Science, Technology and Development:

The Case of India's Investments Abroad

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I Introduction

Trade, capital and labour flows are the binding agents of globalisation. The pattern and nature of these three types of international economic relations are governed by the comparative advantage of the transacting nations. The Heckscher-Ohlin-Samuelson trade theory traces the comparative advantage of trading countries to their factor endowments. Thus labour abundant countries would possess a comparative advantage in labour intensive goods and those abundant in capital would possesses an advantage in capital intensive goods. It is noteworthy that the time honoured theory assumes identical technologies in

the production of the traded goods in the trading countries and immobility of factors between trading countries. Recent developments though cast new light on the analytical underpinnings of the theory. Whilst the tenet that it is comparative advantage that governs the pattern of trade is immutable, the factors that shape comparative advantage have changed radically over the years; chief amongst these is the growth in the mobility of factors between trading countries. Growth in the cross border movement of capital and labour has had a dramatic impact on technological change in the trading countries with a significant impact on trading patterns.

Until recently a substantial proportion of international capital flows was from the developed to the developing or emerging economies, whilst labour flows, especially skilled labour, were mostly from the developing countries to the developed countries. For long, the principal recipients of capital flows, especially Foreign Direct Investment (FDI), amongst the developing countries were mostly the Latin American and East Asian countries. Amongst what are now known as the BRICS (Brazil, Russia, India, and China) only Brazil was a substantial recipient of FDI. China was virtually a closed economy until 1978 and India, though open to trade and capital flows, was lukewarm though not hostile to FDI until the introduction of the liberalisation measures in the year 1991. Inflows of FDI into India during the decade of the eighties averaged around $452 million, since the turn of the century though FDI flows into India

have averaged around $ 4 to 5 billion per annum rising to $ 30 billion per annum in recent years. China has outdistanced all other emerging economies with an annual inflow of FDI of around $60 billion in recent years (UNCTAD, 2008)

The suspicion and distrust of FDI on the part of the two Asian giants is now history; indeed, the game keepers have now turned poachers. Both India and China are now significant participants in the outward FDI from the emerging economies. Although not a novel phenomenon it is only since the late nineties that the emerging economies have registered a visible presence in the league tables on outward FDI. As in the case of FDI inflows, China heads the league tables on outward FDI from the emerging economies with an annual outflow of more than $ 22billion in 2007. India's FDI, at around $ 12 to 13 billion in the years 2006 and 2007, though not as large in volume as that of China (UNCTAD, 2008), is distinct in its pattern and its destination. A relatively high proportion of India's outward FDI is in the developed countries and it is mostly in high tech and skill intensive industries and services. How is it that an emerging economy, whose per capita income at around $1000 well below that of other emerging economies, and an economy that harbours more than 200 million people below the poverty line, ranks alongside the world's leading multinationals in the pattern of its overseas investments with skill intensive pharmaceuticals and software, and technology intensive industries

such as transport equipment and machinery accounting for a high proportion of total investments? This pattern of India's FDI reflects the leap frog nature of transition of India's economy from agriculture to services with pockets of technology and skill intensive manufacturing industries.

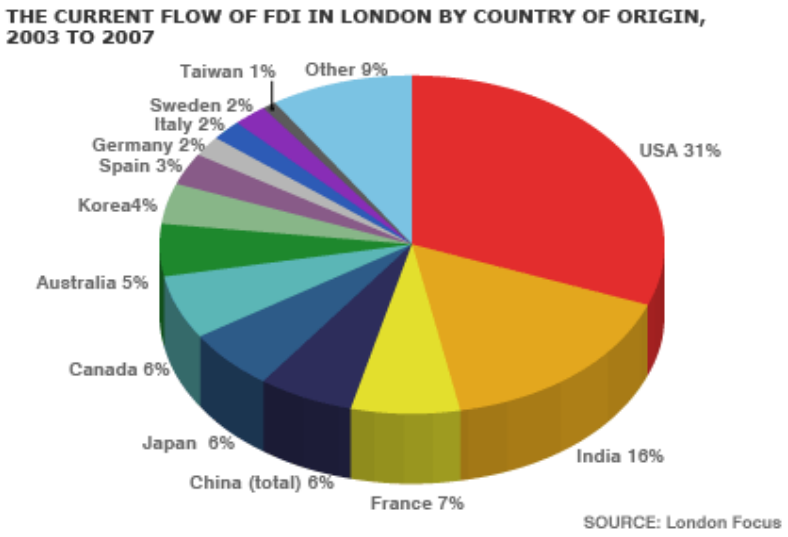
This brief paper argues that India is unique amongst the emerging economies in the pattern of its growth and international economic relations. This unique pattern is shaped by the geographical diversity of the country, its history and the design of development it embarked upon soon after shedding the colonial yoke. The nature and pattern of India's outward FDI is a manifestation of the successful exploitation of these endowments. Outward FDI in turn enriches these endowments in confluence with international trade and labour flows. The rest of the paper elaborates this theme following a brief sketch of the nature and pattern of India's outward FDI

II Th Indians are Coming the Indians are Coming

India's investments in Britain, mostly through acquisitions cover a range of well known manufacturing firms-Tetley Tea, Jaguar and Land Rover, Whyte and Mackay the distillers and Corus steel , to name a few. These and other investments, rank India as the second biggest foreign investor in London, next to United States the longstanding investor in the UK (Chart 1). The pattern and

volume of India's investments exemplify the technology and skill intensive nature of India's investments in general.

