Global Corporate R&D to and from Emerging Economies

Max von Zedtwitz, GLORAD Center for Global R&D and Innovation, Kaunas University of Technology, Lithuania

Oliver Gassmann, University of St. Gallen, Switzerland

The re-emergence of China, India, and other formerly small economies as large markets and manufacturing powers has been one of the most significant events of the beginning of the 21st century. Well into the late 1990s, these countries played, at best, a peripheral role in global research and development (R&D) and innovation.

Expanding R&D into emerging economies

During the restructuring of industries in the wake of the rise and reshuffling of the new economy in the early 2000s, multinational corporations (MNCs) started to move R&D resources to countries with fast-developing markets or countries that at least promised future market growth, and to countries that offered low-cost access to exceptional talent and technology. China fit this bill perfectly, but also India, Brazil, the Russian Federation (Russia), and other countries—many along the Asia Pacific rim or in Latin America—attracted R&D investment from MNCs headquartered in the 'Triad' countries: those in Western Europe, North America (the United States of America and Canada), and Japan (Figure 1). Data from the R&D Locations database reveal that, between 2000 and 2015, the number of MNC R&D centres in emerging countries grew by a factor of five, while in the Triad countries this number merely doubled.[1]

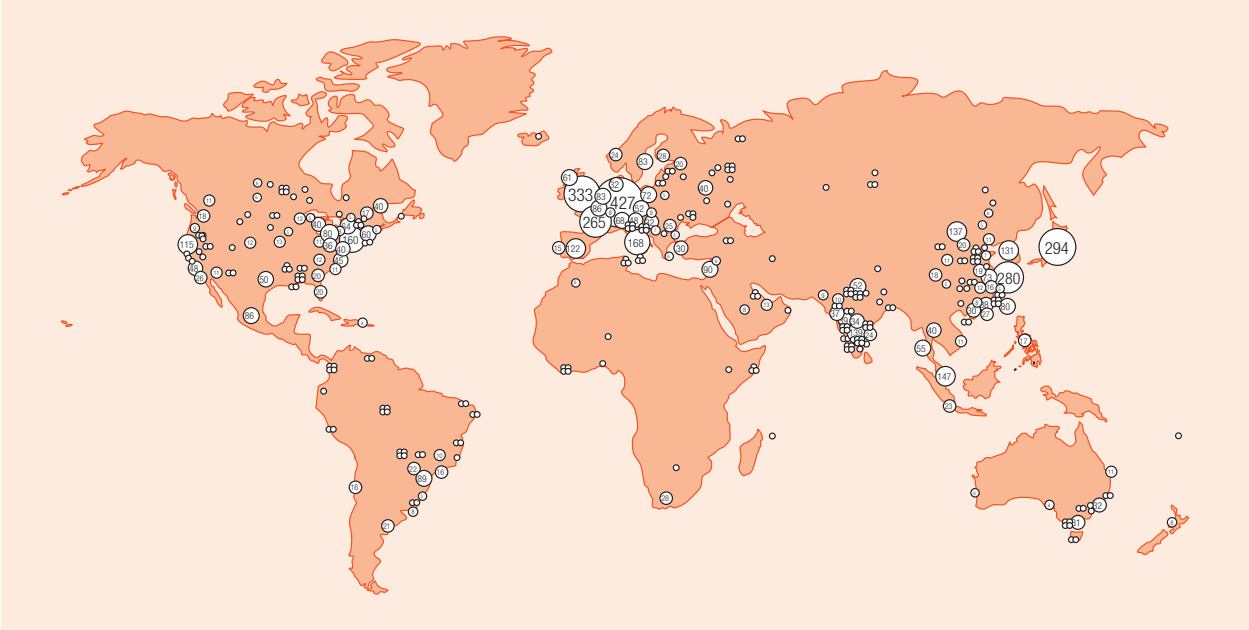
These new R&D centres were part of a strategy for MNCs to expand their global R&D footprint to connect to local markets and local talent. Their hosts provided easy-to-follow rationales for corporate executives to shift R&D investments abroad. For example, the BRIC countries (Brazil, Russia, India, and China) had a total of 18 universities in the ranking of the global 500 universities in 2003, but this grew to 40 universities in the 2015 ranking; of these, eight alone ranked among the top 200.[2] Chinese universities produced 7.5 million graduates in 2015, up from just 1 million in 2000.[3] Between 2000 and 2015 the number of domestic invention patent applications in China grew by a factor of 38—from about 25,300 to more than 968,000 applications per year.[4]

