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THE INTERNATIONALIZATION OF RESEARCH AND DEVELOPMENT

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ABSTRACT

The internationalization of research and development (R&D) activity of transnational corporations has increased manifold since mid 80s. R&D activity that was once kept close to home is going global-not just to industrialized countries but also to developing countries. China and India have been the main beneficiaries of this trend. In global companies' perception of most attractive prospective (2005-09) R&D locations, India is at a third place right after China and USA. In this term paper I have tried to analyse the growing trend of internationalization of R&D activity by focusing on the driving forces in internationalization of R&D, reasons for India becoming an attractive destination and the possible implications for Indian economy.

Keywords: Innovation, internationalization, R&D, Incentives, Globalization

INTRODUCTION

Innovation is necessary prerequisite for development and survival of any enterprise. The ways in which innovation can take place are diverse, but an important source of innovation is through research and development (R&D). Inward and outward FDI in R&D is the most direct way to connect with global centers of knowledge present in other countries. UNCTAD (2005) world investment report¹ has observed that with rapidly changing technologies, falling transport costs and liberalization competition has intensified, and Transnational Corporations (TNCs) are seeking locations with strong capabilities to produce efficiently. As a result the internationalization of research and development (R&D) activity of transnational corporations has increased manifold since mid 80s. Earlier overseas R&D activities of these corporations was concentrated mainly in a few industrialized countries and TNC affiliates based in developing countries received only a small portion of overseas R&D expenditure. Today, R&D activity that was once kept close to home is going global-not just to industrialized countries but also to developing countries. There is high concentration of such R&D activity in developing countries with "only a handful of technologically dynamic countries accounting for bulk of the R&D expenditure" (Nagesh Kumar, 2002). China and India have been the main beneficiaries of this trend. Of the 885 R&D oriented Greenfield FDI projects announced in the region in 2002-2004, three-fourths (723) were concentrated in these two large economies (UNCTAD 2005). Even within a developing country there is significant concentration signaling presence of agglomeration economies² e.g. in India most of the FDI in R&D has come to Bangalore followed by Delhi and Mumbai. According to Johansson and Hans Lööf (2006) "large urban regions across the globe increase their importance as places where multinational companies can benefit from intense interaction with specialized knowledge providers and research centers".

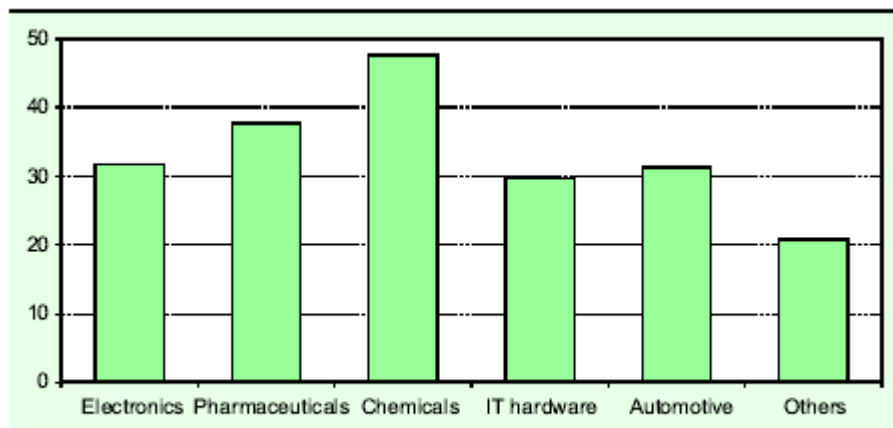
Globalization gave rise to the phenomenon of business process outsourcing (BPO). Knowledge process outsourcing (KPO) is its logical extension. Focus of developed economies is on knowledge intensive industries. But competition requires them to minimize cost leading to first BPO trend and now KPO trend. What was once considered as the most strategic of corporate function is now a target of companies' globalization effort (Fredriksson 2006). Global R&D expenditure of foreign affiliates in host countries has increased from \$30 billion in 1993 to \$67 billion in 2002 (UNCTAD 2005). In developing countries, their share increased from 2% to 18% (Fredriksson 2006). With development of information communication technology (ICT) R&D activity can be divided into sub projects to be completed at different locations based on cost advantage. This kind of internationalization of R&D involves less risk of diffusion of technology to competitors making KPO an increasingly global trend. As a result most of the fortune 500 companies have established their R&D centers abroad.

¹ UNCTAD (2005) World Investment Report "Transnational Corporations and the Internationalization of R&D"

² The term economies of agglomeration is used in urban economics to describe the benefits that firms obtain when locating near each other. It is related to the idea of economies of scale and network effects, in that the more related firms that are clustered together, the lower the cost of production (firms have competing multiple suppliers, greater specialization and division of labor result) and the greater the market that the firm can sell into.

