The impact of international R&D on home-country R&D for Indian multinationals

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Extant research on internationalization of research and development (R&D) has not examined what the impact of foreign R&D investments is for the investing corporate parent firms, in particular on domestic R&D investments. The aim of this paper is to examine the effectiveness of international knowledge sourcing through foreign R&D in an empirical analysis of the effects of foreign R&D investments on domestic R&D intensity for a panel of Indian firms. The paper specifically investigates the importance and impact of the role and the location of foreign R&D centres on parent-company R&D by analysing differences between foreign-technology-seeking and foreign-technology-exploiting R&D, and between centres in advanced countries and in developing countries. The analysis finds contrasting results between advanced and developing countries and between technology-exploring and technology-exploiting investments.

1. Introduction

This paper focuses on the internationalization of research and development (R&D) by Indian multinational enterprises (MNEs) by analysing foreign R&D greenfield investments of Indian MNEs over the last decade. It specifically analyses the impact of foreign technology centres on parent-company R&D in India.

The traditional literature on MNEs refers either implicitly or explicitly to the technology-exploiting motive of foreign direct investment (FDI) (Dunning, 1977; Hymer, 1976; Buckley and Casson, 1976). As a result of market imperfections for technology, firms internationalize by internalizing these technological markets. These firm-specific advantages (Rugman, 1981) or ownership advantages (Dunning, 1977) have often been associated with a technological competence or asset (Markusen, 2001), which is capable of being transferred and thus exploited in other suitably advantaged locations.

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Yet, in more recent years, a complementary motive for FDI has been increasingly recognized, in which an MNE is argued to benefit from the international scope of its activities by seeking or sourcing technology-based assets from its foreign-located investments. The articulation within the firm of this MNE motive or strategy may be the unplanned outcome of the evolution over time of selected subsidiaries (Fors, 1997; Birkinshaw and Hood, 1998). As these subsidiaries mature, they become increasingly capable of local initiatives, entrepreneurship and the creation of new business networks (Birkinshaw, 1997; Forsgren, Holm, and Johanson, 2005). This local competence-creating type of FDI has sometimes been termed technology-seeking or asset-augmenting FDI (Bas and Sierra, 2002; Kuemmerle, 1999).

However, increasingly MNEs – especially from developing economies (DMNEs) – have started seeking out technology without first developing home-country-based advantages. These are technology-deficient firms that are starting with weak advantages and going abroad to access technological resources (Mathews, 2006). Although it is clear that firms' R&D location decisions can benefit MNEs, the effect of such decisions on knowledge production in MNEs' home regions remains underexplored in the current literature. Only a few studies have empirically examined the effect of R&D internationalization on knowledge production or productivity in the home region and tested whether complementarity effects occur between home-based R&D and foreign R&D. So far, it has been implicitly assumed that knowledge acquired and created in foreign locations by a company is transferred to a sufficient degree to its headquarters. However, if this is not the case, it cannot be excluded that international technology sourcing gradually leads to substitution of domestic R&D through the movement of part of a firm's R&D activities to foreign locations. Very little research has been carried out on the impact of the internationalization of R&D on the research carried out at headquarters by DMNEs. Therefore, it is essential to find out whether firms from developing countries can benefit from R&D internationalization. Given that developing countries have not developed R&D bases as advanced countries have, it merits finding out whether the internationalization of R&D does not lead to substitution in home countries.

It is important to understand whether international R&D investments can actually generate positive spillover effects that augment the technological capabilities of DMNEs at home. This article therefore analyses the specific impact of the internationalization of R&D investments by Indian firms. Given that MNEs from developing countries seem to be internationalizing their R&D before having developed a proper home-country R&D base, questions can be posed about the viability and sustainability of this R&D internationalization. Previously, technology-exploring was said to occur as a sequential stage after firms had first developed absorptive capacity in their home base. The exploration of knowledge abroad was said to feed into the knowledge at home. However, what happens to R&D at headquarters if a firm starts exploring technology before developing absorptive capacity at home and exploiting it abroad?

Will exploring technology first still feed into the knowledge base at home, allowing for faster growth of a knowledge base than growing it organically in the home base? Or is this premature R&D internationalization detrimental to the home-country knowledge base?

The starting point of the analysis is the empirical fact that firms pursue different goals when getting engaged in foreign R&D. Given that firms are driven by different motives for investing abroad in R&D, the aim of this study is to investigate the differences between specific motives with respect to the impact of market-seeking versus technology-seeking R&D investment. Market-seeking R&D investments indicate that in fact these companies have already developed some home-country technology and are exploiting it abroad, whereas technology-seeking R&D investments focus on exploring new avenues of research abroad. The paper will therefore analyse the effects of market-seeking versus technology-seeking R&D on the research intensity of parent companies in India. In a similar vein, the analysis will also examine whether the location of the international R&D centre has an impact on home-based R&D, given the different research environments in advanced and developing countries.

The remainder of the text frames the study in the existing literature while also developing hypotheses. The analysis subsequently focuses on the impact of international R&D investments on R&D intensity at home. A distinction is made between the effects of market-seeking and technology-seeking investments on the parent company's innovative intensity, on the one hand, and between R&D investments in advanced and in developing countries, on the other hand. The paper finishes with research conclusions and policy recommendations.

2. Literature background

Innovative effort is traditionally expected to take place mainly in the home country of MNEs (Castellani and Zanfei, 2006). This view is consistent with the product life-cycle hypothesis first introduced by Vernon (1966) and is further explained by the economies of scale associated with R&D efforts; the importance of learning activities, which are supported by economies of agglomeration; and the importance of access to a rich and growing market into which to introduce innovations. This concentration of strategic innovative activities in the home country allows an intensified specialization and division of labour in innovation and the utilization of scale economies, and avoids the additional costs of transmitting knowledge to the local subsidiary.

The extant literature on R&D internationalization has focused on a wide range of issues including (a) firms' motivations for transferring R&D activities abroad, (b) the geographic dispersion of R&D internationalization and (c) the impact of R&D internationalization on innovation in MNEs.

In terms of motivation to transfer R&D activities abroad, a distinction is often made between centripetal forces that support the tendency to centralize R&D in the firm's home country and centrifugal forces that pull corporate R&D activities to locations outside the home country. Centrifugal forces have been categorized into two major motivations of MNEs to internationalize R&D (Cantwell, 1995; Florida, 1997; Håkanson and Nobel, 1993; Kuemmerle, 1997). Traditionally, MNEs conducted R&D activities outside their home countries to support the manufacturing activities of local subsidiaries or to adapt products and technologies developed in their home countries to local market conditions (Doh, 2005). This strategy has been labelled asset exploiting, home base exploiting or competence exploiting. Asset-exploiting strategies are associated with a view of MNEs as a means to exploit firm-specific advantages in foreign markets (Dunning, 1973; Markusen, 1995; Navaretti and Venables, 2004). R&D by the subsidiaries supports the exploitation by adapting technologies, products and processes to local needs, consumer tastes and regulation, among other characteristics (Dachs and Ebersberger, 2009).

