Big Pharma’s Internationalisation of R&D to China

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ABSTRACT  China’s increasing integration into the global pharmaceutical value chain is occurring at a time when big pharma’s traditional R&D model has entered a period of crisis, and when China faces significant challenges in providing healthcare for its huge and rapidly ageing population. Despite China’s ambitions of promoting its own pharmaceutical sector, it is likely to continue to depend for some time on significant contributions from foreign companies. While this situation provides considerable opportunities for big pharma companies to expand their markets in China, they are also hoping that offshoring aspects of their R&D to China may contribute to reconfiguring their current R&D model with its weak record of producing new drugs. Drawing on interviews with a small number of pharma R&D centres in Shanghai, patent analyses and industry reports, we provide insights into both the challenges and the opportunities associated with the early stages of establishing such centres in an emerging region with a rapidly growing market. This paper contributes towards a more nuanced view of the internationalization of R&D in emerging regions.

Keywords: China; pharmaceutical sector; globalizing innovation; foreign R&D centres

1. Introduction

China’s emergence as a significant contributor in the global pharmaceutical value chain coincides with a critical juncture in an industry dominated by “big pharma”, with falling revenues and competitiveness creating a possible need to reinvent the global pharmaceutical industry’s R&D model. Among the reasons for big pharma’s falling revenues is the so-called patent cliff, with the period covering patents of former high revenue blockbuster drugs about to expire. In addition, a dearth of new drugs and intense competition from generic drug manufacturers, some of whom are from India and China, are also having a negative impact on big pharma’s revenues (Munos, 2009). Such pressures on the
competitiveness of big pharma are also among the reasons why regions like China are increasingly being seen as providing significant scope not only for reducing costs and expanding markets, but also for making some contribution to reconfiguring the drug development model.

One of the objectives of this paper is to examine the growing integration of emerging economies within the globalization of innovation, which involves an expanding international scope in the generation and diffusion of technologies. This paper examines the recent stage in the evolution of big pharma’s R&D internationalization strategies with some activities such as active pharmaceutical ingredients (APIs) and clinical research being offshored to emerging regions such as China. This partly reflects a shift from home-based exploiting strategies towards a greater emphasis on augmenting the stock of knowledge by gaining access to local knowledge in rapidly expanding, though complex, markets (Kuemmerle, 1999). While lower costs in key areas such as clinical research are important in attracting such investment, a broader mix of factors, including the abundance of young talent in science and technology, the potential offered by a rapidly expanding healthcare market and the huge scale of state expenditure in healthcare also contribute towards this focus on emerging regions. The timing of the shift in big pharma investment to China is related, therefore, to a convergence of factors arising from the fall in competitiveness in the current business model.

In this paper we build on the literature examining R&D internationalization by multinational companies. Much of the focus to date in the literature has been on a recent shift by multinational companies towards augmenting their stock of knowledge by tapping into other regions. The attention, however, has been primarily on developed regions, and there has been little investigation of the relation between the role of foreign R&D activity and national policies, or on the differences between the objectives of host countries seeking to promote their own indigenous innovation and the objectives of foreign investors. The paper explores why and how pharmaceutical firms are establishing R&D laboratories in China and outsourcing their R&D to local firms and the role played by local R&D capabilities in this process. This can offer insights into the process of R&D internationalization in less-developed countries in science-based industries, in the context of relatively weak science and technology infrastructure, intellectual property rights and regulatory environment, with implications for safety and quality. By examining the relation between big pharma’s R&D internationalization and the specificities of China’s emerging pharma market, this paper contributes towards expanding our understanding of R&D internationalization beyond the current focus on developed regions.

2. Internationalization of R&D and Less-Developed Countries

An important element in the globalization of R&D has been the involvement of multinational corporations through their R&D activities in host countries and their acquisition of existing R&D laboratories or greenfield R&D investment in host countries (Archibugi & Michie, 1995). A much quoted distinction in relation to R&D internationalization strategies is between home-base exploiting and home-base augmenting R&D. Home-base exploiting R&D (Kuemmerle, 1999) or asset-exploiting R&D (Dunning & Narula, 1995) is mainly concerned with exploiting firm-specific capabilities in foreign environments. As firms establish manufacturing facilities abroad and assign increasingly
complex products to them, locating R&D sites in close proximity to factories to adapt products to local conditions becomes a necessity (Chiesa, 1996; Medcof, 1997).

In contrast, home-base augmenting R&D (Kuemmerle, 1999) or strategic asset seeking R&D (Dunning & Narula, 1995) involves monitoring or acquiring competitive advantages which are complementary to those possessed by the firm, to augment its stock of knowledge. This strategy requires the development of links with host-country R&D organizations and systems to enhance the knowledge base at home, connect more closely to the foreign R&D environment and access local knowledge (Florida, 1997). Specific nations or regions might be particularly attractive locations for R&D facilities because of potential knowledge spillovers from existing and productive local R&D organizations, such as research universities, publicly funded research institutes and innovative competitors (Cantwell, 1991).

While much of the literature has focused on the internationalization of R&D from developed countries' multinationals in other developed countries, more recently there has been a shift to less-developed regions, and particularly India and China (Chen, 2004; Dossani & Kenney, 2007; Niosi & Tschang, 2009; Massini & Miozzo, 2012). Less is known about this process in less-developed regions, particularly in the context of a relatively weakly developed local science and technology infrastructure, an embryonic regulatory environment and poor intellectual property protection, which can have implications for quality and safety.

Indeed, the traditional understanding of the R&D function of multinational companies was derived from internationalization theory, which saw the role of subsidiaries as being supportive of the R&D activity of the parent company rather than being innovative in itself (Rugman, 1981). Such earlier conceptualizations placed more emphasis on home-based advantages rather than on the potential afforded by the knowledge resources of host countries (Buckley & Hashai, 2005). With companies moving from this earlier model of transferring innovation to foreign subsidiaries to be adapted to the needs of the local market, the centralized view of R&D is no longer regarded as adequate by scholars who argue that multinationals are tapping into advantageous regions in order to augment their knowledge (Dunning, 1997; Kuemmerle, 1997; Davis & Meyer, 2004).

