Chapter II
Review of Literature and Theoretical Perspectives

2.1 Introduction

The beginning of the Multinational firms as globally important institutions can be ranked as one of the major features of mid-twentieth-century (Fayerweather, 1972). He traced the origin of multinational in the year 1867 with establishment of Singer Sewing Machine Company. The origin of the term “Multinational” dates back to 1960 and credit goes to David E. Lilienthal. Since the early to mid of 20th century, there was a paradigm shift in the world political scenario. On one hand, there was decline in political imperialism and on the other; there was growth of independent states and political nationalism after the post war period. Although, before World War II, several companies like General Electric, Ford, Unilever and so on had considerable international manufacturing abroad. However, till the end of the World War II, multinational firms did not come to the focus. Few economics and business historians have viewed that the international spread of Multinational Enterprises (MNEs) other than the United States was a post-World War II trend. Others argue that the evolution of the modern MNEs dates back roughly to the last half of the nineteenth century. After the World War II and with the expansion of international business, MNEs evolved as the central institution. The increase in the number and activities of MNEs after the Second World War were co related with the increasing opportunities for technology transfer. At the time of war; defense-related research produced many new technologies. These technologies later used for civilian purpose. Simultaneously, in US, during that period, there were also increase in the consumer goods technologies and production. Along with defense related technologies, these technologies later transferred to the various parts of the world through the MNE’s activity (Buckley & Casson, 2010).

The Multinational business expansion occurred with two basic principles: transmission of resources, especially technological and managerial skills; organization of unified multination economic activities, notably in fields where there are advantages from the global integration of research and development (R&D), logistics, and financing (Fayerweather, 1972). Buckley & Casson (2010:5) defined Multinationals as “an MNE owns and controls activities in two or more different countries. It may, for example, develop a product in one country, produce it in a second country and sell it in a third one. Such an MNE will have a research subsidiary in the first country, a production subsidiary in the second country and a sales subsidiary in the third country. It may be headquartered in any one of these countries
– or in some other country altogether, for that matter. It owns and controls interdependent activities located in different countries linked by flows of goods, services and know-how, and coordinated by management”.

Another definition of Multinational is a firm which transfer know-how between operating entities in two or more countries, through a clear decision making system linked by ownership or other form of control, with the shearing of knowledge and resources, which allows coherent and common policies and strategies (Nicholas & Maitland, 2002).

Hennarth defines Multinational as “as a private institution devised to organize, through employment contracts, interdependencies between individuals located in more than one country. Hence a domestic manufacturer who only uses local distributors abroad is not an MNE, but a domestic department store with its own overseas buying offices, but no foreign manufacturing, is a Multinational” (Hennart, 2001).

The shortest possible definition of Multinational Corporation (MNC) is a business enterprise which owns and controls income generating assets in more than one country. Among these definitions the one given by Fayerweather seems relevant in this PhD project. Fayerweather (1969 & 1972) characterize multinational’s in two components: (1) the transmission of resources between nations and (2) the development of unified systems of industrial activities among several nations. In each of these roles the multinational firm may be observed to have special capabilities that account for its fundamental strength (Fayerweather, 1969;1972).

2.2 The Rise of MNEs and their Significance

In today's globalized world, international trade is growing faster than the world output. The degree of openness has reached a record level and has surpassed the pre-World War I levels in many countries. Recent advancement in Information and Communication Technology (ICT) has lowered communication cost; increase in number of consumer goods fuelled the trade and economic globalization process very rapidly (OECD 2008). Buckley & Casson (2010) argued that present form of globalization happened due to the various ‘exogenous factors’. Among the many factors, the most important is the various government policy changes followed by the technological improvements and lower international transport and communications costs. MNEs are the crucial element of all these rapid changes and are the major actor of this globalization process (Kleinert, 2001). During 1980s many national
firms systematically evolved into global firms and become Multinational with their all-encompassing activity along the value chain. With the proliferation of MNEs many scholars proposed that the expansion of MNEs was the cause of globalization. However, many argued that the increasing MNE’s activity is perhaps the consequence of globalization, and not the primary cause. Also different streams of literature suggest that the globalization and MNEs were ‘co-evolving’ (Buckley & Casson, 2010).

Although economic integration is a predominant characteristic of globalization, other factors are also significant, for example social, cultural, political and institutional. For some globalization is merely an economic and technological phenomenon for others it is a social and cultural force. Few see it a huge opportunity for economic progress and development and for others it is a threat to national independence, sovereignty, integrity, self-determination of individual, cultural diversity and so on. However, in the present form globalization process is deeper and perhaps more pervasive. In recent times it is also characterized by the rapid integration of two large and emerging Asian economies; India and China within the world economy. These countries are increasingly tying up with global trade networks by different specialized production and services in global value chains (OECD, 2008).

Organization for Economic Co-operation and Development (OECD) defines “globalization” as the increasing internationalization of financial markets and of markets for goods and services. Globalization refers above all to a dynamic and multidimensional process of economic integration whereby national resources become more and more internationally mobile while national economies become increasingly interdependent (OECD, 2005: 11). Famous economist and Nobel Laureate Joseph Stiglitz defines globalization as the closer integration of the countries and peoples of the world which has been brought about by the enormous reduction of costs of transportation and communication, and the breaking down of artificial barriers to the flows of goods, services, capital, knowledge, and (to a lesser extent) people across borders (Stiglitz, 2002). Whether, a proponent or opponent of globalization; everyone is unanimous on the fact that the Globalization is a potent force, which has affected national economy in a remarkable way (Ohme, 1990). Developed countries especially triad (US, European Union & Japan) has made tremendous economic progress by actively participating in the global economics. Following the developed countries’ model recently, a group of developing countries has stepped into global economics (Zedillo, 2008). The new global players like China, India, Brazil and Russia
have also deeply integrated into the process (Figure 2.1). As OECD report observed, China and India in particular, have enormously increased the global skilled worker supply at lower cost than the developed countries. The overall impact of globalization is also significant with these countries (OECD, 2008).

**Figure 2.1: Spread of globalization**

The process of economic integration is quickly taken pace and perhaps reached at its top in the last 15 years. The three main channels of economic globalization; trade, Foreign Direct Investment (FDI) and the international knowledge and technology transfer have developed very rapidly (OECD, 2008).

Among the many other actors, MNEs that dominate global FDI flows are also the main source of innovation. They are also the crucial players in the National Innovation System (NIS) of both home and the country to which they enter. Because of their certain advantages, MNEs are the vital force in conducting cutting-edge research and innovation. Also, there are many other ways by which international knowledge flows like, trade, licensing, cross-patenting activities, and international technological and scientific collaborations. FDI is one of the mechanism through which MNEs acquire existing assets abroad or set up new wholly or majority owned activities in foreign markets. In its simplest from MNEs are forms or agents of FDI (Narula & Zanfei, 2005). There are many ongoing and unresolved debates concerning the efficiency with which large MNEs employ these resources. However, there is no doubt that MNEs decision regarding size, content and
direction of R&D program as well as pace, mode and geography of the sourcing and exploitation of R&D results; vitally affect the international economy (Granstand et al., 1993).

Modern MNEs are the main driver of economic globalization and the most important channels for cross-border knowledge generation, flows and diffusion of innovation across national borders (Narula & Zanfei, 2005). MNEs control a vast proportion of world’s scientific and technical resources. About 95 percent of the 700 firms spend close to half of the world’s total R&D expenditure and more than two-thirds of the world’s business R&D (UNCTAD, 2005). Many MNEs who are the largest spenders in R&D often spend more than many countries' total R&D budget (OECD, 2008; van Bavel et al., 2006). FDI facilitates international trade and transfer of knowledge, skills and technology. FDI flows are usually favored than other forms of external finance by the host economics, because FDI is non-debt creating, non-volatile. FDI by MNEs is a long term process and the different aspects of internationalization are interrelated with each other along with the firms’ strategy (Edwards, 2002).

This is perhaps, because of recent trade liberalization and unprecedented technological changes. Previously, process and production function of MNEs were located together. Hierarchal structure of R&D and innovation concentrated in home country’s MNEs is breaking down. They are separated and placed apart to take cost advantage, logistics and market differences. Changes in location and organization take place under market force. There are new knowledge hubs emerged in different locations across the globe, such as Shanghai, Beijing in China, Bangalore, Hyderabad, Pune in India, Singapore etc. offer several advantages. Now enterprises are linking up in arm’s length contractual relations or may be other relations in a hierarchical manner. Enterprises are taking up affiliate to manage production and trade under direct control through FDI in a highly coordinated system (Lall, 2003). FDI is increasingly spreading throughout world since last couple of decades. More and more countries and industrial sectors is becoming the part of international FDI network. Different level and diverse forms of FDI integrating world economy in unprecedented way perhaps never happened before. Recently a strong rise in FDI has attracted the global attention as seen in Table 2.1. One of the issues which concern this study of foreign R&D centres in India and China is the FDI. We will also to some explore the regions and cities which attracted the FDI in R&D via MNEs in India and China.
Table 2.1 FDI flows, by few selected region and economy

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<tbody>
<tr>
<td>World</td>
<td>173,530</td>
<td>1,461,074</td>
<td>1,978,838</td>
<td>1,697,353</td>
<td>198,670</td>
<td>1,396,916</td>
<td>2,146,522</td>
</tr>
<tr>
<td>Developed economies</td>
<td>136,628</td>
<td>972,762</td>
<td>1,358,628</td>
<td>962,259</td>
<td>184,680</td>
<td>1,157,910</td>
<td>1,809,531</td>
</tr>
<tr>
<td>Europe</td>
<td>75,507</td>
<td>631,724</td>
<td>899,624</td>
<td>518,339</td>
<td>799,581</td>
<td>1,270,523</td>
<td>944,460</td>
</tr>
<tr>
<td>North America</td>
<td>52,110</td>
<td>296,897</td>
<td>379,590</td>
<td>360,824</td>
<td>35,384</td>
<td>268,621</td>
<td>437,999</td>
</tr>
<tr>
<td>Developing economies</td>
<td>35,326</td>
<td>433,764</td>
<td>529,344</td>
<td>620,733</td>
<td>13,984</td>
<td>215,282</td>
<td>285,486</td>
</tr>
<tr>
<td>Asia</td>
<td>19,613</td>
<td>282,127</td>
<td>331,425</td>
<td>387,828</td>
<td>11,495</td>
<td>144,448</td>
<td>223,081</td>
</tr>
<tr>
<td>China</td>
<td>4,652</td>
<td>72,715</td>
<td>83,521</td>
<td>108,312</td>
<td>1,336</td>
<td>21,160</td>
<td>22,469</td>
</tr>
<tr>
<td>India</td>
<td>58</td>
<td>20,336</td>
<td>25,127</td>
<td>41,554</td>
<td>8</td>
<td>14,344</td>
<td>17,281</td>
</tr>
</tbody>
</table>

(Source: WIR, 2009 Page 247; WIR, 1999 Page 489)

MNEs have large globally dispersed production networks and increasingly export intermediate and final goods between their foreign subsidiaries. Along with the other activities MNEs are increasing the cross border flow of labor, which has also augmented and contributed significantly to international economic integration (OECD, 2008). As a consequence, interest in MNEs and international business research has been advanced both by popular and scholarly fashion. At the policy level, different governments also seeks to understand the role of MNEs in the new global economy and the possible government’s role in the host and home country MNEs in shaping the world economic order (Nicholas & Elizabeth, 2002). Because of trade liberalization enterprises are facing competition in domestic and international markets as well. Different low cost communications medium and rapid technological changes forces enterprises to upgrade process technologies for introducing new products. It also change trade pattern, and more R&D intensive products are increasingly coming into the market in place of less technology intensive segments (Lall, 2003). The increasing internationalization of business research and development (BR&D) is another important dimension of globalization which is now taking place at a much faster pace. Previously, the R&D activity of most of the major global MNEs usually confined in their home country and was less globalized than other activities like sales, manufacturing and marketing. In today’s globalized world, firms are now increasingly offshore their R&D activities to other countries. With the international trade and FDI; technology and capital are moving across geographical borders without loss of time. Moreover, it is spreading more widely, including to developing countries, and involves more than adapting technology to local conditions. It is linked to changing motivations for outward investment in R&D (OECD, 2008). Innovation particularly in high technology
sectors is costly and risky affair, there is greater inter firm and cross national collaboration and networking in innovation effort. Also the knowledge is dispersed globally in different location. India and China are the two emerging economics in global scenario and are the major source of global high skilled low cost manpower. To take advantage of this a new and more recent trend has been observed particularly since the last decade of 20th century in the world scenario. FDI in R&D by MNEs has expanded beyond the Triad (the United States, the EU and Japan). This is one of the most significant changes that have come about in the last two decades or so.

