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Globalisation of European MNCs R&D: overall turn and diverging trends

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Abstract

In this paper we answer two questions: 1) how has the R&D internationalisation process evolved in the last period of time? 2) Is this process still under the dominant influence of strategic asset-seeking motives as documented by previous studies? Our work on a large sample of EU MNCs show EU large firms experienced a process of de-globalisation of their R&D since 2000. We evidence that their motivations do not primarily aimed at augmenting firm home base knowledge but rather at giving a growing importance to exploitation of firm home base knowledge.

Introduction: context and research questions

The increasing attraction of Asian countries (in particular China and India) as R&D locations, the so-called "R&D offshoring" (d'Agostino et al., 2013) has lead to a growing attention paid to R&D globalisation. This topic has stimulated empirical research dealing with the drivers and the consequences of the internationalisation of corporate invention in recent years (Doz and Wilson, 2012; Florida and Kenney, 1994; Frost, 2001; Ambos, 2005; Abramosvsky et al., 2008; Sachwald, 2008). In this paper we study *large European firms* and mainly address two questions 1) how has the R&D internationalisation process evolved in the last period of time? 2) Is this process still under the dominant influence of strategic asset-seeking motives as documented by previous studies?

R&D MNCs activity is the main source of technological knowledge creation, transfer and diffusion. The current dominant view is that this activity is *increasingly internationalised* (Cantwel, 1995; Narula and Zanfei, 2005). According to Iammarino and McCann (2013) the share of new technologies produced globally by MNCs is increasing. In the same vein Moncada-Paternò-Castello et al. (2011) noted: "The globalisation of R&D activities has continued its *growth path* as companies are *increasingly* trying to capture knowledge and market opportunities internationally." This approach is clearly different from the basic idea – while old – developed by Patel and Pavitt (1991) considering that firm technological activity was "an important case of non-globalization". Papers at the turn of the century (Patel and Vega, 1999; Roberts, 2001; Le Bas and Sierra, 2002; UNCTAD, 2005; INSEAD, 2006) concluded to an increasing internationalisation movement, while underlining the rather limited levels of internationalisation – e.g. from 15.8% in 1988-1990 to 19.5% in 1994-1996 in Le Bas and Sierra, 2002). The recent literature expresses a dual consensus about international inventive activities of MNC: it was growing but still weak. For instance Dunning and Lundan (2009) and Patel (2011) noted *the continuing reliance of firms on the* home

country as a base for innovation. Multiple arguments have been put forward for explaining the motives for investing in R&D abroad (Barlett and Ghoshal, 1989; Piscitello, 2011). Numerous empirical studies have all convincingly shown that the dominant strategy as far as location abroad is concerned was Home Base Augmenting (HBA) and not Home Base Exploiting (HBE) (Kummerle, 1997; Patel and Vega, 1999; Le Bas and Sierra, 2002). MNCs have always relative advantages at home. HBA strategies characterize foreign locations that have complementary technological strengths of those created at home. HBE strategies consist in exploiting abroad the advantage created at home in a particular technology field.

The two main reasons why firms tend to internationalize their technological activities are (Cantwell and Bellak, 1997; Dunning, 1997; Kuemmerle, 1997; Ronstatd, 1978; Rugman, 1981): 1) the necessary adaptation of products and processes to foreign conditions, a compulsory rule for penetrating markets abroad corresponding to Vernon (1966) hypothesis related to the international product life cycle, 2) the acquisition of knowledge and expertise from foreign R&D centers and universities. This view states that the international localisation of innovation activities responds mainly to the need to gain access to local competencies and knowledge.

Recently Narula and Zanfei (2005) proposed to analyse the diverse forces supporting the concentration at home and the dispersion of R&D abroad as two opposed forces, centripetal and centrifugal. In effect the R&D investment abroad can be interpreted as a dispersion of resources pulled by the search for technological opportunities that match the firm benefits. But such a conduct implies costs of searching, networking, absorbing and integrating knowledge created in foreign locations. This costly strategy is constrained by resource limitations. As a consequence it is tempting to represent this process of internationalisation through a trade-off home/abroad picturing the R&D investment location model. The

important message delivered by the two authors is that R&D investment abroad must not be considered as always effective.

Empirical studies have tried to quantify the de-facto trade-off and its evolution over time. For instance the UNCTAD survey (2005) points out that a growing share of MNC R&D is performed abroad at least for the time period 1994 to 2002. But such a trend encompasses large variations across countries. Roberts (2001) with a panel of the largest R&D-performing companies in North America, western Europe and Japan found a significant increase of R&D spending abroad as a proportion of their total R&D expenditures from 15% in 1995 to 22% in 2001. The survey conducted by Booz Allen Hamilton and INSEAD (Doz et al., 2006) pointed out that the number of R&D sites in the home country has decreased regularly since 1975 (to 32% in 2000), however it also recorded a small increase from 2000 to 2004 at 34%. Similarly Le Bas and Sierra (2002) remark that the average degree of internationalisation of technology creation in their large sample of 350 MNCs is around 19.5% of their total patenting over the period 1994-1996. That proportion has been increasing over time as it amounted to 15.8% over the period 1988-1990. Similar results are found by Patel and Vega (1999). More recently Patel (2011) considered a sample made of the 963 most technologically active MNC (they accounted for more than 85% of all corporate R&D in 2006), measuring R&D internationalisation made through patents applied for at the European Patent Office between 1991 and 2006. He confirms the small but increasing trend (+2.5% for the total sample) but shows that we should be attentive to regional differences: the growth is higher for the US (4.7%), average for Japan (2.5%) and lower for Europe. So it is relevant to note from these studies that *large firm R&D internationalisation increased while it stayed weak in general*. By contrast some empirical facts indicate a turn. For instance the UNCTAD report (2005) interestingly quotes that the international share of R&D expenditures of the largest Swedish MNCs *stagnates* at 43% after a regular period of growth. The Pro Inno survey (2007) points

out that offshoring of R&D was *expected to increase less than total R&D spending.* Lastly Gammeltoft (2006) hypothesizes that the growth of R&D internationalisation may have come to an end. This quantitative stagnation is linked to a managerial focus shifting towards organizational consolidation of international R&D structures becoming too complex.