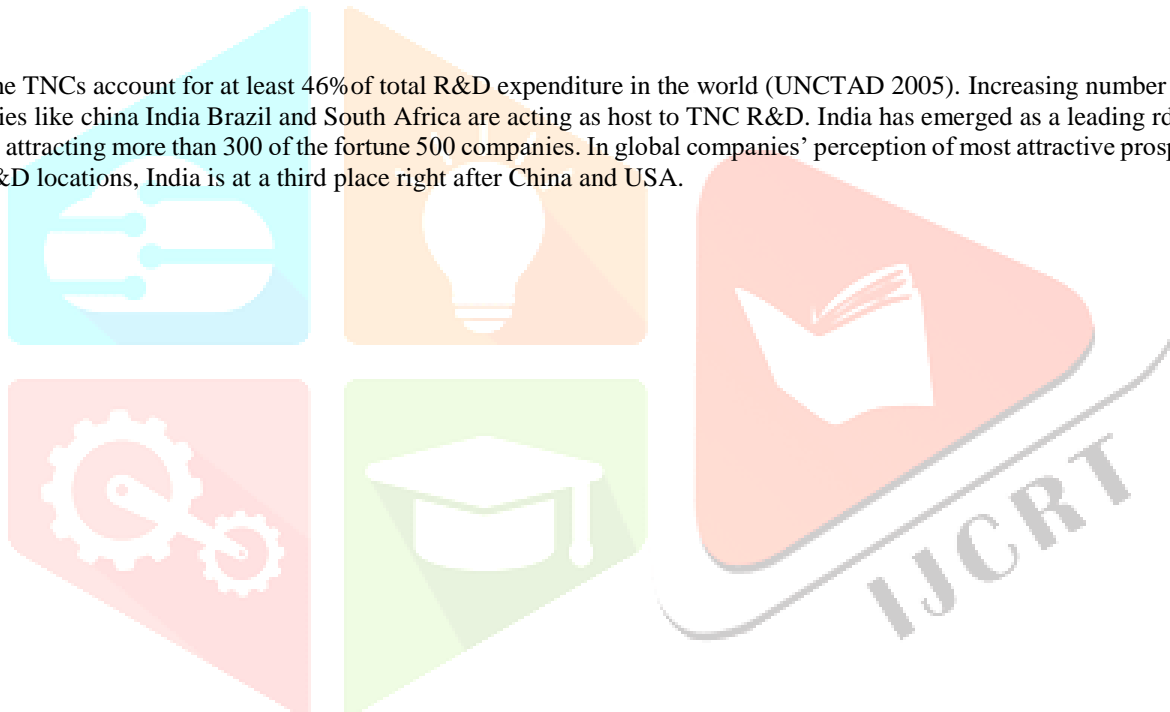
Degree of R&D internationalization by industry, 2004-2005

(Per cent)



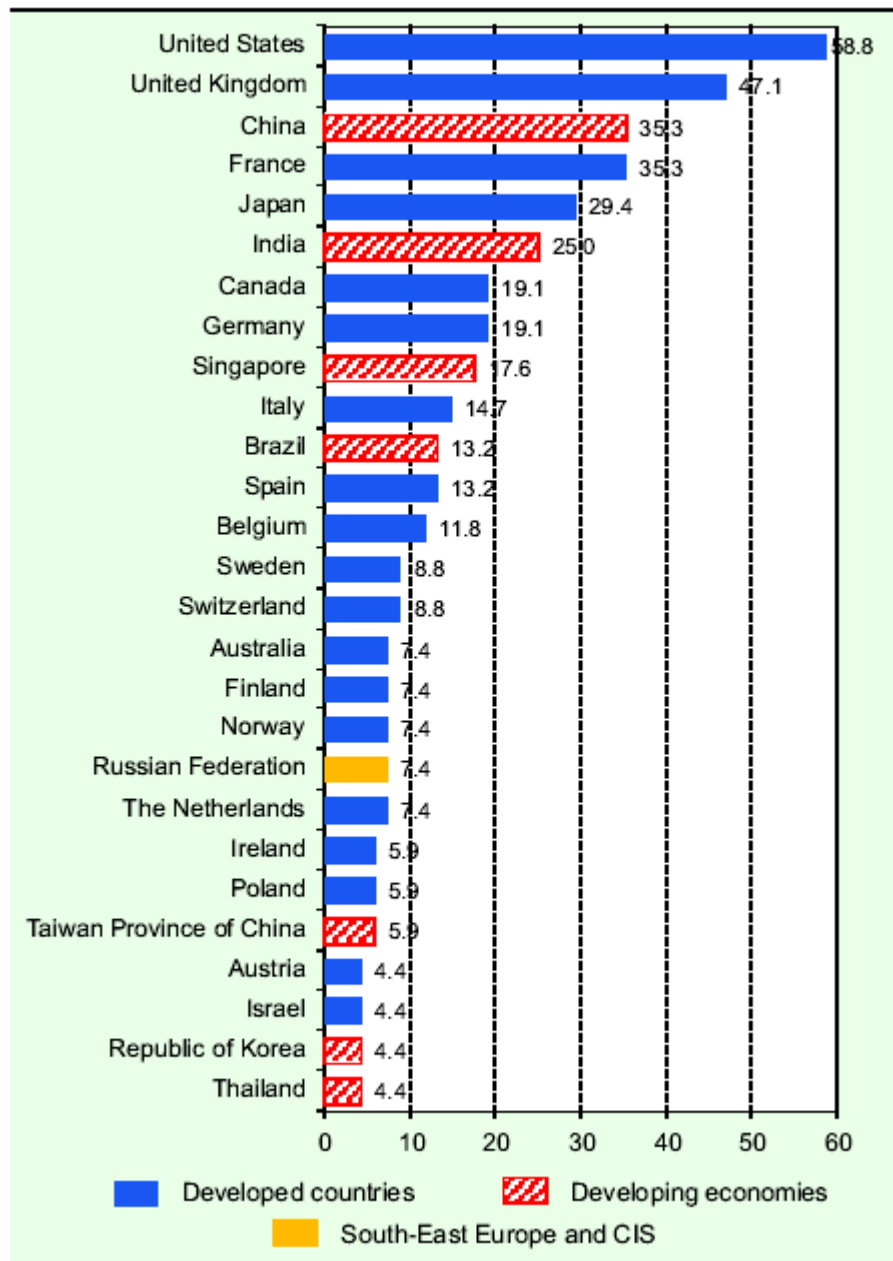
Source: UNCTAD survey.