Castellani et al. (2013), referring to the extensive evidence of multinationals establishing R&D labs in foreign locations, note the increasing tendency to tap into the local pool of competences and that in many cases subsidiaries’ mandates have evolved into competence creation rather than competence exploitation (Cantwell & Mudambi, 2005). According to Castellani et al. (2013), the most significant costs for establishing remote R&D labs are more related to institutional barriers to effective communications rather than physical distance per se, and much progress has been made in developing more effective systems of circulating knowledge within the networks of multinationals in recent years. Sectoral differences are also important in explaining the geography of innovation, with agglomeration effects being dependent on industry structure, the stage in life cycle of firms, and the underlying nature of the knowledge base (Frenken & van Oort, 2004).

In pursuit of the knowledge-based economy, countries have begun to target Foreign Direct Investment (FDI) projects involving R&D, as it is seen as a high-end function (Enderwick, 2005). In the development of innovation policy, however, Costa and Filippov (2008) note that foreign-owned subsidiaries have been for the most part overlooked. Part of the explanation may be related to differences in objectives between host countries.
which are primarily interested in promoting sustainable development, and the goals of foreign companies which are more focused on profit and market concerns (Dunning, 1997). Despite being part of a host’s country’s innovation system, innovation policy tends to ignore the particular characteristics of foreign-owned subsidiaries. Subsidiaries that are better positioned within their corporate network have greater potential for contributing higher value added activities to the host economy (Costa & Filippov, 2008). While many have expressed scepticism about knowledge transfers from foreign companies, Zanfei (2005) argues that multinationals make many positive contributions to innovation in host economies such as training workers and management, demonstrating the feasibility of new technologies and introducing innovative organizational and management practices.

Cantwell and Santangelo (2000), drawing on US patent data, show that multinationals are now more likely than in the past to expand their R&D activities beyond their home base, but they also find that the technologies they develop abroad are less science-based and less dependent upon tacit knowledge than those developed at home. However, within the science-based industries, firms may generate abroad some technologies that are heavily dependent on tacit knowledge, but in areas outside their own core technological competencies. The study by Le Bas and Sierra (2002) confirms this view. Based on a study of multinationals firms with the greatest patenting activity in Europe, they found that the large majority of the firms locate their R&D activities abroad in technological areas where they are relatively strong at home, with home-base augmenting R&D being a more prevalent strategy than home-base exploiting R&D. Thursby and Thursby (2006) point out that multinational companies are more likely to get involved in novel applications of science in emerging countries as opposed to application of science currently used by the firm in more developed regions.

Since the mid-1980s, multinationals have started conducting a small portion of their strategic R&D in some less-developed countries. Both technology considerations (access to science and technology resources) and cost considerations play an important role. By establishing linkages between the local innovation systems and multinationals’ worldwide R&D network, such R&D helps to integrate some less-developed countries into global technology development activities (Reddy, 2011). Increased decentralization of R&D to regions like India and China has been associated with technological developments facilitating the separability of innovation activities. Greater standardization and homogenization of processes have accompanied globalization, resulting, perhaps in a paradigm shift, with multinationals offshoring subsets of R&D to locations with a plentiful supply of skilled talent at relatively lower cost.

Surveys of the locational pattern of multinational R&D confirm a trend towards increased levels of decentralization (The Economist Intelligence Unit, 2007). Among the key factors influencing the offshoring of R&D activity are the increasing costs and complexity of the innovation process, regional talent shortages and collaboration with university scientists. Between 2004 and 2007, multinationals increased their R&D sites by 6% and of these new sites, 83% were located in either China or India, with 91% of additional staff being added by these companies in these two locations (Jaruzelski & Dehoff, 2008). China was a top “net importer” of R&D, where US$24.7 billion of spending was accounted for by foreign companies. It should be noted, however, that R&D spending in healthcare is more concentrated globally than that of other sectors, with a relatively small share of R&D investment going to less-developed regions.
Yet, an UNCTAD (2005) survey of global firms on the most attractive locations for R&D showed 61.8% choosing China with the US in second place at 41.2%. In relation to US firms in China, some have suggested that they carry out little R&D and remain quite dependent on supporting the activities of the parent company (Branstetter & Foley, 2007). More generally, various studies suggest that foreign firms investing in China are less R&D intensive than domestic firms, partly because of poor intellectual property regulation (OECD, 2008). This OECD evaluation of innovation in China suggests that foreign R&D activity in China was mainly focused on short-term adaptation to the market, with only a minority of centres integrating their R&D in China into their global R&D. Others have argued that foreign firms may be reluctant to carry out R&D because China is a laggard in relation to institutional development, which has an impact on the innovation performance of firms (Opper & Schwaag Serger, 2008). China, however, with its new push for indigenous innovation, is determined to use the leverage of its huge market and its control over public procurement to place pressure on multinationals that are slow to register patents in China (Grimes & Du, 2013). While foreign firms were reluctant to register patents in China initially, the need to protect their intellectual property in an increasingly attractive market is leading to a higher level of local registration.

3. China’s Integration into the Global Pharmaceutical Value Chain

R&D networks in the pharmaceutical industry have been the focus of many analyses (Cockburn & Henderson, 1996; Pisano et al., 1988). These large-scale global scientific discovery and development networks involve not only pharmaceutical firms’ headquarters and their subsidiaries but also biotechnology companies and universities. The specific nature of the pharmaceutical value chain involves a development cycle of 10 years or more and a range of activities from drug discovery and development to identifying promising candidates, animal testing and later, trials with humans to ensure the safety and effectiveness of drugs (Wadhwa et al., 2008). The composition of the value chain, with 10 or more parallel processes in the manufacturing process alone, allows for the splitting of that process with early stage activities in low-cost locations and later stages in locations with high quality standards (Mullin, 2013). The emergence of molecular biology and of genomic sciences in recent years, and technological developments particularly in combinatorial chemistry, have enabled the increased outsourcing of parts of the innovation process in biopharmaceuticals (Reddy, 2011). Whereas previously big pharma companies carried out the whole range of processes in the value chain, more recently small biotechnology firms specializing in particular services at different stages of the value chain have emerged.

Concurrently, these processes have enabled the offshoring of some of its activities from developed regions in which big pharma, which dominates the value chain, has concentrated its activities to date, to lower cost locations in the emerging regions. Industry consultants, for example, have been highlighting how big pharma’s traditional business model based around very significant R&D investment to produce blockbuster drugs has entered a period of crisis for a number of reasons. According to Kandybin and Genova (2011), the recent period has been characterized by declining profits and rising costs which is adding to the increased pressure on the competitiveness of the traditional model. This fall in competitiveness is partly related to growing competition from generic drug companies which has been eating into the market share of big pharma, exploiting the “patent cliff”, as more
blockbuster drugs come to the end of the period covered by patents (Davidson & Greblov, 2005). In addition to external pressures, big pharma has also been experiencing its own internal problems associated with declining R&D productivity and an anaemic pipeline of new drugs. As Munos (2009) explains, the industry is increasingly caught between its output of new drugs which is linear and costs that are increasing exponentially.