However, the home base–exploiting perspective was challenged in more recent years by the observation that MNEs increasingly generate new R&D outside of their home countries. Such a strategy has been described as asset seeking, competence creating or technology exploring. This motivation for international R&D is to develop new technologies overseas by accessing foreign R&D resources and local technological and scientific strengths with the aim of improving the technological and innovative capacities of the investing firm (Amighini et al., 2015; Feinberg and Gupta, 2004). The foreign R&D resources can therefore play one or both of two roles: facilitate local adaptation of the MNE's products and services and/or enable the creation and acquisition of globally relevant technology for the entire corporation (Meyer and Mizushima, 1989).

Various scholars have examined the characteristics of companies involved in these two types of FDI (Bas and Sierra, 2002; Berry, 2006; Cantwell and Mudambi, 2005; Kuemmerle, 1999) and the regional characteristics that attract these different FDI types (Papanastassiou and Pearce, 1997; Cantwell and Piscitello, 2005, 2007). The literature has thereby focused mainly on the role of host-country factors in attracting foreign R&D investments (Belderbos, Fukao and Kwon, 2006; Branstetter, 2006; Cantwell and Piscitello, 2005; Hegde and Hicks, 2008; Kumar, 2001). These studies have pointed to the importance of a number of host-country characteristics that attract inward R&D investments, such as large and sophisticated local markets, labour costs, intellectual property rights regimes, and technological and scientific strengths of countries. Asset-seeking strategies are shown to be driven by supply factors, such as the availability of skilled researchers; the need to monitor the technological activities of competitors, clients, universities and other research organizations; or the wish to assimilate local knowledge in the host countries. Recent empirical studies on R&D internationalization investigate technology sourcing as a driver of investments in

R&D at foreign locations. They demonstrate the relevance of this type of foreign R&D and compare the importance of knowledge-seeking strategies with those reflecting market-seeking motives (Cantwell, 1995; Florida, 1997; Frost, 2001; Von Zedtwitz and Gassmann, 2002).

The literature has shown that the knowledge developed in offshore locations by foreign affiliates may be "reverse" transferred to the parent (e.g. Mansfield and Romeo, 1984; Chen, Li and Shapiro, 2012). The international business and management literature shows that MNEs rely increasingly on this type of knowledge transfer – from subsidiary to parent company – in order to source new complementary knowledge from distant locations (Ghoshal and Bartlett, 1988; Ghoshal, Korine and Szulanski, 1994; Mudambi and Navarra, 2004; Rabbiosi, 2011). These reverse technology transfers could result in complementarity effects on the knowledge production process in the home country. Complementarity effects could also emerge as a result of geographical technological specialization.

Examining the impact of R&D internationalization on MNEs is not trivial, as both benefits and costs are expected to be related to R&D internationalization. Benefits relate to sourcing foreign technological and scientific expertise as well as information on local demand. Internationalization costs include increased coordination and integration complexities, possible redundancies in the R&D mandates and efforts of dispersed centres, and reduced economies of scale and scope.

Previous research has found that greater intensity of R&D internationalization leads to better patent output. For instance, several studies found evidence that R&D internationalization facilitates corporate innovation and encourages the diffusion of innovations between the parent company and its foreign subsidiaries (Cantwell, 1989; Cantwell and Mudambi, 2005; Cantwell and Zhang, 2006). Others found that R&D internationalization significantly promotes a firm's innovative output and that the effect can be critical to sustaining a firm's competitive advantage in international markets (Kafouros et al., 2008).

Conversely, other studies have indicated that MNEs with R&D efforts abroad tend to be less successful than firms with R&D activities in their home countries, as high levels of R&D internationalization lead to a greater extent of operation complexity and result in greater challenges in coordination, communication and monitoring (Hsu, Lien and Chen, 2015). When firms distribute their R&D activity too widely, the quality of innovation output suffers (Lahiri, 2010).

Most studies looked only at the impact of R&D internationalization on the overall performance and productivity of the firm. In contrast, relatively little is known about the impact of R&D internationalization on the investing parent firms. Furthermore, most of these studies focus on MNEs from advanced countries. A great deal of the literature on knowledge flows in MNEs has focused on the knowledge transfer involving Western MNEs and their overseas subsidiaries (Nair, Demirbag and Mellahi, 2015). Our theories about the emergence of MNEs and the drivers of international R&D have therefore been shaped by a rather particular set of national and historical contexts, even if these influences are seldom acknowledged or perhaps even recognized. If these contexts differ in important ways from the environment that prevails today, then we might expect MNEs from developing countries (DMNEs) to behave differently and achieve different results than MNEs from advanced countries that expanded their international reach and competitiveness in earlier eras and from different home-country institutional settings.

Extant research is, for instance, limited in identifying and examining how the institutional conditions of the developing countries can enable (rather than inhibit) DMNEs to compete on the basis of knowledge-based resources and capabilities transferred from host countries. Yet, research has shown that DMNEs have developed a knack for acquiring technological capabilities through embodied and disembodied technology imports, on the one hand, and through spillovers from multinational subsidiaries in their home countries, on the other hand (Narayanan and Bhat, 2009; Siddharthan and Nollen, 2004; Pradhan and Das, 2013; Goldar, 2016). As such, technological change in developing countries has often entailed a learning process to acquire and improve on technological capabilities from advanced economies (Di Minin, Zhang and Gammeltoft, 2012).

This form of "eavesdropping" on competition and reverse knowledge integration might enable DMNEs to extract knowledge from international R&D also. Research has indeed shown that international R&D can also lead to reverse knowledge and technology transfer by the MNE (van Pottelsberghe de la Potterie and Lichtenberg, 2001; Driffield and Love, 2003; Ambos, Ambos and Schlegelmilch, 2006; Driffield, Love and Yang, 2014; Giuliani et al., 2014; Zorska, 2013). Kafouros and colleagues (2012) have demonstrated that MNEs use their subsidiaries as knowledge pools, which suggests that the location choice and (reverse) knowledge integration are more important than the prior ownership of knowledge, in particular when innovation is seen as an act of recombining previous knowledge elements. Yiu, Lau and Bruton (2007) argued that DMNEs may have well-developed knowledge integration capabilities that enable them to compete in global market niches, which suggests that location factors prevail over ownership factors. In this context, Di Minin, Zhang and Gammeltoft (2012) show that Chinese R&D units in Europe do not follow the typical pattern of initial exploitation and then exploration of technology but are instead aimed first at exploration and then at exploitation. This literature suggests that firms use international expansion as a springboard to access knowledge overseas, to compensate for their competitive weaknesses and to overcome their latecomer disadvantages (Chen, Li and Shapiro, 2012).