The TNCs account for at least 46% of total R&D expenditure in the world (UNCTAD 2005). Increasing number of developing countries like China, India, Brazil and South Africa are acting as host to TNC R&D. India has emerged as a leading R&D hub vis-à-vis China, attracting more than 300 of the Fortune 500 companies. In global companies' perception of most attractive prospective (2005-09) R&D locations, India is at a third place right after China and USA.



Current foreign locations of R&D in the UNCTAD survey, 2004

(Per cent)



Source: UNCTAD survey.

With this growing trend of internationalization of R&D activity it would be interesting to analyse –

- (1) The driving forces in internationalization of R&D .
- (2) What makes India an attractive destination?
- (3) The possible implications for Indian economy.

I will discuss them in the next three sections.

(1) Driving Forces in Internationalization of R&D

The process of internationalization of R&D is being driven by various complex push and pull factors. R&D was considered as the most strategic and least fragment able activity of a firm which requires skill knowledge and infrastructure assumed to be present only in industrialized countries. Then why is R&D activity being globalised? Answer could perhaps be that competition pressurizes firm to innovate more but shortage of skilled manpower and high costs in developed world limit their ability to innovate. That is where some developing countries fit in with their widening pool of talented / skilled manpower available at a much lower cost. Moreover some of the emerging nations- China, India , Brazil –have strong national innovation systems and patent regime. They are also offering incentives in form of tax benefits to attract such FDI. R&D internationalization today is more of an outcome of desire for global innovation to remain ahead of competitors, then to carry out R&D to suit the needs of local markets. Adaptive R&D to take advantage of domestic market is still an important driving force but today's growth of rd internationalization is a result of competitive pressure to innovate at a lower cost.

Development of international communication and information technology has allowed efficient communication even between research groups based in different continents. TNCs can fragment their R&D projects into smaller sub projects. These can be sub-contracted or outsourced to developing countries. Location will be based on skill availability. The division of labour and specialization advocated by Adam Smith has reached newer heights with erstwhile recognized as a least fragmentable corporate activity –R&D being fragmented and outsourced based on availability of skill in a particular location (Nagesh Kumar,2002). Brain drain today does not involve physical migration of the human being to some other country, only brain is transferred from host country's entity to a TNC unit.

OECD report (2008) has identified some of the major factors driving the internationalization of R&D as:

- (i) The nature of innovation is changing as products and services are becoming more technology intensive;
- (ii) R&D expenditure is increasing and companies are forced to find cost effective measures;
- (iii) Proximity to markets and production, that is, the need for localisation and customisation of global products;
- (iv) Maintaining competitiveness over rivals in lead markets;
- (v) Government policies and incentives, governance in host countries;
- (vi) Sophisticated ICT infrastructure enables and helps companies to manage R&D globally ;
- (vii) Availability of cheap and large number of research skills and talent particularly in some merging economies; and
- (viii) International mobility and availability of skilled human resources (OECD, 2008, pp.17-18).

