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Internationalisation de la recherche développement des FMN européennes : « déglobalisation » et évolution des stratégies de localisation

Internacionalización de la I + D de las multinacionales europeas: “deglobalisation” y estrategia de ubicación

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Résumé de l'article

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Internacionalización de la I + D de las multinacionales europeas: "deglobalisation" y estrategia de ubicación

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Résumé

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Mots clés : grande firme multinationale, R&D, internationalisation, stratégie de localisation

Abstract

The aim of the paper is to track the scale and the strategy of European multinational firms related to the internationalization of their R&D. We address two questions: 1. Can we confirm the general view assuming a growing trend in the internationalisation of technology? 2. Does the "home base augmenting" dominant strategy observed in the 1990s still hold? We use a patent data set for a sample of 349 firms and two time periods 1994-1996 and 2003-2005. We find out: 1) the remaining importance of the national technological bases of MNCs, 2) R&D internationalisation is not continuously growing over the period under observation, 3) an emerging trend working to the detriment of the home base augmenting strategy.

Keywords: large firm (multinational), R&D, internationalisation, locational strategy

Resumen

El propósito del artículo es el seguimiento de la evolución de la escala y la estrategia de las multinacionales europeas sobre la internacionalización de la I + D. Nos dirigimos a dos preguntas: 1. Podemos confirmar las predicciones de opinión general sobre una tendencia creciente en la internacionalización de la tecnología? 2. Continua la estrategia « home base augmenting » observada en la década de 1990 siendo la estrategia dominante? Utilizamos un conjunto de datos de patentes de 349 empresas y dos períodos; de 1994-1996 y 2003-2005. Encontramos que: 1) La base tecnológica de las empresas multinacionales continua siendo importante, 2) La internacionalización de la R&D no se desarrolla continuamente durante el periodo observado, 3) una nueva tendencia se desarrolla a expensas de la estrategia « home base augmenting ».

Palabras claves: grande multinacional firme, I + D, internacionalización, estrategia de ubicación

Global innovation in the contemporaneous knowledge-based economy is a consistent driver of the growth of multinational firms (thereafter MNCs) and nations. As a consequence its management is of a crucial importance for fostering its effectiveness (Santos, Doz and Williamson, 2001; Doz and Wilson, 2012). Building organizational capabilities sourcing and integrating knowledge from dispersed geographic locations are keys for generating high value innovations at lower cost. Structuring and organizing the flows of internal knowledge between the headquarters and

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the subsidiaries and between subsidiaries set up the main goal of multinational activities (see among others: Almeida and Phene, 2004; Frost, 2001). As a consequence managerial tasks concern not only the mastering of internal resources for the production of innovation but also the scale and the scope of knowledge that MNCs have to assimilate. The search of the most effective organizational structures for global innovation process is a key issue for corporate mangement (Mudambi et al., 2007). In this context the importance of global innovation networks is acknowledged as crucial for creating value (De Brentani et al., 2010)[2].

The research presented in this paper builds on these approaches. We put the emphasis on the process of R&D as a key investment for feeding the production of new technological knowledge. In others terms we look at global innovation through its main input: the R&D activity. We are interested in the conduct of *European* MNCs with respect to their decision to implement R&D activities abroad. Their case deserves attention due to their situation: strongly internationalised with respect to their technological activities for a long time, they have experienced waves of mergers and acquisitions in the 1990s and during the first decade of the new millennium. Two related aspects will be observed: the volume of the R&D which is internationalised and the type of R&D strategy followed by European MNCs in terms of location abroad. We finally give evidence in favor of a certain deglobalisation and a new balance between the two important locational strategies.

We give more details on the framework we mobilize and on our research questions in section 1. Section 2 presents the data set we have built up. The following sections set out our main quantitative results with respect to the scale of R&D internationalisation (section 3) and locational strategies (section 4). An in-depth qualitative analysis of 4 well-known European MNCs is presented in the last section showing the main trends previously pictured.

Section 1 – Setting the context, framework and research questions

In recent years the scale and the drivers of the internationalisation of corporate invention have been at the core of numerous empirical researches (see among others, Florida and Kenney, 1994; Frost, 2001; Ambos, 2005; Abramosvsky et al. 2008; Sachwald, 2008). Concerning the scale, the dominant view is that firm innovation activity is *increasingly internationalised* (Iammarino and McCann, 2013). This is well expressed by Moncada-Paternò-Castello et al. (2011): "The globalisation of R&D activities has continued its *growth path* as companies are *increasingly* trying to capture knowledge and market opportunities internationally." With respect to the drivers, the main question is: For what strategic reasons do firms internationalise their technological activities? Few years ago Kummerle (1999) suggested a framework based on the type of knowledge looked for: for adapting products to local markets and thus further *exploiting* the technological home base (HBE strategies) or for looking for complementary technologies and thus *augmenting* the firm capabilities (HBA strategies). Many authors converge towards assessing a dominant and increasing role of asset augmenting motives (Patel and Vega, 1999; Von Zedwitz and Gassman, 2002; Le Bas and Sierra, 2002; Piscitello, 2011).

Locating R&D in a foreign country to take advantage of technological opportunities may also be restricted due to the additive costs (for absorbing and integrating the knowledge produced abroad) it implies (Dunning, 1988). The reduction of transaction costs enables the outsourcing of multiple functions (Iammarino and McCann, 2013) and consequently R&D internationalisation. Nevertheless as too large dispersion may entail higher costs and gives incentives for reducing the level of R&D internationalisation. As a consequence it is tempting to picture the R&D investment location model through a trade-off based on the benefits stemming from the location abroad on the one hand and the diverse costs of the R&D activity dispersion on the other. In line with Narula's analysis (Narula and Zanfei, 2005), Table 1 provides a short survey of recent studies pointing out a set of factors in favour of R&D centralisation (at home) versus R&D dissipation (abroad).