Interestingly if the idea of a growing internationalization of R&D activity is dominating among the academics, the researchers more prone to empirical studies are less affirmative. The gap between the two attitudes deserved our attention. The aim of the paper is to bring more certainty by looking at the data in order to fill the gap. We work on European MNCs and track the degree (the rate) at which the R&D activity internationalized and then examine the type of locational strategy as it is done in the recent quantitative analyses. We built up a very consistent data set on large world firms' patenting. Our basic assumption is that patenting is an output of the R&D activity and can be used as a marker of inventive activity (in the line of previous work by Patel and Vega, 1999 and Le Bas and Sierra, 2002). Section 2 describes in details our data set. Section 3 and section 4 present and discuss our results. The former deals with the overall level and dynamics of MNC R&D internationalisation, showing diverging trends between firms from different European countries. The latter addresses the issue of the *locational strategies* of MNCs and their evolutions. The following section delineates 4 cases studies of firms to illustrate our main results. Our findings show that EU large firms present an overall case of important R&D internationalisation, but that both the levels and the trajectories differ widely between the nations. MNCs from the largest EU countries show an evolution marked by de-globalisation into the last part of the period of time under observation. This sets up our most important result. Secondly there is a clear evolution towards motives that are more linked to market penetration (aiming at exploiting the home knowledge base) even if the search for new capabilities remains prevalent (with the objective

of augmenting the home knowledge base). Once more these results show a strong spatial differentiation.

The data set

Because of the scarcity of data sets accounting for R&D internationalization at national level and the confidentiality of R&D expenditures data at firm level, patent is the source of information most commonly used for researches on R&D internationalisation (see the Handbook edited by Moed et al., 2004). Patenting provides a good indicator of firm innovative capacity (Griliches, 1990; Patel and Vega, 1999). Patents are easy to access (as non-proprietary information), they are often available in long time series, display rich information (place and date of application, identification of inventor and applicant) and are classified in categories according to technology fields. For this research, information on inventors allows to map the firm technological activity at geographical level, i.e. to identify the places where the novelty creation occurred[1]. Patent data have also well-known drawbacks: they reflect only the technological component of innovation activities; they account only for codified knowledge creation, leaving out all kinds of tacit forms of knowledge and, since the propensity to patent differs widely between national patent offices, patents should be used carefully for international comparisons. Balancing these pros and cons, patents can be seen as a relevant indicator for R&D and technology activities (Hagedoorn and Cloodt, 2003; de Rassenfosse and van Pottelsberghe, 2008; Patel 2011).

This research uses the worldwide patent indicator (de Rassenfosse et al., 2013) based on the compilation of priority patent applications that takes advantage of the complete coverage of patenting activities from more than 170 patent offices offered in the Patstat database (version of October 2011 version). This indicator presents two main advantages, compared with the

[1] Among the many discussions on the use of patents as a data source for R&D see e.g the recent de Rassenfosse, 2013.

previous patent indicators that were based on data emanating from a restricted number of large patent offices (EP, WIPO, USPTO) or a combination of them (triadic patent families). First, counting priority patents regardless of the patent office in which the application is filed overcomes the strong national bias, which hampers indicators based on data from a single patent office and has the advantage of covering more inventions than counts based on only considering patents extended internationally through the Patent Cooperation Treaty (PCT) or the very selective choice of "triadic families". Second, as highlighted in Rassenfosse et al. (2013) the worldwide patent indicator better reveals the local nature of inventive activity and better reflects the inventive activity of developing countries. In this respect, the worldwide indicator based on all priority patents provides a global view of MNC internationalisation as it integrates patents outside mainstream countries, e.g. in developing countries.

This worldwide indicator has nevertheless one main drawback. It treats equally patents applied at offices whose rules for patenting are more or less demanding, introducing thus an institutional bias, which is reflected in the very large share of Japanese and Korean patents in the world total of priority patents. This research avoids the bulk impact of this bias by examining not only the raw numbers of patents but by analysing mainly the distribution of patents across various categories, either according to the locations of inventors or according to the strategies reflected in the patents including a foreign inventor.

This research exploits a new database that identifies the priority patents applied for by the largest industrial firms in the world. It has been built in three steps. First, a set of 2800 large industrial R&D performers has been established by complementing the list of 2000 firms identified in the 2009 edition of the IPTS "Industrial R&D Investment Scoreboard" and with top patent applicants from WIPO, EPO and USPTO rankings. Second, relying on the Orbis database edited by Bureau van Dijk Electronic Publishing, we have identified the subsidiaries included in the consolidated perimeter of these industrial groups. Third, the names of the

firms and their subsidiaries have been looked for as potential applicant names in the Patstat database[2].

For this research, we have restricted the set of firms to those that have applied for at least five priority patents in both three years periods 1994-1996 and 2003-2005 retained only the European firms. This drives to a corpus of 349 firms that have applied for 90 452 priority patents between 2003 and 2005 (representing 28.4 % of total priority patents applied by European applicants during this period). Geographical information compiled in this research concerns the national origin of corporations and the places where inventions occurred. It has been identified according respectively to the corporations' headquarters location and to the personal addresses of inventors[3]. Geographical information is treated in two ways. It is first computed at national level for identifying foreign inventions (i.e. patents including an inventor's address located in a different country than the headquarter country) and the corresponding strategies they reveal regarding technological specialisation. Then, the results are analysed either at national level for large countries or at an aggregated or regional level when such a grouping is required either for increasing the size (and therefore the statistical robustness) of the corresponding population of firms and patents or for highlighting similar behaviours among neighbouring countries. In a similar way results can also be aggregated by location of inventors (of large firms inventions) in order to investigate countries in which R&D activity is realised by foreign large firms.

This study uses an unique delineation of firm perimeter at the end of the period of analysis. Corporations' boundaries are based on a single outlining of subsidiaries established in 2008. This unique "static" definition gives an accurate representation of the last period under study.

[2] See Laurens et al. (2013) for a detailed presentation of the building and characterization of this large firms database

[3] When more than one country appears in inventors' addresses in a given patent, a fraction is attributed to each country (fractional counting)

But it has a clear drawback: it does not take into account the mergers and acquisitions made during the period nor the partial sales that often take place. Several estimates let us consider that the bias thus introduced remains secondary to trends observed: mergers and acquisitions had limited impact on inventive activities. We work on a sample of 349 EU firms that are multinational by nature. Table 1 gives information onto firm nationality.

INSERT : Table 1. Sample of EU large firms

Evolution of EU MNC level of RD internationalisation: a turning point

The internationalisation of corporate inventions is measured by comparing the nationality of the firm (i.e. the country where the MNC headquarter is located) and the residence country of the inventor (given in the inventors' addresses). We use the country address of the inventor as a proxy measure for where the technological activity related to the invention occurred. We define the R&D internationalisation rate of a firm as the proportion of its patents with inventors located in foreign countries as done by several academics.

