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from Multinational corporations: an
Aspect of Global Business R&D?**

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The International Mobility of Researchers from Multinational Corporations: an Aspect of Global Business R&D?

La mobilité internationale des chercheurs des firmes multinationales : une dimension de la R&D industrielle globale ?

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Abstract: This article provides a conceptual and empirical analysis of a relatively unexplored aspect of firms' R&D internationalization: the international mobility of their researchers (IMR), critical for ensuring connectivity within globalized knowledge networks. Within the theoretical framework of open innovation, we distinguish intra-firm and external mobility, and test hypotheses regarding the evolution of these two mobilities since 2000, focusing on multinational firms located in France. Our data reveals that, overall, while firms increased their IMR in the 2000s, there was a tendency to use it less in the 2010s. However, two distinct firm profiles emerge: those in an environment at the forefront of knowledge progressively diminish their reliance on IMR, while those in environments further away from scientific excellence continue to practice it more.

Key-words: International mobility of researchers; Globalization of business R&D; Open innovation; Connectivity; Geography of innovation

JEL: F22; F23; J61; O32; O36

Introduction

The Internationalization of Firm Research and Development (IFRD) (Pearce, 1989) contributes to the contemporary dynamics of global innovation (Carlsson, 2006). Its evolution since the last quarter of the 20th century touches as much on its modalities, its objectives, as on its geography,

which now includes emerging countries (Cantwell, 2017; Miguelez *et al.*, 2019). A rich literature has observed and analyzed it (see the exhaustive review of Papanastassiou *et al.*, 2020), mainly through its institutional, organizational and commercial manifestations, which range from the deployment of research and development (R&D) laboratories abroad by firms, to international collaborations for innovation, as well as the internationalization of intellectual property rights transactions (patent market, operating licenses, patent citations) and transactions relating to R&D execution. The studies that observed these practices were based on various data sources: statements by firms on the establishment of laboratories abroad and international collaborations, patent data (patents held outside the country of origin of the firm, location and distance between citing inventors and cited inventors), accounting documents on international exchanges of R&D and knowledge services, databases on multinational corporations (MNCs) (OECD, 2015; Papanastassiou *et al.*, 2020).

However, there is a manifestation of the IFRD that has not been systematically studied in all its dimensions by this literature: the International Mobility of Researchers (IMR) from MNCs. And we argue that filling this blind spot would benefit to a better understanding of the IFRD. To understand this question, we place our work within the theoretical framework of *open innovation* (Chesbrough, 2003), which allows a fine understanding of the renewal of the dynamics of innovation, which occurred at the beginning of the 21st century. This theoretical approach raises two major aspects of this renewal: first, the actors of an innovation process are increasingly multiple, belonging to various institutional, organizational and geographical contexts; then they co-produce knowledge and circulate it. Such a design is particularly relevant for addressing innovation in MNCs, which precisely constitute a space of diversity of actors collaborating to produce and circulate knowledge. The work done under this approach to analyze MNCs shows that, when internationalizing their R&D, MNCs are now seeking to integrate into various articulated knowledge networks (Bartlett & Ghoshal, 1990; De Meyer,

1993; Jacquier-Roux & Le Bas, 2008; Cantwell, 2017) to co-produce knowledge inside them. This strategic trend embraces the geography of innovation and considers the phenomena of scientific activity agglomeration (Feldman, 1994). It also depends on the connectivity that links places, people and organizations (Castellani *et al.*, 2019; 2021). These characteristics suggest that the human foundations of IFRD become essential. The scientific workforce (R&D researchers and engineers) embodies both participation in innovation networks and connectivity potential, essential for global open innovation. As such, the MNCs' IMR must be studied for the role it will play in this new dynamic of the IFRD¹.

Unfortunately, IMR has been fewly analyzed as a strategy at the firm level. Most of the work concerning it study it either from the point of view of the individual trajectories of researchers (especially academic ones – Crespi *et al.*, 2007; Lawson & Shibayama, 2015), or from the point of view of migratory flows of scientific labour (Geuna, 2015; Fink & Miguelez, 2017; Guthrie *et al.*, 2017). When the organizational level of the firm is considered, it is for linking the IMR to international research collaborations involving firms (Ferru *et al.* 2022; Jacquier-Roux, 2018; Scellato *et al.*, 2015; Chinchilla-Rodriguez *et al.*, 2017), or from a global perspective on highly qualified Human Resources management (global talent management – Collings *et al.*, 2019; Kerr *et al.*, 2016), but not necessarily articulated with innovation dynamics. Our purpose is consequently to perform an analysis of the IMR at the MNC level, within the theoretical framework of open innovation, in order to *understand its dynamics and its role in the IFRD phenomenon*. Indeed, hypotheses on its evolution are to be examined, and solid empirical data must be mobilized to test them. That is the purpose of this article.

¹ At the end of their literature review on IFRD, Papanastassiou *et al.* (2020) insist on the emergence of this problematic, which « *poses complex challenges to MNEs, which will have to make remarkable efforts to monitor centers of excellence all over the world, to select qualified scientists, engineers, and managers on a global scale, and to organize their international mobility* ». They note that « *Fact-finding qualitative and quantitative studies are badly needed in this respect* » (p. 648). Guthrie *et al.* (2017) also express this wish.

MNCs' IMR covers two categories of flows: intra-firm IMR, and external IMR. Each one participates in and evolves within its respective innovation network —the internal global network and the external global network— that the MNCs articulate to innovate (double networking – Castellani & Zanfei, 2006). In our analysis, we will distinguish between these two mobility categories. Therefore, we will first propose the hypotheses that the literature allows us to identify for both. Then, we will present our data, followed by the obtained results, which will be discussed before concluding this article.

Intra-firm and external international mobility of researchers: hypotheses

The MNCs' IMR in the economic literature is a subject addressed in a clearly distinct way according to whether the flows of researchers are internal to the firm, or external. We therefore follow this separate approach, in order to propose a series of hypotheses about its evolution in the contemporary context of global innovation.