2.3 MNE and the Internationalization Process

The theories of Internationalization process are drawn from various theoretical traditions for example economic theory, organization theory and marketing theory. The inclusion of internationalization theory in MNE research has introduced a new school of thought both in business research and economics as well. The firm’s internationalization process is related with the changing world. Moreover, the internationalization processes are the result of the combination of various factors (Johanson & Vahlne, 1990). Scholars have examined MNE as a “well established phenomenon in evolution” (Papanastassiou, 1995 p 4). Among many theories of internationalization of MNE the original theory of Dunning’s (OLI approach) and Vernon’s (PLC model) initially provided the crucial understanding of the factors that enabled national enterprise to become an established global players. These works gives a fundamental understanding of the MNEs internationalization process. The theories are still valid today subsequently articulate the ways in which these companies interact in a dynamic fashion in the evolving global economy (Pearce, 1997).

The theories of internationalization process of MNEs can be broadly classified into two categories; the Economic approach and the Behavioral approach (Figure 2.2). Famous among the economic approach are Dunning’s Eclectic Theory (OLI approach), Product Lifecycle Model (PLC) and the Transaction Cost Approach. The famous behavioral approach theories are Decision Making Model, the Uppsala Model, and the Innovation-Related Internationalization Models. These two approaches observe the internationalization process of firms from significantly different view point (Hermannsdottir, 2008). It is expected that, the theory of MNE must explain ‘contractual form for operation abroad’ and the ‘location of overseas activity’ (Nicholas & Elizabeth, 2002). These well-established theories and models are the foundation stone of MNE’s internationalization process, sometimes their validity and applicability is subject to review. Since the last few decades,
many drastic changes have been taken place in international business. Born Global firms, and various complex network relationship between the MNEs and within their value chain (for example suppliers, producers, distributors) does not fit into these models. Regarding the theories of foreign entry modes, there is no general consensus on a unified theory, conceptual framework, or paradigm (Andersen, 1997).

Figure 2.2: Different theories of Internationalization process

2.4 Internationalization of R&D

Internationalization process is being explored extensively over the last few decades from different perspectives like economic, social, organizational, marketing, management and so on. Internationalization is the process of increasing involvement of firms in international operations. The term “Internationalization” is used to describe the dynamic phenomenon of increasing cross-border trade of goods and services and mobility of various production factors such as people and capital. Internationalization is the geographical expansion of a firm’s economic activities beyond its national border. This phenomenon involves a number of interconnected and interdependent activities and actors through different formal and informal channels. Internationalization process requires a firm to adapt its resources, structure and organization to international environments. Investment, divestment growth and expansion, are the part of internationalization process. The term ‘Internationalization’ started to be used after First World War. Perhaps, this phenomenon gradually equated and replaced with imperialism.

The Internationalization of R&D signifies FDI by MNEs in R&D, international collaborations business and knowledge process outsourcing, R&D and technical services outsourcing, and moving other institutional and organizational operations to foreign
locations and so on (Turpin & Krishna, 2007). Theories related to trade and FDI debate, R&D as an important but ‘exogenous factor’ in internationalization of industrial production. R&D is considered as an important ‘input’ or ‘tool’ for MNEs as means of exploiting or defending oligopoly or ‘ownership’ advantages in foreign markets. R&D is considered as a corporate weapon in terms of a demand or market control mechanism.

Overseas R&D is the best possible way to defend or secure market position or some form of ‘monopolistic advantages’. R&D globalization has grown up with monopolistic competitive theories of FDI (Hymer 1972; 1993). The types of research laboratories located abroad in response to these pressures were envisaged to be technology transfer units undertaking minor product modifications and development work to adapt the product to local market conditions. In addition these support laboratories could feed back into the corporate research process for these particular market needs which perhaps applicable in similar other national markets (Howells, 1990). A second line of arguments says that there are needs and requirements of R&D in order to fulfill its role as an element in the competitive advantage of corporations which happen to be multinational rather than national in character. It is therefore a supply side requirements of R&D and the problems associated with organizing these inputs to optimize research output (Howells, 1990). With the growth, firms need to adapt technologies locally to sell successfully in host countries. In many cases, some internationalization of R&D is necessary to accomplish this (WIR, 2005). The table 2.2 shows the process of R&D internationalization, mechanism and actors involved.

### Table 2.2 Process of R&D Internationalization

<table>
<thead>
<tr>
<th>Internationalization Process</th>
<th>Actors</th>
<th>Mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internationalization of Science</td>
<td>Students and researchers</td>
<td>International mobility of researchers as well as international collaboration among S&amp;T researchers</td>
</tr>
<tr>
<td>Internationalization of Business R&amp;D</td>
<td>Firms, foreign S&amp;T employees</td>
<td>Internationalization of R&amp;D activity by MNEs, R&amp;D partnership by MNEs</td>
</tr>
<tr>
<td>International collaboration in R&amp;D</td>
<td>University, firms</td>
<td>Partnership, Joint Venture to develop technological know-how and innovation.</td>
</tr>
<tr>
<td>International exploitation of technology</td>
<td>Firms</td>
<td>Firms exploit their innovation in world market, by licensing or selling their innovation globally.</td>
</tr>
</tbody>
</table>

(Source Archibugi & Michie, 1999; Little & Veugelers, 2005)

2.4.1. Phases and trends in the Internationalization of R&D

Research on the nature and distribution of inward or outward R&D investment in developed countries are available since 1960s. The theories were mainly concentrated on internationalization of production (MNEs and internationalization process has been discussed in the previous section). A separate set of literature exclusively deals with internationalization of R&D (Howells, 1990). Although there are several attempts to
accommodate international production and internationalization of R&D in a unified approach (Dunning, 1977), like famous PLC model and OLI paradigm sometimes used to explain the off-shoring of R&D process. However, the theories and literature on internationalization R&D has developed as a separate stream and can be regarded as separate sub-field. Among the many other theories the two famous Dunning’s Eclectic Paradigm (OLI) and Vernon’s Product Life Cycle (PLC) model is discussed below:

2.4.1.1 Dunning’s Eclectic Paradigm

Since its inception in 1977, the Eclectic paradigm (OLI) is one of the leading analytical frameworks for explaining the foreign activities of MNEs (Figure 2.3).

Figure 2.3: Dunning’s Eclectic Paradigm

(Source: Hermannsdottir, 2008)

According to the theory, firms decide to enter into a foreign market if they have three distinct advantages (OLI advantage). These advantages are; ownership-specific advantages (O), location-specific advantages (L) and internalization-specific advantages (I) (Dunning, 2000). Ownership sub-paradigm emphasize that, the firms engage in or increase FDI if they have competitive advantages with that of other firms and / or are the resident of that particular country (Dunning, 2000). Ownership advantage is some kind of unique sources which gives firm a specific competitive asset. It provides basis of a sustainable demand of a product (embodied in the attribute) in overseas markets. The second sub-paradigm stresses on the value adding activity with the ownership advantage. The firms maintain the immobile, natural or other assets to use jointly with their own competitive advantages. These factors, favor presence in a foreign, rather than a domestic location. The third sub-paradigm of the OLI tripod states that the firms prefer to engage in foreign market if the net
benefit is higher. The firm will enter into the international operation rather than licensing, franchise agreement and so on. Firms usually involve in FDI in R&D if they possess certain ownership specific advantages (O) over their competitors. Also, firms engaged in FDI in R&D in order to acquire advantages, which is location specific (L). These two advantages will help firms to maintain or improve positions. Specifically, Dunning argued that firms engaged in overseas R&D in order to perform one or a combination of the following types of R&D: product, material or process adaptations or improvements; basic materials or product research; rationalized or cost minimizing production research, and scanning research in order to gain an insight into foreign capacities (Dunning, 1992; Serapio Jr & Dalton, 1999).

2.4.1.2 Vernon’s Product Life Cycle Theory

Product life-cycle theory (PLC) (Vernon, 1966) is a bridge between international trade theory and firms perspective of investment in product development. The theory argues that when demand for a new product in countries other than MNE’s home country become significant, the innovating firm has a tendency to set up manufacturing facilities in those countries. It identified different stages in the product life cycle (table 2.3). In the first stage home country is the major market. When the production process is better understood, and documented the firms moved to the second stage. The firm may establish production facilities in other countries or areas with low labor costs than the home country. Again, in the third stage or mature stage, the production process become fully standardized and market become very competitive, the consequence of the production technology diffusing to the rival firms, manufacturing is transferred to the countries with lower wages.

Table 2.3 International Product Life Cycle Model

<table>
<thead>
<tr>
<th>Stage I Introduction</th>
<th>Stage II Growth</th>
<th>Stage III Maturity</th>
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<tbody>
<tr>
<td>Products developed Production activities are located in the developed country. The product is exported into other industrial markets</td>
<td>Export activities increase and finally the production activities are located in proximity to consumers in other developed countries</td>
<td>Production is shifted to developing countries where manufacturing costs are low. The products are later exported to the country of origin.</td>
</tr>
</tbody>
</table>

(Source: Hermannsdottir, 2008)

However, there are many limitations in PLC theory. It explains the rationale of MNEs, overseas investment, it does not explain why it is profitable to undertake direct investment FDI rather than continue to export or licensing from its home base. The model has also weak in explaining short lived products. The model is also limited in explaining for the
companies which have already massive operation in other countries (Edwards, 2002). The PLC model says that, the internationalization of the R&D activity involved the transferring of technology to abroad which are produced at home. According to this hypothesis, foreign R&D units abroad will be only a Technology Transfer Unit (TTU). However, Ronstadt’s (1984) study found that foreign R&D units are not merely a TTU but beyond that. Many of them design or develop products for global market. Many large corporations are developing new products to serve several different national markets at the same time at home, or even developing products for world market from R&D laboratory situated abroad (Pearce 1989). So, the PLC model is not able to answer the latest trend of Internationalization of R&D and has lost some of its original appeal (Niosi 1997; Serapio & Dalton, 1999).

However, R&D has long been one of the least mobile activities of MNEs because of its complex and tacit nature (Pavitt & Patel, 1999; OECD, 2008). Firms usually perform R&D patenting at home because of fear of leakage of technological knowledge to the potential rivals. Also, knowledge is not transferable because of the characteristics of knowledge. It has 'tacit' part and often 'sticky' and embodied in location and persons. Therefore knowledge is not easily transferable. Also, firms’ competitive advantage is often directly related to its strength in home country and is strongly shaped by that country’s industrial specializations and national innovation systems, including its accumulated research and labor force skills (Pavitt & Patel, 1999). The studies at that period has also come up with significant findings that though, R&D has been thoroughly internationalized, but MNEs keep core innovative capabilities close to the their home (Patel & Pavitt, 1991). The study of technological activities of large firms outside their home country shows that firms continue to be firmly embedded in the condition of the technological strength in their home country. US patenting activities of 220 of the most internationalized show that, most of the firms tend to locate their technology abroad in their core areas where they are strong at home. Firms are also engage in small scale activities to monitor and scan new technological developments in centres of excellence in foreign countries within their areas of existing strength. Even the most internationalized firms rarely go abroad to compensate for their weakness at home (Patel & Vega, 1999). Firms, keep R &D activities at home because a R&D unit located close to headquarter can easily be communicated and coordinated (WIR, 2005). Above all firm can easily coordinate with the governmental bodies and can also keep their R&D activity secrete without leaking it to potential rivals (Niosi, 1997). Despite such obstacles, off-shoring of R&D by MNEs are increasing. Empirical evidences show that the top
spenders on R&D have increasingly invested in R&D outside their home country (UNCTAD, 2005; OECD, 2008). For example, UNCTAD (2005) survey found that among the responding firms 69 percent stated that their share of foreign R&D is going to increase. European Commission study also finds similar result; nearly 70 percent of the companies had increased their R&D off shoring over the last couple of years (OECD, 2008).