In order to get a synthetic view of the level of R&D internationalisation of the firms we have ranked the MNCs according to their nationality, in other terms the nation in which their headquarters are located (Table 2). The overall rate of internationalisation in Europe is high in 1994-1996 (40.7%). As a consequence we cannot consider, as Pavitt stated in 1990, that R&D is a case of non-globalisation, at least for the EU large firms. Internationalisation rate is high for firms from the smallest countries (Netherland, Switzerland, Sweden) in accordance with the idea that the smaller the country, the more internationalised its firms are. Our results are roughly speaking in line with those of the studies by Patel and Vega (1999) and Le Bas and Sierra (2002). By contrast our new data set enables to measure the level of internationalisation

in 2003-2005 and therefore to follow its evolution over time. The overall level of R&D internationalisation drops to 30.4%. As MNCs of Nordic and small countries show an increase of their international patenting effort, the fall of the level of internationalisation is directly linked to the MNCs from large EU countries (France, Germany, Italy, United Kingdom). Europe however aggregates different levels of firm internationalisation and different dynamics: German firms, by far the largest patent producers, exhibit both a low level of internationalisation in 2003-2005 (13.8%) and a decrease over the last decade (-13% between 1994-1996 and 2003-2005). At the other extreme, UK firms (including firms headquartered in fiscally attractive locations[4]) stand at a very high (but decreasing) level of internationalisation (from 88% to 80% over the decade). Other "large" European countries, stand in between, especially France, whose trajectory is shaped by two very large R&D players, Alcatel-Lucent and Sanofi-Aventis. The evolution of these two firms explains the drastic overall reduction in internationalisation we observe in France[5]. Such a global picture in Europe is amazingly striking. It witnesses an evolution frankly opposed to the dominant standard view that considers the MNC level of R&D internationalisation as continuously growing. It matches a clear de-globalisation related to R&D activity. Of course we have to remain cautious and would surely need data on a longer period of time for confirming this change. But the fact the trend affects a lot of firms from the largest EU countries shows that this result does not stem from the delineation of our data set. A comparison with MNCs from other continents indicates that if the rate of R&D internationalization is high but declining in Europe, it stays very weak but growing for Asian firms, and medium but steadily increasing for US MNCs (Laurens et al., 2013).

[4] In particular firms headquartered in the West Indies such as Seagate Technology, Covidien or Ingersoll Rand. This explains why on average British firms rely more on inventors located in the US than in the UK, a situation, which was already specific to the UK when considering firms such as Shell, BP or QinetiQ.

[5] When they are left aside, we witness both a far lower rate of internationalisation (23.6% in 2003-2005) and a modest increase over the two periods of time (17%).

INSERT : Table 2. Firm rate of R&D internationalization

Investigating the R&D internationalisation of European firms on a longer period of time (from 1986 to 2005) shows they had followed also a fast rising internationalisation trend from the mid 1980s (when internationalisation stood at 30%) to the mid 1990s when it reaches 43% (Figure 1). It corresponds to a simultaneous increase of "continentalisation" linked to the European common market, and to a fast rising "globalisation", evidenced in the numerous studies that investigated the expansion of European firms in the US (both through the creation of new R&D labs and acquisition of labs via mergers and acquisitions). What is however striking in figure 1 is that internationalisation reached a peak in the mid 1990s before decreasing. Europe at large and most European countries face an inverted U shape trend, witnessing a strong decrease in the second half of the 1990s and a further stabilisation between 2001 and 2005. The analysis of the opposite trends drives us to suggest the following hypotheses. When getting highly internationalised, the dependence of firms towards the wide world is such that it makes difficult to implement any strategy of concentrating on the "home base": internationalisation rates tend then to stabilize or oscillate around this very high level (between 70% and 90%). As if an "optimal rate" does exist. This is true for the UK, Nordic and "small" countries. MNCs from large European countries – in particular Germany and France – play a large role in the "European internationalisation decline". They both peak in 1995, and decline afterwards – very strongly for French firms, rather slowly for German ones. The firms from these large European countries were already strongly internationalized. In the 1990s European MNCs undertook numerous mergers and acquisitions (M&A) in particular in the US. UNCTAD (2005) points out that cross-border M&A increased globally quickly until 2000. This stopped afterwards. This move matches the burst of the so-called "Internet bubble" that affected the IT and telecommunications sectors. We can hypothesize that, in the

following period, MNCs focused on rationalizing and building up a global organisation of their R&D activities. This ended up in stabilising or reducing the overall level of internationalisation. Two further factors corroborate this analysis. The creation of the euro zone, after 2000, has lead to a greater regional integration within Europe with a sharp increase of intra-European FDI flows (UNCTAD, 2005). The second factor is related to the economic context of globalisation. After observing a selection of main trends through indicators provided by UNCTAD (2005) Report, we found interesting and maybe unexpected changes: The upward trend in FDI that began in the 1980s, stopped in year 2000[6]. In this context the decrease in the rate of R&D internationalisation related to European firms is particularly consistent. As a consequence, the basic idea is that new conditions emerged after 2000 that have affected globalisation trends.

INSERT : Figure 1. Evolution of EU MNCs rate of R&D internationalisation by countries

One logical assumption often discussed in meetings at the European Association of R&D managers (EIRMA), is that European firms, after a rapid expansion in Europe, have started rationalising their European labs, while pursuing their global implantations. This is not what we find. On average large European firms have increased their European investments in R&D (from 15.6% to 17.5% between 1994-1996 and 2003-2005), even if this relative increase has been slow while they have drastically reduced their investments in other parts of the world. The share of non-European inventions drops from 25.2% to 12.9%, mostly due to a sharp retraction in the activities in the US.

[6] We register a similar trend for the outward direct *investment* at worldwide level: after a persistent growth since 1970, it registered a peak in 2000 followed by a *decrease* during a four years period of time. It started again to increase after (see the data from UNCTAD 2005). By contrast the outward FDI *stock* increased continuously from 1982 to 2006. In the same vein, employment in foreign affiliates decreased in 2000-2002 after a long time period of growth. This reflects that important aspects of industrial globalisation can be stopped for given time periods.

As a first conclusion, we interpret the results of this section as a confirmation of the mainly national dimension of MNC technological bases. This central trait of corporate invention is massively confirmed by the analysis of inventors location which, as a general pattern, coincides mainly with the headquarter country. We can identify two outliers: United Kingdom (ranked 9th) and Netherlands (ranked 11th), whose internationalisation profiles result from factitious firms nationalities due to fiscal incentives and from the fact that countries internationalisation rates – an aggregate statistics – could stem from a few large firms' behaviours. As a second conclusion it appears that R&D internationalisation is not continuously growing. MNCs from the largest countries in terms of technological activity are going through either a stabilisation or a declining trend[7]. It is relevant to consider this period as a period of stabilisation or, to follow Gammeltoft (2006) as a period of organisational consolidation of the existing complex international R&D structures.

