Role of higher education sector in changing service sector innovation system

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Abstract

Purpose – The purpose of this paper is to identify the role of universities in the service sector innovation system of India.

Design/methodology/approach – Use was made of secondary sources of data such as various reports, books and journals, to gather information on what constitutes the national innovation system (NIS) of a country. An attempt was made to assess the performance of India's innovation system, which comprises investment, infrastructure, knowledge and skill generation, and relations and linkages. The author made broad use of this conceptual framework to make an assessment of the performance of the changing service sector innovation system in India. To examine the performance of India's NIS, three elements were focused on: R&D, FDI in services, and status of higher education sector.

Findings – The paper concludes that India has a well-functioning service sector innovation system yet much needs to be done if India wants to keep alive her ambition of becoming a knowledge powerhouse or innovation superpower. Moreover, the private sector can play an important role in the improvement of quality of education, as has been revealed by the example of NASSCOM.

Originality/value – While there is some research on the NIS of India, not much has been written about the service sector innovation system of India. The paper fills this gap in the current literature to some extent.

Keywords India, Universities, Research and development, Science, Technology, Innovation, Globalization, Internationalization of R&D, FDI, Service sector innovation system, National innovation system

Paper type Conceptual paper

I. Introduction

In the decade of 1950s and 1960s the supremacy of the USA in science and technology and innovation was well known. With increasing globalization many new players have come to the forefront including India. The supremacy of the USA is seriously challenged and partially eroded. There has been gradual emergence of nations such as Scandinavian countries and South East nations such as China and India as innovators (see Richardson, 2002). India is making its presence felt by transition from an imitator to innovator. According to Economist Intelligence Unit (EIU) (2009), India's rank in the Economist Group's Global Innovation Index for 82 countries improved from 58th place in 2006 to 56th in 2008, with a further progression predicted to 54th place by 2013 (Mani, 2010). India has emerged as the fourth-largest economy in the world in purchasing power parity dollars (World Bank, 2011). India has emerged as one of the major destinations for conducting corporate offshore research and development (R&D) (Desai, 2011). Several studies point out that India is one of the attractive locations world wide for R&D and innovation off shoring (LTT Research, 2007; Economic Intelligence Unit, 2004; A T Kearney, 2006; Boston Consultancy Group, 2006 as quoted in Herstatt *et al.*, 2008). The European Union counts India among "major R&D performing countries in the world." It has been pointed out by Mani that the

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knowledge-intensity of India's overall output has expanded. Currently, about 14 percent of India's net domestic product is composed of knowledge intensive production[1], much of it is contributed by the services sector. Growth in knowledge-intensive production outpaced the growth of the economy as a whole. Data show that the majority of new companies belong to knowledge-intensive sectors and that the number of knowledge-intensive enterprises has mushroomed over the past seven years or so (Mani, 2010).

Therefore, the questions like: can Indian become an innovation powerhouse? (Krishnan, n.d.) or can India become a developed country? (Kalam and Rajan, 1998) have been raised. It is important to mention here that the knowledge, as embodied in human beings (as human capital) and in technology has been central to economic development (OECD).

As is evident from the analysis done by Mani (2010) that economic activities are becoming more and more knowledge intensive and this also gets reflected in the growth of high-tech industries and growing demand for skilled labor force. Therefore, there is an urgent need to invest in knowledge such as R&D, education and training, and "innovation eco-system" which are the key drivers of growth of the knowledge economies in the twenty-first century.

Science implies the creation of knowledge and technology is the application of the knowledge toward the welfare of mankind. Innovation is the complete process through which new ideas are created and implemented particularly through the process of commercialization. The presence of innovation system enables a country to harness the benefits of scientific and technological developments (Anand, 2008). The Freeman (1982) and Lundvall (1985) were pioneers of the modern version of concept of National Innovation Systems (NIS). Freeman (1995) describes NIS as "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies." There are a number of studies on NIS with a global perspective. However, studies relating to Indian innovation system were quite few in the beginning of the decade of 2000 but growing in number thereafter (Gupta and Dutta, 2005; Bound, 2007; CII, 2007; Dutz, 2007; Mitra, 2007; Mani, 2006, 2007; Arora, 2007; Nassif, 2007; Krishnan, n.d.).

Broadly, a national innovation system has the following four elements: first, investment (R&D expenditure and government R&D support, venture capital and FDI); second, infrastructure (science and technology institutions, intellectual property rights, government policy, ICT and culture); third, knowledge and skill generation (education and human resources development and labor flexibility); and finally, relations and linkages (university-industry linkages, public R&D and industry, globalization of MNCs R&D, transnational networks) (Baskaran and Muchie, 2007). We are going to make use of this conceptual framework broadly to make an assessment of the performance of changing service sector innovation system in India in the present paper. We will be focussing on three elements namely R&D, FDI in services and status of higher education sector to examine the performance of service sector innovation system of India.

II. Snapshot of the changing scientific and technological landscape in India

After independence, India invested in S&T infrastructure and spent significantly on R&D expenditure. This has totally changed the scientific and technological landscape of India. Presently we are having a vast network of S&T institutions and a critical mass of scientists, engineers and technical persons. India is home to dynamic hubs of innovation, such as Bangalore, Chennai, Delhi, Hyderabad, Mumbai and Pune (Desai, various studies).

