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Globalisation, migration and knowledge transfer: The reconfiguration of R&D capability in Indian pharmaceutical firms

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Abstract

The Indian pharmaceutical industry represents a successful case of indigenous self-reliant development. Over the last three decades the Indian industry, working under weak patent laws, used reverse engineering skills to develop capabilities in process R&D and generics drug development. With the signing of the TRIPS agreement Indian firms faced a stronger regulatory environment which restricted the application of imitative R&D. This change in regulation accelerated development of innovative R&D capabilities in the Indian pharmaceutical firms. Building on process R&D capabilities Indian firms entered the generics market in advanced regions such as Europe and US. Indian firms started their subsidiaries in Europe and US and acquired firms in these countries. From 1995 Indian pharma firms began investing in the development of capabilities in new drug development and new drug delivery systems R&D. Major Indian firms have filed patents for new chemical entities and signed licensing deals with large MNC pharmaceutical firms. Indian firms hired Indian scientists educated or working overseas in multinational pharmaceutical R&D to acquire capabilities in innovative R&D. These scientists played a key role in development of R&D capabilities in Indian firms by bridging knowledge gaps in pharmaceutical R&D. However transfer of knowledge by hiring scientists is a complex process. For Indian firms differences between working cultures of Indian and western firms and importantly differences between the requirements of Indian firms and the skill sets of returnees have hampered effective diffusion of knowledge. Indian firms have responded to these issues by adopting global R&D management practices.

Key words: Globalisation, India, Migration, knowledge, Innovation, pharmaceutical industry

1. Introduction

In the last decade Indian pharmaceutical firms have faced twin challenges in the form of economic liberalisation and the strengthening of regulatory norms following the signing of the Trade Related Intellectual Property Rights (TRIPS) agreement. The preceding weak regulatory system played a crucial role in the development of the domestic pharmaceutical industry. However the TRIPS agreement mandates strengthening of regulatory systems among all World Trade Organisation (WTO) member countries. Indian firms responded to these challenges by reconfiguring their R&D strategies and adopting different business models. Some firms sought to build on their sophisticated reverse engineering practices to offer generic production of drugs once patent protection has expired. Firms

seeking to increase their indigenous innovation capacity have recruited Indian scientists working overseas and employed various innovative HR practises to foster creativity and innovation among their existing employees. However, although the R&D intensity of Indian firms has grown steadily in the last 10 years it is still less than that of established multinational firms. R&D investments in real terms are significantly smaller and scientists who have worked overseas in senior positions for many years find difficulty in adjusting to smaller budgets.

This chapter reports research focused on four established Indian pharmaceutical firms, Ranbaxy Laboratories, Dr. Reddy's Labs, Nicholas Piramal and Lupin. Interviews were conducted with scientists working in these innovative firms and with various stake holders within them (e.g. R&D presidents and hired scientists), and outside the firm e.g. (presidents of Indian pharmaceutical associations, pharmaceutical consultants). We discuss the practical issues raised by the role of returning migrant workers in the development of new capabilities in innovative R&D by the Indian firms and compare these with the experience of the Indian IT sector. The contribution of returnees to both the pharmaceutical and software sectors has led to significant programmes of support and legislative change by the Indian government.

In the four firms, Indian scientists who had studied or worked overseas formed an important component of strategies aimed at developing competencies in innovative R&D. However attracting these scientists to work in Indian firms proved a difficult task. As a result Indian firms changed their recruitment and HR strategies, establishing contacts with senior academics working in Indian institutes and universities in order to locate and attract scientists working overseas. The assimilation of such scientists and their knowledge into existing organisations became the next challenge. One key hurdle was the clear mismatch between the requirements of Indian firms and the skill sets developed by returning scientists in the contexts of Europe and the United States. Indian firms required scientists with knowledge of all aspects of pharmaceutical R&D whereas the returning scientists were often specialists.

2. Literature Review

The experience of leading firms from developed countries and also newly industrialising countries shows that human mobility within or across firms has played a very important role in transferring knowledge and knowledge building capabilities (Ettie, 1980; Leonard-Barton, 1995). Few organisations generate internally all the knowledge required for continuous technological development. Firms therefore, often turn to external sources such as suppliers, buyers, universities, consultants, and competitors. However, given the tacit and complex nature of most valuable knowledge, its acquisition can be difficult (Kogut and Zander, 1992). A significant portion of knowledge that organisations seek to acquire is embedded in individuals. When these individuals move between organisations, they can apply this knowledge to new contexts, thereby effectively transferring knowledge across firms (Argote and Ingram, 2000). Thus human mobility can play an important role in the knowledge building processes of hiring firms, especially where knowledge tends to be 'sticky' and remains localised within firms, regions and countries (Szulanski, 1996). Song et al., (2003) suggest that human mobility served as a crucial mechanism for the acquisition of knowledge for newly industrialising countries firms. In his case study investigating Samsung's entry into the semi-conductor industry, Kim (1997) cited Samsung's deliberate and successful strategy of hiring Korean scientists and engineers from US firms as a platform for acquisition of knowledge. Kim argued that the mobility of experienced experts can facilitate the transfer of capabilities permitting further knowledge building provided the host firm created the environmental conditions that would permit diffusion of knowledge from experts to other members of the firm.