Locational strategies of EU MNCs

The relevant question here is: does the overall diminution of the rate of R&D internationalisation have an impact on the main motivations for off shoring firm R&D activity? And if yes in what direction? For investigating this issue we utilise the model used in the past in particular by Patel and Vega (1999) based on the calculations of the Revealed Technological Advantages (RTA) for each firm technological fields[8] (Table 3). It enables us to consider firm basic motivations for accurately knowing the investment in R&D abroad motivations. Four behaviours are rigorously delineated:

[7] The rate of R&D internationalisation cannot go until 100% there is necessarily an upper bound given by the cost of knowledge dissipation linked to many foreign locations. To date empirical evidence are missing for rightly interpreting this new trend. The reliability of our data set is not questionable. The decreasing slope is lasting over the last years. As a consequence we cannot interpret it as a shock (still less a random shock). Of course further studies will be necessary for better understanding it.

[8] The paper by Laurens et al. (2013) give more details.

1) Home Base Augmenting (HBA) FDI in R&D (Kuemmerle, 1997) or "strategic asset-seeking R&D" (Dunning and Narula, 1995). This strategy consists to target technologies in which the firm has a relative technological advantage at home and in which the host country is also relatively specialised. The search of complementary assets (knowledge sourcing approach) characterizes this type of conduct.
2) Home Base Exploiting (HBE) internationalisation strategy. Firm uses its national comparative technological advantage to export or adapt its core technology in host countries not specialized in that technology. A firm possessing a competitive advantage in a technology field in its home market seeks to exploit it abroad, particularly in regions, which are weak in the technology field considered. Firm searches abroad product adaptive R&D (Hewitt, 1980).
3) Technology Seeking (TS). A firm compensates its national under-specialization in a given technology by seeking foreign skills in host countries specialized in the same technology ("technology-seeking FDI" in R&D for Shan and Song, 1997).
4) Maket Seeking strategy (MS). Moves observed are not driven by a particular technological strategy. It corresponds to situations where a firm invests abroad in technological activities in which it is relatively weak in its home country and the host country is also relatively weak. In other words, there is neither a home technological advantage nor a host technological advantage. The motivation for this fourth type of strategy seems to be not technology-oriented. As a consequence we consider this situation pictures a Market Seeking (MS) internationalisation strategy driven by market considerations.

Each locational strategy is characterized by a binomial relation between the firm RTA in its home country (homeRTA) and the RTA of the country in which it invests a part of its R&D activity (hostRTA). From our data set we first compute RTA for each patent that

depends on the patent technology field, the host and home countries and then aggregate them at the firm level[9]. We end with the distribution of patents according to the four strategies for each firm and further aggregate them by firm home country.

INSERT : Table 3. Four locational strategies for FDI in R&D

The works by Patel and Vega (1999) and Le Bas and Sierra (2002) showed that the most important strategies are the two first, with HBA strategy outclassing HBE strategy. Both strategies for which the firm technological home base is strong (relatively to the firm home country) represented together roughly 80% of cases.

Table 4 gives the distribution of patents (in %) in Europe and according to the MNCs nationality for the two time periods under observation.

INSERT : Table 4. Firm locational strategies by countries and time periods

Our overall results show that HBA and HBE remains the dominant behaviour in Europe which are in line with previous studies (in particular Patel and Vega, 1999). They highlight that R&D offshoring does not aim at offsetting home technological knowledge weaknesses, but at augmenting or exploiting a strong home technological potential. The search for complementary assets (HBA) remains dominant but has slightly diminished (from 44.0% to 40.9%) while the exploitation of home technologies abroad (HBE) has slightly risen (from 35.2% to 37.6%). Both technology seeking and "market" seeking strategies have remained stable over the two periods (respectively around 11.5% and 8%). However this average is the combination of very different national choices, and even diverging trends. Countries that are

[9] The sample of EU firms has been reduced to 242 EU firms due to the fact, in order to calculate RTA, we need that a firm holds two patents in a given technology field with one patent invented in the corporate country and the other in foreign countries.

heavily internationalised (the UK and Nordic countries) privilege the search for complementary assets (between 52% and 53%), even if quite similar levels in 2003-2005 result from diverging trends in the evolution of HBA strategies (they stood at 65.2% in the UK in 1994-1996 and at 49% in Nordic countries). But it is difficult to generalise this trend since firms from "small" European countries that are all very internationalised, witness contradicting evolutions: high level of HBA strategies maintained over time in the Netherlands (also around 52%); and on the contrary a strong decrease for Swiss firms (around 40% in the second period). In all these countries, home base exploiting strategies gain more prominence, at the expense of previously quite important technology seeking strategies. Can we interpret this through the perspective of the numerous management studies that emphasize the growing concentration of large firms on their core technologies associated with more and more outsourcing (including offshoring)? This result may also be a sign of the progressive alignment of specialisations between large firms and their home countries. German firms follow a pattern shaped by a growing role of the search for complementary assets over time (from 37.6% to 41.2%) at the expense of the international exploitation of home based inventions (from 41.5% to 36.8%). French firms show an opposite evolution. The decrease of HBA is drastic as the increase of HBE. French case appears quite unique in the OECD landscape. It is interesting to note that, though they are the two European countries with the largest technology base, we find in both countries a significant number of firms that follow "technology seeking strategies" (13% in Germany and 17% in France in 2003-2005): this manifests the existence in both countries of large firms under-specialised in their home country. These firms have thus internationalised to search for these technologies in specialised countries.

The point deserving significant attention is that unlike studies expecting a lasting growth of HBA conduct – in line with the paper by Patel and Vega (1999) and Le Bas and Sierra

(2002) – our findings predict an opposite evolution. Of course we have to interpret these results cautiously, in particular because the trend is not general. For instance MNCs from small countries do not follow the general rule. But the fact that many large firms follow this pattern indicates doubtlessly, this behaviour is coherent with their international strategy. The case studies pictured in the next section will bring inputs for interpreting these patterns.

EU MNCs R&D internationalisation: Four case studies

The observation of an unexpected combination of a global HBA decline and increase of HBE internationalization strategy in several European countries over the time period under observation leads us to dig behind aggregated data and investigate a few firm case studies where such a change was observed in order to get a better understanding of this trend. Besides, in most European countries a very few firms (or even a single one) concentrate a large share of the patents applied for and thus heavily impact the data at the country level. This occurs in France (Alcatel-Lucent and Sanofi-Aventis), Germany (Siemens), Italy (Fiat), Netherlands (Philips), Switzerland, Sweden (Ericsson).

