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Abstract: There has been an impressive spurt in the outward FDI activity of Indian MNEs since the 1990s. However, despite the rhetoric, this growth has not been exceptional, when compared to other similarly developed countries. Received economic arguments propose that successful outward investors tend to be the most competitive domestic firms in their home economy. Their firm-specific assets tend to be a function of the political economy and economic structure of the home economy. In IB terms, this means that the ownership-specific assets of Indian multinationals are a subset of the ownership assets of their parent companies, which in turn are largely determined by the location-specific assets of the home economy.

The evidence suggests that the strengths and weaknesses in the location assets of India have caused pockets of excellence to emerge, but that these conditions do not lend themselves to a broader growth in competitiveness, meaning that further rapid growth is ultimately not sustainable. Systematic upgrading and radical policy changes are needed to build up India's knowledge infrastructure and institutions to support a shift in India's competitive advantages to new sectors outside these pockets. This ultimately means a policy emphasis on the manufacturing sector, and within that, promoting a shift from low-tech to higher technology manufacturing sectors, and a strengthening of the formal sector.

Keywords: India, innovation systems, comparative advantage, competitiveness, MNEs, infrastructure, globalization, location advantages

JEL: F23, F68, O32.

Introduction

The growing international competitiveness of firms from developing countries has become – once again – an important issue in academic and public policy circles. The idea that the dominant economic bloc shaping the world economy might radically shift due to the advent of powerful new economies is a perennially recurring theme: the rise of Japanese MNEs in the 1970s and 1980s, followed by the rapid growth of MNEs from Asian NICs in the 1990s (in particular, Korea, Hong Kong and Taiwan) also triggered similar soul-searching. It is a human failing that we exaggerate our current conundrums, ignoring history at our peril.

This paper takes a rational look at the evidence on the growth of outward FDI (OFDI) activity by Indian firms. Applying basic principles (see Cantwell 1989, Lall 1992, Narula 1996, 2012), the competitiveness of firms from a given economy derives from the competitiveness of their home economy. That is to say, the ownership-specific (O) assets of firms are a function of the economic, social and political milieu of the location where their strategic activities are based (normally their home country), known as location-specific (L) assets in the IB literature.

We propose that there is an irrational exuberance about the exceptionalism of Indian outward FDI, and prospects for its long-term growth. India's MNEs are a reflection (and a function) of the Indian economy, and the home country plays a fundamental role in shaping the competitiveness of its firms, both at home and abroad. In this case, we show that on a macro level, India's performance is not different from countries of similar economic structure and development, and its pockets of excellence are a reflection of its L assets, but that these assets are insufficient to foster more growth in the long term. Relying on secondary data, this paper examines the L assets of India relative to other significant outward investor countries, and demonstrates that there are systemic weaknesses which constrain the long-term competitiveness of its firms, and ultimately, the competitiveness of its MNEs. Based on our analysis, the pockets of excellence that drove Indian outward FDI since liberalization are unlikely to continue to do so.

Examining India's outward FDI in relative terms

In this section we examine India's OFDI stock levels relative to other economies. The OFDI stock of India increased from $0.1 billion in 1991 to $2.5 billion in 2000, and surged to an accumulated investment of $111.2 billion by 2011 (Table 1). However, the data in Table 1 places the Indian story in perspective. First, outward FDI from India – even in absolute terms – remains modest. In 2011 it was about a third that of China and Singapore ($365 billion and $339 billion respectively), half that of Brazil ($202 billion), and almost on par with Malaysia and Mexico ($106 billion and $112 billion respectively). It is true that it has grown rapidly: in 2001, India's OFDI stock was about the same level as Thailand, and a tenth of Argentina's.

However, it is a little unfair to compare absolute levels of FDI stocks, without considering the capacity or the potential of an economy to generate outward FDI, which is a function of the competitiveness of its economic actors, and therefore that country's underpinning economy. States (like other economic actors) are constrained by their resources, and by extension a small economy (in terms of land area, population or resources) will have a proportionally smaller firm sector, and only a percentage of these firms will be internationally competitive and able to sustainably invest abroad. On the other hand, there are certain advantages bestowed due to a larger economic size. It is for this reason that Table 1 also gives OFDI on a per capita basis. On this basis, India has underperformed given its potential, relative to its size. Its outward FDI stock on a per capita basis remains the lowest of these countries (with the exception of Indonesia) in all three periods, having increased from just $0.1 to $89.6 over the thirty year period. During the same period China's per capita OFDI increased from a negligible level to $271.6. Even in 2011, India's per capita OFDI stock was less than countries such as Thailand, Argentina, Colombia, Venezuela, and transition economies of the erstwhile Soviet Union.

[Insert Table 1 here]

The O assets of Indian MNEs and the competitiveness of its home economy

At the heart of internationalization of any firm remain their O assets. Sustaining competitiveness requires upgrading O assets which in turn is dependent on innovation, and this requires research and development (R&D), and a supportive external environment of the firm (i.e., L assets). Firms have to continuously innovate and upgrade their technological capabilities to avoid falling behind competitors, and countries have to continuously invest in upgrading their technological infrastructure. Moreover, technological capability and production capacity are interdependent because the former generates the latter, and vice versa (e.g. Bell and Pavitt, 1997). Investment in R&D provides new knowledge for the firm as well as the absorptive capacity required to acquire, assimilate, adapt, and apply new knowledge. Firms that conduct their own R&D are better at assimilating external knowledge, and absorptive capacity is developed as a by-product of the firm's R&D investment (Cohen and Levinthal, 1990).

The technological activities undertaken by firms in a location reflect the level of technological advancement in that location, and the specialization of firms and their competitiveness is reflected in the specialization and areas of competitiveness of the home country. In other words, the specialization of a country's firms can be identified by examining the specialization at the aggregate level.

Examining India's aggregate expenditures on R&D gives a good indication of its competitiveness. India's R&D intensity was 0.7 per cent in 2010 which was lower than countries like China (1.7 per cent), Brazil (1.2 per cent), Russia (1.2 per cent), and much lower than developed and newly industrialized countries[1] (UNESCO, 2012). India's R&D intensity has remained almost constant in the last two decades, while other major developing countries have increased their spending significantly. For instance, China's R&D intensity increased from 0.5 per cent in 1996 to 1.0 per cent in 2002, and 1.7 per cent in 2010. India's per capita R&D expenditure was also much lower than major developing and developed countries. In 2007, India's per capita R&D expenditure was $20.7 while that of China and Brazil were more than 5 times, and Russia's 11 times more than India[2] (UNESCO, 2012).

Another indicator of the technological capabilities of a location is the patents its firms receive. At the aggregate level, during 2008-2012 the US Patents and Trademarks Office (USPTO) granted 5336 patents to Indian assignees. In terms of sectors, information technology (IT), software, electronics, pharmaceutical and engineering held more than 85 per cent of patents.

The evidence on India's areas of competitiveness can be discerned from examining its exports and growth of value added activity. India's exports in manufacturing had risen in the 10 years between 2001 and 2010 from 0.79 per cent of the global total to 1.76 per cent. High-tech manufacturing exports also rose over the same period from 0.2 per cent to 0.65 per cent (NSF, 2012), accounting for approximately 11 per cent of all exports. However, in 2001 the share of high tech sectors was about 60 per cent, indicating that low tech exports had grown at a much faster pace than high-tech sectors. Indeed, high-tech manufactures grew in current prices at only about 0.5 per cent per annum over the 10-year period. High tech exports were

[1, 2] See also Table 6 on knowledge infrastructure indicators.

worth $18.2 billion in 2010. Of this, about 43 per cent were from the pharmaceutical sector and 34 per cent from the communications, computer and office machinery sectors. To place India's competitiveness in context, the high-tech exports of the Philippines were $28 billion in 2010, and Indonesia's just under $12 billion. By and large, India has a revealed comparative advantage – as expected from a country in this stage of economic development - in Hecksher-Ohlin and Ricardian sectors, which rely on the processing of natural resources and scale-intensive production of standardized goods, both of which require low technological content (Burange and Chaddha, 2008; Narula and Dunning, 2000), with a comparative disadvantage in knowledge intensive sectors – and this trend has not changed (Kumar and Gupta, 2008).