The reason behind this uninterrupted trend may be many. *Firstly*, technology transfer to manufacturing unit located abroad usually needs some degree of adaptation of the basic design. *Secondly*, foreign R&D units give a better hold of local market. *Thirdly*, the tapping of foreign R&D skills is become easy from globally dispersed knowledge hubs, available at low cost. *Finally*, it is the host country government, may offer more public inducements to conduct R&D than the home country of the corporation, thus reducing the cost of conducting research in a foreign location (Niosi, 1997).

Although there are strong forces for centralization of R&D in home country, decentralization of R&D seems an inherent in the growth and evolution of MNEs. Håkanson & Nobel (1993) identified three possible reasons for increasing share of foreign R&D over time (figure 2.4). These reasons are Acquisition, Greenfield investment, Exploitation of foreign R&D resources.

**Acquisition:** A MNE usually acquire assets overseas for the purpose of strengthening the company’s technological competency in new product areas. The company then expands their R&D activity with specific responsibility. After acquisition firm usually maintain or expand R&D in acquired company and later the activity specified depends upon the competence. However, it is not always that firms acquire to strengthen their R&D capability. It may be acquiring a foreign company unrelated to technology like market entry, brand name and sometime for the host country’s policy and so on. In case of such Horizontal acquisition, R&D units acquired by the company are often duplicated parent company’s activity at home. Sometimes the acquisition made due to political pressure for example host country’s restriction on foreign firms’ equity.

**Greenfield investment:** Greenfield investment happens when firms already has sales subsidiary and has market position. Initially newly established subsidiary tend to rely exclusively on parent technology. The subsidiary established in the host country usually dependents on adaptation of products and processes from the central R&D units located in the home country. If a subsidiary situated in small market this kind of dependency
continued for long time and may even entire life of the subsidiary. However, these kinds of units are useful in terms of accumulation of technical knowledge regarding locally manufactured products and their process. Such expertise is needed to perform technical service and the customization of products for the local need. Moreover, this technical knowledge can be utilized also in technical cooperation with local customer and to undertake technical adaptations needed while introducing a new technology developed in the parent laboratories. The autonomy of these kinds of units is limited and can be regarded as “small support laboratories”. The engineering departments of these kinds of laboratory are usually small and employ only a few people (Håkanson & Nobel, 1993). Gradually, the “support laboratories” tend to become involved in more advanced design and product development work. Such R&D derives in the commercial relations with the local market: specific market needs that cannot immediately be solved, unexpected results from technical activities that can be commercially exploited.

Exploitation of foreign R&D resources: High technology sectors particularly biotechnology and IT are very high R&D intensive. Firms in these sectors, sometimes do some basic research beside their normal product development. This kind of R&D is important for those firms in order to maintain their sufficient technological capacity and able to monitor world scientific development. The R&D internationalization process is shown in the Figure 2.4.

**Figure 2.4: Internationalization of R&D**

![Internationalization of R&D](source)

Internationalization of R&D was not the important research topic for scholars till the early 1980’s. Up to the early 80’s, the internationalization of R&D was an insignificant or
secondary topic of research, among government policy and decision making bodies even among the scholars particularly in India. Except a few expressed the concern and noticed that, the overseas research and development activities of US-based firms may hollow out the national technological capability (Mansfield et al., 1979). However, by the 1990s it had become an important subject among all concerned parties because of empirical evidence of rapid increase in foreign-funded and foreign-performed R&D that took place in most industrialized countries during the 1980s (Niosi, 1999). The available empirical evidence of internationalization of R&D is mainly backed by three types of data, patenting activity by foreign affiliates, the geographical distribution of the R&D expenditures of MNEs, and survey based evidence on the question of R&D location (Dunning & Lundan, 2009). A new trend observed by different concerned parties in late 80’s was the rapid increase in foreign-funded and foreign-performed R&D in most industrialized countries. OECD Science and Technology Indicators Report and the United States National Science Board Science and Engineering Indicators reported in early 1990s, that there is acceleration in the internationalization of industrial R&D (Niosi, 1999) (National Science Foundation US estimated that U.S foreign R&D expenditures had increased with an average increase of 12 percent per year, from 2.2 billion dollars in 1978 to more than 6 billion dollars in 1988) (Cheng & Bolon 1993; NSF, 1990). As a consequence of that, by the end of 1990s; internationalization of R&D, had become an important research area. Scholarly journals also deal with the subject in depth; and come up with special issues in regular intervals like IEEE Transactions on Engineering Management 1996 Volume 43, Issue 1, Research Policy 1999 Volume 28 Issue 2-3, World Investment Report 2005 by UNCTAD, Journal of Technology Transfer 2008 volume 33 and so on. The new research trends opened up new theoretical framework and hypothesis. The previous notions of foreign R&D centers are being challenged by many scholars. Studies have confirmed that MNE’s foreign R&D laboratories were not only confined themselves to adapting parent company technology to host countries, but gradually evolved to develop major innovations for catering the needs of global market. Previously, MNEs overseas R&D largely involved adapting products and services to the local need. Beside this, R&D activities were also a supporting to the MNEs’ local manufacturing operations.

Different scholars (Reddy, 1997; Hegde & Hicks, 2008; Niosi, 1999; Cantwell & Piscitello, 2000; Dunning & Lundan, 2009) have identified the different phases of internationalization of R&D firms (Table 2.4). These studies have provided theoretical and empirical insights covering techno-economic, social, impact of foreign R&D centers in the innovation system,
motivations, underlying conditions, endogenous and extraneous influences, interactions with different actors within and external to the national innovation system, issues of knowledge spillovers, etc. An important part of this exercise covers the evolution of foreign R&D centers over a period of time. The framework that is developing borrows heavily from economics i.e. literature covering theory of international operations of firms. From recent influential work by Reddy, 1997; Niosi, 1999; Hedge & Hicks, 2008, it is possible to distinguish foreign R&D firms over a period of time. However, these phases are not strictly water-tight compartments. These works show that, the dominant type of foreign R&D in a country depends on technological capability, economic, social and political configurations. In spite of the heterogeneity, it is still possible to have a broad assessment of evolution of foreign R&D firms.

2.5 Globalization of R&D

It may be pointed out that globalization of R&D in this thesis is considered as an integral of part of the maturing of internationalization of R&D or its higher stage of development. Since the 1960s, companies have been increased their R&D activities outside their home countries. This phenomenon become quite visible during 1980s and became even more significant in the 1990s. In the 1990s, the performance of R&D abroad by MNEs had not only increased substantially in quantitative terms, but also increased significantly in qualitatively. The scope of work had gone beyond local market adaptation to develop strategically important products for the global markets. Some firms even undertake basic research to develop generic technologies (Reddy, 1997). Although, the foreign R&D activities in offshore location were restricted among ‘Triad’ nations (the dominant phase of internationalization of R&D), recently, two major changes have been observed. Firstly, many large MNEs locating strategic innovation activities in developing ‘emerging economies’ outside the developed world; and secondly, since the first decade of 21st century, many firms from emerging economies have also entered into the global markets (globalization of R&D) with innovative products and services, developed through their own in-house R&D in the emerging economies (Reddy, 2011). However, there are wide differences in the degree of globalization of R&D between the home country of MNEs and between different industry groups. For example Japanese MNEs, rarely perform their R&D in foreign locations. Generally, high technology industries, like biotechnology, electronics, and pharmaceuticals, had a general tendency to internationalize their strategic R&D in comparison to other industries (Niosi, 1999).
The economic internationalization process accelerated in the post-second-world-war era and appeared unrivalled until the early 1970s, by the new phenomenon called globalization (Ruzzier & Bostjan, 2006). Globalization usually refers the firm's operations which are managed on a global scale rather than few selected countries. It is characterized by the worldwide integration of ever more competitive markets and companies facing global competition. Globalization also includes the functional integration of geographically dispersed economic activities. Globalization shoots from interdependencies across the subsidiaries within an international firm (Nicholas & Elizabeth, 2002). Globalization of R&D is a recent trend where firms extend its innovation networks beyond the country of origin and the triad regions to foreign locations in the emerging economies. With the recent improvement in ICT innovation networks, they do not need to closely locate their manufacturing facilities in the home countries or corporate headquarters. Global products can be created by driving greater integration of R&D across different locations thus efficiently combining multiple talents or capabilities of different locations (Turpin & Krishna, 2007).

The term “globalization” is sometimes used when internationalization has further deepened and encompasses a large number of countries worldwide and when the process has become increasingly separated from a particular home country of the parent company. Although some scholars have used the term interchangeably (ITPS, 2006), Narula (2005) has made a distinction between these two processes:

> Globalization is an ongoing process, rather than an event. Economic globalization implies the growing interdependence of locations and economic units across countries and regions. Cross-border linkages between economic entities do not imply globalization, merely internationalization (Narula, 2005; 2003).

Notwithstanding Narula’s distinction between internationalization and globalization, in this thesis globalization of R&D is considered as an offshoot or matured stage of internationalization of R&D as shown in Table 2.4. Globalization of R&D is boosted in recent years because of three major reasons (OECD 2005). Firstly, the explosive growth is because of easily available high technology at low-cost particularly the web technology. Internet and the Web Technologies are connecting people and locations at no time creating awareness and new business opportunities. Secondly, free trade agreements and financial deregulation have increased business among nations. Thirdly, the worldwide economic restructuring and liberalization has given it a tremendous boost. For example, socialism has collapsed in Russia and few European countries and lately the expansion of markets in Asia,
particularly India and China. Despite all these driving forces of globalization, internationalization has not been replaced, rather, many observations and theories on internationalization still persists and valid today (Ruzzier & Bostjan, 2006).

In a globalizing economy, MNEs are the major drivers through which globalization has occurred and are developed. MNEs are the generator of new technology and vehicles for technology transfer. By means of ‘green filed’ or ‘brown field’ investment and other forms of cross-border value-adding activity, multinational enterprises usually transfer technology across borders (Dunning & Lundan, 2009). In today’s globalized world MNEs are gradually organizing themselves into cross-border international networks beyond their country of origin. Due to the intense international competition and the urgent need for strategic interactions, (asset exploiting or asset augmenting) (Kuemmerle, 1999) MNEs are rapidly expanding beyond their geographical boundaries. This new trend of knowledge generation activity is observed during the last few decades. As mentioned earlier, advances in the transportation and communication technologies associated with globalization have enabled the spread of the value creating activities of MNEs on a global scale. Accordingly, the geography of the innovative activities of MNEs has radically changed. The knowledge generation activities of Multinationals are no longer encircled by distinct geographical boundary rather considerable proportion of knowledge created by MNEs is the result of their cross-border knowledge-generating activities. Dunning (2009) has observed three main trends in the patterns of the internationalization of the knowledge-creating and knowledge sourcing activities of MNEs. First, Although, the internationalization of the innovative activities of MNEs are increasing at an phenomenal rate still it is less preferred activity than the internationalization of production. Second, MNEs foreign subsidiaries are getting more autonomy in their R&D activity. Third, the innovative activities of MNEs have become more geographically dispersed than before (Dunning & Lundan, 2009).

This changing dynamics of R&D being performed abroad by MNEs have given two similar and interconnected concepts of ‘internationalization’ and ‘globalization’ of R&D. Internationalization involves joint R&D between two or more firms from different countries; and globalization involves development of a global R&D strategy by the MNEs both in their in-house R&D and R&D at the offshore location. Many scholars have opinion that in overseas R&D units are given a small and subordinate role in R&D activity, but in globalization, there is a involvement to overseas R&D, based on systematic division of labor between laboratories in different countries. Internationalization is usually motivated
by the need to support overseas production and marketing, whereas globalization is independent of such motives (Reddy, 2011; page 49).

Archibugi & Michie (1999), have categorized the globalization of innovation into three main categories the international exploitation of technology produced on a national basis; the global generation of innovations; and the global technological collaborations (Archibugi & Iammarino 1999). Little & Veugelers (2005) found four main processes behind the globalization of R&D (Table 2.4). Both the public and private actors are involved to exploit the potential to benefit from international exchanges either in terms of research and training or access to technology. Internationalization of business R&D today is not only influencing the innovation and technology strategies of companies rather it enforces and changes the network of science around the world (Archibugi et al., 1999).