INTRA-FIRM INTERNATIONAL MOBILITY OF RESEARCHERS

The literature on this category of IMR is sparse, but it clearly mentions how this practice creates value for MNCs through “*intra-firm knowledge transfer across locations and subsequent knowledge recombination*” (Choudhury, 2020, p. 183). It thus facilitates the two aspects of the dynamics of network global open innovation: the circulation of knowledge and the co-production of knowledge in the MNC.

The intra-firm IMR first promotes “*the dissemination of local knowledge and innovation at the global level*” (Mendez, 2002, p. 6), a major challenge for the activation of the intra-firm global network, whatever the flow of this diffusion: from the central laboratories to the laboratories

abroad, in a classical logic of deployment (Branstetter *et al.*, 2015²); from the laboratories abroad to the central laboratories (reverse innovation, and its current avatars where laboratories located in emerging countries are at the origin of innovations and ways to innovate disseminated throughout the MNC – Laperche & Lefebvre, 2012); or between laboratories abroad. More precisely, according to Choudhury (*op. cit.*), "*(1) geographically mobile employees can act as a bridge to transfer knowledge between firm locations; (2) intra-firm geographic mobility can aid in the creation/strengthening of intra-firm communication networks, especially informal ones [...]; and (3) intra-firm geographic mobility can help host locations receiving the knowledge better interpret and utilize said knowledge.*" (p. 184).

The intra-firm IMR then promotes the co-production of knowledge on an internal global scale in MNCs, notably by deploying researchers who act as "boundary spanners" (Schlunze, 2022). These key actors of innovation in MNCs, in their travels, not only bring knowledge to disseminate, but also orchestrate global R&D projects, supervise the local translation in laboratories and allow the overall coherence of the internal activity of R&D. Several practices necessary for knowledge co-production in the internal global network of MNCs can be facilitated by the mobility of these «boundary spanners»: the identification and development of expertise on a global scale (Mendez, 2002) ; the animation of internal communities of practices in the R&D field (Guérineau *et al.*, 2017); dialectical regulation, essential to any dispersed production of knowledge, between knowledge management situations (causing cognitive disruption) and implementation of knowledge sharing devices (stabilizing learning) (Jacquier-Roux *et al.*, 2020).

These advantages provided by intra-firm IMR therefore lead us to wonder to what extent MNCs make use of them. However, empirical work on this issue is very incomplete. Some studies were conducted at the end of the 20th century, and concluded, in a convergent manner, that

² They show that USPTO patents of Chinese origin are mostly due to US MNCs installed in China and which have moved US researchers there.

intra-firm IMR was weak (Reger, 1999; Mendez, 2002). Regarding the subsequent evolution, we do not have specific work for this intra-firm IMR. However, various significant developments may have had a notable impact on this practice. This leads us to consider a succession of hypotheses.

On the one hand, the transformation of innovation in the MNCs towards a global network open innovation strongly dependent on connectivity, makes it possible to envisage an increasing use of intra-firm IMR since the 21st century, in order to promote the circulation and knowledge co-production. The following hypothesis can therefore be considered:

Hypothesis 1: intra-firm IMR has been increasing since the beginning of the 21st century.

On the other hand, the transition to global connected network open innovation has been accompanied by the development of practices that could counteract the growing use of intra-firm IMR. In particular, the development of digital technology and NICTs has shaken the foundations of connectivity and opened up the range of practices that enable it beyond the mobility of researchers and the face-to-face that it allows. On the one hand, "quasi-mobility" competes with permanent mobility, in the form of temporary mobility (lasting less than 2 years, without change of position in the company), or even one-off mobility (of a few days), connectivity being ensured in the meantime thanks to the NICTs (Ferru *et al.*, 2022; Choudhury, 2020; Mendez, 2002). On the other hand, virtual teams composed of remote workers become common (Choudhury, 2020; Papanastassiou *et al.*, 2020) and free themselves from mobility, at least in its permanent form. The Covid-19 pandemic in the early 2020s was an opportunity to accelerate these practices. The following hypothesis can therefore also be considered:

Hypothesis 2: intra-firm IMR stagnates or even decreases since the beginning of the 21st century.

These two contradictory trends could in fact play a distinct role depending on the R&D intensity of the MNCs' sector. In MNCs whose sectors have low or medium R&D intensity, R&D is a support function in the value chain, and the processes are often materialized. This makes the intra-firm IMR necessary to realize, *in situ*, the interface between R&D and other functions, especially the production. On the contrary, in sectors with strong R&D intensity, R&D becomes an operational function at the heart of the MNC value chain, and processes are more intangible. When intra-firm IMR takes place in these sectors, it mainly concerns relations between researchers. But above all, it can be limited to one-off or temporary mobility, or even be replaced by remote relationships thanks to NICTs. The following hypotheses can therefore be considered:

Hypothesis 3.1: in sectors with low or medium R&D intensity, intra-firm IMR has increased since the 21st century, and it is mainly inter-functional mobility.

Hypothesis 3.2: in sectors with strong R&D intensity, intra-firm IMR has decreased since the 21st century, and it is mainly intra-functional.

EXTERNAL INTERNATIONAL MOBILITY OF RESEARCHERS

The literature on external IMR is more abundant in general, but it becomes scarce when we consider it at the level of companies, especially when we wonder about its effects on their innovation dynamics.

Several arguments combine to consider on the one hand that the MNCs benefit from practicing external IMR in their strategy of IFRD and global open innovation. From a cost and risk management perspective, MNCs sometimes make a disappointing evaluation of deploying R&D laboratories abroad. The investments to be made can be considerable. Researchers in OECD countries demand high wages. Tax, social and environmental constraints increase the costs. And the alternative of deploying R&D in emerging countries (efficiency seeking) is not feasible when the objective is precisely to be present in global excellence hubs located for the most part in developed countries. Political risks, as well as those related to the leakage of knowledge out of laboratories, should not be overlooked. Thus, the MNCs can consider external IMR as a possible alternative, to follow the open innovation tendency. They can first practice one-off mobility (sending and receiving researchers for a few days) or temporary mobility (make researchers from the company stay abroad, in another organization, or receive foreign researchers from other organizations, for a stay of several months in the company). These practices strengthen the MNC's connectivity in the external global network and make sense in the case of international collaborations, with researchers acting as ambassadors for their organization's R&D (Ferru *et al.*, 2022). But this logic also applies to permanent external IMR. Concerning the inflows into companies, the objective is, through the recruitment of foreign researchers, to achieve learnings (learning-by-hiring, according to Song *et al.*, 2003), to benefit from access to the networks in which these researchers are inserted. Concerning outgoing flows, several studies highlight the advantage that can be obtained by the fact that a researcher of the company is recruited by another company abroad, thanks to the bridges it can build to foster collaborations between the company it leaves and new potential partners in its recruitment territory (Agrawal *et al.*, 2006; Somaya *et al.*, 2008; Scellato *et al.*, 2015). The following hypothesis can therefore be considered:

Hypothesis 4: external IMR has increased since the beginning of the 21st century.