Nowadays this issue has been revisited because the diminishing costs of communication (linked to ICT diffusion) and transportation (linked to the development of container-based shipping) have enabled to invest abroad and to offshore numerous activities (including knowledge production through R&D activity). These perspectives have given rise to the so-called "end of distance conjecture" or the "flat world vision" (Friedman, 2005). The idea that the offshoring of R&D activities might have no limits stems from this approach of globalisation. By contrast, another perspective considers that the world is not becoming flatter but more curved (McCann, 2008), spiky (Florida, 2005), lumpy or uneven (Iammarino and McCann, 2013)[3]. The trend of decreasing communication, transportation and transaction costs does not apply everywhere at the same rate and does not affect the organisations with the same force. The large concentrated corporation has not disappeared; on the contrary its role has increased by shaping and managing important internal and external networks. Empirical studies conducted converge towards mitigated conclusions. For some the trade-off drives to a weak but growing level of internationalisation of R&D (Roberts, 2001; UNCTAD survey, 2005; Booz Allen Hamilton and INSEAD, 2006) in

2. Besides these approaches of global innovation management new research directions appear as "reverse innovation" often linked to frugal innovation (Basu et al., 2013; Radjou et al., 2013; Zeschky et al., 2014) or the topic of *born-global* (Knight and Cavusgil, 2004).

3. See also the work by Belberdos et al. (2008).

TABLE 1
What the recent literature tells us on the factors affecting firm positions on the home/abroad trade-off for R&D

Factors in favour of home country centralisation	Factors in favour of foreign country dissipation
Risk of dissipation of knowledge towards local firms (Almeida, 1996) In particular when the IPR regime in foreign countries is weak (The Economist Intelligent Unit Report, 2007)	Firms can increase their foreign market share thanks to the development abroad of more locally adapted products ("old" but always relevant view formulated by Rugman, 1981)
Less efficient (or weak volume of) intra MNCs knowledge transfer (Sanna-Randaccio and Veugelers, 2001)	Foreign national stock of private R&D capital (Erken and Klein, 2010) conditional to the complementarity between firm domestic R&D and the stock of foreign knowledge (Frank and Owen, 2003)
A leading firm decides to invest first in the market of the follower firm in order to deter the knowledge absorption through FDI by the follower firm of the other country (Bjorvatn and Eckel, 2006)	Access to qualified staff and talent (most cited reason in the survey by Booz Allen Hamilton and INSEAD, 2006; The Economist Intelligent Unit Report, 2007); and in particular searching for skilled people with lower labour costs (UNCTAD, 2005; Erken and Kleijn, 2010).
Importance of transaction costs (Iammarino and McCann, 2013)	R&D agglomeration (or clustering) abroad can facilitate knowledge spillovers and the reversed transfer to the home country (Gersbach and Schmutzler, 2006)

line with the quantitative assessment previously conducted by Patel and Vega (1999) and Le Bas and Sierra (2002). More recently some others (Pro-Inno survey, 2007; Patel, 2011) note that R&D offshoring is expected to increase less than total R&D spending or that many firms (but from specific countries) experiment a decreasing trend of R&D internationalisation. In the same vein Gammeltoft (2006) hypothesized that the growth in R&D internationalisation may have come to an end (a quantitative stagnation) due to the fact the firms focus their efforts on the organizational consolidation of the existing complex international R&D structures[4]. Finally, the important message delivered by the recent literature based on the trade-off is that we cannot take for granted an *always ever-increasing growth* of the internationalisation of firm R&D activities.

The drivers of R&D internationalisation are deeply linked to the motivations for locating R&D activities abroad as noted by a significant literature (Cantwell and Piscitello, 1999; Dunning, 1997; Kuemmerle 1997 and 1999; Lall, 1979; Ronstatd, 1978; Rugman, 1981). Two main reasons account for why firms internationalize their technological activities:

1. the adaptation of products and processes to foreign conditions, a quasi-compulsory rule for penetrating markets abroad (well-known as a the "Vernon hypothesis"). The product adaptation to the local markets matches a *technology adaptation*.

2. the acquisition of knowledge and expertise from foreign R&D centres and universities (Belitz, 2010)[5]. This is related to the "knowledge seeking" motivation of MNCs foreign direct investment (FDI) according to Cantwell (1989) and Dunning (1981)[6]. In this approach, firms search for a close geographic proximity with foreign knowledge producers (networking) in order to acquire new knowledge including tacit knowledge (Le Bas and Jacquier-Roux, 2008).

Location has become an increasingly important determinant of the scope, pattern, form and growth of MNCs (Dunning, 2009). Here we do not address why firm invests abroad but where it invests. The strategic locational choices made by firms with respect to their R&D abroad have been pictured through a method based upon Revealed Technological Advantage (RTA) indexes (Patel and Vega, 1999; Le Bas and Sierra, 2002). It enables to identify four different R&D internationalisation strategies: Home-base Augmenting (HBA), Home-base Exploiting (HBE), Technology Seeking (TS) and Market Seeking (MS) internationalisation (more details are provided below)[7]. Both converge in showing that the most important strategies are

4. The international organizational aspects of the MNC R&D have been recently addressed by Chen et al. (2012).

5. See also Almeida (1996), Daniels and Lever (1996), Florida (1997), Cantwell and Iammarino, (2000), Kumar, (2001), Von Zedtwitz and Gassmann (2002), Dicken (2004), Iwasa and Odagiri (2004), Ambos (2005), Ito and Wakasugi (2007).