From the mid-2000s, Western pharmaceutical companies began R&D operations in China, with Roche starting operations in 2004, Pfizer and Sanofi-Aventis in 2005, GlaxoSmithKline (GSK) and AstraZeneca in 2007, Novartis in 2008, and both Eli Lilly and Johnson & Johnson in 2009 (Hughes, 2010). The scarce amount of data on the internationalization of R&D activities of pharmaceutical companies leads us to argue that less-developed countries play a minor role in the globalization of R&D. Indeed, publications by big pharmaceutical companies in less-developed countries have increased but remained very low compared to those in developed countries, and seem to be associated with “development” rather than “research”, possibly related to the adaptation to local market and the coordination of clinical research outsourced to local contract research organisations (CROs) or public centres (Rafols et al., 2013).

4. Method: Rationale, Design and Questions

The research objective was to learn more about the operations of Western pharmaceutical companies in China. These companies constitute a major part of the group known as “big pharma” and have R&D investments in China ranging between US$3.56 and US$9.4 billion (Table 1). Their sales in China account for between 0.9% and 2.7% of global sales (Table 2).

This is an exploratory case study, which seeks to understand the nature and challenges of the offshoring of Western pharmaceutical companies R&D activity to China within the context of China’s increasing integration into the global pharmaceutical value chain. In line with the exploratory nature of our research, data collection followed a loose timeline, with overlap with data analysis, a common feature of theory building through case study (Eisenhardt, 1989). We sought what happened within a case by looking beyond descriptive features and studying the surrounding context.

### Table 1. Top 10 pharmaceutical multinationals in China by investment (US$ billion)

<table>
<thead>
<tr>
<th>Company</th>
<th>Investment</th>
</tr>
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<tbody>
<tr>
<td>Pfizer</td>
<td>9.4</td>
</tr>
<tr>
<td>Roche</td>
<td>9.2</td>
</tr>
<tr>
<td>Merck &amp; Co.</td>
<td>8.12</td>
</tr>
<tr>
<td>Novartis</td>
<td>8.08</td>
</tr>
<tr>
<td>Johnson &amp; Johnson</td>
<td>6.84</td>
</tr>
<tr>
<td>GSK</td>
<td>6.09</td>
</tr>
<tr>
<td>Sanofi</td>
<td>5.94</td>
</tr>
<tr>
<td>AstraZeneca</td>
<td>5.3</td>
</tr>
<tr>
<td>Eli Lilly</td>
<td>4.88</td>
</tr>
<tr>
<td>Bristol-Myers Squibb</td>
<td>3.56</td>
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</table>

We drew on both primary and secondary data. We carried out a series of field visits to Shanghai between 2009 and 2011, examining the evolving state of investment in R&D activity by a range of multinational companies in science and technology, including three pharmaceutical companies and a US clinical trials company. We also explored United States Patent and Trademark Office (USPTO) patents in the US with Chinese citations or Chinese inventors for the top Western pharmaceutical multinationals. Finally, we explored a wide range of industry and consultancy reports on the pharma sector in China, and tracked media coverage of the key companies involved.

Interviews were conducted in Shanghai, which is the most significant location in China for big pharma R&D investment, although the overall number of R&D centres is relatively small. Around 50 hours of interviews with the senior management of R&D centres were conducted examining the challenges of establishing R&D activity in China in the context of a changing industrial and innovation policy environment, in which greater emphasis was being placed by the state on promoting indigenous innovation. Interviews were taped and subsequently transcribed for analysis. Semi-structured interviews were organized around a set of questions, each devoted to a specific issue area: (1) the role of the R&D centre in the global corporation; (2) the implications of industrial and innovation policy, especially concerning patents and intellectual property protection; (3) the supply of skills and the role of returnees and (4) the involvement of foreign companies’ R&D in China’s market.

While this paper focuses specifically on pharma R&D activity in China, the experience of R&D centres in other related sectors also adds useful insights to the common challenges facing foreign R&D centres in China. Because of the many challenges facing foreign companies in China in relation to legal and political issues and the embryonic nature of institutional frameworks in areas such as intellectual property regulation, foreign researchers conducting company interviews in China can encounter particular challenges in dealing with what are often sensitive issues.

The interview transcripts, the industry reports and patent analyses were considered by the authors, who compiled the material into different categories, which began with the main topics of the interviews. The authors spent considerable time sharing interpretations to achieve consensus on the findings regarding the nature and challenges of the operations of Western pharmaceutical companies in China.

### Table 2. Importance of sales in China for pharmaceutical multinationals

<table>
<thead>
<tr>
<th>Company</th>
<th>Chinese sales as % of global sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>AstraZeneca</td>
<td>2.7</td>
</tr>
<tr>
<td>Pfizer</td>
<td>2.4</td>
</tr>
<tr>
<td>Sanofi</td>
<td>2.2</td>
</tr>
<tr>
<td>Roche</td>
<td>2.0</td>
</tr>
<tr>
<td>GSK</td>
<td>1.6</td>
</tr>
<tr>
<td>Merck &amp; Co.</td>
<td>1.4</td>
</tr>
<tr>
<td>Novartis</td>
<td>1.1</td>
</tr>
<tr>
<td>Johnson &amp; Johnson</td>
<td>0.9</td>
</tr>
</tbody>
</table>

5. Findings

Consistent with the method outlined above, the key results can be grouped into six sections: reconfiguration of pharma’s R&D model and China, attractions and limitations of China for big pharma, concentration of Chinese firms on generics and APIs, clinical research outsourcing in China and nature of big pharma R&D in China.