Foreign subsidiaries of the DMNEs do not leverage new knowledge abroad but transfer it back to work out product innovations to be introduced in domestic and global markets as quickly as possible. Ramamurti (2012) remarks that DMNEs may go abroad to acquire technologies and skills primarily for exploitation in their home markets and not abroad. The ultimate objective for DMNEs' knowledge-seeking investments is to improve their technological capabilities in their home markets, as they want to reduce their reliance on foreign technologies and to develop indigenous knowledge and innovation (Chen, Li and Shapiro, 2012).

This knowledge transfer from foreign subsidiaries to parent firms in developing countries expands the technological capabilities of DMNEs through higher R&D spending levels by parent firms for absorbing and leveraging transferred knowledge (Chen, Li and Shapiro, 2012). This suggests that international R&D might produce knowledge and technological spillovers from the host to the parent company that feed into their domestic R&D operations.

Since developing countries encourage and reward indigenous technological efforts, providing favourable policies (De Beule et al., 2010) to motivate DMNEs to pursue technological development in their home market (Chaminade and Vang, 2008), these companies naturally seek to integrate the knowledge they have acquired internationally into their existing knowledge stocks and to concentrate on technological development at home (Child and Rodrigues, 2005). Thus, a primary goal of seeking knowledge overseas is to integrate it into the current knowledge stock to enhance innovativeness. Following this logic, DMNEs engage in international R&D to enhance innovation through knowledge seeking and knowledge integrating (Wu, Chen and Liu, 2016).

Hypothesis 1. R&D activities in foreign locations positively influence the Indian parent firm's research.

Furthermore, it seems that technology-seeking and technology-exploiting foreign R&D affect the investing firm's innovativeness differently. The extant literature has produced substantial evidence of the knowledge-sourcing objectives of foreign R&D units. Technology sourcing through foreign R&D affiliates allows MNEs to tap into leading-edge knowledge by locating affiliates abroad in search of new ideas on novel technologies, products and processes. Overseas knowledge sourcing and reverse knowledge transfer enhances the knowledge base of the firm at home, feeding process and product innovation processes, and enhancing the parent firm's ability to create value (Belderbos, Lokshin and Sadowski, 2015; Driffield and Love, 2003; Griffith, Harrison and van Reenen, 2006; Shimizutani and Todo, 2008). In contrast, if R&D activities abroad focus more on exploiting technology through adoption or adaptation to local demands, foreign R&D is less likely to improve parent firms.

Technology-seeking investments thus seem to have a more positive impact on a firm's innovativeness than technology-exploiting investments. An increasingly prominent debate on how in-sourced technologies from different national origins may influence a firm's performance and competiveness has drawn significant attention in the literature, with special focus on the latecomers in developing countries that are catching up (Ahuja and Katila, 2004; Cantwell and Santangelo, 2000; Castellacci and Archibugi, 2008; Dunning and Lundan, 2009; Fu and Gong, 2011; Lahiri, 2010; Li, Miller and Eden, 2012). Firms need to source technology across borders in order to reap the benefits of another country's specializations in particular technological fields or its qualified scientists and engineers (Desyllas and Hughes, 2008; Lahiri, 2010; Malmberg and Maskell, 2006; Singh, 2008). Foreign technologies are commonly considered a building block for latecomer firms to use to improve their productivity (Katrak, 1990; Kim, 1980). These benefits are unlikely to be gained if the technology inputs remain within the domain of the established technology function of the MNE, as evidence suggests that knowledge diversity unlocks innovation. The notion that dispersion of technological development enhances innovation in the network of the MNE as a whole is based on the realization that innovation is location-specific and firm-specific (Cantwell, 1989). For instance, Belderbos, Lokshin and Sadowski (2015) found that for firms active in industries in which the home country is behind the global technology frontier, foreign R&D provides positive returns and has a complementary relationship with domestic R&D.

Moreover, the impact of the parent firm's innovativeness depends on the kind of foreign R&D activity. Iwasa and Odagiri (2004) investigated the impact of R&D activities of the United States affiliates of Japanese manufacturing firms and found that only research activities had a positive effect on the patent productivity of parent firms when the affiliates are located in high-tech areas. In contrast, more application-oriented development activities had no significant influence on innovation performance. Shimizutani and Todo (2008) examined R&D expenditure data and also found that overseas innovative R&D raises the parent firm's productivity growth, whereas adaptive R&D has no such effect.

Hypothesis 2. Technology-seeking R&D activities in foreign locations more positively influence the Indian parent firm's research than technology-exploiting R&D activities.

Finally, studies have also suggested that local knowledge sourcing by foreign affiliates is positively associated with the abundance of R&D and the strength of technological capabilities in the host country (Fernández-Ribas and Shapira, 2009; Song, Asakawa and Chu, 2011). In locations where there is a critical mass of R&D activity and a large stock of relevant technological knowledge, MNEs have greater opportunities to source valuable knowledge, benefit from spillovers from local R&D clusters, potentially find valuable partner firms with which to conduct joint R&D activities, and hire talented and experienced scientists and engineers for their R&D centres. In contrast, if the host country is behind the technological frontier, R&D activities are less likely to contribute to the advancement of the MNE.

During the knowledge-seeking stage, DMNEs look for knowledge in two ways. By establishing R&D bases in foreign countries, DMNEs obtain the opportunity to directly hire high-quality graduates in local universities and R&D workers from local labour markets, which enables them to cultivate knowledge and ideas in a broader group of elites, which is likely to increase the success rate of innovation (Wu, Chen and Liu, 2016).

The second way that DMNEs can acquire knowledge in foreign markets is from knowledge spillovers. Even if DMNEs invest abroad to exploit their advantages without positively attempting to engage in exploration for knowledge, they can still learn from the foreign market (Wu, Chen and Liu, 2016). The knowledge transfer literature suggests that parent firms tend to increase their R&D spending in order to absorb knowledge transferred from subsidiaries, as well as to combine it with their existing knowledge to innovate, and that increased R&D spending for these two purposes enhances the parent firm's technological capabilities.