6. See Chen et al. (2013) for other references.

7. With respect to the two main drivers of R&D internationalisation, HBA and HBE, locational strategies match respectively the search of new knowledge and the product adaptation.

the two first, HBA motivated patenting outclassing HBE motivated patenting. Their body of evidence confirmed by Dunning and Lundan (2009) and Patel (2011) emphasized the continuing reliance of firms on the home country as a base for innovation[8]. These studies also indicate a growing trend over time in favour of HBA-based strategies. The relevance of home-base augmenting motivations for internationalisation has not changed according to the recent study by Picci and Savorelli (2012). Nachum and Song (2012) argue that firms take advantage of the location-specific assets driving them to build synergistic portfolios of knowledge. This means that we might find not one overall trend, but specific combinations of different options, and in particular a mix of HBA and HBE options. These findings set up an argument for tracking the recent evolution of motivations for R&D internationalisation.

In this paper we focus on European MNCs. Compared to firms' headquartered in other continents EU firms are often internationalised[9] on a larger scale for a longer time (Laurens et al. 2015). Corporate R&D activities beyond national borders started in Europe in the 1960s in small European countries (the Netherlands, Belgium and Switzerland) as well as in the UK (Pavitt and Patel, 1991). In small but dynamic countries, the early R&D internationalisation is due to a limited domestic market and a long internationalised industrial history. This partly explains the regional differences between European countries in the internationalisation level and schemes of firms' R&D. It is only from the 1980s that MNCs in France and Germany started to internationalise. After the stage of European economic integration linked to the 1992 Single Market Act, cross-border (inside the European area) mergers and acquisitions enabled the building up of very large firms capable to effectively compete on the international markets. As a consequence the level of MNCs' R&D internationalisation was mechanically enhanced and is now higher than for US and Asian firms. Internationalisation of firms can follow defined strategies such as market driven or technology seeking ones but it can be also 'incidental' to international merging or acquiring (Ronstadt, 1978). This latter 'side effect' may be of particular importance in Europe and can highly influence internationalisation of R&D measured using patents since the main European corporate applicants have often been extensively reorganised in the 1990s (Gammeltoft, 2006). In small EU countries, the internationalisation occurred due to the presence of national global players such as Philips, Solvay or ABB that outsourced more than half of their R&D activities. A preferred R&D European integration was obvious in Dutch, Belgian and Swedish MNCs (in electrical equipment and computing industries) while a more global overseas strategy was preferred in MNCs in *larger* countries (France, UK, Germany) and in Switzerland.

Proximity (geographical but also cultural) is also a matter of importance in explaining internationalisation processes of European firms. Using patent data, Picci (2010) has shown an integrating effect of the European Union that alleviates the negative effect of distance on internationalisation. A European common regulatory framework, a common market and an innovation policy positively influence international collaboration within Europe and internationalisation of MNCs in Europe. However even in a context of an on-going globalisation since the beginning of the 2000s, more than 50% of EU firms still cite home country as the most attractive location for R&D investments before citing most often another European country as second choice. The share is even higher for German firms but lower in smaller countries. This strong preference for domestic R&D evidenced in the surveys on the R&D investments Business Trends conducted by IPTS is unchanged from the first edition in 2005 to the last one in 2014 (The EU Survey on industrial R&D investments trends, 2005 to 2014)[10]. Using patent data, Harhoff and Thomas (2009)[11] evidence a higher level of R&D internationalisation in European firms compared to those located in US or Asian countries. They also note disparities among EU countries both in terms of the level of internationalisation and its evolution over time. In small EU countries and UK firms are highly internationalised but in Germany and Italy they are weakly internationalised. The internationalisation level has remained more or less constant from the mid-1980s to the mid-2000s in moderately internationalised countries (France, Sweden) but has increased in already very internationalised countries (the Netherlands and Switzerland). Some weakly internationalised countries internationalised in the late 1990s

8. Interestingly D.J. Teece speaks about "*a semi-global*" trend when he is dealing the internationalisation of knowledge production activity.

9. Concerning internationalisation in Europe, there is no consensus about what should be considered as international: some authors consider that internationalisation between European countries is not internationalisation but rather "cross-border" exchanges and that only overseas internationalisation should be considered when comparing the level of internationalisation in the US and in European countries. Here we do not adopt this convention and consider as a type of R&D internationalisation intra-European R&D investments. Compared to US or Japanese counterparts the high level of internationalisation of EU firms results partly from cross-border activities within Europe.

10. According to the edition, this share ranges from 50% to 66%.

11. Moreover, they are among the few authors that determine, as we do, internationalisation considering consolidated firm perimeters by using the country of the parent owner of the patent applicant (and not the country of the applicant as done in several other works) and the country of the inventors. Considering consolidated perimeter of the firm will enable to consider IBM France as a US firm (and not as a French one). Consequently a patent from French inventor from IBM France will be counted as an internationalised patent of an US firm. Otherwise it would be counted as a domestic invention of a French firm.