On the other hand, we must point out some limitations of the external IMR that increase from the beginning of the 21st century. Learning by hiring can face various obstacles: organizational, when the company fails to care for the connectivity between the new recruit and the organization (via integration into projects, knowledge sharing) (Tzabbar *et al.*, 2015) ; cognitive, if the recruited researcher specializes in a scientific field that is too similar to that of the company (Song *et al.*, 2003) ; social when the company is located in a center of excellence with high-level scientific workforce and high remuneration, which makes the cost of living dissuasive and access to housing difficult, reducing the attractiveness of the company for foreign researchers. Concerning researchers leaving the company for an installation abroad, the risks of dry loss of knowledge for the company are not to be neglected, if the connectivity potential of the expatriate is not exploited, thus depriving the company of the collaboration prospects it hoped for. Finally, since the 2010s, and even more so since the Covid-19 pandemic (DeFilippis *et al.*, 2020), MNCs have been using NICTs, including videoconferencing, as a substitute for the international mobility of researchers, without prejudice to their international collaborations. The following hypothesis can therefore also be considered:

Hypothesis 5: external IMR has been decreasing since the beginning of the 21st century.

In any case, the location of the MNC's R&D can actually influence the evolution of the external IMR. The latter is less crucial if the R&D is located in a cluster, a Global Innovation Hotspot (Miguelez *et al.*, 2019), a metropolis or other agglomeration place of world-renowned scientific activity. Because geographical proximity, the density of scientific activity, and the NICTs

guarantee the MNC both local and global connectivity³ within a Global Innovation Network. Quasi-mobility, virtual face-to-face and informal networks characterize the functioning of R&D in this type of location (Cantwell & Marra, 2022). Local collaborations can be a relay to make contact with foreign partners, because all local actors are strongly connected internationally. This reduces the need for external IMR to “network”. Castellani *et al.* (2021) show that the facilitation of international mobility is not an important criterion for distinguishing these places agglomerating the R&D (unlike those agglomerating headquarters). On the other hand, if R&D is situated in more decentralized locations, such as medium-sized cities or sectoral clusters of regional or national importance, external IMR remains potentially essential for connecting with a Global Innovation Network and forming partnerships. Moreover, the quality and cost of living can enhance the attractiveness of foreign researchers and facilitate learning by hiring. The following hypotheses can therefore be considered:

Hypothesis 6.1: when the MNC’s laboratories are located in highly agglomerated world poles of excellence, the external IMR decreases since the beginning of the 21st century.

Hypothesis 6.2: when the MNC’s laboratories are located in more decentralized scientific sites, external IMR has been maintained or increased since the beginning of the 21st century.

The theoretical framework of open innovation therefore lends itself concretely to the formulation of distinct hypotheses, even, for some, opposite. This suggests that context matters, both in its temporal evolution and in its spatio-organizational configuration. The analysis of

³ "Successful clusters cannot be self-sufficient in terms of the knowledge base they draw upon, and the organizations within them (whether firms, universities, public laboratories or other actors) deliberately build international links to complementary pools of knowledge abroad, which would not otherwise be available locally" (Miguelez *et al.*, 2019, p.30).

empirical data, to which we now devote ourselves, aims to provide enlightening answers to these proposals.

Data and processing

In order to test the hypotheses made above, this article deals with French data, drawn from several sources available from INSEE⁴. We can thus obtain the following information in order to build IMR measurement indicators.

THE SAMPLE OF MNCs CONDUCTING R&D IN FRANCE

Source: *MESRI-SIES, annual R&D survey – years 2000 to 2019*⁵

The data processed come from the *survey on the resources devoted to R&D by companies in France*, conducted annually by the statistical service (SIES) of the Ministry in charge of research (MESRI) among companies in France. It allows us to identify foreign companies with R&D capabilities in France, as well as French MNCs performing R&D in France.

The methodology of data processing is as follows.

The *survey on the resources devoted to R&D by companies in France* having evolved in its method from 2015, we proceed as follows to constitute the sample of **MNCs conducting R&D on French territory**.

From 2000 to 2013, all foreign group companies reported in the survey, and any French group company with at least one financial exchange with another company of the group abroad, are considered as MNCs during this period. From 2015 to 2019, we consider as MNC any company of the survey (foreign or French group, the survey does not detail it) having at least one financial exchange with another company of the group abroad. Financial exchanges between companies

⁴ Institut National de la Statistique et des Etudes Economiques

⁵ Access to some of the data used in this work was carried out in secure environments provided by CASD – Centre d'Accès Sécurisé aux Données (Ref. 10.34724/CASD).

of the same MNC are indeed a genuine element of its operating way and allow an effective (even if not exhaustive) identification of the MNCs in the survey.

The union of these two lists constitutes the sample of MNCs performing R&D on French territory. It varies between 1198 and 2155 MNC depending on the year.

THE LOCATION OF THE RESEARCH ACTIVITY AND THE RESEARCH ACTIVITY SECTOR OF THE MNCs ON FRENCH TERRITORY

Source: *MESRI-SIES, annual R&D survey – years 2000 to 2019*

The survey mentioned above also provides, for each company conducting R&D activities in France, the location of these activities (with precision at the department level) as well as the sector of research activity.

The methodology for processing these data is as follows.