However, the high-tech manufacturing exports data excludes software and services. India's share of global value added activity in all high-tech sectors (including IT services and software) increased from 0.71 per cent in 2001 to 1.54 per cent in 2010 (NSF 2012). Focusing even closer on global value-added in commercial knowledge-intensive services, India's share in 2010 was 2.1 per cent. Nonetheless, given that services activity is often provided closer to the customer, this implies that the competitiveness of Indian firms is not revealed by examining domestic value added or exports.

This data clearly reveals that India's competitiveness is in a few pockets of excellence, and with the exception of pharmaceuticals and biotech, India has few high-tech manufacturing strengths. Indeed, Table 2 gives the R&D intensity of Indian-based firms in several sectors, and the benchmark international R&D intensity in these same sectors. The four highest R&D intensities for India were in pharmaceuticals, chemicals, food products, and motor vehicles. With the exception of food products, no Indian sector comes close to the global R&D intensity.

[Insert Table 2 here]

The pharmaceutical sector may have had the highest R&D intensity among Indian companies, but this was still half of its counterparts in the rest of the world (Table 2). Table 3 gives details of the R&D intensity of the largest Indian R&D spenders in 2011, but even here, the highest R&D intensity was 7.3 per cent (in the pharmaceutical sector). Infosys was the highest R&D spender in absolute terms in India in 2011 (but with a R&D intensity of just 5.3 per cent). Indian companies in the oil and gas, and iron and steel industries also had high

R&D expenditures but had lower R&D intensities than their international counterparts located elsewhere (Table 3).

[Insert Table 3 here]

Table 4 gives details of patents granted to firms based in India between 2008 and 2012, and suggests that 3450 US patents granted were to 91 subsidiaries of foreign MNEs. That is, 77 per cent of all patents granted were to foreign firms. Just 45 Indian firms accounted for 688 patents over the same four year period, and 90 per cent of patents to private firms were in two sectors: pharmaceuticals and IT/software (Table 4). There was only one Indian firm in the 20 largest Indian patent assignees in that period, compared to eight out of the first 20 in China. The patent data for Indian companies indicate that they had not fully leveraged India's location advantages for R&D while foreign multinationals had.

[Insert Table 4 here]

The structure of R&D performers suggests that MNEs control a disproportionately large share of R&D activity. Estimates are that close to 60 per cent of expenditures in R&D were made by large Indian business groups, 15 per cent by SOEs, and less than 10 per cent by MNEs (NISTADS 2008). The following industrial sectors accounted for the majority of R&D expenditures (in order of significance): Pharmaceuticals, transportation equipment, defence, electrical and electronic equipment, chemicals, fuels, and IT and software. These are the same sectors (with the exception of defence) in which India's OFDI is concentrated. Indeed, of the more than 1100 M&As by Indian firms in 2011-12, the majority were by software and business service companies, pharmaceutical and chemical companies and auto parts and machinery. In other words, *the sectors with higher levels of R&D and patenting are also the sectors which have internationalized the most.*

The data reviewed in this section make clear that only a few industries in India are internationally competitive, with the commensurate innovation capabilities to sustain this. These industries have higher R&D intensity and patenting levels than others, leading to the creation of 'pockets of excellence'. Most of the rapidly internationalising Indian MNEs of the last two decades are concentrated in these sectors.

How home country L assets shape the competitive advantages of firms

Our primary argument rests around the interrelatedness of the home country's L assets and the international competitiveness of its firms. Economic development of any given nation and the growth of its firm sector co-evolve, meaning that lesser developed economies tend to have a smaller and less competitive firm sector. By extension, such an economy will have fewer firms that possess O assets which will permit them to engage in viable outward *direct* investment, and many of the competitive advantages of domestic firms will be location-bound. Simply being capital-rich and in the absence of strong non-location bound O assets permits foreign investment, but not foreign direct investment. Resource-rich countries may acquire assets and firms in foreign locations, for instance through sovereign wealth funds or state-owned enterprises. However, such acquisitions are akin to portfolio investments, where control of these foreign assets is not on-going and actively or systematically coordinated and managed (as indeed is the case with the 'direct investments' associated with a number of middle-eastern oil-exporting economies) and therefore are not 'multinational enterprises' in the sense that we understand.

The fundamental basis of these principles of economic theory has not changed with globalization. Countries demonstrate a broadly similar economic structure (and set of L assets) at different levels of economic development, and also a similar degree of competitiveness of their domestic economic actors (and therefore its MNEs), given exogenous limitations due to their resources constraints or abundance (Dunning 1981, Narula 1996, Narula and Dunning 2000, 2010).

From a more general (and IB) perspective, the relationship between outward FDI and the home country can be stated as follows (Narula 2012). Internationalization requires O assets, and the ability to be competitive in overseas markets depends on acquiring, maintaining and developing these assets. The home country plays a significant role in constraining and defining the kinds of assets an MNE possesses, and provide the initial conditions for its international expansion. These 'initial conditions' are the L assets of a country. There are of course inevitable differences in the L assets between home countries, because countries have different resource endowments, innovation systems and political economies, and as such there are differences in the economic structure of different home countries, and by extension, the sectors in which they develop competitive firms.

Countries evolve as they grow, with a consequent upgrading of L assets through a variety of means and interactions. Broadly speaking, there is a movement away from labour- and natural resource-intensive activity towards capital-intensive activity, and later to more knowledge-intensive activity (Dunning and Narula 1996). The country's comparative advantages and the competitive advantages of its firms show a high degree of interdependence. Strong initial comparative advantages biases a country's economic structure towards industries that utilize this initial advantage in future periods. Agglomerations tend to build around such specializations, with subsequent growth in both upstream and downstream aspects (as well as related sectors). Firms of each country tend to embark on a path of knowledge accumulation within the envelope of these L assets, and shape a distinct profile of national technological specialization (Cantwell 1989). The technological specialization of firms also changes very slowly given that there is a close overlap with the technological specialization of their home country. The O assets of nascent MNEs – which are the progeny of the more competitive domestic firms from these environments – therefore continue to reflect the home country innovation systems, and industrial structure and specialization (Narula 1996, 2003). The O assets of firms in any given period tend to be a function of the home country's L assets, but only when these L assets are internalized (Narula 2012).

[Insert Figure 1 here]

Thus initial internationalization by 'nascent' or 'infant' MNEs will tend to reflect the home country L assets in their mobile O assets to a much greater extent, because as the Uppsala model of internationalization makes clear, firms embed themselves in host countries only gradually (Figure 1). Thus, the effect of host country L assets on the MNE's portfolio will initially be minimal. More mature MNEs with greater international experience will have become integrated with the host country innovation system and socio-economic milieu, and will become multiply embedded (Meyer et al 2011). Nonetheless, the influence of the home country continues to persist, not least because multiple embeddedness requires considerable organizational and managerial capacity. Although it has often been argued that nascent MNEs are able to acquire host country L assets through strategic asset seeking activity, 'instantaneously', there is simply no evidence that the requisite recombinant O assets to do so are widely available. Indian MNEs have been especially active in making large acquisitions in what has been dubbed the 'big bang approach' to internationalization (Chittoor and Jana 2013). Indeed, Chittoor and Jana (2013) find that the majority of Indian acquisitions are not integrated into the parent company, allowing the acquired firm to maintain a high degree of organizational and managerial autonomy. While this approach avoids the classical problems of integrating different organizational cultures, it also reduces the synergies that might ordinarily evolve from an M&A. Put another way, the absence of the requisite skills to manage complex and diverse MNE in multiple locations is rationalized not to be a disadvantage, although the implication is that many of these acquisitions are in essence a collection of portfolio investments in the guise of direct investments.

Examining location-specific assets

Our principle thesis in this paper is that the strengths and weaknesses of the L assets of the Indian economy shape and determine the kinds of O assets of its domestic firms, and by extension, the O assets of its MNEs. A secondary thesis is that by examining the L assets of the Indian economy, it is possible to observe the potential for growth of the OFDI activity by Indian firms.

It is fairly uncontroversial that the competitiveness of firms derives from their ability to leverage, develop and upgrade their knowledge assets, which presumes a certain extent of formal and informal innovation activities. While innovation is utilized and internalized at the firm level, firms exist as part of 'systems'. Firms are embedded through historical, social and economic ties to other actors in their home country (Narula 2003, 2014). Of course, the environment involves broader factors shaping the behaviour of firms: the social and perhaps cultural context; the institutional and organizational framework; infrastructure; the processes which create and distribute scientific knowledge, and so on.