But a country's capacity to attract international R&D is related to the efficiency of economy's National Innovation System (NIS)³. Weaknesses and strengths in NIS of a country will influence the volume of FDI in R&D coming to that country. UNCTAD(2005) report has identified ten major components that influence the nature and shape of FDI in R&D,

- I. The general investment climate: macroeconomic and social stability, security, and regulatory regime, and transparency;
- II. Economic structure: industrial structure, market size, natural resources, infrastructure, and culture and language;
- III. Availability of scientific and engineering skills for competitive wage rates compared to developed countries;
- IV. Strong educational system, particularly technical tertiary education system producing skilled and quality technical people and researchers;
- V. Presence of R&D performing institutions (Private and public firms and labs, universities) and standards and quality setting institutions;
- VI. Presence of institutions (universities and other) doing high level of basic research and publications;
- VII. Strong links between knowledge institutions and production enterprises;
- VIII. Strong IPR regime, particularly to protect industries where technologies are easy to imitate;
- IX. Presence of dynamic science parks that facilitates interaction between diverse range of firms and institutions;
- X. Presence of diverse industrial structure with high class clusters of technological and industrial activity.

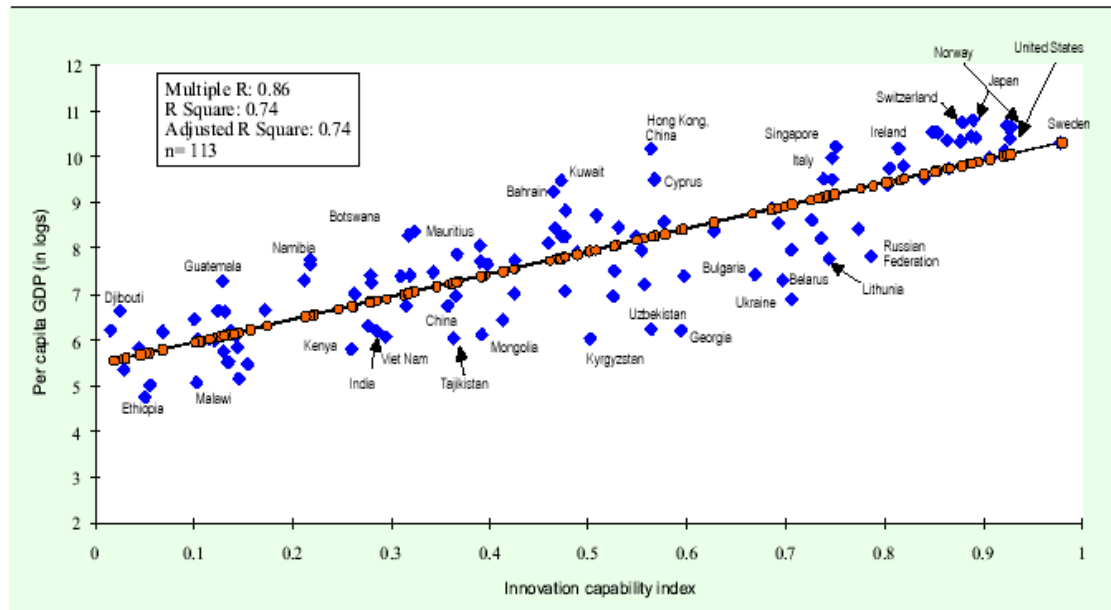
Baskaran & Muchie (2008) have argued that when all these ten components are strongly present in a country's NIS, then it is quite likely that the NIS is more efficient in attracting FDI in R&D at even higher level of technological and innovation complexity. When all these ten components or majority of them are not present in a country's NIS, then NIS will fail to attract any meaningful FDI in R&D. Between these two extreme scenarios a country will be able to attract comparatively less complex technological and innovative activities and it is also likely to attract R&D in some higher level of innovation and technological activities in selected areas. The extent to which developing countries can link up with global networks of learning and knowledge creation depends on their national innovative strengths. These strengths differ greatly, and the UNCTAD Innovation Capability Index⁴ shows that gaps between countries tend to persist over long periods.

³ National innovation system (NIS) is a tool to achieve the goal of industrial/economic competitiveness, but it is about achieving a broader development and wider social benefits. To understand the major elements of NIS and their corresponding linkages, see Baskaran, Angathevar & Muchie, Mammo, (2008). Foreign Direct Investment and Internationalization of R&D: The Case of BRICS Economies.

⁴ "Innovation Capability Index". The Index is defined as the average of the two separate indices — technological activity index and human capital index. The first is determined by a measure of R&D personnel per million population and patents granted per million population as well as scientific publications. The second is determined by literacy rate measured as percentage of population, secondary

school involvement as percentage of age group and tertiary enrolment. The indices have been worked out for various countries. While China figures in the medium group of countries with an index of 0.354, India comes distinctly lower with a score of 0.285.

. Relationship between the UNCTAD Innovation Capability Index and log per capita GDP, 2001



Source: UNCTAD.

Although India's innovation index value is very low but there is a possibility for improvement.