- **Location MNCs' research activity:** belonging to a global center of excellence or a more decentralized scientific site

The *survey on the resources devoted to R&D by companies in France* indicates, for each MNC in the sample, the French administrative department where the R&D is conducted.

We have compiled a list of **departments corresponding to poles of global excellence** by merging two types of departments: departments that have hosted or host, at least once during the period studied, the headquarters of a Competitiveness Cluster⁶ (the list of Competitiveness Clusters is provided and updated by the official sources of the Ministry of Economy), and

⁶ Pôles de Compétitivité

departments that include or belong to at least one of the 22 French metropolises (according to the official 2023 list).

The other departments, not concerned by at least one of these two characteristics, constitute the list of **departments corresponding to more decentralized scientific sites**.

For MNCs with R&D activities in several departments, we consider them to be located in a pole of excellence if at least one of their R&D sites is located in a department corresponding to a pole of excellence.

- **Research activity sector:** Strong R&D intensity or low or medium R&D intensity

The *survey on the resources devoted to R&D by companies in France* indicates for each MNC in the sample its sector of activity (the so-called APE/NAF sector).

We have compiled a list of **sectors of activity with a strong R&D intensity** based on the INSEE data for France in 2015 for the whole period studied (Balcone and Schweitzer, 2019). In this list, we select sectors whose R&D intensity is higher than the average observed in the general field to which they belong (Manufacturing industries on the one hand, Services on the other). These two general areas are themselves characterized by higher R&D intensity than the national average. A few sectors of activity in the general Primary-Energy-Construction sector are also in this list, because their R&D intensity is higher than the national average.

The **sectors of activity with low to medium R&D intensity** comprise most of the sectors of activity in the general field Primary-energy-BTP, because their R&D intensity is lower than the national average. We add all sectors in Manufacturing and Services with below average R&D intensity in each of these two broad areas.

THE INTERNATIONAL MOBILITY OF RESEARCHERS FROM MNCs IN FRANCE

Source: *MESRI-SIES, R&D survey – researchers section – years 2000, 2002, 2004, 2007, 2009, 2011, 2013, 2015, 2019* (researchers' mobility data not available for 2017)

The *section of the R&D survey devoted to researchers and R&D engineers in companies* is carried out every two years among all companies in France. It concerns R&D staff (researchers and research engineers). Companies document the workforce (stock) and circulation of researchers and R&D engineers in terms of inflows and outflows, specifying whether these flows are international.

The methodology for processing these data is as follows.

In the *section of the R&D survey devoted to researchers and R&D engineers in companies*, R&D staff and flows are recorded as physical persons (PP). In addition to the staff at the end of the year, it gives us for each company surveyed and for each year of the survey the arrivals of researchers and engineers in the R&D department of the company according to their former provenance, as well as the exits from the company's R&D service with their future destination. The data distinguish between national and international flows; intra-firm and external flows; in intra-firm flows, intra- and inter-functional flows (only from the 2007 edition for the latter information).

Among the MNCs in the sample previously compiled, we select those that document at least one international arrival and/or exit during the selected period. This is the sample of **MNCs carrying out IMR**. Their number varies from year to year between 157 and 212.

We then define two IMR indicators for these companies:

The **Annual international flow of researchers in a company**: estimated by the sum of the arrivals into R&D activity from abroad and exits from R&D activity to abroad of researchers in that company during the year.

The **International mobility rate of researchers from a company (IMR rate)**: determined by relating the Annual international flow of researchers to the R&D workforce of that company during the year.

The IMR rate of a company is the indicator that we analyze in this article, insofar as it allows to correct the size effects (between companies and between periods).

Results and discussion

We calculated the IMR rate for the MNCs of our sample according to various configurations, corresponding to the hypotheses to be tested.

OVERALL MNCs' IMR

First of all, an overall approach (Figure 1) makes it possible to specify the order of magnitude of the IMR phenomenon of MNCs performing R&D on French territory: all categories combined, their IMR rate is around 10% (9% on average over the period), and it remains generally stable over the observation period, with a slight tendency to increase. So, nearly 10% of MNCs' researchers perform international mobility during the year.

There are, however, two successive phases behind the overall evolution: until the end of the 2000s, the IMR of the MNCs tends to increase, while it then decreases. This observation is important, we will find it again later and see its structuring character.

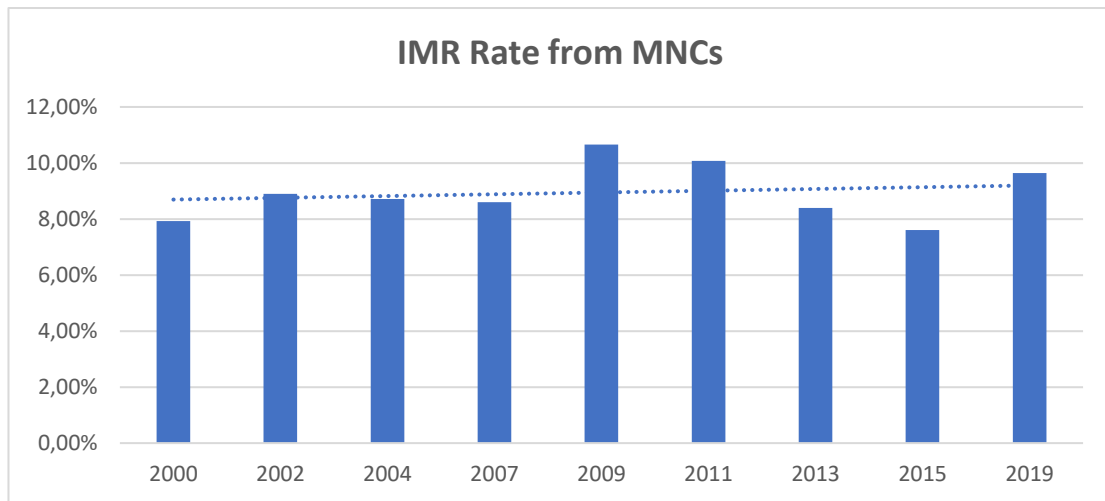


Figure 1. International mobility rate of researchers from MNCs conducting R&D in France

INTRA-FIRM IMR

Does the evolution of intra-firm IMR, considering all MNCs combined, confirm hypothesis 1 (increase since the 2000s) or hypothesis 2 (stagnation, or even decline, over the same period)?