It is out of the scope of this paper to conduct a comprehensive review of the Indian economy, or of the theory of L assets. To simplify the task we will examine L assets within three broad categories:

1. There are L assets that can be described a 'basic infrastructure' because they are public goods, and are available to all firms at marginal cost. All L assets are in principle 'generic, multi-user and indivisible', and this is also the case for this category. Examples include unskilled human capital, health care, utilities, telecoms, ports, security, public transport etc. Basic infrastructure is fundamental to attracting FDI flows and promoting growth (e.g. Dunning, 1981; Wheeler and Mody, 1992; Asiedu, 2002; Kinoshita and Campos, 2006; UNCTAD, 2008). The efficient provision of basic infrastructure has a positive influence on the cost structure and productivity of firms operating in a location. If infrastructure services are not publicly provided, firms seek to create their own private networks, leading to wastage of

resources and duplication, thereby affecting the efficiency of firms (Erenberg, 1993). In this paper we classify unskilled human capital as a 'basic' L asset, distinguishing it from skilled human capital which falls into the next category.

2. The second category of L assets is 'knowledge infrastructure' which consists of public research institutes, universities, organizations for standards, intellectual property protection, etc. that enables and promotes science and technology development (Smith 1997). Knowledge infrastructure is synonymous with what can be usefully described as the 'non-firm sector', because it is not driven by a rent motive (Narula 2002). Such L assets play an important role in promoting the innovatory and absorptive capacity of firms. They also act as a mechanism to "direct" technology strategy and as a mechanism to implement industrial and innovation policy. Progress towards more knowledge-intensive manufacturing and service activities crucially depends on the existence of knowledge infrastructure. Knowledge infrastructure has the unusual characteristic that it is often not a purely public good, but a quasi-public good. They are available differentially to different players, either because of government policy, or because they are controlled by a group of incumbents. In short they are not freely available, and may not be used by others without (some) detriment to their value. This knowledge may be available to incumbents (whether domestic or foreign), by virtue of their existing activities on that location, and acquired through experience.

   Quasi-public goods imply exclusive access, but in the case of developing countries which are resource-constrained, when a certain set of assets is in limited supply, those with access to them may not wish to compete with others through markets for this access, thereby creating barriers to entry. That is, L assets can move from the public to the private domain (i.e., they are internalized by specific economic actors), and they are no longer L assets but constitute O assets.

   In addition to L assets that derive from the non-firm sector, knowledge infrastructure also needs to include inward FDI. Foreign-owned affiliates engaged in knowledge intensive activities generate spillovers that are in principle also L assets because they are potentially available to all firms in the same location. Thus, collocation with foreign affiliates has potential knowledge externalities for domestic firms (Criscuolo and Narula 2008; Narula and Santangelo 2012). Foreign MNEs are likely to establish local operations in sectors where the L assets are strongest, and in so doing further reinforce the L assets available in a given location.

3. The third category of L assets is institutions. The interactions between the various actors within an economy are governed by institutions. They are the 'glue' that binds the various actors together, and determine the efficacy of their interaction (or lack thereof). Institutions are taken here to be of two types, informal and formal, and are generally understood as 'sets of common habits, routines, established practises, rules, or laws that regulate the interaction between individuals and groups' (Edquist and Johnson 1997). In essence, institutions underlay the cumulative causation of all elements within a system in the sense proposed by Myrdal (1957). Institutions are associated with public goods, but are not exclusively so, and therefore classified separately in this paper.

   Government policies are an essential component of institutions, and include the appropriate intellectual property rights regime, competition policy, the creation of technical standards, taxation, the establishment of incentives and subsidies for innovation, the funding of education, etc. Government policies also foster informal institutions, for example, by encouraging firms and individuals to collaborate, or by promoting entrepreneurial spirit, and good governance (Narula 2014).

In the following sections we examine the strengths and weaknesses of India's L assets with these three categories.

Basic infrastructure bottlenecks

Well-developed basic infrastructure is considered to be a L asset. For instance, an uninterrupted supply of electricity and efficient transportation network enables firms to meet production targets, reduce costs and supply customers on time. In the case of India, the per capita consumption of electricity is much lower than other major developing countries (Table 5). In 2010, electricity power consumption was 616 kWh, while China and Brazil consumed 4 times and 3 times more than India on a per capita basis. It was also lower than countries such as Thailand, Venezuela, and Indonesia. Growth of consumption is spectacularly low: in 1991 the per capita power consumption of India (286 kWh) was higher than Indonesia (159 kWh), but by 2010 Indonesia has moved ahead of India.

Good infrastructure leads to increase in productivity and decrease in production costs, but it has to expand fast enough to respond to economic growth, which is especially significant for developing economies. In India, physical infrastructure has not only failed to reach the levels of developing countries at a similar stage of development, but has also failed to expand in response to the rapid economic growth of the last two decades. For instance, during the Eleventh Five-Year Plan period (2007-2012), in spite of the creation of new generation capacity there was still an energy shortage of 8.7 per cent as of 2012 (Ministry of Finance, 2013). More than 40 per cent of firms had invested in private generators due to frequent power blackouts and brownouts (World Bank, 2006). In addition to the widening gap between energy demand and supply, electric power transmission and distribution losses are considerable. The value lost through electrical outages remains very high in India compared to other major developing countries (Table 5).

Along with energy, transportation forms an important component of the backbone of any economy. An efficient transportation network provides economic and social opportunities, and leads to multiplier effects through additional investment, accessibility to markets, and increases in employment. Transport infrastructure is also considered to have great impact on the 'supply chain capability' of a country, given that firms are intricately linked to a variety of customers and suppliers of goods and services, and the efficiency with which intermediates and other inputs for the focal organization can be delivered (Alam and Bagchi, 2011). It has a pronounced effect on the efficiency and competitiveness of firms operating in that location. This has much to do with the logistical infrastructure, and in particular, transport.

Although India has one of the largest rail networks in the world, it has consistently underinvested in upgrading its network. Between 1950 and 2010, the size of the network grew at a compound annual growth rate (CAGR) of 3 per cent, while freight and passenger traffic grew at a CAGR of 54 per cent, leading to oversaturation of the rail network (Deloitte, 2012). Although India had a larger network than China in 1990, China made significant investments[3] in its railway infrastructure over the last two decades, and by 2011 the total route length in China exceeded India's (Table 5). In addition to the lack of investment in infrastructure, transit times for freight in India are long and uncertain. For instance, a freight train takes as much as 6-8 days to travel a distance of 2000 kilometres (Deloitte, 2012).

61 per cent of cargo is moved by road in India compared to 37 per cent in the US and 22 per cent in China. However, the percentage of paved roads in India is lower than countries like

[3] China spent $8.8 billion on railway infrastructure construction in the first quarter of 2013 (Wall Street Journal, 2013).

China, Russia, Indonesia, and the developed world (Table 5). In addition to the inadequate road network and poor quality of roads, transit times are also long. For instance, according to a study by Transport Corporation of India, a 2150 kilometre journey between Kolkata and Mumbai trucks typically have to stop for as much as 32 hours at various checkpoints at 26 different locations, taking up to 8 days to cover the distance (Economist, 2006).

[Insert Table 5 here]

In addition to railways and roads, other modes of transport also suffer from several issues. For example, the average turnaround time for ships in an Indian port is more than double the turnaround time in ports in Colombo, Singapore, Hong Kong and Rotterdam (Deloitte, 2012). Air cargo also suffers from issues such as congestion and long waiting time as a result of inadequate infrastructure and bureaucratic delays. For instance, the waiting time for exports in India is 50 hours compared to world average of 12 hours while the waiting time for imports in India is 182 hours compared to world average of 24 hours (Deloitte, 2012).

Telecommunication forms an integral part of the physical infrastructure in a country. An efficient telecommunication network reduces the transaction costs of firms. As the telecommunication infrastructure improves in a location, the costs of doing business decreases, leading to an increase in output for the firm (Leff, 1984). In addition, growth effects are considered to be significantly higher in countries where telecommunications infrastructure has reached universal service (Roller and Waverman, 2001). For instance, a 10 per cent increase in broadband penetration increases per capita income growth by 0.9-1.5 per cent (Czernich et al, 2011)

Although India is one of the fastest growing telecom markets in the world, it lags behind other developing countries in terms of broadband penetration. Just 1 per cent of India's population has broadband access compared to 11.6 per cent in China, 8.5 per cent in Brazil, and 13.1 per cent in Russia. Overall internet penetration in India is 11.4 per cent of total population which is one of the lowest among developing countries (Table 5).

