The 4th ASIALICS International Conference

'Making Innovation Work for Society: Experiences from Asia'

22-24 July, 2007
Kuala Lumpur, Malaysia

The Making of the Indian National Innovation Systems: Lessons on the specific characteristics of the domestic and the external co-evolutions of technologies, institutions and incentives.

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Abstract

India is one of the few large economies that have functioning national systems of innovation. It has followed largely a period when self-reliance and selective and guided intervention in the world economy prevailed until the early 1990s when liberalisation of the economy took off. Its economy now is growing at a nearly 8 % of GDP and is seen as an emerging economy on a par with China. The policy makers in India have asked: can India become a developed country by 2020? (see Kalam, 1998). India has tried to apply science and technology to industrialise agriculture and build a modern economy. To this day despite the splendid achievements, India has not escaped from underdevelopment, poverty and inequalities. The specification of the peculiarities and characteristics of India's system of innovation by taking various indicators is critical to undertake.

India's strategy for building its national system of innovation has borne always a dualistic and lopsided feature in terms of priorities for science and technology selection and foresight, policies for supporting science, technology and innovation, creating institutions and their linkages, knowledge and learning, capability and training, diffusion and incentives. Despite its significant achievements in areas such as building strong industrial and R & D base, establishing a large number of science and technology institutions, and creating large pool of scientists and engineers, the Indian national innovation system has been criticised for its low quality manufactured good, and inability to eradicate poverty.

Key issues taken up for this paper are:

- What is the effort of India to create an efficient national system of innovation?
- Can India's system of innovation catapult it to a developed nation status in the next fifteen to twenty years?

We would like to confront the challenges and opportunities for India to evolve a national system of innovation, economy and production capable of overcoming poverty and forging an industrial economy. We would undertake the weaknesses, strengths, opportunities and threats in the existing system with a view to creating a system of innovation with the capacity to deal with the adverse consequences and impacts from the world economy.

1. Introduction

"…we must take science to the people. All of us are fond of quoting Pandit Jawaharlal Nehru's famous words… that 'Scientists are a minority in league with the future'. This is true. But let us also remember that a bright future can be realized only when science is in league with the majority of our society."

- Atal Bihari Vajpayee, Then Prime Minister of India (in Science and Technology Policy 2003)

The ability of a nation to deploy its institutions, use resources, put in place incentives and sanctions, and implement policies is related to what is normally described as a functioning national innovation system. Over the last 50 years, India has gone through several phases of building its national

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economy by placing science and technology as major drivers of its national economic development. Its economy has gone through two broadly discernable phases: a) self-reliance, b) and liberalisation. Consequently, the national innovation system of India has passed through the self-reliant phase and is now fully in the period of liberalisation.

Since India started liberalization of its economy in the early 1990s, there has been growing interest, particularly since the late 1990s, on developments in the Indian economy. Main focus seems to be on the evolution of the Indian national innovation system (NIS) and the impact of liberalization policies on various aspects of the economy such as rate of economic growth, FDI flow, and R&D investment by foreign companies, and so on. Expectations are high both within and outside India that India could emerge with a strong economy comparable to the developed world. There is now a global interest on the rise of China and India in the world economy prompting analysts to conjecture a 'Chindia effect' on the world economy. In a book by the Oxford Economist Andrew Glyn entitled, *Capitalism Unleashed* (2006), world manufacture is said to migrate to India and China employing the huge labour force in both these continental economies and transforming them into the "workshops of the world".

For their part Indian policy makers believe that India is poised to make a historic transition from a developing economy into a fully developed economy. They think this status can be achieved if the rate of economic growth that India has now above 8 % is maintained until and up to the year 2020. This paper intends to examine whether the Indian national innovation system and the elements that need to come together are in place in order to promote and achieve this national objective. We would like to keep the global context in mind and explain the complex trajectories and developments of the Indian economy. We shall analyse various aspects of Indian national innovation and production system to unravel its strengths and weaknesses, and evaluate the realise-ability of the ambition to make India a fully developed self-reliant economy.

Although there is considerable literature on some individual elements or aspects of the national innovation system in India such as science and technology policy, case studies of particular industrial sectors such as manufacturing, automobiles, ICT, and education/human resources development, and above all the literature analysing the overall national innovation system in India is rather limited. There is no comprehensive and readily accessible work that critically analyses the national innovation system and production in India. This paper attempts to capture this with an overview of the existing literature.

2. Indian National System of Innovation: Overview

Particularly since India started liberalization in 1991, there has been growing interest, particularly since the late 1990s, on developments in the Indian economy. Although there is considerable literature on individual elements or aspects of the national innovation system in India, the literature analysing the overall national innovation system in India is limited. The existing literature can be categorised as following: (i) *Evolution/ Conceptualisation of Indian NIS* (e.g. Baskaran and Muchie 2003; Baskaran 2000, 2005; Mashelkar 2001; Krishnan 2002); (ii) *Policy* (e.g. Mascarenhas 1982; and Cooper 1988, Bhojani 1985); (iii) *Competitiveness and Growth* (e.g. Rodrik and Subramanian 2004; Panagariya 2004; Poddar 2004); (iv) *Sector Specific Innovation Studies* (e.g. automobile sector: Parhi 2005; Chakrabarty et al. 2003; manufacturing sector: Topalova 2004a; Unel 2003; agricultural innovation: Hall et al. 1999); and service sector: Gordon and Gupta 2004); (v) *Infrastructure* (e.g. Subrahmanian 1990; Eisemon 1984; Jain 2002).

In this paper we attempt to capture broader developments in the Indian NSI particularly since the liberalisation in 1991-92 – both negative and positive developments. We discuss selected major developments and issues and try to outline the challenges faced by the Indian NSI.

Broadly, a national innovation system has the following major elements: (i) Investment (R&D Expenditure and Government R&D Support, Venture Capital, and FDI); (ii) Infrastructure (Science & Technology institutions, Intellectual Property Rights, Government Policy, ICT, and Culture); (iii) Knowledge and skills generation (Education and Human Resources development, and Labour Flexibility); (iv) Relations and Linkages (University-Industry Linkages, Public R&D and Industry, Globalisation of MNC R&D, Transnational Networks). Figure 1 illustrates these. We will employ this conceptual framework to analyse the Indian NIS.

