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Patents as indicators of R&D internationalization

Lars Håkanson

lh.egb@cbs.dk

Copenhagen Business School

Research Article

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Patents as indicators of R&D internationalization

Lars Håkanson[1]
lh.egb@cbs.dk

Abstract
This paper examines the reliability and validity of the common practices of (1) identifying the geographical location of inventions by the address of the first-listed inventor in patent applications, and (2) making comparisons between U.S. and non-U.S. MNEs based on USPTO patent records. The first inventor criterion is problematic when co-inventors reside in different countries, since there is no convincing evidence that the address of the first one reliably indicates where the work underlying the invention took place. Comparing USPTO patenting activities of U.S. and foreign firms is problematic, because propensities to patent domestically are higher than doing so abroad. Domestic patents therefore include a higher share of inventions with low or very uncertain economic value than do ones filed by foreign companies. The analyses presented are based on two sets of empirical data, (1) USPTO pharmaceutical patents for the years 2000-2015, and (2) results from a questionnaire survey directed to U.S. and UK patent attorneys. The results provide no support for the common assumption that the address of the first inventor is a reliable indicator of where the R&D underlying the invention was performed, although it can sometimes be a reasonable proxy. The results raise questions regarding the reliability and validity of the methods employed in much of the inherited literature and suggest conclusions as to how best to employ patent data in research on international R&D.

Keywords Patents, R&D internationalization, multinational enterprises, inventor addresses

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[1] Department of International Economics, Government and Business, Copenhagen Business School, Frederiksberg, Denmark

Introduction

Among other uses, patent records have come to form an important source of data in the analysis of the internationalization of research and development (R&D) in multinational enterprises (MNEs), and of the factors that influence the location of their R&D units. The approach has been highly influential and has won broad acceptance but is associated with several methodological problems and caveats. Patent records provide valuable rich data linked to innovations, but they are collected for other purposes and objectives than geographical analyses of innovative activity. Unsurprisingly, therefore, patent statistics as indicators of R&D internationalization entail several sources of 'noise'. This paper discusses the nature of these and offers an assessment of their likely impact on the reliability and validity of reported findings.

Patent records provide information on the names and addresses of both assignees and inventors. Combined with information on company ownership structures, the former make it possible to determine the identity of ultimate patent owners, such as the names and domiciles of MNEs; the latter provide indications of the location(s) where the underlying R&D took place.

Other problems arise when inventors listed in patent applications reside in different countries. In such cases, the predominant custom is the convenient and cost-saving practice of assigning the geographical origin of patented inventions according to the address of the first-listed inventor, a tradition that has rarely been discussed or questioned. In fact, the practice appears to have become so entrenched that, at times, it is not even specified in reported research (Archambault, 2002:19) [1]. It is commonly based on the (often unstated) assumption that first-named inventors are 'project leaders' and/or 'main contributors', and that their addresses can safely be taken as indicators of the geographical sources of the inventions in question and, by extension, of the locations and internationalization of R&D in MNEs.

[1] At times, the problem shorthandedly concealed by merely referring to "the address of the inventor" (in singular) (Cantwell and Immarino, 2000: 320; Cantwell and Piscitello, 2002:74).

This note offers an examination of this practice, assessing both its merits and the relative importance of potential caveats. It provides first a brief outline of how research on international R&D has evolved over time in response to the availability of new data sources. In Section 3 follows an overview of methodological issues relevant to the use of patent records as indicators of R&D locations before examining the merits and possible demerits of using the address of the first-listed inventor as indicator of R&D locations. Section 4 reports the responses to an internet questionnaire directed to U.S. and UK patent attorneys familiar with patent filings with the United States Patent and Trademark Office (USPTO), enquiring by which criteria inventors' names are commonly listed. The responses indicate that the inventor who made the greatest contribution is often listed first, but that this is far from always the case.

For the task of determining the country of origin of an invention, this is of course only an issue in instances where inventors reside in different countries. If this is rarely the case, the country of residence of the first listed inventor would provide a reasonable approximation. To throw some light on whether this is the case, section 5 presents an analysis of a large sample of USPTO pharmaceutical patents revealing differences in this regard not only between U.S. and non-U.S. firms but also between individual pharmaceutical companies and demonstrating that the issue not trivial but worthy of attention. The final section summarizes overall conclusions and implications.