First, we evidenced that such a strategic evolution was not rare since half of the 25 largest European firms (in terms of the number of priority patents applied for in 2003-2005) exhibit such pattern. Among those firms, we select four industrial and largely internationalized firms from different countries, Alcatel Lucent in France, GKN in the United Kingdom, ABB in Switzerland and Fiat in Italy. These corporations stand among the first applicants of their home country: Alcatel Lucent is the first French corporate applicant in the period 1994-1996 and ABB the first Swiss applicant in the two time periods. For these firms, we investigate the distribution of their international patents by inventor country and by technological field for the two periods in order to assess the causes of the changes of patenting strategy pattern and try to link it to the global evolution of the firm internationalisation scheme.

From a methodological point of view, such a global change from HBA to HBE stems from situations where the corporate *remains* globally specialized in its home country (HomeRTA >1) and where the number of inventors located in host countries specialized (hostRTA >1) in the patent technological fields became lower than the number of inventors located in host countries not specialized (hostRTA <1) in the patent technological fields. This could result from:

- a change of the distribution of inventors' countries: for a given technological field, the patents are invented in a specialized host country (hostRTA >1) in the first period and in a non-specialized country in the second period (hostRTA <1). Shifting a R&D center from one foreign country to another one could induce such a strategic trend.

- a change of the distribution of the patent technological fields: the inventors remained located in the same country during the two periods but the technological field of patents change from one field where the host country was specialized (hostRTA >1) in the first period to a different field where the host country is not specialized (hostRTA <-1) in the second period (the homeRTA >1 in the two fields). A technology diversification resulting from merging or acquisitions of a complementary firm can feed such a pattern.

- a change of the technological specialization pattern of a host country between the two periods: the patents remain invented in the same foreign country and in the same technological field but the host country initially specialized in the field (hostTRA >1) became under specialized in the second period (hostTRA <1). Such cases can be encountered in small countries where the global technological specialization is not as stable as in larger countries.

More complex cases involving changes of the firm home specialization (and thus TS and MS strategies) could also participate to the combined HBE progress and HBA decline.

Usually corporations rely on inventors from several countries and patents in different technological fields, therefore several strategic schemes cohabit within the same large firm. A global strategy changeover between two periods of time can also stem from a change of the distribution of inventor location or technological fields (without any individual hostRTA change)

GKN a group from the UK boosting its overseas internationalization with a HBE strategy

GKN is a British multinational automotive and aerospace components company headquartered in the United Kingdom. From the 1970s, GKN has intended to reduce its dependence on UK automaker customers. It diversified his activities into military vehicles, aerospace and industrial services and internationalized them by opening plants in the United States, Europe and Japan and by investing worldwide. Then from the 1990s, GKN sized down and refocused its activities into aerospace, mechanical engineering for transport and powder metallurgy. In order to gain the leadership in these fields, GKN has acquired many firms in the United States, in Europe and then in Asia. The growing internationalisation strategy of GKN is also evident from its patent portfolio: foreign inventors (not located in UK) were involved in 82% of GKN priority patents in 1994-1996 and in 96% of GKN priority patents in 2003-2005. GKN priority patent number involving foreign inventor have increased 3.2 fold.

In 1994-1996, most of the GKN patents originated from the German GKN Automotive AG affiliate and involved inventors in Germany (they top 82% of foreign inventors). As Germany is specialized in the core technological fields of GKN (namely “Mechanical elements” and

"Transport" fields that totalize 77% of all GKN patents), GKN was largely dominated by a HBA strategy (86.2%). The US GKN Automotive affiliate with US located inventors, the second largest applicant of the group, accounts for most of the HBE strategy (13.8%) since the US are not specialized in GKN patent technological fields.

In 2003-2005, the rate of HBA strategy decreased to 83.2% and its HBE strategy increased to 16.8%. This evolution is directly linked to the higher share of patents applied for by GKN Automotive US (with US inventors) feeding an HBE strategy compared to GKN Automotive AG that is feeding the HBA strategy.

ABB: a corporate following a dominant HBE strategy in its internationalization in Europe

ABB Group is a multinational corporation headquartered in Switzerland. The group resulted from the merger of a large Swedish corporation (ASEA) and a Swiss company (BBC) in 1988. In the 1990s it purchased several enterprises in the US to break into the North American market. After facing important difficulties in the 2000s, ABB was reorganized and operates now worldwide in robotics and mainly in the power and automation technology areas.

ABB is the largest Swiss corporate patent applicant. In the periods 1994-1996 and 2003-2005, ABB accounts respectively for 36% and 26% of priority patents applied for by Swiss MNCs. Between the two periods, ABB augmented the share of patents involving foreign (non Swiss) inventors from 74% to 81% mainly by boosting its share of European foreign inventors (in the same time the share of inventors in US declines from 16.6% to 7.4%). In Europe, its inventors are located in Germany (53%), Finland (14%) and Sweden (10%). Between the two periods, the share of inventors from Germany and Finland rise sharply while Sweden inventors' share diminishes. In 2003-2005, German and Finland inventors stand respectively for 53% and 14%

of all ABB patent inventors. ABB patents cover a wide range of technological fields (related to Electrical engineering, Measurement or Mechanical engineering domains) but the corporation is largely specialized in "Electrical machinery, apparatus" (accounting for 47.3% of all patents). From 1994-1996 to 2003-205 a change in ABB technological patent profile is noticeable with a reinforcement of the "Electrical machinery, apparatus, energy" and "Measurement" field specializations and decreasing shares of "Engines, pumps, turbines" and "Thermal processes" fields. ABB follows a dominant HBE strategy in particular in its principal fields of specialization where the HBE strategy accounts for 97% to 99%. The global HBE strategy was reinforced between the two periods (from 50.5% to 58.2%) at the expense of the HBA strategy that declined from 16.8% to 9.8%. This trend results primarily from the reinforcement of the ABB specialization in technological fields where HBE is the only strategy fed by inventors from Germany, Finland or Sweden.

