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# Cross-Border Knowledge Flows through R&D FDI: Implications for Low- and Middle-Income Countries

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## Abstract

*R&D related foreign direct investments represent a powerful mechanism for cross-border knowledge sharing that can stimulate the process of technological catch-up. However, low-income countries and smaller middle-income countries remain largely excluded from this kind of global flows of knowledge. In this chapter, we discuss the motivations and implications of this type of FDI for low- and middle-income countries, building on a critical review of the existing literature, and analyze the trajectory of R&D FDI during the period 2003-2017 by region and industry. The data is used as a point of departure to discuss potential policies specially tailored for low- and middle-income countries and their capacity to attract and anchor R&D related FDI for technological catch up. The chapter concludes with an outline of a future research agenda.*

## Introduction

Foreign direct investment (FDI) has long been considered an important channel through which international technology transfer unfolds (Abramovitz, 1986). Through FDI, multinational enterprises (MNEs) increasingly act as global orchestrators of knowledge by tapping into diverse knowledge clusters and allowing connections between knowledge sources across distant locations. However, FDI is a very heterogeneous phenomenon, and the potential for cross-border knowledge exchange depends crucially on the type of activities that MNEs decide to offshore to each particular location (Narula and Dunning, 2010).

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It seems self-evident that FDI related to research and development (R&D) represents the type of investment with the highest potential for cross-border knowledge flows, since its purpose is precisely to access, generate and potentially diffuse knowledge within global innovation networks. Therefore, it is not surprising that attracting R&D FDI has become a high priority for policymakers throughout the world.[1]

The current global innovation landscape, characterized by increased technological capabilities in emerging economies coupled with open models of innovation, modularization and high technological complexity, is influencing the way that MNEs organize their R&D activity – from a centralized and hierarchical organization towards one that is more loosely structured around global innovation networks. Such networks include the R&D centres established by MNEs, collaborating both among each other and with other firms, universities and public research institutes in the different countries, regions and clusters where they are located.[2]

With the spread of global innovation networks, national, regional and local innovation systems influence and are increasingly influenced by R&D-related investments undertaken by MNEs. On the one hand, MNEs are considered as key actors characterized by superior technological resources in the location where they establish their subsidiaries, potentially generating knowledge spillovers (Javorcik, 2004). On the other hand, MNEs take advantage of their international investments to tap into local knowledge pools, embedding in technological hubs and creating networks with local actors (Marin and Arza, 2009). Therefore, their R&D-related location decisions are highly influenced by the innovation performance of the different national or regional innovation systems, particularly when investments respond to knowledge-seeking strategies.

In this chapter, we focus on inward R&D FDI as a driver of economic development and catching-up for low- and middle-income countries (LMICs). The following section on cross-border knowledge flows through R&D FTI delves into the motivations and implications of this type of FDI, building on a critical review of the existing literature. The next section[3]

[1] The high relevance of R&D FDI for policymakers was already confirmed in 2005 when the United Nations Conference on Trade and Development (UNCTAD) chose 'Transnational Corporations and the Internationalization of R&D' as the thematic focus of the World Investment Report (UNCTAD, 2005). This report, in turn, spurred a growing interest on the topic in subsequent years, both in policy as well as in academic circles.

[2] The concept of 'global innovation network' is analysed further in Chaminade et al. (2016).

[3] P. 357 *infra*.

provides an overview of R&D FDI during the period 2003–2017, analysing key trends of greenfield investments and acquisitions by region and industry. The final section[4] provides suggestions for a future research and policy agenda, focusing on the opportunities and challenges for LMICs.

## Cross-Border Knowledge Flows through R&D FDI: Motivations and Impact on Low- and Middle-Income Countries

MNEs have traditionally located their offshore R&D centres in developed countries. However, since the late 1990s a significant amount of R&D FDI is directed towards LMICs. Scholars from economic geography, international business and innovation studies have tried to shed light on the motivations of MNEs to locate R&D investments in low- and middle-income countries, as well as on the impact of such investments on the innovation performance of host countries.[5] The rest of this section summarizes key findings of this strand of research.

### *Motivations Driving R&D FDI to Low- and Middle-Income Countries*

The factors that influence the location of MNEs' R&D centres are many, including traditional drivers such as market size and factor costs, as well as knowledge-seeking motivations such as the availability of qualified engineers and scientists and, more generally, the possibility to tap into disperse 'global knowledge reservoirs' (Kafouros et al., 2012).

There are several reasons that help explain the growing attractiveness of low- and middle-income countries as locations of R&D FDI. First, the substantial increase in public investments in R&D in emerging countries and the availability of new, high-quality scientific infrastructure, particularly in certain metropolitan areas in China and India (Crescenzi and Rodríguez-Pose, 2017). Second, the large pools of highly skilled personnel available at relatively low cost combined with the shortage of highly skilled scientists and engineers in developed countries, as illustrated with the case of investments in IT and software services in India (Arora and Bagde, 2006) or biotechnology investments in China (Haakonsson, 2013). Third, the return migration of engineers, scientists and managers, who can play a bridging role between developing and developed

[4] P. 367 *infra*.
[5] For recent reviews, see Cantwell (2017), Lema et al. (2015) and Mudambi et al. (2018).

countries (Saxenian, 2006). Fourth, the large and dynamic markets of new emerging powers like China and India, which offer great opportunities for large-scale commercialization of different products and services and for incremental innovation aimed at adapting products to the domestic markets (Chen, 2008). Finally, and related to this last point, the obligation to conduct R&D in the country as a precondition to access the local market through FDI (Lema et al., 2015).

This mixture of market-seeking, efficiency-seeking and knowledge-seeking motivations leads to different types of offshore R&D centres located in LMICs. While some of them focus on creating new products (or adapting existing ones) to respond to local demand (Wang et al., 2012), others have the main purpose of reducing costs by conducting routine research activities that were previously performed in a high-income country at a higher cost (Reddy, 1997). Generally, earlier studies have shown that such R&D centres tend to focus (at least initially) on lower-end and routine R&D activities, given the weak technological capabilities of LMICs relative to high-income countries. In the words of Thursby and Thursby (2006), R&D activities by MNEs in low- and middle-income countries normally involve 'familiar science' (i.e. applications of science currently used by the firm and/or its competitors) rather than 'new science' (i.e. novel applications of science), which hitherto remained concentrated in the core high-income countries.