Background

From its inception, availability of data has shaped the study of international R&D in multinational enterprises (MNEs). National statistical bureaus traditionally restricted their data collection to activities and entities within their country borders, and for a long time, systematic information on the extraterritorial activities of multinational enterprises (MNEs) was accordingly limited.

The main exception was the U.S., where the U.S. Department of Commerce 1966 undertook a benchmark survey, with industry level data published in full by the U.S. Tariff Commission (1973). This formed the baseline for subsequent surveys of samples of U.S. MNEs (Cordell, 1976; Creamer, 1976; Duerr, 1970), and despite the small number of observations, it provided the basis for several statistical analyses of the determinants of the propensity to perform R&D abroad (Hewitt, 1980;

Hirschey and Caves, 1981; Lall, 1979). In the mid-1970s, more complete and more systematic evidence of the foreign R&D activities of U.S. MNEs became available through the surveys of industrial R&D undertaken by the National Science Foundation. These indicated international R&D to be a quite marginal phenomenon and of limited empirical and theoretical interest, accounting for a mere 7-9 per cent of the total R&D effort (NSF, 2023).

Although a few studies of foreign direct investments in other host countries than the U.S. (e.g. Dunning, 1958; Safarian, 1966; Cordell, 1971; Stubiensky, 1970) documented significant presence of local R&D in foreign subsidiaries, the consensus at the time was that MNEs centralize R&D to their home countries in the proximity of the head office and major production facilities. Thus, Franko (1976:181) concluded that "[t]he general rule in both American and European practice seems to have been to keep R&D at home." Similarly, Terpstra (1977:26) stated that "…the last activity of the firm to be organized on an international basis… is R&D."

This assessment prevailed also after the seminal case studies of individual foreign R&D units by Ronstadt (1977, 1978) and Behrman and Fischer (1980a, 1980b). Indeed, the latter study proceeded on the premise that "…not much R&D is being performed abroad by transnational corporations regardless of nationality…" (p. 5). Dunning (1992: 25) summarized this view: "It is… known that, except for some European and a few US MNEs, the average proportion of R&D activity undertaken outside their home countries is quite small, and that, in the case of almost all Japanese MNEs it is negligible."

Over time, however, evidence based on statistically meaningful samples of individual MNEs from a broader range of countries made it increasingly evident that internationalization of R&D was neither a novel nor marginal phenomenon (Mansfield, et al., 1979; Håkanson, 1981; Pearce, 1989; Pearce and Singh, 1991; Wortmann, 1990), especially not in MNEs from other countries than the U.S. These early empirical surveys and case studies of individual MNEs formed precedents for a subsequently important line of research (including e.g. Ambos, 2005; Cantwell and Mudambi, 2000; Gassmann and von Zedtwitz, 1998, 1999; Gerybadze and Reber, 1999; Håkanson and Nobel, 1993a, b). Such studies provided much valuable detail on the motives and driving forces for R&D internationalization and about the organization and coordination of international R&D, but they were demanding in terms of time and resources, and they could typically only provide momentary cross-sectional data.

A key novel approach and an influential impetus for the establishment of international R&D as a core IB topic was the exploitation of increasingly digitized patent databases as sources of longitudinal, detailed, and standardized information, including the names and addresses of assignees and inventors, making it possible to trace over time the geographical pattern of inventive activity in multinational firms.

The first and most prominent employment of patent records for this purpose was based on a database of U.S. patents compiled in cooperation between the University of Reading and the Science Policy Research Unit (SPRU) at the University of Sussex. It was drawn from a list of the 792 largest industrial firms in 1982 as recorded by the *Fortune* magazine. The coverage of the sample was extended over time and formed the basis for many influential publications (including e.g. Cantwell, 1991, 1992; Cantwell and Hodson, 1991; Cantwell and Immarino, 2000; Cantwell and Janne, 1991; Cantwell and Piscitello, 2002; Patel and Pavitt, 1991; Pearce, 1989) and created a paradigm for much subsequent research. Unfortunately, much of the literature in this tradition lacks critical reflection of the reliability and validity of the methods employed, and, at times, the presentation of the data sources is directly misleading.[1] To explore and exploit properly the information contained in patent records, it is necessary to address and assess more thoroughly than in past and current practice the associated caveats, pitfalls and uncertainties.