The extent to which firms can assimilate externally sourced knowledge is determined, in part, by the nature of the knowledge to be sourced (Kogut and Zander, 1992) and in part by a firm's absorptive capacity (Cohen and Levinthal, 1990). Even within-firm, tacit knowledge is 'sticky' and does not necessarily flow easily unless the individual possessing the tacit knowledge also moves (Szulanski,

1996). If the movement of within-firm tacit knowledge is difficult, its transfer across firms is likely to be even more challenging. Firms use several mechanisms to access external knowledge, including strategic alliances, co-location in technology intensive regions, and foreign direct investment. However these mechanisms have limitations in acquisition of tacit and 'non-codified' knowledge. Therefore the hiring of engineers or scientists can play an important role in acquiring tacit and complex 'human embodied' knowledge (Ettie, 1980).

The ability of mobile engineers or scientists to leverage their knowledge bases in new firms will reflect both their attributes and those of the firms. With organisational success, routines and processes may become more standardised, making it more difficult to assimilate external knowledge (Nelson and Winter, 1982). Hence path dependence impedes a firm's receptivity to external knowledge by reducing motivation and ability to seek, recognise and assimilate knowledge that differs from current practice. In the case of mobile engineers/scientists, individuals with stronger innovative capabilities are likely to have more knowledge than those with weaker abilities. Expertise stemming from individual experience is an important source of power. However, long years of experience also shape behavioural practices or processes, building routines for both individuals and organisations. These can act as potential barriers to knowledge transfer. Such conditions require adjustment from both firm and individual. For the newly hired expert, effectively transferring or diffusing outside knowledge into the firm is hard.

Much research on human mobility has focused on investigating the factors influencing mobility, neglecting other core internal firm level factors affecting knowledge diffusion. It is necessary to identify the challenges and conditions under which human mobility is most likely to result in knowledge transfer or diffusion.

Researchers such as Song et al (2003), suggest that mobility is more likely to result in inter-firm knowledge transfer when individuals and hiring firms possess different technological expertise, and when the incoming engineers work in non-core technological areas in their new firm. However, it is also important to analyse how the knowledge possessed by these hired scientists is socialised at an organisational level. These important behavioural issues remain unattended in studies of human mobility and diffusion of knowledge. Therefore, as Argote and Ingram (2000) suggest, further research is needed to assess and understand how people transfer knowledge.

Thus, in spite of the voluminous literature on international transfer of technology, the challenges involved in knowledge acquisition or transfer through cross border human mobility has received surprisingly little formal attention or rigorous analysis.

3. The Indian Pharmaceutical industry

The Indian pharmaceutical industry is a successful high technology based industry, which has witnessed consistent growth over the last three decades. The sector has developed sufficient capability to ensure the country is self sufficient in addressing health care needs. Furthermore, its export ability makes it a strategic trade sector in the Indian economy. The Indian pharmaceutical industry exports generic drugs to CIS (Commonwealth of Independent States) countries, Africa, and recently to the highly regulated US and European markets. The Indian industry is characterised by a low degree of concentration; a large number of firms with similar market shares, a low level of R&D intensity ratios and a high level of brand proliferation. The need and incentive for innovation was undermined by the low purchasing capability of the domestic market along with ease of imitation and horizontal product differentiation; features typical of industries behind a technological frontier.

The growth of the Indian industry was very slow up until 1970. The Patent Act of 1972 and government investment in the drug industry infused life into the domestic pharmaceutical industry by removing product patents for pharmaceuticals, food and agro-chemicals and allowing patents only for production processes. The statutory term was shortened to seven years for pharmaceuticals and

automatic licensing was put in place. This started an era of reverse engineering where firms developed 'new' products by altering production processes. Figure 1 below sketches the growth of revenues in the industry which grew rapidly in the 1990s, with an average growth rate of about 15% for bulk drugs and 20% for formulations (OPPI, 2001).