12. They do not evidenced any significant movement of delocalisation of inventions by EU firms in the US but rather showed that the share of inventions made in the US decreased (Germany: -8 points) or followed rather a smooth inverted U (France, UK, Switzerland, Italy, the Netherlands and Sweden). A significant opening in Europe is evidenced in most of the EU firm countries (to the exception of France) until the early 2000s but then slowed down. Germany and France were the most attracting places.

or early 2000s before partly re-localising their activities[12]. Motives for home country preference are related to the access of public support for R&D and proximity to other activities of the firms in particular in larger EU economies[13] (Cincera and Ravet, 2014). Motives of R&D location abroad is first market access and then access to R&D knowledge, and skilled researchers while cheaper labour cost is a minor motive for internationalisation. In the latter years, according to Cincera and Ravet (2014), never more than 25% of R&D investments of the surveyed firms were invested out of Europe. North America remains the first overseas destination (approximately 10% of EU R&D investments) before India and China (attracting each less than 4%).

This paper thus focuses on European MNCs and addresses two questions: 1. Can we confirm the general dominant view assuming a growing trend in the internationalisation of technology production? 2. Does the dominant locational strategy observed in the 1990s ("home base augmenting") still hold ten years later?

Section 2 – The data set

Because of the scarcity of data sets accounting for R&D internationalisation 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[14]. 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). Finally it seems important to note that we do no compare firms according to their innovative (patenting) capacity but we are interested by the place (the location) where the invention is made.

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). This indicator presents two main advantages compared with the 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 de 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 (considering only subsidiaries in which one of the Global Ultimate Owners had more than 50.01% of shares). Third, the names of the firms and their subsidiaries have been looked for as potential applicant names in the Patstat database[15].

13. Their results are based on the results of the 2008 EU Survey on industrial R&D investments trends.

14. Among the many discussions on the use of patents as a data source for R&D, see de Rassenfosse et al. (2013).

15. See Laurens et al. (2015) for a detailed presentation of the building and characterization of this large firms database.

For this research, we restricted the set of firms to those that have applied for at least five priority patents in both three-year periods 1994-1996 and 2003-2005 and 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). For each firm of the sample, we get the yearly level of patenting for the time period 1986 to 2005. 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 location of the corporation headquarters and to the personal addresses of inventors[16]. It is 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.

This study uses a 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. 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[17]. We work on a sample of 349 EU firms that are multinational by nature. Table 2 gives information on the nationality of the firms.

Section 3 – Evolution of EU MNC level of RD internationalisation: a turning point towards "deglobalisation"

The internationalisation of corporate inventions is measured by comparing the nationality of the firm (i.e. the country where the MNC headquarters are located) and the residence country of the inventor (given in the inventors' addresses). We use the country address of the inventor as a proxy for the place 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. Moreover, we also follow the level of R&D

TABLE 2

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	5.0	59
Other	1.8	0.5	6
Europe	100.0	100.0	349
Number Europe	349	90 452	

16. When more than one country appear in inventors' addresses in a given patent, a fraction is attributed to each country (fractional counting).

17. The bias induced by such a static firm delineation was investigated by comparing the internationalisation rate obtained for a set of firms using either a firm delineation in 2008 or a delineation in 1995. The difference on the internationalisation rate was 7%. For details, see Laurens et al. (2015).

internationalisation that originate from Europe (i.e. with an inventor from a foreign European country) as a percentage of the overall internationalisation rate of firms.

In order to get a synthetic view of the level of R&D internationalisation of the firms, we have ranked MNCs according to their nationality i.e. the nation where their headquarters are located (Table 3). The overall rate of internationalisation of European firms 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. The internationalisation rate is high for firms from the smallest countries (Netherlands, Switzerland, Sweden) in accordance with the idea that the smaller the country, the more internationalised its firms are. Our results are in line with those shown 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[18]) 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[19]. Such a global picture in Europe is amazingly striking. It highlights an evolution clearly opposed to the dominant standard view that considers the MNC level of R&D internationalisation as continuously growing. It shows a clear deglobalisation related to R&D activity. Table 3 also shows that this deglobalisation trend of corporate R&D investment is associated with a "continentalisation" trend: the share of the contribution of EU countries to the EU MNCs internationalised R&D has climbed from 38.2 to 57.6% over ten years. This provides clear evidence that in 2003-2005 the firms' R&D carried out abroad is mainly located in Europe. Approximately three fourth of the foreign R&D of large firms from small EU countries is located in another European country. For French and German MNCs, these shares are close to 50%. In most EU countries, these shares have significantly increased over time (from 20% in the UK to approximately 75% in Germany, Denmark or Switzerland).

Of course we have to remain cautious and would surely need data on a longer period of time for confirming these tendencies[20]. But the fact the trend affects most 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 internationalisation is high but declining in Europe, it stays very weak but growing for Asian firms, and medium but steadily increasing for US MNCs[21].

Investigating the R&D internationalisation of European firms with the same dataset on a longer period of time (from 1986 to 2005) shows they had also followed 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 these 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

18. 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.

19. 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%).

20. One point would deserve particular attention. We are in a frame of a relative (and not absolute) deglobalisation: The total amount of priority patents in our dataset has increased by 1/3 from the mid-90s to the mid-2000s while the number of priority patents involving a foreign inventors only increased by 1/10.This increase of the EU firm priority patents since the mid-1990s is in line with the general and still ongoing trend of the worldwide patent inflation (the famous "surge" in patenting). We are aware that this inflation may of course result from different strategic motives that do not first aim to protect a technological invention. We could not address this issue in the present article but are starting to investigate it by comparing the respective qualities of patents involving foreign inventors and patents with only domestic inventors. A higher value of foreign patent (measured by citations or patent family size) could indicate their higher technological value.

21. From 1994-1996 to 2003-2005, the internationalisation rate has increased from 0.7% to 2.5% in Asia and from 9.8% to 17.3% in the United States (Laurens et al., 2015).