However, more recent studies show that some middle-income countries are increasingly engaging in more advanced R&D activities (e.g. D'Agostino and Santangelo, 2012). This often results from an evolutionary, learning-based upgrading whereby MNE subsidiaries gradually move from adaptation to the market of products already developed in the headquarters to conducting applied research and even basic research, developing new knowledge and technological competences along the way. In the international business literature, this phenomenon has been described as a progressive shift from the traditional *market-seeking* or *efficiency-seeking* investments going to middle-income countries towards more strategic *knowledge-seeking* FDI. In some instances, this knowledge-seeking behaviour has led to *reverse innovation*, whereby innovations generated by MNE subsidiaries in middle-income countries are subsequently re-used to cater for global markets (Govindarajan and Ramamurti, 2011; Von Zedtwitz et al., 2015). A well-known example of the latter is the pocketsize ultrasound scan developed by General Electric in China with rural doctors in mind, which has rapidly reached a global market.

### *Impact of R&D FDI in Low- and Middle-Income Countries*

R&D FDI is especially relevant for LMICs as part of a process of catching-up by absorbing foreign knowledge. Indeed, the attraction of R&D FDI can enhance economic and social progress by facilitating the transfer of foreign knowledge and fostering the kind of structural changes that lead to an increasing participation in higher value-added activities within global value chains. Eventually, it may have a positive spillover effect on the R&D efforts of local firms,[6] create new opportunities for local talent and lead to the emergence of technology start-ups.

However, attracting R&D FDI remains a difficult task for low- and middle-income countries. Besides the obvious difficulties involved in competing with the most advanced innovation systems and technological hubs of developed countries, the existing literature points to various factors that may deter MNEs from locating R&D activities in low- and middle-income countries. These include the complexity of coordinating increasingly disperse structures as well as the high political risks and uncertainty in legal reforms common to many low- and middle-income countries. In particular, several studies have underlined that weak intellectual property (IP) regimes LMICs might be a significant hindrance, especially for more advanced types of R&D, to the extent that it harms MNEs' ability to appropriate the returns of such investments. For example, an empirical study for 2002–2006 by Chuang and Lin (2011) finds that the degree of IP protection in host countries has a significant negative influence on the overseas R&D activities of MNEs in emerging economies. However, the other side of the coin is that stronger IP regimes may diminish the scope for imitation and learning, creating an additional barrier for catching-up.[7]

Moreover, the benefits from R&D FDI are far from automatic. The upgradation process depends crucially on parallel efforts by host countries to improve their domestic technological capabilities and absorptive capacities[8]. In some instances, the impact might even be negative. Along these lines, Bruche (2009) stresses how R&D centres established by MNEs in developing countries may attract the best local scientists and engineers, leading to an *in-situ brain drain* that deprives local companies

[6] For example, Qu et al. (2013) finds that inward R&D FDI has a positive effect on the R&D efforts of Chinese firms, based on an empirical study of 12,309 manufacturing firms in the ICT sector.

[7] See Branstetter and Maskus (Chapter 13 in this volume).

[8] For further discussion on the crucial role of absorptive capacity for international knowledge transfer see Branstetter and Maskus (Chapter 13 in this volume).

of human capital. Other authors have also cautioned that MNEs might lead to a *crowding-out* of local firms, engage in a research agenda of little relevance to the local economy and divert scarce resources from more useful purposes (Pearce and Papanastassiou, 2009).

All in all, the existing literature suggests that R&D FDI provides opportunities for knowledge transfer to LMICs. Nevertheless, the extent of the impact in terms of learning and upgrading depends both on the motivation of the MNE, as well as on the quality of the host country's innovation system.

## R&D FDI In Low- and Middle-Income Countries: An Overview

In this section, we first offer an overview of R&D FDI globally, and then focus on investments going towards LMICs. We consider both greenfield FDIs and cross-border acquisitions, over the period 2003–2017.

Data on greenfield investments are provided by FDI Markets, a database maintained by the Financial Times Group, which collects worldwide cross-border deals since 2003. For each investment, it gives information about the date and the location (country, region and city) of the deal, the name, the geographical origin, the industrial sector of specializations of the investor and the business activity undertaken with the investment project. In this chapter, we make use of this last piece of information to identify the investments in activities related with R&D. In particular, following Crescenzi et al. (2013), we consider deals in research and development (R&D) as well as in design, development and testing (DDT), defining them as R&D&DDT greenfield investments.

Data on cross-border acquisitions comes from Zephyr, a database maintained by Bureau van Dijk, providing name, sector and geographical origin of both the acquirers and the target companies, date and status of the deal and ownership share transferred from the target to the acquirer. We include in our analysis acquisitions of at least 10 per cent of the target's ownership, following the UNCTAD definition of FDI.[9] Identifying R&D-related acquisitions is not an easy task (Piscitello et al., 2015). Following Ahuja and Katila (2001), we focus on acquisitions involving a target company with some patenting activity[10] in the five years preceding

[9] Available at http://unctad.org/en/Pages/DIAE/Foreign-Direct-Investment-(FDI).aspx.

[10] We consider INPADOC (International Patent Documentation) families containing all the patent applications filed by the target company at any patent office that share the same priority date and protect a single invention (Martinez, 2010). The advantage of

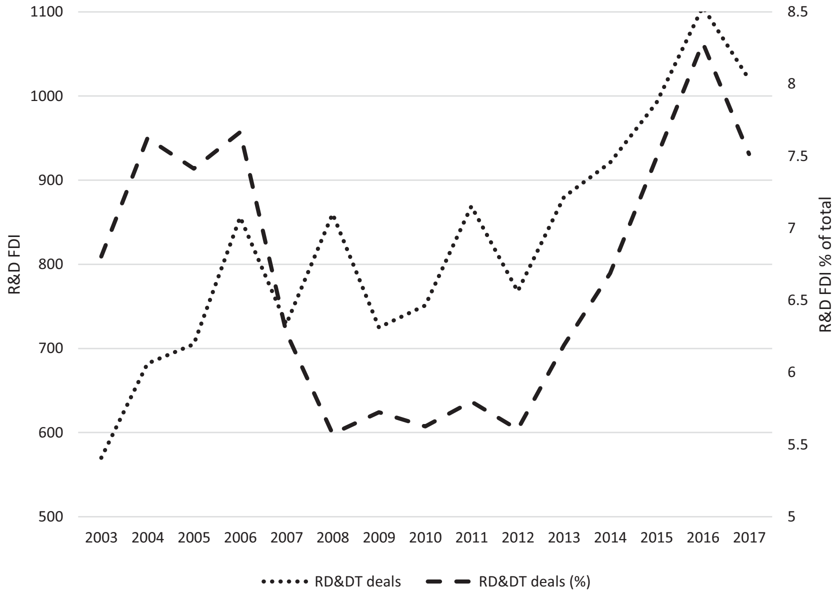


**Figure 11.1** Dynamics of R&D&DDT greenfield investments (total and %)
*Source:* fDi Markets.

the acquisition, as an indication of previous R&D activity. To facilitate the search, we restrict our analysis on R&D-related acquisitions undertaken by the top 1,000 global companies by R&D expenditure.[11] These companies account for 65 per cent of global business expenditures in R&D (UNESCO, 2018) and have undertaken more than 40 per cent of all R&D greenfield investments according to fDi Markets.