5.1. Reconfiguration of Big Pharma’s R&D Model and China

Our fieldwork reveals that despite the significant challenge from generic drug companies, particularly in emerging markets, it is precisely in markets such as China that big pharma sees significant opportunities for reducing production costs, expanding their market share and bringing about major changes in the overall drug development model. According to one venture capitalist with whom we had discussions during fieldwork, a part of big pharma’s strategy includes developing generic versions of previously successful drugs either independently or through collaborating with generic drug companies. Indeed, this confirms repeated claims that big pharma is too bureaucratic to be innovative and should leave the early stages of R&D to more nimble biotech companies, which are often under-funded (Kessel, 2011; Kessel, 2013). Part of the reconfiguration of big pharma’s model, therefore, involves a global search for intellectual property from small biotech companies for potential products during the various stages of clinical trials (Salter, 2009, p. 68). This search can proceed through mergers and acquisitions or through joint ventures, while different aspects of R&D can be allocated to particular locations (Goodall et al., 2006). A significant loss of intellectual property can be avoided in locations like China by segmenting R&D into particular slices (Bruche, 2009). It is within this context, therefore, of both challenges and opportunities that we can see the increasing shift of big pharma R&D activity to China.

The share of foreign R&D being invested in emerging markets is still relatively small compared to developed regions. In 2010, for example, US foreign affiliates invested only 3.7% of all US R&D invested overseas in China. Despite this, however, there is growing concern in countries like the UK in which there was a loss of 6000 pharmaceutical R&D jobs in 2011, including 2400 which were lost from the closure of Pfizer’s R&D centre at Sandwich (Jack, 2011). Pfizer recently reduced its R&D budget from $9 billion to $3 billion, and despite the closure of its 2400-person research lab in Ann Arbor, Michigan in 2007, the overall effect to date has been a greater concentration of R&D activity in the US. Since its merger with Wyeth, Pfizer has only four major R&D sites globally, down from 20 sites at the time of acquisition in 2009 (Kessel, 2011). Such closures are explained by management as being a result of the need to free up fixed assets in old plants, providing opportunities for a more flexible approach in new locations, but it is more widely interpreted as one of the consequences of the failure of the current big pharma R&D model more generally and also a failure of policymaker awareness of what very well could be a significant shift in this R&D model. Part of the new approach could be a move away from the traditional in-house laboratory approach towards greater reliance on outsourcing research to universities and small biotechnology companies both in developed and emerging regions. Rather than a fundamental shift in the paradigm of drug development, however, Kessel (2011) argues that many of the cost-
cutting measures being adopted by big pharma are more related to short-term efforts to increase earnings.

5.2. Attractions and Limitations of China for Big Pharma

Although China presents considerable attractions for foreign pharmaceutical companies, reaping the benefits of these opportunities also involves considerable challenges. Because of lower costs and also because of potential market growth, both India and China have already become important offshore centres, particularly for preclinical R&D, large clinical trials and contract manufacturing (Wadhwa et al., 2008). The huge growth in demand for healthcare together with China’s expenditure in biomedicine, estimated to be $71 billion in 2011, partly explains the increased focus by big pharma in establishing manufacturing and R&D centres in China. The uniqueness of the genomics and metabolomics of the Chinese population requires new R&D investment by multinationals in Asia and will also give competitive leverage to domestic R&D entrants (Bioassociate, 2012).

According to one industry consultant, with the number of people earning between $7000 and $27,000 expected to grow to 75% of China’s population by 2020, the rapidly increasing numbers of patients with the ability to pay presents both a challenge for China’s healthcare system and opportunities for big pharma companies in China (Furchielli, 2013a). Since many diseases were either not previously treated or misdiagnosed, the numbers with chronic conditions such as hypertension and cancer are rapidly expanding. For example, recent estimates suggest that China has 114 million diabetics and perhaps as many as 493 million prediabetics (Huang, 2013). The projected programme of urbanization on an unprecedented scale in the coming decades is likely to increase these numbers significantly, which, together with the rapid ageing of China’s population which is estimated to have 223 million persons 65 years and over by 2030, will place health system under increased pressure.

The enormous benefits which such a burgeoning healthcare system offers foreign pharmaceutical companies at a time of falling competitiveness in more developed regions must be qualified by the many challenges faced by such companies in the Chinese market. It is not surprising therefore that the Financial Times reports that, although China has already become an important market for big pharma companies, it contributes only 1–3% of global revenue for most foreign companies (Table 1). McKinsey’s 2012b report “Healthcare in China” advises companies, for a number of reasons, to think twice about investing in China. One reason for caution relates to the fragmented nature and complexity of China’s market with 3700 domestic companies accounting for 75% of annual sales, of which 95% operate in the low value generics market (Dierks et al., 2013). Most of China’s needs are met by local drug companies selling generics, with only between 6% and 7% being patent-protected innovative drugs. Also with 40% of China’s healthcare budget being spent on medicine compared with 10–12% in Western countries, not surprisingly big pharma companies in China are experiencing considerable political pressure to reduce prices (KnowledgeWharton, 2013a).

Yet, because of the growing significance of the Chinese market, some multinationals like GSK, Eli Lilly and Novartis have already moved into a more mature phase in R&D in China, shifting from late-stage drug development and R&D outsourcing to setting up a second wave of more fully integrated R&D capabilities (Li et al., 2008). The level of
investment in China by big pharma companies to date reveals considerable commitment to this market (Table 2).

Despite this commitment, the innovative output is low as shown by an analysis of patents. Only 1.78% of the 9543 patents granted by the USPTO between 2004 and 2014 by the top big pharma companies had Chinese citations and only 1.44% had Chinese inventors (Table 3). Of the latter, Roche accounted for 65% and Novartis for 18%.

From our fieldwork, it is clear that the strategy of developing China as a major pharmaceutical R&D hub, however, is likely to be a long-term one with a view to developing a significant market share in the coming 10–20 years, as growth opportunities in other markets decline. Many of the challenges faced by foreign pharmaceutical companies in China relate to the early stage of development of China’s pharmaceutical/biomedical ecosystem, which also has implications for China’s own ambitions to become a significant pharmaceutical hub. While having an abundant supply of science and technology graduates, though of varying quality, the scarcity of leadership and management skills is a barrier. The former head of AstraZeneca’s R&D in Asia recently noted that because of China’s shortage of experienced toxicologists, pathologists, statisticians and clinicians, it could take several decades before China’s pharmaceutical ecosystem was fully developed (McKinsey, 2012a).