Methodological issues

Differences in patent propensities

Many of the methodological issues associated with the use of patent statistics are well known and have been thoroughly discussed in the literature (see e.g., Acs and Audretsch, 1989; Archambault, 2002; Bergek and Bruzelius, 2010; Griliches, 1990; Griliches, et al., 1987; OECD, 2009; Pavitt, 1988). Some of the most obvious ones emanate from differences in patent propensities between industries and individual firms. Firm-level variations are difficult, if not impossible, to gauge systematically.

[1] According to Cantwell (1991:109), for example, "… in completing the US patent application form *the location of origin of invention* must be recorded, even if the patent is granted to a firm (or an agent on their behalf) in another country."

However, differences between national jurisdictions and industries largely reflect the differing strengths of appropriability regimes that are generally well understood and broadly possible to assess. Considering such differences is crucial in any analysis involving comparisons across firms in different countries and industries (Dernis, Guellec, and van Pottelsberghe, 2001).

To avoid the problems emanating from differences in the cost of patenting and the level of protection afforded in different jurisdictions, most international comparisons use patents filed in a common country. Most research on R&D internationalization using patent records draws on USPTO databases. Being largely digitized and available online, these are easily accessible and provide longitudinal reliable records of patents granted according to strict and standardized criteria. As summarized by Pavitt (1988: 597), "[t]he US patenting data are probably the most reliable, given the rigour and comprehensiveness of its patent legislation, the degree of detail and accessibility of patenting data, and the attraction (for sales and therefore patenting) of the large and technically sophisticated US market…"

However, the propensity to file a patent locally is generally higher than doing so abroad. Patents from local firms are likely to include a higher proportion of economically less relevant inventions than is the case of those from foreign firms, where, on average, the decision to engage in the cost and trouble to obtain a foreign patent is likely preceded by careful assessment of its potential value (Dernis, Guellec, and van Pottelsberghe, 2001: 142; OECD, 2009: 60). The nature of USPTO patents filed domestically by U.S. firms therefore differ substantially and systematically from those of foreign firms (Patel and Vega, 1999:148). As Pavitt emphasizes, "… one shortcoming of using the US patenting data base is that *it precludes many* (but not all) *comparisons including patents of US origin* (Pavitt, 1988: 517, italics added)."

Identification of ultimate owners

In many MNEs, a central patent department prepares and files patent applications in the name of the corporate parent, regardless of where the R&D underlying the invention took place. However, this is far from always the case, and it is common that foreign subsidiaries themselves apply for patents on locally developed inventions. This is especially likely in the case of acquired foreign firms, who may have both the requisite R&D capabilities to develop patentable inventions and personnel familiar with

local patent application procedures. To obtain an accurate understanding of the extent of R&D internationalization in individual MNEs, it is therefore necessary to consolidate the patents of all its activities and affiliates, regardless of location.

Today, the databases provided by international business information providers enormously facilitate this, but in the past, it was a formidable task (see, e.g., Zander, 1994). The early analyses, such as those by Patel and Pavitt (1991) or Cantwell (1992), included data on MNEs consolidated for only one point in time. They could therefore not capture the effect of mergers and acquisitions on the internationalization of R&D, in most firms the strongest mechanism for the addition of R&D units abroad. The analyses presented in the following draw on data from the Thomson Reuter database *Thomson Innovation* and *Orbis Intellectual Property* by Moody's Analytics, both of which enable the consolidation of patents assigned to MNE affiliates to their Global Ultimate Owners (GUOs), typically their parent corporations.

Inventor mobility

USPTO patents list the locations of inventors' residences as stored in USPTO records at the time of issuance. Since the USPTO will on request update residence addresses in case, for example, that an inventor moves while the patent is pending, these may differ from those at the time of application and when the work underlying the invention was made. The likely relative importance of post-filing international relocations for the study of R&D internationalization is difficult to assess. The overall international migration rates among inventors are high and have increased over time (Miguelez and Fink, 2013; Drivas, et. al., 2020), and their absolute and relative importance varies strongly between countries. Individual characteristics of inventors are also important, such as their age, education and innovatory productivity, factors that also differ between industries (Lissoni and Miguelez, 2024). The time span between application date and date of patent issue varies considerably between patents and over time, as do the interest and propensity of inventors to proactively file requests for address updates. Moreover, information on inventors may be collected more accurately and consistently by some patent offices than others (Lissoni and Miguelez, 2024), for example in distinguishing inventors' domicile and correspondence addresses.