Knowledge infrastructure bottlenecks

Knowledge and innovation activities are often concentrated in space, which implies that knowledge spillovers generated by innovative and technological activities often stay within the location in which knowledge was originally created, leading to regions of specialization. In the absence of a strong knowledge infrastructure, spillovers may be lost. The main function of the knowledge infrastructure is production and diffusion of knowledge, protection of knowledge through regulation and standards, creating skilled workforce through education and training, and generating spin-offs (Smith, 1997).

The single most important constituent of knowledge infrastructure in any location is skilled human capital. One channel through which human capital affects economic growth is by facilitating the adoption of new technology (e.g. Nelson and Phelps, 1966; Acemoglu, 2003; Caselli and Coleman, 2006). This is particularly important for firms from developing countries that are considered to be in a phase of catch-up with their developed country counterparts. Human capital is an important source of competitive advantage for firms because knowledge is acquired and used by the people in an organization, both collectively and individually.

As Table 6 shows, the number of researchers in R&D per million people in 2009 was 863.2 in China, 703.7 in Brazil, 3092.3 in Russia, 1091.2 in Argentina, while there were only 135.8 researchers per million people in India. The gap between India and newly industrialized and developed countries is much wider as can be seen in the table. Similarly, only 13.1 per cent of total researchers in India have advanced research qualifications such as PhD's, lower than other major economies (Table 6).

[Insert Table 6 here]

Indeed, India's output of doctorates in science and engineering (S&E) is possibly insufficient to meet demand, both currently and in the future. A recent report indicates that most IIT's, India's top-tier technical universities have on average almost half their academic positions vacant[4], in part due to the lack of qualified PhD's, and in part due to the greater financial prospects in industry (and abroad). Herstatt et al (2008) suggest that the shortfall in qualified PhD-level teaching positions in India was in the range of 40,000. It is worth noting that between 2006 and 2009, there were 8266 Indian recipients of US doctorates, of whom 88 per cent indicated they had plans to stay on in the US. This suggests a rather large (and possibly permanent) brain drain (NSF 2012). Contrast this with the fact that Indian universities produced fewer than 8000 doctorates in 2006, the most recent year for which data is available (NSF 2012). This is significantly lower than China, which produces three times as many S&E PhD's.

[4] Times of India (2013).

This lack of academic staff amongst universities has implications for the expansion of university education to meet growing demand for S&E graduates. Although India produces more than half a million S&E graduates every year, a study suggests that in 2011 only 17.5 per cent of the engineers were employable in the IT support services sector, while a mere 2.7 per cent of engineers are employable by information technology product companies which require high levels of knowledge of algorithms and computer science (Aspiring Minds, 2011). Of the 355 universities in India in 2008, only 140 were accredited, of which only a third were rated by the Indian government as ‘A’ grade (National Knowledge Commission, 2009). Indeed, the low quality problem amongst S&E graduates has been noted elsewhere, including Herstatt et al (2008). As is the case with much of Indian infrastructure, there are important pockets of excellence. The IIT’s are generally acknowledged to be world class institutions, but are limited in what they can do. Although they doubled their intake from 2003 to 2012, they admitted just over 12000 students in 2012. Given that demand for S&E graduates has increased year-on-year for the last 10 years at approximately 20-25 per cent, capacity increases have simply not kept up. The emigration of the best graduates from these institutions – possibly a third to half – to postgraduate programmes in the US – coupled with another third moving into management training – creates a further drain, meaning that fewer highly skilled engineers are available to Indian firms, given that a substantial proportion also prefer to work for MNEs in India. Although the Indian government has turned to the private sector to create new capacity in the tertiary education sector, this has yet to make any significant contribution[5] (Ministry of Human Resource Development, 2009). India has one of the lowest expenditures on higher education per student in Asia, in addition to having one of the lowest gross enrolment ratios in the developing world (National Knowledge Commission, 2009). There are considerable bottlenecks in the provision of vocational training, primary of which is that there is simply an insufficient supply of graduates.

These shortages of skilled workers puts an upwards pressure on the costs of employing the most competent graduates, and this is perhaps the largest single bottleneck underlying Indian industry over the next few decades. Under-qualified workers due to the deficiencies in the educational system require expensive in-house training programmes, which is an additional cost to employers. Indeed, several large companies maintain quite considerable in-house training capacity for this reason (Modwel and Jelassi 2010). A related issue is the bottleneck

[5] The Yashpal Committee Report indicates that 108 private universities had been set up by 2008. However, in the absence of clear guidelines, accreditation systems and monitoring, the quality remains quite ambiguous.

in skilled and experienced managers, which ultimately tends to be sourced from the same pool of employees within firms. For instance, McKinsey (2001) found that by 2010 there would be a shortfall of 200,000 managers in the IT sector alone.

Interactive learning within an economy depends in large part on collaboration between firms, universities and public research organizations. The non- firm sector plays a dual role as providers of R&D and as providers of human capital (Pavitt, 1984), which is essential for firms to build absorptive capacity. There is limited interaction between academic and research institutions and firms in India (D'Costa, 2009), which points to the nascent nature of national innovation system in India.

Indeed, while India has a large non-firm sector, with about 2000 public research institutes (Ministry of Science and Technology, 2010), most of these is run along administrative lines similar to government ministries, and suffers from considerable inefficiencies (NISTADS 2008). Just one Indian organization[6] belonging to the non-firm sector appears in the top 20 USPTO patent assignees from India during the period 2008-2012. The number of patents held by the non-firm sector in China and South Korea is higher in the top 20 patent assignees. Although there is only one non-firm[7] in the top 20 patent assignees from China, it holds more patents than all Indian non-firms combined. Similarly, there are three non-firms[8] in the top 20 patent assignees from Korea, and together they were granted seven times more patents than Indian non-firms.

Almost 75 per cent of India's public R&D expenditures were directed towards atomic energy, space research, defence and agriculture. 15 per cent was accounted for by biotechnology, IT, ocean development, non-conventional and renewable energy sources, medical research and environment and forests, and 10 per cent to industrial research (NISTADS 2008).

Firms are extremely dependent on their internal resources for financing of innovation activities, including human resource development, with limited resources and support from the public research sector. This is unlike the case in the US and Europe where the innovation

[6] Council of Scientific and Industrial Research (CSIR) is the only Indian organization in the top 20 patent assignees in India. USPTO granted 260 patents to CSIR during 2008-2012.
[7] Tsinghua University was granted 435 patents by USPTO during 2008-2012, which is higher than 334 patents (see Table 4) granted to nine Indian non-firms during the same period.
[8] Electronics and Telecommunication Research Institute, Korea Advanced Institute of Science and Technology, and Korea Institute of Science and Technology were granted a total of 2620 patents by USPTO during 2008-2012.

system mitigates the uncertainty within innovation, both financial and technological (Arora 2011).

Many of these research organizations suffer from a fundamental mismatch between their mandate and demand. Although the Indian economy was liberalized in 1991, public research organizations continue to prioritize self-reliance rather than developing products and services to compete in international markets. Instead, India's public research efforts were designed to disseminate best practice within its hitherto protected internal markets, as expected from an import-substituting model of industrialization. India's non-firm sector was not designed to promote domestic enterprises to achieve competitiveness at an international level, as would be expected for an export-oriented policy of economic development (NISTADS 2008). As such, these organizations suffer from systemic inertia, and are acutely unsuited to support industry for the challenges of the global economy (Narula 2003).

An exception to this is the Council of Scientific and Industrial Research (CSIR), which coordinates 40 subsidiary centres. CSIR has a stock of highly specialized 4,600 scientists and 8,000 scientific and technical support personnel. It supports 7,000 research scholars for doctoral research in S&T throughout the country and awards over a 1000 doctorates annually. It is also the single largest Indian patent assignee in India. 65 per cent of their budget is spent on pharmaceuticals, biotech, electronics/electrical equipment, and chemicals/petrochemicals research.