The calculation of the intra-firm IMR rate (Figure 2) shows that, in line with hypothesis 2, it stagnates, with a slight decrease over the entire period.

More precisely, it is also observed here that intra-firm IMR tended to increase significantly until 2011, but then decreased. The MNCs have not extended this Human Resources practice, opting instead for alternatives such as “quasi-mobility” and the use of NICTs.

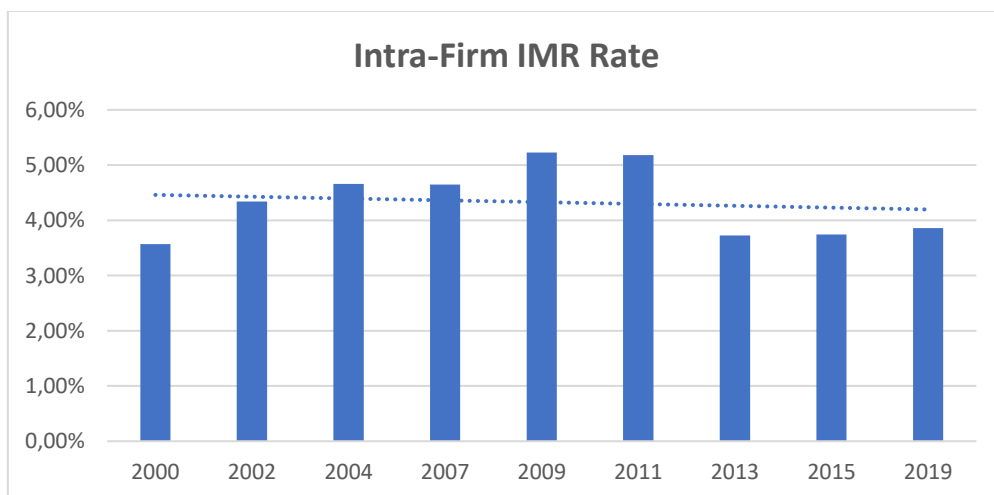


Figure 2. Intra-firm International mobility rate of researchers from MNCs conducting R&D in France

Let us now refine the analysis by distinguishing the MNCs based on the R&D intensity of their activity.

The evolution of the intra-firm IMR rate for MNCs in sectors with medium or low R&D intensity (Figure 3) confirms hypothesis 3.1: The intra-firm IMR for this category of MNCs increased overall over the period, despite an irregular pace. Moreover, it is mainly inter-functional (Figure 4). Researchers in laboratories in these MNCs are increasingly experiencing international mobility, playing their role of «boundary spanners» and articulating the issues of R&D and production *in situ*.

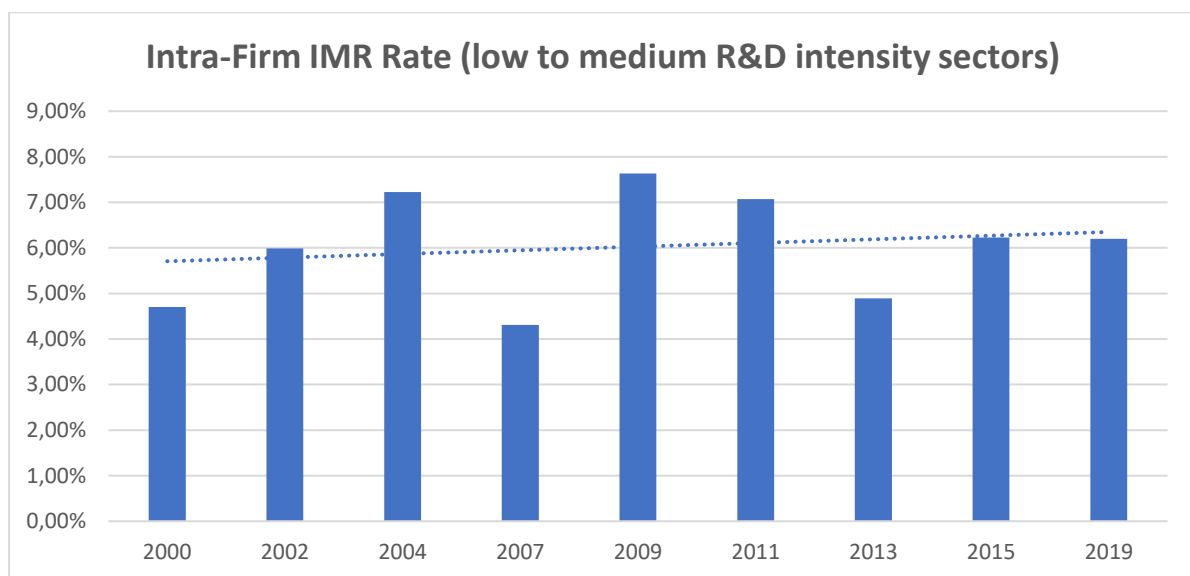


Figure 3. Intra-firm International mobility rate of researchers from MNCs conducting R&D in France in low to medium R&D intensity sectors