To assess the magnitude of the potential problem, Bergek and Bruzelius (2010: 1326), compared inventor addresses for equivalent patents filed with the European Patent Office (EPO), which typically refer to the addresses designated at the time of application. In five of seven patents with an EPO equivalent, the listed country of residence when the patent was granted by the USPTO was the same as when the application was filed with the EPO. Thus, in more than 28 per cent of this small sample international mobility confounded the indication of the international location of inventive activity. In their main analysis, a detailed study of 53 patents by ABB with at least one inventor resident in Sweden and at least one in another country, nine patents (17 %) were found to include inventors having moved from Sweden after the R&D project had ended. A further 11 (21 %), included persons on temporary assignments who had moved from Sweden after the R&D project had ended.

Clearly, the residence listed on a granted patent does not always reliably indicate where the inventor lived when the invention was made or when the application was filed. To provide further evidence regarding the degree to which inventor mobility may affect the reliability of findings, the inventory addresses in a random sample of 300 pharmaceutical patents granted by the USPTO in 2020 were manually checked against EPO equivalents. In the vast majority (88.2 %) there was no discrepancy, and in less than five per cent (four cases) did the domicile listed for one or more inventors differ.[1] However, the exercise revealed a further and somewhat unexpected inconsistency, in that in 22 cases (7.3%) the number of listed inventors differed somewhat between the two sets of patents. The finding is unexpected primarily because U.S. patent law requires that *only* and *all* inventors must be listed in an application, and although corrections for mistakes may be permitted during the process, patents not meeting this obligation may be challenged in court.[2]

It therefore appears that the overall magnitude of the problem is limited, but it may well be more important in some instances than others, for example in MNEs with geographically dispersed R&D

[1] In one case because the EPO listed the address of the company rather than that of the inventors, one of whom clearly commuted from a neighbouring country.

[2] This may be one explanation for why, in my experience and as reported by Bergek and Bruzelius (2010:1326), inventors are often reluctant to discuss the composition and roles of co-inventors.

units and technical expertise, a caveat that is rarely discussed in patent-based studies of R&D internationalization but worthy of more attention.

First listed inventors as indicator of R&D locations

In the literature, different ways have been employed to assign patents to their geographical origins with the help of inventor addresses, depending on the purpose of the analysis. They include fractional counting (e.g. Criscuolo, et al., 2005), plurality (e.g. Jaffe, et al., 1993), and multiple counting (e.g. Tijssen, 2001), each with its own strengths and caveats. But as already noted, the by far most common practice is to assign the country of origin of patents and the associated R&D activities by reference only to the address of the first-named inventor.

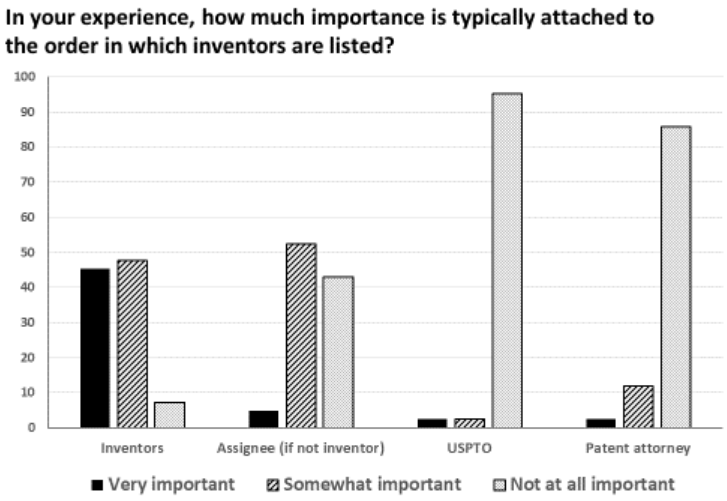
A common argument in favor of the use of first-named inventors is that these are typically project leaders with overall responsibility for the activities that resulted in the inventions and/or because they provide the most valuable contribution (as is often assumed or implied in academic articles). Although intuitively plausible, the assumption lacks convincing empirical support. The order in which inventors are listed has no legal significance; all have the same rights and obligations. The USPTO application guidelines merely state that the address of the first-named inventor will be used as a default for correspondence in case the designated assignee cannot be reached.