### *Greenfield Investments*

In the period 2003–2017, global R&D&DDT greenfield investments have increased 1.8 times, from 570 deals in 2003 to 1020 deals in 2017 (Figure 11.1). The growing relevance of investments in R&D-related activities becomes even more evident if we consider their share out of the total number of greenfield investments (indicated on the right vertical

employing INPADOC families rather than patent applications to individual patent offices is to count all the patents filed by a firm and, at the same time, avoid the double counting for the same invention (see for example Amendolagine et al., 2018).

[11] Based on the R&D Investment Scoreboard, available at https://iri.jrc.ec.europa.eu/scoreboard/2017-eu-industrial-rd-investment-scoreboard.

Table 11.1 *Geographical distribution of R&D&DDT FDI (total and %)*

| Region | DDT | R&D | Total R&D&DDT |
|---|---|---|---|
| Low- and middle-income | 3,951 (42.0) | 1,151 (38.0) | 5,102 (41.0) |
| High-income | 5,453 (58.0) | 1,879 (62.0) | 7,332 (59.0) |
| Africa | 179 (1.9) | 38 (1.2) | 217 (1.7) |
| Latin America | 534 (5.7) | 127 (4.2) | 661 (5.3) |
| North America | 1,149 (12.2) | 405 (13.4) | 1,554 (12.5) |
| Europe | 3,286 (35.0) | 1,063 (35.1) | 4,349 (35.0) |
| Asia | 4,085 (43.4) | 1,349 (44.5) | 5,491 (43.7) |
| Oceania | 171 (1.8) | 48 (1.6) | 219 (1.8) |
| Total | 9,404 (100.0) | 3,030 (100.0) | 12,434 (100.0) |

*Source:* fDi Markets.

axis). From 2008 to 2017, the share has risen from 5.6 to 7.5 per cent, reaching a peak in 2016 (8.3 per cent).

In terms of geographical distribution, Table 11.1 indicates that the largest share of greenfield R&D&DDT FDI is hosted by Asian countries (44 per cent), followed by Europe (35 per cent) and North America (12 per cent). Considering the disaggregation between LMICs and high-income countries, 59 per cent of the R&D investments (7,332 deals) go to the advanced economies and the remaining 41 per cent (5,102 deals) to LMICs. Considering the disaggregation between R&D and DDT, in low- and middle-income countries, 23 per cent of deals correspond to R&D (77 per cent in DDT) while the share goes up to 26 per cent in high-income countries (74 per cent in DDT). Thus around three-fourths of R&D&DDT FDI projects are really related to DDT.

Table 11.2 provides industry-specific details.[12] LMICs receive large shares of global R&D&DDT investments in just two sectors: software & IT services (47 per cent) and communications (41 per cent). In these two sectors the share of R&D relative to DDT investments is lower than the average: 10 and 21 per cent respectively. In contrast, in the chemical sector more than 50 per cent of investments are in R&D. By region, Asia hosts 53 per cent of R&D&DDT investments in electronics and 44 per cent in

[12] The industrial classification is based on fDi Markets and corresponds to the Standard Industrial Classification. Automotive aggregates Automotive OEM and Automotive Components; Electronics: Consumer Electronics, Electronic Components and Semiconductors; Chemicals: Biotechnology and Pharmaceuticals.

Table 11.2 *Geographical and sectoral distribution of R&D&DDT FDI (total and %)*

| Region | Software & IT services | Chemicals | Electronics | Communi-cations | Automotive | Machinery | Others |
|---|---|---|---|---|---|---|---|
| Low- and middle-income | 1,843 (47.0) | 679 (36.8) | 508 (40.0) | 474 (40.7) | 358 (40.0) | 248 (37.3) | 992 (37.1) |
| High-income | 2,079 (53.0) | 1164 (63.2) | 764 (60.0) | 691 (59.3) | 535 (60.0) | 416 (62.7) | 1,683 (62.9) |
| Africa | 79 (2.0) | 32 (1.7) | 12 (0.9) | 23 (2.0) | 12 (1.3) | 5 (0.7) | 54 (2.0) |
| Latin America | 232 (5.9) | 101 (5.5) | 44 (3.4) | 77 (6.6) | 45 (5.0) | 22 (3.3) | 140 (5.2) |
| North America | 378 (9.6) | 286 (15.5) | 127 (10.0) | 137 (11.8) | 146 (16.3) | 89 (13.4) | 391 (14.6) |
| Europe | 1,413 (36.0) | 645 (35.0) | 403 (31.7) | 405 (34.8) | 314 (35.2) | 246 (37.0) | 923 (34.6) |
| Asia | 1,741 (44.4) | 762 (41.4) | 675 (53.1) | 488 (41.8) | 372 (41.7) | 293 (44.2) | 1,103 (41.2) |
| Oceania | 79 (2.0) | 17 (0.9) | 11 (0.9) | 35 (3.0) | 4 (0.5) | 9 (1.4) | 64 (2.4) |
| Total | 3,922 (100.0) | 1,843 (100.0) | 1,272 (100.0) | 1,165 (100.0) | 893 (100.0) | 664 (100.0) | 2,675 (100.0) |

*Source:* fDi Markets.

software and IT services. Europe is particularly attractive to the machinery industry (37 per cent) and software & IT services (36 per cent) while North America attracts a large share of R&D investments in the automotive industry (16 per cent) and in chemicals (15 per cent).

