R&D centres and personnel (Ebrahim *et al*., 2009). Another is the so called 'Smart Specialisation' (Foray and van Ark, 2007), where all regions are given a fair chance to compete, as opposed to directing resources to more advanced regional R&D centres –. In this context, the mother firm would be able to exploit regional strengths wherever they appear to be (Varblane, 2009; Santangelo, 2009).

However, the potentially positive aspects of the internationalisation of R&D should not be forgotten nor overshadowed by fears over job losses, innovative capacity and industrial diversification. Foreign R&D activities may provide access to foreign technologies and can therefore provide a channel for transferring knowledge back to the home country. This is referred to in the literature as 'reverse technology transfer' and highlights how R&D conducted abroad may be seen as a complement rather than a substitute for R&D carried out at the mother company centres (OECD, 2005a; Griffith *et al.*, 2004).

Table 4 summarises the possible impacts (both favourable and adverse) that R&D globalisation may have on both the host and home country. Which of these effects prevail is of course a matter of empirical investigation.

Table 4: Possible impacts of corporate R&D internationalisation

Impact	On host country	On home country
Positive	▪ Increased local technical capability ▪ Knowledge & economic spillover ▪ Better tailored products ▪ Productivity increases ▪ Employment and sales growth	▪ Access to other sources of expertise and innovation ▪ Enhance access to foreign markets (sales growth) ▪ Results of R&D abroad may be exploited at home, producing economic benefits ▪ Prolong the life cycle of existing goods/services
Negative	▪ Foreign control over domestic R&D resources ▪ Results may be exploited elsewhere; loss of economic benefit ▪ Decrease in R&D impact if the link with production gets weaker	▪ Loss of technical capability ▪ Hollowing out of industries ▪ Loss of economic benefits if results are exploited only locally ▪ Negative impact on industrial diversification ▪ Loss of jobs in the short-term

Source: Compiled from Sheehan (2004); Fryges, (2004); Harrison *et al.* (2008); Hall *et al*. (2008); Ketokivi and Ali-Yrkko (2009); Voigt and Moncada-Paternò-Castello (2009); Cincera and Ravet (2011).

Apart from the effects of R&D internationalisation on the host or home country, the impact on a) competitiveness, and b) on employment, as discussed below.

a) Effects on competitiveness

Although access to foreign technologies from carrying out R&D overseas is possible (thus transferring knowledge back to the home country, i.e. 'reverse technology transfer'), empirical evidence tends to provide a mixed picture (OECD, 2005a; Griffith et al., 2004)[20]. Añón Higón et al. (2011) suggest that returns are higher in MNEs than in wholly domestic firms, and to a lesser degree higher in services than in manufacturing. Furthermore, engaging in foreign R&D activities for primarily knowledge-oriented reasons appears to be positively correlated with innovation performance, while foreign R&D for market- or resource-oriented reasons correlate positively with productivity. It seems that R&D facilities set up abroad need to be embedded in both the host country and the parent company for knowledge to flow back to the home country.

Assessing the impact of both geographic and industrial diversification of economic activities on the productivity performance of large European R&D-performing MNEs, Cincera and Ravet (2011) found a positive impact for globalisation (especially in the US) on firms' R&D productivity, with a negative impact being reported for industrial diversification. Cincera and Aldieri (2009) explored the magnitude of the geographic and technological R&D spillover effects on the productivity growth for large companies with international R&D operations, while controlling fortheir ability to identify, assimilate and absorb the external knowledge flow. Thus, the authors found that both the geographic and technological R&D spillover have an important and positive impact on the productivity growth of firms, with the effects of pure technological externalities being higher than geographic spillover. Therefore, countries can benefit from the presence of foreign-owned firms [FOF] in two ways: directly through higher productivity in the FOF, and indirectly through productivity increases in domestically owned firms, as a result of knowledge spillover or fiercer competition.