The ordering of inventors in patent applications

Absent available evidence concerning the criteria applied in the selection of first listed inventors, an internet questionnaire was distributed to U.S. and UK patent attorneys familiar with application procedures to the USPTO. Its aim was to explore whether there are established common standards regarding the ordering of inventors on applications. An internet search of law firms advertising themselves as patent specialists yielded a sample of 523 patent attorneys. In total, 62 (12%) usable responses were returned, in line with what can be expected from an unsolicited email questionnaire. Despite the meagre response rate, the results provide some rather clear indications of current practice.

For one, they confirm that the USPTO takes no interest in the ordering of inventors, and in reflection of this, patent attorneys also see no reason to pay this any attention (Fig. 1) Conversely, patent attorneys

believe that the ordering is often important to the inventors themselves, possibly, because there is an element of prestige associated by being first-named and thereby getting one's name associated with the patent, which in citations will typically be quoted with the first inventor's last name, followed by et al. However, the responses also suggest that assignees are less concerned, perhaps because they consider it irrelevant or because they may have other priorities.



Fig, 1 Importance attached to the ordering of inventors on patent applications.
Source: Internet questionnaire to U.S. and UK patent attorneys (n=62)

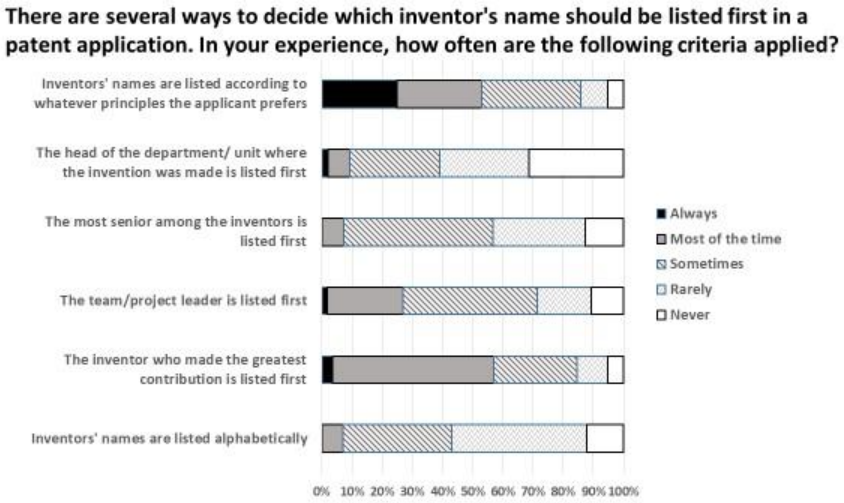


Fig. 2 Criteria for the ordering of inventors on patent applications.
Source: Internet questionnaire to U.S. and UK patent attorneys (n=62)

Unsurprisingly, patent attorneys, for whom the issue is not usually an important one, generally apply the ordering that their clients prefer (Fig. 2). The most prevalent custom is to list first the team/project leader or the person who made the greatest contribution to the invention, lending some empirical support to the practice applied in most patent-based studies of R&D internationalization. However, no generally agreed principle exists, and there are clearly many cases where other criteria are applied. The overall impression of the questionnaire responses well matches the conclusion of one of the respondents:

> My anecdotal evidence is that the order in which the inventors are listed is not a reliable indicator of anything. Since completing the survey, I have thought of one other factor that will influence the order in which inventors are listed: pure chance. In my experience, it is often the case that patent attorneys are not instructed to list the inventors in any particular order, so the inventors are listed essentially at random by the attorney (or, more likely, paralegal) completing the application form. The criteria mentioned in the survey (alphabetical order, order of seniority etc.) are indeed commonly used, but there are so many factors at work (including randomness) that it is a mistake to draw any inferences from the order in which inventors are listed. (Philip Cupitt, Marks & Clerk LLP, personal communication, May 25, 2021.)

In summary, the responses indicate that inventors and assignees at times take an interest in the order of which inventors are listed, and that there is a tendency to list first if someone is seen to have made the most important contribution. However, they do not provide evidence of any predominant practice in support of the assumption that the address of the first listed inventor is a reliable indicator of the location where the underlying R&D occurred.

As already noted, the geographical assignment of R&D activities according to the addresses of first-named inventors is potentially problematic and misleading only in cases where patents list inventors from more than one country. If this is only rarely the case, the convenience of the procedure probably outweighs potential inaccuracies. Conversely, if the incidence of multi-country inventors is high, an assessment of potential threats to the reliability and validity of the practice is clearly needed.