MNCs were not just moving to countries with low costs for doing R&D. They also used this opportunity to modernize their global R&D profile. The new R&D centres were housed in state-of-the-art facilities, employed the best and brightest of a young and ambitious generation, and focused on new technologies and applications that were possible only in markets with low or no switching costs. These centres developed unique sets of capabilities that gave their often larger, more established, and much more experienced cousins at home a run for their money.

Enter emerging market MNCs

The improvement of national science and technology systems was primarily targeted at making domestic companies more competitive, although foreign MNCs benefitted from better infrastructure and better-educated R&D employees. Local companies that initially benefitted from protected markets and preferential access to low-cost resources transformed themselves into innovative high-tech MNCs themselves: Examples are Huawei and TCL in China, Infosys and Tata in India, Embraer in Brazil, and Kaspersky Labs in Russia. As these companies have entered international markets themselves, they have established local R&D posts and R&D centres in target countries or—especially in the case of cash-rich Chinese firms—acquired competitors and integrated attractive technology resources. Huawei, for instance, set up its first international R&D office in Moscow as early as 1997. In 2015, Huawei had 16 global R&D centres outside China alone, and a total of 23 such centres worldwide. According to the R&D Locations database, Chinese companies had the 7th largest foreign footprint of all countries with 178 R&D centres set up or acquired outside China by the end of 2015.[5] Table 1 shows the origin ('Source countries') and targets ('Target countries') of all the

Figure 1: Global map of cross-border R&D centres



Source: R&D Locations database, accessed 5 March 2016; see http://www.glorad.org and von Zedtwitz and Gassmann, 2002.
Note: The figure shows a total of 5,877 cross-border R&D centres.

MNC centres in the R&D Locations database.[6]

Initially, these emerging market MNC (EMNC) R&D centres were focused on hiring overseas expatriates (e.g., Chinese graduates from US engineering programmes, a strategy that hurt local firms as much as it benefitted Chinese MNCs); they also emphasized ensuring a smooth transfer of technology from local competitors, universities, or acquisitions back home. In the meantime, many EMNCs established R&D centres to demonstrate innovation leadership, to attract the best people regardless of origin or ethnicity, and to steer global markets with products and technology from their home countries. The share of MNCs from countries outside the Triad rose from 29 in 2000 to 156 in 2015, with 98 alone coming from China.[7] And although the value of domestic patents in emerging countries is often debated, EMNCs have dramatically increased their share of global patent cooperation treaty (PCT) patents from 4.3% in 2000 to 21.5% in 2014. In 2005 only six EMNCs were among the top-100 PCT filers; there were 11 EMNCs in this group in 2015. It is mostly a China story, though, with seven of these top-100 PCT filers coming from China, two of them in the top 10: Huawei in the first spot and ZTE in the third, with 3,898 and 2,155 patent applications, respectively.[8] Armed with indigenously developed technology, these firms not only are equal partners in technology standardization decisions, they very often determine the direction of future technology standards in industries they now lead.

Patterns in global R&D evolution

The emergence of high-technology EMNCs from developing countries provides the opportunity to reassess the applicability, and value, of global strategy and innovation theory that was established on the basis of observing the behaviour and motivation of firms from developed countries only. For instance, does globalization help or hinder the internationalization of R&D and innovation? Given more transparent borders, more pervasive traveling, and more efficient information and communication technologies, is it easier to attract global R&D capability to a firm's home base than to expand an R&D network overseas? What exactly do EMNCs do?