Traditionally, reverse technology transfer occurred among corporate units located in advanced countries, where good locational advantages favoured expanding R&D activity by foreign MNEs from advanced countries and their subsidiaries. The reverse knowledge and technology flows were concentrated almost entirely in the group of advanced countries. More recently, a second trend relates to a new reverse transfer from advanced to developing countries, which results from the expansion led by MNEs from less developed countries. The penetration of DMNEs into advanced markets through outward FDI is a significant but relatively understudied phenomenon. An important motivation for such OFDI is to access knowledge and capabilities in advanced countries and to utilize them to improve the technological and innovative capabilities of the parent companies in developing markets. This knowledge-seeking motivation of DMNEs has been supported by recent studies that have investigated their location choice as a function of technological endowments in host markets (Chen, Li and Shapiro, 2012; Kedia, Gaffney and Clampit, 2012; Kumar, 2001; Makino, Lau and Yeh, 2012). The level of economic development of the host country influences the extent of knowledge flows. Subsidiaries from more competitive countries are likely to be viewed as trendsetters that are more efficient when it comes to technical, managerial and marketing expertise. This makes the knowledge held by such subsidiaries very desirable and attractive to the DMNE parents, and it is likely to increase the outflow of knowledge from the subsidiary to the parent. For instance, recent evidence shows that outward knowledge flows from subsidiaries in advanced countries are significantly higher than those from developing countries (Li, Barner-Rasmussen and Björkmann, 2007; Nair, Demirbag and Mellahi, 2015).

Reverse knowledge flow from the overseas subsidiary to the Indian parent is therefore positively associated with the competitiveness of the host country compared with that of the home country (Nair, Demirbag and Mellahi, 2015). There is ample evidence that augmenting home-based R&D centres with a clear knowledge-sourcing objective are most likely to be located in countries with competitive and technological advantages (Ambos and Ambos, 2011; Belderbos, Fukao and Iwasa, 2009; Chung and Alcácer, 2002). Belderbos, Lokshin and Sadowski (2015) found that foreign knowledge sourcing by MNEs and the effective combination of this knowledge with the fruits of domestic R&D enhances firms' technology development efforts to bring productivity gains at home if firms conducting foreign R&D can benefit from foreign knowledge spillovers by exposure to a more advanced technology-intensive industry environment abroad.

The complex nature of technological strategies is therefore intrinsically linked to the DMNEs' location choice. Although we would expect the majority of international R&D to be directed towards the most technologically advanced countries, this may not always apply. If the technology gap between home and host countries is too high, DMNEs may not have sufficient absorptive capacity to exploit the knowledge available in the host country. In a bid to reduce this gap, DMNEs may prefer R&D in other developing countries and exploit inward FDI by MNEs from advanced countries in their home countries, as an alternative way to access specific knowledge and competences. As DMNEs are more competitive than advanced-country MNEs in low- to medium-tech segments, they are not attracted to countries with the highest level of technological development but rather prefer to locate in countries specialized in middle-end technologies and medium-tech manufacturers, being not too distant from their own technological capabilities (Amighini et al., 2013). Nonetheless, in a study of 493 MNEs from emerging countries over the years from 2000 to 2008, it was found that those with foreign subsidiaries in technologically advanced markets subsequently exhibit stronger technological capabilities at home (Chen, Li and Shapiro, 2012).

Hypothesis 3. Research activities in advanced economies more positively influence the parent firm's research than research activities in developing economies.

3. Data and methodology

We make use of the *Financial Times*' fDi Markets database to examine which companies invested in foreign technology. This database covers cross-border investments around the world since 2003, drawing on press releases, newspaper reports, information from local and national investment agencies, and information provided by investing firms. It includes information on the investing firm and its parent company, the city and country of investment, the sector of investment and the type of activity (e.g. R&D, manufacturing, logistics, distribution, retail). In addition, it provides information about job creation and the capital investment made. The database is often used by researchers and international organizations to track greenfield investment deals around the globe (UNCTAD, 2015; Belderbos and Somers, 2015; De Beule and Van Den Bulcke, 2012).

In this database, we tracked all foreign technology investments made by Indian companies from 2003 through 2012. We cut off the observation period in order to be able to measure the impact of these investments on R&D intensity in the years following the investments. This avoids simultaneity bias by lagging the foreign technology investments relative to the explanatory variables. Technology investments are defined in the database as investments in two kinds of industry activity: Research & Development (R&D), and Design, Development & Testing (DD&T). We collected information on 194 foreign technology investments, made by 92 Indian firms (see table 1). Of these 194 investments, we can classify 144 as technology-exploiting DD&T projects, and 50 as technology-seeking R&D projects. Because we also know in which countries these investments were made, we can classify these investments further into projects performed in advanced markets (AM) and those performed in developing markets (DM). To distinguish between both types of countries, we made use of a classification table provided by the International Monetary Fund (IMF). The IMF table uses a composite of indicators and assessments based on countries' economic and financial data to classify countries as developing and advanced, and is widely used in research. In table 1, we can observe that most technology investments occur in advanced markets (106 projects versus 88). In addition, the table shows that Indian companies have a preference for performing both types of technology projects (R&D and DD&T) in advanced markets.

Subsequently, we matched the companies included in the fDi Markets database with firms present in the Prowess database. Prowess is a database that includes financial information on Indian companies. More specifically, it includes all companies traded on the National Stock Exchange and the Bombay Stock Exchange, thousands of unlisted public limited companies and hundreds of private limited companies. We were able to include more than 11,000 companies. The Prowess database is built from annual reports, quarterly financial statements, stock exchange feeds and other reliable sources. However, the match was not complete, resulting in a smaller sample of firms with foreign R&D investments. Table A1 in the appendix shows that we were able to match 157 technology investments (made by 68 Indian firms). There are no significant differences in sectoral distribution between the full and final samples. Table 2 shows that our matched sample is representative for the population of firms with foreign R&D investments. In the following discussion, we therefore address only the final sample.

Table 1. Foreign technology investments by Indian companies

Variable	Advanced countries (AM)		Developing countries (DM)	
	Population	Matched sample	Population	Matched sample
Technology-seeking centres (R&D)	26	19	24	10
Technology-exploiting centres (DD&T)	80	70	64	58

Source: Financial Times' fDi Markets database.