(Figure 1 here)

During the last three decades the larger private Indian pharmaceutical firms focused their efforts on reverse engineering oriented process R&D, activities were limited to applying known knowledge, or to making small adjustments in content. A few public laboratories under the Council of Scientific and Industrial Research (CSIR) also operated specifically imitative process R&D in pharmaceuticals. Production technologies were well mastered and the lag period between the launch of a new product in its first market and in India was reduced, in some cases to as little as two years (Lanjouw, 1996). The Indian pharmaceutical industry represents a successful case of indigenous self-reliant development.

From 1970 onwards, Indian pharmaceutical firms slowly started dominating the domestic market reducing the market share and influence of Western companies. Today the market share of domestic firms is around 60-70% compared to 10% in 1970. In 2003, the top ten firms together covered around 34% of the total pharmaceutical market (an 8% increase in the concentration ratio from 1996). Six of those top ten firms were now of Indian origin and four were MNC subsidiaries, accounting for 13% and 22% of the market respectively. A point of interest is that the Indian firms that had an external market focus gained in market share and emerged in the top ten, even while the large MNCs operating in India were focussed on serving the Indian market alone.

(Table 1 here)

3.1 Twin challenges of globalisation: Economic Liberalisation and TRIPS

At the beginning of the 1990s India's pharmaceutical industry faced twin challenges for its survival: the opening of the economy and de-licensing of the pharmaceutical industry. The second and more critical challenge came from signing of TRIPS agreement by Indian government.

In 1991 the economy was liberalised and the pharmaceutical sector was de-licensed. In 1995, 50% of the drugs were also removed from price control and by 2004 only 76 drugs (26%) remained under control. Liberalisation of national and international financial transactions followed (in 1995). In 1994, hot on the heels on liberalisation, India announced its entry to the WTO and its intention to institute the intellectual property regulations required by TRIPS. In 1999, the Patent law of 1970 was repealed. The new Patent Act strengthened patent protection, re-introducing recognition of product patents for pharmaceuticals, food products, agro chemicals and micro organisms and significantly increasing the life of a patent from seven to twenty years.

Agreement to WTO requirements, specifically TRIPS, meant significant change for Indian industry and market structure. In a product patent regime, Indian firms will have to look for new future sources of growth and the biggest source will be productive R&D, which can deliver patentable innovations. The TRIPS requirement of strong patent laws is triggering change in the pharmaceutical industries of developing countries which have grown on the basis of weak patent laws. To survive in an era of strong patents, Indian pharmaceutical firms must develop competencies in innovative R&D.

3.2 Response of Indian firms to twin challenges

Indian firms responded to these twin challenges by adopting combination of strategies such as entering generic markets of advanced countries by using process innovations, offering services to MNC firms, importing innovations and entering new drug discovery research.

(Figure 2 here)

Both process innovation and service model strategies were based on existing competencies while new drug discovery required new competencies. Over the years Indian pharmaceutical firms have developed a knowledge base firmly rooted in imitative reverse engineering process R&D, accumulating extensive knowledge in process R&D (synthetic and organic chemistry) but leaving severe weaknesses in other scientific disciplines such as medicinal chemistry and biology, important knowledge gaps for those firms developing new drug discovery and new drug delivery systems. Kale (2004) found that Indian pharmaceutical firms are filling these knowledge gaps by hiring US-based Indian scientists with experience of innovative research in multinational pharmaceutical firms. These scientists are not only a valuable source of knowledge but also provide firms with entry into technology networks in advanced countries. However Indian firms realised that assimilating and using their knowledge raises sensitive and complex issues like the insertion of senior scientists into established routines or the impact of returnee incentives on other employees. This clearly pointing out the transfer of knowledge by hiring of scientists is not a straightforward process and requires a deliberate action.

3. Research Methodology

Comparative case studies were employed as the main research method, focusing on four established Indian pharmaceutical firms, viz. Ranbaxy Laboratories, Dr. Reddy's Labs, Lupin Laboratories Ltd and Nicholas Piramal. These are among the top firms in the Indian pharmaceutical industry. Table 3 shows their R&D performance.

(Table 2 here)

Primary data was collected through interviews with scientists working in these four innovative Indian pharmaceutical firms. Interviews were also conducted with various stake holders within the firms (such as the R&D president and hired scientists), and outside the firms (presidents of Indian pharmaceutical associations, pharmaceutical consultants). All interviews were taped and transcribed for data analysis.

Data collection focused on the relationship between the firm's policies and the activities of the hiring scientists. In parallel to the field study interviews with members of the Indian branch of the American Association of Indian Pharmaceutical scientists (AAiPS) provided crucial evidence regarding issues involved in the movement of Indian scientists from US to Indian firms. The AAiPS coordinates networking activities between scientists working in India and US.