Focusing now on LMICs, the main destinations of R&D&DDT greenfield investments are India and China, which receive respectively 36 per cent (1,843) and 30 per cent (1,502) of the total number of investments going to this group of economies. It is worth noticing that India is particularly attractive for DDT investments, which represent more than 80 per cent of R&D&DDT FDI going to the country. In China, the share of DDT is substantially lower, at 69.5 per cent. Other significant host countries, albeit with a much lower share, are Brazil (5 per cent), Mexico (3 per cent) and Russia (almost 3 per cent) (Table 11.3). Altogether these five large middle-income countries represent as much as 77 per cent of all R&D&DDT investments going to LMICs.

In terms of countries of origin, 95 per cent of R&D&DDT investments going towards LMICs comes from high-income countries, mainly from the US (46.5 per cent), Germany (9.3 per cent), Japan (7.1 per cent), the UK (5.8 per cent) and France (4.6 per cent), which altogether represent around three out of four deals. In particular, the US undertakes 60 per cent of the deals in India, 44 per cent in Mexico and 43 per cent in China. Its main investment sectors are software & IT services, electronics and, particularly in China, chemicals. Germany undertakes 13 per cent of greenfield investments in Vietnam and 12 per cent in Mexico, mostly focusing on chemicals and software & IT services. Japan is relatively more present in Thailand and Vietnam, where it represents, respectively, 42 and 22 per cent of the deals and, in this case, the main sectors are automotive and rubber (Thailand) and software & IT services (Vietnam).

Global cities identified following Goerzen et al. (2013),[13] attract about 38 per cent of global R&D greenfield investments, with the share increasing to 41 per cent in LMICs and reaching 49 per cent in Asia. Table 11.4 lists the major global cities attracting R&D FDI in LMICs. In Africa, Johannesburg is the most important global city, hosting 10 per cent of all R&D FDI directed to the continent. In Asia, Bangalore is the global city

[13] Goerzen et al. (2013) identify 122 global cities around the world defined by the following characteristics: (i) a high degree of interconnectedness to local and global markets (through, for instance, major financial centres, headquarters of international institutions, or international transportation nodes); (ii) a socio-cultural cosmopolitan environment; (iii) a large endowment of advanced producer services (such as finance, law or advertising).

Table 11.3 *R&D&DDT greenfield investments towards low- and middle-income countries: main host and home countries (total and %)*

| | **USA** | **Germany** | **Japan** | **UK** | **France** | **Others** | **Total** |
|---|---|---|---|---|---|---|---|
| India | 1109 (60.2) | 138 (7.5) | 77 (4.2) | 104 (5.6) | 58 (3.1) | 357 (19.4) | 1843 (100) |
| China | 659 (43.3) | 175 (11.5) | 152 (10.0) | 66 (4.3) | 67 (4.4) | 404 (26.5) | 1523 (100) |
| Brazil | 106 (38.8) | 25 (9.1) | 13 (4.8) | 16 (5.9) | 20 (7.3) | 93 (34.1) | 273 (100) |
| Mexico | 76 (43.9) | 21 (12.1) | 5 (2.9) | 6 (3.5) | 8 (4.6) | 57 (32.9) | 173 (100) |
| Russia | 62 (42.2) | 16 (10.9) | 6 (4.1) | 5 (3.4) | 12 (8.2) | 46 (31.3) | 147 (100) |
| Malaysia | 48 (35.0) | 11 (8.0) | 11 (8.0) | 11 (8.0) | 2 (1.5) | 54 (39.4) | 137 (100) |
| Thailand | 20 (18.3) | 10 (9.2) | 46 (42.2) | 5 (4.6) | 4 (3.7) | 24 (22.0) | 109 (100) |
| Vietnam | 26 (25.0) | 14 (13.5) | 23 (22.1) | 9 (8.6) | 5 (4.8) | 27 (26.0) | 104 (100) |
| Total | 2372 (46.5) | 476 (9.3) | 365 (7.1) | 298 (5.8) | 237 (4.6) | 1354 (26.5) | 5102 (100) |

*Source:* fDi Markets.

Table 11.4 *Global cities attracting R&D&DDT greenfield investments in low- and middle-income countries (total and %)*

| Global cities | Total FDI (%) | Main sectors (total FDI) |
|---|---|---|
| **Africa** | | |
| Johannesburg (ZA) | 22 (10.1) | Software & IT services (8); chemicals (5) |
| Cairo (EG) | 16 (7.4) | Software & IT services (7); communications (4) |
| Cape Town (ZA) | 14 (6.4) | Software & IT services (9) |
| Total | 217 (100) | Software & IT services (79); chemicals (32) |
| **Asia** | | |
| Bangalore (IN) | 597 (15.0) | Software & IT services (319); electronics (79) |
| Shanghai (CN) | 543 (13.6) | Chemicals (150); software & IT services (77) |
| Beijing (CN) | 241 (6.0) | Software & IT services (86); communications (37) |
| Mumbai (IN) | 92 (2.3) | Software & IT services (33); chemicals (32) |
| Ho Chi Minh (VN) | 50 (1.2) | Software & IT services (23); electronics (7) |
| Total | 3979 (100) | Software & IT services (1410); chemicals (523) |
| **Europe** | | |
| Moscow (RU) | 47 (15.9) | Chemicals (13); software & IT services (10) |
| St Petersburg (RU) | 24 (8.1) | Software & IT services (15); machinery & electronics (2) |
| Total | 295 (100) | Software & IT services (143); chemicals (34) |
| **Latin America & Caribbean** | | |
| Sao Paulo (BR) | 68 (11.1) | Software & IT services (30); chemicals (18) |
| Rio de Janeiro (BR) | 33 (5.4) | Software & IT services (9); communications (8) |
| Mexico City (MX) | 30 (4.9) | Software & IT services (10); chemicals (8) |
| Bogota (CO) | 21 (3.4) | Software & IT services (6); communications (6) |
| Buenos Aires (AR) | 19 (3.1) | Software & IT services (10); communications (5) |
| Total | 610 (100) | Software & IT services (211); chemicals (90) |

*Source:* fDi Markets.

with the largest share of R&D greenfield FDI (15 per cent of the investments), followed by Shanghai (14 per cent) and Beijing (6 per cent). Russian global cities, i.e. Moscow and Saint Petersburg, are attracting greenfield investments in software & IT services and chemicals. In Latin America, R&D FDI are concentrated in Sao Paulo and Rio de Janeiro, which receive investments in software & IT services, chemicals and communications.