The factor conditions of emerging markets still differ markedly from those experienced by the Triad countries during their foray into global R&D and innovation in the 1980s and 1990s, and national policy makers are applying the lessons that MNCs from those advanced markets have learned over the years. Many of their largest firms—EMNCs that

Table 1: Number of cross-border R&D centre establishments by source and target countries, 2016

Source countries	Target countries: Triad	BRIC	Rest of World
Triad	3,131	1,332	1,235
BRIC	192	23	66
Rest of World	146	86	44

Source: R&D Locations database, http://www.glorad.org, accessed 5 March 2016.
Note: The Triad includes Japan, Western Europe, the USA, and Canada.

are easily inside the global top 100 by revenue or market value—are still surprisingly domestic, not just in R&D. They are in good company: Many if not most companies in advanced markets have no global R&D either, and they run all of their product development and innovation activities from their corporate centre—which is usually in their home country. In fact, this is the de facto configuration for most companies when they start up, and most maintain this centralized R&D organization as a small and medium-sized enterprise even as they start distributing products internationally. A dominant market or technology position (e.g., Microsoft in the 1980s) allows these firms to concentrate R&D and innovation in their home country, where it can be controlled better for effectiveness, costs, and ownership. This is called the 'ethnocentric centralized configuration of R&D', also known as the 'do-alone' setup (see Figure 2 for an illustration of the five configurations discussed in the text).

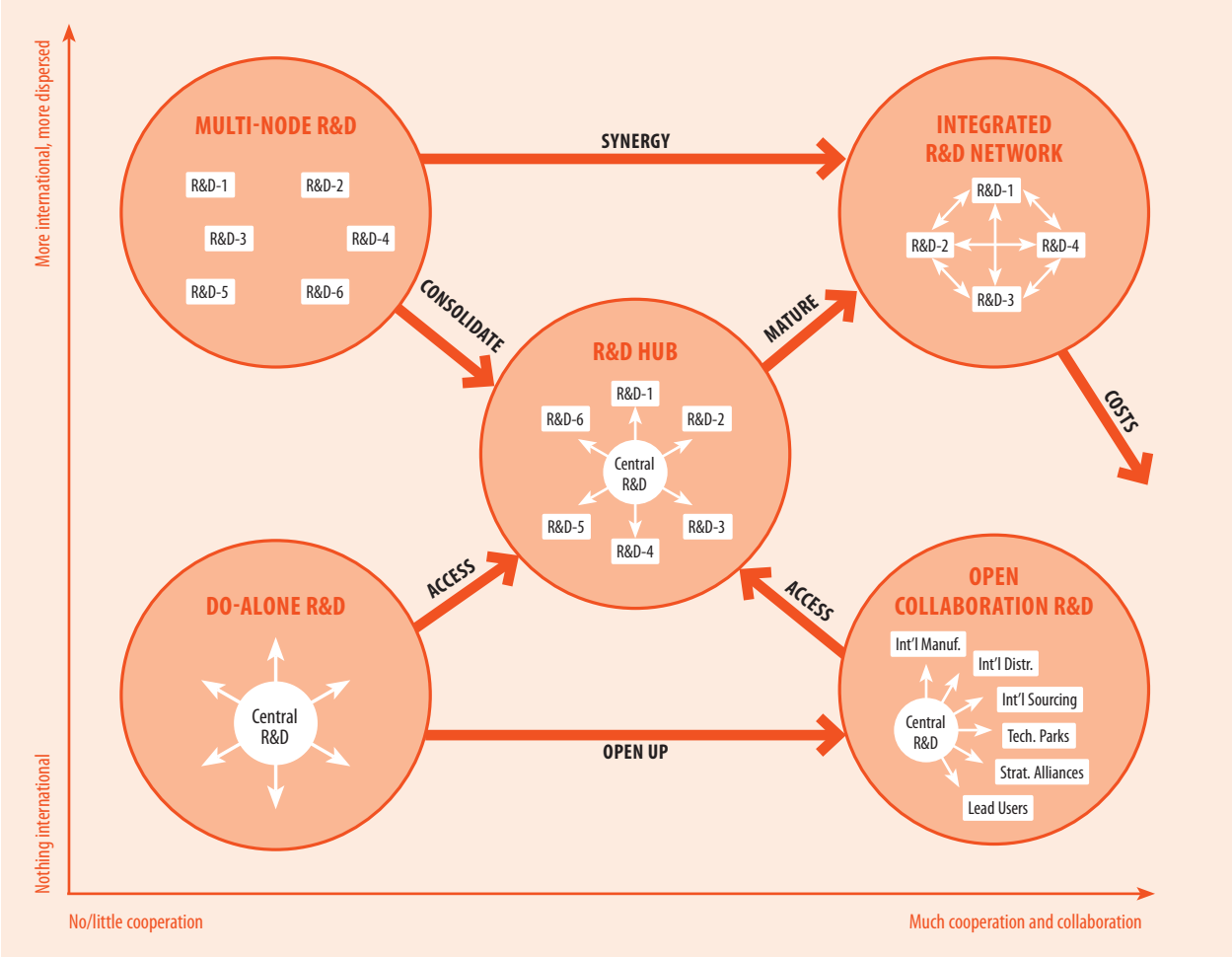
As companies further internationalize their horizons by expanding into new markets and new product offerings—that is, as they make strategic decisions about which technologies to pursue on their own and which ones to buy—they employ the support of specialized technology providers. They engage outwards, reaching out to universities and research laboratories for upstream R&D, and to lead-users and local joint venture partners for product development. Their R&D may still be very much centralized in just one location, but they cooperate across both geographical and industry borders to drive internal innovation. This is the geocentric centralized model, the 'open model' of innovation, a natural first step towards internationalized innovation for many companies. It is also the typical course of action for many local manufacturers in China and India that are trying to become product suppliers to global customers. Once they have established themselves as preferred original equipment manufacturing partners, they accumulate in-house R&D expertise, climb the value chain, and become original design manufacturing suppliers to overseas sellers, innovating at home, from an emerging economy, in cooperation with global brand leaders for the benefit of customers worldwide.