{Table 3 here}

The qualitative data was analysed by using pattern matching (Yin, 1994) and analytical tables (Miles and Huberman, 1984). The qualitative analysis software Atlas.Ti was used for data organization and standardisation to facilitate its analysis.

4. Firms under investigation

4.1 Ranbaxy laboratories Limited

Ranbaxy, India's largest pharmaceutical firm is ranked amongst the top ten generic companies in the world. Ranbaxy's initial forays into research and development activities began in the late 1970s.

In the 1990s Ranbaxy gradually began to change focus from process R&D to new initiatives in new drug discovery research (NDDR) and NDDS. In 1999 Ranbaxy registered its first success in innovative R&D with the development of once-a-day dosage for the Ciprofloxacin molecule.

Despite having a few molecules in clinical and preclinical trial stages, Ranbaxy reached a critical stage by 2002 as the bulk of its R&D was still in generics. Ranbaxy needed more scientists with experience in state-of-the-art drug discovery technologies. To fill those knowledge gaps Ranbaxy started hiring Indian scientists based in US and Europe, who were working with multinational R&D laboratories. Ranbaxy's R&D size and infrastructure and success with Ciprofloxacin helped the company in its efforts to encourage 'reverse brain drain'. In 2003, Ranbaxy hired Dr. Rashmi Barbhैया, who was vice president of drug discovery in Bristol Mayer Squib (BMS) as its R&D President. He was closely involved in many contemporary drug discovery technologies in BMS. After Dr. Barbhैया, Ranbaxy hired Dr. Batra from Schering-Plough Research Institute in the US, as a new Vice-President, Pharmaceutical Development to lead the development of new chemical entities and new drug delivery research. In 2003, under the leadership of Dr. Barbhैया, Ranbaxy took some key decisions regarding future R&D direction. In 2004 Dr. Rajinder Kumar, previously global head of clinical psychiatry R&D at GlaxoSmithKline (GSK), took charge of Ranbaxy's R&D with responsibility of accelerating company's drug discovery effort.

However Ranbaxy faced difficulties in retaining returned scientists as Dr. Barbhैया left the company after 3 years and Dr. Rajinder Kumar after 11 months. An ex-R&D President of Ranbaxy explains:

"first, the people they brought in were specialised in one subject. R&D consists of multiple disciplines and one should bring men who understand almost every discipline. One person came here with pharmacokinetics background. Pharmacokinetics is not even 1% activity of total R&D. Also, he has never done generic R&D in his life so there was a total vacuum. Another man came with clinical research background. But Ranbaxy hardly does clinical research. They only maybe have one compound. So it was a mismatch actually".

4.2 Dr. Reddy's Laboratories Ltd

Dr. Reddy's Laboratory (DRL) has emerged as the first Indian pharmaceutical company to discover a new chemical entity and license it to a MNC pharmaceutical firm. In the last decade it has consistently ranked amongst the top ten pharmaceutical firms in India. Recognising the importance of innovative basic research in post-2005 India, DRL built the Dr. Reddy's Research Foundation (DRF) in 1992. DRF is exclusively dedicated to research in the area of new drug discovery and became the first organisation in the Indian pharmaceutical private sector to take up basic research.

Within three years of starting innovative research DRF discovered one of the most potent glitazones, Ragagltizar. Soon, DRF began evaluating its R&D capabilities and started hiring scientists to fill knowledge gaps.

DRF focused on hiring fresh scientists to work in drug discovery R&D and so identified Indian students studying abroad on doctoral and post doctoral courses as a main source of talent. In DRF almost 15% of research staff working in discovery R&D are recruited from overseas while for 80% of R&D scientists, it was their first job. DRF's former R&D president elaborates recruitment strategy adopted by the firm:

"We accelerated our plans to do drug discovery research and at that time we certainly wanted to recruit top-notch talent. Fortunately there was no competition in India. Nobody else was looking for scientists for drug discovery. It was relatively easy for us to attract the talent given the world class infrastructure we created. Every scientist returning from US was visiting us or corresponding with us asking about our plans. So we recruited really top notch talent".

After establishing discovery research in Hyderabad, DRF wanted to introduce leading edge skills such as drug discovery based on genomics and proteomics. It wanted to move from analogue research towards target based discovery or rational drug design but struggled with this change. The former R&D president described the situation:

"we could not recruit the requisite skills because it's not the one scientist, you need a whole team and we could not do this quickly. We located scientists, 1 or 2 were willing to come out, but they had

inhibitions and they needed a lot of time and were unable to take quick decisions. Then we decided there is no point in waiting. We cannot bring people here; we will move our lab there”. Therefore in 2000, DRF set up a lab in Atlanta, US dedicated to discovery and design of novel therapeutics. The lab is called Reddy US Therapeutics Inc (RUSTI) and its primary aim is to conduct drug discovery for next generation drugs using molecular genomics and proteomics approaches. DRL recruited Dr. Uday Saxena as CSO of its Atlanta subsidiary and within two months RUSTI built a team of 12 scientists.