To conclude, Table 11.5 lists the companies with more than 20 R&D greenfield FDIs in LMICs. The largest investor is IBM with 108 investments (31 in China and 28 in India), followed by Microsoft with 78 investments and Intel with 63 – all mainly operating in IT and software services. An interesting difference between IBM and the other two investors is that IBM focuses on DDT (only 9 R&D investments) while both Microsoft and Intel invest a larger share in R&D (27 and 38 per cent respectively). There are three German multinationals in the list: Siemens, Bosch and BASF. Huawei Technologies, from China, is the only company in the list not coming from a high-income country, and it has made 29 deals, mainly concentrated in Bangalore (India) and Johannesburg (South Africa). Among the companies with a largest share of their activities in R&D are DuPont (51 per cent) and Samsung (47 per cent).

### *Acquisitions*

Applying the selection criteria defined in the above overview section on R&D FDI in LMICS,[14] we have identified 45 R&D-related cross-border acquisitions, corresponding to 11 per cent of all acquisitions made by top R&D spenders in LMICs over the period 2003–2017. Table 11.6 provides a summary of those deals. The main destinations are China (11 deals), Brazil (8), Russia (6), India (5) and Turkey (5). In China, acquisitions took place mainly in the electronics industry (5 deals), followed by food and metals (two deals each), and originated from countries such as Germany, the Republic of Korea, Switzerland and the US (2 deals each).

Two notable acquisitions in India were undertaken in Bangalore by two leading US technology companies: IBM and Twitter. In both cases, the target companies were endowed also with patents filed with non-Indian patent offices (USPTO and PCT). The company acquired by Twitter in 2015 is Zipdial, a small start-up offering companies a special phone number, which their brands can use in print ads or TV commercials.

[14] P. 357 *supra*.

Table 11.5 *Top R&D&DDT investors in low- and middle-income countries (total FDI)*

| | **Total FDI** | **Main sectors** | **Main host countries** | **Main global cities** |
|---|---|---|---|---|
| IBM (US) | 108 | Software & IT services (102) | China (31); India (28) | Beijing (15); Bangalore (10) |
| Microsoft (US) | 78 | Software & IT services (75) | China (33); India (15) | Shanghai (9); Bangalore & Beijing (7) |
| Intel (US) | 63 | Electronics (41) | China (23); India (11) | Bangalore (8); Beijing (5) |
| Siemens (DE) | 41 | Software & IT services (14) | China (17); India (11) | Bangalore (4); Beijing & Mumbai (2) |
| General Electrics (US) | 38 | Machinery (8) | China (13); India (12) | Bangalore (6); Shanghai (6) |
| DuPont (US) | 37 | Chemicals (16) | China (11); India (10) | Shanghai (9) |
| Robert Bosch (DE) | 37 | Automotive (20) | India (14); China (9) | Bangalore (8); Ho Chi Minh (4) |
| SGS (CH) | 33 | Business services (25) | China (7); India (6) | Mumbai (6); Shanghai (6) |
| BASF (DE) | 30 | Chemicals (26) | China (11); India (8) | Shanghai (8); Mumbai (3) |
| Intertek Group (UK) | 30 | Business services (28) | India (6); China (5) | Ho Chi Minh (2); Shanghai (2) |
| Samsung (KR) | 30 | Electronics (23) | India (7); China (6) | Hanoi (2) |
| Hewlett-Packard (US) | 29 | Software & IT services (18) | China (9); India (5) | Bangalore (3); Beijing (2) |
| Huawei Technologies (CN) | 29 | Communications (29) | India (8); South Africa (3) | Bangalore (7); Johannesburg (3) |
| Motorola (US) | 25 | Communications (16) | China (12); India (5) | Beijing (5); Bangalore (2); St Petersburg (2) |
| Honeywell (US) | 24 | Machinery (5) | China (10); India (5) | Shanghai (4); Bangalore (2) |
| General Motors (US) | 22 | Automotive (22) | China (9); India (5) | Shanghai (5); Bangalore (3) |
| Nokia (FI) | 22 | Communications (15) | India (7); China (6) | Mumbai (4); Bangalore (3) |

*Source:* fDi Markets.

Table 11.6 *R&D-related acquisitions in low- and middle-income economies*

| Target economy | Number | Main sectors | Main economies |
|---|---|---|---|
| China | 11 | Electronics (5); food, metals (2) | Germany, Republic of Korea, Switzerland, US (2) |
| Brazil | 8 | Chemicals (5) | USA (3) |
| Russia | 6 | Various sectors | India (2) |
| India | 5 | Business services (2); chemicals (2) | France (2); US (2) |
| Turkey | 5 | Furniture (2) | US (2) |
| Malaysia | 2 | Electronics (2) | Japan, Chinese Taipei (1) |
| Mexico | 2 | Chemicals (2) | Germany, US (1) |
| Argentina | 1 | Coke & petroleum | France |
| Bulgaria | 1 | Metals | Sweden |
| Indonesia | 1 | Machinery | Japan |
| Serbia | 1 | Chemicals | Germany |
| South Africa | 1 | Business services | Germany |
| Thailand | 1 | Electronics | Japan |
| Total | 45 | | |

*Source:* Bureau van Dijk, Zephyr, at www.bvdinfo.com/en-gb/our-products/data/economic-and-ma/zephyr.

Customers can call the number and hang up before they are charged for the call, while brands can phone or send text messages about their business to the 'missed callers'. This type of service is particularly valuable in LMICs, where prospective customers may not have the money for the call. In other words, the start-up is targeting the potentially vast market segment of low-income consumers, leading to a diversification of the traditional business of a tech company such as Twitter.

In China, the most innovative target (by number of patents) is *Tianning flavour & fragrance Jurong*, within the Eastern-side of Jangsu province, acquired in 2017 by the Irish Kerry Group. This company is the largest Chinese producer of food ingredients, with a strong R&D capacity, holding a large number of patents registered at the Chinese patent office. The main reason for this acquisition was the interest of the Kerry Group to enter into the very large Chinese market for food, given that the acquired company is the main supplier of flavours and fragrances of some of the Chinese leading beverage and food groups. The focus on the Chinese market explains why the patent activity of the company has a clear domestic orientation. Another interesting acquisition in China was undertaken by Trumpf, a German family-owned business in machine tools for metal processing, buying its rival Jangsu JingFang Yuan. This is a rare case of an acquisition backed by the Chinese government in an industry classified as key by Beijing authorities.