Table 2. Industry cluster distribution

Cluster	All investments				DD&T				R&D			
	Population		Matched sample		Population		Matched sample		Population		Matched sample	
	#	%	#	%	#	%	#	%	#	%	#	%
Consumer goods	1	1	1	1	0	0	0	0	1	2	1	3
Creative industries	10	6	3	2	8	6	3	2	2	4	0	0
Energy	1	1	1	1	1	1	1	1	0	0	0	0
Environmental technology	3	2	3	2	3	2	3	2	0	0	0	0
Financial services	8	4	7	4	7	5	6	5	1	2	1	3
ICT & electronics	109	56	101	64	101	70	94	73	8	16	7	24
Industrial	11	6	10	6	8	6	7	5	3	6	3	10
Life sciences	33	17	15	10	2	1	1	1	31	62	14	48
Physical sciences	1	1	1	1	1	1	1	1	0	0	0	0
Professional services	1	1	0	0	0	0	0	0	1	2	0	0
Transport equipment	12	6	12	8	9	6	9	7	3	6	3	10
Wood, apparel and related products	4	2	3	2	4	3	3	2	0	0	0	0
Total	**194**	**100**	**157**	**100**	**144**	**100**	**128**	**100**	**50**	**100**	**29**	**100**

When we take a look at the sectors in which these Indian companies make their foreign technology investments (table 2), we can observe that most investments are made in the ICT & Electronics industry cluster (64 per cent). Furthermore, we can notice that 10 per cent of all investments are made in the Life Sciences industry cluster. Again, this is not surprising as India is quite competitive in the pharmaceutical industry (Pradhan, 2008). When we distinguish between DD&T and R&D investments, we can see clear differences. The large majority (73 per cent) of DD&T investments are made in the ICT & Electronics industry cluster, while the majority (48 per cent) of R&D investments are made in the Life Sciences industry cluster. DD&T investments are more oriented towards applied research, which explains why most of their investments are made in sectors where applied science is relatively more important than basic science (such as ICT, software, electronics, creative industries and industrial sectors). R&D investments, in contrast, are more oriented towards basic research, which explains why most are made in the Life Sciences industry cluster, where basic research is very important.

After linking the Prowess database with the fDi Markets database, we can also compare firms that go overseas to invest in R&D or DD&T with those that do not perform any foreign technology investments. Table 3 compares these firms in terms of age, assets, number of employees, R&D expenditures and intangible assets. The table also differentiates between firms that make at least one technology investment and firms that make at least one technology investment in an advanced market. The table clearly shows that firms that internationalize their technology activities are older and larger in terms of assets and employees. In addition, we can observe that these firms have on average much higher R&D expenditures and intangible assets, confirming previous literature (e.g. Buckley and Casson, 1998; Caves, 1996). The table also shows that firms that internationalize in advanced markets have higher R&D expenditures and possess more intangible assets. This lends support to the argument that firms which internationalize their technological activities in more advanced markets need to have more absorptive capacity (which can be measured by R&D expenditures or intangible assets).

To analyse the impact that foreign technology investments have on the parent company's R&D activities, we ran several regression analyses. We made maximal use of the longitudinal data of our set of Indian companies by running panel regressions. Furthermore, we worked with random effects after the Hausman test showed that this model was to be preferred in the study.

In our empirical analysis, the dependent variable is the R&D intensity of the parent company that invests in the home country, which is measured as domestic R&D expenditures divided by domestic sales. To test our first hypothesis, we included for each firm its number of foreign technology centres. The second hypothesis was tested by including the number of foreign R&D centres (technology-seeking investments) and the number of foreign DD&T centres (technology-exploiting investments). Finally, our last hypothesis was tested by making a further distinction between technology centres in advanced countries and technology centres in developing countries.

We also control for several other factors that could influence a firm's R&D activities. For instance, given that firms can also gain access to technology through technology imports, we included the variable *embodied technological import,* which measures the imports of capital goods. These imports could bring firms the latest machinery and equipment technology, a practice that Indian companies have long employed (Kathuria, 2001; Kumar and Aggarwal, 2005). With the help of modern technology, a firm would be able to cater to the needs of the global market more efficiently.

Import of designs, drawings and blueprints for royalty payments also brings with it technological knowledge that can be used to produce products and services of world standards. To take this into account, we added the variable *disembodied technological import,* which measures the foreign exchange spent on royalties and technical know-how. Firms may augment these imported technologies with in-house efforts to assimilate the existing technology and then improve it to produce proprietary technological assets (Kumar and Aggarwal, 2005).

We have also controlled for other firm-level characteristics, such as profitability, export intensity, marketing intensity, importance of intangible assets and group membership. We also controlled for size and age. To control for potential industry effects, we included industry dummies that indicate the primary NIC (National Industrial Classification) of the Indian parent firm. We constructed these dummies at the two-digit level. In India, the NIC is the standard classification followed for classifying economic activities. The NIC is prepared to suit the Indian conditions and follows the principles and procedures laid down in the United Nations' International Standard Industrial Classification (ISIC) of all economic activities, as revised from time to time.

All continuous variables (i.e. all variables except for the hypothesis-testing variables and the industry dummies) are taken in logarithms to improve model fit. Accordingly, their coefficients can be interpreted as elasticities. Table 4 reports a correlation table of all variables; for the definition and summary statistics of all independent variables, see Appendix A. There are no problems of multicollinearity between the variables of interest. Some overlapping categories have high correlations but these variables have obviously not been taken up in the same regression analyses.

To test our hypotheses, we made three different sets of regressions. The first set (table 5) illustrates the results of random effects panel regressions run with the complete sample of firms present in the Prowess database (including those companies that do not carry out any R&D). In this table, we take up five models. The first model tests for the impact of total foreign technology investments on in-house R&D intensity in the home country (hypothesis 1), the following two models differentiate between technology-seeking and technology-exploiting investments (hypothesis 2), and the last two models make the distinction between investments in advanced markets and in developing markets (hypothesis 3). Table 6 shows the results of regressions run only with the sample of firms that performed R&D activities. Accordingly, here we excluded firms that did not have any R&D activities, in order to make sure the results also hold when comparing with R&D-active firms. Finally, table 7 further disentangles the effects by presenting four categories that indicate both the type of investment (*R&D* versus *DD&T*) and the location of the investment (*advanced market* versus *developing market*).

Table 3. Comparison between firms by type of investment in technology, mean values

	Age	Assets (million rupees)	Employees	R&D expenditures (million rupees)	Intangible assets (million rupees)
Non-investing firms	20.31	2,028.82	3,904	5.99	17.83
R&D/DD&T investing firms	24.98	36,571.82	15,138	251.43	308.68
R&D/DD&T investing firms in AM	23.79	29,434.15	14,841	319.46	347.08

Source: Prowess database, Centre for Monitoring Indian Economy; and the Financial Times' fDi Markets database.