4.3 Nicholas Piramal (I) Ltd

In 2003 Nicholas Piramal India Limited (NPIL) emerged as the 4th largest Indian pharmaceutical firm with 4.4 % market share. NPIL is part of Piramal Enterprises, one of the India’s largest diversified business groups.

Innovative R&D forms an important constituent of NPIL post-2005 strategy. It is based on the idea of developing product patented molecules to Phase II and then licensing them to multinational firms. With this aim, in 1998 NPIL forayed into innovative R&D by acquiring the research centre of Hoechst Marion Russell located in Mumbai, India.

In 2002 NPIL hired Dr. Somesh Sharma as Chief Scientific Officer to lead its innovative R&D effort. He was the Vice President of the Monoclonal Antibody and Vaccine Unit at Anosys Inc, US. Dr. Sharma was in the USA from 1967 where he obtained a Doctorate in Pathology from the University of Maryland’s School of Medicine. He has co-founded companies like Anergen, Wizard Laboratories, S2 Pharmaceuticals and Calyx Therapeutics.

In 2004 NPIL hired Dr. Maneesh Nerurkar from Merck as head of formulations and new drug delivery systems to strengthen company’s new drug delivery efforts. In NPIL, a total of around 60 scientists have experience of working abroad constituting 20% of the R&D work force.

In 2005 NPIL opened a state-of-the-art R&D laboratory totally dedicated to the development of innovative pharmaceutical R&D.

4.4 Lupin Laboratories Ltd

Lupin is a dominant leader in the anti-TB segment of the Indian domestic market with 42% market share in 2003. Lupin also exports to more than 50 countries and 41% of Lupin’s sales in 2003 came from exports; although mainly in the form of bulk drugs or active pharmaceutical ingredients to semi-regulated markets.

In 2001 Lupin decided to engage in innovative R&D and built a state of the art R&D laboratory in Pune, India. Lupin is a new entrant to innovative pharmaceutical research which is reflected in a small but increasing R&D intensity. Lupin hired, from Ranbaxy, Dr. Himadri Sen as Executive Vice-President of Pharmaceutical R&D and Dr. Sudershan Arora as Executive Vice-President, to lead the company’s effort in innovative R&D. In Ranbaxy Dr. Sen had been in charge in NDDS (new drug delivery research) while Dr. Arora was in-charge of new chemical entity research. Ranbaxy brought both of them from overseas to lead company’s projects in innovative R&D.

Lupin has adopted a different strategy for hiring scientists. Rather than going abroad and scouting talent, it focuses on hiring talent that has already returned to work in other Indian firms. Lupin’s R&D vice presidents for new drug delivery systems and new chemical entities are returnees but first they joined other Indian firm and then later joined Lupin. The hiring of these scientists proved successful in building a core team with expertise in drug discovery as other scientists working in Ranbaxy also joined Lupin.

5. Analysis and Discussion

These snap-shot case histories of four firms help reveal important insights regarding issues affecting the diffusion of knowledge through the migration of scientific labour in India. An ex-R&D president of Dr Reddys Laboratories (DRL) explains that barriers exist to the attraction of senior scientists based in overseas MNC firms:

“people who have settled jobs in big multinationals must have stayed there more than eight to ten years. They are used to the American style of living and enjoy all the major benefits of a multinational work culture, scientific environment, physical comfort and attractive salaries. For them to leave all that and come with kids can be a problem because if kids were born there and are going to those schools it will be a major displacement for them to return. Also their spouse is also working there, all these factors add up”.

Senior scientists who have returned from overseas point out their main concerns regarding returning back to work in Indian firms. The Chief Scientific Officer of Nicholas Piramel Industries Ltd (NPIL) describes some of the concerns,

“There were 2-3 main concerns. One, working for an [Indian] family owned company is very different than working for a company in the US, mostly a public company. So that certainly was a concern; I had a friend who was working here in a company in India and he had disagreements with the chairman and was fired the next day. So I had heard those kinds of stories. The other concern was whether drug discovery research could really be done in India. First, I have already alluded to you earlier how quickly can you change direction and implement your ideas and how quickly can you execute them - because pharmaceutical R&D is very competitive and medical knowledge changes and based on that you may have to stop what you have been doing for 2 or 4 years and quickly take a left turn or right turn, whatever is necessary. I was very concerned about the hierarchical system that I knew existed in India. Then of course the manpower; how well trained would scientists here be in terms of drug discovery”.