There are also some cases of south–south technology-driven acquisitions, such as that undertaken by Mahindra and Mahindra, an Indian multinational car-manufacturing corporation headquartered in Mumbai, which acquired Erkunt Traktor Sanayii AS, a Turkish tractor maker. Through this acquisition, Mahindra aims at increasing its globalization reach, entering the large Turkish market, but also diversifying its portfolio, taking advantage of the strong technological capability of the target in its field of specialization.

In sum, what the previous data show is that R&D-related investments (whether greenfield or acquisitions) towards LMICs are not ubiquitous. Rather, they are highly concentrated in a handful of countries, industries and cities which have managed to reach a certain level of technological capability in particular industrial fields. This has important implications in terms of policies, as will be discussed next.

## Towards a New Research and Policy Agenda

This section aims to link the main contributions of the existing literature discussed in the above section on 'Cross-Border Knowledge Flows through R&D FDI'[15] and the empirical evidence presented in the above section on 'R&D FDI in LMICs',[16] pointing to promising avenues for a future research and policy agenda.

### *Engaging in More Comprehensive Analyses of Impact Channels*

Learning opportunities for LMICs are larger when MNEs collaborate in innovation with local firms, universities and public research institutes. Indeed, the formation of linkages that enable an intense participation of local actors in innovation networks is a critical condition for spillovers to unfold (Amendolagine et al., 2019). As discussed in the above section on 'Motivations Driving R&D FDI to LMICs',[17] the modes and directions of cross-border knowledge flows are shifting from unilateral North–South

[15] P. 354 *supra*.
[16] P. 357 *supra*.
[17] P. 354 *supra*.

knowledge transfer to mutual learning relations, but we still lack conclusive evidence of the magnitude and implications of such shifts.

Future research should continue to analyse the interplay between absorptive capacity, linkages and spillovers, a line of research that has produced substantial insights but still needs further empirical grounding. For instance, while the existing literature points to significant spillover effects associated with R&D FDI, it does not clarify the type of technology being transferred and whether it is appropriate for LMICs. In order to maximize spillovers, developing countries should aim at strategically aligning inward R&D FDI with the capabilities of their local industries and human capital. To address these issues, there is a clear need for micro studies investigating the mechanisms for knowledge transfer and spillovers in different geographical contexts.

Moreover, although the impact of R&D FDI can be expected to be different depending on the entry mode,[18] most of the literature tends to focus on greenfield FDI, without sufficiently considering the case of cross-border acquisitions. This can be explained by the relatively small number of R&D-related acquisitions in LMICs and the difficulties of measuring R&D-related cross-border M&As, as discussed in the above section on 'Cross-Border Knowledge Flows through R&D FDI'.[19] Future efforts to develop new measurement frameworks and databases of such investments would be most welcome[20] as they will enable further research comparing the motivations and impact of both modes of entry.

### *Acknowledging the Heterogeneity of Low- and Middle-Income Countries*

As shown in the above section on 'Cross-Border Knowledge Flows through R&D FDI',[21] R&D-related FDI reaching developing countries is strongly concentrated in large middle-income economies like China, India and Brazil. The governments of these large upper-middle-income

[18] While greenfield R&D FDI is generally attributed to be a net positive impact on the host country, the impact of cross-border R&D-related acquisitions is more controversial in view of concerns that the acquiring firm might discontinue or delay the acquired firm's pre-merger R&D activity to align it with its own research agenda and avoid duplications (Buehler et al., 2017).

[19] P. 354 *supra*.

[20] A promising line of research would be to use indicators of patent quality for this purpose, along the lines of Ernst et al. (2019), Chapter 12 in this volume.

[21] P. 354 *supra*.

countries, especially China, have successfully used their market size as a bargaining tool, by introducing local content requirements related to R&D and coordinating procurement and technology policies with approvals for foreign investments in order to build local capabilities.[22] They have actively encouraged foreign investors in manufacturing to open up R&D centres as well, in a process that Lema et al. (2015) refer to as 'trading market access for technology'. In parallel, as discussed by Manning (2008), these countries have also 'customized' their institutions and business networks in specific clusters or 'islands of excellence' to meet the needs of foreign investors in R&D.

However, it is not always easy for other smaller or lower-income countries to either attract R&D FDI or to enforce linkages and knowledge spillovers. In particular, future research should explore further the case of lower-income countries that remain largely excluded from global innovation networks. A deeper understanding of the interplay between building absorptive capacity and opening the economy to international investments in low-income countries is dearly needed (Chaminade et al., 2018). For example, from a policy perspective, it is questionable whether low-income countries that lack absorptive capacity should invest public money to attempt to attract R&D-related FDI in the face of other more pressing societal challenges.

### *Adopting Systemic, Time-Sensitive and Multi-Level Approaches to Guide Public Policies*

The priority for any country aiming to attract R&D FDI is to improve the quality of its national innovation system, as this will obviously make it more attractive to foreign investors. In particular, a salient finding in the existing literature is the paramount importance of enhancing the quality of universities, so that they train highly skilled researchers and become relevant partners for research collaborations with the R&D centres of MNEs (Belderbos et al., 2016; Guimón and Salazar-Elena, 2015; Pietrobelli and Rabellotti, 2011). As emphasized in the above section on 'Impact of R&D FDI in LMICs',[23] the quality of the IP rights regime is

[22] According to Dachs (2017, p. 6), 'with the expansion of European and US MNEs into Asia, local content requirements in R&D (mandatory technology transfer, mandatory joint ventures, requirements to perform R&D in the host country) gained some prominence as a policy tool'.

[23] P. 356 *supra*.

another important element influencing the location choice of R&D centres by MNEs.

Only when a certain level of technological capability has been built can other direct policy interventions to attract R&D-related FDI be considered. This sequential, step-wise approach is paramount. Without a certain quality of the national innovation system, it is very difficult, if not impossible, for LMICs to attract and benefit from R&D FDI (Chaminade et al., 2018; Lema et al., 2018).

More 'direct' policy interventions aimed at providing targeted incentives to foreign investors in R&D might include tax credits, direct subsidies and public-private partnerships. In this regard, it is important to highlight that despite the growing use by governments of financial and tax incentives to attract R&D FDI, the debate around their effectiveness remains unresolved.[24] Based on the case of Chile, Guimón et al. (2018) illustrate the advantages of targeting incentives to specific projects that demonstrate potential for building knowledge-intensive linkages with local actors in selected technology fields or industries where there is already a threshold level of absorptive capacity that can facilitate the transfer of knowledge.