Once local markets become sizable for an MNC, its local market units start to support sales with local R&D tasked with product localization, product adaptation, and local product development. Corporate R&D sometimes confers local market scanning and technology intelligence roles onto such small R&D outposts. These local R&D units are specialized in focus and function, and they depend on the home-based R&D centre's technological guidance. Previously centralized R&D configurations, either of the do-alone or the open-collaboration type, thus expand their international reach. In sectors dominated by the efficient use of technology platforms (such as the automotive industry), this R&D hub model of global R&D is usually the optimal setup. Centrally coordinated R&D plans are executed with the support of local R&D units in different markets and countries. MNCs from countries with strong national cultures influencing global organization also tend to fall into this hub category.

In some MNCs the market orientation is so strong that all local activities and accountabilities are managed at the local level, with only financial functions reporting to the far-away parent holding company. Local R&D units develop products serving local customers, without much input from or coordination with R&D centres in the parent MNC's headquarters. These market-focused companies tend to compete on market proximity, service, and customer understanding rather than cutting-edge technology, which offers little room for differentiation. If technologies have matured globally, these local R&D centres develop their own R&D plans and product roadmaps. This form of running international R&D is the polycentric decentralized or 'multi-node' R&D organization. It is the perfect form for highly market-oriented companies in technologically mature environments with little need of global R&D coordination.

Some MNCs also arrive at a multi-node R&D configuration by virtue of mergers and acquisitions. This is especially the case for many Chinese firms searching for technology assets in industrialized

Figure 2: Global R&D organization of MNCs: Five typical configurations and how they evolve over time



Source: Based on Gassmann and von Zedtwitz, 1999.