Figure 1: Major Elements of National Innovation System

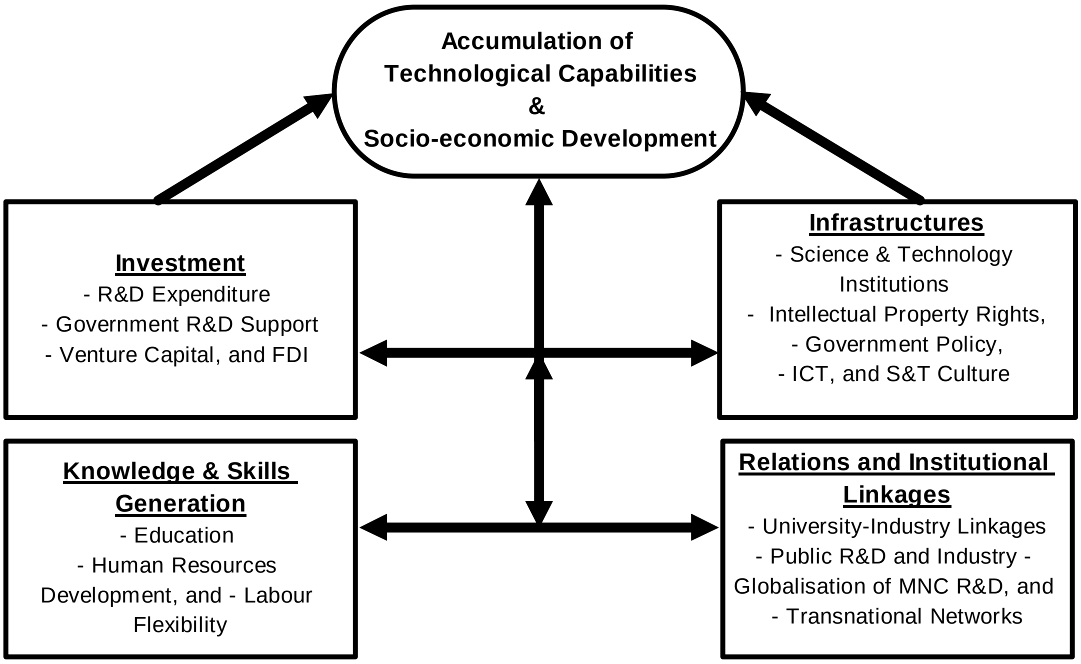
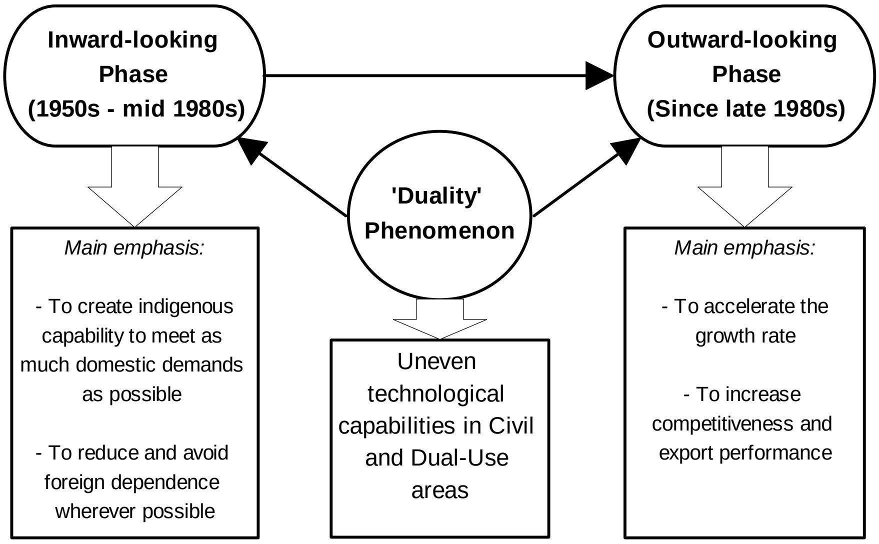


Figure 2 illustrates the three major features of the evolution of Indian national innovation system: (i) Inward looking Phase I; (ii) Outward looking Phase II; and (iii) the phenomenon of 'duality'.

Phase I (1950s-mid 1980s): Inward Looking NSI

Indian national innovation system that evolved between 1950s and mid-1980s was driven by two major factors; (i) 'blind faith' in science and technology; and (ii) an inward-looking policy of 'self-reliance'. The principal policy objective behind India's industrialisation effort has been 'self-reliance'. Jawaharlal Nehru, Then Prime Minister, said that India could not be economically or politically independent unless it strengthened its scientific and technological capacity (Eisemon, 1984, p. 269). Indian leaders feared the domination and influence of foreign firms if free and unrestricted entry were allowed. Therefore, India's 'self-reliance' policy was defensive and inward looking rather than outward looking. India aimed to create local technological capabilities to meet mainly the domestic demands and reduce foreign dependency rather than developing an industry that should be competitive in the global market. This fundamental factor determined the shape and efficiency of Indian innovation system in Phase I. To achieve self-reliance, India implemented a number of measures such as industrial policy clearly defining the roles of private and public sectors, regulation of private investment through industrial licensing, regulation of foreign private investments, and regulation of technology imports to encourage indigenous research and development (Mascarenhas, 1982, p.4). This led to the development of indigenous R&D capabilities and local machine tools and industrial equipment suppliers as little or no technical assistance was received from foreign technology suppliers (Cooper, 1988, p.117).

Figure 2: Three Major Features of Indian National Innovation System



There were two major developments in the industrial sector. On the positive side, India has developed relatively a high level of indigenous technological capabilities to design and operate plants in number areas of capital and intermediate goods sectors. On the negative side, Indian firms hardly made major innovations to their products to establish a significant and sustainable export market. They mainly produced cheap and reliable products for the domestic market and a number of firms started in-house R&D to develop such products by adapting imported technology. By the early 1970s, most of the public R&D institutions made effort to catch up with research in the developed countries and conducted research at the frontier level. Although they produced scientific knowledge and created a strong basic research base, often they did not contribute directly to help solve socio-economic problems of the country (Mascarenhas, 1982, p.2). The government's attempt to force firms to buy technology from public R&D institutions was given up in 1975 and by the early 1980s India started liberalising its policies towards import of 'new technology'.

Phase II (Since late 1980s): Outward Looking NSI

By the mid 1980s dissatisfaction with the performance of the economy started a shift towards an outward-looking national innovation system to achieve competitiveness and higher growth. This shift became clear when the industrial policy liberalisation was announced in 1991 that led to major changes in the areas such as industrial licensing, foreign investment, foreign technology agreements, public sector and Monopolies and Restrictive Trade Practices Act. This marked a clear shift from import regulating activity to export promotion activity.

The liberalisation of policy regime has had a significant impact on the performance of Indian NSI. The foreign technology import, manufacturing operations, and investment have increased since the 1990s (Goldar and Renganathan, 1998; Kumar and Agarwal, 2000). One of the significant developments is the opening up of R&D centres by MNCs in India and forging of collaborative relationships with Indian S&T institutions. Another development is the outsourcing of operations by foreign companies to India, mainly in the service sector. This seems to be increasing as this helps foreign companies to cut cost and enhance their efficiency, because of high-skilled and highly qualified workforce available in abundance in India (Getty, 2003). The complexity and volume of outsourcing to India seems to be increasing. In the era of 'knowledge economy' it is an important development, as skills are as much valuable as technology and products.

In the area of export and competitiveness, progress appears to be slow in many industrial sectors. However, the IT sector, which emerged in the 1980s and 1990s as a major sector has witnessed significant export growth, particularly in the area of software. There is a general perception that the availability of abundant skilled labour is the main reason for this. The answer is more complex than this. India missed the semiconductor revolution in the 1970s, due to protectionism and inter-departmental turf war (*Commerce* 1983; Khandelwal 1981). India learned valuable lessons and was careful not to repeat the mistake in the 1980s when the computer/IT revolution started. Since early 1980s, that is, long before the major liberalisation in the 1990s, significant policy measures were taken to promote and expand the computer industry. The Computer Policy was announced in 1984 that removed capacity curbs, liberalised the licensing system and import duty to enable economies of scale and increase competitiveness (*Commerc*e, 1984, p. 845). The Electronics Policy 1985 noted that "the software content of electronics is increasing and India is most appropriately placed to take advantage of this" (Bhojani, 1985, p. 807). The computer industry was predominantly left in the private sector and competitive environment was fostered. Soon, hundreds of firms in all sizes emerged. This subsequently appears to have established India as a leading player in the software market in the 1990s. India's success in this sector was mainly due to intensive R&D effort by the companies and the presence of strong basic research capability in the country. The liberalisation of policy regimes in the 1990s has demonstrated the potential of Indian innovation system in achieving a higher rate of growth despite persistent weaknesses of Indian innovation system such as continuing problems in forging closer linkages between R&D institutions and firms.

3. Performance of Indian NSI

India's innovation system often faced criticism because of its inefficiency that led to low rate of growth, its poor export performance, and relatively low quality of manufactured goods. These criticisms, although valid, either ignored or deliberately failed to take into account the context of the evolution of national innovation system in India. Particularly in the first phase, the principal objective of India's economic and S&T policy regimes was creating indigenous capabilities in the industry to meet as much domestic demands as possible, and there by reducing or avoiding undue foreign dependence. Although ritual mentions were made in policy declarations about exporting, it was not the main driver of Indian innovation system in the first phase unlike the case of South Korea or Taiwan. Indian firms failed to export not because they were incapable, but because they "prefer to exploit local markets where they have factor cost and marketing advantages" (Eisemon, 1984, p.272). Despite major flaws, there were significant achievements during the first phase of Indian national innovation systems. These included: (i) creation of S&T infrastructure and the expansion of higher education with great emphasis on basic research; (ii) development of indigenous capability to produce a range of goods which even today many developed countries are not capable of; (iii) implementation of the Green Revolution to achieve self-sufficiency in food grains; and (iv) creation of the scientific and industrial innovative potential to compete at international market.