Among the factors slowing the development of a more innovative drug development environment in China is failure to create a more effective regulatory infrastructure, to reform education and to allow public–private partnerships to drive research (Baeder & Zielenziger, 2010). Other barriers to development include the negative effects of a three to four year time lag between drug registration in Europe and in China because of the critical regulatory issue requiring foreign pharma companies to conduct clinical trials in China prior to their product launches. Because of various government restrictions, foreign pharma companies opt for partnerships with local companies and while increased collaborations between big pharma and contracting companies in China often entail sharing of

<table>
<thead>
<tr>
<th>Total patents</th>
<th>Patents with China citation</th>
<th>Patent with China inventor</th>
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<tbody>
<tr>
<td></td>
<td>Total</td>
<td>% of total patents</td>
</tr>
<tr>
<td>AstraZeneca</td>
<td>744</td>
<td>23</td>
</tr>
<tr>
<td>Johnson &amp; Johnsonb</td>
<td>921</td>
<td>24</td>
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<tr>
<td>GSK</td>
<td>346</td>
<td>8</td>
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<tr>
<td>Novartis</td>
<td>1678</td>
<td>34</td>
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<tr>
<td>Pfizer</td>
<td>820</td>
<td>14</td>
</tr>
<tr>
<td>Roche</td>
<td>2530</td>
<td>40</td>
</tr>
<tr>
<td>Eli Lilly</td>
<td>513</td>
<td>7</td>
</tr>
<tr>
<td>Sanofi</td>
<td>1196</td>
<td>16</td>
</tr>
<tr>
<td>Merck &amp; Co.</td>
<td>795</td>
<td>4</td>
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</tbody>
</table>

Source: Own elaboration, based on USPTO.

*We thank Yilin Li with assistance with USPTO calculations.

bData collected under the query of Janssen Research & Development, LLLC, the pharmaceutical companies of Johnson & Johnson.
knowledge about how to run long-term projects, they rarely involve the transfer of core intellectual property (Engardio & Rissing, 2008).

Already some foreign companies have faced significant fines for being associated with the common practice of offering poorly paid Chinese doctors incentives for promoting the use of their drugs. Unlike in developed countries, our fieldwork showed that drugs in China are dispensed primarily by doctors in the main hospitals, which can create an environment in which corrupt practices may flourish. The current anti-corruption push to date has been focused primarily on foreign companies, with GSK in particular suffering significant reduction in sales because of negative publicity. Although many acknowledge that illegal practices are widespread within the pharmaceutical sector generally, some suggest that foreign companies are more easily targeted as part of the anti-corruption push of the new regime in power. While some have interpreted the crackdown on corrupt practices as a growing hostility to foreign companies, others suggest that it is a relatively easy way to give a wider message to the sector more generally, including local companies, and also to put pressure on companies to reduce costs.

While China presents a range of opportunities and challenges for big pharma investors, China’s increasing integration into the global pharmaceutical value chain must also be evaluated within the context of China’s ambitions to develop its own pharmaceutical and biotechnology capacity (Goodall et al., 2006). Thus, while acknowledging China’s definite aspirations to become a global biopharmaceutical innovator, and to develop molecules in China for its own population in place of big pharma drugs, some commentators suggest it will take 5–10 years to duplicate developments similar to those of the US (KnowledgeWharton, 2013b). Some also argue that if China’s recent push for “indigenous innovation” was to result in focusing too much on domestic applications, it could negatively affect its innovative capacity (Salter, 2011). This domestic orientation is reflected in the fact that China’s share of biotechnology patents has remained at 1%, which is the same level as its overall USPTO share.

### 5.3. Concentration of China on Generics and APIs

Thus while Chinese firms increasingly occupy higher value segments of the pharmaceutical value chain, few of these firms engage in the discovery and development of new-concept drugs because of the high costs involved and also because of their high failure rates (Wadhwa et al., 2008). Most domestic companies are engaged in producing low-cost generics or copycat versions of existing drugs for which there is a significant market. Because of the need to balance drug innovation with the challenge to deliver healthcare to its huge population, there is not the same emphasis in China on inventive science as in developed countries. Salter (2011) argues that China needs to invest in basic science and to ensure that innovation is not constrained by a bureaucracy that limits autonomy. A major challenge facing China is gaining ownership of intellectual property through a judicious use of national and international patenting systems. In the view of an industry consultant, China will continue to rely on foreign companies to provide the necessary expertise because pharmaceutical innovation lags considerably behind that of the west and this dependency presents multinationals with an opportunity to leverage their position in the Chinese market (Forchielli, 2013b).

The US and the UK remain in a very dominant position in life sciences generally, with China making little impact to date in terms of foreign patents; particularly in the US
market (Salter, 2009). While Zhang et al. (2011) believe that China has considerable potential to become a laboratory for biotechnology development, the low patent ratios of Chinese companies show the limitations of a state-sponsored model in generating knowledge for value addition. China’s biotechnology sector is highly internationalized with 50% of biotechnology inventions owned by either foreign companies or co-inventors compared with 12% in the US. Most state funding, however, was diverted to building physical infrastructure rather than to actual research, while multinational companies have been more effective in exploiting China’s large and relatively low-cost talent pool in science. Zhang et al. (2011) also note that biotechnology multinationals in China, particularly CROs, interact mainly with their headquarters and thus have weak horizontal linkages with local companies. Not surprisingly therefore, although pharmaceutical exports from China average US$67 billion annually, virtually none of this revenue comes from innovative products, since few Chinese companies are involved in developing drugs (Bioassociate, 2012).

Thus, while considerable challenges face foreign companies involved in the early stages of China’s pharmaceutical market development, a number of significant areas of pharmaceutical activities have emerged in China helping to integrate it more fully into the global value chain. One of these areas in which China (and also India) already plays a significant role in the global pharmaceutical supply chain is as provider of APIs. Between 2007 and 2011, Asia’s portion of the world API market went from 24% to 28% and is expected to reach a value of more than US$50 billion by 2017 (Gross, 2013). A consultancy report on the API sector in China stated that the sector was worth US$31 billion in 2010, and despite some recent high-profile quality issues, improvements were underway with the help of Western companies, so that the sector was expected to expand to US$65 billion by 2015 (JZMed, 2010). A particular regulatory loophole the Chinese Food and Drug Administration has been battling against in recent years, which affects China’s credibility globally, is the ambiguous definition of “chemical entities”, which allows industrial-grade factories to produce and export intermediaries or chemicals which eventually end up in APIs intended for human use (Bioassociate, 2012). Despite China’s efforts to attract investment in high-end API and finished drug dosage manufacturing, Western pharma companies were reluctant to outsource these activities to Chinese contract manufacturing organizations because it constitutes the last step in the production process and also because of the difficulty of monitoring the quality of regulations in China (Dierks et al., 2013).