Table 4. Correlation matrix for all variables

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.
1. RDintensity (dependent variable)	1																		
2. Sales	0.003	1																	
3. Age	-0.005	0.012	1																
4. Embodied technological import	0.004	0.412	0.007	1															
5. Disembodied technological import	0.001	0.456	0.007	0.310	1														
6. Return on sales	-0.001	0.000	-0.003	-0.001	0.000	1													
7. Indian group	0.014	0.025	0.038	0.039	0.043	0.007	1												
8. Export intensity	0.083	0.010	-0.017	0.021	0.007	-0.004	0.033	1											
9. Marketing intensity	0.006	-0.010	-0.003	-0.005	-0.005	-0.001	0.028	0.008	1										
10. Intangible assets over total assets	0.019	-0.005	0.001	-0.001	0.004	-0.002	0.023	0.055	0.016	1									
11. Foreign technology centres	0.036	0.097	-0.002	0.049	0.024	0.000	0.039	0.086	-0.006	0.017	1								
12. R&D centres	0.034	0.022	0.000	0.020	-0.002	0.000	0.039	0.072	-0.001	0.026	0.570	1							
13. DD&T centres	0.031	0.103	-0.002	0.050	0.028	0.000	0.034	0.077	-0.007	0.011	0.970	0.354	1						
14. Technology centres in AM	0.034	0.052	-0.002	0.047	0.028	0.000	0.041	0.078	-0.003	0.022	0.894	0.508	0.867	1					
15. Technology centres in DM	0.033	0.117	-0.002	0.044	0.018	0.000	0.033	0.079	-0.008	0.010	0.938	0.535	0.910	0.682	1				
16. R&D centres in AM	0.043	0.025	0.001	0.023	-0.001	0.000	0.019	0.051	0.004	0.022	0.479	0.839	0.298	0.537	0.364	1			
17. DD&T centres in AM	0.020	0.050	-0.002	0.044	0.033	0.000	0.039	0.069	-0.005	0.016	0.828	0.218	0.879	0.926	0.632	0.180	1		
18. R&D centres in DM	0.006	0.008	0.000	0.007	-0.001	0.000	0.046	0.064	-0.007	0.019	0.414	0.729	0.256	0.231	0.496	0.238	0.163	1	
19. DD&T centres in DM	0.035	0.127	-0.002	0.047	0.020	0.000	0.024	0.071	-0.008	0.006	0.926	0.400	0.937	0.691	0.974	0.339	0.655	0.286	1

4. Data Results

When we analyse the regression output (table 5), we can see that the results clearly indicate that foreign technology investments have a positive impact on the R&D intensity of the corporate parent in the home country (India). The first model shows that if the number of *foreign technology centres* increases by one unit, the R&D intensity of the parent firm will increase with approximately 1 per cent. In order to account for the difference between knowledge-seeking and knowledge-exploiting investments, we split the sample between R&D and DD&T investments, respectively. The results indicate that there is a significant difference between the two (models 2 and 3). In fact, foreign knowledge–seeking R&D centres have a significantly bigger positive impact on the R&D intensity of the corporate parent than do foreign knowledge–exploiting DD&T investments abroad. The size of its coefficient is more than four times the size of the coefficient of the other. This result clearly shows that technology-seeking activities abroad can be an important means of knowledge sourcing. A similar conclusion can be drawn for investments in advanced versus developing economies (models 4 and 5). The results show that the positive impact of investments in technology in advanced markets have a greater impact than those in developing markets, although the difference between both types of investments is less pronounced.

Furthermore, the results also indicate that the purchase and import of embodied technology has a positive impact on home-country R&D intensity although disembodied technological import does not. This is in line with existing literature that indicates that even if the imported technology is not enhanced, developing-country firms can become globally competitive by taking advantage of low technological and managerial costs in their home countries to internationalize (Lall, 1982). The results furthermore indicate the importance of export intensity, as exporting is a clear driver of research intensity. The results with these control variables are robust across models.

When we turn to the analysis of R&D-active firms in table 6, the number of observations and number of firms decreases, as we are taking up only firms that have carried out R&D. Whereas the previous analyses included 8,060 firms, in this analysis the number decreases to 1,369 firms. This means that about 20 per cent of the firms from our initial set performed any R&D activities within our time frame. When we look at our key independent variables, we can observe that these results are still in line with our expectations and accordingly confirm our hypotheses. It is, however, worth noting that embodied technological import and disembodied technological import do not assist in increasing R&D intensity for R&D-active firms. Although these intermediary channels might be useful for R&D-inactive firms to kick-start their innovation, this does not seem to play any significant role for R&D-active firms. Export intensity, however, does have a greater importance in driving R&D intensity.

Table 5. Panel regression on the impact of foreign R&D investments on parent R&D, for the full sample, 2003–2010

	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	0.0332*	0.0324*	0.0333*	0.0330*	0.0333*
	(0.0183)	(0.0183)	(0.0183)	(0.0183)	(0.0183)
Sales	-0.0008	-0.0008	-0.0008	-0.0008	-0.0008
	(0.0008)	(0.0008)	(0.0008)	(0.0008)	(0.0008)
Age	-0.0096	-0.0095	-0.0097	-0.0096	-0.0097
	(0.0065)	(0.0065)	(0.0065)	(0.0065)	(0.0065)
Embodied technological import	0.0011*	0.0011*	0.0011*	0.0011*	0.0011*
	(0.0006)	(0.0006)	(0.0006)	(0.0006)	(0.0006)
Disembodied technological import	0.0012	0.0015	0.0012	0.0013	0.0012
	(0.0017)	(0.0017)	(0.0017)	(0.0017)	(0.0017)
Return on sales	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Export intensity	0.0303***	0.0306***	0.0304***	0.0303***	0.0304***
	(0.0073)	(0.0073)	(0.0073)	(0.0073)	(0.0073)
Marketing intensity	-0.0099	-0.0099	-0.0099	-0.0101	-0.0098
	(0.0216)	(0.0216)	(0.0216)	(0.0216)	(0.0216)
Intangible assets over total assets	0.0003	0.0010	0.0000	-0.0002	0.0006
	(0.0247)	(0.0247)	(0.0247)	(0.0247)	(0.0247)
Foreign technology centres	0.0104***				
	(0.0039)				
R&D centres		0.0420***			
		(0.0132)			
DD&T centres			0.0093**		
			(0.0047)		
Technology centres in AM				0.0202**	
				(0.0087)	
Technology centres in DM					0.0154**
					(0.0062)
Time dummies	included				
Observations	41,224	41,224	41,224	41,224	41,224
Number of firms	8,060	8,060	8,060	8,060	8,060
Average observations per group	5.115	5.115	5.115	5.115	5.115
R^2 overall	0.00543	0.00552	0.00518	0.00534	0.00529
R^2 within	0.0013	0.0014	0.0012	0.0013	0.0013
R^2 between	0.00576	0.00594	0.00569	0.00567	0.00577
Rho	0.773	0.773	0.773	0.773	0.773