Over the years, India invested significantly in S&T infrastructure and R&D expenditure. Its R&D investment is comparable not only to developing countries like South Africa and China but also to some developed countries (see Tables 1). This created a vast network of basic S&T institutions and infrastructure that led to significant output in terms of number of engineers, scientists, and technical persons (see Tables 2).

Table 1: Comparison of Goss Domestic Expenditure on R&D (GERD) in US$ billions PPP and R&D intensity (GERD/GDP) between 1990 and 2000

Country	**1990**		**1994**		**1996 - 1997**		**1999 - 2000**	
	GERD (1)	***GERD/GDP (2)***	***(1)***	***(2)***	***(1)***	***(2)***	***(1)***	***(2)***
India	2.5	0.8%	10.1	0.6%	13.2	0.6%	20.0	0.7%
China	12.4	0.8%	23.3	0.7%	21.1	0.6%	50.3	1.0%
Israel	1.8	2.5%	2.4	2.7%	3.4	3.2%	6.1	4.7%
South Africa	2.9	1.0%	1.8	0.6%	2.5	0.7%	3.6	0.8%
Japan	67.0	3.1%	80.0	2.8%	83.1	2.8%	98.2	2.9%
European Union	101.9	2.0%	128.6	1.8%	137.9	1.9%	174.7	1.9%
North America	156.4	2.6%	178.1	2.5%	209.0	2.6%	281.0	2.7%

Source: UNESCO, "A Decade of Investment in Research and Development (R&D): 1999-2000," *UIS Bulletin on Science and Technology Statistics*, Issue No 1, April 2004.

An efficient innovation system is where technological accumulation and progress is also accompanied by higher growth performance of the industrial sector. During Phase I, the industry has witnessed significant growth, although "the overall growth rate remained much below the plan targets and also below the achievements of several newly industrialising countries such as South Korea and Brazil" (Subrahmanian, 1990, p. 205). Initial high growth rate gave way to stagnation since mid-1960s. However, this changed since mid-1980s when India started liberalising its industrial and technology policy regimes. Since then, India's industrial growth has been significant (see Table 3). The relative inefficient performance in Phase I appears to be largely because of rigid policy regimes. The liberalisation in Phase II aimed to accelerate investment, growth, and employment appears to have produced mixed results (both positive and negative).

Table 2: Comparison of Number of Scientists, Engineers, and Technicians (SET) -- Between India and Selected Countries (World-wide)

Country	**Year** *	**All R&D Personnel**	**Research** *Persons*	**Technicians**	**Support Staff**	**Year** **	**Research Persons / million**	**Technicians / million**
India	***1996***	***357 172***	***149 326***	***108 817***	***99 029***	***1994***	***149***	***108***
Argentina	**2000**	37 515	26 420	5 707	5 228	**1995**	660	147
Brazil	**2000**	78 565	55 103	21 914	1 548	**1995**	168	59
Canada	**1998**	139 570	90 200	31 380	19 560	**1993**	2 648	1 070
China	**2000**	922 131	695 062	**---**	**---**	**1995**	347	200
France	**2000**	314 452	160 424	**---**	**---**	**1994**	2 583	2 873
Germany	**1999**	480 415	255 260	110 364	114 415	**1993**	2 843	1 472
Israel	**1997**	13 110	9 161	3 023	926	**1984**	4 828	1 033
Nigeria	**1984**	18 345	1650	9 696	6 999	**1987**	15	76
Republic of Korea	**1999**	137 874	100 210	26 160	11 504	**1994**	2 637	318
Russian Federation	**1999**	989 291	497 030	80 498	411 76	**1997**	3 587	600
South Africa	**1993**	60 464	37 192	11 343	11 929	**1993**	1 031	315
UK	**1998**	**---**	157 662	**---**	**---**	**1993**	2 413	1 017
USA	**1997**	**---**	1 114 100	**---**	**---**	**1993**	3 676	**---**

Source: UNESCO, *Statistical Year Book 1999 and Science and Technology: Personnel Engaged in R&D (1996-2000)*, November 2002.

* Year relates to All R&D personnel, Researchers, Technicians and Support staff columns only.

** Year relates to Research persons / million and Technicians / million

Table 3: India – Trends of Major Macroeconomic Indicators (1990-91—2005-06)

Country	*1970-71*	*1980-81*	*1990-91*	*2000-01*	*2002-03*	*2003-04*	*2004-05*	*2005-06*
1. Growth Rate (%)								
GDP at constant factor cost*	5.0	7.2	5.6	4.4	3.8	8.5	7.5p	9.0q
Index of Industrial Production (Base: 1993-94 = 100)	28.1	43.1	91.6	162.6	176.6	189.0	204.8	221.5
Index of Agricultural Production (Base: triennium ending 1981-82)	85.9	102.1	148.4	165.7	150.4	182.8	176.9	189.3
Exports (in US$ billion)	2.03	8.49	18.14	44.56	52.72	63.84	83.54	103.09
Imports (in US$ billion)	2.16	15.87	24.08	50.54	61.41	78.15	111.52	149.17
Trade Balance (in billions)	- 0.13	-7.38	5.94	-5.98	-8.69	-14.31	-27.98	-46.06
2. Foreign direct investment (FDI) (US$ billion)	--	--	--	6	5	5	6	--
3. Foreign Exchange Reserves (US$ billion) – Excluding gold and SDR	0.58	5.85	2.24	39.55	71.89	107.45	135.57	145.11
4. Debt Indicators								
External Debt to GDP ratio (%)	--	--	28.7	22.4	20.4	17.8	17.3	15.8
Debt service ratio (%)	--	--	35.3	16.2	16.0	15.9	6.0	9.7

Source: Government of India (Ministry of Finance), *Economic Survey 2006-2007; India's External Debt: A Status Report, 2006;* Government of India (Investment Commission), *Investment Strategy for India,* 2006.

* Figures until 1999-2000 are based on 1993-94 prices and figures after that are based on 1999-2000 prices. P = Provisional estimate; Q = Quick estimate

Positive Side of Indian NSI

On the positive side, a number of developments could be identified. These include the significant GDP growth, FDI inflow, technology transfer and global/international R&D, export performance, emergence of ICT sector as one of the leading sector, employment growth and other socio-economic development.

Economic Growth

India's GDP growth has crossed 8 per cent in recent years after fluctuating during the 1990s. The foreign currency reserves also increased from US$1 billion in 1991 to over US$ 145 billion in 2006. The debt service ratio was brought down from 35.3 per cent of current receipts in 1990-91 to less than 10 per cent in 2005-06. The external debt-GDP ratio has improved from 38.7 per cent in 1992 to less than 16 per cent in 2006. While the industrial production has registered significant steady growth between 1991 and 2005, the agriculture production has been inconsistent, although growing. Exports have grown from $18 billion to over $100 billion. However the imports have been out growing the exports leaving a significant negative trade balance (see Table 3). Table 4 shows the principal exports across different sectors. It is evident that the growth of exports of manufactured goods played a major role in the growth of total exports. During the Phase II of Indian NSI, the area that played a major role in export growth is the Indian IT industry; particularly the software sector and IT enabled services (ITES). This clearly evident from Tables 5 and 6.

Table 4: Principal Exports across Sectors (US$ million)

Sector	*1970-71*	*1980-81*	*1990-91*	*2001-02*	*2004-05*	*2005-06*
Agriculture and Allied Products	644	2601	3521	6256	8809	10549
Ores and Minerals	217	523	834	906	4568	5361
Manufactured Goods	1021	4738	13229	35181	62023	74199
Mineral Fuels and Lubricants (Including Coal)	17	35	528	1931	7140	11867
TOTAL EXPORTS (Including Misc. sectors)	**2031**	**8486**	**18143**	**44560**	**83536**	**103091**

Source: Government of India (Ministry of Finance), *Economic Survey 2006-2007*, p. S-84.