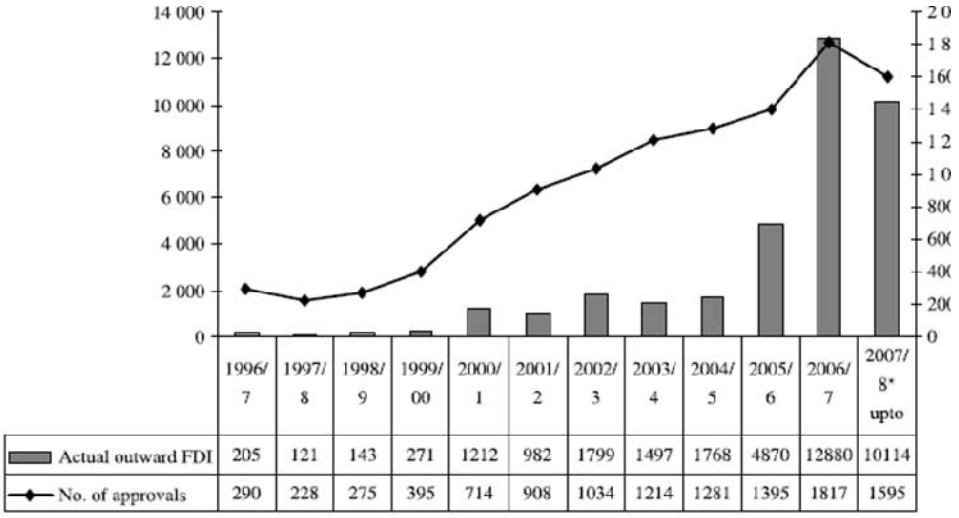
CHART 1



Detailed data on India's foreign investments from official publications are difficult to find. We rely here on an excellent set of data put together by Nagesh Kumar (2008).

The data shows three significant characteristics of India's outward FDI. First, it has accelerated since the year 2000 from around $1.2 billion to around $12.8 billion in the year 2007 (chart 2). Second, the volume of India's outward FDI is

CHART 2



	1996/7	1997/8	1998/9	1999/00	2000/1	2001/2	2002/3	2003/4	2004/5	2005/6	2006/7	2007/8* upto
Actual outward FDI	205	121	143	271	1212	982	1799	1497	1768	4870	12880	10114
No. of approvals	290	228	275	395	714	908	1034	1214	1281	1395	1817	1595

Figure 1 Outward foreign direct investment (FDI) by Indian enterprises, 1996–2008.
Note: *for April–December 2007.
Source: Author based on Ministry of Finance and RBI data.

much lower than that of China. In the year 2006 data compiled by Nagesh Kumar shows that India's outward FDI amounted to $9.6 billion compared with an outflow of $16 billion from China. The share of India in total outflows from developing countries estimated at $174 billion was 6% compared with a figure of 9% in the case of China.[1] Third, the composition and destination of India's outward FDI is markedly different from that of other emerging economies. The bulk of India's investments are in manufacturing and services with the share of the latter increasing in recent years (Appendix Table-1). Also the share of the developed countries in India's outward investments has increased markedly from around 35% at the end of the year 1995 to 54% at the end of the year

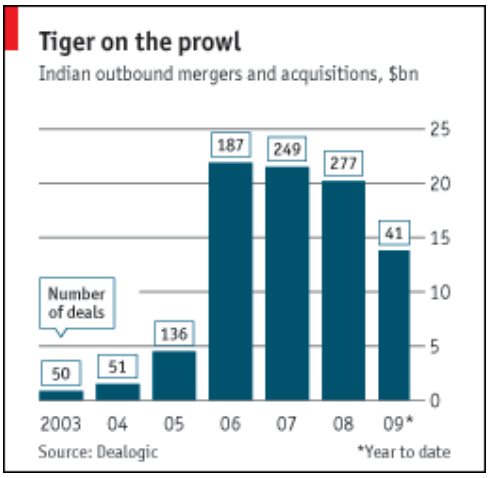
[1] The World Investment Report (UNCTAD 2008) puts the outflow of FDI from China at a s high a figure as $22 billion and that for India at $13 billion, at the end of the year 2007.

2006, with more than 65% of the total investments of $6,233 million, approved by the government of India, in the developed countries (Kumar 2008). More than 75% of India's investments in ther manufacturing sector are in high technology and human skills oriented industries such as automobile and parts, electrical and electronic equipment, chemicals, pharmaceuticals and engineering goods. Information technology including software and financial services account for 80% of total investment in services. Another feature of India's overseas investments is that almost all of it is undertaken by privately owned firms unlike that of China's investments that are dominated by state owned firms. As the Boston Consulting Group report (2008) puts it "Where the globalizing Chinese companies differ dramatically from the globalizing Indian companies is in their ownership structures. More than two-thirds of the Chinese companies… are state owned and state controlled, often with publicly traded subsidiaries or with minority stakes in the hands of strategic investors…. Of the remaining companies, some have a mixed-ownership structure but only four Chinese companies on the list are privately owned. The shares of the Indian companies are usually divided among private owners, strategic investors, and the general public, with no single investor possessing a majority stake. All the Indian companies on our list are publicly traded… and only one Indian company on the list is state controlled". Supplying China's growing need for natural resources including oil seems to be the basic objective of the country's

overseas investments. It is arguable if such investments reflect the investor's ability to manage and conduct operations abroad or they constitute a mere ownership of a resource that requires no more than drilling equipment and basic skills to operate the equipment.

Yet another feature of India's investments is that acquisitions account for the bulk of India's investments as opposed to green field investments. The London Economist reports that "between 2000-2008 Indian firms announced more than 1000 acquisitions and mergers amounting to $72 billion (Chart 3), most of the deals had been sealed by the end of 2006 (Economist, May 28, 2009) A large proportion of the acquisitions are paid for with cash raised at home and abroad rather than through leverage buy outs and provision of shares in the acquirer companies for the acquired firms. The fact that Indian firms are able to raise the cash required to acquire foreign firms attests to the confidence of global investors in the management of Indian firms. These and other features of India's overseas investments suggest that the Indian firms have arrived and they represent yet another feature of the economy that sets it apart from that of other emerging economies including China. In a nutshell Indian firms operate at the quality end of the international markets. The analytically interesting issue is- what are the factors that have endowed Indian firms with this premier position in the international league tables?