**Table 2.4 Evolution of Globalization of R&D**

<table>
<thead>
<tr>
<th>Period</th>
<th>Overseas R&amp;D function</th>
<th>Facilitating factor</th>
<th>Drivers</th>
<th>Dominated Industries</th>
<th>Proposed framework for the Indian situation</th>
</tr>
</thead>
<tbody>
<tr>
<td>First wave</td>
<td>Very little R&amp;D abroad, confined to home country only</td>
<td>To gain entry into foreign markets.</td>
<td>Based on clients’ need</td>
<td>mechanical, electrical, automobile engineering.</td>
<td>1960s and 1970s: phase of international technology transfer</td>
</tr>
<tr>
<td>1960’s</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second wave</td>
<td>R&amp;D activity for market customization, ICT, learning to operate abroad, host government policies</td>
<td>Increasing demand by foreign customer</td>
<td>Consumers products, food products etc.</td>
<td></td>
<td>1980s: Emergence of Internationalization of R&amp;D</td>
</tr>
<tr>
<td>1970’s</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Third wave</td>
<td>Complex technologies, Multi-Product innovation, Frontière Innovation</td>
<td>Decreasing communication costs, Various means of communication, Proximity to manufacturing &amp; to industrial customers</td>
<td>S&amp;T, Knowledge base human capital</td>
<td>Microelectronics, ICT, Biotech, Pharmaceuticals, New Materials</td>
<td>1990s: Globalization of R&amp;D with TNCs and local institutions participating in R&amp;D</td>
</tr>
<tr>
<td>1980’s</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fourth wave</td>
<td>Targeted products for the domestic / international markets, New product segments, Global innovation network, etc</td>
<td>Co-location of R&amp;D independent of production, market; MNEs turning into globally integrated enterprise with no center of gravity; network mode of operation</td>
<td>Speed of innovation, New centers of lead market, Increasing product differentiation, Reduction in technological cycle time, etc.</td>
<td>Microelectronics, ICT, Biotech, Pharmaceuticals, new materials</td>
<td>2000 and beyond: Globally Dispersed Networked Innovation and Internationalization of Indian firms (mergers and acquisitions (abroad))</td>
</tr>
<tr>
<td>Late 1990s onwards</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Source: Reddy, 1997; Niosi, 1999; Hedge & Hicks, 2008; Krishna, et.al., 2012)

Today, MNEs are not only exploiting knowledge generated at home in other countries, but also source technology internationally and tap into worldwide centers of knowledge. This technology scouting process was more prevalent among Triad region and among developed countries MNEs. Although internationalization of R&D is not entirely new, previously it
was more prevalent among Triad Nations (US, Europe and Japan), in recent years it is taking place in an unprecedented way and at a much faster pace than before (OECD, 2008). However, the current web of internationalization of R&D is markedly different from the earlier phase. OECD (2008) report marked the present internationalization as: *it is gathering pace*, it is all *invasive* and *spreading* to more and more countries, including developing countries, and it goes beyond adapting technology to local conditions. Dunning (2009) has also observed that internationalization of the knowledge-creating and knowledge sourcing activities of MNEs are increasing at a phenomenal rate beyond their national origin. However, it is still a less preferred activity than the internationalization of production (Dunning & Lundan, 2009). Also, in the 1980s, Internationalization of R&D was mainly a developed country phenomenon and FDI in R&D usually took place between the triads (i.e. United States, Europe and Japan). However, with the present wave of globalization large upcoming and promising countries like, South Korea, Singapore, Taiwan, India and China are rapidly integrated with the global value chain. Scholarly works argued that even if MNEs moved to developing countries in the era of early to mid-1990s, their operations were confined to *‘one way technology transfer’* or oriented towards *‘adaptive R&D’* or *Home Base Exploiting (HBE type)* rather than *‘creative R&D’ or Home Base Augmenting (HBA type)*. In the specific case of India, an influential study by Kumar and Aggarwal (2000: 22) also substantiate the similar observation, *‘MNE affiliates focus on a customization of their parents’ technology for the local market or on exploiting the advantages of India as an R&D platform for their parents. With the present web of globalization, form the year 2000 and beyond there is gradually emerging a globally dispersed and networked innovation. Base on the framework discussed in the table 2.4 the study will investigate the recent trends of internationalization of R&D.*

As evidenced from various literatures, until recently, offshore R&D was a least globalization activity by MNE than any other activities like marketing, production etc. Because of global competition among MNEs, firms are now increasingly offshore their R&D activities to other countries mainly developing countries like India and China. Global competition, worldwide dispersed knowledge centers, market, and many other factors have forced companies to innovate and develop commercially viable products and services without loss of time. Empirical trend of increasing internationalization of corporate R&D is materialized through a variety of different channels. There is growing evidence of this trend (Edler & Polt, 2008):
 Firstly, there is an increasing volume of cross-border technology transfer. The cross boarder technology transfer is increasing at a remarkable rate. The mode of cross boarder technology transfer is occurring through technology-intensive trade and also through international licensing and patents. As evidence from OECD countries, between 1994-2003 periods, there was a significant growth in High-Tech exports than total manufacturing exports.

Secondly, the joint generation of knowledge across borders has grown considerably. The joint patents with foreign inventors have risen for all major OECD countries except Japan\(^1\). The alliances are more prominent in high technology sectors and more recently alliance tendency is gradually shifting from ICT towards life sciences and pharmaceuticals. University and research institutes are increasingly getting greater attention and importance towards alliance partner.

Thirdly, FDI in technology-related sectors have increased and it is reflected in R&D expenditure (input indicator) and patent statistics (output indicator). Economist Intelligence Unit (EIU, 2007) survey of 300 senior executives found that most of them favored India as a favored R&D location followed by US and China. UNCTAD survey of the largest R&D spenders worldwide, China ranked third and India sixth as current locations for R&D (Figure 2.5).

**Figure 2.5 Current foreign R&D locations** (Source OECD, 2008 Page 28; UNCTAD, 2005)

![Figure 2.5 Current foreign R&D locations](source.png)

There is a growing concern among the policy makers all over the world to best utilize the situation. Among the many other issues, the issues related to this growing trends about the

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\(^1\) Within OECD countries between 1931 and 2003 the share of joint patents increased from 6 percent to 11 percent for the US, 7 percent to 16 percent for France and 12 percent to 22 percent for the UK. But Japanese patenting activity have raised only slightly from 2.1 percent to 2.5 percent. Strategic technology alliances between companies have almost quadrupled between 1980 and 1995 (Narula 2003). While co-operation within Europe has slightly diminished, the co-operations between European and US companies have increased by the end of the 1990s. Most recent data published by UNCTAD 2005 have confirmed the rising importance of alliances (UNCTAD 2005, p. 126) Edler & Polt (2008).
motives of firms, benefits and challenges of international R&D for a given innovation system, embedded into the them into the local innovation system and so on.

In sum, foreign R&D by multinational in early days has been a centralized activity. The primary purpose of foreign R&D units was mainly for the technical support or adaptation of products in the local market. Beside this, foreign R&D units were rarely carried out global or original R&D in their R&D units abroad. Few scholars has the opinion that foreign R&D activity increased often because of host political pressure, the accidental or chance development of a subsidiary’s technical activity or incidental consequence of an acquisition (Chiesa, 1995).

In the light of the discussion and brief review of relevant studies the basic important question which triggered our theoretical and empirical research in this thesis is: What is the recent trend in the internationalization of R&D? Is there an evolution of the trend towards globalization of R&D?

Thus the hypothesis that will be tested in the empirical part of the thesis is: Internationalization of R&D in the era after 1990s is no more restricted to ‘Triad’ regions. The trend is leading us to understand globalization of R&D process. Hence it can be assumed that World’s leading MNEs which have entered into emerging economies such as India and China are doing their crucial R&D in Asia particularly in India and China.

### 2.6 Motivations for Globalization of R&D

The main motive behind investment in foreign R&D are technology-related, (i. e. to gain access to S&T resources) and cost-related, (i. e. to exploit the cost differentials). With the rapid globalization process in the last few decades, it is realized that knowledge is the most important source of competitiveness, innovation and development. Globalization and the increasing economic importance of knowledge dispersed globally have given rise to a more recent trend towards increasing internationalization of firm. Although, firms have internationalized their sales and manufacturing activities, since long, the globalization of R&D is a more recent phenomenon. For knowledge generation, acquisition and diffusion firms increasingly internationalize their core activities like R&D. MNEs are usually retain their R&D in the home country for a variety of reasons including fear of leaking secrets to competitors, embedded ness in a particular knowledge cluster or near to university and so on. Although, MNEs generally retained R&D close to headquarters in their home country, their science, technology and innovation processes are today increasingly dispersed.
geographically across the value chain (Gammeltoft, 2006). What is also of significance is the fact that countries such as India and China have increased their innovation ecosystems and enhanced their skill and technological capabilities. Regions such as Bangalore, Shanghai, Beijing, and Hyderabad etc. have evolved as important knowledge centres where high level of skill and human resources are available.

Although, MNE performs most of their R&D activity in the home country a number of recent studies have found that foreign R&D by MNEs is increasing to exploit benefit from foreign R&D. The decision to locate R&D is quite complex and influenced by a variety of factors (Thursby & Thursby, 2006). Overseas R&D in MNEs is in response to both demand side and supply side factors. On the demand side laboratories can help to adapt or develop products for particular markets. However, since these markets may now be much wider than one country, where a laboratory doing such product development is located may also be influenced by where the best scientific inputs are available (i.e. supply-side factors). Also overseas R&D labs may do basic or applied research not related to current market needs or production conditions. The location of this is even more likely to be influenced by countries’ scientific capabilities and capacities (Pearce, 1994). Drawing upon Boddewyn's (1985) work, Cheng & Bolon (1993) classified three important factors responsible for increasing multinational R&D. These are conditions, motivations, and precipitating circumstances. Latest ICT development, newly development economics with their socio-economic conditions and technological capability, uniform patent rule are the conditions that make foreign R&D possible or economically rational. Motivations are the return firms could expect to gain (higher innovation output or lower operating cost) from investing in foreign R&D. Scientific talents, new ideas, location specific international division of labor, market need, host government incentives are motivation factors. Precipitating circumstances reflect actions both inside and outside the firm which make the firms to invest abroad. Participating circumstances include technical support to local market, competitor’s R&D investment abroad, shortage of R&D workers in home country, host government pressure for investment in R&D, center of excellence dispersed globally. Literature on internationalization of R&D of last decades concentrated on the various push and pull factors to explain the phenomenon and found that internationalization of R&D is location dependent and government policy has significant role (Granstand, et. al., 1993).

The motive behind FDI is a combination of various factors (Lundvall, 2008). Although there are many motives behind the investment in foreign countries by multinationals, the
motives can be broadly categories into three types. These are market-seeking, resource-seeking and efficiency-seeking (UNCTAD 2007). However, some other factors such as host country business environment is also important. Gammeltoft (2006) categorized six types of motives for foreign R&D: market-driven, production-driven, technology-driven, innovation-driven, cost-driven and policy-driven (Gammeltoft, 2006). Foreign R&D by MNEs is subject to different location drivers. Von Zedtwitz & Gassmann (2002) observed that research is concentrated in only few concentrated pockets worldwide, while development is more globally dispersed (von Zedtwitz & Gassmann, 2002). The geographical location of R&D by MNEs has been analyzed in terms of two competing and contradictory forces i.e ‘Centrifugal forces’ (decentralization) and ‘Centripetal forces’ (centralization) (Chiesa, 1996). Various factors cause the centralization and decentralization of R&D is grouped in the table 2.5.