TABLE 3

Firm rate of R&D internationalisation

Country of firm	Internationalisation rate (share of EU internationalisation) 1994-1996 (%)	Internationalisation rate (share of EU internationalisation) 2003-2005 (%)	Evolutions 1994-96 to 2003-2005 (%)
Austria	53.8 (72.4)	49.3 (89.4)	-8.2 (23.2)
Belgium	55.1 (48.3)	67.6 (68.9)	22.8 (45.2)
Denmark	46.4 (29.2)	46.1 (54.2)	-0.9 (74.5)
Finland	31.3 (75.3)	34.4 (53.3)	10.0 (-29.2)
France	48.0 (36.4)	34.1 (50.7)	-29.0 (39.0)
Germany	15.8 (28.4)	13.8 (49.6)	-12.8 (74.5)
Italy	45.1 (54.4)	36.8 (38.9)	-18.4 (-28.6)
Netherlands	80.1 (51.0)	89.0 (77.6)	11.2 (52.0)
Norway	21.2 (68.3)	29.5 (84.2)	38.8 (23.2)
Spain	31.2 (32.7)	17.0 (33.3)	-45.5 (1.8)
Sweden	44.5 (45.2)	56.1 (74.1)	25.9 (63.8)
Switzerland	78.0 (42.6)	72.8 (75.6)	-6.6 (77.5)
United Kingdom	88.1 (28.4)	79.9 (35.0)	-9.3 (23.3)
Europe	**40.7 (38.2)**	**30.4 (57.6)**	**-25.3 (50.8)**

Note: The share of EU internationalisation is the contribution of EU countries at the overall internationalisation. For instance in 1994-1996 the total internationalisation rate of Austria was 53.8%. It can be split into intra EU (72.4%) and overseas (27.6%).

France – play a large role in the "European internationalisation decline". They peak in 1995, and decline afterwards – very strongly for French firms, rather slowly for German ones. In the 1990s European MNCs undertook numerous mergers and acquisitions (M&A) in particular in the US. For instance UNCTAD (2005) points out that cross-border M&A increased globally quickly until 2000 and 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. We found an upward trend in FDI that began in the 1980s and stopped in 2000 (UNCTAD, 2005)[22]. In this context the decrease of 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 of the R&D activity.

In order to confirm the main trends emerging from the figure 1 we carried out econometric exercises. Table 4 reports OLS estimates of the annual rate of R&D internationalisation using two basic models[23]. Model 1 gives an estimate of the slope of a linear equation in which the annual rate of R&D internationalisation is the dependant variable and time the independent variable. By contrast Model 2 has a quadratic form for the independent variable time. If the coefficients estimated of Model 2 are statistically significant and the coefficient related to time square negative we are in the frame of an inverted U shape relationship. In the two models we add dummy variables for the countries to take into account the large variations of the rate of internationalisation across countries[24]. We first estimate

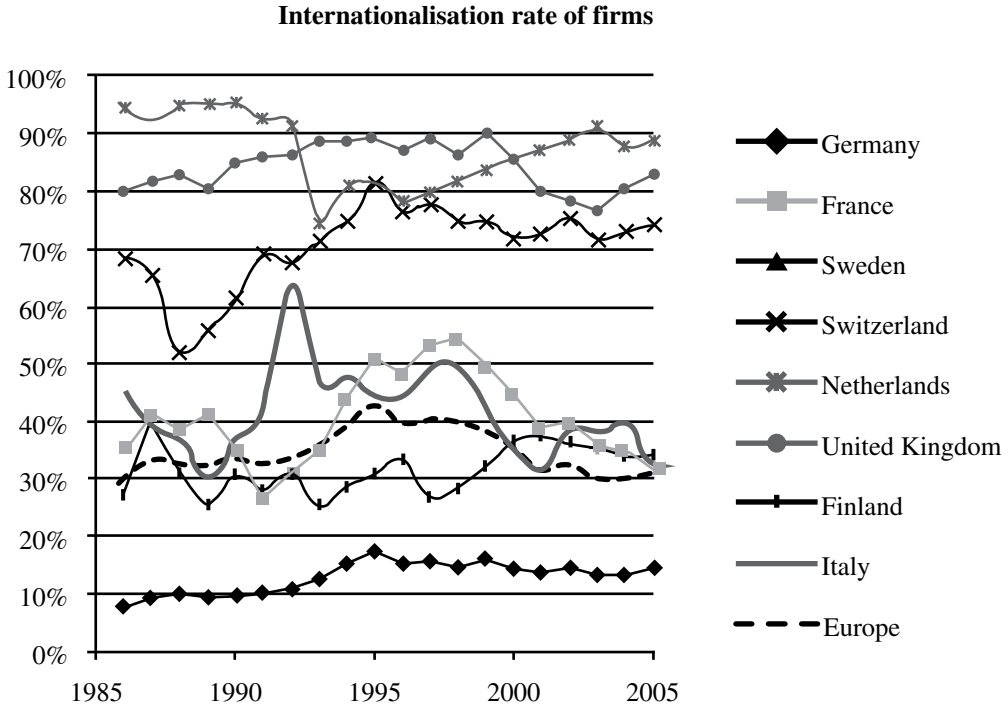
22. We register a similar trend for the outward direct *investment* at worldwide level: after a persistent growth since 1970, it registered a peak in 2000 followed by a *decrease* during a four years period of time. It started again to increase after (see the data from UNCTAD 2005). By contrast the outward 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.