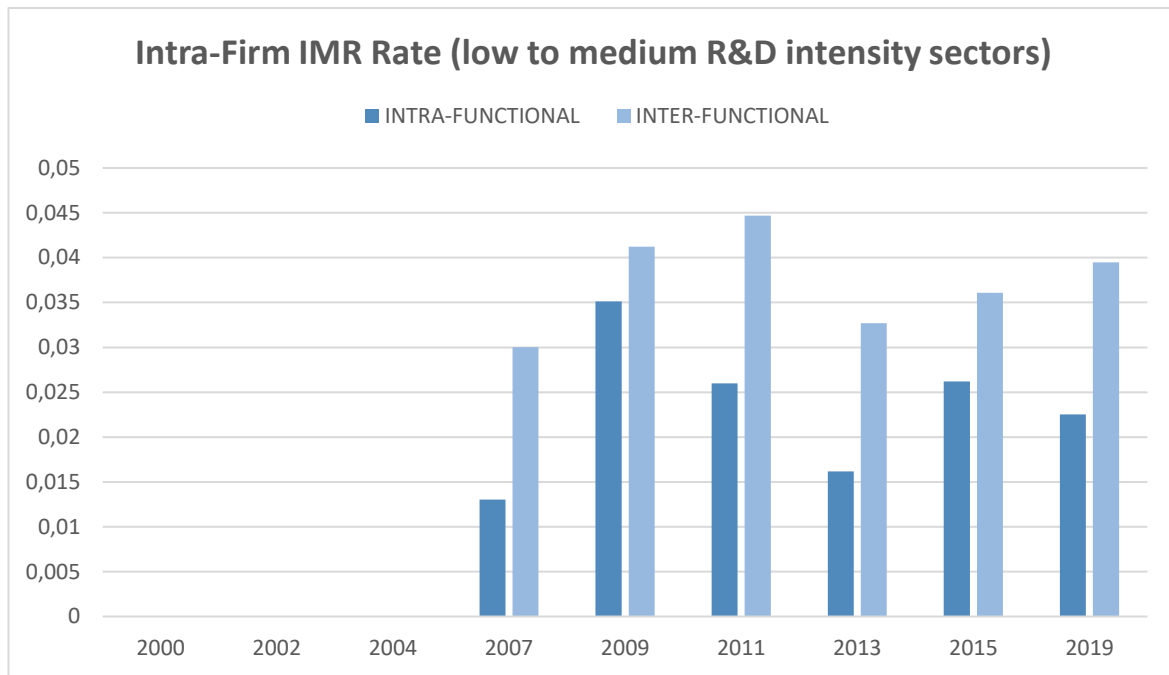


Figure 4. Intra-firm International mobility rate of researchers from MNCs conducting R&D in France in low to medium R&D intensity sectors, distinguishing between intra-functional and inter-functional mobility

Regarding the MNCs of sectors with strong R&D intensity, the evolution of their intra-firm IMR rate (Figure 5) confirms the hypothesis 3.2. Intra-firm IMR for this category of MNCs decreased overall over the period, and was predominantly intra-functional (Figure 6). A more detailed observation of the evolution of that rate shows however that at the beginning of the period (until 2007), it increased significantly. But then it decreases. This category of MNCs is making less and less use of intra-firm IMR, as the NICTs and other forms of mobility ensure the smooth functioning of their internal global network.

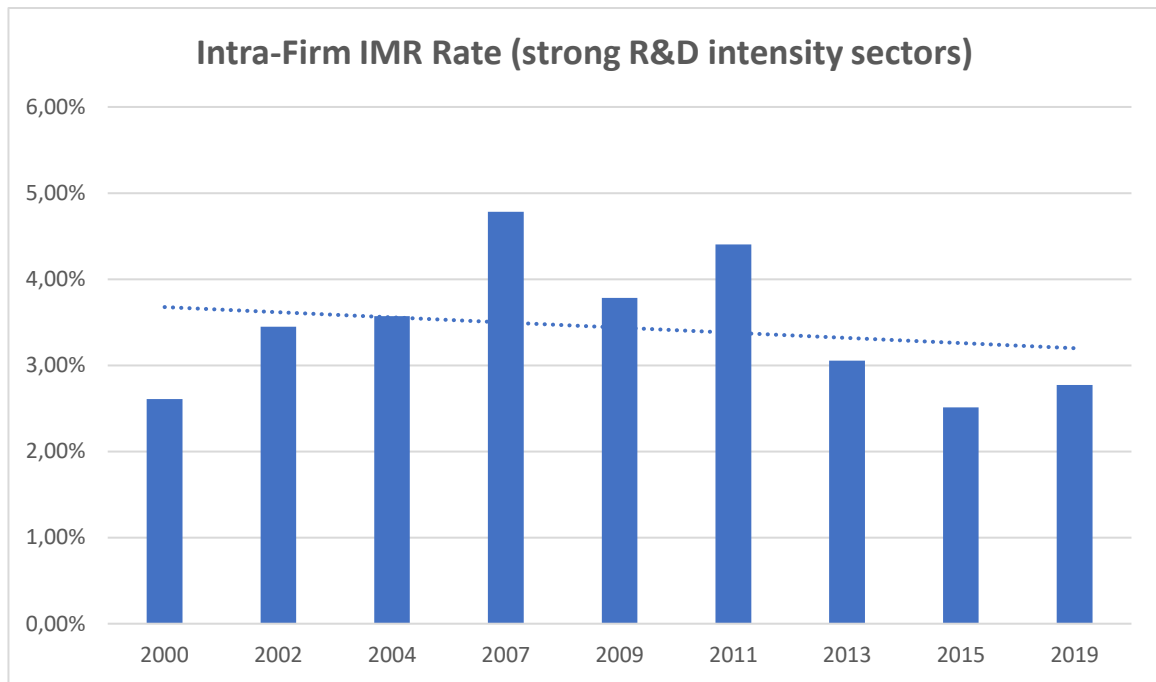


Figure 5. Intra-firm International mobility rate of researchers from MNCs conducting R&D in France in strong R&D intensity sectors