Table 5: IT & Electronics Exports 1998-99 to 2003-04 (Rupees in billion)

Sector	**1998-99**	**1999-2000**	**2000-01**	**2001-02**	**2002-03**	**2003-04**
Electronics Hardware	*18.0*	*14.0*	*47.88*	*58*	*56*	*60*
Computer Software	*109.4*	*171.5*	*283.50*	*365*	*461*	*555*
TOTAL	***127.4***	***185.5***	***331.38***	***423***	***517***	***615***

Source: Ministry of Communication & Information Technology (Government of India), *Annual Report 2003-04*, p.16.

Table 6: Indian IT Industry Production and Exports (2002-2003)

ICT Industry	*Production*			*Exports*			
	Value (Rs. b)	**Growth** %	**CAGR** % (5 years)	**Value** (Rs. b)	**Value** (U$ b)	**Growth** %	**CAGR** % (5 years)
IT & Electronics	*974*	*22*	*25*	*531*	*11.2*	*26*	*41*
Of IT & Electronics:							
Hardware	*375*	*15*	*11*	*560*	*1.2*	*-3*	*14*
Software and Services	*599*	*26*	*43*	*475*	*10*	*30*	*49*
ITES (part of Software & Services)	--	--	--	*117*	*2.5*	*65*	--

Source: National Task Force on Information Technology & Software Development (Government of India), *National Background Note for Task Force on HRD in IT*, <http://it-taskforce.nic.in> 1US$ = About Rs. 42

The number of IT firms in India has grown significantly as a result of policy initiatives. For example, the Software Technology Parks of India (STPI) played a major role in the growth of software industry and exports. They acted as 'single-window' in providing services to the software exporters and incubation infrastructure to small and medium enterprises. Over 7,000 units have been registered under STPI, of which 3,520 firms are exporters. These firms have exported software worth of Rs. 465.7b (US$ 10.2b) during 2003-2004, compared to Rs. 371.8b (US$ 7.75b) during 2002-2003. That represents a growth of 25 per cent in rupee terms and 32 per cent in US$. The members of STPI accounted for nearly 80 per cent of the national software exports. These figures suggest that policy measures towards increasing software exports have been largely effective. However, one cannot discount other external factors such as growing global demand and market that could have contributed to the growth of software exports from India. Particularly, the role of Silicon-Valley based Indian scientists and engineers in promoting the Indian IT industry appears to be significant (Saxenian, 2002).

One of the main factors that can contribute to the efficient performance of an NSI is the level of investment in the economy. It generally accepted that to achieve a GDP growth of over 8% p.a., the investment needed is over 32% of GDP. It is clear from Table 7a that for the first time (2004-05) India has crossed this critical mass and this partly explains India's higher GDP growth rate since then. Table 7b highlights India's ambition and determination in maintaining this level of investment consistently in future as well.

Table 7(a): Investment in the Indian Economy (US$ billion)

Investment by	***2001-02***	***2002-03***	***2003-04***	***2004-05***
Public Sector and Others	27	32	45	61
Private Sector	27	29	41	57
Household sector	54	65	72	82
FDI (included above)+	6	5	5	6
Total Investment (GDCF)	110	128	164	209
GDP at Market Prices	494*	524*	600	694
Investment as % of GDP**	22.3%	24.4%	27.2%	30.1%

Source: Government of India (Investment Commission), *Investment Strategy for India,* 2006, p.6.

+ India has set the goal to increase the FDI level to $15 billion by 2007-08
* GDP at market prices for 2001-02 and 2002-03 is at 1993-94 prices (old series)
** For an over 8% p.a. GDP growth, the investment needed is over 32% of GDP

Table 7(b): Investment Goals for Indian Economy (US$ billion)

Investment by	***2006-07***	***2007-08***	***2008-09***	***2009-10***
Domestic Investment	203	242	290	350
FDI	12	15	17	20
Total Investment (Goals)	275	305	340	370
GDP	860	930	1000	1090
Investment as % of GDP**	32.0%	33.0%	34.0%	34.0%

Source: Government of India (Investment Commission), *Investment Strategy for India,* 2006, p.7.

Table 8: Employment in the Public Sector by Industry (in million)

Industry Sector	**1981**	**1991**	**1995**	**2000**	**2001**	**2002**	**2003**	**2004**
Agriculture, Hunting, etc	0.46	0.56	0.54	0.51	0.50	0.48	0.51	0.49
Mining and Quarrying	0.82	1.00	1.02	0.92	0.88	0.86	0.84	1.03
Manufacturing	1.50	1.85	1.76	1.53	1.43	1.35	1.26	1.19
Electricity, Gas and Water	0.68	0.91	0.94	0.95	0.94	0.92	0.91	0.87
Construction	1.09	1.15	1.16	1.09	1.08	1.03	0.95	0.93
Whole Sale and Retail	0.12	0.15	0.16	0.16	0.16	0.16	0.18	0.18
Transport, Storage, Communications	2.71	3.01	3.11	3.08	3.04	3.01	2.94	2.82
Finance, Insurance, Real estates	0.75	1.19	1.28	1.29	1.28	1.23	1.38	1.41
Community, Social and personal services	7.36	9.23	9.50	9.77	9.83	9.74	9.61	9.28
TOTAL	**15.49**	**19.05**	**19.47**	**19.30**	**19.14**	**18.78**	**18.58**	**18.20**

Source: Government of India (Ministry of Finance**),** *Economic Survey 2006-2007,* p. S-49.

Table 9: Employment in the Private Sector by Industry (in million)

Industry Sector	**1981**	**1991**	**1995**	**2000**	**2001**	**2002**	**2003**	**2004**
Agriculture, Hunting, etc	0.86	0.89	0.89	0.90	0.93	0.86	0.90	0.92
Mining and Quarrying	0.13	0.10	0.10	0.08	0.08	0.07	0.07	0.07
Manufacturing	4.55	4.48	4.71	5.09	5.01	4.87	4.74	4.49
Electricity, Gas and Water	0.04	0.04	0.04	0.04	0.05	0.04	0.05	0.05
Construction	0.07	0.07	0.05	0.06	0.06	0.06	0.04	0.05
Whole Sale and Retail	0.28	0.30	0.31	0.33	0.34	0.34	0.36	0.35
Transport, Storage, Communications	0.06	0.05	0.06	0.07	0.08	0.08	0.08	0.08
Finance, Insurance, Real estates	0.20	0.25	0.29	0.36	0.37	0.39	0.43	0.46
Community, Social and personal services	1.22	1.49	1.60	1.72	1.73	1.74	1.76	1.79
TOTAL	**7.41**	**7.67**	**8.05**	**8.65**	**8.65**	**8.45**	**8.43**	**8.26**

Source: Government of India (Ministry of Finance**)**, *Economic Survey 2006-2007,*and p. S-50.

Another indicator for measuring the performance of an NSI is employment generation. Tables 8 and 9 show employment in public and private sectors (and also across different industrial sectors). It is evident that still public sector in India is the major source of employment. That is, over 18 million compared to over 8 million in the private sector (organised sectors). However, the number of employed in public sector since 2001 remains more or less constant around 18 million. Similarly, the total number employed in the private sector since 2001 slightly declined and remained consistently around 8 million. Major industries under the public sector that provide higher level of employment are community and social services, transport and communications, manufacturing, and construction. In the private sector, the main employers are manufacturing, community and social services, and agriculture. What is interesting is the employment in community and social private sector has been increasing steadily, while the employment growth in the private manufacturing sector more or less stays constant around 4.5 million.

Table 10: Growth of IT Professionals/ Employment (1991-2003)

Year	**Number**
1991	*56,000*
1997	*160,000*
2000	*284,000*
2003	*650,000*

Source: NASSCOM (see: http://news.bbc.co.uk/go/pr/fr/-/1/hi/business/4071369.stm)

Since early late 1990s, IT is an area that witnessed rapid growth. Between 1991 and 2003, the employment in the IT grew by ten times (see Table 10). Table 11 shows the employment distribution across different areas of IT industry in 2003. It clearly shows the importance of ITES.