Incidence of listed inventors from different countries

Archambault (2002:20), who analyzed all USPTO patents 1980-1999, found the overall proportion of international collaborations, as measured by the incidence of inventors with addresses in different

countries, to be quite modest. Despite a more than threefold increase during the period, they accounted for a mere 2.6 per cent of the total number of applications, primarily reflecting the low shares of international collaborations in applications by assignees from the U.S. and Japan. However, in other countries the geographical allocation of inventory activity by the domicile of the first named inventor differed, in some cases considerably, from the allocation obtained by considering all listed inventor countries.

To explore the issue, Fig. 3 presents an analysis of USPTO pharmaceutical patents (IPC patent classes A61K and A61P) filed in the years 2020-2025 sourced from the *Orbis Intellectual Property* database. The pharmaceutical industry is an interesting case because of its high R&D intensity and because it has in recent decades undergone massive concentration through international mergers and acquisitions, often associated with an increase in international R&D. The database lists 117,916 patent records for the period, including patents filed by individual inventors, domestic U.S. firms, universities and other research institutes. The analysis presented here is based on a total of 31,613 patents (26,8%) which, in addition to the name and country of the applicant also includes those of the Global Ultimate Owner at the time of application.

In the sample, patents with first-listed inventors from another country than the ultimate owner accounted for 52.9 per cent of the total. In a further 9.4 per cent, the country of the first listed inventor was the same as that of the ultimate owner but included also inventors from at least one more country. Including the latter group in the identification of ‘international patents’ increases the percentage to 64.4%.

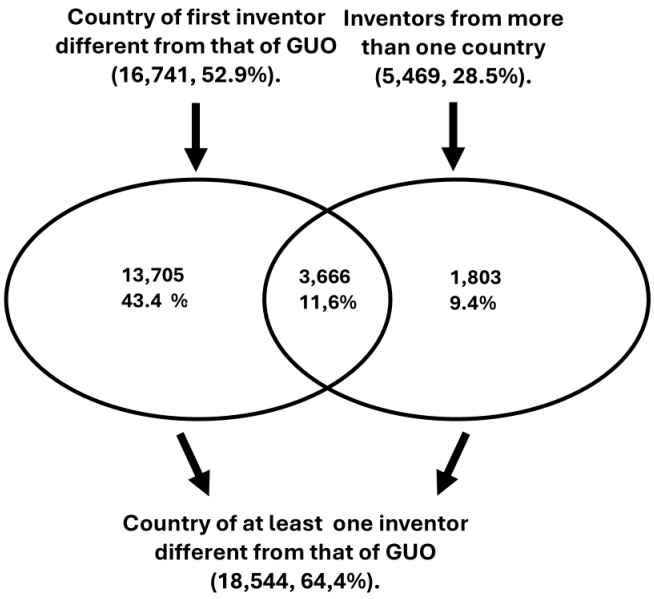


Fig. 3 Comparison of classifications of international patents.
Pharmaceutical patents filed with the USPTO 2020-2025 (n=31,613)

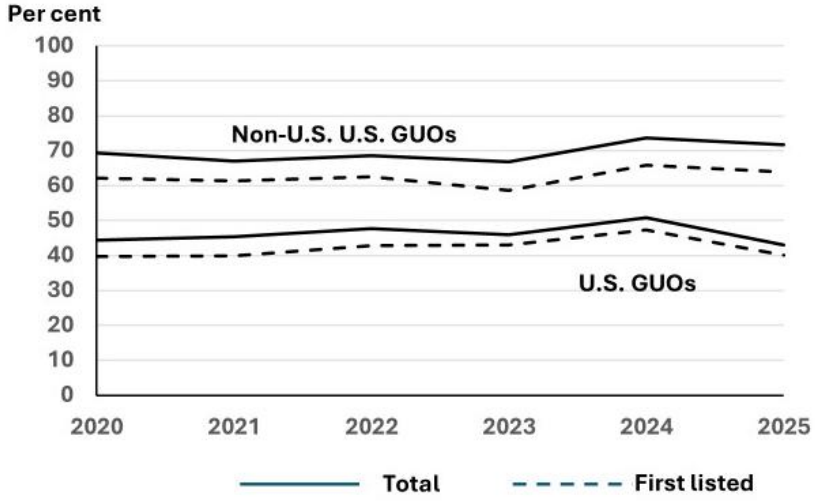


Fig. 4 Inventor addresses as indicators of R&D internationalization: Global Ultimate Owners (GUOs) domiciled in the U.S. compared to ones domiciled in other countries.
Pharmaceutical patents filed with the USPTO 2020-2025 (n=31,613)