Alcatel Lucent: a merging of overseas partners

Alcatel Lucent is a French mobile phone manufacturer and telecommunications equipment company, headquartered in France. The group was formed when Alcatel merged with Lucent Technologies, a large US corporate, in 2006. Alcatel Lucent accounts for 22.1% of the priority patents applied for by French MNEs in 1994-1996 and only 15.2% in 2003-2005. In the former period, more than 90% of the corporate patents originate from the American Lucent Technologies partner (with US inventors) and consequently the corporate exhibits a very high internationalisation rate 89.7%. In 2003-2005, the respective patenting weight of the two partners has changed with Alcatel being involved in 73% of the corporate patents. As a result, the internationalization rate decreases (to 84.3%) and the distribution of inventor location changes with a huge drop of US inventor share (from 96.8% to 57.3%) and the growing presence of inventors from Germany (17%), Belgium (7%) and China (6%). As another consequence, the corporate technological profile was also noticeably modified

between the two periods. We witness a huge rise of the patent share in Digital communication (from 11% to 31%) at the expenses of patents in Computer technology or Optics. Not surprisingly the global international patenting strategy was also impacted. We observe an HBA decrease from 36.3% to 24.2% combined with a limited HBE increase (46.5% to 47.3%) and a large TS increase (from 0.3% to 17%). The drop of HBA was largely related to the decrease of the HBA strategy in the several major fields of specialization for the benefit of either HBE or TS strategy. In the field of Computer technology, most of the patents have US inventors in both periods but a change of homeRTA (from >1 to <1) led to a change of strategy from HBA to TS (with hostRTA remaining higher than 1). In Digital communication, the growing share of German inventors (HostRTA <1) to the expense of US inventors (HostRTA >1) promotes a HBE strategy.

Fiat: a large figure of Italian innovation system

Fiat is a famous Italian automobile manufacturer. The group activities were initially focused on the production of cars, industrial and agricultural vehicles. Over time it has diversified into many other fields. In the early nineties facing the crisis, all Fiat Group companies started a radical restructuring process in order to regain competitiveness. From 1994-1996 to 2003-2005, the share of Fiat patents involving foreign inventors rises from 51.9% to 61.5%, with a drop of European inventors (from 28% to 15.7%) and a sharp increase of overseas inventor share (from 23.9% to 45.8%). In 1994-1996, foreign inventors were either located in France (44.9%) or in the US (45.6%). In the period 2003-2005, 70.2% of them were in the United States (the rest came from Belgium or Germany and the share of inventors from France dropped to 3.2%). This change is linked to the growing patenting activities of CNH Global N.V. a Fiat's affiliate born in 1999 from the merging of two American firms (New Holland and Case IH) that became a leader in manufacturing agricultural and construction equipment.

Fiat is specialized in three main technological fields: “Other special machines”, “Transport” and “Mechanical elements”. As a result of CNH growth, Fiat reinforced its specialization in “Other special machines” (whose share sharply rises from 23.3% to 43.3% between the two periods). In addition, Fiat patenting strategy evolves from a mixed strategy in the first period (combination of HBA, HBE and TS strategies with shares around 28%) to a MS dominant strategy (40.8%) in the second period. Simultaneously, HBA and TS sharply drop (to 14.8% and 18.9% respectively) while HBE moderately decreased (to 25.5%). This change of international strategy is the consequence of the increasing share of US inventors. Being largely involved in patents in “Other special machines”, a field where both Italy and the United States are under specialized (homeRTA and host RTA <1), they account for the MS dominant strategy in 2003-2005 (with a hostRTA >1 in 1994-1996, US inventors fed the TS strategy in the first period). The reduction of the HBA strategy first resulted from the declining share of inventors from France due to a decreasing activity of the Magneti Marelli affiliate that often co-invent with French car-makers.

These case studies highlight the fact that the massive reorganizations (fusion, merging, acquisition…) in large European corporations in the 1990’ are often responsible of changes of the firm patenting policy either by modifying technological profiles or geographical loci of inventions. Under such circumstances, both rate of patents with foreign inventors and mode of internationalization strategies may exhibit disrupted evolutions or deviate from expected trends at the firm or country level.

Conclusion

The two main findings of this research are 1) an unexpected process of de-globalisation (following an internationalisation phase ending in the mid 1990s) is experienced by European MNCs but not for our overall sample of firms, 2) a new balance between the two more

important locational strategies (namely HBA and HBE) appears to the detriment of HBA conduct while diverging cases still exist. The previous section has presented reasons explaining the rebalancing that is specific to EU MNCs (see Laurens et al. 2013). Regarding the first we are aware a longer time period is needed for confirming this trend that is specific to EU MNCs, in particular for firms from large countries[10]. US and Asian firms starting at a lower level are continuing their process of technological globalization (Laurens et al., 2013). How can we explain it? From a theoretical view point it might be factors affecting the trade-off between concentration at home and the dispersion of R&D abroad (Narula and Zanfei, 2005) play more strongly against the dispersion at a certain level of internationalisation. For instance we note the importance of a) a less efficient intra MNCs knowledge transfer (Sanna-Randaccio and Veugelers, 2001), in particular when there is weak regime of IPR in foreign countries (Branstetter et al., 2006), b) a risk of dissipation of knowledge towards local firms (Almeida, 1996) transaction costs could be higher (Iammarino and McCann, 2013). These factors are in line with the idea of a necessary organizational consolidation put forth by Gammeltoft (2006). It opens a new research program dedicated to the understanding of MNCs global innovative activity in a time period of de-globalisation.

References

Abramovsky Laura, Griffith Rachel, Mcartney Gareth; Miller, Helen (2008). « The location of innovative activity in Europe », Institute for Fiscal Studies, UK. IFS Working Papers W08/10 (downloaded on 03 december 2013 from http://www.ifs.org.uk/wps/wp0810.pdf).

d'Agostino, Lorena M., Laursen, Keld ; Santangelo, Grazia D. (2013). « The impact of R&D offshoring on the home knowledge production of OECD investing regions », *Journal of Economic Geography*, vol. 13, n° 1, p. 145-175.

Almeida, Paul (1996). « Knowledge sourcing by foreign multinationals: patent citation analysis in the U.S. semiconductor industry », *Strategic Management Journal*, vol. 17, Winter special issue, p. 155-165.

Ambos, Bjorn (2005). « Foreign direct investment in industrial research and development: A study of German MNCs », *Research Policy*, vol. 34, n° 4, p. 395-410.

[10] We do not think this result would be an effect of the use a patenting data instead of R&D expenditures in particular because this trend of de-globalisation is not general in Europe.

Bartlett, Christopher A.; Ghoshal, Sumantra (1989). *Managing Across Borders: The Transnational Solution*, Harvard Business School Press, Boston, Mass.

Branstetter, Lee G., Fisman, Raymond; Foley, Fritz C. (2006). « Do stronger intellectual property rights increase international technology transfer? Empirical evidence from US firm-level panel data », *Quarterly Journal of Economics*, vol. 121, n° 1, p. 321-349.