Despite these difficulties scientists are returning to work in Indian firms and evidence suggest shows major generational differences in return migration.

Return migration is happening at two levels; at senior scientist and post-doctorate levels. This two-level migration has implications for firm strategy as each group has different requirements and expectations from firms. At the post-doctorate level a scientist is mainly concerned about learning new skills and finds it comparatively easy to be assimilated in the firm. At senior scientist level concerns were focused on the long term future of firm and the role a scientist can play in creating that future. An ex-R&D president of DRL explains that for senior scientists important issues concern the long-term commitment of the firm to innovative R&D,

“the guy who has worked there for 10 years in a MNC and is a US citizen, things like long term growth plan of firm and other things matters. But for post-docs who were only abroad for 3-4 years; they have advanced skills, are enthusiastic and energetic. For them immediate landing into a research position is more important than long term things. It is important for them that the first five years go well for them because there are so many R&D centres they can switch job to after that”.

Interviews with non-returnees showed a great desire to contribute to the development of Indian pharmaceutical capabilities just as their counter parts did for Indian software. However differences between software and Pharma regarding technology restrict contributions from these scientists. For example in software, professionals can be more hands off, managing work by travelling between India and US. This is not practical in the case of pharmaceutical R&D. Many Indians working in Silicon Valley contributed to the growth and knowledge of the Indian software industry by setting up units in India whilst working in the US. While based in the US they could utilise Indian skill sets and thus contribute towards the development of an Indian industry. With pharmaceuticals, the nature of technology and work requires relocation. Technological differences include the need for investment in wet labs with consequent need for hands-on experimentation. For example in the case of drug discovery research a scientist has to be present in a laboratory to oversee experimentation, analyse findings and evaluate future action. The cross-disciplinary nature of drug discovery research means that experimentation and evaluation of results require input from scientists associated with different

disciplines such as chemistry, biology and pharmacokinetics. In the case of software development a programmer can write a code based on instructions provided by a distant project manager. Thus, Indian software professionals could maintain their links overseas, avoiding complete relocation while contributing to the growth of the Indian industry by providing much-needed skills and access. In the case of the pharmaceutical industry such an arrangement is difficult to embed and complete relocation results in loss of links and disruption of family.

The majority of HR managers and R&D president suggested that Indian firms are new to drug discovery and required scientists who are knowledgeable in various areas of drug discovery and development. Thus they require scientists who have knowledge of a wide range of pharmaceutical R&D areas whereas returning scientists had mainly specialist capabilities. This mismatch between the requirements of firms and scientists skills has emerged as a main barrier to effective diffusion of knowledge in Indian firms. The R&D president of an Indian firm elaborates on differences in skill sets:

“we are seeing a significant number of people who are interested to come back to India. They are coming. But if you look at a person who is working in a Glaxo or Pfizer, the typical applicability of that type of talent to India is not exactly correct. There is a mismatch because they work in highly specialised subjects and specialised departments in places like Glaxo. So the guy who is doing specific molecular biology work, even within molecular biology he will be doing only one type of cell line. But that type of specialisation at this early level is bad for Indian companies. So they are picking up people from post-doc level rather than senior. In a Glaxo, doing something at 10-15 million dollars is nothing. In a typical Indian company they will try to complete an entire project for 15 million dollars. Skill sets from start-up biopharmaceuticals companies may be much better suited to India rather than people from the big companies”.

Indian firms are family owned businesses and have grown mainly through their reverse engineering capabilities. The R&D intensity of Indian firms has grown steadily in the last 10 years but is still less than multinational firms. R&D investments in real terms are a lot lower and scientists who have worked overseas in senior positions for many years find difficulties in adjusting. Growing up on the basis of the generics business, Indian firms have become used to fast returns on R&D investment. However innovative R&D requires a longer period to provide investment returns additionally Indian firms are still learning these processes. . The adjustments are difficult to make and result in pressure on overseas scientists to deliver performance in a very short time.

According to one of the returned scientists:

“Over here the mentality has to change big time because people are still with old mentalities and especially for people like us who are young, we have very different mindset. I think we have to try really hard to change that. So unless and until we have a group of people of our age who go up to much higher positions, it is very difficult to change the mentality”.

One of the key findings of this research was the importance of support from government policy in initiating and sustaining return migration. Research suggests that Indian firms are using various strategies to attract and retain returned scientists. However these efforts from Indian firms are not enough, as the ex-R&D president DRL explain concerning social infrastructure:

“they expect first a good scientific environment, it is very important. The second thing is that their kids get a good education and the third thing is of course salary; combination of these three things. They expect to live a decent life, enjoy all corporate benefits”.