23. The dependent variable being a limited dependent variable, OLS can only give a first assessment of the effects of the explanatory variables.

24. We also estimate a relation more complex by adding dummies for controlling industries effects and a proxy for firm size (approximated by the number of patents). The new estimates do not change significantly the coefficients related to our main explanatory variables. Moreover there is no significant firm size (defined as we do) effect.

FIGURE 1

Evolution of EU MNCs rate of R&D internationalisation by countries



the models with the entire sample of MNCs (see the first columns of Table 4). Both show identical goodness of fit (R Square) and statistically significant time variables. The first model gives an increasing rate of R&D internationalisation over time, the second one an inverted U shape relationship where the rate of R&D internationalisation decreases in the last part of the period of time. The two interpretations are not statistically contradictory. In order to get a better vision we replicated the same estimations splitting the initial sample in two parts: the firms having a weak rate of R&D internationalisation (below 50% in 1994-1996) and the firms having a higher rate. The results are amazingly striking. For weakly internationalised firms, the linear model fits well but the quadratic does not (the coefficients related to time variables are not significant). For the sample of MNCs having a high level of R&D internationalisation, it is the opposite: the quadratic model fits well. In other terms, the rate of R&D internationalisation declines during the last part of the period of time only in MNCs highly internationalised in the mid-1990s. We understand now that the entire sample of firms is a mix of two subsets of firms having diverging trends. It is also worth noting that for all the estimated equations the dummy variables for countries are very often significant indicating that the home base affects significantly the rate of R&D internationalisation. The basic message that these very first estimations deliver is that firms having a high level of R&D internationalisation experiment a declining trend of their R&D carried out abroad. This result gives relevance to the idea of a threshold in terms of R&D internationalisation. Some findings by Harhoff and Thomas, (2009) also support this hypothesis

To conclude, we would like to highlight two major results. The first one is linked to the other face of internationalisation: the remaining (and even growing) importance of the national technological bases of MNCs. This central trait of corporate invention is massively confirmed by the analysis of inventors' location, which as a general pattern, coincides mainly with the headquarters country. We can identify two outliers: firms from the United Kingdom and the Netherlands, two countries known for their fiscal policy driving firms to locate their headquarters without having any significant activity in the country. Our second conclusion is that R&D internationalisation is not continuously growing. MNCs from the largest countries show either a stabilisation or a declining trend of their internationalised technological activity. It drives us to consider the period under observation as a period of stabilisation or, to follow Gammeltoft (2006) as a period of organisational consolidation of existing complex international R&D structures in firms. As a consequence, in the mid-2000s, the foreign R&D activities of EU firms are first located in Europe (instead of the US as it was ten years before).

TABLE 4

The determinants of annual firm rate of R&D internationalisation (1986-2005)

	All sample		Weak internationalisation (<50% in 1994-1996)		High internationalisation (>50% in 1994-1996)	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Time	0.388 (5.277)***	1.118 (3.931)***	0.52 (7.917)***	0.17 (0.684)	0.17 (1.790)	2.509 (7.001)***
Time square		-0.038 (2.656)**		0.018 (1.413)		-0.121 (6.764)***
Austria	-31.45 (3.891)***	-32.07 (3.902)***	28.12 (4.456)***	28.12 (4.456)***	-10.62 (1.494)	-11.04 (1.566)
Belgium	-16.42 (2.102)	-16.47 (2.110)*	23.55 (3.731)***	23.55 (3.732)***	-4.79 (0.746)	-4.99 (0.785)
Switzerland	-32.09 (4.215)*	-32.13 (4.223)***	18.34 (3.373)**	18.36 (3.376)**	-11.65 (1.863)	-11.83 (1.907)
Germany	-74.28 (9.886)***	-74.33 (9.897)***	8.27 (1.594)	8.29 (1.598)	-26.87 (4.202)***	-27.24 (4.295)***
Denmark	-50.39 (6.455)***	-50.40 (6.461)***	24.97 (4.528)***	24.98 (4.531)***	-26.61 (3.908)***	-26.61 (3.941)***
Spain	-57.31 (7.087)***	-57.39 (7.100)***	14.34 (2.503)*	14.38 (2.510)*	-9.94 (1.276)	-10.18 (1.318)
Finland	-63.08 (8.203)***	-63.14 (8.215)***	12.66 (2.366)*	12.66 (2.372)*	-17.38 (2.535)*	-17.51 (2.575)*
France	-54.29 (7.195)***	-54.30 (7.201)***	19.13 (3.658)***	19.14 (3.661)***	-18.06 (2.875)**	-18.08 (2.903)**
United Kingdom	-27.00 (3.582)***	-27.05 (3.5890)***	15.87 (2.970)**	15.91 (2.977)**	-11.59 (21.885)	-11.72 (1.922)
Hungary	-88.89 (8.417)***	-88.89 (8.421)***				
Ireland	-1.68 (0.192)	-1.79 (0.204)			-1.28 (0.180)	-1.63 (0.231)
Italy	-55.76 (7.135)***	-55.79 (7.143)***	25.19 (4.592)***	25.22 (4.597)***	-36.55 (5.21)***	-36.55 (5.256)***
Luxembourg	0.774 (0.452)	4.768 (0.452)			-4.95 (0.576)	4.95 (0.581)
Netherlands	-22.69 (2.966)**	-22.78 (2.979)**	30.99 (5.688)***	31.05 (5.700)***	3.00 (0.474)**	2.78 (0.443)**
Norway	-72.37 (8.81)***	-72.39 (8.823)***	16.31 (2.878)**	16.31 (2.880)**		
Sweden	-38.82 (5.098)***	-38.87 (5.107)***	31.79 (5.940)***	31.83 (2.88)**	-2029 (3.213)**	-20.35 (3.250)**
Constant	87.384 (11.651)***	85.10 (11.278)***	-2.88 (0.555)	-1.79 (0.341)	89.11 (14.518)***	81.76 (13.223)***
Number of observations	6643	6643	3795	3795	2648	2648
R^2	0.276	0.277	0.119	0.119	0.093	0.109