Note: Each of the five configurations represents a typical way that MNCs organize global R&D around a headquarter R&D centre (solid white circles), subsidiary R&D units and foreign R&D partners (solid white boxes). The small white arrows denote the interaction within the R&D organization, and the large orange arrows represent the drivers and directions of the evolution of those configurations.

countries, but is certainly not limited to EMNCs. Once acquired, the future for the local R&D centre is uncertain and depends on the capabilities and competence of the R&D network of the acquiring company. Whether it is the external impetus of an acquisition and local mission redefinition or the internal realization of the potential for cost reduction and rationalization, MNCs are always tempted to rebalance a poorly coordinated multi-node R&D organization by either consolidating R&D resources into specific market or technology-facing units—that is, centralizing command and control back to a hub configuration—or by swapping R&D resources and plans such that the R&D units complement each other more harmoniously, with each R&D centre contributing a unique and significant value-added to the overall innovation effort, forming what is called an 'integrated R&D network'.

The integrated R&D network often appears as the holy grail of global R&D organization: Each centre is a centre-of-excellence in its own right, and innovation results from the global interaction of contributors in these centres under the leadership of a programme leader serving the global needs of the company in multiple markets simultaneously. Many pharmaceutical MNCs tend to fall in this category, as do many telecommunication companies: These are industries characterized by global products with high rates of innovation. But maintaining such a highly dispersed and coordinated network is not cheap, and MNCs with integrated R&D

networks will try to reduce management complexity by eliminating unnecessary R&D units when they can, selling or even closing them, to bring down the costs of the overall innovation effort. If they centralize into overseas R&D centres, their R&D internationalization may also go up rather than down, especially if domestic R&D is relatively expensive, as is the case for many advanced market MNCs.

Managing global R&D is more than just managing an international R&D footprint or coordinating foreign R&D teams—it is about managing the flow of innovation regardless of corporate allegiances and ownership, and appropriating the benefits irrespective of headquarter locations. No single form stands out as 'the best and only' way to do global R&D.[9] There is no 'one size fits all', and MNCs must choose carefully how to manage global innovation processes given their unique histories, provenance, and technological and competitive environments.

Global R&D and innovation: Recent trends and national policy

Two types of innovation have gained in popularity in the context of emerging markets: frugal innovation and reverse innovation. In frugal innovation, products are designed such that nonessential features are removed, product complexity is reduced, and manufacturing labour and material costs are minimized.[10] Although frugal innovation is by no means limited to specific geographies, it rose to prominence in India under the term 'Jugaad' or 'Gandhian' innovation; 'bottom-of-the-pyramid' and 'blow-back innovation' are also close synonyms. Of course, eliminating complexity and reducing cost in products are two major goals in R&D anywhere, and advanced market MNCs have long used the terms 'product defeaturing' or 'product localization' to characterize their product development approach to emerging markets. For innovators in developing countries, however, frugal innovation is often not a choice but a necessity. Unconstrained by global product plans or regulations, they bring their intimate market understanding to bear in developing perfectly suited 'good enough' solutions. Advanced market MNCs are trying to absorb these qualities in their own innovation efforts through local R&D centres in emerging countries, training R&D engineers in their more expensive bases elsewhere in the secrets of frugal innovation.

Whereas a frugal innovation may never leave its country of origin, a reverse innovation—by definition— must be introduced to an industrialized advanced country at some point.[11] Reverse innovations can be based on frugal innovation but do not have to be; some reverse innovations are actually very sophisticated and expensive offerings. Transferring an innovation from a developing country to an advanced one is not as trivial as one might expect, as customers in target markets may reject innovations from developing countries because they perceive them to be of lower quality, and even local management in advanced markets may fear that innovations from abroad cannibalize their own home-grown and often more expensive products. Crucial for the success of such a reverse innovation, especially if it originates from a local frugal innovation, is thus either the definition of a new product category—for example, one based on cost-effectiveness and different functionalities—or an entirely new business model. MNCs with global R&D centres have the opportunity to get involved in reverse innovation much earlier than MNCs that keep R&D at home. MNCs with globally integrated R&D networks do not wait for an innovation to be launched first in a developing country before it is transferred to an advanced one—they already conduct some if not all of the R&D, including design and discovery, in the developing country's R&D centre with a global launch in mind. This requires coordination between R&D centres and product management elsewhere.