The productivity effect on the host economy of private R&D investment from abroad has been discussed widely in the literature. Thus, authors found that different types of FDI have markedly different productivity spillover effects. Generally, 'domestic firms' gain substantially from inward flowing FDI motivated by a strong technology-based ownership advantage, while inward FDI motivated by technology-sourcing considerations leads to little or no productivity spillover (see Driffield and Love, 2007, for example). According to the European Commission's Competitiveness Report 2010 (European Commission, 2010c), based on data from the Community Innovation Survey [CIS] 2006, European FOFs operate at higher productivity levels than both domestically owned non-group firms [DnGF] and domestically owned group firms [DGF][21] although, the country of origin apparently does not matter for productivity. In fact, FOFs from other EU countries and those from outside the EU exhibit a similar productivity lead over DnGFs and DGFs. This finding is confirmed by Helpman et al. (2004) and Brainard (1997), who suggest that only the most productive firms go abroad with FDI. However, after controlling for size and other company characteristics, the evidence of higher productivity growth rates for FOFs is mixed.[22] Due to data constraints, it is not possible to measure indirect

[20] Griffith *et al.* (2004) show that the total factor productivity of UK firms who established a high proportion of US-based inventors benefited disproportionately from the growth in R&D in the US during the 1990s.

[21] The analysis thus distinguishes between three types of firms: (1) Domestically owned non-group firms [DnGF] which are not affiliated to an enterprise group, and are typically small or medium sized enterprises [SME]; (2) Domestically owned group firms [DGF], comprising firms belonging to a domestic enterprise group (i.e. which could be a domestic multinational); and (3) Foreign-owned firms (FOF), which are domiciled in the country, but owned by a firm or individual from another country.

[22] FOFs show slightly higher growth rates than DGFs, but not DnGFs.

spillover effects on the productivity of DGFs and DnGFs. However, the fact that the growth rates are similar for FOFs and domestically owned firms gives at least indirect evidence that domestically owned firms do not fall too far behind them.

b) Employment effects

The employment effects of internationalising corporate R&D activities are closely related to productivity effects. Moreover, any resulting product innovation may also affect productivity. In fact, a new or improved product may require a change in production methods and input mix, which could either reduce or increase labour requirements (see Harrison et al., 2008). Different mechanisms of technological change have varying implications on the use of labour. For example, efforts to develop new products and new markets may lead to new jobs, whereas a search for a labour-saving process innovation may lead to job losses. However, these mechanisms do not operate the same for all industries and the distinction between manufacturing and services is of little relevance to understanding the outcomes (Bogliacino and Pianta, 2010).

Fryges (2004) examined the relationship between three indicators of company performance (labour productivity, employment growth, and sales growth), and the export behaviour of a sample of young, small, technology-oriented firms in Germany and the UK founded in the period 1987-1996. The author concluded that international R&D activities improve labour productivity as well as employment and sales growth. On the other hand, Bürgel et al. (2004) examined the same firms during an earlier stage of their life cycles and showed that international high-tech activities did not affect employment growth. Therefore, it may be that the results found by Bürgel et al. apply when high-tech firms are at a less mature stage of their life cycles, while those for Fryges demonstrate that the performance-improving effect of internationalisation applies only during the more mature stages of a high-tech firm's development. As outlined above, the average FOF experiences a higher productivity growth than domestically owned firms, which in turn leads to greater job losses. These negative employment changes, however, appear to be outweighed by the output growth for old products and by the contribution of new products to employment growth. In general, output growth for 'old' products may lead to more employment than product innovation for all types of firms. Interestingly, job creation arising from increased demand for existing products is highest for affiliates from other countries, closely followed by domestically owned unaffiliated firms.

The main difference between foreign owned and domestically owned firms lies in the contribution of product innovation to employment growth, which is smaller in absolute terms than the contribution of old products. New products, however, play a much more important role in employment creation in foreign owned affiliates than in domestically owned unaffiliated firms, or firms belonging to a domestic group in both periods. Here, affiliates of EU and non-EU MNEs tend to be similar. Again, employment growth is driven mainly by shifts in demand for old products and the leverage due to product innovation, both of which more than compensate for job losses resulting from general productivity gains and displacement effects of process innovations. New products make an even greater absolute and relative contribution to employment growth for both non-European and European affiliates. Furthermore, foreign-owned firms can utilise the existing products and technologies of the parent company, and learn from their experience with product innovation in other countries. This may help them to achieve higher output growth from new products, which translates into a higher contribution to employment growth (Dunning, 1981; Caves, 1996; Mairesse and Sassenou, 1991; Markusen, 2002; Hall *et al.,* 2008).