Despite this immense public infrastructure, India has a low share of public sector R&D, and public R&D has fallen in real terms with economic growth, with the private share of total R&D increasing from about 50 per cent to 65 per cent between 2003 and 2005 (NISTADS 2008). Six industrial sectors (pharmaceutical, automotive, electrical, electronics, chemicals and defence) account for about two-thirds of the total industrial R&D. The higher education sector contributes about 5 per cent of total R&D expenditures, but remains highly concentrated in a few institutions. However, Herstatt et al (2008) suggest that prospects to expand the role of universities to undertake more R&D is limited, given the shortage of academic staff at the IITs (discussed earlier), while many of the lower-tier universities are primarily teaching institutions.

Institutional bottlenecks

Research on economic growth and development has identified various factors that determine economic performance across regions and countries in the world. Productivity, technology, openness, income distribution, infrastructure and resource endowments are some of the factors that influence growth and development. In recent years, additional factors such as the quality of a country's institutions have been highlighted as the reason behind differences in competitiveness between countries (Acemoglu et al 2001, Glaeser et al 2004, Rodrik et al 2004). Institutional quality has also been found to influence FDI flows. Poor institutions at home drive away firms in search of locations with better institutional development (e.g. Witt and Lewin 2007).

The dominant view in research on institutions and development is that institutions determine economic performance (e.g. Acemoglu et al 2005). Although India has achieved rapid strides in economic development since liberalization in the early 1990s, institutional development has not kept pace. For example, the settlement of industrial disputes in the organized sector is still governed by the Industrial Disputes Act 1947. Firms employing more than 100 workers still need to obtain government permission before firing employees or closing down.

The quality of administrative practices such as costs of starting a business, obtaining permissions and licences, and hiring employees are important inputs for new enterprise creation and improving productivity (e.g. World Bank 2010; Branstetter et al 2013). Procedural delay due to red tape is another constraint faced by firms and multinationals in India. As shown in Table 7, the time taken to enforce a contract in India is double the time taken in Brazil, three times that of China, and five times that of Russia. Senior management of a typical firm in India spends 6.7 per cent of management time in a week to deal with government regulation related to taxes, customs, licensing and labour regulation compared to 0.9 per cent in China, 1.6 per cent in Indonesia and 0.4 per cent in Thailand. It takes almost 30 days to obtain an electrical connection in India whereas it takes only about 7 days in China and 4 days in South Korea. The time taken to clear exports through customs in India is 15 days while it is much lower in other developing Asian economies (Table 7). A delay in shipping a product by an additional day reduces the volume of trade by more than 1 per cent (Djankov et al 2010).

[Insert Table 7 here]

Another aspect of institutional quality that influences development and competitiveness is corruption (e.g. Shleifer and Vishny 1991). Corruption is also linked to the procedural delays faced by businesses in many countries. According to the World Bank Enterprise Survey, 47.5 per cent of firms in India are expected to make informal payments to ‘get things done’. This is much lower in all other countries in Table 7. 25.6 per cent of firms in the survey considered corruption as a major constraint in India while this is only 0.6 per cent of firms in China.

India has strong democratic political institutions which encourages legislation through debates and discussions. However, this has also created deadlocks due to disruption of the parliament by opposition parties, and also because of the pressure on the leading ruling party to satisfy the ideological whims of its coalition partners to ensure coalition stability (e.g. Spary and Garimella, 2013). This has often resulted in a logjam of bills to be passed by the parliament, many of them pertaining to important policy decisions.

Informal institutions also play a role in business. Research has shown that national pride influences attitudes towards global economic issues (e.g. Muller-Peters 1998) as well as M&A decisions (e.g. Hope et al 2011). Hope et al (2011: 129) define national pride as ‘‘an indication that national, social, or political considerations could influence decision-making of individual decision-makers (business owners or managers), either rationally or irrationally’’. Developing countries have been found to bid higher on average to acquire assets in developed countries. Tata Steel acquired Corus in 2007 for $12 billion, a price that was inflated mainly due to the bidding war with Companhia Siderúrgica Nacional (CSN) of Brazil. Corus has faced losses since 2009, made 2500 job cuts in the UK, and is trying to dispose assets and refinance debts (Financial Times, 2013). A report by Ambit Capital says that Indian companies become ‘victims of their own success’, and ‘arrogance and hubris’ results in inorganic expansion into unfamiliar territories at the expense of discipline on cost and quality (Financial Times, 2013). Informal institutions such as culture and customs impede human capital development to an extent. For example, the tendency of people in India to get married at a young age hampers their prospect of further education such as pursuing a PhD.

Discussion and implications for Indian MNE growth

The discussion heretofore makes the point that the O assets of MNEs are a function of O assets of domestic firms, and these in turn are determined by the home country’s L assets. We have examined the strengths and weaknesses of India’s economy and the pockets of excellence that have arisen therefrom that have shaped the growth of OFDI. In this section we discuss the implications of our preceding analysis, paying special attention to the bottlenecks to long-term competitiveness of India’s economic sectors, and the prospects for outward FDI. The evidence suggests that the strengths and weaknesses in the L assets of India have caused pockets of excellence to emerge, but that these conditions do not lend themselves to a broader growth in competitiveness, meaning that further rapid growth is ultimately not sustainable.

Growth in the services sector

The growth of India's service sector is an important curiosity for several reasons. First, quite unlike other developing countries, the gradual shrinking of the relative importance of the agricultural sector over the last 40 years has not been associated with a commensurate growth in India's manufacturing sector, which has shown only marginal changes in its share of the economy, with the slack being taken up by the growth of the service economy (Kumar and Gupta 2008). To some extent service sector growth has happened despite government policy.

Second, although it requires knowledge infrastructure, this sector has grown through firms substituting public goods with private goods. Service firms by definition are even more dependent upon recruiting skilled workers (which make up the majority of their employment), and for whom output is crucially associated with the quality of these employees. ILO (2013) notes that salaried workers in services reported a 150 per cent increase in wages between 2006 and 2010, three times the increase in the consumer price index. The bottlenecks in the education sector discussed earlier, coupled with the high rates of attrition means that Indian firms are pushed to move abroad, as wage costs go up but labour productivity does not demonstrate a commensurate increase. The services sector has benefitted from a large inflow on FDI by highly competitive MNEs, causing domestic firms to 'raise their game' through greater innovativeness. At the same time, this has also caused an upwards pressure on wages.

Data show that over the period 1980-2004, over 60 per cent of the total factor productivity growth in India came from the services sector. (Das, et al, 2010) The services sector in India will struggle to grow at quite the same pace it enjoyed during the last two decades because of fundamental shortage of skilled (and affordable) manpower, both technical and managerial. The services sector will see greater internationalization, because there will be a 'push' effect to overcome shortage of critical inputs, in addition to its natural propensity - by virtue of its demand driven nature - for proximity to the customer. Indeed, services and software are already the largest areas of outward FDI.

The state-owned enterprise sector

The SOE sector – while not as large as China – is still relatively large at approximately 15 per cent of GDP (Dougherty et al 2009), and a similar share of employment. State-ownership is considerable in sectors as diverse as telecommunications, energy, banking and dairy processing, and in most instances remains highly inefficient. McKinsey (2001) estimated that continued state ownership supressed GDP growth by approximately 0.7 per cent annually and there is little evidence that this has been addressed in the decade since this study.

Industries dominated by a few state-owned firms (or indeed firms of any kind of ownership) rarely benefit from the competition effect from inward FDI. India has a larger number of sectors where output is concentrated in the hands of a very small number of actors. Dougherty et al (2009) estimated that India's share of highly concentrated industries was three times as large as that of China or the US. This suggests that there is a much greater potential for anti-competitive behaviour by firms, and less of an incentive to upgrade their O assets. It also means that such firms are able to generate monopoly rents and are less likely to venture abroad, and where they do so, will not be concerned with the commercial viability of these activities.

Indian SOEs in India are known to be poorly managed at home, and suffer from low productivity. These firms enjoy a near monopoly (or at least have a market-making position) in some sectors guaranteeing their profits however unproductive they may be. Poorly-performing SOEs in industries open to competition such as steel and retail banking can get government support, allowing them, too, to survive despite their inefficiencies (McKinsey 2001). In some sectors, the government controls both the large players and the regulators, creating an uneven playing field for private competitors. Any expansion of this sector abroad – primary amongst them are resource intensive SOEs – will in any case not be based on a financial or performance motive.