p <5%, ** p<1%, *** p<0.1%, Student t in brackets

Section 4 – 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 offshoring firm R&D activity? And if it does, in which direction? To investigate this issue we mobilise 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[25] (Table 5). It enables us to delineate four firm basic behaviours to accurately investigate the motivations of R&D investment carried out abroad.

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.

Home Base Exploiting (HBE) internationalisation strategy. Firms use their national comparative technological advantage to export or adapt their 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. It develops product adaptive R&D (Hewitt, 1980).

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).

Market Seeking strategy (MS). Observed moves are not driven by a particular technological strategy. They correspond 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 not to be 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 for each patent the RTA that depends on the patent technology field, the host and home countries and then aggregate them at the firm level[26]. We end up with the distribution of patents according to the four strategies for each firm and can then further aggregate results by firm home country.

The works by Patel and Vega (1999) and Le Bas and Sierra (2002) show 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) represent together roughly 80% of the cases.

Table 6 gives the distribution of patents (in%) in Europe and according to the MNCs nationality for the two periods of time under observation.

INSERT: Table 6. Firm locational strategies by countries and periods of time

TABLE 5

Four locational strategies for FDI in R&D

Corporate technological activities in home country	Technological activities in host 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).

25. See more details on the approach in Laurens et al. (2015).

26. The sample of EU firms has been reduced to 242 firms. In effect 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. This constraint tends to rule out firms.

TABLE 6

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**

Our overall results show that HBA and HBE remain the dominant behaviour in Europe, which is 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 the mid-1990s to the mid-2000s (from 44.0% to 40.9%) while the exploitation of home technologies abroad (HBE) has slowly 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 different national choices, and even diverging trends. Countries where firms are 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). However it is difficult to generalise the 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 conversely, 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 an atypical pattern[27] 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 European landscape. It is interesting to note that, though they are the 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 of large firms under-specialised in their home country. These firms have thus internationalised to search for these technologies in specialised countries.

A 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

27. With respect to the European average.

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.

Section 5 – EU MNCs R&D internationalisation: Four firm case studies

The unexpected combination of a global HBA decline and increase of HBE internationalisation strategy in several European countries over the period of time under observation deserves further considerations at the firm level. It is worth reminding that the promotion of a HBE strategy while the HBA strategy diminishes corresponds to situations where the firm *has remained* specialized in its home country (HomeRTA >1). However the share of patents invented in specialized host countries (hostRTA >1) has lowered compared to the share of parents invented in host countries not specialized in the patent technological fields (hostRTA <1). It occurs when the distribution of inventors' countries and/or of the patent technological fields are modified or when the technological specialization pattern of a host country has changed.

We evidenced that such trends were frequent among the largest applicants: 50% of the 25 largest European firms exhibit such pattern. In order to further examine how evolutions of the distribution of the international patents by inventor country and technological field promote such changes of the patenting strategy, we select and analyse locational strategies of four industrial firms that stand as top applicants in their home country: ABB (Switzerland), Alcatel Lucent (France), GKN (UK) and Fiat (Italy). These 4 firms exhibit similarities: they are highly internationalised (from 50% for Fiat to 90% for Alcatel Lucent) and were significantly restructured in the last years by mergers or acquisitions.

ABB was created from the merging of the Swiss (ASEA) and Swedish (BBC) firms in 1988[28], Alcatel Lucent resulted from the merging of the French Alcatel and the very large US firm Lucent. Acquiring many firms worldwide, GKN reduced its dependence on the production of car parts and refocused activities in aerospace, transport and metallurgy. Fiat was also radically restructured to regain competitiveness and CNH Global N.V. one of its American affiliates took a leading role in the group becoming a leader in manufacturing agricultural and construction equipment. Such large reorganisations have modified the distribution of inventors' locations as well as the technology profile of the patent portfolios and promoted the share of firms' inventions carried out in countries not specialized in their previous core technologies.

ABB illustrates a case where the HBE strategy dominated both periods. ABB augmented the share of patents involving foreign non-Swiss inventors from 74% to 81% over time mainly by boosting its share of European foreign inventors (the share of US inventors has declined from 16.6% to 7.4%). Due to the reinforcement of activities in its technological fields of specialisation ("Electrical machinery, apparatus, energy" and "Measurement"), the HBE strategy (fed by inventors from Germany, Finland or Sweden) was reinforced from 50.5% to 58.2%. Simultaneously, the HBA strategy declined from 16.8% to 9.8%. Being the largest Swiss corporate patent applicant[29], ABB explains to a significant extent the overall internationalisation strategy of Switzerland (HBA: -11 percentage points and HBE: +6.5 percentage points).