Finally, it should be recalled that, even if the firms' driver for deciding the location of R&D investment is to access specialised workers (skills) rather than for actual R&D costs (as pointed out above), Europe has relatively high labour costs compared to its main competitors, and in Europe these represent 70% of an average corporations' R&D spending. In the US and Ja-

pan, labour costs represent only about 45% of the R&D budget, and in the rest of Asia labour costs comprise less than 30% of the total R&D budget (Battelle, 2010). High labour costs thus weaken labour flexibility; and the scarce availability of a specialised labour force could represent an obstacle for MNEs investing in R&D in the EU.

To summarise, until recently, the dominant trend for internationalising R&D was not so much to transfer low-cost R&D operations to less affluent regions, but to 'swap' between nations. Therefore a 'new R&D model' emerges, where R&D offshoring appears in both emerging economies, like China and India, and developed ones. Moreover, because R&D skills improve in less affluent nations, these will claim a larger slice of the total amount of R&D being outsourced. As such, the threat from developing countries is not necessarily due to less affluent countries having lower *R&D costs*, but to a growing population of R&D talent which is quickly becoming very well educated and attracting investment from the rest of the world (i.e. *R&D supply* issues). This is what Europe - with its ageing population - will have to compete with. Accordingly, it can be concluded that Europe needs an excellent R&D and innovation system based on local strengths (e.g. outstanding R&D base, effective protection of intellectual property, well trained workforce and infrastructures). In other words: There is a strong toehold for policy making in this regard.

6 Conclusions and policy implications

The phenomenon of the internationalisation of corporate R&D represents a rapid and accelerating evolution of the business model adopted by MNEs. Drawing from recent literature and from the comprehensive debate in course of the 2nd European Conference on Corporate R&D (CONCORD 2010), it seems that globalised firms tend to do more R&D, innovate more and get higher returns from doing so than purely domestic firms. However, it should be highlighted that the occurrence, drivers and impacts of internationalising corporate R&D activities depend highly on the assumed typology of firms, in terms of size, sector characteristics and financial constraints, etc. From this perspective, the European economy, which is characterised by a dominant role for SMEs and traditional sectors, may risk playing a minor role in the international arena in comparison with the US and the emerging Asian economies.

Nevertheless, although European firms are lagging behind their US counterparts in terms of R&D intensity, those that engage in R&D internationalisation appear to be fully involved in the mainstream trends. For instance, they outsource R&D around the globe, with China and India increasingly becoming preferred foreign locations. However, the largest foreign R&D investments by EU-based companies are still concentrated in the US and Canada, followed by India, China, other European countries, Japan and the rest of the world. Moreover, European MNEs move their R&D capacities abroad for reasons that mainly relate to: a) access to markets and specialised R&D knowledge; b) proximity to production sites (often the home base); and c) reliability of the legal framework for R&D, notably intellectual property rights.[23] This evidence from European companies is consistent with the general trend of R&D globalisation being increasingly driven by an 'asset augmenting' attitude.

In this respect, the policy interest in the globalisation of R&D should not be driven by the fear that moving R&D operations outside the EU might undermine its efforts to become a knowledge-based society, but rather by understanding the opportunities arising from foreign

[23] There are further factors that affect a company's R&D investment, such as opportunities for collaboration and knowledge exchange, strength of the public science base and the existing public R&D support instruments and favourable framework conditions (market demand stimulation), amongst others.

R&D as complementary rather than as a substitute. Indeed, the fact that European companies have increased the range of their overseas R&D operations over the last decades must not be seen as a threat, but as an opportunity to move the European technological frontier ever onwards.

At a national or regional level, the key problems towards internationalisation of R&D are: i) beneficial returns from knowledge, regardless of where they come from; and ii) the comparatively lower attractiveness of local markets and ideas. The implementation of so called 'smart specialisation'[24] could be one of the approaches for solving both problems.