5.4. Clinical Research Outsourcing in China

Our fieldwork shows that, with its huge population of potential participants in clinical trials, China is increasingly seen as an attractive location to significantly reduce the costs of this essential aspect of drug development. Salter (2009) argues that China can exploit its large pool of human subjects for clinical trials in exchange for access to basic science and venture capital. Being in the early stages of developing its health service, China presents “an interesting case study of relationships between health, medicine, market and politics” (Salter & Waldby, 2011, p. 288). One of the ways China’s hospital system responds to the huge pressure on its services is to enrol poor patients in international clinical trials which provide additional income for hospitals. Cooper (2011) describes these arrangements as a form of nonskilled risky labour, by which non-
paying patients gain temporary access to medical checks and drug treatment in return for bearing the experimental risk involved.

Although a number of big pharma companies have established some elements of R&D activity in China already, some suggest that the greatest potential for developing a partnership platform between China and multinational companies is in clinical trials (Forchielli, 2013b). Because CROs assume none of the risks associated with drug development, and are paid a fixed amount for performing specific stages of drug development and testing, this sector is particularly suitable for the early development of the pharmaceutical sector (Wadhwa et al., 2008, p. 13). Domestic CROs focus on specific segments of the pharma R&D value chain such as standardized chemistry research (Dierks et al., 2013). The rise in this sector in emerging regions like China is revealed in a recent Reuters report (2011) based on data from the Tufts Center for the Study of Drug Development which noted that the North American share of clinical trials had declined from 83% in 2001 to 53% in 2009, while Western Europe’s share increased from 9% to 14% and that of the rest of the world had increased from 5% to 33%. While China presents considerable attractions for CRO investment, among the obstacles to its growth revealed in the fieldwork are a low level of English language ability, ethical challenges, and the fact that Chinese regulations require clinical trials with Chinese patients before a new drug can be sold in the local market. Before trials can commence in China compounds must be tested in phase II trials elsewhere, creating a considerable time lag before approval is granted (Schulz, 2012).

Nevertheless a complementarity exists between the innovation resources of big pharma, who increasingly lack the necessary capital for the further development of potential candidates in the molecular pipeline, and China’s wealth of early and late-stage clinical trial resources. Clinical trials can account for between 40% and 60% of total costs of drug development, and estimates of savings in China vary from 67% to 80% of the costs in the US or Japan (Forchielli, 2013b). China also has an enormous and willing patient pool for trials that could gain some access to free healthcare, and could lead to faster and cost-efficient recruitment. Under current Chinese laws, however, first-in-human investigations are prohibited in China for foreign-developed molecules, which necessitates either late-stage animal studies or earlier R&D stages taking place in China. The requirement, however, that trials seeking global approval must be based on patients with similar genotypes to the population of the markets being targeted, will influence the location decisions of these trials.

For big pharma companies seeking to penetrate what is likely to be a significant future market, it makes sense to conduct international, multicentre clinical trials in China (Forchielli, 2013b). Some commentators, however, referring to the recent GSK bribery investigation and to other incidents of corruption in China, have suggested that these incidents could have a seriously negative impact on the more than 3000 clinical trials by foreign companies in China, with consumers being concerned about the integrity of the trials, and also that participating doctors are not unduly influenced by monetary compensation (Joyner, 2013). It has also been suggested that drug companies outsourcing clinical trials to China will continue to have problems such as “sloppy data and misconduct” if they did not provide better oversight for these trials (Armstrong, 2013). A company interviewee, who was charged with establishing clinical trials in oncology for an American company explained that CRO outsourcing was a specific inward investment category that China was seeking to attract, because of its perceived potential contribution, and
because of that policies and regulations in this area were improving for inward investors with some preferential treatment being offered to companies. Lower tax rates for the first three years were among the incentives offered, but there was little support to date for companies that had reached a more advanced level in their operations. This interviewee noted that generally there was a lack of knowledge among officials about the processes and that big pharma companies had to educate them gradually (Pharma Company Interview 2, 2011).

The fact that phase I clinical trials of foreign company drugs were not permitted in China was a source of serious dissatisfaction for one of our interviewee company managers, whose main goal was to establish a phase I oncology centre. This interviewee emphasized the importance of phase I research as the first important step in establishing a new potential medicine in a human, and that without this step drug development cannot move forward. The interviewee explained that China’s State Food and Drug Agency, known as the State Food and Drug Agency before 2013, requires that foreign companies must do the preclinical work and the Chemistry, Manufacturing, and Controls, which involves synthesizing the molecule, in China.

This agency has had its own turbulent history, with a former director being executed in 2007 for taking bribes from companies in exchange for licences. The policy is that foreign companies can get involved in China only after they have completed phase I trials elsewhere (Joyner, 2013), since the risk at this stage is lower, and the agency does not want to take on the responsibility of managing earlier risks. This interviewee felt that not allowing phase I trials 10 years ago in China was acceptable as China had not developed any innovative product and the developed product was just imported, but now with so many foreign-owned and domestic R&D centres in China the situation has changed. Yet, foreign companies were not allowed to use their products on Chinese patients for phase I trials. She explained that it had to be done outside China and then they could come back for further development, and that “this is really an historical legacy from 10 years ago that does not make much sense today” (Pharma Company Interview 2, 2011).

5.5. Nature of Big Pharma R&D in China

Despite China’s apparent ambiguities about the role of FDI, an interviewee manager of one of Shanghai’s biggest foreign-owned R&D centres claimed that the government was doing its best to attract big pharma multinationals to China, offering all forms of incentives, and that there was considerable competition between cities to attract R&D investment, because of the benefits in terms of GDP, knowhow and technology. In his view, the government’s approach was now more even-handed, treating both foreign and local companies in the same way, and he emphasized that foreign companies were expected to have the same high standards in areas like environmental protection as in developed countries. At this stage there were no local companies capable of competing with big pharma because of the high risks associated with drug development. It might be possible in the longer term for some of the clinical research outsourcing companies to compete when they have acquired sufficient knowledge, but at this stage, with the plentiful business available in providing services to other companies, they were happy to maintain their profit margin from existing activities (Pharma Company Interview 1, 2011).

This interviewee explained that Shanghai, with the most concentrated clusters, is the most favoured location for pharma multinationals to begin R&D activity in China, with
much fewer clusters concentrated in Beijing. Pharmaceutical companies cannot survive in isolation and thus the presence of major Chinese CROs like Wuxi and Shanghai Pharma, both listed on the New York Stock Exchange, was important for forming joint venture partners or for collaborations. The Shanghai region had a pharmaceutical legacy, with several dozen companies run by returnee-Chinese who were educated abroad, and who therefore had a strong background in the pharma industry. Big pharma companies invested heavily in cutting edge science while the CROs provided services, not just to local R&D centres but to big pharma globally. By facilitating the process they were an important component of the emerging ecosystem in China. The situation was somewhat similar to what happened earlier in Japan when multinationals set up R&D centres, but because of cost factors they had relocated their operations to China (Pharma Company Interview 1, 2011).