Table 2.5 Determinants of R&D Internationalization

<table>
<thead>
<tr>
<th>Centrifugal forces</th>
<th>Centripetal forces</th>
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</thead>
<tbody>
<tr>
<td><strong>Demand-driven factors</strong></td>
<td>Economies of scale and scope in R&amp;D</td>
</tr>
<tr>
<td>proximity to local customers</td>
<td>Fear of leakages of key technology to the competitor</td>
</tr>
<tr>
<td>products to local market</td>
<td>High co-ordination and control of R&amp;D</td>
</tr>
<tr>
<td><strong>Supply-driven factors</strong></td>
<td>Strong R&amp;D base in home country</td>
</tr>
<tr>
<td>Access to highly skilled scientific personnel</td>
<td>Ease of communication</td>
</tr>
<tr>
<td>Proximity to renowned university and private R&amp;D laboratories</td>
<td>Achieving economies of scale &amp; critical mass</td>
</tr>
<tr>
<td>Proximity to potential partners (customers and suppliers)</td>
<td>Exploiting firm-specific technological advantages from home market conditions</td>
</tr>
<tr>
<td>Access to low-cost supply of R&amp;D personnel</td>
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<tr>
<td>Accessing technological centers of excellence</td>
<td></td>
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<tr>
<td>Recruiting qualified technical personnel</td>
<td></td>
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<tr>
<td>Responding to local demand needs</td>
<td></td>
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<tr>
<td>Increasing proximity to key customers</td>
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<tr>
<td><strong>Political factors</strong></td>
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<tr>
<td>Increasing the local technological content of production</td>
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<tr>
<td>Interacting with government institutions</td>
<td></td>
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<tr>
<td><strong>Image</strong></td>
<td></td>
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<tr>
<td>Enhancing the firm’s image on international markets</td>
<td></td>
</tr>
</tbody>
</table>

(Source: Granstand et al., 1993; Chiesa, 1996; Duysters & Hagedoorn, 1996)

Several empirical surveys and case studies have found the motivation and determinants of decentralization of R&D. For example; a survey of about 200 multinationals by Thrusby & Thrusby (2006) from 15 industries group found four major factors viz.: output market potential, quality of R&D personnel, university collaboration, and intellectual property protection. However, in emerging economics, major attraction for MNEs for offshore R&D, and the most important attraction is the local market potential followed by the high quality
of R&D personnel. Also, the host government’s incentives in the form of tax break, and the ease of collaborating with universities is important factor for offshoring R&D. For emerging economics, the intellectual property protection was an issue and acted as detracting factor before 2005 but not after this year as the countries became part of WTO regime. One of the most important and perhaps unique results came out of the survey is that the universities are increasingly playing role in the global innovation system.

Although, Booz & Company and INSEAD Survey (Doz et al., 2006) found the traditional drivers like proximity to market and production facility is still the most important driver of R&D globalization. High skilled manpower ranked second in developing countries. However the drivers highly differentiated across region (Figure 2.6). The study further predicted that growth in the developing world will be motivated by ‘low cost skills base’ and ‘access to markets and customers’. The major finding of the study was that in India, firms are attracted by highly qualified staff on the other hand in China, the major drivers are potential market and low cost skills base. The study implies that companies are focusing lower on the innovation value chain in China than in India.

**Figure 2.6 Drivers of foreign R&D sites in India and China**

![Diagram showing drivers of foreign R&D sites in India and China](Source Booz & Company and INSEAD Survey 2006; p 5)

During the second half of 1980’s Japanese firms actively engaged in overseas R&D activity, the support for local marketing was an important motivation (Odagiri & Yasuda, 1996). However, in the later the trend among the Japanese multinationals’ R&D activities abroad shows that the basic and applied research of overseas subsidiaries aims at the exploitation of foreign advanced knowledge. But the host country market size is the determining factor for development and design activities (Shimizutani & Todo, 2008). The survey by Thrusby &
Thrusby (2006) on the factors that influence decisions on the place of R&D found that major motivating factors are; output market potential, quality of R&D personnel, university collaboration, and intellectual property protection. While in setting R&D unit in developing countries, the most important influencing factor is the market size followed by the quality of R&D personnel. Tax incentives by various host country governments, the expertise of university faculty are also the motivating factors. However, MNEs are concern about the host country intellectual property protection protections. Study of German and Non-German MNEs operating in Germany showed, the market adaptation of products is still the major driver for German companies, but international knowledge seeking is increasingly important, especially in technological areas that are linked very closely to basic research. Germany as a host of international industrial R&D is much more attractive for applied research (mechanical engineering) than for basic research (Edler, 2004). However, the recent WIR 2005 report finds India and China as the most attractive location in terms investment. China is considered the most attractive location by 85 percent of TNCs and experts. India’s high ranking, albeit with 30 percent fewer responses than China’s, is even more remarkable, given that FDI flows to the country have been modest until recently (Figure 2.7).

Figure: 2.7 Attractive global business locations by MNE

<table>
<thead>
<tr>
<th>Responses from experts</th>
<th>Responses from TNCs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. China (85%)</td>
<td>1. China (87%)</td>
</tr>
<tr>
<td>2. United States (55%)</td>
<td>2. India (51%)</td>
</tr>
<tr>
<td>3. India (42%)</td>
<td>3. United States (51%)</td>
</tr>
<tr>
<td>4. Brazil (24%)</td>
<td>4. Russian Federation (33%)</td>
</tr>
<tr>
<td>5. Russian Federation (21%)</td>
<td>5. Brazil (20%)</td>
</tr>
<tr>
<td>6. United Kingdom (21%)</td>
<td>6. Mexico (16%)</td>
</tr>
<tr>
<td>7. Germany (12%)</td>
<td>7. Germany (13%)</td>
</tr>
<tr>
<td>8. Poland (9%)</td>
<td>8. United Kingdom (13%)</td>
</tr>
<tr>
<td>9. Singapore (9%)</td>
<td>9. Thailand (11%)</td>
</tr>
<tr>
<td>10. Ukraine (9%)</td>
<td>10. Canada (7%)</td>
</tr>
</tbody>
</table>

(Source: WIR, 2005)

The Rational Choice theory is possible explanations for the formation of traditional R&D clusters. It can predict the concentration or spatial distribution of already formed industrial clusters but it cannot predict the rise of new or emerging geographic clusters. So, an alternate Imitating behavioral model emerges, which assume that the rational choice or standard factors are many not be the causes for MNE’s decision of locating R&D center in a particular location. This theory proposes the idea that location choice of a foreign R&D center is cumulative path-dependent process. A behavioral theory of agglomeration formation explains the emergence of regionally dispersed, local agglomerations by means of
mimetic behavior. Sometimes firms follow the others, even the competitors of the same industry, even without proper rationale. Information uncertainties lead firms to follow signals from others. Firms to some extent, reacting to each other's actions, creating symbolic, rather than functional, communities and that the locus of power determining local growth is diffused among location decision-makers. This theory may help to understand the emergence of R&D in new places (Appold, 2005; Sun et al., 2006; Sun, 2009).

Various scholars have supported these arguments of the locations of R&D centers in new places. Sun et al., (2006), Sun & Wen (2007) use these frameworks for possible explanations for MNEs decision on locating R&D center in China. While in Indian case no such study has been conducted. In exploring the growth and motivation of foreign R&D centres in emerging economies such as India and China, the questions are: What is the growth pattern of foreign R&D units in India and China?; What are the motivating factors for selecting India and China as a preferred locations by the foreign firms? and what types of locations foreign MNEs are selecting to locate their R&D units? The above questions raised guide the research in this thesis. The three hypotheses that are relevant for empirical exploration are:

a) **Hypothesis**: Along with the increasing inflow of FDI in India and China it is expected that MNEs are setting up more and more R&D units in India and China

b) **Hypothesis**: MNEs are locating their R&D units in India and China not only for future market related factors but also for highly qualified R&D personnel, proximity of higher educational institutes (HEIs) and Public Research Institutes (PRIs). Collaboration and source of knowledge seems to be other motivating factors. Other reasons may be the countries government incentives such as tax breaks and public policy support to create knowledge hubs (ICT parks, R&D or Science Parks etc.)

c) **Hypothesis**: MNEs are more likely to set up R&D units in Indian and Chinese cities where knowledge hubs are evolving or emerging.

**2.7 Types of R&D Units in Host Countries**

Having explored growth, location and motivations for foreign R&D centres to locate their R&D operations in developing and emerging regions, this section will deal with types of R&D units. The theoretical frameworks have changed accordingly to accommodate new realities and new data. Overall, three phases can be found in the literature. First up to the early 1980s, centralized structures were the most prominent form of R&D units. Second
period begins in the later part of 1980’s and lasts up to early 1990s. In this period a ‘polycentric structure’ or ‘decentralized federation’ was very common form of R&D units. Last phase or third phase the R&D units were globally dispersed and decentralized units. Management and coordination within a global network became more important issue (Niosi, 1999).

Ronstadt (Ronstadt, 1977), was the first to suggested the major evolutionary pattern in R&D establishments of US MNEs abroad. According to Ronstadt foreign R&D centers can be categorized into four categories namely; Technology Transfer Units (TTU) Indigenous Technology Units (ITU), Global Production Units (GPU) and Corporate Technology Units (CTU)

Transfer Technology Units (TTUs): TTUs are usually created to provide technical support to the parent company’s manufacturing subsidiaries and their customers’ needs. To implement these changes, interactions among several groups (R&D, marketing, engineering, and manufacturing) was necessary. So, these units were often located within or close to manufacturing plants. However TTUs were established where product or processes are yet to be standardized. Initial R&D investment was very low because R&D work in TTU usually involved only minor changes in existing technology so technical risks were also low.

Indigenous Technology Units (ITUs): ITU is the administratively independent units for creating improved product for the foreign market. They were established when parent unit was unable to meet local need. These units usually performed a broad range of R&D activity and were administratively independent units.

Global Product Units (GPUs): These are second most frequent units usually developed at later stage and produce new products for world market. Global product units were created in nations where there was a major foreign market and sites of production. These units required large investments compared to TTU’s, in terms of large R&D professionals, specialized R&D facilities. Moreover, these units acted independently of other non R&D functions.

Corporate Technology Units (CTUs): This was the third most frequent type of R&D establishment in the US to generate long term technology exclusively for the corporate parents. These units created abroad to get competencies of scientific advances in their active areas where skilled professionals were available. These units either small or large
mainly performed exploratory research to support existing business for global exploration.

Firms invest abroad to reap profit from the innovations developed for the domestic market. MNEs prefer to get benefit from the innovations developed at home rather than selling or licensing technology to the foreign entity (Bartlett & Ghoshal, 1989). Bartlett & Ghoshal has primarily categories two types of Innovation process; Central Innovation Process and Local Innovation Process. In central innovation process centrally developed technology exploited worldwide. On the other hand in local innovation process, the subsidiaries of the parent company use their resources infrastructures and capability to develop technology to meet the local demand. Although both MNEs usually develop both the processes large corporations mainly dominates in global companies with centralized structure while local innovation process is common in MNEs decentralized federation organization. However, in their study of nine multinationals Bartlett & Ghoshal (1989) have observed new trends of R&D and management function i.e. locally leveraged and globally linked. In locally leveraged innovation the local entity usually take advantage of resource and entrepreneurship of the local company to tap world market. The globally linked innovation coordinates resources and capabilities both locally and centrally. According to the market orientation Pearce (1989) have devised three categories. They are, Support laboratory, Locally Integrated laboratory; internationally interdependent laboratory. Kuemmerale (1999) have categorized foreign R&D units into two types based on the motives, location, evolution, mode of entry of FDI in R&D. Accordingly foreign R&D units may be Home-base-exploiting FDI (HBE-FDI) and Home-base-augmenting FDI (HBA-FDI). In HBE type foreign firms exploits technology generate in the home base into the foreign market. In HBA type firms exploit globally dispersed knowledge to strength its capability in the home base which can be exploited globally.

There are many ways to classify foreign R&D units depends on different kinds of parameters. For example; categorization can be possible based on the organizational strategy, R&D management practices and so on. However, with the recent surge of foreign R&D activity these typologies perhaps have limited scope (WIR 2005 pp 139). So, based on the types of R&D undertaken by MNE’s affiliates in host countries WIR report (2005) has come up with new typologies of R&D units. Those types may be:

Adaptive R&D: This kind of R&D is mainly to manufacture product or process according to the local market. This R&D is basically conducted keeping in view of the market and do not
fall into the actual R&D. However, it can vary depending upon the condition. For example it can be from local production support to the upgrading of imported technologies. Also, another it depends upon the other factors like locally available technical skills, demand and conditions.

**Innovative R&D:** It can be placed in higher order than adaptive R&D. It is linked with the production for local or even regional market. The evolution of adaptive R&D into innovative R&D depends upon the available technical skills also with supplier R&D capabilities and institutional support.

**Global innovative R&D:** If enough skilled human resource available subsidiaries of MNEs can develop into global innovative R&D lab.