Presence of factors identified by UNCTAD AND OECD reports will influence both the quantity and quality of inflow of FDI in R&D. this will have considerable consequences for the host country as possible technological spillover resulting from FDI in R&D can have positive effects on the host country's development.

(2) What Makes India an Attractive Destination?

As per TIFAC report on FDI in R&D more than US \$1.1b flowed into R&D sector between 1998 and 2003. 100 biggest foreign companies with R&D centres in India employ about 23000 researchers. The USA leads with 15900 workers. Germany is the second country in terms of size and investment accounting for 7% in terms of number of companies (see TIFAC report 2006 on FDI R&D). But most of this FDI is routed through Mauritius. FDI in R&D has more than doubled since 2003 and it now amounts to 25% of total FDI is largely concentrated in software and IT services, chemicals, pharma sector, electronics and automobile sector. Types of foreign R&D in India include (1) in house rd by TNC affiliates (2) collaborations (3) contracts or other forms of relationship with private entities, public laboratories and universities (Mitra, 2007). Nearly half of the FDI companies are cases of relocation of in-house R&D to India. TNCs are opening independent R&D centres of undertaking research in new and emerging high tech areas. Initially the FDI came to exploit domestic market but now major players have shifted their research arms to India to take advantage of low costs for their global operations. GE's John F. Welch technology centre in Bangalore employs over 2200 scientists, researchers and engineers. This is second largest of GE's global research team. (Mitra, 2007). IBM is now said to have more researchers in India than it has in the U.S. The R&D services have become an important player in services export with Bangalore emerging as a major hub for R&D rd services exports. But companies investing in R&D are not doing it purely for export purpose.

S.No.	Activity type of top 100 FDI companies in R&D sector	No. of cases
1	Only R&D exports	0
2	R&D exports + domestic market	23
3	Manufacturing for domestic market +R&D exports	19
4	Only offshore R&D for in house R&D	53
5	Contract research for other companies	20
	Total	

(Source TIFAC report)

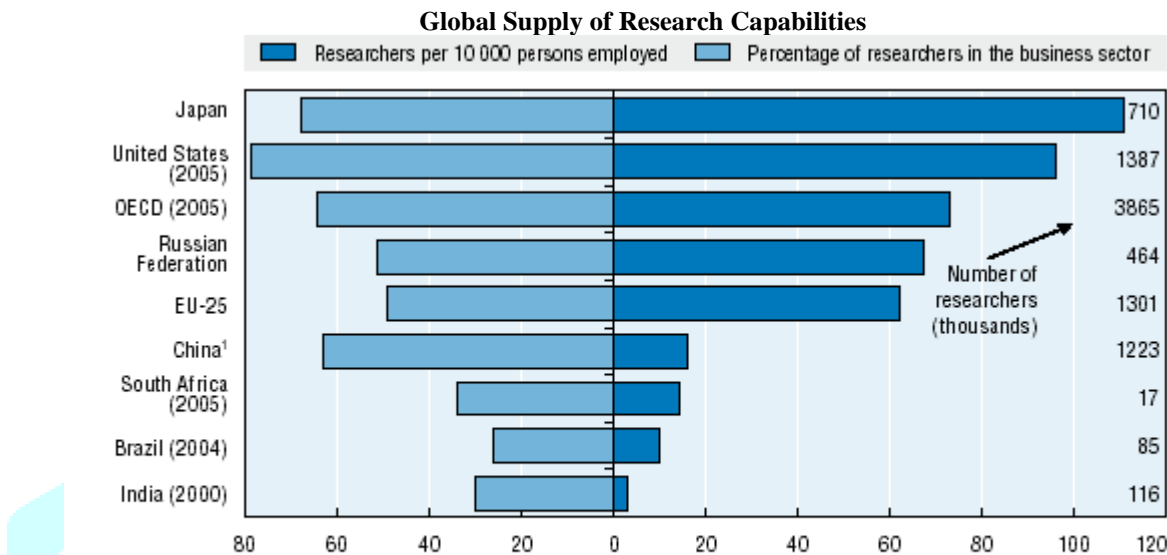
Existence of large domestic market is still an important incentive for these companies. Most of the FDI R&D is in IT sector followed by pharma, automobile, chemical and agro based industries. In IT sector, globalization started with general software moving to BPO and now focus is on high end R&D services. Another interesting development Mitra(2007) has pointed out is that even small and medium enterprises have started R&D operations in India . So what makes India an increasingly attractive destination for FDI IN R&D? If we try to analyze India's national innovation system (NIS) based on ten components identified by

UNCTAD WIR 2005, we can easily see that India satisfies most of the requirements necessary for strong NIS to attract meaningful FDI in R&D. We have a large pool of scientists and engineering skills available at one tenth of the cost in USA.