CHART 3



III The Genie is out of the Bottle

The 1991 economic reforms have wrought a dramatic change in the structure of the Indian economy. The abolition of the industrial licensing system, the considerable reduction in import tariffs and the relaxation of the foreign investment regime have all exposed economic agents to increased competition from both domestic and international sources. The Indian entrepreneurs have risen to the challenge posed by increased competition for markets. As the London Economist suggests" The challenge is to forestall competition from foreign multinationals, one way of doing so is to join them seems to be one of the reasons for investing abroad(Economist, May 28,2009)." It is not just that if you can't beat them join them, it is a case of if you wish to beat them join them. It is noteworthy that the economy was never deficient in risk taking entrepreneurs and managers. Family businesses such as the Tatas

and the Birlas date a long way back in India's economic history. In recent years another band of entrepreneurs such as Premji and Narayana Murthy who have promoted the software industry and the Mittlas and the Ambanis in the steel and mining industries, have joined the established business houses. These entrepreneurial skills lay latent in the pre liberalisation era in the absence of the challenge of competition and the presence of administrative barriers to entry into international markets. The liberalisation measures of 1991 provided the much needed competition and unleashed India's managerial and entrepreneurial talents. The inward looking economic policies of the past based on the objective of self sufficiency in both human and material assets though have had their positive side too- they have endowed the entrepreneurs with supplies of engineering and science based skills vital for their entry into developed country markets.

The endowments of engineering and managerial skills is a legacy the country owes to its first prime minister Nehru's vision of an industrial democracy free of dependence on the developed countries for its requirements of human skills and basic ingredients of industrialisation. The Nehruvian strategy included the generation of a core of scientists and engineers to man the engineering and science based industries. Higher education institutions were heavily subsidised and the prestigious Indian Institutes of Management, the five Indian Institutes of Technology and scientific research establishments such as

the Tata Institute for Fundamental Research werte established. Nehru was justly proud of the science establishments of India. As he wrote:

> "O*ne of the biggest things that we have done since independence is the development of our magnificent national laboratories all over India, which are already showing important results and which are likely to be the very basis of India's progress in the future. If we had done nothing else during the last five years but the development of these laboratories, we would have had some reason to take credit for our achievements*" (Cited in Gopal 1979, also see Balakrishnan, 2008, for a discussion of the Indian economy during the Nehru era).

It should be added that though the growth in science and engineering education was initiated in post independent India. its origins date back to the late nineteenth century when the Indian Institute of Science and three major universities were established. The Indian Institute of Science in Bangalore was pioneered and largely financed by Jamsetji Tata (Lala, 2004).

The inward looking industrialisation policies have also yielded other largely unexpected benefits to the post liberalisation economy of India. One such major gain is the contribution of the Indian diaspora resident in the US and the UK to the Indian economy in the form of funds and much more importantly human skills and technology. The relatively large investments in engineering

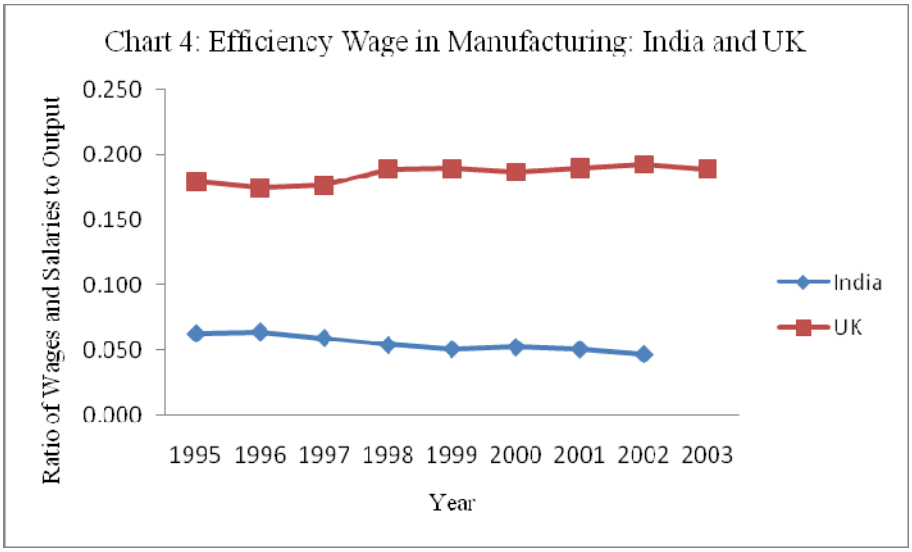
and medical sciences during the pre-liberalisation era produced a stream of engineers and physicians all of whom could not be absorbed by the slow growing Indian economy. Migration to the US and the UK or the brain drain as it was styled is now recognised as having provided a safety valve in the absence of which the educated unemployed may have been a source of strife and tension in the economy. In the post liberalisation era the diaspora, estimated at 1.6 million Indians in the US and around half a million in the UK, have made a major contribution to the growth of the economy, especially so in skill intensive sectors such as software and pharmaceuticals. The funds repatriated to India by its diaspora, estimated at $24 billion in the year 2005-06, have exceeded the volume of foreign direct investment India receives. According to a study on remittances (Guilano and Arranz, 2009) in most developing countries remittances are pro cyclical with a positive link between growth and remittances. India's growth may be a factor in the increased remittances the country has attracted (Chisti, 2007). A large number of the diaspora have returned to their home country attracted by the liberalised economy on a high growth path and some belong to the so called to and fro migrants who visit their home land often on business related trips. There is good reason to argue that the contribution of diaspora investments in the economy may have yielded a relatively high social rate of return (Wei and Balasubramanyam,2006). The diaspora are also a vital link between Indian enterprises and markets abroad.