Cantwell, John (1995). « The globalisation of technology: what remains of the product cycle model? », *Cambridge Journal of Economics*, vol. 19, n° 1, p. 155-174.

Cantwell, John; Bellak, Christian (1997). « Small latecomer countries in a globalising environment: constraints and opportunities for catching-up », *Development and International Cooperation*, vol. 13, n° 24-25, p. 139-179.

Doz, Yves L.; Wilson, Keeley (2012). *Managing Global Innovation: Frameworks for Integrating Capabilities Around the World*, Watertow, Harvard Business School Press, 272 p.

Doz, Yves L.; Wilson, Keeley, Veldhoen, Steven, Goldbrunner, Thomas; Altman, Georg (2006). « Innovation: is global the way forward? A joint study by Booz Allen Hamilton and INSEAD », INSEAD.

Dunning, John H.; Narula, Rajneesh (1995). « The R&D activities of foreign firms in the United States », *International Studies of Management and Organisation*, vol. 25, n° 1-2, p. 1-64.

Dunning, John H. (1997). « The economic theory of the firm as the basis for a 'core' theory of international production », in: I. Islam and W. Shepherd, (Eds), *Current issues in international business*, Cheltenham, Edward Elgar, pp. 60-68.

Dunning, John H.; Lundan, Sarianna M. (2009). « The internationalisation of corporate R&D: A review of the evidence and some policy implications for home Countries », *Research Policy*, vol. 26, n° 1-2, p. 13-33.

Florida, Richard; Kenney, Martin (1994). « The globalisation of innovation: the geography of Japanese R&D in the US », *Economic Geography*, vol. 70, n° 4, p. 344-369.

Frost, Tony S. (2001). « The geographic sources of foreign subsidiaries innovations », *Strategic Management Journal*, vol. 22, n° 2, p. 101-123.

Gammeltoft, Peter (2006). « Internationalisation of R&D: trends, drivers and managerial challenges », *International Journal of Technology and Globalisation*, vol. 2, n° 1-2, p. 177-199

Griliches, Zvi (1990). « Patent Statistics as Economic Indicators: A Survey », *Journal of Economic Literature*, vol. 28, n° 4, p. 1661-1707.

Hagedoorn, John; Cloodt, Myriam (2003). « Measuring innovative performance. Is there an advantage in using multiple indicators? », *Research Policy*, vol. 32, n° 8, pp. 1365-1379.

Hewitt, Gary (1980). « Research and development performed abroad by U.S. manufacturing multinationals », *Kyklos*, vol. 33, n° 2, p. 308-327.

Iammarino, Simona; McCann, Philip (2013). *Multinationals and economic geography: location, technology and innovation*, Cheltenham, Edward Elgar Publishing Ltd, 496 p.

Industrial R&D Investment Scoreboard Report (2008). « From the Institute for Prospective Technological Studies of the European Commission IPTS », (downloaded on 12 November 2013 from http://iri.jrc.ec.europa.eu/scoreboard12.html).

Kuemmerle, Walter (1997). « Building effective R&D capabilities abroad », *Harvard Business Review*, March-April, p. 61-70.

Laurens, Patricia, Le Bas, Christian, Schoen, Antoine, Villard, Lionel; Larédo, Philippe (2013). « Internationalisation of Large Firms R&D: is the increase trend levelling off? », Working paper (downloaded from http://ifris)

Le Bas, Christian; Sierra, Christophe (2002). « Location versus home country advantages in R&D activities: some further results on multinationals' locational strategies », *Research Policy*, vol. 31, n° 4, p. 589-609.

Moed, Henk F., Glänzel, Wolfgang; Schmoch Ulrich (2004). *Handbook of Quantitative Science and Technology Research*, Dordrecht, Kluwer Academic Publishers, 800 p.

Moncado-Paternò-Castello, Pietro, Vivarelli, Marco; Voigt, Peter (2011). « Drivers and impacts in the globalisation of corporate R&D: an introduction based on the European experience », *Industrial and corporate change*, vol. 20, n° 2, p. 585-603.

Narula, Rajneesh; Zanfei, Antonello (2005). « Globalisation of innovation: the role of multinational enterprises », in: J. Fagerberg, D. Mowery et R.R. Nelson, (eds), *The Oxford Handbook of Innovation*, Oxford University Press, p. 318-345.

Patel, Pari; Pavitt, Keith (1991). « Large firms in the production of the world's technology: an important case of "Non-Globalisation" », *Journal of International Business Studies*, vol. 22, n° 1, p. 1-21.

Patel, Pari; Vega, Modesto (1999). « Patterns of internationalisation of corporate technology: location vs. home country advantages », *Research Polic*y, vol. 28, n° 2-3, p. 145-155.

Patel, Pari (2011). « Location of innovative activities of EU large firms », SPRU Working Paper Series n° 190, (downloaded on 3 December 2013 from http://www.sussex.ac.uk/spru/documents/sewp190.pdf).

Piscitello, Lucia (2011). « Strategy, location, and the conceptual metamorphosis of the MNE », *Global Strategy*, vol. 1, n° 1-2, p. 127-131.

Pro Inno Europe Report, (2007). « The implications of R&D off-shoring on the innovation capacity of EU firms », Helsinki School of Economics (downloaded on 12 November 2013 from http://www.edocr.com/doc/8/implications-r-d-shoring-innovation-capacity-eu-firms).

de Rassenfosse, Gaetan; van Pottelsberghe, Bruno (2008). « A policy insight into the R&D patent relationship », *Research Policy*, vol. 38, n° 5, p. 779-792.

de Rassenfosse ; Gaetan, Dernis, Hélène, Guellec, Dominique, Picci, Lucio ; van Pottelsberghe de la Potterie, Bruno (2013). « The worldwide count of priority patents: A new indicator of inventive activity », *Research Policy*, vol. 42, n° 3, p. 720-737.

Roberts, Edward B. (2001). « Benchmarking global strategic management of technology », *Research Technology Management*, vol. 29, n° 1, p. 71-88.

Ronstadt, Robert C. (1978). « International R&D: the establishment and evolution of research and development abroad by seven US multinationals », *Journal of International Business Studies*, vol. 9, n° 1, p. 7-24.

Rugman, Alan M. (1981). *Inside the multinationals: The economics of internal markets*, New York, Columbia University Press, 179 p.

Sachwald, Frédérique (2008). « Location choice within global innovation networks: the case of Europe », *Journal of Technology Transfer*, vol. 33, n° 4, p. 364-378.