The comparison suggests that the domicile of the first listed inventor may by and large provide a not only convenient but also reasonably accurate indicator of R&D internationalization – on a par, perhaps, with other sources of 'noise' inherent to geographical analyses of patent data. However, the conclusion is associated with several caveats. The overall sample is dominated by domestic patenting by U.S.

ultimate owners that constitute nearly half of the sample (44.7%) (Fig. 4). As already noted, domestic patenting by U.S. firms differs from that of non-U.S. companies, and it is rarely meaningful to include the former in international analyses of USPTO patent data.

This is illustrated by the fact that, on average, patents by U.S. MNEs list inventors from other countries more rarely than ones domiciled elsewhere, and when they do these tend to come from only one country, making the address of the first listed inventor a rather good indicator of R&D internationalization. This is also the case for MNEs from other home countries, but in several the difference between the two indicators is quite considerable (Table 1).

GUO domicile country	Patents with inventors domiciled in other countries		
		First listed	
	Total	Number	%
United States	6,518	5,908	90.6
Switzerland	1,770	1,586	89.6
United Kingdom	1,757	1,485	84.5
Japan	1,214	1,194	98.4
France	1,046	986	94.3
Netherlands	860	831	96.6
Germany	802	530	66.1
Ireland	715	695	97.2
China	493	492	99.8
Denmark	489	445	91.0
Canada	342	330	96.5
Cayman Islands	275	275	100.0
Australia	222	183	82.4
Italy	182	159	87.4
Belgium	168	162	96.4
India	167	123	73.7
Spain	149	137	91.9
Sweden	142	134	94.4
South Korea	135	135	100.0
All other countries	1,098	951	86.7
TOTAL	18,544	16,741	90.2

Table 1 Inventor addresses as indicators of R&D internationalization by domicile of GUO 2020-2025. Pharmaceutical patents filed with the USPTO 2020-2025 (n=31,613)

As Fig. 5 illustrates, there are also considerable differences between individual firms, where in some European MNEs a rather large proportion of patents list foreign inventors from more than one country, raising doubts as to the reliability of the first listed inventor criterion as indicator of R&D internationalization. In others, however, there is no such discrepancy. Especially in U.S. MNEs, the country of all listed inventors tends to be the same as that of the first listed one.