Note: Standard errors in parentheses, significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 6. Panel regressions on the impact of foreign R&D investments on parent R&D, for R&D-performing firms, 2003–2010

	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	0.0831	0.0778	0.0834	0.0814	0.0832
	(0.0638)	(0.0638)	(0.0638)	(0.0638)	(0.0638)
Sales	-0.0104***	-0.0104***	-0.0103***	-0.0104***	-0.0103***
	(0.0040)	(0.0040)	(0.0040)	(0.0040)	(0.0040)
Age	0.0015	0.0032	0.0011	0.0021	0.0012
	(0.0194)	(0.0194)	(0.0194)	(0.0194)	(0.0194)
Embodied technological import	0.0018	0.0018	0.0018	0.0018	0.0018
	(0.0012)	(0.0012)	(0.0012)	(0.0012)	(0.0012)
Disembodied technological import	0.0009	0.0013	0.0008	0.0010	0.0008
	(0.0024)	(0.0024)	(0.0024)	(0.0024)	(0.0024)
Return on sales	-0.0031***	-0.0031***	-0.0031***	-0.0031***	-0.0031***
	(0.0010)	(0.0010)	(0.0010)	(0.0010)	(0.0010)
Export intensity	0.1570***	0.1561***	0.1572***	0.1562***	0.1575***
	(0.0238)	(0.0238)	(0.0238)	(0.0238)	(0.0238)
Marketing intensity	-0.1153	-0.1180	-0.1154	-0.1155	-0.1158
	(0.0942)	(0.0942)	(0.0943)	(0.0943)	(0.0942)
Intangible assets over total assets	-0.1175*	-0.1148*	-0.1187*	-0.1188*	-0.1169*
	(0.0689)	(0.0689)	(0.0689)	(0.0689)	(0.0689)
Foreign technology centres	0.0135***				
	(0.0044)				
R&D centres		0.0440***			
		(0.0138)			
DD&T centres			0.0138**		
			(0.0054)		
Technology centres in AM				0.0288***	
				(0.0102)	
Technology centres in DM					0.0196***
					(0.0067)
Time dummies	included				
Observations	6,594	6,594	6,594	6,594	6,594
Number of firms	1,369	1,369	1,369	1,369	1,369
Average observations per group	4.817	4.817	4.817	4.817	4.817
R^2 overall	0.0319	0.0314	0.0321	0.0319	0.0320
R^2 within	0.0158	0.0159	0.0152	0.0155	0.0156
R^2 between	0.0450	0.0444	0.0458	0.0450	0.0456
Rho	0.980	0.980	0.980	0.980	0.980

Note: Standard errors in parentheses, significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

In table 7, four categories define the type of investment (R&D versus DD&T) and the location of the investment (AM versus DM). These categories help us to further disentangle these effects. The regressions were first run separately and subsequently taken up together. Coefficients are robust across models. Models 1, 2 and 3 are run with the full sample, and Models 4, 5 and 6 with the reduced sample of R&D-performing firms. These models enable us to make significant qualifications of our previous results. In fact, the results show that the highest positive impact on home-country R&D intensity can be expected from R&D centres in advanced markets. Accordingly, for Indian companies that want to augment their knowledge stock, it can be very useful to perform knowledge-seeking investments in more advanced markets. The results also show that investing in R&D centres in other developing countries leads to a decrease in R&D intensity at home. As such, the results indicate that these R&D centres do not feed into the research capacity at home and have some sort of substitutionary effect. A similar conclusion can be drawn from the coefficient of DD&T centres in advanced markets, which have a negative impact on home-country R&D intensity. This more adaptive research in advanced markets substitutes for research intensity back home. Finally, and quite in contrast, adaptive research in other developing countries (DD&T in DM) does lead to an increase in research at the corporate parent. Therefore, Indian firms can experience new insights by making technology-exploiting investments in other developing countries that feed into the research back home.

5. Conclusions and recommendations

This study has analysed the impact of R&D internationalization of Indian companies on the parent company's R&D intensity. By and large, this analysis has shown support for the hypotheses put forward. The analysis indicates that R&D activities in foreign locations can positively influence an Indian parent firm's innovation activities. Technology-seeking R&D activities in foreign locations thereby more positively influence the parent firm's R&D than technology-exploiting DD&T activities, while investments in advanced countries more positively influence the parent firm's innovation performance than technological activities in developing countries. This leads us to conclude that Indian parent companies can and do benefit from R&D internationalization.

However, when disentangling the results, there are some interesting differences between the type of R&D investment and the location of the investment. In fact, there seems to be a reverse conclusion for advanced versus developing host countries. Technology-seeking investments in advanced countries have a positive impact on home-country R&D intensity, while more adaptive technology-exploiting investments have a negative impact on R&D intensity at the corporate parent. A reverse conclusion can be drawn for research investments in other developing countries. R&D centres

Table 7. Panel regressions on the impact of foreign R&D investments on parent R&D, 2003–2010