While lower costs may be a factor for a big pharma company in establishing an R&D centre in China, it was more an additional help than a driver, since labour costs formed only a small proportion of the total cost of drug development, and the top 10 senior scientists in the centre earned salaries equivalent to those in the west. The main driver was the expectation that the new research group would be more productive, that it would think outside the box and that it would develop a new way of doing innovation in China, somewhat different from the Western model. This interviewee marvelled that three of the top global pharma companies in terms of revenue had already established R&D centres in Shanghai’s Zhangjiang High Tech Park, and doubted that such a cluster was to be found in any other global location. Over time, it was expected that each of these companies would develop their own separate campus facilities in different locations (Pharma Company Interview 1, 2011).

The primary factor bringing pharma multinationals to China was the market, which was still at an early stage of development. They were currently testing the water to ensure that they could have a legitimate presence when the market was more mature, since they could not just jump in at the last minute. As part of its open door policy, in existence for 30 years, China had encouraged young people to study abroad and now they were being encouraged to return, which together with local science graduates, though of variable quality, created a large talent pool. With the large numbers of graduates, companies could choose the top graduates from the best universities. Companies were also attracted by the entrepreneurial spirit in China, thinking “if it is so hard to push innovation in well-established Western companies, maybe we can have an experiment in another world region”. Executives from company headquarters visiting Shanghai were generally impressed with the infrastructure and with what they saw, and thus Shanghai was growing in popularity as an investment location (Pharma Company Interview 1, 2011).

When questioned about intellectual property protection, which has been an on-going issue of controversy for many foreign companies in China, this interviewee manager said that it was not an issue in their case. Although there were some cases where Chinese copycat companies made generic versions of foreign drugs and tried to export them to Western markets, in most cases these companies copied drugs whose patents had already expired. If foreign companies have not filed patents in China for their drugs, it was legitimate for local companies to make copies and sell them in China, but not for export to countries where the intellectual property was protected. While big pharma brand names are gaining popularity among the growing Chinese middle class who can afford them, they faced considerable competition from lower priced generics (Pharma Company Interview 1, 2011). Between 1992 and 2008 pharmaceutical patents
could be violated in China and marketing approval was provided in cases where minor structural differences were made to existing drugs (Bioassociate, 2012). Although China finally adopted comprehensive patent protection regulations in 2008, the implementation of intellectual property regulations needs to be improved.

In relation to the significance of the Shanghai R&D centre, the interviewee explained that from the beginning it was established as an end-to-end R&D centre, focused on Alzheimer’s, which had not been researched by any of the company’s other R&D centres, and that while there was a small centre in Singapore with 50 people, this was the company’s main centre for the Asia Pacific region. Unlike other big pharma companies, it had no research facility in India. The centre had significant autonomy about what to research and how to do it, but as part of a global corporation it was necessary to follow guidelines on key issues such as the care of animals and those regarding compliance. Explaining why the centre was assigned the task of focusing on Alzheimer’s research, the interviewee explained that in seeking a senior pharma scientist in China who spoke Chinese as a director for the centre, the company selected a Chinese scientist who already had an established record of research in multiple sclerosis. Although the company had been thinking about working on infectious diseases that were common in China, they were sufficiently flexible to change their focus to the area of the expertise of the selected director. The interviewee was impressed with the company’s open attitude in building a research centre from “ground zero” and recruiting the best talent worldwide (Pharma Company Interview 1, 2011). Since the interview in 2011, however, this company has faced two major upheavals in China, one in relation to offering incentives to doctors to promote their drugs and the second has been the dismissal of the director of their R&D centre because of misrepresenting data in a 2010 scientific paper. The first issue has had an immediate impact on the company’s revenues in China and the second is seen as presenting a more general problem for the future of multinational R&D research in China in the pharma sector (Tremblay, 2013). Because this particular scientist had been assigned huge responsibilities with the management of research in an entire disease area, his sacking was seen by some to have wider implications for the credibility of Chinese scientists in pharma R&D in China.

China’s policy push for greater indigenous innovation since 2006 not only sought to pressure foreign companies to file patents in China, but also to compensate local inventors, something that was not always easy to do within the global R&D model of many corporations. Interestingly, however, the Chinese-born interviewee manager of this R&D centre was very much in agreement with the new Chinese policy, stating that the approach of Western companies was that “you work for me and everything you invent belongs to the company” (Pharma Company Interview 1, 2011). His view was that if he was involved in developing a drug that turned out to be worth billions, he was entitled to some compensation, and this view may reflect possible tensions between the traditional global R&D model of multinational companies that seek to acquire knowledge inputs from different global locations, and the aspirations of an emerging country like China which seeks to push for greater indigenous innovation within its own borders. He did say, however, that China’s patent office in Beijing interacted with foreign companies like his to get some feedback about policy developments.

While some interviewees commenting on the work being carried out in the foreign-owned R&D centres in China claimed that they were beginning to bridge the link between drug discovery and development, one interviewee emphasized that in most cases multinationals were only beginning to test the water in relation to R&D, since
China was still in the early stages of building local capabilities. The company of this particular interviewee, like some others, was adopting a collaborative approach with local scientists, since they did not have any laboratory in China as yet. The company did not have any facilities for toxicology work in China, and it outsourced early stage work to local supplier companies while focusing on later stage work themselves, which was supervised by expatriate personnel from headquarters. In some cases while working with a local company that already had developed a chemical compound, it was necessary to redo the work because of quality issues. The cost and availability of senior skills were factors, with high turnover levels among personnel, and issues in relation to the training of graduates, affecting the quality of their work, were also raised. Continuity in relation to senior management was an issue because of the tendency for expatriates to spend only a few years in China, and while returnee-Chinese filled many senior positions, issues related to compliance required a continued reliance on expatriates (Pharma Company Interview 3, 2011).