**Technology-monitoring R&D:** Technology monitoring units are the R&D units which monitor the technology development in the host market. Subsidiary can also learn from the supplier, consumers and others from foreign markets.

Based on the above discussion about the type of R&D units in the host locations, the following are the research questions and hypotheses formulated to guide the empirical research in the thesis. *What type of R&D units are predominant in India and China? Are the R&D units working more global, local or regional product mandate? What type of R&D unit has been established by foreign MNEs in India and China? Do they reflect simple one way or two way technology transfers?*

**Hypothesis:** Foreign R&D units by MNEs in India and China no more reflect a simple local type of R&D units shows by studies (in 1980s /1990s). R&D units are more likely to be differentiated in terms of Local Regional and Global units.

**Hypothesis:** Internationalization of R&D (MNEs established R&D units in Developing Countries) in the 1980’s was mainly characterized as a one way Technology Transfer and involved adaptive technology for local national markets. A new trends in the last decade appears to be a two way Technology Transfer. MNE’s R&D units in the new trends are more likely to undertake ‘creative technology’ or ‘new technology’ for regional and global markets in addition to adaptive technology for local markets.

### 2.8 Effect of Foreign R&D on Host Countries: Spin-offs and Spillover

The effect of MNEs R&D in host country is a complex issue. The majority of studies of knowledge spillovers from the presence of MNEs have focused on whether or not, rather
than how knowledge spillovers occur from MNEs subsidiaries to local host country firms. From the developing country’s perspective, MNE’s knowledge creation by offshoring of foreign R&D has lots of positive as well as negative impact. Scholars have difference of opinion on the subject (Reddy, 2005; Granstand et al., 1993; Reddy, 1997). The enhancement or retardation of independent technological capability depends on the innovation capacity of the host country and the nature of R&D carried out by the MNEs (Reddy, 2011; Hallin, & Lind, 2012). The table 2.6 lists few potential cost and benefit of foreign R&D by MNEs in host country, home country and from the firm’s side also.

Table 2.6 Costs and benefits of Internationalization of R&D

<table>
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<tr>
<th>Potential cost</th>
<th>Potential benefits</th>
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<tr>
<td>Multinational Enterprises</td>
<td>Reduced economies of scale and scope, disadvantage of being outsider in the host country innovation system; increased obstacles in the internal knowledge transfer due to inter-unit geographical and technological distance; Leakage of key technology to foreign competitors.</td>
</tr>
<tr>
<td>Home Economy</td>
<td>Loss of control over domestic innovative capacity; Potential damage to the technological competitiveness of domestic firms through intensified competition for limited specialized resources.</td>
</tr>
<tr>
<td>Host Economy</td>
<td>Erosion of domestic innovative capacity (technology export, ‘hollowing out’ of domestic research base); Employment losses.</td>
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</table>

(Source: Criscuolo, 2004)

Spillovers are the unintentional transmission of knowledge to others beyond the intended boundary. In any interaction, there is always a possibility of knowledge exchange. If knowledge is exchanged with the intended people or organizations, it is “knowledge transfer”, any knowledge that is exchanged outside the intended boundary is spillover. The unintended “use” of exchanged knowledge is called “Knowledge Externality”. The new trend of FDI in R&D seems to offer some fresh opportunities for developing host countries. R&D investments are opening up new employment opportunities and also international prestige. Also, international R&D may also motivate indigenous industry to perform its own R&D. However, the opportunity depends upon the ‘readinesses’ of the host country (Reddy, 2005). However, it is universally accepted that, MNE’s R&D activities related to product development for regional/global markets and generic technologies diffuse skills and
knowledge to the host countries. Linkages between the local innovation systems and MNEs’ worldwide R&D network, helps to integrate developing countries into global technology development activities (Reddy, 1997). The presence of foreign R&D centers can trigger the spillover effect onto the host country's innovation system depending on the ability, preparedness and conducive policy of the host country (Cohen & Levinthal, 1990; Granstand et al., 1999; Mody, 2007; Mrinalini & Wakdikar, 2008).

R&D activities of MNEs generate widespread impacts in the society and industry at large in developing countries. Blomström & Kokko (1998) identified two kinds of spillovers; productivity spillover and market spillover. MNEs differ from the local firms in the way that they possess unique propriety knowledge which gives them firms’ specific advantage. On the other hand local firms have better knowledge about the local market. To compensate this MNEs use their ‘firm specific knowledge’ and international experience to compete with them. So, the entries of MNE into a local market disturb the existing equilibrium. This likely to cause various types of spillovers this ultimately leads to productivity increase in local firms (Blomström & Kokko, 1998). Jaffe (1996) identified three distinct channels of knowledge spillover. First, market spillovers which arise as a result of markets for innovative products which benefits consumers and non-innovating firms. Second, knowledge spillovers; which occur because of public good nature of knowledge it may not be confined to a firm rather it can creates value to others. Finally, the network spillover; interrelationship among firms on interdependent technologies create economic benefits for other firms and their customers (Jaffe, 1996). Reddy has categories the potential impact of R&D-related FDI on a developing host country (examples were drawn from Indian case) can be classified into direct effects, spin-off effects and spillover effects (Reddy, 2005).

**Direct Effect**

The visible direct effect as categorized by Reddy (2005) is of two types; Technology transfer and sub-contracting R&D to local firms or institutes.

*Technology transfer:* MNEs bring new equipment, machinery, research methodologies, R&D management styles, to the host country. Although the host country personnel may possess necessary basic scientific and technical skills, an inflow of new and superior knowledge by foreign firms helps the host country personnel in acquiring such application knowledge.

*R&D sub-contract:* Foreign firms have may sponsored research projects in local universities. The empirical part of the thesis will explore the joint R&D, contract research,
clinical trials activity by foreign firms in these two countries. Both India and China is a low cost destination for doing R&D in many high technology areas providing finances, equipment and training.

**Spin-off Effects** may be of the following types; *Transfer of technology to local firms, emergence of spin-off firms and acquisition of new skills and knowledge by supplier firms.*

*Transfer of technology to local firms:* MNE’s R&D affiliate may transfer few technologies to the local firms developed by them. During the course of R&D, an affiliate may develop some by-products that the TNC may not want to keep for itself. In such cases an affiliate may transfer such technologies to local firms for commercialization.

*Emergence of spin-off firms:* There are many examples of spin off firms from the MNEs affiliates. Scientists working in an R&D affiliate leave and start their own R&D firms. The knowledge acquired while working in MNEs helps these scientists to set up such new firms.

*Skill and knowledge acquisition by supplier firms:* As MNEs’ R&D activities may ask for new products and services from the local supplier. For satisfying such demands, local firms must have to learn new tools, techniques to meet the MNEs demand. This perhaps will lead to skill enhancement of local firms on value chain.

**Spillover Effect** Because of foreign R&D three types of spillover effect may occur (Reddy, 2005). Firstly it may foster the *growth of new class of entrepreneur* and secondly *Competition for R&D personal* and finally, it may *nurture R&D culture* in developing host country.

Foreign firm’s R&D activity in the host country (particularly in India and China) seems to offer many new opportunities. R&D investments can bring international prestige as well as employment opportunities. The quantitative data of spillover in both India and China is very scarce. So, the study will try to explore spillover effect of foreign R&D activity, using some example of technology transfer, R&D subcontract, emergence of spin off firms etc. The following research questions arise from the above discussion and the issues will be dealt with in the empirical chapters of the thesis.

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3**Horizontal spillover** is generally happen between competitors. It benefits domestic firms of the same sector. Domestic firms can enhance their productivity if they are capable of absorbing the knowledge, for example by employing workers (formal or informal) trained by foreign firms. However, the ability to exploit external knowledge is largely a function of the level of prior related knowledge (Cohen & Levinthal, 1990; Mody, 2007). In host country, negative externalities arise when foreign investors amplify their demand of meager resources for example; skilled manpower, and domestic credits, which ultimately raises production cost.

**Vertical spillover** is the relationships between the foreign investor and the supplier. Thus where vertical relationship exists there should be significant spillover. The evidence suggests that local infrastructure and capabilities are important for the establishment of backward linkages (Mody, 2007).
**Research Question:** What kind of spillover is generated in these two countries?

**Hypothesis:** Foreign R&D activities generate positive externalities in the host country in terms of backward, forward linkages, spin off firms and training.

**Hypothesis:** Foreign firms’ entry in both India and China is comparatively a recent phenomenon. So, examples of spin off firm from foreign MNEs are comparatively rare. Also, Venture Capital in China is comparatively weaker than India. Therefore, there will not be many spin off from foreign firms in China.

2.9 Linkages of MNE’s R&D Units with Actors of Host Country’s Innovation system

Firms create new knowledge through investments in R&D and must manage this knowledge through its dispersed network of subsidiaries. To remain competitive particularly in high technology industry firms, continuous access to new information, know-how, and ideas is essential to success. Presently, the knowledge produces and generated around the world in an unprecedented manner which world has never witnessed before. It is very difficult for a firm or any other single entity to keep track of the development in various technology fields. There are new technologies emerging with the convergence or fusion of technologies. Firms must continuously monitor and absorb knowledge from other organizations including domestic and international firms, government laboratories, and universities. In high technology sector particularly in biotechnology the large firms are no longer the sole locus of innovative activity. The locus of innovation is dispersed like a "network” of inter-organizational relations. Moreover, the network-like structure of the organizations responsible for innovation in biotechnology may well be a temporary phenomenon arising from the relative immaturity of the technological paradigm. In modern capitalist economies the innovation process requires new and different organizational arrangements to combine specialized complementary assets, controlled by different types of agents, to be combined (Arora & Gambardella, 1990). Firms can access external knowledge by engaging in inter organizational alliances. Empirical research has confirmed that strategic alliances are an important source of scientific and technological knowledge (Ahuja, 2000). Alliances are formal, legal entities that take time to establish and, being costly in terms of managerial time and attention, must be limited in their number, and targeted to specific needs. In an environment where the nature, location, and type of potential knowledge sources are continuously changing, firms need to develop flexible mechanisms of knowledge acquisition (Almeida, et. al., 2011).
In a NIS, the linkages among the various actors are central for the best performance. Among the many other actors, universities, firms, research institutes, think tanks, venture capital firms, government policy, infrastructure etc. are important. It should be taken into account, that the efficient operation of a SI requires not only the activities of its component parts, but also the interaction among them. The innovative performance of a country depends to a large extent on how these actors relate and interact with to each other as elements of a broader system (Dahlman & Utz, 2005). Linkages can take in the form of joint research project, joint development of a product, personnel exchanges, joint patenting, technology licensing, equipment purchase, and also a variety of other channels. Better networking may lead enhanced resource flows to the companies. Therefore, the networks between the group of firms and extra-regional actors are of importance (Rickne, 2001).

Foreign MNEs in India conduct R&D in many different ways. According to Reddy (2011) the foreign firms in India may have wholly owned stand-alone R&D units, reporting directly to the MNCs’ headquarters. MNEs linkages with different Indian entities are in several different forms, it may be a joint venture R&D with Indian companies; technology alliances with Indian companies, including outsourcing of R&D to Indian companies; and (4) research collaboration with Indian universities and national research institutes (Reddy, 2011). It has also observed that In India there is recently many R&D service providers are emerging. Such service providers include both foreign and local companies. Indian ICT and biotechnology R&D service providers have established their reputation globally as capable to deliver products and processes Also, India has a number of world class educational institutes to whom foreign firms prefers as collaborative partners. There are many examples of MNEs R&D units situated in Indian universities campuses.