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Constant	0.0315*	0.0333*	0.0316*	0.0721	0.0826	0.0699
	(0.0183)	(0.0183)	(0.0183)	(0.0637)	(0.0637)	(0.0636)
Sales	-0.0008	-0.0008	-0.0008	-0.0105***	-0.0102**	-0.0102**
	(0.0008)	(0.0008)	(0.0008)	(0.0040)	(0.0040)	(0.0040)
Age	-0.0092	-0.0096	-0.0091	0.0051	0.0011	0.0050
	(0.0065)	(0.0065)	(0.0065)	(0.0194)	(0.0194)	(0.0193)
Embodied technological import	0.0011*	0.0011*	0.0011*	0.0018	0.0019	0.0020*
	(0.0006)	(0.0006)	(0.0006)	(0.0012)	(0.0012)	(0.0012)
Disembodied technological import	0.0017	0.0011	0.0016	0.0018	0.0007	0.0018
	(0.0017)	(0.0017)	(0.0017)	(0.0024)	(0.0024)	(0.0024)
Return on sales	-0.0000	-0.0000	-0.0000	-0.0031***	-0.0031***	-0.0031***
	(0.0000)	(0.0000)	(0.0000)	(0.0010)	(0.0010)	(0.0010)
Export intensity	0.0305***	0.0302***	0.0303***	0.1545***	0.1564***	0.1539***
	(0.0073)	(0.0073)	(0.0073)	(0.0238)	(0.0238)	(0.0237)
Marketing intensity	-0.0105	-0.0103	-0.0109	-0.1183	-0.1127	-0.1153
	(0.0216)	(0.0216)	(0.0216)	(0.0941)	(0.0941)	(0.0939)
Intangible assets over total assets	0.0009	-0.0002	0.0007	-0.1117	-0.1181*	-0.1078
	(0.0247)	(0.0247)	(0.0247)	(0.0688)	(0.0688)	(0.0687)
R&D centres in AM	0.0857***		0.0783***	0.0893***		0.0803***
	(0.0182)		(0.0198)	(0.0184)		(0.0205)
DD&T centres in AM	-0.0068		-0.0271*	-0.0116		-0.0644***
	(0.0109)		(0.0139)	(0.0145)		(0.0197)
R&D centres in DM		-0.0417	-0.0658**		-0.1287***	-0.1803***
		(0.0274)	(0.0279)		(0.0379)	(0.0389)
DD&T centres in DM		0.0238***	0.0254***		0.0420***	0.0566***
		(0.0073)	(0.0097)		(0.0088)	(0.0124)
Time dummies	included	included			0.0196***	
Observations	41,224	41,224	41,224	6,594	6,594	6,594
Number of firms	8,060	8,060	8,060	1,369	1,369	1,369
Average observations per group	5.115	5.115	5.115	4.817	4.817	4.817
R^2 overall	0.00617	0.00546	0.00647	0.0306	0.0311	0.0298
R^2 within	0.0018	0.0014	0.0021	0.0184	0.0186	0.0241
R^2 between	0.00626	0.00581	0.00623	0.0427	0.0437	0.0408
Rho	0.773	0.773	0.773	0.980	0.980	0.980

Note: Standard errors in parentheses, significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

there do not feed back into increased R&D back home, while adaptive research investments do lead to increased R&D investments in India.

As such, for Indian companies that want to augment their knowledge stock, it can be very useful to perform knowledge-seeking investments in more advanced markets. This is an important realization as Indian companies seem to be developing a lot of technology-seeking investments in advanced countries. Indian companies seem to be able to benefit from these investments as they positively impact the parent company's R&D investments in subsequent periods.

Furthermore, we can observe that adaptive technology-exploiting investments in developing countries also exert a positive – although smaller – impact on the parent firm's R&D expenses, while technology-seeking R&D investments in developing markets have a negative impact on R&D intensity back home, showing that Indian firms do not experience complementarity gains by making technology-seeking investments in other developing countries. A similar conclusion can be drawn for adaptive technology-exploiting investments in advanced countries that do not feed into R&D back home.

Our results are partly in line with extant research, which shows that the performance effects are contingent on the technological position of the host country. However, our results also indicate that it is not merely the location of the foreign research centre but also the nature of the R&D being carried out there. This is an important conclusion given that DMNEs need to be able to integrate knowledge from abroad to overcome their backwardness so as to become globally competitive.

Our analyses obviously suffer from certain shortcomings. Despite the fact that the *Financial Times*' fDi Markets database is the most comprehensive database of cross-border greenfield investments available, it suffers from a lack of real yearly investment data. As such, we were forced to use a count of research centres rather than annual investment figures. The database is also limited going back to 2003, although this might not be a major issue for our data set given that most Indian companies only really started to invest in the last decade or so, especially in technology. It would also have been preferable to be able to add annual R&D expenses by foreign subsidiaries of the Indian MNEs to be able to supplement the research centre data. However, these data are not readily reported in public financial data across the globe.

In summary, it is important to conclude that R&D in India benefits from the internationalization of R&D centres abroad. In general, there is a positive correlation between foreign R&D and R&D in India, and this relationship varies with the type of R&D activity being internationalized and the location of the foreign R&D centre. It can be in an Indian firm's best interest to try to seek out new innovations in advanced economies in order to improve the innovativeness of the company. Insights from such R&D internationalization can be used to enhance R&D activities of the company at home.

This also has important repercussions for home-country policy, especially given India's backlog in terms of research and innovation. Most research on technology-seeking investments and research internationalization, more generally, has focused on MNEs from advanced countries. It is important to realize that Indian MNEs also seem to be able to benefit from R&D internationalization, which suggests that the Indian Government can take a positive stance as far as such internationalization is concerned. The results of the various analyses indicate a better impact for companies carrying out research than for companies without any R&D investments. This indicates that the Indian Government should also try to get more Indian companies to carry out domestic R&D, as this is a prerequisite for knowledge augmentation. In this respect, the Indian Government has a long way to go.

Appendix

Table A1. Definition of all independent variables

Variable Name	Definition	Mean*	Standard Deviation*
Sales	Log (1 + sales)	3,386.470	43,359.330
Age	Log (1 + age, expressed in years)	27.878	81.545
Embodied technological import	Log (1 + import of capital goods)	45.259	738.430
Disembodied technological import	Log (1 + foreign spending on royalties and technical know-how)	3.438	83.320
Return on sales	Log (1 + EBITDA / sales)	0.431	49.798
Indian group	Dummy indicating whether firm belongs to Indian group	0.285	0.451
Export intensity	Log (1+ exports / sales)	0.137	0.259
Marketing intensity	Log (1 + marketing expenses / sales)	0.018	0.044
Intangible assets over total assets	Log (1 + intangible assets / total assets)	0.013	0.063
Foreign technology centres	Number of foreign technology (R&D + DD&T) centres	0.011	0.240
R&D centres	Number of foreign R&D centres	0.002	0.062
DD&T centres	Number of foreign design, development and testing (DD&T) centres	0.008	0.211
Technology centres in AM	Number of foreign technology centres in advanced markets	0.005	0.114
Technology centres in DM	Number of foreign technology centres in developing markets	0.006	0.147
R&D centres in AM	Number of foreign R&D centres in advanced markets	0.001	0.044
DD&T centres in AM	Number of foreign DD&T centres in advanced markets	0.004	0.098
R&D centres in DM	Number of foreign R&D centres in developing markets	0.001	0.035
DD&T centres in DM	Number of foreign DD&T centres in developing markets	0.004	0.134

* Mean and standard deviation are shown in levels before taking logarithm of variables.
Note: These variables are lagged relative to the dependent variable, R&D intensity.

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