6. Concluding Discussion

This paper seeks to understand the nature and challenges of the offshoring of big pharma R&D activity to China within the context of China’s increasing integration into the global pharmaceutical value chain. This offshoring can be seen within the broader context of multinational R&D offshoring to newly emerging regions as part of their augmenting strategies to enhance their global knowledge base and to develop new products (Dunning & Narula, 1995; Kuemmerle, 1999). The focus to date, however, has been primarily within the developed economies, with insufficient attention to the implications of the relation between foreign R&D and national policies in less-developed countries. Within the context of the globalization of the pharmaceutical value chain, the offshoring of big pharma R&D to China needs to be evaluated in relation to the convergence between big pharma’s growing needs to reconfigure its traditional business model based on deriving major blockbuster drugs from significant R&D investment and the increasing attractions and opportunities associated with China’s emergence as a major market for pharmaceutical products as well as a potential centre for drug development. In addition to understanding China’s increasing significance as an R&D centre for big pharma, it is also important to appreciate China’s interest in attracting big pharma investment in relation to China’s own ambitions to develop its pharmaceutical sector.

Although China has major ambitions to become a significant pharmaceutical innovation hub, its pharmaceutical ecosystem is still in the relatively early stages of development, with only a limited output of innovative drugs to date and an absence of senior specialist research and management skills. Despite significant state investment in recent years, China is under mounting pressure to provide for its huge healthcare requirements with increasing numbers of people suffering from untreated or misdiagnosed diseases such as cancer, diabetes and hypertension. Thus despite the recent policy push in China towards “indigenous innovation”, China continues to rely heavily on attracting big pharma investment to help develop its own pharmaceutical ecosystem and to provide medication for a rapidly growing middle class with the ability to pay. China’s growing healthcare needs provide big pharma with an ideal opportunity to expand its markets at a time when markets in more developed regions are experiencing little growth.

In addition to China’s healthcare needs, big pharma is also looking to China and other emerging regions to help reconfigure its traditional business model which has become
increasingly uncompetitive in recent years. A major reason has been the “patent cliff” with many blockbuster drugs reaching the end of their patent period and facing significant competition from generic drug companies. It must also be acknowledged that big pharma’s own R&D productivity in recent years has declined significantly, with few major innovative drugs being developed despite huge investment. In order to both reduce the costs of drug development and to seek new forms of innovation, big pharma has been increasingly integrating China and other emerging regions into a more globalized value chain. Because of the relatively early stage of development of China’s ecosystem, much of big pharma’s offshoring to date has related to the early stages of drug development. China in particular has become a major centre for developing APIs and also for clinical trials for big pharma. Despite its growing significance in the API sector, it is noteworthy that concerns about the embryonic stage of its regulatory environment and associated safety and quality issues, big pharma has been reluctant to offshore the high end of this activity to China.

Concerns about China’s developing regulatory environment have also affected the development of clinical trials in China, which is widely regarded as showing significant cost-saving potential for big pharma. With big pharma’s growing need to reduce the cost of drug development, China, with its huge population of patients willing to become involved in clinical trials, presents particular attraction as a location for expanding this investment. An important aspect of big pharma’s growing investment in R&D in China relates to the specific needs of the local population in relation to the prevalence of particular diseases. The insistence by Chinese regulations, however, that phase I trials must be conducted outside China adds a considerable time lag to the process of approving new drugs for the local market. Thus, while, on the one hand, China provides significant opportunities for increasing the market share of existing blockbuster drugs for major diseases such as diabetes, even in generic forms, big pharma is also researching solutions for diseases that are more prevalent within the local population.

Despite the considerable investment by a number of big pharma companies in R&D centres in China to date, this investment is still in its very early stages, with big pharma aware that its success in the Chinese market depends on long-term investment. With China accounting for less than 3.0% of the global revenue of most big pharma companies to date, the complexity and fragmentation of China’s market present particular challenges for big pharma companies. With much of the local market dominated by generic drugs and with the Chinese state determined to reduce the cost of its burgeoning health budget, which is largely made up of the cost of pharmaceuticals, the opportunities for expanding market share in China will be somewhat restricted. The significant problems faced by one big pharma company to date, relating to the provision of incentives to local doctors for promoting their products, together with the sacking of a major Chinese pharmaceutical scientist as director of their R&D centre in Shanghai, indicates some of the thorny issues which big pharma companies may have to negotiate before achieving significant success in the local market. As with other sectors in which foreign investment plays a significant role in China, most big pharma companies are likely to adopt a patient and long-term strategy to eventually reap the benefits which China offers both in terms of providing considerable market expansion and also in contributing to reducing the costs of drug development.

Our research builds on and extends existing literature on internationalization of R&D (Archibugi & Michie, 1995; Cantwell & Mudambi, 2005; Castellani et al., 2013). While much of the literature on the internationalization of R&D to date has looked at developed regions, this paper contributes to understanding some of the opportunities
and challenges facing foreign R&D in emerging economies. By exploring the process of pharmaceutical companies establishing R&D operations in China, we can see that the specificities of China’s market, particularly its huge scale, and the embryonic nature of its health system present enormous challenges for the state, and that while China’s policy of indigenous innovation favours domestic companies, the reality is that it will continue to depend significantly on foreign contributions for some considerable time, with many of the senior management positions going to those educated in the west. While China is determined to develop its own pharmaceutical sector, it is still lagging far behind, needing significant institutional evolution in the regulatory environment and in intellectual property protection. The deficiencies associated with its early stage of development presents both challenges and opportunities for foreign companies establishing R&D activity in cities like Shanghai.

In examining the specific context of China’s evolving pharmaceutical market this paper contributes towards a more nuanced theory of the internationalization of R&D investment in emerging regions. Looking beyond the recent shift by multinationals towards tapping into knowledge sources outside their home countries, the paper suggests that greater attention be given to a range of other considerations. First, in the context of an increasingly globalized industry, more attention needs to be given to how global value chains are giving rise to particular R&D specializations in emerging economies. Indeed, fragmentation of the pharma global value chain is giving rise to the greater offshoring of early stages of drug development, with China becoming an important centre for APIs and clinical trials, but with some reservations by big pharma towards offshoring later stage activities because of quality concerns. Second, greater attention also needs to be given to distinguishing between the drivers of R&D internationalization and the objectives of host countries. With China’s own ambitions of becoming an innovative centre for drug development, it is not clear how foreign R&D centres might contribute towards, or perhaps hinder, this objective. China is a powerful state with a hugely attractive market and thus has considerable leverage in dealing with foreign companies who need to expand their market share. Ideological differences can also arise between a state which seeks technology transfer in exchange for market access and the traditional global R&D model of multinational companies seeking to protect their intellectual property within the corporation.

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