The discussion with returned scientists points out the importance of social infrastructure on the decision-making of US based Indian scientists to return, clearly suggesting an indispensable role for government policy in providing and establishing adequate physical and social infrastructure.

5.1 Indian firms' strategic response to assimilation challenges

a. Adopted innovative HR strategies to locate and attract potential scientists

Some Indian firms use links with Indian universities and institutes to identify and attract scientists, specifically experienced post-doctorate and recent PhDs. An ex-R&D president of Dr Reddys Laboratories (DRL) explains:

“the mentors of post-docs were known to me, known to some of us. Postdocs were valuable and it was relatively easy. But to attract somebody who worked in a MNC in the US was difficult and is indeed still difficult today”.

b. Created leadership positions for new scientists.

Indian firms are trying to attract returning scientists by giving them independent charge of drug discovery projects thus providing opportunities for them to learn leadership and R&D management skills. Scientists returning at post-doc level view working in an Indian firm as a good opportunity to acquire leadership and management skills. Firms are offering them positions in middle management, and experience in managing and leading projects. Overseas in big MNC firms post-doc Indian scientists work in specialised areas and in small project teams whereas Indian firms hire them as project managers with considerable freedom to develop projects. This represents important experience for their future careers.

The ex-R&D president of DRL explains,

“They are here at director level, we are giving them leadership positions, we are giving them a position which is going to lead into the management of the organisation, management of the scientific programme, not just running a small lab and all that, supervising few people but they are participating in decision making. Such a thing is not possible there”.

c. Developed new training programmes and incentive systems

Indian pharmaceutical firms are now providing extensive training support to enhance scientists' research skills and scientific knowledge bases. Scientists were rotated from lab to lab to evaluate their aptitude and skills then given independent task to perform by designing a research programme with the opportunity to work on it. The focus is on how the patent holders started, what they did and where did they end up. After that scientists are encouraged to design their own molecules. This approach to patent analysis provides an understanding of the intricacies involved in innovative drug discovery. Indian firms are offering new financial as well as work related incentives to scientists such as stock options, attendance at important conferences and training in overseas university and institutes.

d. Influenced by Indian IT firms' HR practises to attract and retain IT engineers

Indian IT firms devised innovative HR management practises to attract and retain talented IT employees. Indian pharmaceutical firms are now employing similar practises to retain and absorb overseas scientists. For example DRL hired its HR head from Wipro technologies; a leading Indian software firm.

6. Conclusion

This research reveals important insights into the diffusion of knowledge through migration of scientific labour. The analysis of firm level 'assimilation processes' revealed major issues including: generational differences of returnees, differences in working culture of Indian firms and western firms and, importantly, differences between requirements of Indian firms and skills sets of returnees that hamper effective knowledge diffusion.

The 'global Indian' knowledge worker has become a key resource for Indian firms and businesses providing leadership and management skills and more importantly 'sticky knowledge' in the area of science and engineering. India relies on this diasporic innovation resource to allow Indian firms to both benchmark and shadow established global players, with an awareness of their different capacities and capabilities.

Leading Indian pharmaceutical firms have responded to the challenge of adapting to the post-TRIPs era by changing their style of R&D project management through new incentive structures, less

hierarchical management systems and support for returnees to adjust to their new. However the findings also identify a key role for government policy in attracting returnees.

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Table 1: Top ten pharmaceutical companies in India from 1970 to 2003

| Rank | 2003 Company (market share) | 1996 Company (Market Share) | 1970 Company (Market Share) |
|------|--|-----------------------------------|-----------------------------------|
| 1 | GlaxoSmithKline* (5.6) | Glaxo-Wellcome* (4.97) | Sarabhai (4.97) |
| 2 | Cipla (5.5) | Cipla (2.98) | Glaxo* (2.9) |
| 3 | Ranbaxy(4.7) | Ranbaxy (2.67) | Pfizer* (2.6) |
| 4 | Nicholas Piramal (3.4) | Hoechst- Roussel*(2.6) | Alembic (2.6) |
| 5 | Sun Pharma (3.1) | Knoll Pharma* (1.76) | Hoechst* (1.7) |
| 6 | Pfizer* (2.7) | Pfizer* (1.73) | Lederly* (1.7) |
| 7 | Dr. Reddy's (2.6) | Alembic (1.68) | Ciba* (1.6) |
| 8 | Zydus Cadila (2.5) | Torrent Pharma (1.60) | May & Baker* (1.6) |
| 9 | Abbott* (2.3) | Lupin Labs (1.56) | Parke Davis* (1.5) |
| 10 | Aventis – includes merger with Hoescht * (2.2) | Zydus-Cadila (1.51) | Abbott* (1.5) |