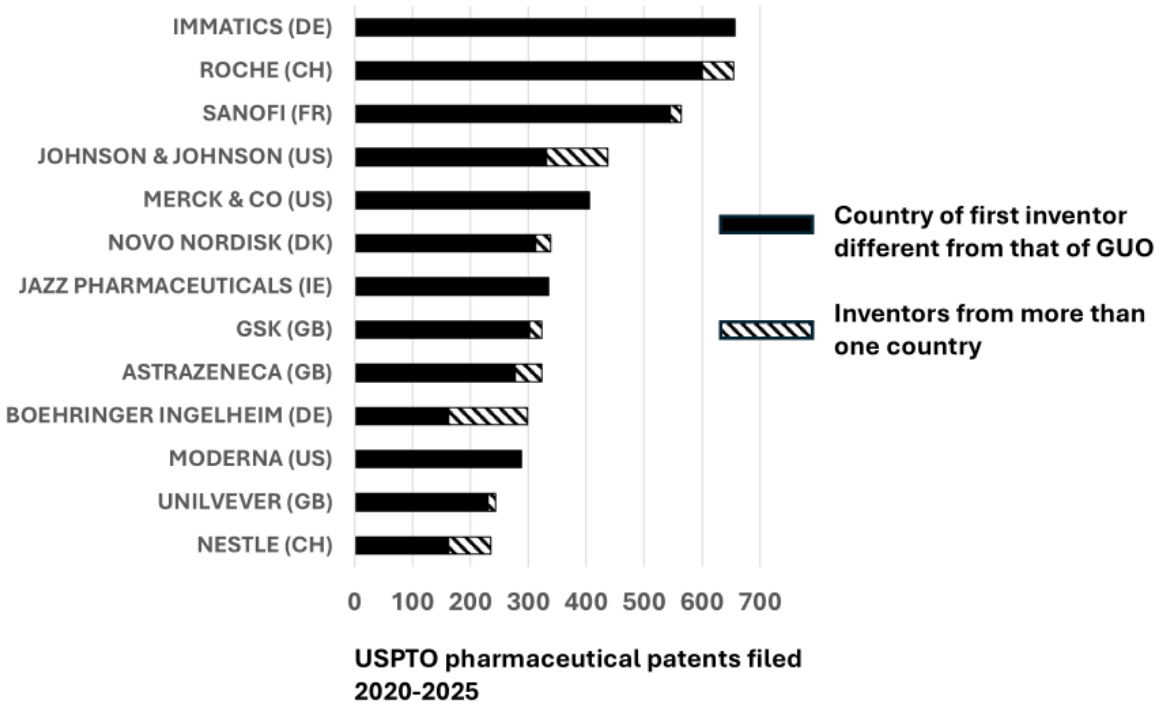


Fig. 5 Inventor addresses as indicators of R&D internationalization in major pharmaceutical companies.

Summary and conclusion

With the emergence of digitized patent data banks, patent records rapidly became of key importance in the mapping and analysis of R&D internationalization in MNEs. Following the lead of the pioneering efforts of researchers at the Science Policy Research Unit (SPRU) at the University of Sussex and at the University of Reading, the bulk of this research has been based on U.S. patent data, as made available by the U.S. Patent and Trademark Office (USPTO). Access to high-quality standardized patent data over long periods opened entirely new opportunities to trace developments of innovative activity across time, geographically, over industries and individual companies, resulting in important

findings and new insights. However, in the excitement of exploring these new possibilities, there was a tendency to downplay and, at times, obscure the inevitable methodological caveats associated with the analysis of patent data compiled for entirely different purposes.

This paper discusses the main methodological issues associated with the use of patent data for the study of R&D internationalization. Some of these are well known and have been given appropriate attention in the literature, others are also well known but have not received such consideration. This paper highlights two of these.

The first concerns the geographical allocation of R&D units based on the addresses of first listed inventors, based on the (often unstated) assumption that these are generally project leaders and/or have made the greatest contribution to the invention. The origin of this idea is unclear since there is no legal or institutional basis for it. All listed inventors have equal rights regardless of their ordering on the application and the USPTO guidelines merely stipulate that the address of the first named inventor will be used as a default in cases where the address of the assignee is not known. Although the empirical evidence in the literature is scant, it appears that there are also no generally accepted conventions regarding the ordering of inventors. A survey of patent attorneys to explore common practices in USPTO applications demonstrated that inventors having made the greatest contribution are often listed first but provided no evidence of generally established standards in this regard.

Of course, the ordering of inventors matters for the identification of where the R&D underlying the invention took place only in patents listing inventors from more than one country. If the proportion of such patents is small, the error of only considering the address of first listed inventor may be acceptable. However, the incidence of co-inventors residing in different countries, sometimes taken as evidence of the existence of ‘virtual teams’, appears to have increased over time posing a potential threat to the validity and reliability of this practice.

A sample of around 31,000 pharmaceutical USPTO patents applied for 2020-2025, where the patent record identifies the name and domicile of the Global Ultimate Owner, thereby excluding private inventors and domestic U.S. companies and other institutions. In more than half (52.9 per cent) the address of the first inventor was different than that of the assignee, the criterion commonly employed

as indicator of R&D internationalization. A further overall 8.2 per cent also listed inventors from more than one different country, but that percentage varied greatly between countries of origin and between individual MNEs. As indicated by these percentages, the criteria employed to determine the geographical origin of patented inventions clearly matter. The first inventor criterion was established and convenient at a time when computing capacities were limited and potential measurement inaccuracies had to be accepted. Today, this is no longer the case, and for most purposes this practice should be abandoned in favor of fractional allocation across all inventor locations.

The second issue emanates from differences in the propensities to patent domestically and abroad. Researchers have long recognized that this makes it impossible to meaningfully compare patents filed by U.S. firms in their home market with those filed with the USPTO by foreign firms. The paper confirms this conclusion, illustrating the dramatic differences between U.S. and non-U.S. firms, both in the aggregate and with examples from individual firms. Some of these undoubtedly reflect differences in the structures and strategies of U.S. firms from those from other countries, but it is impossible to distinguish these from differences in the characteristics between domestic patenting and patenting in foreign jurisdictions. USPTO data bases are very useful for comparisons of patenting of MNEs from third countries but are unsuitable for comparisons between these and U.S. firms.

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