Growth in the manufacturing sector

FDI from India's manufacturing sector is abysmally low. From textiles and apparel to pharmaceuticals there is considerable evidence that while there are opportunities for export growth, Indian firms remain concentrated in the upstream and low(er) value adding parts of the value chain. The low levels of OFDI compared to the high share of exports of these two sectors indicate that their O assets are location-bound, and location-specific. In pharmaceuticals, despite improvements in India's IPR laws, protection for patents remains weak, acting to limit inward FDI as well as discouraging domestic firms from expanding into new drug discovery (as evidenced by the low R&D intensity of Indian companies).

In sectors such as automotive components and textiles, domestic growth will be limited by the problems of small scale production by the multitude of micro-enterprises that dominate in India, in sectors where there are large minimum efficient scales, and there are considerable economies of scale.

The automobile sector has gone shopping for acquisitions to overcome their limited O assets portfolio, and the growing competition from inward FDI. They have responded by engaging in significant acquisitions abroad, but the evidence is that *they are able to acquire but not to merge*. That is, they maintain their foreign acquisitions as autonomous subsidiaries. From their failure to upgrade the products from their domestic operations with superior technology from these acquired firms, it seems clear that they do not have the organizational and managerial skill to engage in systematic reverse technology transfer. There are few reasons to believe that Indian firms can substitute for weaknesses in the L assets at home by going abroad, or avoiding investing in R&D themselves by buying up firms with an existing portfolio of technological assets. Both require recombination advantages and an especially high absorptive capacity.

Certainly, there are opportunities in inter-industry integration. For instance, the growth of inward FDI in the IT/software sector is partly driven by hardware companies that seek complementarities in software from India. There is great potential in the hardware side of IT, if the innovation system were upgraded to promote an integrated approach that boosts the hardware and software sectors simultaneously.

There are other areas for possible cross-fertilization, where India's existing pockets of excellence can 'cross-over', such as, for instance, bio-informatics, and the growth of biotechnology (an area where the government has invested considerably (NISTADS 2008)). However, each presents its own challenges, and broadly speaking, the same bottlenecks in terms of basic and knowledge infrastructure, as well as institutions will constrain each of these 'new' sectors.

Prospects for new pockets of excellence

Outward FDI by Indian firms from its existing ‘pockets of excellence’ has limited potential for sequential growth, except perhaps where it is to ‘escape’ the confines of India’s limited innovation system. Growth in new sectors depends in large part upon new pockets of excellence developing, but this depends crucially upon developing new sectors within manufacturing. This in turn means developing the appropriate L assets. However, there are several reasons why we are pessimistic that this can happen without considerable and radical changes to the innovation milieu.

Although India potentially has an almost limitless supply of people given its large population, it is also a particular feature of the Indian economy that a very large share of the economy remains in the informal sector, and this share has grown rather than shrunk. 94 per cent of total employment in 2003 was in the informal sector, increasing from 92.6 per cent in 1993. Much of this increase has been in the non-agriculture sector, while the formal sector has shrunk over the same period, along with the agricultural sector (Dougherty et al 2009). Employment in the private sector manufacturing industry was just over 5 million in 2007-08, an increase of just half a million from 1990. This growth is dismal in a country where 10 million workers are estimated to join the work force annually (Bhagwati and Panagariya 2013).

Several facts are worth noting here[9]. First, the formal sector accounts for the vast majority of India’s exports. Second, the Indian manufacturing sector is dominated by micro-enterprises, of which the overwhelming majority are in the informal sector. Third, these micro-enterprises have a total factor productivity that is half that of larger enterprises. Fourth, Indian manufacturing is concentrated in sectors where there are considerable scale economies. Fifth, they are sectors which are also capital intensive, which works against India’s comparative advantage.

It is a fundamental paradox that the informal sector has grown, despite its greater inefficiencies. This is ultimately a result of India’s labour legislation and pre-reform regulations that provides on the one hand special incentives to micro-enterprises by limiting entry to larger firms in certain sectors, while on the other hand, limiting the ability of larger firms to lay off or replace workers, or declare bankruptcy. Firms therefore prefer to be capital-intensive rather than labour-intensive to avoid the complexities of becoming larger. Large firms also tend to fragment outsourced activities to a considerable number of small

[9] Based on Dougherty et al (2009)

units (perhaps because the smaller firms predominate) creating further inefficiencies. From our perspective it means that there will be fewer firms with O assets that can be exploited abroad, at least within the manufacturing sector.

There is no evidence to suggest that the domestic manufacturing sector is likely to grow, at least not in the knowledge-intensive sectors. Poor physical and knowledge infrastructure limit India's competitiveness in such sectors, and this applies not only to knowledge-intensive sectors (where India does not have a comparative advantage). Even more labour-intensive sectors such as textiles and apparel are becoming less competitive due to rising costs caused by infrastructure bottlenecks.

In particular, the weakness of state sector support in education and training creates a cost for private firms, since they must privately provide what is normally a public good, making them less competitive. Larger firms are able to overcome some of these gaps in public goods by investing in their own infrastructure – building training centres and institutes, generating their own electricity, and so on, but smaller firms (and less successful ones) simply cannot absorb such costs.

This makes Indian firms less competitive in international markets. Firms without the political clout to seek exceptions from politicians and policy makers (typically the large business groups and SOEs that dominate the Indian economy) will seek to 'exit'. From the point of view of OFDI, it means we are likely to see the more competitive firms seeking to escape institutional voids, and India's growing location *disadvantages* by relocating abroad.

The high degree of illiteracy, the large (and inefficient) informal agricultural sector, and the problems of internal migration means despite a large population, there is a shortage of workers with basic skills where demand is greatest. Besides, Indian firms have a disincentive to employ more workers due to unwieldy labour regulations[10], preferring to substitute capital for labour, assisted by low costs of borrowing during the boom era. As the cost of capital has risen, and liquidity in the domestic sector decreased further growth through this means is limited. Where firms in these sectors have non-location-bound O assets, it is possible that we see an increase in OFDI to lower wage nations in the region. However, in sectors such as textiles and apparel, there is no indication that they can expand abroad, because they remain in the low value adding aspect of the industry, and act as outsourcers to larger non-Indian

[10] For example, producers of certain textile products face limits on their spending on new plants.

MNEs that own the knowledge-intensive and proprietary O assets further downstream[11]. In addition, due to their small size they simply do not have the resources to do so, and these resource constraints include a lack of managerial capacity to expand abroad. Where they are able to overcome their resource constraints, their scale of activity is often far below the minimum efficient scale to compete abroad[12].

Indeed, there are two issues that seem to apply across the board. First, the limits to growth from derive from poor institutions that dis-incentivize firm growth (seen by the fact that the informal sector's share of employment has expanded, rather than shrunk, during the last two decades). The success of the services sector derives in part from the fact that many restrictive labour laws, including the Factories Act, did not apply to the service industries such as software. These laws, in combination with the unwieldy regulations that on the one hand encourages micro-enterprises, but on the other then puts brakes on their ability and willingness to expand, hold back the ability of firms to develop O assets in much of the manufacturing sector.

Second, there are fundamental gaps in the infrastructure in India. The limited physical infrastructure is not simply a cost for firms in terms of moving goods, and achieving just-in-time delivery. It also presents a cost in terms of labour mobility. MNEs and domestic firms must concentrate themselves in specific areas, since there are very low levels of internal migration. Domestic firms do not easily relocate themselves (or establish subsidiaries) to take advantage of lower wages in other locations, or less onerous employment regulations (there is considerable variation between Indian states, which work on a federal basis). Indeed, wage differentials between different parts of the country mean that moving abroad can in some instances be cheaper than relocating within India. Limited migration within India has adverse impacts of trade liberalization, and ultimately for firm competitiveness, particularly for states with heavily protected labour markets.

Systematic upgrading and radical policy changes are needed to build up India's knowledge infrastructure and institutions to support a shift in India's competitive advantages to new sectors outside these pockets. There are reasons to be pessimistic that radical action to correct these structural impediments to growth will be acted upon boldly, and this has to do with the

[11] India's technology value-added in manufactured products in 2009 was 8 per cent, considerably less than China (31 per cent), Brazil (14 per cent) and Mexico (21 per cent) (Rajan 2012)

[12] The average Indian textiles factory has only about 50 machines, compared to over 500 in a Chinese plant (McKinsey 2001).

fact that Indian policy makers face a dual and sometimes conflicting set of challenges. They must invest in technologies and assets that reduce inequality and poverty, particularly in the rural areas through resource-saving but labour-intensive ‘appropriate’ technologies, which provide no advantages in international markets. Simultaneously they must promote R&D in state-of-the-art emerging knowledge-intensive sectors that increase the competitiveness of Indian firms. The social and political costs of neglecting the first have to be weighed against the economic costs of underperforming in the second. However as Drèze and Sen (2013) argue, in the long run, this is not an either/or scenario. In a world where the space between domestic and global markets has shrunk so radically, indecision is not an option.