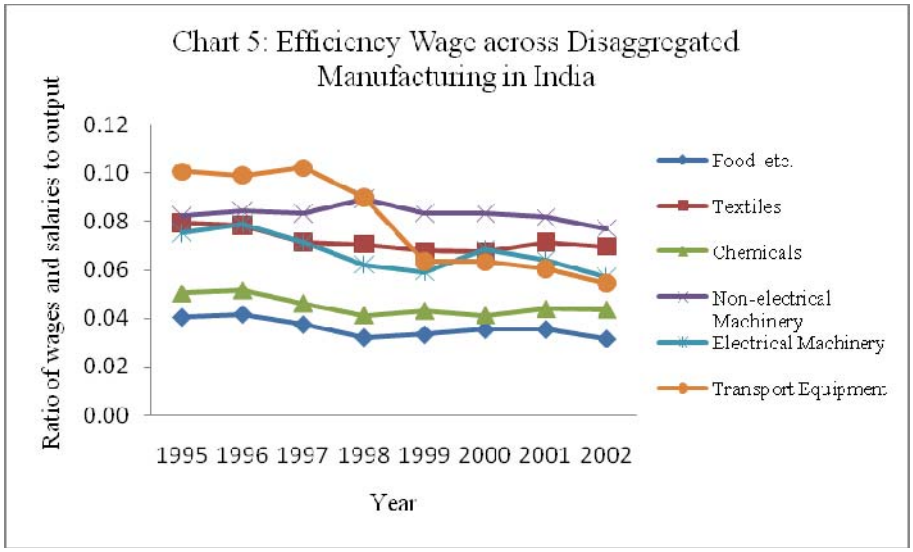
They would be a dependable source of trained and skilled labour for Indian enterprises investing abroad.

The so called ownership advantages, that the theory of international investment suggests is a prerequisite for firms to venture abroad, is mostly resident in the human and technological skills Indian firms posses and these have been acquired over a long period of time. These skills have also enabled Indian firms to adapt and restructure imported technologies much more successfully in the post liberalisation era than in the pre liberalisation era. Indian firms imported technology through technology licensing agreements with foreign firms during the inward looking import substituting industrialisation era. Technology licensing agreements were the preferred option of the government of India for the importation of technology and know how in the pre liberalisation era. But the imported technologies had little impact on the productivity of the Indian firms mostly because in a protected market for their products they had little incentive for restructuring and adapting the technologies (Balasubramanyam 1972). In the post liberalisation era faced with competition from internal and external sources the Indian firms have successfully adapted and restructured the imported technologies (Kathuria, 2007). This ability to adapt and restructure imported technologies seems to be a factor of significance in the ownership advantages possessed by skill intensive industries such as pharmaceuticals. As Chittoor et al(2008)note in a perceptive article based on a

survey of a sample of 118 pharmaceutical firms " 'inward internationalization' of technology inputs is the primary means by which the Indian pharmaceutical firms attempted to build absorptive capacity and play the 'catchup' game with international players". R and D expenditures as a percentage of sales of the firms the authors surveyed had grown by 17% per annum over the period 1996 to 2005, a sizeable figure for Indian firms.

That the Indian firms in most industry groups had cashed in on their endowments of skills when faced with the challenge of competition is amply illustrated by a simple statistical exercise that estimates the efficiency wage for total manufacturing and selected sub groups of the manufacturing sector (Chart 4 and 5Appendix Tables 2- 4)





Estimates of output per unit of wages and salaries (the inverse of the efficiency wage) shows a substantial growth over the years both in the case of the aggregate manufacturing sector and the sub sectors listed in the Appendix Table 4. For purposes of comparison the inverse of the efficiency wage is estimated for both Indian and the UK industries in PPP dollars. These data show that the output per unit of wage has not only grown much faster in India compared with that in the UK but the magnitudes of the estimated productivity .measure is more than three times higher in India than in the UK. Admittedly the absolute level of wages are much higher in the UK than in India, but that which is impressive is the growth in productivity of the Indian manufacturing sector as a whole and that of the individual industry groups over the years. It is also noteworthy that the wage bill has increased in India but the growth of output has outpaced the growth of the wage bill resulting in a relatively low

efficiency wage over the years. This growth in productivity is the result of a combination of factors including imported know how embodied in imported equipment, increased domestic Rand D expenditures and increased capacity utilisation, growth in X efficiency and the relatively high capital intensity of Indian industry in general, a consequence of the distorted factor prices in existence in the past.

This growth in productive efficiency along with managerial skills of Indian entrepreneurs is a factor of significance in the growth of outward FDI from India. Pradhan's (2004) econometric analysis of India's outward FDI suggests as much. The essential point though is that the reforms of 1991 unleashed the pent up entrepreneurial and managerial skills in the promotion of productive efficiency. This was not the case in the earlier era because of the absence of competition that dulled the entrepreneurial instincts of Indian entrepreneurs.

Apart from the animal spirits of Indian entrepreneurs, the desire to acquire new technologies and know how is also a factor in the decision to invest abroad on the part of Indian firms. As stated by several commentators including Pradhan (2008) and Kumar (2008), outward FDI from India is of the asset seeking variety, though search for markets is also an objective. Acquisitions of foreign firms or brown investments as opposed to green field investments, as Pradhan refers to them, have been motivated by the desire to capture technology and knowhow resident in the foreign firms that are acquired. This method of

acquiring technology and knowhow may be much more effective, both in terms of costs and the utilisation of technology, than through other means such as licensing agreements, as we have argued elsewhere (Forsans and Balasubramanyam 2009). An apt analogy here would be between renting a house (licensing agreements) and purchasing a house albeit with borrowed money (acquisitions). Here again it is worth emphasising that the so called brown investments are likely to succeed in their objective provided the acquirer firms are also endowed with skills and know how complementary, though not equally efficient, to those possessed by the firms they acquire. Indian firms for the reasons stated earlier appear to be uniquely qualified on this score. It may not be amiss to say that the objective of Indian investments abroad was one of assets augmenting and not just assets seeking. It is these features of Indian investments in developed countries that set them apart from investments from other emerging economies.

It is of some interest that the Late John Dunning in his seminal book on American Investments in the UK (1958, 1994) argues that US investments in the UK were of the assets seeking variety, most US investments were brown investments and the productivity of the investor firms were not only higher than that of other US firms but also higher than that of the firms they had acquired. Indian investments, as shown earlier, display most of these characteristics noted by Dunning in the case of |US investments in the UK. It should be added that

both India and the US share other characteristics too; English is the lingua of business in both countries and both countries possess a culture of science and engineering cultivated by their renowned universities and science establishments.