Therefore, the internationalisation of industrial R&D is intertwined with the shift of manufacturing operations to other countries, with the emphasis of management attention and stakeholder pressure on business financial performance, the availability of creative, well-educated and ambitious workers, the reputation of research and higher education institutions, and how they are concentrated and coordinated within the research and innovation systems, as well as with access to large emerging markets.

In general, evidence suggests that affiliates of foreign firms tend to do more R&D, innovate more and get higher returns from doing so than purely domestic firms. However, this is not necessarily due to foreign ownership but to the larger and more internationalised nature of these companies. In fact, large domestic firms with international activities do not differ much from their foreign owned counterparts. Thus, while company growth and internationalisation may be healthy for both the firms concerned and the economy in general, attracting foreign firms (e.g. FDI) may not be the only possible or most appropriate policy option. It was argued that policies aimed at 'dynamising' the domestic economy and supporting internationalisation may be even more important.

With respect to motives for R&D internationalisation, most of the foreign R&D performed by European firms comes from the companies' existing knowledge bases, which are normally strongly linked to the country of origin (and its innovation system), or are adaptations to particular circumstances in the host country. Most European firms have a strong preference for doing R&D at home or elsewhere in Europe. The quality of the national innovation system, in which the R&D of many firms are well embedded, is an important factor behind this preference. There are some signs that European innovation systems are developing in some sectors but not in others. Thus the available information, although scarce, seems to indicate that global sourcing of R&D resources in new areas is rather uncommon among European firms. European firms taking part in global sourcing seem mainly to be driven by cost considerations and are limited to certain sectors and locations (e.g. China and India). Hence, R&D outsourcing is on a relatively small scale and lags considerably behind outsourcing of other types of activities. The evidence seems to suggest that this is something that policy makers should be very concerned about at the present stage.

R&D investment by European companies is generally determined by demand, competition and business opportunities. However, regulations, standards and availability of finance (including public funding, tax incentives) are also important factors, especially for companies that traditionally do little R&D. Several studies indicate a need for policy action or at least point towards a toehold for R&D policy making. Thus, the 'indirect' effects of policy making (e.g. measures targeting general access to finance, not specifically linked to R&D activities) may be as important for R&D as R&D-targeted support programmes. This is something that deserves more attention in future research. It is important to avoid the 'lamp-post' syndrome, i.e. focusing only on the most obvious factors affecting corporate R&D and those policies especially designed for this purpose, when in fact there may be other more relevant factors (including unintended

[24] See: Foray (2009).

side-effects caused by other policies). This argument points towards the need for a holistic perspective on policy, and a strong emphasis on coordination across different policy areas.

To summarise, evidence suggests that most companies are well embedded in their national innovation systems and have a strong preference for doing R&D nationally. In fact, the quality of the innovation system matters significantly when locating their R&D, and the quality in Europe is still perceived as good. This is good news for policy makers, as it shows that catering for domestic national R&D systems is a very good investment on their part, and justifies their efforts to support R&D. Moreover, European companies that wish to invest in R&D abroad, prefer to do so in Europe. This is again good news for EU policymakers, as it indicates a toehold for R&D policy at the European level and suggests developing a well functioning European (sectoral) innovation system (across national borders). Thus, efforts at both national and European levels should go hand in hand to be most effective.

Two complementary policy strategies should be therefore put in place, to a) favour internationalisation of businesses, especially SMEs including R&D, and b) attract private R&D investment in a given territory. These policy strategies could benefit from the implementation of the following:

- Combining efforts to increase R&D intensity in the private sector by increasing R&D investment in the public sector and raising excellence levels, thus improving the prospects for healthy interaction and attracting footloose R&D capacity from abroad.
- Continuing efforts to create a strong single/integrated market (e.g. in EU, Africa or in the Americas), to make it attractive for foreign R&D investment.
- Support indigenous companies in their efforts to access and exploit new knowledge capabilities abroad.
- Reduce companies' administrative burden, particularly for SMEs (with a unified and simple regulatory framework) and improve conditions for business R&D and innovation activities (IPO platform and European Patent System).
- Use public procurement to promote innovation, in particular from SMEs and NTBF (compensate for size disadvantage, favour innovative/emerging technologies).
- Promote new collaborative international R&D and innovation schemes as "smart specialisation" to make local markets and ideas comparatively attractive and get beneficial returns from knowledge.