Sanna-Randaccio, Francesca ; Veugelers, Reinhilde (2001). « Multinational knowledge spillovers with centralized vs decentralized R&D: a game theoretic approach », CEPR discussion paper, n° DP3151, (downloaded on 07 November 2013 from http://dev3.cepr.org/meets/wkcn/2/2303/papers/veuglers.pdf).

Shan, Weijian; Song, Jaeyong (1997). « Foreign direct investment and the sourcing of technological advantage: evidence from the biotechnology industry », *Journal of International Business Studies*, vol. 28, n° 2, p. 237-284.

UNCTAD (2005). « World Invest Report: Transnational corporations and the internationalization of R&D », United Nations, New York and Geneva, (downloaded on 12 November 2013 from http://unctad.org/en/docs/wir2005_en.pdf).

Vernon, Raymond (1966). « International investment and international trade in the product cycle », *Quarterly Journal of Economics* vol. 80, n° 2, p. 190-207.

Table 1. Sample of EU large firms

Country of firm	Firm share (%)	Patent share 2003-2005 (%)	Firm Number
Austria	1.4	0.42	5
Belgium	3.4	0.56	12
Denmark	3.2	0.47	11
Finland	5.2	4.0	18
France	14.3	16.0	50
Germany	24.9	57.5	87
Italy	3.2	1.3	11
Netherlands	6.9	4.2	24
Norway	1.4	0.36	5
Spain	2.0	0.11	7
Sweden	7.7	5.0	27
Switzerland	7.7	4.6	27
United Kingdom	16.9	0.5	59
Other	1.8	5.0	6
Europe	100.0	100.0	349
Number Europe	349	90 452	

Table 2. Firm rate of R&D internationalization

Country of firm	Internationalization rate 1994-1996 (%)	Internationalization rate 2003-2005 (%)	Evolution 1994-96 to 2003-2005 (%)
Austria	53.8	49.3	-8.2
Belgium	55.1	67.6	22.8
Denmark	46.4	46.1	-0.9
Finland	31.3	34.4	10.0
France	48.0	34.1	-29.0
Germany	15.8	13.8	-12.8
Italy	45.1	36.8	-18.4
Netherlands	80.1	89.0	11.2
Norway	21.2	29.5	38.8
Spain	31.2	17.0	-45.5
Sweden	44.5	56.1	25.9
Switzerland	78.0	72.8	-6.6
United Kingdom	88.1	79.9	-9.3
Europe	**40.7**	**30.4**	**-25.3**

Figure 1. Evolution of EU MNCs rate of R&D internationalisation by countries

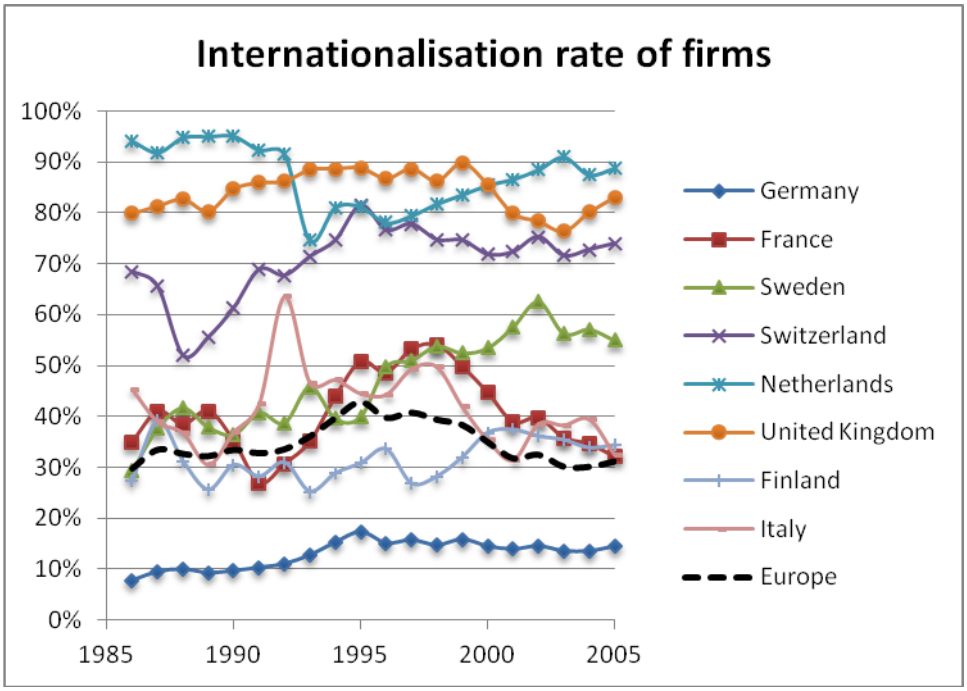

Table 3. Four locational strategies for FDI in R&D

	Technological activities in host country	
Corporate technological activities in home country	**Strong**	Weak
Strong	HBA	HBE
	HomeRTA > 1 HostRTA > 1	HomeRTA > 1 HostRTA < 1
Weak	TS	MS
	HomeRTA < 1 HostRTA > 1	HomeRTA < 1 HostRTA < 1

Source: adapted from Patel and Vega (1999) and Le Bas and Sierra (2002).

Table 4. Firm locational strategies by countries and time periods

Country of firm	HBA 1994-1996 (%)	HBA 2003-2005 (%)	HBE 1994-1996 (%)	HBE 2003-2005 (%)	TS 1994-1996 (%)	TS 2003-2005 (%)	MS 1994-1996 (%)	MS 2003-2005 (%)
Austria	26.1	15.7	60.4	67.5	11.8	10.5	1.7	6.4
Belgium	29.8	33.6	44.2	36.2	17.9	16.0	8.2	14.1
Denmark	72.5	43.2	26.0	53.6	0.8	1.0	0.7	2.2
Finland	35.6	51.3	52.5	39.9	5.2	7.1	6.7	1.7
France	40.8	27.7	34.0	42.7	11.8	17.1	13.3	12.5
Germany	37.6	41.2	41.5	36.8	12.0	12.9	8.9	9.1
Italy	37.2	24.8	27.9	27.2	20.2	16.8	14.8	31.2
Netherlands	27.1	42.7	52.4	52.2	14.0	3.4	6.5	1.7
Sweden	50.7	55.9	36.8	31.4	4.5	9.0	8.0	3.7
Switzerland	50.4	39.5	25.9	32.3	19.1	22.2	4.6	6.0
United Kingdom	65.2	52.5	29.5	37.5	2.0	2.9	3.3	7.1
Europe	**44.0**	**40.9**	**35.2**	**37.6**	**11.4**	**11.7**	**8.4**	**7.8**