The similar trends are also observed in case of China. There are several different forms in which foreign companies conduct R&D in China: wholly owned subsidiary; R&D activities along with firms manufacturing units; joint venture R&D with Chinese partners; collaborative research with Chinese research institutes and universities or institutes (von Zedtwitz 2004). Foreign companies locate R&D in China to tap the informal networks and information sources for business success. Local R&D activities facilitate a company’s gaining access to and maintaining informal networks with local universities and scientific communities (Schwaag-Serger 2006). Various studies observed that, MNEs R&D centers in China have positive influence in terms human resources development, R&D management and on overall technological upgrading. Foreign R&D centers bring advanced R&D and
network management to China (Yuan 2006). The linkages between foreign R&D centers and local entities can take various forms; Joint-research labs (between Bell Labs and Tsinghua University), Joint-research projects (Intel China Research Centre and Tsinghua University), Internship programs (between Bell Labs and Peking University), employee’s orientation training programs in the universities (Motorola with Peking University), Informal flow of scientists form universities or research institutes to foreign R&D centers and vice versa (Chen 2008)

This study deals with the two high technology sector; ICT and Biotechnology, so it is expected that the linkages of foreign firms in both India and China will be with different actors of innovation systems like; universities, indigenous firms and government research institutes. Based on the above discussion this study will try to answer the following research question with the empirical evidences. *What kind of linkages do foreign R&D units have developed with Indian and Chinese institutes? Do they interact more with universities, public research institutes or business enterprises?*

**Hypothesis:** Foreign firms in India and China are more likely to interact and have linkages with universities and government research institutes than business enterprises

**Hypothesis:** From a comparative perspective, it is expected that foreign R&D centres in India are likely to interact more with public research institutions (universities and public research laboratories) than the private business enterprises. On the contrary, R&D centres in China are expected to interact more with business enterprises than the public research institutions

### 2.9.1 Innovation and Network

The knowledge and technology capabilities required for firms to innovate are dispersed internationally. Also, due to convergence among different industries, knowledge is increasingly overlapping across industries (Doz, 2006). Firms’ get competitive edges over its competitors, if succeed in commercializing new technology with speed efficiency and accuracy. Technology is seen as a means by which firms can achieve ‘competitive advantage’ in a difficult and uncertain environment (Rothwell, 1994). According to the concepts, techniques & tools used for managing research in the firms in different period of time scholars have categorized R&D management processes, into four different generations; *First, Second, Third and Fourth* generations (Rothwell, 1994; Liyanage et al.; Nobelius, 2004). However, the term R&D generations are not very stringent, or clearly demarcated,
because R&D management in most of the companies constitute mixture of the generations. Some authors have gone beyond the fourth generation and proposed fifth generation. The characteristics of fourth generation of innovation process, which started after 1990’s is characterized R&D as integrative activity, focusing on core businesses and core technologies, and rapid growth in the number of strategic alliances between companies. Rothwell (1992, 1994) has gone beyond the 4th generation and argued that the 5th Generation of innovation process is characterized by greater overall organizational system integration including external networking (Rothwell, 1992). The systematic handling and assimilation of external knowledge resources is another key feature of fifth generation R&D management. The growth of collaborative activity is taken place by means of the growing interdependence of locations and economic units across countries and regions (Narula, 2003). Throughout the five identified R&D generations of innovation process, the complexity associated with R&D management has continually expanded. As a result, inter-organizational network has grown considerably in recent past as network exposes a firm to access novel ideas, fast access to resources, and enhance technology transfer.

Although, the network approach is not new but its use in innovation process was limited. The heterogeneous groups of contacts and its usefulness, originated form three different schools of thought i.e sociology, anthropology and role theory. By definition inter-organizational network means “...by which organization can pool or exchange resources, and jointly develop new ideas and skills.”. Tichy et al defined network analysis is one method of conceptualizing organizations that captures the intersection of both static and dynamic aspects of organizations by focusing on the linkages between social objects over time (Tichy, 1979).

Various empirical research in early 1960’s finds that the external sources (for example; scientific, technical and market information) have a major role in successful innovation by business firms. Collaboration among ostensible rivals was once regarded as temporary phases for entering a new market (Powell & Stine, 2006). Later, such transitory alliances may become incorporated inside the boundaries of the firms by mergers or acquisitions. Inter-organizational partnerships are increasingly becoming the new core concept of the corporate strategy. These collaborations can take a number of forms (research consortia, joint venture, strategic alliances, subcontracting and so on). Through various forms of partnerships, firms are tapping knowledge from a wide range of external partners like universities, research institutes, and even customers. Presently, complex network of firms’
universities and government research laboratories are critical feature of many industries. However, the cooperation is particularly intense in high technology and capital intensive sectors. Firms of high technology sectors in particular, need to innovate constantly to survive. These are sectors where firms have expanded internationally fastest, not only to compete in the various markets simultaneously, but also to exploit and acquire location specific assets and technology. In high technology sectors, particularly in Biotechnology and ICT research units therefore has a leading role in firm’s strategy and formulation of long term corporate goals. However, firms or organizations do not necessarily possess all resources required for new knowledge or discoveries. Hence firms finding it necessary to corporate or form alliance with other organizations with similar or dissimilar activity in order to gain access to external creativity and new knowledge. Because of the similarity of technologies across geographical boundaries and cross-fertilization of technology between sectors, coupled with the increasing costs and risks associated with innovation there is a global trends in increasing R&D alliances (Narula & Duysters, 2004). However, in present day globalized world, firms moving from the older paradigm of *hierarchical capitalism* to the age of *alliance capitalism* (Narula & Dunning, 1998; Narula & Duysters, 2004). In the ‘*the age of alliance capitalism*’ cooperative activity is not only limited to related firms but also sometimes undertaken with international competitors. Sometimes alliance is also gradually shifting from equity-based partnering to no equity forms of agreements. Firms usually prefer a full equity control in its affiliates particularly in foreign market. However, firms seek collaborative agreements when full internalization was not possible. So, alliances and networks are become the more popular options for firms in “*alliance capitalism*”. A number of literatures in this line clearly indicate that firms are able to increase their innovative capabilities by the use of strategic technology alliances (Narula & Duysters, 2004). Organizations in rapidly developing fields’ heterogeneous collaborations allow firms to learn from a wide stock of knowledge (Powell & Stine, 2006). Various studies observed that exchange of new ideas or knowledge can be optimized when firms are aliened in a network (Suarez-Villa, 2002). Networks contribute significantly to the firm’s innovative capabilities in R&D, along with the many other corporate activities, like sales, marketing and so on (Powell & Stine, 2006). Hagedoorn (2002) explores 40 years of data on R&D partnerships since 1960,s among ‘Triad’ regions found that cooperation is the best option, rather than majority control. A recent joint survey by Booz & Company and INSEAD found that highly dispersed companies had higher levels of collaboration with research Institutes and universities (Doz, 2006). Also, it is a general trend among the highly dispersed firms to
have more joint ventures with local companies. It is easier to manage partnerships by dispersed companies, because they have close physical proximity to their local partner. Because of this reason, dispersed firms are in more advantageous position than the non-dispersed firms.

To sum up, networks can become locus of innovation as the creation of knowledge is crucial to improving competitive position. Empirical evidences (Hagedoorn et al., 2000) observed that, firms participate in research corporations in order to, decrease transaction costs, enhance the scope of activities; increase efficiency, synergy, and power through the creation of networks; access external complementary resources and capabilities to better exploit existing resources and develop sustained competitive advantage; promote organizational learning, internalize core competencies, and enhance competitiveness; create new investment options in high opportunity, high-risk activities; internalize knowledge spillovers and enhance the appropriability of research results, while increasing information sharing among partners; lower R&D costs; pool risk; and co-opt competition.

Based on the theoretical proposition discussed above, the following research questions emerge: What type of linkages foreign firms developed with local entities? Is it R&D, Joint development, training, services or arm length transactions? What type of R&D units are likely to have which types of linkages? Do global type / regional type are likely to develop better linkages with local government research institutes and business enterprises?

**Hypothesis:** Foreign MNEs in India and China are less likely to develop linkages in R&D core domains with firms and institutes. They are most likely to develop linkages in R&D peripheral domain (Clinical trial, ICT services, training etc.)

**Hypothesis:** Global units or the units which have more than one function must have more number of linkages than units which have served single market for example regional or local units.

### 2.9.2 Different Modes of Alliances

From the economists’ perspective, continuous innovation is regarded as crucial factor for productivity, growth and the competitive performance of firms, industries or nations. As, innovation is costly and risky affair, there is greater inter firm and cross national collaboration and networking in innovation effort. However, successful innovation in inter-firm alliance networks depends upon the pattern of control and linkage (Freeman, 1991). INSEAD and booz & Co survey in 2005 (Doz et al., 2006) collected response from 186
companies, from 19 countries, and 17 sectors. Study found that that companies are tapping a broad range of external partners, with collaboration firmly rooted in relationships with research institutes/universities and customers. However, collaboration with suppliers, alliance partners, R&D consortia and start-ups were not significant (Doz et al., 2006). Inter-firm alliances network can be differentiated depends upon their durability, stability and the purpose they serve. As a result networks vary from short term projects to long term relationships. Network governance depends upon the different temporal dimensions. Some networks are hierarchical, monitored by central authority, while others are more flat organization with more autonomy and distributed authority (Powell & Stine, 2006).

Granovetter (1973) has defined three types of network ties. They are Strong tie, weak tie and structural holes. Between two network partner tie is “Strong tie” if the interaction is on regular basis, weak tie is a small time interaction but much information is available from weak tie in the form of novelty in different ideas. Structural hole is the potential connection between clusters of units that are not connected. The three aspects of network structure paly different role in innovation process (Granovetter, 1973; Ahuja, 2000). There is a debate in network analysis as whether strong ties, bridge or structural wholes offer greater opportunity for innovation. Clearly variation in network structure is associated with different content in relationship. Strong ties between two parties may restrict information gathering in terms of breath of search but the information that is exchanged is thick or detailed or rich. Weak ties are thinner and less durable but provide better access to non-redundant information.

Different empirical studies of innovation demonstrated that for a successful innovation both formal and informal networks are important. Although, it was not measured properly, rather systematically scholars had given more weight to informal networks. Informal collaboration with the universities, government laboratories, different research groups, consultants, or even rival firms could be multiple sources of information. It is very hard to measure informal network. The informal network is some time equivalent to tacit knowledge. In general tacit knowledge is more important because it is not codified and embedded in person and difficult to transmit. Thus the formal or informal ‘ties’ could complement the in-house R&D capacity of a firm (Freeman, 1991). The formal network between the firms (research association; for example the Cooperative Research Associations in UK after World War I) are the examples of corporate networks. Empirical studies of the relationship between the network and innovation mainly focuses on formal ties. In high-technology industries, using patents as proxy indicators, research finds strong positive correlation
between the alliance formation and innovation process among various industries. Many large firms joined research alliances to take advantages of information shearing (Hakansson, 1989). Thus by joining a network corporate enterprises can be benefited by cost shearing, acquiring technical know-how, pilot plant or prototype development. These kinds of collaborations thought to be evolved as a means to avert market failure, for the smaller firms where cost of R&D is too high. The crucial point here is that the most strategic and sensitive R&D information in large firms remains to be in-house for competitive reasons. By joining research collaboration corporate complements their R&D capability rather than substitute their indigenous innovation capability (Freeman, 1991). As the firms become more and more familiar with the technology, it will shift from the cooperative arrangement and finally they will keep strategically sensitive areas under their direct and immediate control.

Strategic alliance by any firm is “…any voluntarily initiated cooperative agreement between firms that involves exchange, sharing, or co-development, and it can include contributions by partners of capital, technology, or firm-specific assets (Gulati 1999; 1998). Depends upon the degree of inter-organizational interdependency and levels of internalization Narula & Duysters (2004) categorize R&D alliance into Equity and Non-Equity arrangements (Figure 2.8).

**Figure 2.8 Types of alliances**

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<td>One time Arm’s Length Contract</td>
</tr>
<tr>
<td>Smaller</td>
</tr>
<tr>
<td>Higher</td>
</tr>
</tbody>
</table>

(Source: Contractor & Lorange 2002; Narula & Duysters, 2004)

In equity alliance, the wholly owned subsidiary is the extreme form where the newly emerged subsidiary is dependent with the parent. Where as in Arm’s length is where the participating firms remain completely independent of each other. Equity-based agreements represent a higher level of internalization and inter-organizational interdependence than no equity agreements (Narula & Duyester 2004). Although, the traditional joint ventures were
generally undertaken across several activities, like marketing and production. The latest trends in joint ventures are formed primarily to conduct R&D are often referred to as research corporations.

In the similar line of the figure 2.8, to study the firms’ linkages, this PhD project follows the typology developed by Ariffin (2000), and Figueiredo (2011). The details discussed in the empirical chapter VII where a difference has been made between arm’s length transaction and joint R&D. Weights are given based on the degrees of quality of knowledge-intensive linkages. For this study, the linkages were ranked from 1 to 4 according to their intensiveness of the knowledge creation involved. This typology helps answer the following research question with respect to the degree of collaboration of subsidiaries with the local actors.