More generally, policies to enable national innovation systems to benefit from changing global knowledge and innovation geography include (i) evolution of the challenges that innovation policy should address, (ii) an increase in strategic planning related to policies to support internationalisation of innovation activities, (iii) an increased demand for more complex internationalisation support services, provided by public sector intermediaries, and (iv) an increased need for coordination across a range of policy areas.

Policy making in this regard is obviously a multi-dimensional approach, which can benefit from additional efforts to develop indicators and statistical frameworks to track the effects of international cooperation and further areas where R&D and innovation activities could be coordinated (at a national and/or EU level). In this regard, collaboration among producers of R&D statistics may be helpful, as this may allow the preparation of more reliable indicators regarding international R&D investment flow in Europe, and R&D and innovation activities in general. This seems to be essential for comprehensively assessing its impact and for fine tuning policy measures to support R&D.

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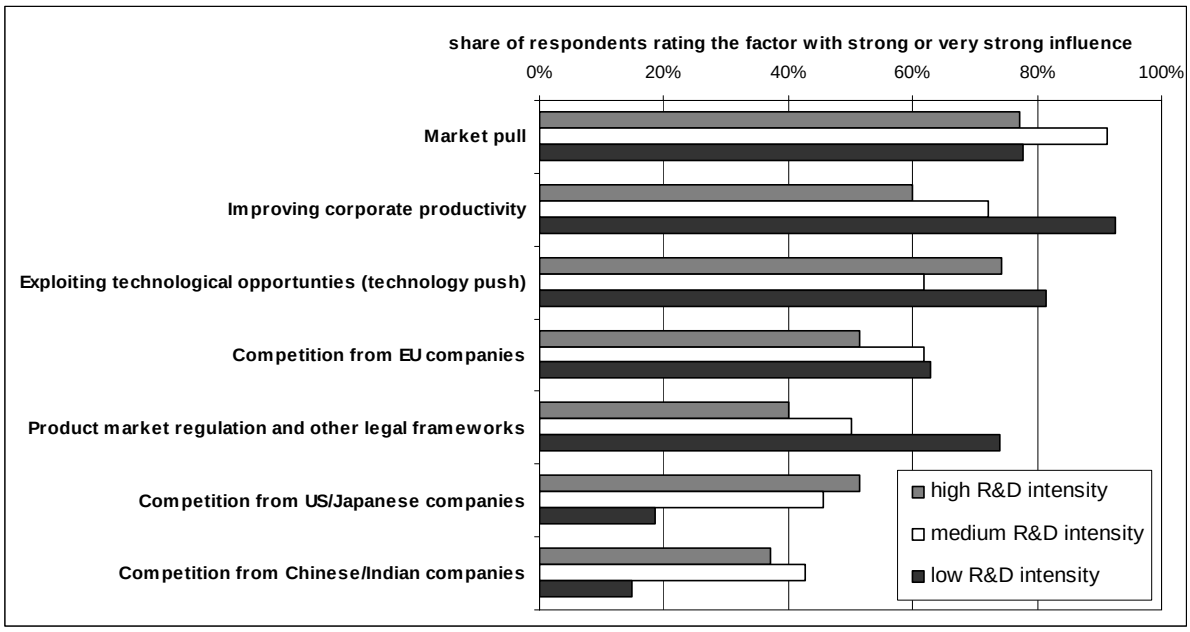
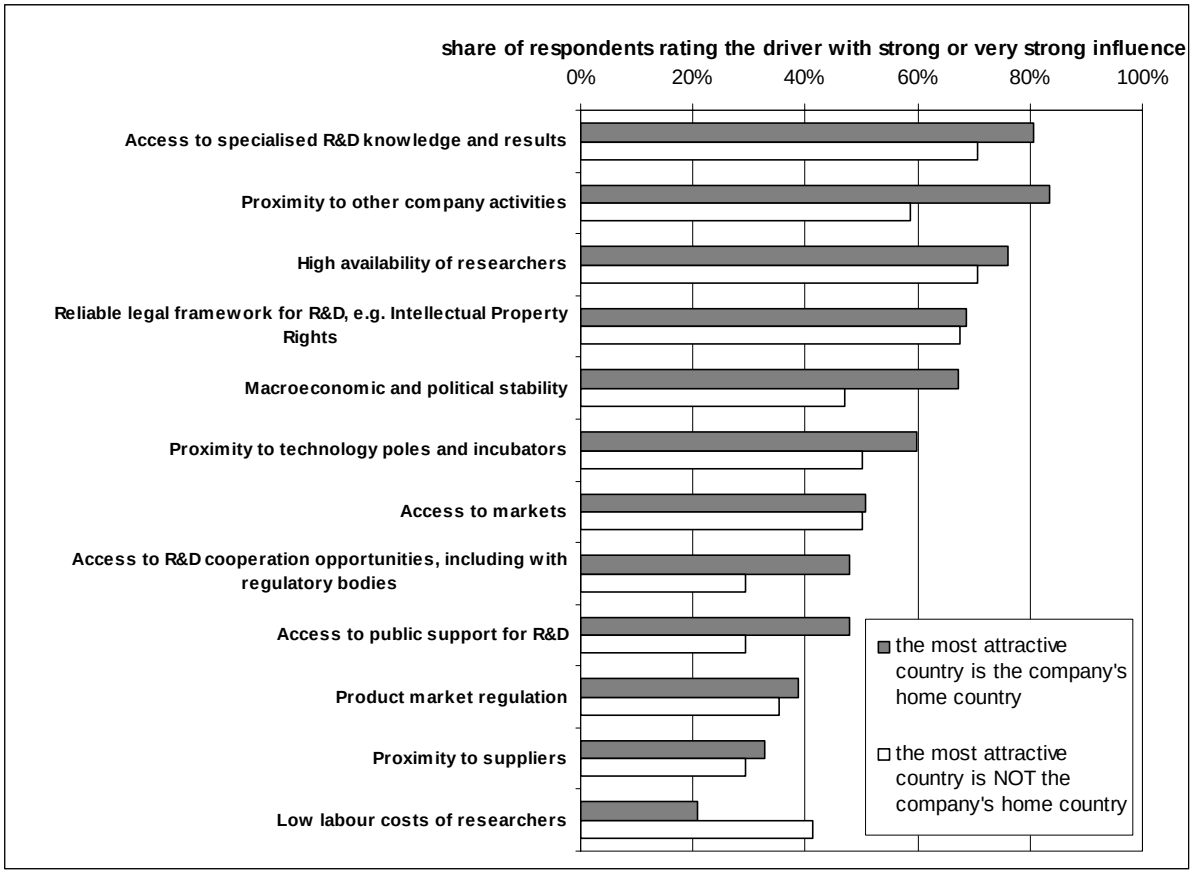
Annex

Figure 4a/b: Factors considered by EU companies when locating their R&D activities





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Abstract

The globalisation of R&D activities has continued to grow as companies are increasingly trying to capture knowledge and market opportunities internationally. The rapid evolution of national economies and the ways to conduct knowledge-intensive businesses has brought researchers and analysts to pursue a deeper understanding of the globalisation of corporate R&D and the related driving factors and impacts.

This *Working Paper* provides an overview of the evolution of globalised business R&D activities and an outline of trends is provided with quantitative information from 2001 to 2009. Thus, the literature on the main drivers and impacts of the research process is reviewed and controversial arguments are discussed and reflected upon in the light of recent empirical observations. In particular, the drivers for firms to undertake R&D in their home country, to internationalise their R&D operations and to select a particular location for undertaking R&D are analysed according to both the perspective of S&T supply side and for goods and services demand side. Furthermore, the impact of the internationalisation of business R&D is analysed for firms' host or home countries, with a particular focus on the effects on competitiveness and employment. The conclusions and policy implications from the main results of this work are presented in the last section of the document.

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