Concerning Alcatel Lucent, both the distribution of inventors' location and the technological profile of the patent portfolio radically changed over one decade. In the earlier period, more than 90% of the patents originated from the American partner, Lucent Technologies, while 10 years later Alcatel was involved in 73% of the patents. Consequently the share of US inventors has dropped (from 96.8% to 57.3%) while the share of inventors from Germany, Belgium and China has grown. This went along with a huge rise of the patent share in "Digital communication" between the two periods (from 11% to 31%)[30]. Not surprisingly, the global international patenting strategy was thus impacted with a decrease of the HBA strategy 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%). Accounting for 22.1% of the patents of French MNCs in 1994-1996 and 15.2% in 2003-2005, Alcatel Lucent also contributes significantly to explain the overall locational behaviour observed for French MNCs (HBA: -13 percentage points, HBE: +7 percentage points).

GKN is a firm with a largely dominating HBA strategy (86.2% in 1994-1996 and 83.2% in 2003-2005) but where the HBE strategy has progressed over time (from 13% to 16.8%). The lowering of the HBA strategy is directly linked to the evolution of the location of the firm's inventors. The share of patents applied for by GKN Automotive US feeding an HBE strategy has increased compared to the share of the German affiliate GKN Automotive AG that fed the HBA strategy[31].

In the Fiat Group, the growing share of patents applied by the affiliate CNH Global significantly changed both the distribution of the locations of foreign inventions and the

28. It then purchased several enterprises in the US to break into the North American market. Facing important difficulties in the 2000s, ABB was then further reorganized. It now operates worldwide in robotics and mainly in the power and automation technology areas.

29. In the periods 1994-1996 and 2003-2005, ABB accounts respectively for 36% and 26% of priority patents applied for by Swiss MNCs.

30. At the expense of patents in "Computer technology" or in "Optics" technologies.

31. Germany was specialized in the core fields of GKN ("Mechanical elements" and "Transport"), the US was not.

patent technology profile. In 1994-1996, foreign inventors were located either in France or in the US (45% in each country) and Fiat was specialized in three main technological fields: "Other special machines", "Transport" and "Mechanical elements". Ten years later, almost three fourth of inventions made abroad originated from the US (the share of inventions made in France was around 20%) and Fiat sharply reinforced its specialization in "Other special machines". The changes mainly reinforced the overall MS strategy of the group (neither US nor Italy being specialized in "Other special machines"). Simultaneously, a larger decrease of the HBA strategy due to the decreasing contribution of French inventors in the patenting activity contributed to enhance the HBE/HBA ratio from about 1 to 0.6. Being by large the first Italian applicant, Fiat contributes to a large extent to the large increase of the MS strategy of Italian firms observed at the country level (from 15% to 31%).

These case studies illustrate how the massive reorganizations of a few large European corporations are responsible for the changes of the overall patenting policy exhibited by large firms from one country, modifying either technological profiles or geographical loci of inventions. Under such circumstances, both the share of patents with foreign inventors and the mode of internationalisation may exhibit disrupted evolutions or deviate from expected trends at the country level.

Conclusion: tentative interpretation

The first finding of this research is an unexpected process of deglobalisation (following an internationalisation phase ending in the mid-1990s) experienced by European MNCs but not for our overall sample of firms. We do not think this result is an effect of the use of patenting data instead of R&D expenditures. We are aware that a longer time period is needed for confirming the trend of deglobalisation that is specific to EU MNCs, in particular for firms from large countries. US and Asian firms starting at a lower level are still continuing their process of technological globalization (Laurens et al., 2015). How can we explain it? The rate of R&D internationalisation cannot reach 100%, there is necessarily an upper bound given by the cost of knowledge dissipation linked to many foreign locations. The decreasing slope we found for the average European rate is lasting over the final part of the period of time under observation. As a consequence we cannot interpret it as a shock (still less a random shock). Of course further studies will be necessary for a better understanding but we can already put forth some elements. From a theoretical viewpoint, there might be factors affecting the trade-off between concentration at home and dispersion of R&D abroad that play more strongly against the dispersion at a certain level of internationalisation. For instance, other works have underlined the importance of a) a less efficient intra MNCs knowledge transfer (Sanna-Randaccio and Veugelers, 2001), in particular when there is a weak IPR regime in foreign countries (Branstetter et al., 2006); and b) a risk of dissipation of knowledge towards local firms (Almeida, 1996) because the 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). Our main result opens a new research program dedicated to the understanding of MNCs global innovative activity in a period of deglobalisation.

Today we observe a development of strategies with respect to R&D outsourcing. For instance, the French firm Peugeot has decided to outsource part of its R&D to the corporation Altran that is opening a large research center in Marocco (Le Monde 2014 Nov. 6). As a consequence this new research center does not appear as an R&D investment abroad. Such practices (and more generally the open innovation conducts) if they generalize will underestimate the degree of R&D internationalisation by MNCs.

Our second finding evidenced an emerging trend working to the detriment of HBA conduct while diverging cases still exist. There is a new balance between the two most important locational strategies (namely HBA and HBE). It is worth noting that this trend is less clear than the first pattern affecting the rate of R&D internationalisation. It is not a break since HBA conducts remain dominant. However, many firms and countries diverge with respect to the average trend. For instance the weight of HBA conduct increases for MNCs from Belgium, Finland, Germany, Netherlands or Sweden. Our hypothesis is that this rebalancing is less an effect of a deliberate change of locational strategy than a record of the reconfiguration of firm R&D activity in the time period under observation. Very often this restructuring means a move from the US to European host countries, which can be qualified as a "recontinentalisation".

Finally further developments are needed to better connect the two aspects addressed separately in the paper, the rate of R&D internalization and locational strategies. Econometric treatments could help us delineate how the variations of the rate of R&D internalization affect firm conducts in term of location. In order to better understand locational strategies we should consider models through which we could account for the determinants of locational strategies in relation with the global trends.

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