Rank out of 102 countries

▪ Availability of scientist and engineers	3
▪ Quality of management schools	8
▪ Quality of scientific research institutions	20
▪ Quality of educational system	36

▪ (Source: World Economic Forum's 'Global Competitiveness Report, 2003-04')⁵

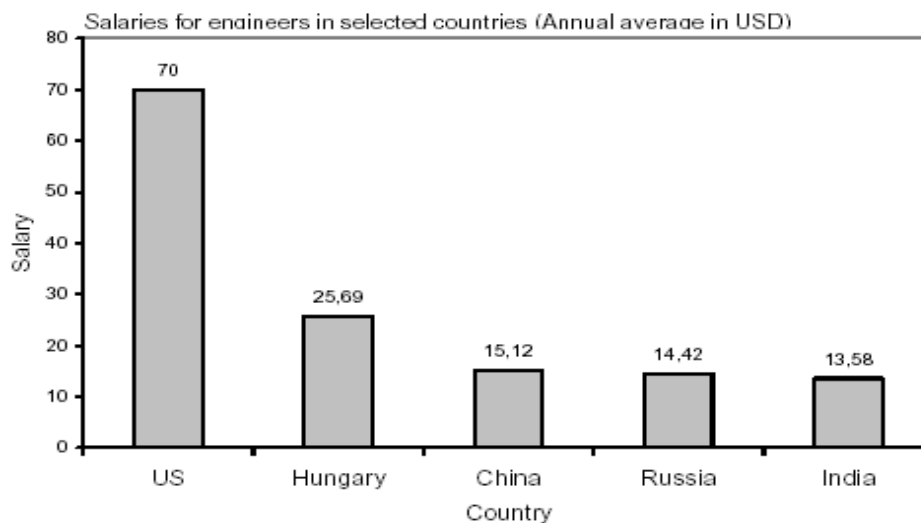


1. Data for scientists and engineers rather than researchers; overestimation possible.

Source: OECD report 2008

In 2003–04, there were approximately 9,400 colleges for general education, 2,750 colleges for professional education, and 380 universities/institutes⁶. India has the third largest number of students in higher education in the world with English as the primary language of instruction. Most of the educated Indian workers speak at least some English. In India, there are more than 200,000 engineering graduates annually, more than 300,000 post graduates from non-engineering colleges, 2.1 million other graduates, and about 9,000 PhDs. This pool of largely English speaking workforce available at low cost is an important pull factor that gives India a comparative advantage over China.

Average annual salaries of engineers in 2003 in different countries



Source⁷: FICCI 2005, adapted from www.workforce.com

⁵ Dua, Ajay.(2005). Foreign Direct Investment in India. Department of Industrial Policy & Promotion, Government of India.

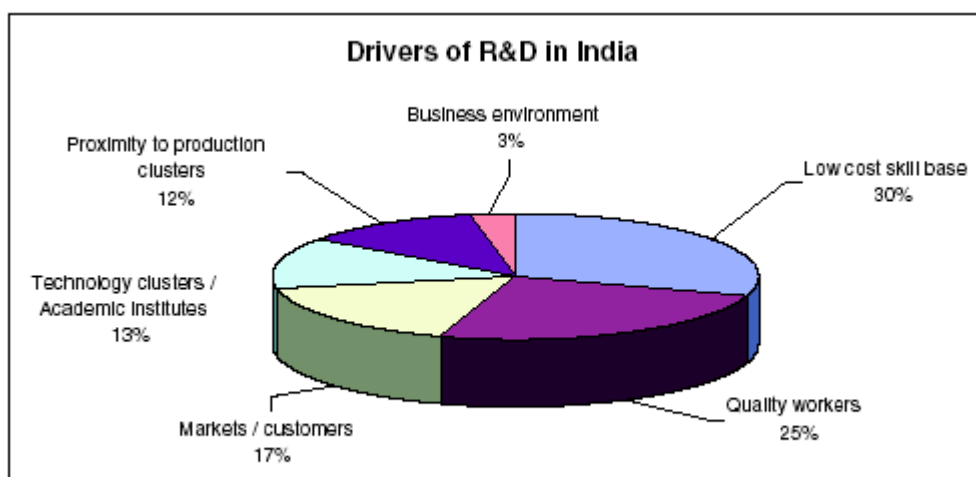
⁶ Dua, Ajay.(2005)

⁷ As mentioned in Mitra (2007) "India's Emergence as a Global R&D Center - an overview of the Indian R&D system and potential".