Since the late 1990s, (as shown by Tables 11) another area that witnessed rapid growth in terms of revenue and employment is the business processing outsourcing (BPO). Firms in other countries resort to outsourcing their business operations mainly for two reasons – cost management and increasing complexity of ICT environment. India has emerged as one of the leading destinations for BPO due to location attractiveness and availability of large pool of English speaking skilled workers at low cost.

Table 11: Growth of BPO Sector in India (1999 to 2003)

Year	***1999-2000***	***2000-01***	***2001-02***	***2002-03***
Revenue in Rupees (billion)	*2.4*	*4.25*	*71*	*113*

Source: Ministry of Communications and Information Technology (Government of India),

Task Force on HRD in IT, <http://www.mit.gov.in/eiel/bpoutsoursing.asp>

However, the spread of BPO in India is mainly confined to major cities where basic ICT infrastructure already exists and is being developed further. About 90 per cent of BPO are situated in 9 cities – Ahmedabad, Bangalore, Chennai, Hyderabad, Kochi, Kolkatta, Mumbai, Greater Delhi, and Pune. Most of the BPO services in India are related to medical transcription, call centre, and back office operations. The BPO has registered a significant growth both in terms of revenue and employment between 2001 and 2003. Its revenue grew to US$ 2.3b and it employed over 171,100 skilled people in 2002-03.

We can see that from the nature of growth of BPO in India that benefits of ICT industry such as employment is highly concentrated in some major cities. Policy initiatives to spread ICT to second and third tier cities have not been successful. Also, mostly these cities are concentrated in the Southern and Western India. Clearly, there is a regional imbalance in the way ICT industry has grown over the years.

Growth and Impact of FDI

As part of over all investment in the economy and as the mechanism that facilitates the flow of technology FDI can contribute significantly towards efficient performance of an NSI. A steady and growing market size, abundant availability of natural resources for manufacturing, cost attractiveness, reliable business community, high levels of intellectual manpower, engineering expertise and a reform process that has brought about economic liberalization appear to have made India an attractive destination for foreign investment. The top 10 sources of FDI include Mauritius, US, Japan, Netherlands, UK, and Germany (see Table 12).

Table 12: Country-wise FDI Inflows from August 1991 to December 2005 (US$ million)

Ranking	***Sector***	***FDI inflows***	*% Of Total Inflows*
1	Mauritius	11,115.47	37.25
2	U.S.A.	4,912.75	15.8
3	Japan	2.059.33	6.79
4	Netherlands	1,987.18	6.65
5	U.K.	1,911.77	6.26
6	Germany	1,338.88	4.27
7	Singapore	962.41	3.14
8	France	772.99	2.55
9	South Korea	748.98	2.28
10	Switzerland	613.58	1.98
11	Italy	485.74	1.58
12	Sweden	471.99	1.56
13	Hong Kong	366.11	1.05
14	Australia	154.79	0.51
15	Denmark	156.49	0.51
Total (All countries)		**30,452.54**	**100**

Source: See <http://www.economywatch.com/foreign-direct-investment/countrywise-fdi-inflows.html>

Table 13: FDI Inflows to India (in US$ millions)

Year (April-March)	**Equity**	**Re-invested Earning**	**Other Capital**	**Total FDI Inflows**	**Portfolio Investment including GDR/ADR, FIIs and Offshore Funds**
1991-92	129	--	--	129	4
1992-93	315	--	--	315	244
1993-94	586	--	--	586	3 567
1994-95	1 314	--	--	1 314	3 824
1995-96	2 144	--	--	2 144	2 748
1996-97	2 821	--	--	2 821	3 312
1997-98	3 557	--	--	3 557	1 828
1998-99	2 462	--	--	2 462	(-) 61
1999-2000	2 155	--	--	2 155	3 026
2000-01	2 400	1 350	279	4 029	2 760
2001-02	4 095	1 645	390	6 130	2 021
2002-03	2 764	1 833	438	5 035	979
2003-04	2 387	1 798	488	4 673	11 377
2004-05	3 362	1 816*	357*	5 535	8 909
2005-06 (Up to Sept. 2005)	2 327	465*	63*	2 855	5 106
Total (Aug. 1991 – Sept. 2005)	**32 818**	**8 907**		**43 740**	**34 178**

Source: Reserve Bank of India Bulletin, December 2005 (Table No. 46)
(See <http://dipp.nic.in/fdi_statistics/india_fdi_index.htm)
* Provisional data

Although interest of foreign investors in India is growing substantially, FDI flows are far below than that of other emerging economies such as China. According to IMF the FDI flow has been hindered in India by a difficult investment climate, caps on FDI in certain sectors, and inadequate infrastructure. However, India has established itself as an outsourcing destination and is attracting large financial inflows. For example, in 2004, it accounted for one-fourth of the portfolio flows to emerging Asia (Website E). Table 13 shows the FDI inflow under various categories to India between 1991 and 2005 amounted to over US$ 43 billion, which is very low compared to FDI inflow to China. Wenhui Wei (2005) identified the reasons for the big difference between the flow of FDI to China and India. That is, higher level of FDI flow to China is mainly due to larger domestic market and higher international trade ties with OECD countries and the flow of FDI to India is mainly influenced by cheap skilled labour, lower country risk, and cultural similarities.

Table 14: Sector-wise FDI Inflows from August 1991 to December 2005 (US$ million)

Ranking	*Sector*	*Amount of FDI Inflows*	*% Of Total FDI Inflows*
1	Electrical Equipments (Including computer software & electronics)	4,885.88	16.5
2	Transportation Industry	3,143.09	10.34
3	Services Sector	2,971.66	9.64
4	Telecommunications	2,890.12	9.58
5	Fuel (Power & Oil Refinery)	2,521.49	8.41
6	Chemicals (Other than Fertilizers)	1,889.51	5.86
7	Food Processing Industries	1,173.18	3.67
8	Drugs and Pharmaceuticals	948.54	3.18
9	Cement and Gypsum Products	746.79	2.54
10	Metallurgical Industries	627.32	2.12
Total (Including all sectors)		**30,452.58**	**100**

Source: See <http://www.economywatch.com/foreign-direct-investment/sectorwise-fdi-inflows.html>

Table 14 shows the most attractive sectors for FDI inflow in India. These include Electrical Equipment (including computer software & electronics), Transportation Industry, Services Sector, Telecommunications, Fuel (Power & Oil Refinery), Food Processing Industries, and Drugs and Pharmaceuticals.

Table 15: Number of Cumulative Foreign Technology Collaborations (FTC) Approvals

Period	**Number of FTC Approvals**
August 1991 to September 2005	7 723
April 2004 to March 2005	90
April 2005 to September 2005	41

Source: See <http://dipp.nic.in/fdi_statistics/india_fdi_index.htm>

Tables 15 and 16 show the foreign technology transfer collaboration approvals in India between 1991 and 2005 amounted to 7 723. Although this is very significant figure, it is not clear whether all these approvals have materialised actually.

The US, Germany, UK, Japan and Italy have been the major sources of technology transfers to India between 1991 and 2005. These countries provided two third of the technology transfers to India. Table 16 provides data on sector-wise technology transfer approvals during this period. It clearly shows that Electrical Equipments (Including computer software & electronics), Chemicals (other than fertilizer), Industrial Machinery, Transportation Industry, and Engineering Industry have been the sectors that witnessed highest technology transfers.

Table 16: Sector-Wise Technology Transfer Approvals (1991-2005)

Rank	Sector	Number of Technical Collaborations
1	Electrical Equipments (Including computer software & electronics)	1 247
2	Chemicals (other than fertilizer)	869
3	Industrial Machinery	863
4	Transportation Industry	707
5	Misc. Mach. Engineering Industry	437
6	Other sectors	3 600
Total	**All Countries**	**7 723**

Source: See <http://dipp.nic.in/fdi_statistics/india_fdi_index.htm>

A number of leading foreign companies have entered India through joint venture or fully owned businesses. Some examples from selected sectors are highlighted here.