India's software sector that has contributed more than $30 billion to India's exports in recent years and is a major player in India's outward investments (AppendixTable-1) is in a class of its own. State support for infrastructure including the establishment of technology parks and fiscal concessions for exports of the sector are a factor in the impressive growth performance of the sector. The sector owes its birth and growth to a combination of state support, a steady stream of trained graduates from the several engineering colleges in most states of India, the contribution of skills, market intelligence and investments by India's diaspora in the USA, and the entrepreneurial zeal of Indian entrepreneurs such as Narayana Murthy and Premji, founding members of INFOSYS and WIPRO, two of the leading Indian software firms. This combination of factors that have promoted the software sector is unique to India.

The software sector seems to be peculiarly suited for the cultural traits of most Indians, who prefer desk bound jobs as opposed to those that require them to work with machines and tools on the shop floor. Also establishment of software firms does not entail heavy fixed costs, hardware or computers being

the most essential inputs. It is often said that India's software sector and Indian universities have not achieved the sort of collaboration that US firms have established with US universities such as Stanford. Admittedly so; but Indian Universities do supply a steady stream of young engineering graduates who can be easily trained on the job. In fact, much of the skills of the software trade are learned on the job. Again not all Indian universities are institutions of excellence, a claim that can be justified only in the case of the Indian Institutes of Technology and a few other colleges of engineering. Software though does not require high calibre graduates, its demand is for ones that have an aptitude for the trade and are young and easily trainable. Thanks to the age profile of India's population, more than 65%of the population is in the age group of 15 to 65, and earlier investments in engineering education the sector has access to a pool of young engineers who are easily trainable.

It is the combination of state support, diaspora connections and India's comparative advantage in software grounded in its endowments of young trainable engineers and a culture bound preference for the sort of desk work that software requires that account for India's outward investments in software. These and other factors that account for India's outward investments in manufacturing and services are unique to India. It is thus the high proportion of India's investments in technology and human skills intensive industries and services in the developed countries.

IV What's In It for Us?

Overseas investments are influenced by a variety of motives including search for new markets, lure of low cost labour and access to tried and tested technology and knowhow. Search for markets and technology and knowhow is reported to be the most significant of these motives underlying India's overseas investments. These objectives seem to be intermingled in most investments. Thus Tata's acquisition of Jaguar cars and Land Rover vehicles in the UK provides it with an access to European markets, Tatas are also able to benefit from the managerial know how and production technology resident in the vehicles company they have acquired. Press reports suggest that Tatas have not reorganised the management of the acquired company in a major way, they are content to own the knowhow and technology. This though could be a viable stratregy in the case of Tatas because of their long established presence in the vehicles industry in India, experienced Indian managers from Tatas are able to oversee and shape the management as required. The knowhow and technology of the Indian firm in this case complements that of the acquired firm. This complementarity along with the established reputation of the Jaguar and Land Rover brands also enables Tatas to exploit the Indian market for these vehicles. This they have begun to do with the opening of a showroom for Jaguar and Land Rover in Bombay just this year.

It is also to be added, that in addition to the usual motives for overseas investments, long established firms such as Tatas appear to regard overseas presence as essential to withstand and benefit from global competition. Press reports on the reaction of the managers to the heavy costs imposed by the credit crunch suggest as much. The short term costs of the unforeseen crunch may be heavy, but that may be a price to be paid for the long term benefits.

The major gain to be reaped from overseas investments for Indian firms though is the access to technology and knowhow. It should be emphasised that the Indian firms that venture abroad are mostly in human skills intensive industries such as pharmaceuticals and software along with technology intensive industries such as automobiles and automobile parts and components. The technology and know how they acquire from their investments, as said, earlier are complementary to the skills they possess. Again, as said earlier, Indian managers and technicians are, as it were, reborn in the post liberalisation era are able to reap synergies from the wider pool of technology and knowhow resulting from overseas investments.

This expanded pool of technology and knowhow may have had a twofold impact on Indian firms. It can increase the productivity of the domestic producing units either through technological progress or through increased technical efficiency. The utilisation of known and existing technology much more effectively than before is referred to as technical efficiency or allocative

efficiency and the introduction of new technologies that shifts the production frontier outwards is referred to as technological progress (Nishimuzu and Page, 1982, Sindhu and Balasubramanyam,2006) In the case of human skill intensive industries such as software India's outward FDI may be a major factor in increasing productivity of domestic software firms in India. Outward FDI in software can impart efficient management practices including methods of organisation and marketing to Indian firms through the to and fro movement of India's diaspora that work for Indian firms abroad. Here again the complementarity between Indian investors and the firms they establish abroad(green field) or those that they acquire(brown filed) is a factor of importance, especially so because of the significant presence of India's diaspora, with cultural affinity to Indian labour, in the firms abroad. In the case of human capital intensive industries such as software and pharmaceuticals growth in efficiency with existing techniques of production would be the prime contributor to productivity growth. This is clearly seen in the estimates of productive efficiency using the Malmquist productivity estimates (see appendix 6.7.8and9) that decomposes growth in productivity into that due to technological progress and that due to technical efficiency (allocative efficiency)

In the case of manufacturing industries such as engineering industries technological progress can be expected to be greater than efficiency change.

This is because technology embodied in machinery and equipment and superior raw materials could be expected to contribute much more to productivity growth than technical efficiency in these *relatively* low human capital intensive industries. The estimated Malmquist indices in the case of automobile and ancillaries suggest as much (appendix table-9) Overseas investments could be a major source of such technology and knowhow embodied in machinery and equipment. It could also provide the sort of skills needed to produce the relevant equipment at home

Besides the impact on productivity overseas investments could also promote exports of goods in the relevant categories of manufacturing industries, an outcome identified by several statistical studies on FDI (Blomstrom et al,1988). Pradhan (2008) provides statistical evidence to show that in most Indian industry categories with overseas investments, exports had increased. One explanation for this observed complementarity between overseas FDI and exports is that firms investing abroad would import raw materials and components from home based sources. This could be so because of the relatively low cost sources of materials and components in developing countries such as India, a factor that has induced foreign firms to outsource the production of components to these countries. Other reasons for the complementarity between overseas investments and exports include market segmentation and avoidance of trade restrictions. Exports may consist of standardised products

destined for the mass markets, whilst overseas production may be for the richer income groups that demand differentiated products. Production of the latter would require proximity of the producer to the consumers to facilitate marketing. Overseas FDI may also provide Indian firms access to markets to countries in the European Union. Indian firms located in say the UK may import products from home and re -export them, with minor modifications, to other European Union markets taking advantage of the absence of restrictions on trade between members of the European Union. This sort of a trade oriented overseas investments though may attract restrictions such as local content requirements. The presence of successful Indian firms with reputable brands in overseas markets may promote the image of products and services manufactured in India in general. It is also likely that overseas investments will generate intra-industry trade, especially so in consumer goods. Indians firms located abroad may cater to the demand for differentiated products produced abroad and firms located in India may service markets abroad for goods with distinctively Indian characteristics.