Governments can also make use of 'soft' policy instruments aimed at FDI promotion, including marketing campaigns, international missions, and 'after care' services. The latter is particularly important to foster an evolutionary technological upgrading of existing MNE subsidiaries, as Medcof (2007) and Chen (2008) discuss in relation to the case of China. Another policy option for LMICs is to negotiate provisions in international agreements that promote a more intense knowledge sharing by MNEs. Indeed, the scope of international investment agreements can be expanded beyond their traditional focus on protecting the interests of MNEs, by including also more references to their obligation to contribute to national science and innovation objectives, as suggested in Bellak and Leibrecht (2016) and Chaminade (2015).

In sum, governments of LMICs aiming to attract R&D FDI should adopt a systemic policy approach that takes into consideration the diversity of policy instruments. A combination of financial, regulatory and soft instruments needs to be grouped together within a coherent policy mix that responds to each country's structural and institutional conditions.

[24] For recent reviews of the evidence on the impact of incentives on R&D FDI location decisions see Belderbos et al. (2016) and Bellak and Leibrecht (2016).

Moreover, a multilevel governance approach that considers the regional and local dimensions is critical to better guide policymaking. Indeed, as discussed above,[25] R&D FDI LMICs is very concentrated in just a few regions and cities. This regional concentration of R&D FDI accentuates the already acute polarization of innovation systems in LMICs.[26] In view of the self-reinforcing process whereby agglomeration economies drive the regional clustering of innovation activity by both local and foreign-owned firms, it would be relevant for future research to monitor the regional concentration of R&D FDI and to reflect on possible policies to promote a more balanced technological development across regions. Thus, while debates about the impact and policy implications of R&D FDI in the innovation systems and international business literatures tend to focus on national economies and national policy responses, more emphasis on cities and regions would be necessary to properly address those challenges, drawing more extensively on insights from economic geography.

## Conclusions

During the last two decades, some middle-income countries have attracted an increasing share of R&D FDI, becoming important nodes within global innovation networks. These investments represent a powerful mechanism for cross-border knowledge sharing that can stimulate the process of technological catch-up. However, R&D FDI LMICs is still very concentrated in just a few large emerging countries, and in just a few regions and cities within these countries. Meanwhile, low-income countries and smaller middle-income countries remain largely excluded from this kind of global flow of knowledge. In view of these trends, future research and policy analysis should place the focus on the possibilities for fostering a more balanced distribution of R&D FDI across countries and regions. In this chapter, we have pointed out several promising avenues for a future research agenda that provides a more nuanced analysis of impact channels and policy options, building on contributions from international business, economic geography and innovation studies.

[25] P. 368 *supra*.

[26] Recent research has found that the levels of agglomeration of innovation in China, India and Russia significantly exceed those found in the US and the EU (Crescenzi and Jaax, 2017; Crescenzi and Rodríguez-Pose, 2017).

## Bibliography

Abramovitz, M., 'Catching Up, Forging Ahead, and Falling Behind' (1986), *Journal of Economic History* 46: 385–406.

Ahuja, G. and Katila, R., 'Technological Acquisitions and the Innovation Performance of Acquiring Firms: A Longitudinal Study' (2001), *Strategic Management Journal* 23: 197–220.

Amendolagine, V., Giuliani, E., Martinelli, A. and Rabellotti, R., 'Chinese and Indian MNEs' Shopping Sprees In Advanced Countries. How Good is it For Their Innovation Output?' (2018), *Journal of Economic Geography* 18: 1149–1176.

Amendolagine, V., Presbitero, A., Rabellotti, R. and Sanfilippo, M., 'Local Sourcing in Developing Countries: The Role Of Foreign Direct Investments and Global Value Chains' (2019), *World Development* 113: 73–88.

Arora, A. and Bagde, S., 'The Indian Software Industry: The Human Capital Story', in DRUID Conference 2006, Copenhagen.

Belderbos, R., Sleuwaegen, L., Somers, D. and De Backeri, K., 'Where To Locate Innovative Activities in Global Value Chains: Does Co-Location Matter?' (2016), *OECD Science, Technology and Industry Policy Papers* 30.

Bellak, C. and Leibrecht, M., 'The Use of Investment Incentives: The Cases of R&D-Related Incentives and International Investment Agreements', in A. T. Tavares-Lehmann, Perrine Toledano, Lise Johnson and Lisa Sachs (eds), *Rethinking Investment Incentives: Trends and Policy Options*, New York, Chichester: Columbia University Press, 2016.

Bruche, G., 'The Emergence Of China and India as New Competitors in MNCS' Innovation Networks' (2009), *Competition & Change* 13: 267–288.

Buehler, B., Coublucq, D., Hariton, C., Langus, G. and Valletti, T., 'Recent Developments at DG Competition: 2016/2017' (2017), *Review of Industrial Organization* 51: 397–422.

Cantwell, J., 'Innovation and International Business' (2017), *Industry and Innovation* 24: 41–60.

Chaminade, C. (ed.), *Technology driven FDI by emerging MNEs in Europe*, Lund: Lund University, 2015.

Chaminade, C., De Fuentes, C., Harirchi, G. and Plechero, M., 'The Geography and Structure of Global Innovation Networks: Global Scope and Regional Embeddedness', in R. Shearmur, C. Carrincazeaux, and D. Doloreux (eds), *Handbook on the Geographies of Innovation*, Cheltenham: Edward Elgar Publishing, 2016.

Chaminade, C., Lundvall, B.A. and Haneef, S., *Advanced Introduction to National Innovation Systems*, Cheltenham: Edward Elgar Publishing, 2018, chapter 10.

Chen, Y.-C., 'Why Do Multinational Corporations Locate Their Advanced R&D Centres in Beijing?' (2008), *Journal of Development Studies* 44: 622–644.

Chuang, W. B. and Lin, H. L., 'Overseas R&D Activities and Intellectual Property Rights – a Longitudinal Study of Multinational Enterprises in Emerging Economies' (2011), *Technology Analysis & Strategic Management* 23: 159–173.

Crescenzi, R. and Jaax, A., 'Innovation in Russia: The Territorial Dimension' (2017), *Economic Geography* 93: 66–88.