In the automotive sector: *Ford India*, a joint venture between Ford and Mahindra & Mahindra (M&M) was set up in 1995. The company became *Ford India Limited* in February 1999, following a change in equity pattern with Ford holding the majority stake. The company has made an investment of over US$ 350 million and has the capacity to manufacture over 50,000 vehicles per annum. Ford India has exported over 28,000 CKDs (completely knocked down kits) to South Africa and Mexico in 2001, constituting over 66 per cent of total car exports from India. It has entered into a strategic tie-up with Hindustan Motors to manufacture engines and transmission units for its cars. *Daimler Chrysler India:* Apart from entering Indian car market, Mercedes has started tapping into the auto components market too. The company has been manufacturing auto components in India and exported them leveraging the cost advantages.

Hyundai Motors India, a wholly owned subsidiary set up operations in India in 1996. The company brought rigorous quality standards and technology innovation. It has set up a fully integrated state-of-the-art manufacturing plant near Chennai. The plant is considered to have one of the most advanced production, quality and testing capabilities in the world.

'Honda Motorcycles & Scooter India' was incorporated in 1999. The company manufactured 40,000 units in 2001-02. After good response from the market it has increased its target by 40 per

cent for 2002-03 and advanced its plan to increase production capacity. *Yamaha Motor India* started its operations in India in 2001. The company is the only 100 per cent Yamaha company in Asia, outside Japan.

In the consumer electronics sector: *Samsung India* entered India in 1995 and now it has positioned itself as a leader in the high-tech consumer electronics and home appliances market in the country. It has set up an R&D Centre at NOIDA, which serves as the regional R&D hub for India, Middle East and South East Asian region. Samsung Electronics India Information and Telecommunications limited formed in May 2000 has product portfolio that constitutes of PC monitors, hard disk drivers, laser printers, multifunctional products and mobile phones. Samsung has also set up its software operations unit in Bangalore.

In the telecommunications sector: *Motorola India* first entered India through a joint venture with Blue Star to manufacture modems. It then went on to become a wholly owned subsidiary. In 1991, Motorola set up its first software centre in Bangalore. In 1999, Motorola set up two chip designing units around Delhi, and a third one in Hyderabad. All of these units including the software centre are 100 per cent export units. India is now well established as a source of software and chip design, also helping Motorola to maintain its competitiveness globally. By 2000, it employed over 2000 software engineers in India. *Singapore Telecom* has invested over US$400 million, which is the largest investment by an international investor in the Indian telecom sector. Global telecom equipment manufacturers like Motorola, Ericsson, Nokia are also active in the Indian telecom industry.

In the financial services sector: *GE Capital India*, a wholly owned subsidiary of GE, was set up in 1993. It began operations in India through its financing activities, primarily serving the local market. GE capital has grown rapidly and by 2002 it employed over 6000.

In the infrastructure sector: P&O (Peninsular & Oriental), Ports of Australia and Port of Singapore Authority International (PSA International) are among the largest investors in the port sector in India. In the information technology sector *Oracle India* started its Indian operations in 1993. It set up software development facilities in Bangalore and Hyderabad with over 600 people. Oracle sells more call-centre software in India than the rest of Asia Pacific combined (Website F).

FDI for setting up R&D centres has seen significant growth in India. A recent survey of the United Nations Conference on Trade and Development (UNCTAD) notes that the global trend in FDI has shifted in recent years towards R&D in developing countries, with China and India first and second on the list. Of the 885 R&D-oriented FDI projects announced in the Asian regions in 2002 to 2004, 75 percent (723) were concentrated in these two large economies. More than 100 MNCs have established R&D facilities in India. Microsoft, for example, launched its sixth global research centre in Bangalore in early 2005 after opening one in Beijing in 1998. According to a study lower cost is not the chief factor driving companies to locate their R&D in countries like India. The quality of R&D personnel available and opportunities for university collaboration are important factors (See Website G).

Another factor is that more and more companies such as IT and Telecom are relying heavily on India to serve their R&D needs, not just routine tasks like call centre services which initially sparked the whole outsourcing boom in the country. Frost and Sullivan (2004) estimated that the

R&D outsourcing market in India would grow from $1.3 billion to about $9 billion by year 2010. In IT, opportunities abound for R&D on computing architecture, encryption and network security, human computer interface, programming language and software engineering. It was also noted that more and more high-tech firms, especially makers of microprocessors, are investing in R&D in India. US chipmaker AMD recently announced it would invest at least $5 million in setting up a design facility in Bangalore that will employ Indian engineers. It cited outstanding engineering talent and lower operating cost as reasons for selecting Bangalore, the very same reasons cited by chipmakers Intel and Texas Instruments which also set up design centres in Bangalore (Website H).

Motorola's research and development facilities in India helped produce a sub-$40 cellular phone for emerging markets. Microsoft launched its third international research centre in India. Intel has 800 India-based engineers working on software and hardware designs for its communication and semiconductor product lines. Other US companies are also involved in designing from auto parts to consumer electronics in India through outsourcing or setting up their own facilities. These are considered just the beginning of advanced research and development in India and it is argued that this is likely to lead to basic research and product innovation in India. However, it is pointed out that much of the R&D in India is generally geared towards smaller projects that complement other innovation centres in Silicon Valley and elsewhere (Website I).

Also, increasing numbers of pharmaceutical companies are conducting R&D operations in India. Attracted by a largely untapped, skilled and English-speaking workforce more and more pharmaceutical companies are conducting clinical trials and setting up R&D facilities in India. A study conducted by clinical research consultancy Oxygen Healthcare estimated that 1% of global clinical trials are currently conducted in India. This figure, it suggested, could increase to 10% in the next five years and India has the potential to be the premier destination for conducting global clinical trials (Website J).

The growth of MNC R&D in India started with the IT sector, expanded to the telecom and automobile sectors, and is now emerging strongly in the pharmaceuticals and biotechnology sectors (Mani 2006). A survey by the UN Conference on Trade and Development (UNCTAD) notes that the global trend in FDI has shifted in recent years towards R&D in developing countries, with China and India first and second on the list. Of the 885 R&D-oriented FDI projects announced in the Asian regions in 2002 to 2004, 75% (723) were concentrated in these two large economies, with over 100 MNCs establishing R&D facilities in India. Microsoft, for example, launched its sixth global research centre in Bangalore in early 2005 after opening one in Beijing in 1998.

The common view is that lower costs are the main drivers for companies to relocate their R&D to countries such as India. However, it is found that in addition to cost, quality of R&D personnel available and opportunities for university collaboration have played an important factor in relocation decisions (Kauffman, 2006). For example, this is highlighted in the case of outsourcing of laboratory and diagnostic tests to India. It is pointed out not only are costs 70-80% lower, but India has more than 20,000 laboratories with highly skilled personnel to conduct a large number of tests quickly (See Website M). According to another report, IT and telecommunications companies are relying heavily on India to serve their R&D needs, a far cry from routine tasks like call centre services, which sparked the outsourcing boom in India. Following Intel and Texas Instruments, chipmaker AMD has sought to establish a design facility in India, citing outstanding engineering talent combined with lower costs (Website N).

However, it appears that while globalisation has overall had a positive impact on India, it also has contributed to the marginalisation of R&D in traditional technologies.

One of the main objectives of economic liberalisation and opening up the economy to FDI in India is to increase its export performance. Therefore it is important to analyse the impact of FDI on exports. Export performance in India has been growing faster than GDP and several factors appear to have contributed to this phenomenon including FDI. For example, Indian companies are also showing a greater export focus and they are also investing more in plant and machinery (Reddy: see Website K). Athreye and Kapur (2001) argued that although India needs fresh investment, FDI alone couldn't achieve this. They further argued that in Indian context growth-led FDI is more likely than FDI-led growth. They suggest that India should improve investment environment for both domestic and foreign firms.