In sum overseas investments confer a wide variety of benefits on the Indian economy including access to technology and know- how, access to export markets and broadening of consumer horizons.

The gains to the host countries from inward FDI have been the subject of a huge literature. India's investments in the developed countries though may

confer specific kinds of benefits on them not generally recognised in the literature. It provides the sort of human resources- especially engineering and science oriented resources much in demand in the developed countries. As is well known, the demand for science and engineering based higher education in the UK is on the wane, with entrants to Universities opting for finance and management courses. India with its relatively elastic supply of science and engineering graduates can fill this gap. Indian firms abroad can also provide the sort of employment desired by prospective immigrants to the UK. Although a highly controversial topic, immigration of educated Indians into the UK is regarded by some as a solution to the growing problem of demographic dependency or the growth in the proportion of people aged above 60 years. Also Indian firms abroad can be a source of employment for India's diaspora, specifically the second and third generation people of Indian origin. Indeed, as stated earlier one of the factors promoting India's overseas investments may be the presence of the sizeable diaspora both in the US and the UK. It is worth noting here that in both countries overseas students and the diaspora are reported to account for a sizeable proportion of those reading for engineering and science degrees, so much so that the returns to these degrees have declined dissuading the local citizens from science and engineering education (Bound etal 2009). Besides these sorts of benefits Indian firms abroad can also supply

local markets with relatively inexpensive goods, as is the case with pharmaceuticals and food products.

V Conclusions

This paper has analysed the factors that have promoted the growth of India's overseas investments in recent years and its benefits for India and the home countries. The analysis, based on the extant literature on the topic, attempts to identify the specific factors that explain the relatively high proportion of India's investments in the technology and skill intensive industries in the developed countries. The paper attributes the phenomenon to the unique features of the Indian economy grounded in its education policies, its cultural links with the developed countries and the confluence of trade, investments and labour flows. Several of the propositions in the paper though await statistical verification.

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Appendix Table 1

Table 4 Sector-wise distribution of outward foreign direct investment (FDI) from India ($ million)

	Pre-1990	1991–1995	1996–2000	2001–2004
Extractive	**4.04**	**1.53**	**59.61**	**979.42**
Share in total (%)	(1.82)	(0.21)	(1.71)	(20.86)
Exploration and refining of oil	0.02	1.52	59.58	913
Exploration of minerals and precious stones	4.02	0.01	0.03	66.42
Manufacturing	**145.22**	**406.2**	**1 224.96**	**2 647.6**
Share in total (%)	(65.28)	(55.38)	(35.19)	(56.39)
Oilseeds, food products, and processing	9.06	31.94	37.38	62.08
Textiles and garments	9	44.84	67.71	27.94
Wood, pulp, and paper	11.51	0.7	17.02	1.77
Leather, shoes, and carpets	20.55	11.45	16.95	6.74
Chemicals, petrochemicals, and paints	7.82	52.95	39.17	2 114.2
Drugs and pharmaceuticals	4.72	54.48	168.1	223.32
Rubber, plastic, and tyres	2.32	2.84	82.95	25.34
Cement, glass, and building material	4.19	27.47	52.31	2.84
Metals	16.17	14.38	36.29	43.12
Electrical and electronic equipment	2.11	6.42	84.44	16.39
Automobiles and parts thereof	3.21	2.93	21.07	59.05
Gems and jewelry	0	6.25	11.59	14.62
Electronic goods and consumer durables	0.27	8.82	11.93	4.98
Beverages and tobacco	3.24	17.61	124.43	16.05
Engineering goods and industrial machines	8.53	13.35	52.86	8.33
Fertilizers, pesticides and seeds	39.93	32.87	294.09	3.68
Miscellaneous	2.59	76.89	106.68	17.15
Services	**73.2**	**325.77**	**2 196.4**	**1 068.24**
Share in total (%)	(32.91)	(44.41)	(63.10)	(22.75)
Information technology, communication, and software	5.64	120.84	1233.54	746.46
Hotels, restaurants, and tourism	24.96	52.88	59.56	16.1
Civil contracting and engineering services	1.8	2.45	14.12	14.7
Consultancy	0.43	1.53	6.53	2.8
Trading and marketing	12.47	90.89	5.56	3.11
Media broadcasting and publishing	0.01	0.5	739.13	77.12
Financial services and leasing	26.32	37.92	57.56	125.95
Transport services	0.55	11.17	37.16	61.21
Other professional services	1.05	7.6	43.08	20.79
Total	**222.45**	**733.5**	**3 480.98**	**4 695.26**

Source: Research and Information System for Developing Countries database.