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Table 1: OFDI stock and OFDI per capita from major home countries.

	1981		1991		2001		2011	
Country	**OFDI**	**OFDI per capita**	**OFDI**	**OFDI per capita**	**OFDI**	**OFDI per capita**	**OFDI**	**OFDI per capita**
Developing countries								
China	39.4	0.0	5368.0	4.7	34653.8	27.6	365981.0	271.6
Brazil	38751.9	311.0	42059.1	276.4	49688.6	280.9	202586.3	1030.2
India	**80.1**	**0.1**	**113.1**	**0.1**	**2531.8**	**2.4**	**111257.0**	**89.6**
Russia	_	_	_	_	44219.0	302.5	362101.0	2535.1
Mexico	1663.2	23.7	2849.3	33.2	55628.2	549.0	112087.8	976.4
Indonesia	5.0	0.0	99.0	0.5	_	_	9502.0	39.2
Argentina	5863.4	205.3	6106.7	184.5	21282.6	570.5	31329.0	768.5
S. Africa	6059.3	203.1	16100.4	427.2	17580.0	387.3	72284.7	1432.5
Thailand	13.8	0.3	603.3	10.5	2626.0	41.1	33226.0	477.9
Venezuela	29.0	1.9	1368.0	67.8	7894.0	318.2	19808.0	672.9
Newly industrialized countries								
S. Korea	148.9	3.9	3327.6	76.7	19966.9	432.1	159338.9	3292.7
Malaysia	474.5	33.5	762.8	40.8	8354.2	348.6	106216.6	3680.5
Singapore	819.0	332.5	9312.4	3004.5	83556.1	20989.0	339095.1	65362.3
Developed countries								
Germany	-	-	173265.2	2175.2	617766.1	7498.5	1441611.0	17545.8
Japan	24506.0	209.7	231791.0	1889.0	300113.8	2383.8	962789.5	7611.1
UK	85714.8	1516.7	232140.8	4031.5	869700.4	14660.9	1731094.6	27629.1
USA	228348.0	970.1	827537.0	3189.2	2314934.0	7997.1	4499962.0	14198.1

Source: UNCTADStat

Table 2: R&D intensities of various industries in India and worldwide.

<table>
<tr><th rowspan="2">Industry</th><th colspan="2">R&D intensity, 2006-07</th><th rowspan="2">Share of inward FDI (%)</th><th rowspan="2">Share of manufacturing exports (%), 2005</th></tr>
<tr><th>India</th><th>Global</th></tr>
<tr><td>Pharmaceuticals</td><td>6.91</td><td>15.1</td><td>22.61</td><td>4.0</td></tr>
<tr><td>Chemicals</td><td>2.49</td><td>3.1</td><td>23.43</td><td>15.9</td></tr>
<tr><td>Food products</td><td>1.90</td><td>1.6</td><td>13.24</td><td>na</td></tr>
<tr><td>Automobile</td><td>1.76</td><td>4.2</td><td>29.41</td><td rowspan="2">18.3</td></tr>
<tr><td>Machinery</td><td>1.33</td><td>3.1</td><td>27.17</td></tr>
<tr><td>Electronics</td><td>1.48</td><td>5.1</td><td>21.62</td><td rowspan="2">2.8</td></tr>
<tr><td>Electrical machinery</td><td>0.37</td><td>5.8</td><td>22.78</td></tr>
<tr><td>Software</td><td>1.15</td><td>9.5</td><td>24.32</td><td>na</td></tr>
<tr><td>Rubber & plastic</td><td>0.59</td><td>2.1</td><td>25.53</td><td>na</td></tr>
<tr><td>Textiles</td><td>0.25</td><td>2.7</td><td>20.41</td><td>23.1</td></tr>
<tr><td>Basic metals</td><td>0.14</td><td>1.3</td><td>17.79</td><td>7.6</td></tr>
</table>

Source: NISTADS (2008), Kumar and Gupta (2008)

Table 3: Top Indian R&D spenders, 2011

Company	**Industry**	**R&D expenditure, 2011(million Euros)**	**R&D intensity (%)**
Infosys	IT/software	258.8	5.3
Tata Motors*	Automotive	182.9	2.5
Reliance Industries	Oil & gas, chemicals	143.5	0.3
Dr Reddy’s Laboratories	Pharmaceuticals	84.4	6.2
Tata Steel	Iron & Steel	73.4	0.4
Mahindra & Mahindra	Automotive	70.8	0.9
Lupin	Pharmaceuticals	68.1	6.7
Ashok Leyland	Automotive	51.5	2.8
ONGC	Oil & gas	47.0	0.4
Bharat Heavy Electricals	Industrial engineering	46.6	0.8
Cipla	Pharmaceuticals	43.9	4.3
Cadila Healthcare	Pharmaceuticals	42.4	5.7
Glenmark	Pharmaceuticals	42.3	7.3
Sun Pharmaceutical	Pharmaceuticals	41.5	7.3
Wockhardt	Pharmaceuticals	36.0	5.4

*Tata Motors was not ranked in the EU Industrial R&D Scoreboard 2012. They spent INR 11.87 billion on R&D in 2010-2011 which was converted to Euro at the average Euro-INR exchange rate of 64.88 in 2011 (Source: European Central Bank Statistical Data Warehouse) to obtain 182.9 million Euros.

Source: European Union Industrial R&D Scoreboard 2012 and Tata Motors Annual Report 2010-2011.

Table 4: Sectoral distribution of USPTO patent assignees in India* (2008-2012)

Industry	Total		Indian firms		Foreign firms	
	Number of firms	Patents	Number of firms	Patents	Number of firms	Patents
IT/software	49	1909	10	188	39	1721
Pharmaceutical	36	506	32	457	4	49
Electronics	32	1003	1	12	31	991
Telecommunication	6	48	0	0	6	48
Engineering	4	497	1	5	3	492
Chemicals	3	88	1	8	2	80
Medical/healthcare	2	14	0	0	2	14
Automotive	1	34	0	0	1	34
Oil and gas	1	13	1	13	0	0
Energy	1	5	0	0	1	5
Textile	1	5	1	5	0	0
Financial service	1	11	0	0	1	11
Media service	1	5	0	0	1	5
Non-firm	9	334	9	334	0	0
Total	147	4472	56	1022	91	3450

* Includes all organizations that received five or more utility patents and excludes individual patent assignees. Note that industry classification of patents is based on industry of patenting firm, not industry of patent granted.

Source: US Patents and Trademarks Office

Table 5: Basic infrastructure indicators for major countries

Country	Access to electricity (% of population) – 2009	Electric power consumption (kWh per capita) – 2010	Electric power transmission and distribution losses (% of output) – 2010	Value lost to electrical outages (% of sales) – 2002-2012*	Rail line (total route kilometres) – 2011	Paved roads (% of total roads) – 2008-2011*	Fixed broadband internet subscribers (per 100 people) – 2011	Internet penetration (% of population) - 2012
Developing countries								
China	99.4	2943.8	6.1	1.3	66239	84.1	11.6	40.1
Brazil	98.3	2383.7	16.6	3.0	29817	12.9	8.5	45.6
India	**66.3**	**616.2**	**21.9**	**8.1**	**63974**	**49.5**	**1.0**	**11.4**
Russia	-	6430.6	10.1	2.0	85292	79.0	13.1	47.7
Mexico	-	1990.4	16.3	3.4	26704	36.4	10.2	36.5
Indonesia	64.5	641.3	9.3	2.2	-	56.9	1.1	22.1
Argentina	97.2	2904.4	13.4	3.5	25023	-	10.5	66.4
S. Africa	75.0	4802.5	9.5	1.6	22051	-	1.8	17.4
Thailand	99.3	2243.4	6.3	1.5	4429	-	5.0	30.0
Venezuela	99.0	3286.6	19.3	8.3	-	-	6.1	41.0
Newly industrialized countries								
S. Korea	-	9744.5	3.6	0.0	3379	79.3	36.9	82.5
Malaysia	99.4	4117.3	6.5	3.0	1665	80.4	7.4	60.7
Singapore	100.0	8306.7	7.0	-	-	100.0	25.6	75.0
Developed countries								
Germany	-	7215.4	3.8	0.0	33708	-	33.1	83.0
Japan	-	8394.1	4.4	-	20035	-	27.6	79.5
UK	-	5733.1	7.1	-	31471	100.0	32.7	83.6
USA	-	13393.9	5.9	-	228513	100.0	27.4	78.1

*For each country, the latest available year of data is used.