The most visible impact of FDI in the manufacturing sector has been in expanding the range of products available to the consumers such as cars, two-wheelers, consumer durables, food products and apparel. In services sector, FDI inflow has resulted in the entry of more banks, new insurance companies, and it appears that global management consultancies and accountancy firms have established a leading position in the Indian market (Reddy: Website K).

Intellectual Property Rights / Patenting

India has introduced various legislative and institutional measures for the implementation of TRIPS. It is argued that stronger patent protection in India under TRIPs will encourage domestic and foreign investors to invest in India. Further, it would encourage both foreign and domestic private investments in R&D in the Indian seeds sector (in the plant variety protection area -- PVP). It is further argued that signing up to TRIPs will not strongly impact designs, trademarks and copyright as these were already strongly protected areas in India. However, the strengthening of patenting will affect Indian pharmaceutical (both prices and industrial growth) and biotechnology industries. For example, already significant consolidation has taken place in the Indian pharmaceutical industry even in anticipation of a changed product-patenting regime. However, except for PVP, India has lacked innovation in exploiting the options in any of the IPRs covered in TRIPs (UN Economic and Social Commission for Asia and the Pacific 2001).

An analysis of the patenting by Indian organisations in the United States showed that, of the 1423 patents granted during 1995 to 2004, about 82% were made by Indian inventors, and the share of MNC's had declined from 23% in 1995 to 11% in 1999. The share of government research institutions, particularly laboratories of Council of Scientific and Industrial Research (CSIR), had significantly increased their share of patenting. He also found that all local applicants were chemical or pharmaceutical firms, while all foreign applicants were either electronic or IT firms (Mani, 2006).

Education and Human Resources Development

A number of positive developments have been observed in the area of education and human resources development (World Bank 2005): (i) rates of literacy have risen to 65.4% in 2001 from 52.2% in 1991; (ii) in the past 20 years the share of population with complete primary education has doubled from 4.7 to 10.5%; (iii) the role of the private sector is increasing in all levels of schooling -- primary, upper primary and secondary -- and is the main factor behind rapid progress in the 1990s made in education, particularly at secondary level; (iv) government spending is skewed towards secondary and tertiary education; and (v) some state governments are trying to improve the quality and relevance of education in government schools by linking up with private institutions (for example, the National Institute of Information Technology (NIIT) is involved in government schools in Tamil Nadu, Karnataka, West Bengal and Punjab).

Negative Side of Indian NSI:

Indian NSI has been facing number of serious challenges and problems such as high level of illiteracy, imbalance in income levels, socio-economic development across different states and within states (provinces), FDI inflows, weak linkages between R&D institutions/ university and industry, lack of product innovation culture among the firms, lopsided growth with ICT sector dominating others (whether real or myth) and serious weaknesses in the education system.

Lack of Product Innovation

By studying the Indian innovation system in the 1980s, Desai argued (1988) that, under protective regimes, Indian firms lacked any major innovations to their products, which would help establish a significant and sustainable export market. Subrahmanian (1990) has also expressed a similar view. Many studies still highlight this problem of the Indian NSI failing to develop a high-level capability for product development and innovation. Several studies have sought to highlight the continued existence of this problem, even in the nominally successful IT sector (e.g. D'Costa 2002; Krishnan and Prabhu 2002; Parthasarathi and Joseph 2002) and product development in biotechnology sector **(**Utkarsh Palnitkar, 2002). He argues that, despite India's strength in biotechnology R&D, there has been little commercialisation of Indian-developed products. Instead, both domestic and foreign firms import many products. Over all, Indian companies are largely seen as service providers rather than product developers (FINPRO India et al. 2005).

Problems with Indian ICT Industry and Policy

Although Indian ICT industry has emerged as a major growth sector, it certainly suffers from a number of weaknesses such as uneven growth, imbalances between different sectors, weak linkages between the industry and R&D performing institutions such as universities, inability to perform at higher level of technological complexity, high concentration of firms in some major cities, and so on. ICT industry in India is heavily concentrated in cities in Southern part of the country, especially Bangalore, Hyderabad, and Chennai. This regional imbalance in the growth of ICT industry is very striking. Although other cities in other regions are trying to catch up with them, it is unlikely that they will ever match the growth of ICT industry of the South. Another problem with the software industry is that it has failed to develop a high level capability for product development and innovation (Krishnan and Prabhu, 2002). However, this appears to be changing.

As far as ICT industrial policies are concerned, impact of ICT can be viewed at two levels: the direct effect -- in the areas of employment, income and export earnings; and the indirect effect -- increased productivity, competitiveness and growth of other sectors due to diffusion of ICT across the whole economy, and emergence of new services and spin-offs. While India's ICT policies appears to have achieved significant gains in the area of direct benefits, the economy as a whole does not appear to have benefited because of highly regional concentration of ICT activity and low diffusion of ICT to other sectors of the economy. This is because of the excessive emphasis placed by the government on export-led growth. Further, over emphasis on ICT sector is likely to have an adverse impact on other sectors of the economy, which compete with it for skills (Joseph, 2002).

The extent of ICT diffusion in rural areas is very limited, mainly as a result of widespread illiteracy, high access costs and inadequate infrastructure (World Bank 2002, 1-2). Very small sections of people in the rural areas have access to a computer or Internet connection. Many of the ICT projects initiated for rural development have not been thoroughly evaluated. Baskaran and Muchie (2006) argue that India needs to learn from its experience of introducing technology such as radios, television and telephone into rural areas. They argue that, if the rural areas have to benefit from ICT, the state needs to create the basic infrastructure to make the availability of ICT cheaper. The incorporation of the private sector -- either in parallel or subsequently -- will serve to accelerate this process. However, Baskaran and Muchie maintain that the key factor is the lowering of the cost of access to ICT in rural areas.

Problems with Education and Skills

A study by the World Bank (2005) made a number of negative observations about the education and human resources development in India and made a number of recommendations to improve the sector. They included: (i) the need to encourage critical thinking and learning skills for all, not just for the elite; (ii) improvements to educational quality and relevance; (iii) reducing school drop-out numbers and teacher vacancies; (iv) a reform of tertiary education curriculum to include skills required by the knowledge economy; (v) raising the quality of all higher educational institutions, not just a few world class ones, such as the Indian Institutes of Technologies (IITs); (vi) enhancing the private sector's contribution to the educational sector; and (vii) shifting the role of government from managing administrative aspects to becoming the architects of standards and regulations aimed at improving and monitoring quality.

While India has seen significant growth in private technical and management education, this has been limited to certain, more developed states. Tamil Nadu, Maharastra, Karnataka, Andhra Pradesh and Kerala account for 31% of the population but 69% of engineers, while Uttar Pradesh, Bihar, Gujarat, Rajasthan and Orissa account for 43% of the population but 14% of engineers (See Website L).

Despite widespread belief that India has been producing a large number of scientists, engineers, and technical personnel, it is argued that there has been a chronic shortage of research scientists and engineers as a result of poor quality of science and engineering education in the country and the 'brain drain'. It is further argued that India has too few scientists and engineers engaged in R&D, noting that the density of scientists and engineers engaged in R&D is one of the lowest among the emerging economies (Mani 2001). Also, there are concerns that over-emphasis on the ICT sector would have an adverse impact on other sectors of the Indian economy (Joseph 2002).

Weak University – Industry Linkages

One of the major weaknesses of Indian NSI is the continued weak links between R&D performing institutions and industry. This has come out clearly in number studies since 1980s (e.g. Mascarenhas 1982; Desai 1988; Vijayakumar 2005). In a recent work, Vijayakumar examined the collaborative research environment in India. He found that the lack of in-house R&D capability, cutbacks in R&D budgets, the changing nature of research priorities, government intervention to promote successful linkages, innovation excellence at university resources and cost saving are the common reasons for the government laboratories to look for linkages with the industry. However, a lack of communication on the part of universities about their capabilities and insufficient knowledge about the technological needs of the industry has hindered the development of these links.