The central government has been the major investor in higher education as well as in R&D in the country. The high budgetary allocation of Rs.17750b for 2007-08 given to department of science and technology is indicative of our government's commitment to R&D spending. Several public institutes were created for carrying out R&D . CSIR, ICAAR, ICMR as well as different universities are responsible for the R&D work undertaken in India⁸. A large number of world class research institutes- IITs, IISc, BITS, NCL etc. that are capable of providing quality R&D exist in India. There are approximately 200 national laboratories as well as 1300 R&D units in the industrial sector giving employment to around 3 lakh people. There are 380 universities , 32 deemed universities and 10 institutes of national importance that pursue science and technology activities. The number of universities and research institutes has increased significantly. But a lot needs to be done to bring them at par with the world level. Improvement in education infrastructure, legal and regulatory framework and market conditions have resulted in India climbing to third position in global perception report. Fundamentals of our economy are strong enough to face the challenges of the global financial crisis. This is as a result of our macroeconomic stability and we will therefore attract more and more FDI in different areas especially in R&D in future. Our government is also giving generous incentives in form of tax breaks, relaxation on custom duty, 100% depreciation benefits etc. Several dynamic science and technology parks have been established to facilitate interaction between diverse range of firms and institutions for IT services. Our intellectual property rights regime (IPR) has also improved significantly in post reforms era, with amendments made to adhere to TRIPS. This has definitely given a boost to the confidence of TNC interested in R&D location in India

Thus, we can say India has emerged as an attractive location for FDI in R&D in terms of availability of science and engineering skills at low cost, English speaking workforce, public funded innovation system, large number of universities and specialized institutions in R&D , generous incentives and tax breaks, science parks, macroeconomic and politically stable environment, existence of improved IPR regime and well developed legal infrastructure .

All of this is necessary to provide strong research base and quality R&D.



Source: Compiled from INSEAD Business School, France, and Booz Allen Hamilton, 2006

By EXIM bank

But there are some constraining factors that need to be addressed to remain competitive in future. A shortage of supply of qualified engineers, PhDs is emerging gradually and competition among TNCs is resulting in wage inflation with high attrition rate for public sector. Our physical infrastructure –transportation and communication systems and utilities(electricity, clean water supply)- is increasingly becoming insufficient to meet the needs of a growing economy. This can turn out to be a major handicap vis-à-vis other competitors like China. We are in bottom group according to global competitiveness report whereas china figure in the middle group of countries with well developed physical infrastructure¹⁰.

⁸ India has S&T agreements with more than 50 countries, S&T and IPR agreements with France, EU and Russian federation. India also has joint R&D programmes on material science, cellular and molecular biology, laser and electro-optics information technology.

⁹ Taken from EXIM Bank: Research Brief(2006). www.eximbankindia.in

¹⁰ Bottom group-General infrastructure poorly developed and inefficient ;middle group- well developed; top group- among the best in the world. Dua, Ajay.(2005). Foreign Direct Investment in India. Department of Industrial Policy & Promotion, Government of India

Physical Infrastructure

Top 1/3	MLY-12 THA-29	MLY-7	MLY-26 THA-20	MLY-9
	CHN-55	THA-36 CHN-54	THA-41 CHN-60	IND-47
	IND-70	IND-69	IND-85	CHN-68
	Overall	Ports	Electricity	Air Transport

Source: Global Competitiveness Report 2003-04)

(3) Implications

Nagesh Kumar (2002) in his book “Globalization and Quality of FDI” has mentioned that India with its relatively well developed science and technology infrastructure, cheap R&D manpower availability has attracted some R&D investments and research contracts from MNE. Most of it is in areas of modern or new technology such as ICT, biotechnology, pharmaceuticals and chemicals. The opportunities offered by these emerging sectors are yet to be fully exploited. Agglomeration economies have driven R&D investments in India as we have already achieved a certain level of technological capability in these industries (Nagesh Kumar, 2002). Therefore, some of the R&D is also intended to absorb knowledge spillovers from innovation system of the emerging developing countries as evident from the table below.

1. Greenfield FDI projects in R&D, 2002-2004
(Number of projects)

Home economy	Host economy			Total
	Developed	Developing	South-East Europe and CIS	
Developed	"Traditional" 612	"Modern" 953	40	1 605
Developing	"Catch-up" 63	"Expansionary" 97	2	162
South-East Europe and CIS	"Catch-up" 3	"Expansionary" 3	-	6
Total	678	1 053	42	1 773

Source: UNCTAD survey.

Are we deriving any benefits from the presence of foreign R&D? What is the impact of foreign R&D on our innovation system? Is FDI in R&D the golden grail for which we have to go extra mile?