Both of these recent types of innovation challenge the common assumption that who conducts the R&D is not as important as owning the result. Outsourcing R&D to third parties and purchasing technology 'as required' provides no competitive advantage over others. For global firms—from either advanced or emerging countries—it is important to be able to read local markets and to understand local innovations intimately and incorporate them as effectively as possible (as in the case of frugal innovation) and then leverage them globally as efficiently as possible (as in the case of reverse innovation). Managing that global flow of innovation is one of the key competencies of long-lasting multinationals that repeatedly and continuously balance the benefits of being global and local at the same time. This process does not come without glitches and mistakes, but successful MNCs are able to learn and respond quickly. They adapt their global R&D organization to run transnational innovation flows smoothly, finding 'the right form' in the context of their own corporate culture and in response to long-term changes in the business environment.

One understandable temptation for MNCs is to try to measure the impact of their global innovation activities for the purposes of better supervision and management; every meaningful effort to bring more clarity into this managerial and organizational conundrum should be supported. However, even academic circles concede that it is next to impossible to capture even local innovation fully, let alone innovation that is dispersed geographically (with all the various local legal challenges); furthermore, local innovation is also dispersed across different subsidiaries, often in collaboration with local research institutes or joint venture partners. This lack of transparency undermines the trust that is required for true win-win partnerships between local and global innovators, and forces them to focus on quick wins and tangible results. The data show that international R&D is much more short-term oriented than home-based R&D, which is where most of the strategic long-term research is still taking place.

National policy can reasonably influence only what happens at local subsidiaries of MNCs, within a nation's territorial borders. For the most part, national S&T policy has favoured and supported foreign MNCs to invest in local R&D, expecting positive spillovers such as inbound technology transfer, greater local patenting output, a more highly skilled labour force, and ultimately a better quality of life through better products and technology. But with MNCs increasing their skills in managing global innovation flows, products that are developed locally and supported financially through a nation's fiscal subsidies may now benefit customers in other countries as well. This is, of course, not a bad thing, and various transfer pricing schemes are in place to soften the effects. But ultimately the local presence of MNCs rests on their ability to exploit just that: to source innovation locally and to apply it globally.

Although national policy favours inbound innovation flows, they may be less supportive of such outbound reverse innovations.[12] China's Going Out policy (Zǒuchūqū Zhànlüè) has supported China's rise as a major source of foreign direct investment, and is in no small part responsible for China's global R&D footprint as well.[13] The primary idea is to improve the global competitiveness of Chinese MNCs and to advance technological capability in China. Policy makers have every incentive to support inbound innovation flows and to improve quality of life at home in the process. Dissipation of innovations to other countries is not the primary goal of governments seeking to enhance the standing of their domestic industry. The most experienced MNCs, however, have learned that they gain the most when innovation flows in both directions, when subsidiaries and headquarters complement each other, and when the creative effort of one team in one location—whether in a developing country or an advanced one—can support the development of a market opportunity somewhere else. Global R&D and innovation by private MNCs is thus a natural counterbalance to the more particular, locally optimizing ambitions of national policy.

To expand pervasive win-win scenarios for innovation, developing global innovation partnerships across countries must not be confined to only a few MNCs: Entire countries and their innovation ecosystems must collaborate and facilitate innovation flows not only within but also across national boundaries. The European Framework programmes are indicating the direction that such multilateral R&D collaborations could take (the same-spirited initiatives in China and the USA are also encouraging). After all, the most pressing global problems—such as environmental pollution, population migration, and economic imbalance—will be solved only if countries and companies find ways to cooperate and develop innovative solutions together.