Imbalance in FDI Flow Across States

Although India has been benefiting from the FDI inflow since the liberalisation of its economy in 1991, only selected states and regions are reaping the benefit. Tables 17 and 18 show the FDI inflow since 1991 to 2007. It is very clear that apart from Delhi, which is also the capital of India (23%), only the Western region (mainly Maharastra and Gujarat – 27%) and the Southern region (mainly Tamil Nadu, Karnataka and Andhra Pradesh –18%) are attracting the bulk of FDI. There are states, which hardly attracts any FDI. Like China (the imbalance between Eastern and Western regions), India is also witnessing imbalance in growth caused in different states and regions. In the long-term this is likely to be a serious problem in India.

Table 17: Imbalance in State-wise FDI flow to India (1991 – 2000)

Rank	State	Number of Approvals			% Of Total*
		Total	*Technical*	*Financial*	
-	**All India**	**21926**	**7039**	**14887**	**2804.4 (Rs billion)**
1	Maharastra	3959	1146	2813	17.4
2	Delhi	1951	214	1137	12.0
3	Tamil Nadu	2152	542	1610	8.3
4	Karnataka	1950	448	1502	7.7
5	Gujarat	1049	505	544	6.6
6	Andhra Pradesh	1010	239	771	4.7
7	West Bengal	591	191	400	3.1
8	Orissa	136	49	87	2.9
9	Uttar Pradesh	737	261	476	1.7
10	Haryana	779	288	491	1.3
11	Rajasthan	320	100	220	1.1

Source: Balasubramanyam and Mahambare (2003), "Foreign Direct Investment in India," Working paper, Lancaster University Management School (Originally gathered from Ministry of Commerce and Industry, Government of India).

* States with less than 1% of the total FDI inflow are excluded from the table by the authors

Table 18: Imbalance in State-wise FDI flow to India (2000 - 2007)

Rank	State(s)	FDI Inflow (Rupee billion)	FDI Inflow (US$ billion)	% Of FDI Inflow (in Rupee terms)
1	Maharastra, Dadra Nagar Haveli, Daman & Diu	345.91	7.65	23.9
2	Delhi, Part of Uttar Pradesh and Haryana	336.45	7.46	23.3
3	Tamil Nadu, Pondicherry	106.90	2.36	7.70
4	Karnataka	93.61	2.07	6.48
5	Andhra Pradesh	52.81	1.16	3.65
6	Gujarat	44.35	0.97	3.07
7	Punjab, Haryana, Himachal Pradesh	15.65	0.34	1.08
8	West Bengal, Sikkim, Andaman & Nicobar	15.33	0.33	1.06

Source: Reserve Bank of India, *Fact Sheet on Foreign Direct Investment (FDI) 1991-2007*

Imbalance in Literacy Rates:

In the area of social development, one of the most serious imbalances between states/ regions is the rate of literacy. Again states in the Western and Southern regions are significantly ahead of other regions. This is clearly illustrated by Table 19, which shows some states in the Northern regions such as Bihar and Jharkand are far behind the leaders in the literacy league such as Kerala, Mizoram, and Maharastra. However, it is also clear that all states have been improving the literacy rate steadily over each decade since 1951.

Table 19: Imbalance in Literacy Rates (in %)
-- Selected States with Higher and Lower Literacy Rates

State	***1951***	***1961***	***1971***	***1981***	***1991***	***2001***
1. States with Higher Literacy Rate:						
Kerala	47.18	55.08	69.75	78.85	89.81	90.86
Mizoram	31.14	44.01	53.80	59.88	82.26	88.80
Maharastra	27.91	35.08	45.77	57.24	64.87	76.88
Tamil Nadu	--	36.39	45.40	54.39	62.66	73.45
Gujarat	21.82	31.47	36.95	44.92	61.29	69.14
West Bengal	24.61	34.46	38.86	48.65	57.70	68.64
2. States with Lower Literacy Rate:						
Bihar	13.49	21.95	23.17	32.32	37.49	47.00
Jharkhand	12.93	21.14	23.87	35.03	41.39	53.56
Arunachal Pradesh	--	7.13	11.29	25.55	41.59	54.34
Jammu & Kashmir	--	12.95	21.71	30.64	--	55.52
Uttar Pradesh	12.02	20.87	23.99	32.65	40.71	56.27
Rajasthan	8.5	18.12	22.57	30.11	38.55	60.41
ALL INDIA	**18.33**	**28.30**	**34.45**	**43.57**	**52.21**	**64.84**

Source: Government of India (Ministry of Finance), *Economic Survey 2006-2007,* p. S-114.

Table 20: Percentage of Population Below the Poverty Line in India
1973-2000

Year	***Rural***	***Urban***	***Total***
1973-74	**56.4**	**49.0**	**54.4**
1977-78	53.1	45.2	51.3
1983	45.7	40.8	44.5
1987-88	39.1	38.2	38.9
1993-94	37.3	32.4	36.0
1999-2000*	27.1	23.6	26.1

Source: Government of India (Central Statistical Organisation), *Selected Socio-economic Statistics India 2006*, p. 153.

* The 1999-2000 estimates may not be comparable to the estimates of earlier years because of some changes in the methodology of data collection.

Table 21: Imbalance in Population Below Poverty Line (BPL) (in %)
Selected States with Lower and Higher Rates of Poverty (199-2000)

State	***Rural***	***Urban***	***Total***
1. States with Lower % Population Below Poverty Line:			
Jammu & Kashmir	3.97	1.98	3.48
Goa	1.35	7.52	4.40
Punjab	6.35	5.75	6.16
Himachal Pradesh	7.94	4.63	7.63
Haryana	8.27	9.99	8.74
Kerala	9.38	20.27	12.72
Gujarat	13.17	15.59	14.07
2. States with Higher % Population Below Poverty Line:			
Orsisa	48.01	42.83	47.15
Bihar*	44.30	32.91	42.60
Madhya Pradesh*	37.06	38.44	37.43
Sikkim	40.04	7.47	36.55
Assam	40.04	7.47	36.09
Tripura	40.04	7.47	34.44
Meghalaya	40.04	7.47	33.87
ALL INDIA	**27.09**	**23.62**	**26.10**

Source: Government of India (Central Statistical Organisation)**,** *Selected Socio-economic Statistics India 2006*, p. 154.

* Data for undivided Bihar and Madhya Pradesh (i.e. data include for newly created states Jharkhand and Chattishgarh in 1991).

Population Below Poverty Line (BPL)

Table 20 clearly shows that since 1970s, India has been able to reduce the people living below poverty line from about 55% to 26%. However, like the case of literacy, there is serious imbalance in population living below poverty line among states. Table 21 provides figures for two groups – states with lower percentage of population BPL and states with higher percentage of population BPL. While the former group has less than 10% of population BPL, the latter has over 40% of population BPL. This again illustrates the duality of the Indian NSI and poses a very serious challenge for India to achieve its ambition of becoming a developed economy by 2020.

Conclusions

Since India started major economic liberalisation thrust in the early 1990s, its economy has registered significant growth in terms of GDP, exports, employment, investment, foreign technological and investment inflow, ICT industry, international investment in R&D and so on. Over the years, Indian NSI has helped to create a high level of human resources in terms of qualified and skilled labour and has emerged as the undisputed leader of IT and R&D services. The wage differences and English-speaking capability are the major advantages of this large pool of human resources. In the last 10 years, although India has been mainly recognised as a software and services hub, it is also slowly catching up as a new manufacturing destination.

On the other hand Indian NSI is also facing serious problems and challenges such as imbalances in income and wage growth, level of literacy and poverty, and foreign investment inflow across different states and regions. Also some of the old problems such as lack of product innovation culture among firms and weak linkages between R&D institutions/ universities and the industry are persisting. Indian NSI needs to tackle and overcome these problems if India wants to achieve its ambition of becoming a developed economy. However, liberalisation of policy regimes may not be enough to realise the full potential of Indian system of innovation. For this, fundamental changes to the institutions (including firms) and research culture and the way they interact among themselves and with the industry and community also may be needed.

Despite some inconsistent performances over the years, Indian NSI is refining and it is likely to perform with greater efficiency with increasing reforms to its policy regimes and greater strategic focus and response to domestic and global changes.

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