Source: World Bank World Development Indicators, CIA World Factbook, Internet World Stats

Table 6: Knowledge infrastructure indicators for major countries

Country	Researchers in R&D (per million people) – 2005-2009*	R&D expenditure per capita ($) – 2006-2009*	Researchers with ISCED grade 6# education (% of total researchers) – 2003-2009*	R&D expenditure (% of GDP) - 2010	Scientific and technical journal articles – 2009	Secure internet servers (per million people) - 2012	High technology exports (% of manufactured exports) - 2011	Inward FDI (million $) - 2012	Per capita inward FDI ($) - 2012
Developing countries									
China	863.2	115.5	-	1.7	74019	3.1	25.8	832882.0	615.3
Brazil	703.7	121.2	34.9	1.2	12306	55.5	9.7	702208.2	3540.1
India	**135.8**	**20.5**	**13.1**	**0.7**	**19917**	**3.5**	**6.8**	**226345.5**	**179.9**
Russia	3092.3	234.5	27.4	1.2	14016	38.6	7.9	508890.0	3566.1
Mexico	383.5	54.5	28.9	0.3	4127	29.7	16.5	314968.0	2711.8
Indonesia	89.6	3.3	14.0	0.1	262	4.0	8.3	205656.3	840.2
Argentina	1091.2	86.6	24.8	0.5	3655	42.3	7.9	110704.3	2692.3
S. Africa	393.0	95.9	47.9	0.9	2864	84.6	5.1	138964.0	2738.8
Thailand	315.5	16.4	17.6	-	2033	19.1	20.7	159124.6	2276.7
Venezuela	182.6		54.8	-	354	10.9	2.4	49079.0	1641.9
Newly industrialized countries									
S. Korea	5481.4	983.4	-	3.3	22271	2733.4	25.7	147230.0	3030.2
Malaysia	364.6	78.6	36.8	0.6	1351	66.1	43.4	132399.7	4515.4
Singapore	6173.1		19.6	2.5	4187	651.6	45.2	682395.7	129824.9
Developed countries									
Germany	3849.6	1010.9	-	2.8	45003	1102.4	14.9	716344.0	8736.9
Japan	5179.9	1086.5	17.4	3.4	49627	774.3	17.4	205361.1	1624.2
UK	3794.1	641.3	-	1.8	45649	1534.1	21.3	1321352.0	20961.8
USA	4673.2	1305.1	-	2.8	208601	1501.0	18.1	3931976.0	12301.1

*For each country, the latest available year of data is used.

#International Standard Classification of Education 1997, grade 6 – Tertiary programmes leading to the award of an advanced research qualification such as Ph. D.

Sources: World Bank World Development Indicators, UNESCO Institute for Statistics, Battelle/R&DMag 2012 Global R&D Funding Forecast

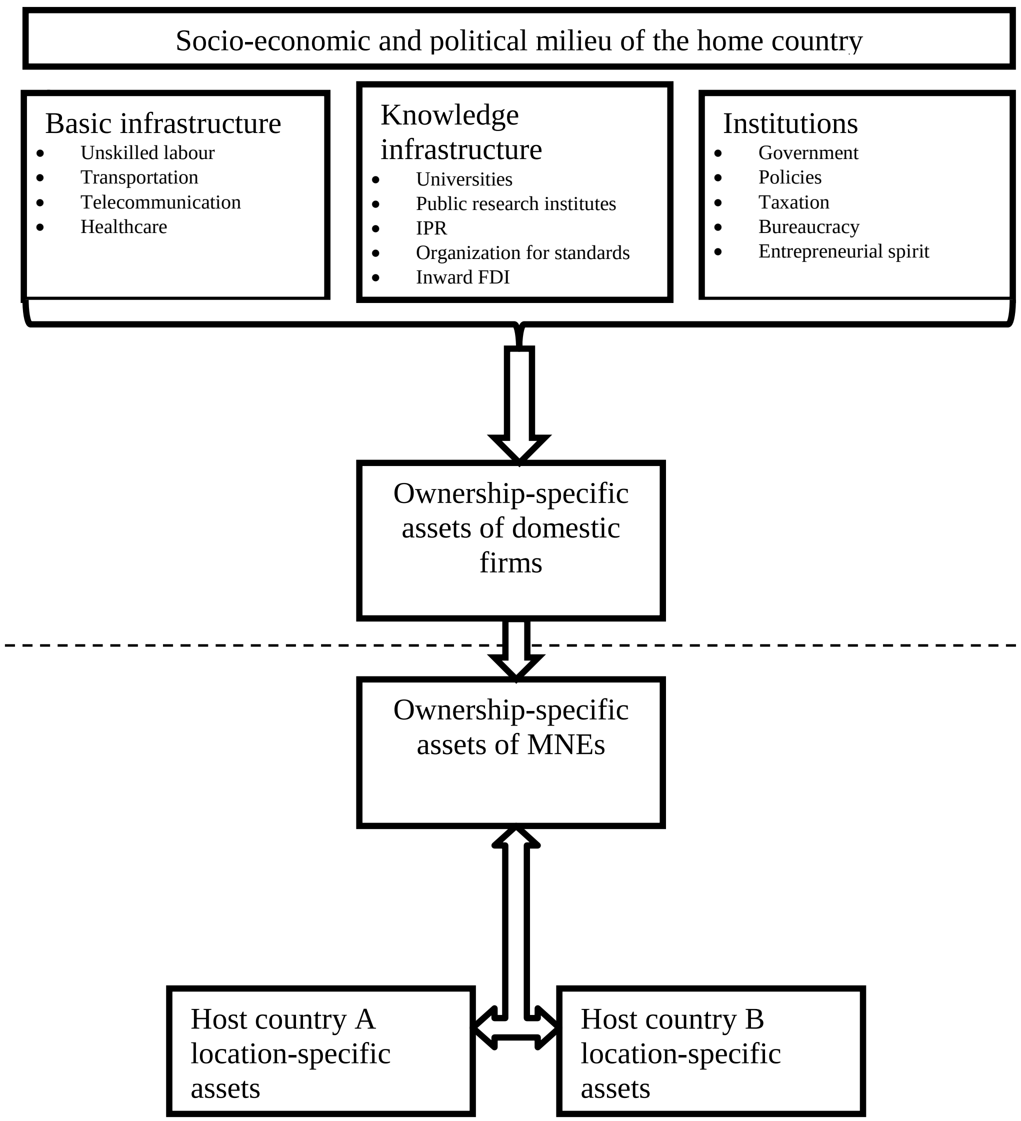
Table 7: Institutional indicators for major countries (2005-2012)*

Country	Number of days to enforce a contract	Percentage of firms expected to make informal payments to 'get things done'	Management time spent on dealing with government regulation (% of mgmt time in a week)	Days to obtain an electrical connection	Days to clear exports through customs
Developing countries					
China	406	10.7	0.9	6.9	7.6
Brazil	731	11.9	18.7	36.8	15.9
India	**1420**	**47.5**	**6.7**	**29.5**	**15.1**
Russia	270	20.5	14.7	120.4	5.6
Mexico	415	11.6	13.6	17.1	7.0
Indonesia	498	14.9	1.6	15.5	2.3
Argentina	590	18.1	20.8	54.2	7.3
S. Africa	600	15.1	6.0	15.8	4.5
Thailand	440	-	0.4	27.9	1.3
Venezuela	510	23.6	27.6	13.9	18.4
Newly industrialized countries					
S. Korea	230	14.1	0.1	3.9	7.2
Malaysia	425	-	7.8	10.7	2.7
Singapore	150	-	-	--	-
Developed countries					
Germany	394	-	1.2	3.2	4.7
Japan	360	-	-	-	-
UK	399	-	-	-	-
USA	370	-	-	-	-

*For each country, the latest available year of data is used.

Source: World Bank Doing Business, World Bank World Enterprise Survey

Figure 1: Relationship between O assets and L assets



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