* indicates a multinational firm

(Source, OPPI, 2000, 2003; Lanjouw, 1996

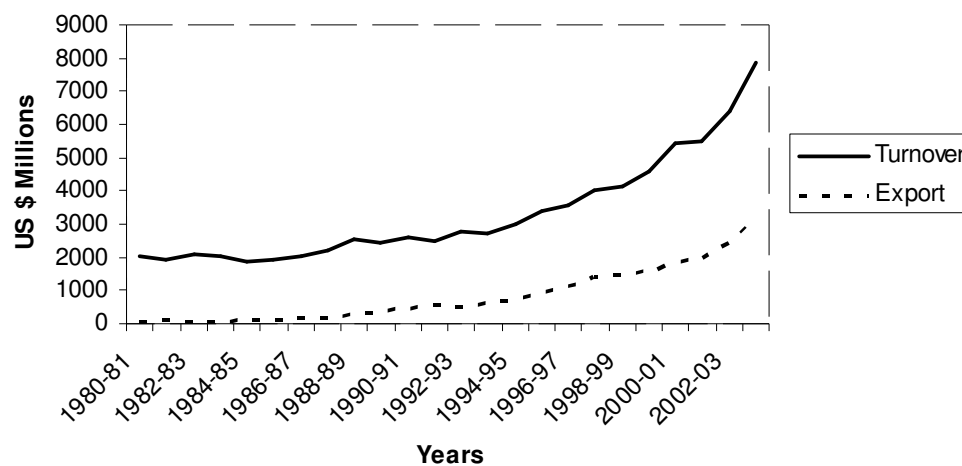
Table 2 Firms under study

| Name of the firm | Year of establishment | Focus Area |
|------------------------------|-----------------------|--------------------------|
| Ranbaxy Laboratories | 1962 | Generics, NDDS, NCE |
| Dr. Reddy's Laboratories Ltd | 1984 | Speciality generics, NCE |
| Nicholas Piramal (I) ltd | 1988 | Contract research, NCE |
| Lupin Laboratories Ltd | 1968 | Herbals, Generics, NCE |

Table 3 R&D Performance of selected firms (Annual Reports, 2007)

| No. | Firms | DMF (Drug Master File) | ANDA (Abbreviated New Drug application) | NDDS patents | NCE patents |
|----------|--------------|------------------------------------|---|------------------------------|--------------------------|
| 1 | Total | 1264 | 701 | ~ 30 | 25 |
| 2 | Ranbaxy | 77 | 127 | 4 | 3 |
| 3 | DRL | 103 | 84 | | 5 |
| 4 | NPIL | | | 4 | 6 |
| 5 | Lupin | 55 | 49 | 7 | 4 |
| | | Bulk and contract manufacturing | Generics and Bio- generics | New Drug Delivery Systems | New Chemical Entities |

Figure 1: Turnover and export growth in Indian pharmaceutical industry (1980 – 2003) (Source: OPPI, 2001)



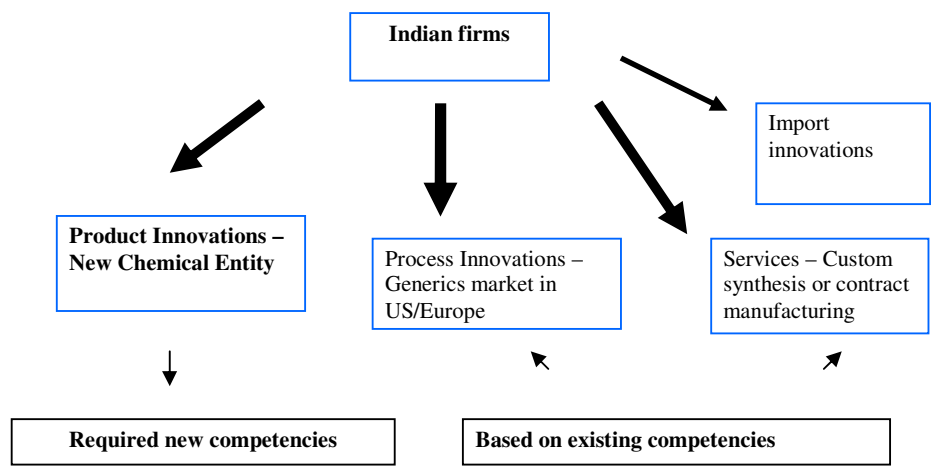


Figure 2 Response of Indian firms to twin challenges