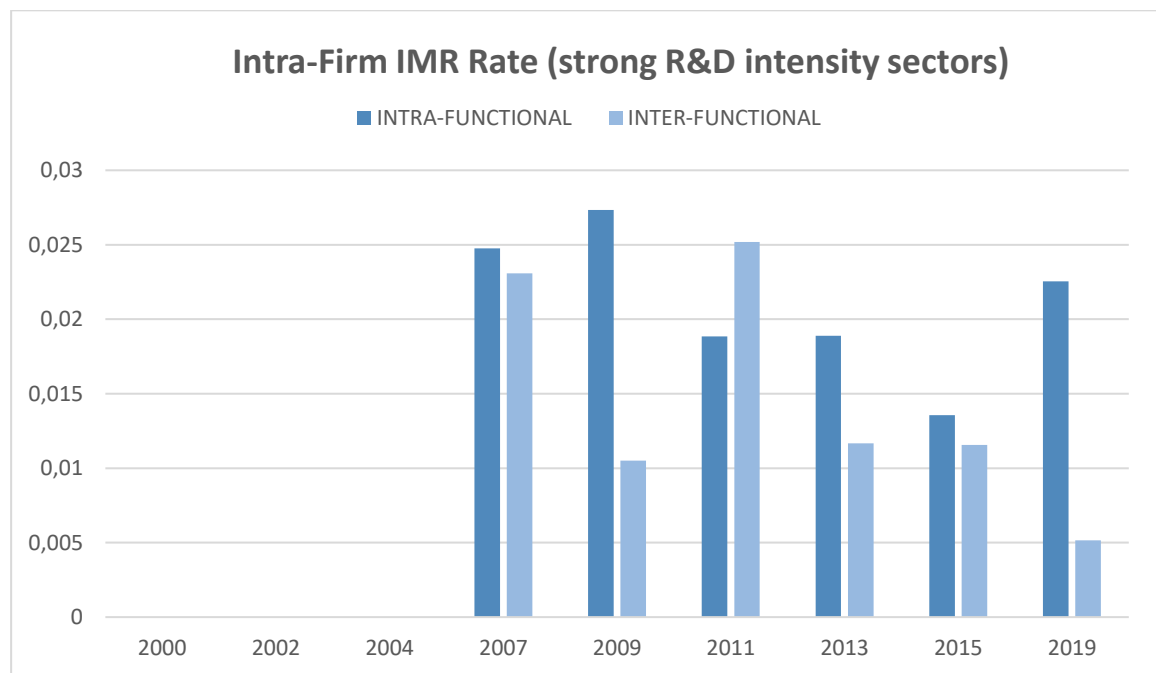


Figure 6. Intra-firm International mobility rate of researchers from MNCs conducting R&D in France in strong R&D intensity sectors, distinguishing between intra-functional and inter-functional mobility

Comparing the Intra-Firm IMR of the two categories of MNCs over the years, MNCs in sectors with strong R&D intensity show that the trend in their intra-firm IMR rate (Figure 5)

consistently stays at a lower level compared to sectors with medium or low R&D intensity (Figure 3).

EXTERNAL IMR

Has the external IMR for all MNCs increased over the period (hypothesis 4) or decreased (hypothesis 5)? The evolution of the external IMR rate (Figure 7) shows overall that it has increased, in line with hypothesis 4: MNCs are increasingly circulating researchers in their external global network. However, behind this overall increase, there is an irregular, almost cyclical evolution. The MNCs significantly decrease their external IMR during certain periods, before and after phases where they instead accentuate it.

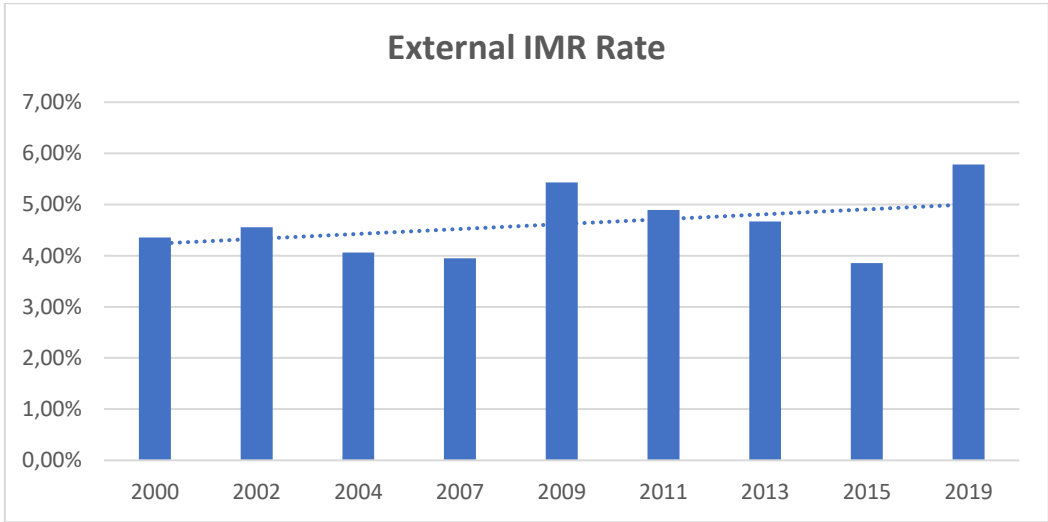


Figure 7. External International mobility rate of researchers from MNCs conducting R&D in France

Let us now distinguish the MNCs according to the location of their R&D activity (Figure 8). For MNCs performing their R&D in poles of global excellence, the external IMR rate shows stagnation. Hypothesis 6.1 of a decrease is therefore not perfectly confirmed, but the results are not opposed to it: there is simply no growing substitution of NICTs and other quasi-mobilities to external IMR. However, what is notable here is also the irregularity of the evolution of the external IMR rate for these MNCs: external IMR is not a practice that is consolidating.

For MNCs performing their R&D in more decentralized scientific sites, the external IMR rate, on the other hand, increases significantly over the period, which confirms hypothesis 6.2. The relative geographical isolation of these MNCs vis-à-vis the actors of global innovation networks pushes them to circulate researchers to be inserted in them via international mobility.