**Research Question:** What type of linkages foreign firms developed with local entities? Is it R&D, joint development, training, services or arm length transactions?

**Hypothesis:** Foreign MNEs in India and China are less likely to develop linkages in R&D core domains with firms and institutes. They are most likely to develop linkages in R&D peripheral domain (Clinical trial, ICT services, training etc.)

**2.10 MNEs Knowledge Production Patterns in Host Countries**

Innovation has central role in theories of FDI and the MNEs. Since the famous product Life Cycle Model (PLC) proposed by Veron (1966), MNEs were viewed as the institutions that primarily exploit their proprietary knowledge, created at home at the offshore location. MNEs are specialize organization in the generation, and transfer of knowledge through their network of subsidiaries. Differentiated learning network of foreign subunits play an important role in managing knowledge. Based on the evidence drawn from 100 years of US Patent Office data (USPTO), Cantwell observed that contrary to the PLC model innovation not always located in the home country of the parent company (Cantwell, 1995). Particularly, in recent years a ‘radical shift’ has occurred in MNEs innovation activities. It is not only the MNEs headquarter but also different units are increasingly involved in the generation, use and transmission of knowledge. Also, the subsidiaries are developing relationships with local counterparts, and developing external networks through which foreign affiliates gain access to external knowledge sources (Zanfei, 2000). Firms are developing international networks to exploit the locational differentiated potential of foreign centres of excellence (Cantwell, 1995; Bartlett & Ghoshal, 1989; Frost, 2001). The
existence of a multifaceted network of technology which is differentiated among the different types of subsidiaries is important for generation and transmission of knowledge. MNEs are recognized as ‘differentiated network’, where knowledge is created in various parts of it and transferred to interrelated units (Bartlett & Ghoshal, 1989; Gupta & Govindarajan, 1991; 2000).

It is discussed earlier, that MNEs conducted R&D in their subsidiaries abroad mainly for the purposes of the adaptation of products developed in their home countries to local tastes or customer needs. Subsidiaries were mainly dependent on the competence developed in the country of origin of their parent companies. So, the foreign units’ role was to exploit home base advantage. Many of them were doing ‘adaptive R&D’ as Kümmerle (1999) termed it as ‘home-base exploiting’. However, with the present form of globalization subsidiaries are developing globally dispersed R&D networks. Many subsidiaries’ R&D is doing more ‘creative R&D’, to generate new technology in accordance with the comparative advantage in innovation of the country in which the subsidiary is located. This requires much more profound involvement in original research or product development to support the longer term evolution of the core technology. The evolution of decentralized labs' positioning in MNE knowledge strategies implies (i) an increasing involvement in product development rather than adaptation, (ii) an interdependent rather than dependent position in group technology programmes, (iii) increased relevance of supply side influences (host country technology competencies, capacities and heritage), (iv) decline of centralising forces on R&D (e.g., economies of scale, communication and co-ordination problems, concerns of knowledge security)(Pearce, 1999).

This transformation has led to a quantitative increase in the level of R&D undertaken in at least those subsidiaries that have acquired this kind of competence-creating mandate, and in these subsidiaries there has been a qualitative upgrading in the types of research project away from the purely applied towards the more fundamental; although the research undertaken is generally of an (increasingly) specialized kind, to take advantage of the particular capability of local personnel and the other local institutions with which the subsidiary is connected (Cantwell & Mudambi, 2004).

Zanfei (2000) has argued that MNEs work in ‘double network’ structure. In one side MNEs have strongly interconnected networks of various units to produce internal knowledge which may be termed as ‘internal network’. Beside the internal network structure, there are also, units which develop external networks, with other firms and institutions in the host
countries where the R&D centre is located. These units develop potential for use external knowledge and generate new knowledge for its overall use across the MNE. There are cooperative relations among the different units which increasingly use such networks to gain access to local sources of information and applications abilities (Zanfei, 2000). According to Zanfi (2000) the double-network structure of innovative activities benefits MNEs in many ways. For example, the knowledge is universal and the recent development of different scientific disciplines, many innovation hubs developed in different parts of globe. With the recently developed ICT particularly the web technology this ‘context-specific knowledge’ can be more effectively collected and transferred through MNEs external network to the internal networks for use in different and distant areas.

Usually the among the many responsibilities, one of the major responsibility of manufacturing and sales subsidiaries abroad are to get acquainted with the host countries’ value, culture, objectives, norms and so on. Gradually, with the globalization foreign R&D subsidiaries play a key role in this process of knowledge accumulation and transfer. Present day foreign R&D centres are no longer considered as 'listening posts' to capture innovative ideas that are generated by the local context. These units are playing remarkable role in absorbing and assimilating local knowledge and to generate new knowledge for the parent unit. It is found that important innovation was increasingly being done with the collaboration between external partners and the subsidiaries. University and research laboratories are gradually interested in forming industry partnerships to commercialize their research. Even individuals are today eager to license and sell their intellectual property. So, many global major MNEs trying to exploit this potential through ‘open innovation’ mode to enhance their knowledge at home base. Rapid development of ICT particularly the web technologies and the Internet has opened new means to access worldwide talent. Even the major MNEs like International Business Machine (IBM), Eli Lilly Proctor and Gamble (P&G) are doing research with the new concept of ‘open innovation’ (Chesbrough, 2003). For example; P&G in 2000, realized that P&G couldn't meet its overall corporate growth objectives by spending more and more on R&D for less and less return, so they reinvent the company's innovation business model by connecting ideas across internal businesses. By doing this, 50 percent of P&G’s innovation comes from outside the company (Huston & Sakkab, 2006).

It is important here to measure the innovation inputs (total innovation expenditure, including non-R&D expenditure), as well as the output side of the innovation process.
Innovation and technological changes of firms usually measured using input and output indicators. The publicly available, internationally comparable and reliable data on innovation and technological change in Indian and Chinese case is extremely rare. This study undertook a more elaborate measurement of innovation inputs (innovation expenditure announced by firms, manpower employed in R&D). This study also attempts to measure the output side (patents, new product announcements) of the firms’ innovation process. Patent and publications are the output indicators to access the innovation potential of firms. Patents have the advantage that they measure innovation directly. Patents are often used as an output measure of innovation because patent data is public and available quite easily. To measure the knowledge production pattern for foreign subsidiary in these two host countries, i.e. India and China. This study will ask the following research questions:

What are the patenting and publication patterns (output parameter) by MNEs in these two countries? What are the trends in R&D manpower & R&D expenditure by MNEs in these two countries (input parameters)? The research question raised above will direct to the following hypothesis:

**Hypothesis:** International patenting as reflected in USPTO, by MNEs in India and China increasing over a period of time. Secondly, this patenting is depending on Indian and Chinese innovation potential.

**Hypothesis:** With the increasing FDI in R&D it is expected that firms will increase their input parameters i.e. R&D expenditure and R&D Manpower in R&D in both India and China

### 2.11 Summary Hypothesis and Research Questions

Few decades ago Internationalization of R&D was mainly restricted to triad countries. MNEs usually set up their R&D centers in the foreign locations to enhance their capability in home or to meet the host countries market demand. In recent years, there is a significant R&D outsourcing by MNEs to developing countries mainly in India and China. This new phenomenon has become a subject of increasing interest among the scholars and policy makers from both developing and developed countries perspective. The developed countries are concerned about the possible hollowing up NIS capabilities because of increasing off shoring of R&D into the developing country. Developing host countries are concerned about the possible benefits extraction from the MNE’s R&D centres. There are many different models of foreign R&D centers in host countries perspective. Very few works is done from developed countries’ perspective. So, perhaps a new typology and the new way
of investigating foreign R&D centre in India and China is required to address the following issues listed in the summary of research question and hypothesis in table 2.7.

Table 2.7 Summary hypothesis and research questions

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Hypothesis</th>
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<tr>
<td>What is the growth pattern of foreign R&amp;D units in India and China?</td>
<td>Along with the increasing inflow of FDI in India and China it is expected that MNEs are setting up more and more R&amp;D units in India and China</td>
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<td>What types of locations foreign MNEs are selecting to locate their R&amp;D units?</td>
<td>MNEs are more likely to set up R&amp;D units in Indian and Chinese cities where knowledge hubs are evolving or emerging.</td>
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<td>What are the motivating factors for selecting India and China as a preferred locations by the foreign firms.</td>
<td>MNEs are locating their R&amp;D units in India and China not only for future market related factors but also for highly qualified R&amp;D personnel, proximity of higher educational institutes (HEIs) and Public Research Institutes (PRIs). Collaboration and source of knowledge seems to be other motivating factors. Other reasons may be the countries government incentives such as tax breaks and public policy support to create knowledge hubs (ICT parks, R&amp;D or Science Parks etc.)</td>
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<td>What is the recent trend in the internationalization of R&amp;D?</td>
<td>Internationalization of R&amp;D in the era after 1980’s is no more restricted to ‘Triad’ regions. World’s leading MNEs are doing their crucial R&amp;D in Asia particularly in India and China</td>
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<td>What type of R&amp;D units are predominant in India and China? Are the R&amp;D units working more global, local or regional product mandate?</td>
<td>Foreign R&amp;D units by MNEs in India and China no more reflect a simple local type of R&amp;D units shows by studies (in 1980s /1990s). R&amp;D units are more likely to be differentiated in terms of Local Regional and Global units.</td>
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<td>What type of R&amp;D unit has been established by foreign MNEs in India and China? Do they reflect simple one way or two way technology transfers?</td>
<td>Internationalization of R&amp;D (MNEs established R&amp;D units in Developing Countries) in the 1980’s was mainly characterized as a one way Technology Transfer and involved adaptive technology for local national markets. A new trends in the last decade appears to be a two way Technology Transfer. MNE’s R&amp;D units in the new trends are more likely to undertake ‘creative technology’ or ‘new technology’ for regional and global markets in addition to adaptive technology for local markets</td>
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<td>What are the trends in R&amp;D manpower &amp; R&amp;D expenditure by MNEs in these two countries?</td>
<td>With the increasing FDI in R&amp;D it is expected that firms will increase their input parameters i.e. R&amp;D expenditure and R&amp;D Manpower in R&amp;D in both India and China</td>
</tr>
<tr>
<td>What are the patenting and publication patterns (output parameter) by MNEs in these two countries?</td>
<td>International patenting as reflected in USPTO, by MNEs in India and China increasing over a period of time. Secondly, this patenting is depending on Indian and Chinese innovation potential.</td>
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<tr>
<td>Question</td>
<td>Answer</td>
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<tr>
<td>What type of linkages foreign firms developed with local entities? Is it R&amp;D, Joint development, training, services or arm length transactions?</td>
<td>Foreign MNEs in India and China are less likely to develop linkages in R&amp;D core domains with firms and institutes. They are most likely to develop linkages in R&amp;D peripheral domain (Clinical trial, ICT services, training etc.)</td>
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<tr>
<td>What type of R&amp;D units are likely to have which types of linkages? Do global type / regional type are likely to develop better linkages with local government research institutes and business enterprises?</td>
<td>Global units or the units which have more than one function must have more number of linkages than units which have served single market for example regional or local units</td>
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<td>What kind of linkages do foreign R&amp;D units have developed with Indian and Chinese institutes? Do they interact more with universities, public research institutes or business enterprises?</td>
<td>Foreign firms in India and China are more likely to interact and have linkages with universities and government research institutes than business enterprises. From a comparative perspective, it is expected that foreign R&amp;D centres in India are likely to interact more with public research institutions (universities and public research laboratories) than the private business enterprises. On the contrary, R&amp;D centres in China are expected to interact more with business enterprises than the public research institutions.</td>
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<td>What kind of spillover is generated in these two countries?</td>
<td>Foreign R&amp;D activities generate positive externalities in the host country in terms of backward forward linkages, spin off firms and training. Foreign firms’ entry in both India and China is comparatively a recent phenomenon. So, examples of spin off firm from foreign MNEs are comparatively rare. Also, Venture Capital in China is comparatively weaker than India. Therefore, there will not be many spin off from foreign firms in China.</td>
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