Crescenzi, R., Pietrobelli, C. and Rabellotti, R., 'Innovation Drivers, Value Chains and the Geography of Multinational Corporations in Europe' (2013), *Journal of Economic Geography* 14: 1053–1086.

Crescenzi, R. and Rodríguez-Pose, A., 'The geography of innovation in China and India' (2017), *International Journal of Urban and Regional Research* 41: 1010–1027.

D'Agostino, L. M. and Santangelo, G. D., 'Do Overseas R&D Laboratories in Emerging Markets Contribute to Home Knowledge Creation?' (2012), *Management International Review* 52: 251–273.

Dachs, B., 'Internationalisation of R&D: A review of drivers, impacts, and new lines of research', MPRA Paper No. 83367, 2017.

fDi Markets, a service from the Financial Times, (n.d.), available at www.fdiintelligence.com/fdi-markets.

Goerzen, A., Asmussen, C. G., Nielsen, B. B., 'Global Cities and Multinational Enterprise Location Strategy' (2013), *Journal of International Business Studies* 44: 427–450.

Govindarajan, V. and Ramamurti, R., 'Reverse Innovation, Emerging Markets, and Global Strategy' (2011), *Global Strategy Journal* 1: 191–205.

Guimón, J. and Salazar-Elena, J. C., 'Collaboration in Innovation between Foreign Subsidiaries and Local Universities: Evidence From Spain' (2015), *Industry and Innovation* 22: 445–466.

Guimón, J., Chaminade, C., Maggi, C. and Salazar-Elena, J. C., 'Policies to Attract R&D-Related FDI in Small Emerging Countries: Aligning Incentives with Local Linkages and Absorptive Capacities in Chile' (2018), *Journal of International Management* 24: 165–178.

Haakonsson, S., 'Offshoring of Innovation: Global Innovation Networks in the Danish Biotech Industry', in T. Pedersen, L. Bals, and P. D. Ørberg Jensen (eds), *The Offshoring Challenge: Strategic Design and Innovation for Tomorrow's Organization*, London: Springer, 2013.

Javorcik, B., 'Does Foreign Direct Investment Increase the Productivity of Domestic Firms?' (2004), *In search of spillovers through backward linkages, American Economic Review* 94: 605–627.

Kafouros, M. I., Buckley, P. J. and Clegg, J., 'The Effects of Global Knowledge Reservoirs on the Productivity of Multinational Enterprises: The Role of International Depth and Breadth' (2012), *Research Policy* 41: 848–861.

Lema, R., Quadros, R. and Schmitz, H., 'Reorganising Global Value Chains and Building Innovation Capabilities in Brazil and India' (2015), *Research Policy* 44: 1376–1386.

Lema, R., Rabellotti, R. and Sampath, P. G., 'Innovation Trajectories in Developing Countries: Co-evolution of Global Value Chains and Innovation Systems' (2018), *The European Journal of Development Research* 30: 345–363.

Manning, S., 'Customizing Clusters: On the Role of Western Multinational Corporations in the Formation of Science and Engineering Clusters in Emerging Economies' (2008), *Economic Development Quarterly* 22: 316–323.

Marin, A. and Arza, V., 'The Role of Multinational Corporations in National Innovation Systems In Developing Countries: From Technology Diffusion to International Involvement', in Bengt-Åke Lundvall, K. J. Joseph, Cristina Chaminade and Jan Vang (eds), *Handbook of Innovation Systems and Developing Countries*, Cheltenham: Edward Elgar, 2009.

Martinez, C., 'Insight into Different Types of Patent Families', *OECD Science, Technology and Industry Working Papers 2010/2*, Paris: OECD Publishing, 2010.

Medcof, J. W., 'Subsidiary Technology Upgrading and International Technology Transfer, with Reference to China' (2007), *Asia Pacific Business Review* 13: 451–470.

Mudambi, R., Narula, R. and Santangelo, G. D., 'Location, Collocation and Innovation by Multinational Enterprises: A Research Agenda' (2018), *Industry and Innovation* 25: 229–241.

Narula, R. and Dunning, J. H., 'Multinational Enterprises, Development and Globalisation: Some Clarifications and a Research Agenda' (2010), *Oxford Development Studies* 38: 263–287.

Pearce, R. and Papanastassiou, M., 'Multinationals and National Systems of Innovation: Strategy and Policy Issues', in R. Pearce and M. Papanastassiou (eds), *The Strategic Development of Multinationals Subsidiaries and Innovation*, Basingstoke: Macmillan Publishers, 2009.

Pietrobelli, C. and Rabellotti, R., 'Global Value Chains Meet Innovation Systems: Are There Learning Opportunities For Developing Countries?' (2011), *World Development* 39: 1261–1269.

Piscitello, L., Rabellotti, R. and Scalera, V., 'Chinese and Indian acquisitions in Europe: the relationship between motivation and entry mode choice', in A. Risberg, D. King and O. Meglio (eds), *The Routledge Companion to Merger and Acquisition*, London: Routledge, 2015.

Qu, Z., Huang, C., Zhang, M. and Zhao, Y., 'R&D Offshoring, Technology Learning and R&D Efforts of Host Country Firms in Emerging Economies' (2013), *Research Policy* 42: 502–516.

Reddy, P., 'New Trends in Globalization Of Corporate R&D and Implications For Innovation Capability in Host Countries: A Survey from India' (1997), *World Development* 25: 1821–1837.

Saxenian, A., 'The New Argonauts', in *Regional Advantage in a Global Economy*, Cambridge, MA: Harvard University Press, 2006.

Thursby, J. and Thursby, M., ‘Where Is the New Science in Corporate R&D?’ (2006), *Science* 314: 1547–1548.

UNCTAD, *World Investment Report 2005: Transnational Corporations and the Internationalization of R&D*. Geneva: United Nations Commission for Trade and Development 2005.

UNESCO Institute for Statistics (2018) Global Investments in R&D Fact Sheet No. 50, June 2018, UIS/FS/2018/SCI/50 https://unesdoc.unesco.org/ark:/48223/pf0000265401.

Von Zedtwitz, M., Corsi, S., Søberg, P.V. and Frega, R., ‘A Typology of Reverse Innovation’ (2015), *Journal of Product Innovation Management* 32: 12–28.

Wang, J., Xue, L. and Liang, Z., ‘Multinational R&D in China: From Home-Country-Based to Host-Country-Based’ (2012), *Innovation* 14: 192–202.