Appendix Table 2

Ratio of output-to-wages in Aggregate Manufacturing: Comparison between India and UK

Year	Ratio of Output to Wages		Growth of Manufacturing Wages (%)		Growth of Manufacturing Output (%)	
	India	UK	India	UK	India	UK
1995	15.941	5.580				
1996	15.611	5.716	0.71	1.59	-1.37	4.06
1997	16.856	5.667	4.99	5.25	13.36	4.36
1998	18.455	5.290	-13.81	3.45	-5.64	-3.42
1999	19.595	5.287	10.41	0.29	17.23	0.24
2000	19.031	5.364	5.39	0.14	2.35	1.60
2001	19.629	5.274	-1.31	0.13	1.79	-1.54
2002	21.359	5.192	6.62	-1.01	16.02	-2.56
2003		5.291		-2.42		-0.55
Average	18.31	5.41	1.86	0.93	6.25	0.27

Appendix Table 3

Ratio of output-to-wages in Disaggregated Manufacturing: India and UK

	Food & Bev.	Textiles	Leather Manuf.	Chemicals	Non-metal Min.Prod	Metal Prod	Non-elect. Mach.	Elect. Mach	Transp Eq.
India									
1995	24.62	12.60	16.49	19.82	16.01	12.87	12.15	13.26	9.93
1996	23.93	12.75	16.77	19.30	15.31	12.12	11.85	12.67	10.10
1997	26.61	14.00	19.49	21.63	15.46	13.56	11.96	14.02	9.79
1998	30.92	14.15	20.53	24.22	16.28	14.03	11.19	16.07	11.12
1999	29.82	14.75	19.54	23.19	18.16	12.60	11.97	16.89	15.71
2000	28.11	14.82	19.91	24.22	16.33	11.92	11.98	14.56	15.80
2001	28.04	14.00	19.84	22.80	16.33	12.79	12.23	15.64	16.52
2002	31.50	14.36	18.17	22.92	14.28	13.25	12.96	17.53	18.35
2003									
Avg.	27.94	13.93	18.84	22.26	16.02	12.89	12.04	15.08	13.42
UK									
1995	8.74	4.24	3.69	6.63	4.29	4.54	4.36	5.37	5.42
1996	8.95	4.18	4.92	6.83	4.24	4.49	4.51	5.57	5.84
1997	8.37	4.10	4.50	6.99	4.24	4.35	4.32	5.67	6.22
1998	7.87	3.88	4.35	6.08	4.09	4.14	4.12	5.28	5.81
1999	7.45	4.00	5.05	6.00	4.24	3.91	3.99	5.46	5.82

2000	7.44	4.05	5.24	6.30	4.26	3.97	4.01	5.49	5.75
2001	7.44	4.27	5.49	6.15	4.12	4.03	3.95	5.03	5.71
2002	7.37	4.22	5.60	5.88	4.41	3.98	3.97	4.70	5.69
2003	7.46	4.46	4.92	6.25	4.52	3.98	4.05	4.65	5.78
Avg.	7.90	4.16	4.86	6.34	4.27	4.15	4.14	5.25	5.78

Appendix Table 4

Growth in Wages across Disaggregated Manufacturing in India (in %)

	Food & Bev	Textiles	Leather Manuf	Chemicals	Non-metal Min Prod	Metal Prod	Non-elect. Mach	Elect. Mach	Transp. Equip.
1996	8.97	-2.76	-2.74	1.27	5.80	4.77	5.42	-6.22	2.54
1997	-1.11	8.09	4.37	10.23	3.44	3.17	-5.94	10.40	3.72
1998	-3.20	-16.70	1.11	-9.50	-16.55	-5.52	5.45	-17.94	-43.08
1999	14.04	7.86	13.93	21.72	24.80	10.77	-0.98	2.17	14.65
2000	3.59	7.17	14.28	-1.65	7.35	16.61	1.89	11.81	-3.93
2001	0.86	-6.90	3.83	0.75	1.11	-10.01	0.74	-7.02	-0.56
2002	3.48	6.07	5.89	4.59	19.86	10.91	-0.50	12.95	12.03
Average	3.80	0.40	5.81	3.92	6.54	4.39	0.87	0.88	-2.09

Appendix 5

The Malmquist Productivity Index

The Malmquist productivity index decomposes total factor productivity into two components: technological change: an indicator of the distance covered by the efficient frontier from one period to another due to innovation or technological improvements, and efficiency change, which reflects the ability of a firm to obtain maximum output from a given set of inputs due to learning by doing, improved methods of organisation- that can all be broadly defined as X-efficiency. In addition, unlike the conventional growth accounting method of estimating TFP, the index does not require the assumption of efficient allocation of resources, instead defines the 'best-practice' or the efficient production technology (frontier) generated by the sample against which each observation is measured.

Following Färe et al (1994), the Malmquist (output oriented) TFP index between period t (the base period) and period t + 1 is given by:

$$M_o(x^{t+1}, y^{t+1}, x^t, y^t) = \left[\left(\frac{D^t(x^{t+1}, y^{t+1})}{D^t(x^t, y^t)} \right) \left(\frac{D^{t+1}(x^{t+1}, y^{t+1})}{D^{t+1}(x^t, y^t)} \right) \right]^{1/2} \text{.....(2)}$$

Where, *D* represents the distance function. *x* and *y* denote input and output respectively, and the value of M_o is the Malmquist productivity index. In equation (2) productivity growth is the geometric mean of the two Malmquist indices where the first index is evaluated with respect to technology in period t and the second with respect to technology in period t+1. A value of M_o greater than one will indicate positive TFP growth from period t to period t+1, while a value of less than one will indicate decline in the growth of productivity and a value equal to one indicates no productivity change.

Alternatively, the productivity index can be written as:

$$M_{t,t+1}(y^t, y^{t+1}, x^t, x^{t+1}) = \underbrace{\frac{D^{t+1}(y^{t+1}, x^{t+1})}{D^t(y^t, x^t)}}_{Efficiency\,Change} \underbrace{\left[\frac{D^t(y^t, x^t)}{D^{t+1}(y^t, x^t)} \times \frac{D^t(y^{t+1}, x^{t+1})}{D^{t+1}(y^{t+1}, x^{t+1})}\right]^{1/2}}_{Techno\,\log ical\,Change}$$