Countries like China, Brazil and Korea are investigating the balance of benefits from the activities of foreign R&D centres in their respective countries (Mrinalini & Wakdikar, 2008). In case of foreign R&D activity brain drain does not require migration. “it is accessible on its own soil and at much lesser cost” (Mrinalini & Wakdikar, 2008). Priorities of TNC and host country may not coincide. According to Dunning (1992), there is a possibility of indirect positive as well as some negative effects on the host country’s innovation system. Positive effect is due to technological spillovers; local firms having access to high technology through

partnership/collaboration. Working in TNC research centre provides valuable experience and training for India's scientists and engineers in area of innovation management. New enterprises can be set up by scientist and engineer's earlier working in foreign R&D centres to pursue new ideas that are not of direct relevance for that TNC. Exploitation of potential of our skilled R&D manpower by TNCs can motivate domestic firms and government to utilize these valuable assets in an efficient manner. According to UNCTAD (2006) report, presence of foreign R&D centres can encourage commercial culture among scientists and engineers and inculcate innovative culture among local firms. But there are possible negative spillovers – diversion of talent from India specific needs and Indian organizations. TNCs pay higher wages and salaries compared to public institutions. So quality of work done in public institutes may suffer due to higher attrition rate. Therefore, net effect of rapid increase in number of foreign R&D centres in India is hard to discern and require careful sector wise analysis.

Not many studies have been undertaken to analyse the effects¹¹. The TIFAC report has stressed the need to monitor the impacts of this investment on jobs and export revenues it generates. Also how effectively are the technologies developed in these centres being transferred to India's public sector needs to be assessed. In a study undertaken by IIFT it was found that "diffusion of technology has been highly limited and their contributions in the capacity building of the country are not many in number." There is no system to assess the effects of foreign R&D centre on the country's technological development. Our researchers employed in such centres may be financially better off but whether the country as a whole is better off or not needs to be assessed carefully.

Dahlman, Dutz, & Goel (2006) have argued that it is not necessarily in India's best interest for the government to offer more incentives to TNCs to locate R&D in India. A neutral policy that does not favor foreign firms over domestic firms will be more appropriate. We need to improve our infrastructure – physical and human to strengthen our national innovation system. A strong NIS is capable of attracting enough FDI without going overboard with generous fiscal incentives. Government should invest more in education sector to improve both quantity and quality of our workforce that has presented India with a competitive edge over several other countries. If our NIS is strong and we have the infrastructure to absorb the positive technological spillovers India can benefit from TNC global R&D drive. In such a scenario R&D coming to India will be meaningful and in high tech area. Although as Nagesh Kumar has pointed out that TNCs still do not relocate leading edge research in core technologies of companies. His research in case of Japanese MNEs has shown that they seem to be practicing an international division of labour where high value adding activities including R&D in relatively high technology industries are retained at home and others are gradually moved out (Nagesh Kumar, 2002). According to Archibugi & Michie (1995) a TNC/MNE is "a polyp with its brain in the home country and tentacles in the host country". The government must analyse the positive and negative spillovers associated with FDI in R&D thoroughly before taking policy decisions as once a foreign company's plan to start a unit gets approved no government agency monitors the work of the unit. We need to ensure that they must work in synergy with the Indian academic institutions.

CONCLUSIONS

Earlier in economic literature research was seen as a highly centralised activity. Lately the focus has shifted on analysis of different business strategies resulting in globalization of R&D. Dunning & Narula (1995) and Kummerele (1996) argued that R&D FDI is asset exploiting or home based exploiting on one side and strategic asset augmenting or home base augmenting on the other side. So "firms internationalize their R&D to improve the way in which assets are utilized" (Narula & Zanfei, 2004). Internationalization of R&D is an attempt by firms all over to further follow the law of division of labour and specialization. Presence of both internal and external cost economies is responsible for globalization of an activity that was always kept close to home-R&D. To remain competitive globally firms are on a cost cutting drive. Well developed innovation system, conducive for carrying out research and development, present in some of the emerging economies with modern Information and Communication Technology is intensifying this phenomenon of KPO. But it is also true that TNCs still do not outsource research activity in their core technology areas to prevent any spillovers to rival firms. This phenomenon of internationalization will have both positive and negative effects on both the host and the home country. The extent to which the host country will benefit from positive spillovers will depend upon the absorptive capacity of the host country and technological gap between the host country and the TNC. India and other emerging economies have lot to gain from this growing wave of internationalization of R&D activity only if they do not fall into the competitive trap of giving incentives. Such a competition among developing countries will result only in a perfectly competitive outcome-zero economic profit and even possible loss. TNCs may then emerge as the only winners of this game with their ever increasing control over R&D activities of the world. FDI in R&D is likely to have both positive and negative impacts on emerging economies like India. It is important that policy makers take steps to increase positive outputs from FDI in R&D by strengthening various components of NIS and also by creating strong linkages to local economy.

¹¹ There is some evidence of positive technological spillovers from R&D expenditure of multinational firms in India, See Basant, R. and B. Fikkert (1996), 'The Effects of R&D, Foreign Technology Purchase, and Domestic and International Spillovers on Productivity in Indian Firms', *The Review of Economics and Statistics* and Kathuria, V. (1998), 'Foreign Firms and Technology Transfer Spillovers to Indian Manufacturing Firms', INTECH Discussion Paper No. 9804 (United Nations University). Business practices introduced by multinational firms can also improve the international competitiveness of domestic firms.

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