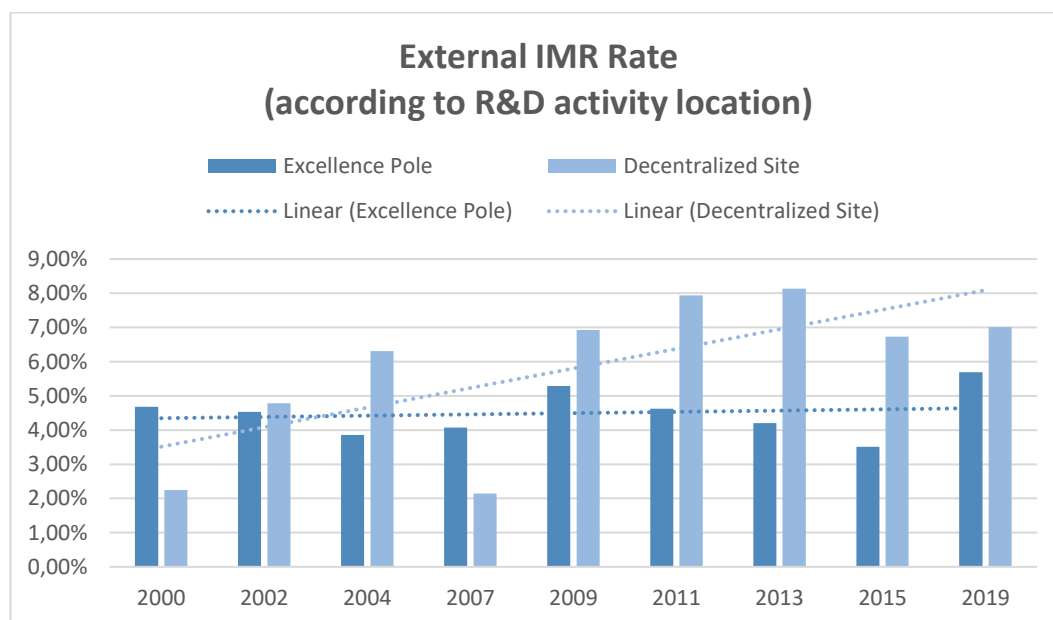


Figure 8. External International mobility rate of researchers from MNCs conducting R&D in France, distinguishing between MNCs according to whether they perform their R&D in a pole of global excellence or in a more decentralized scientific site

TWO MNC PROFILES ABOUT USING IMR

Thus, assumptions 2, 3.1, 3.2, 4, 6.1 (imperfectly) and 6.2 are confirmed by the data. Overall, while open innovation initially led MNCs to resort more to IMR in the 2000s, the NICTs, allowing videoconferences, virtual teams and remote collaborations have cut in its momentum this evolution: in the 2010s, MNCs' IMR is declining.

This configuration must however be nuanced by distinguishing in reality two profiles of MNC performing R&D in France. Indeed, it is all the more pronounced as the MNCs are *in sectors with strong R&D intensity and/ or located in poles of global excellence*. NICTs seem to be more

effective substitutes for IMR for these cutting-edge MNCs. The *ubiquity*⁷ they allow for researchers working in the poles of global excellence (already noted by Torre, 2014) guarantees sufficient efficiency for their R&D globalization and the activation of knowledge networks.

In contrast, for MNCs in sectors with low to medium R&D intensity, or located outside poles of global excellence, IMR seems to be increasingly a means of strengthening their integration into global knowledge networks. Geographical proximity remains important here (Torre, op. cit.), and IMR makes facilitates it.

This difference raises questions: is it a simple time lag between these two MNC profiles, and in the long term, all MNCs will use of NICTs and quasi-mobility instead of IMR? Or, on the contrary, are we witnessing a decisive shift to virtual networks in the organization of globalized R&D for the MNCs of sectors and territories at the forefront of science, but not for others, with the sustainable coexistence of two models?

Conclusion

The objective of this article was to analyze the role played by the IMR as a Human Resources modality of the business R&D globalization. Our data, which document the evolution since the early 2000s for MNCs performing R&D in France, show that they did indeed use it growingly initially, until the early 2010s. The IMR enabled them to activate their global knowledge networks, both internal and external. But since the 2010s, their practice has evolved: IMR stagnates, as less expensive modalities offer alternatives, such as the use of NICTs that allows an organizational proximity in these networks (Torre, 2014), or quasi-mobility. Moreover, an important lesson of our analysis is the contrast between two MNC profiles: those that are in an environment at the cutting edge of science (in terms of their location and the R&D intensity of

⁷ Defined by Torre (2014, p. 10) as “*the possibility for an agent or group of agents to be simultaneously present here and elsewhere and thus to develop a register of action that goes beyond location or mobility.*”

their activity) reduce their use of IMR as a whole, replacing it with other methods of integration into global knowledge networks (NICTs, quasi-mobility). While those whose environment is further away from scientific excellence (geographically as well as from the point of view of their R&D activity) are increasingly using the IMR, in order to strengthen their possibilities for knowledge co-production in their global networks. Thus, our results contribute to a refined approach to the theoretical framework of open innovation, when it concerns the flows of people and the dynamics of ecosystems that co-produce and circulate knowledge: the actors of open innovation are not always more and more mobile, and the scale of the opening of ecosystems is not bound to widen.

These contributions lead us to various questions and perspectives of extensions of the analysis. The two distinguished MNC profiles address a problem of territorial differentiation: in the poles of global excellence, the MNCs are satisfied with a stable pool of researchers, and resort less to IMR, at the risk of a relative inbreeding; while MNCs in less scientifically advanced territories are increasing their stock of researchers to fuel their R&D dynamics. Does this bring with it long-term prospects for the disruption of territorial hierarchies, with a cognitive stagnation of certain clusters, and the emergence of new territories increasingly integrated into global knowledge networks?

Then, IMR, while it continues to be encouraged for the individual careers of researchers, is already gradually being neglected by MNCs at the forefront of science. IMR's prospects are therefore becoming more favorable in sectors and territories that are not considered the most stimulating. How to integrate this contradiction in the management of researchers' careers?

Our paper provides data and results on the MNCs' IMR, which has been lacking in the economic literature to date. However, two extensions of the analysis are desirable. On the one hand, it would be interesting to have data on the international quasi-mobility of MNCs' researchers (temporary, one-off, reversible, etc.). This would make it possible to compare the share of other

forms of mobility and that of NICTs-based substitutes in the explanation of the decreasing use of IMR for MNCs at the cutting edge of science.

On the other hand, one dimension should be investigated for a more detailed analysis: the influence exerted by the size of the company's R&D activity, in particular as regards the differentiated use between intra-firm and external IMR. Do companies with a high number of researchers practice IMR more than those with a small staff? Are they more oriented towards intra-firm IMR (thus circulating their pool), while smaller firms would resort more to external IMR (to join global networks that are necessary for them)?

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