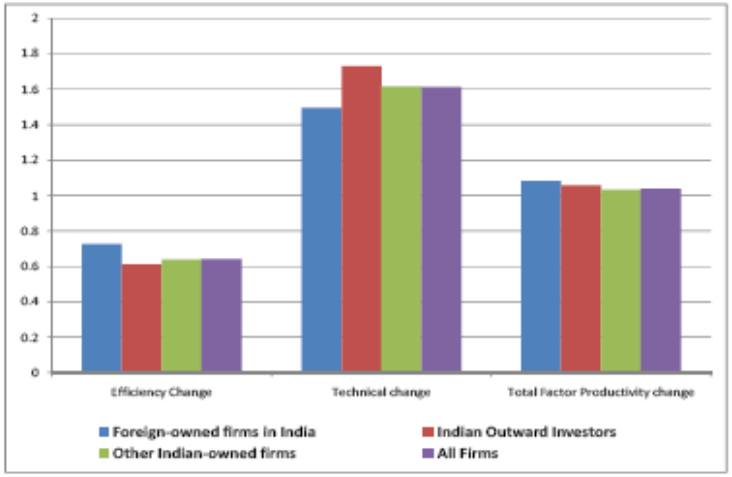
The ratio outside the square bracket measures the change in output oriented measure of technical efficiency specified by Farrell (1957) between period t and t + 1 (i.e., the distance by which the observed variable is away from the frontier). The geometric mean of the two ratios inside the brackets measures the shift in technology between two time- periods evaluated at x^t and x^{t+1}. If the

efficiency change is greater than or less than one, then the observation is moving closer or diverging from the production frontier. Similarly, if the technological change component is greater than, equal to or less than one then the technological practice is improving, remains unchanged or declines.

The Malmquist productivity indices can be estimated by using Data Envelopment Analysis (DEA) techniques such as linear programming methods (for details see Färe et al, 1994). Our estimates of the Malmquist index for software, drugs and pharmaceuticals and automobiles and ancillaries the organised Indian manufacturing for the period 2003-2006 is estimated using DEAP computer program that follows the DEA analysis (Coelli, Rao and Battase, 1998). The procedure assumes that the production function governing the industries is subject to constant return

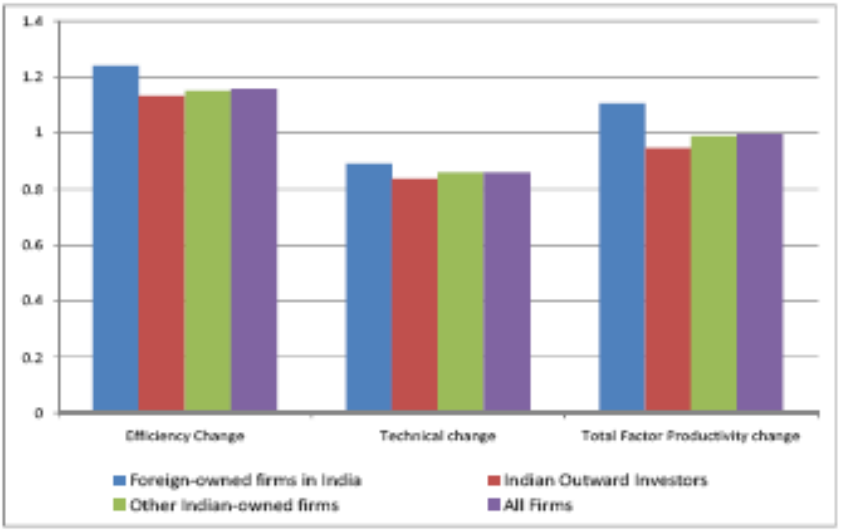
Appendix 6

(a) Automobile Ancillaries



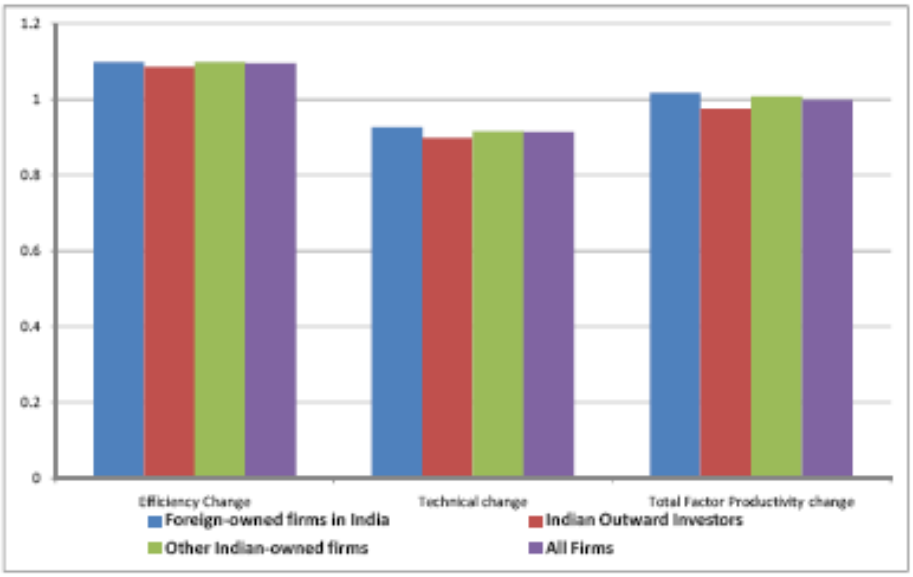
Appendix 7

(b) Drugs and Pharmaceuticals



Appendix 8

(c) Software



Appendix 9

(a) Automobile Ancillaries

Firm type	Efficiency Change	Technical change	TFP change
Foreign-owned firms in India	0.72760816	1.518382971	1.104701565
Indian Outward Investors	0.617630365	1.702311603	1.051747314
Other Indian-owned firms	0.638069283	1.613667584	1.029700016
All Firms	0.642715327	1.612144177	1.036225166

(b) Drugs & Pharmaceuticals

Firm type	Efficiency Change	Technical change	TFP change
Foreign-owned firms in India	1.161924367	0.885395521	1.029062208
Indian Outward Investors	1.152677651	0.840465775	0.968768082
Other Indian-owned firms	1.151846225	0.857564426	0.987869291
All Firms	1.153127481	0.8593987	0.991098766

(c) Software

Firm type	Efficiency Change	Technical change	TFP change
Foreign-owned firms in India	1.098086916	0.925424797	1.0162348
Indian Outward Investors	1.08505083	0.898233139	0.974678666
Other Indian-owned firms	1.098469887	0.915895505	1.00604339
All Firms	1.094535184	0.912200894	0.99843391