Notes

1 As per the R&D Locations database hosted at the GLORAD Center for Global R&D and Innovation; see http://www.glorad.org.

2 ARWU, 2015.

3 National Bureau of Statistics of China, accessed 5 March 2016.

4 SIPO, 2015; accessed 5 March 2016. See also Haour and von Zedtwitz, 2016.

5 As per the R&D Locations database hosted at the GLORAD Center for Global R&D and Innovation; see http://www.glorad.org.

6 For an early study on cross-border R&D flows involving developing countries, see von Zedtwitz, 2006.

7 See the Fortune 500 Ranking, available at http://www.fortune.com/global500.

8 WIPO, 2015; accessed 5 March 2016.

9 See Boutellier et al., 2008, for a rich compendium of 22 case studies of both advanced and emerging market MNC R&D organizations.

10 Zeschky et al., 2014.

11 Examples of research on reverse innovation include Zeschky et al., 2014; von Zedtwitz et al., 2015; and Haour and von Zedtwitz, 2016.

12 National policy makers too often overestimate the attraction of tax advantages, but the main drivers for internationalization are markets and resources. Markets cannot be changed that easily—even the most conservative Keynesian has to admit this—but supplying resources in the right quality and quantity is the biggest playing ground for policy makers. This means investing in cutting-edge education, developing a strong research university, and supporting an intellectual property regime that encourages win-win technology spillover to industry. This allows innovation ecosystems to arise, which in turn attract the best R&D labs from abroad.

13 China's Going Out policy has recently been updated by its Belt and Road Initiative, which also calls for greater international R&D collaboration with countries in Central Asia, Africa, and Europe; see http://english.gov.cn/archive/publications/2015/03/30/content_281475080249035.htm.

References

ARWU (Academic Ranking of World Universities). 2015. *Academic Ranking of World Universities, 2003–2015.* Shanghai: SJTU Press. Available at http://www.shanghairanking.com.

Boutellier, R., O. Gassmann, and M. von Zedtwitz. 2008. *Managing Global Innovation: Uncovering the Secrets of Future Competitiveness.* 3rd ed. Springer: Heidelberg.

Gassmann, O. and M. von Zedtwitz. 1999.'New Concepts and Trends in International R&D Organization'. *Research Policy* 28: 231–50.

GLORAD Center for Global R&D and Innovation. No date. 'R&D Locations' database. Available through http://www.glorad.org, accessed 5 March 2016.

Haour, G. and M. von Zedtwitz. 2016. *Created in China: How China Is Becoming a Global Innovator.* London: Bloomsbury.

National Bureau of Statistics of China. 2015. *China Statistical Yearbook 2015.* Beijing: China Statistics Press. Available at http://www.stats.gov.cn/.

SIPO (State Intellectual Property Office). 2015. *Statistics of the State Intellectual Property Office of the PRC.* Beijing: State Intellectual Property Office. Available at http://english.sipo.gov.cn/statistics/.

WIPO (World Intellectual Property Organization). 2015. *Statistics on the Hague, Madrid and PCT Systems.* Geneva: World Intellectual Property Office. Available at http://www.wipo.int/ipstats/en/statistics/pct/.

von Zedtwitz, M. 2006. 'International R&D Strategies of TNCs from Developing Countries: The Case of China'. In *Globalization of R&D and Developing Countries,* ed. UNCTAD. New York: United Nations. 117–40.

von Zedtwitz, M., S. Corsi, P. Soberg, and R. Frega. 2015. 'A Typology of Reverse Innovation'. *Journal of Product Innovation Management* 32 (1): 12–28.

von Zedtwitz, M. and O. Gassmann. 2002. 'Market versus Technology Drive in R&D Internationalization: Four Different Patterns of Managing Research and Development'. *Research Policy* 31 (4): 569–88.

Zeschky, M., S. Winterhalter, and O. Gassmann. 2014. 'From Cost to Frugal to Reverse Innovation'. *Research Technology Management* 57 (4): 20–27.