The S&T departments functioning under the auspices of Central Government are: Department of Science and Technology (DST), Department of Scientific & Industrial Research, Department of Atomic Energy, Department of Space, Department of Biotechnology and Department of Ocean Development. Among the S&T organization associated with other Central Government Ministries, Defence Research & Development Organisation under the Ministry of Defence, Indian Council of Agricultural Research under the Ministry of Agriculture and Indian Council of Medical Research under the Ministry of Health & Family Welfare have large R&D infrastructure[2].

In the year 2006, there were 3,960 R&D institutes in India. The maximum number of which were located in Maharashtra. The national expenditure on R&D increased from Rs. 18,088.16 crores in 2002-2003 to Rs. 28,776.65 crores in 2005-2006. R&D expenditure as percentage of GNP stood at 0.89. India's per capita R&D expenditure increased from Rs. 169.38 in 2002-2003 to Rs. 260.20 in 2005-2006.

The Central Government is the chief patron of R&D expenditure. Its share in the national R&D expenditure was 57.4 percent followed by public sector industry, 4.5 percent; private sector, 25.9 percent; state government, 7.7 percent; and higher education, 4.4 percent. The industrial sector (both public and private sector) R&D expenditure was 30.4 percent in India where as in case of developed countries it is usually more than 50 percent. A total of 74.1 percent R&D expenditure was met from government sources and 25.9 percent came from private sources in 2005-2006. A total of 86 percent of the Central Government expenditure was incurred by 12 major scientific agencies (DST, web site).

It has been pointed out by Desai (2009) that though India was the first country in the world that passed the Scientific Policy Resolution in 1958 yet unlike other developing countries India does not have an explicit innovation policy to strengthen the innovation system as a whole.

So far as R&D is concerned, a large proportion of R&D (76 percent) in India was performed by the Central and State Governments including the public sector and industrial sector. The private sector accounted for 20 percent and 4 percent was accounted for by the higher education sector (Department of Science and Technology, 2008). However, this trend is in sharp contrast with the developed countries where an overwhelming portion of R&D is performed by the private enterprise and the universities have strong linkages with the corporate world. As Mani (2010) points out that though government accounts for major share in R&D investment yet there has been decline in share of the government is R&D.

Internationalization of R&D is also taking place at a faster rate after the introduction of economic reforms of 1991. There is transformation taking place from global production network to global innovation network now. Firm are off shoring, outsourcing and subcontracting various R&D activities to other regions (in addition to their home country) to have access to broader knowledge base, S&T resources and markets. Generally, three modes are used by MNCs to expand their domain of R&D namely joint venture, greenfield, mergers and acquisitions. R&D investment is flowing in case of India in various sectors such as information technology (IT), drugs and pharmaceuticals, biotechnology and automotive, etc. There were approximately 100 foreign organizations (mainly MNCs) and 16 countries which established their R&D centers in India over last decade (TIFAC, 2005). The USA is leading in terms of numbers of these centers and employment in them. Bangalore is the favorite hub of global MNCs[3].

India's innovative performance improved from 3.65 to 3.93 during the period 1995-2007. A small but positive change of +0.28 was observed despite the fact that India's R&D expenditure during 1990-2007 has hovered around only 0.8 percent of its GDP. Another noticeable point is that there is an increasing trend in the number of patents granted to companies by the Indian Patent Office, indicating greater awareness of the importance of knowledge (Desai, 2009). In 2009, 5,314 residents of India and 23,626 non-residents filed patent applications (World Bank, 2011, p. 315).

In addition to R&D establishments, the other major body pursuing S&T activities in India is the country's vast university system comprising of 43 central universities, 129 deemed universities and 297 state universities, 65 institutes of national importance and other university level institutions and 100 private universities and 33,023 colleges as on December 2011. Higher education sector is a major source of S&T manpower development. There were 11,161 PhD produced by 305 universities/university level institutes in 2009-2010 (provisional estimates) out of which 34 percent was in sciences faculty and 9 percent in engineering/technology[4]. The Prime Minister's Science Advisory Council has estimated that if India wants to claim the status of being a knowledge-based economic power, it has to produce five times more the number of PhD scholars of international standards.

However, studies reveal that there is lack of dynamism in the government R&D system. The significant contribution of government laboratories has been the building up of pool of human resource. It is from this pool, the Indian software industry drew heavily during its formative years. Historically, the R&D system of government worked in isolation and on its own agenda, largely unaware of the need of the industry's requirements in the absence of academia-industry interface. Therefore, only a small proportion of its output was translated into industrial application. Though India is termed as prominent R&D hub of the world yet its contribution to the world research papers was quite low at 2 percent as per the statistics of Ministry of Science and Technology in 2003[5].

Having examined our changes in scientific and technological landscape in India. Let us try to find out the extent of FDI inflows in India which are considered to be important contributors to efficiency of NSI.

a. FDI in services

"As part of overall 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" (Baskaran and Muchie, 2007). India has been trying to tap the growing stock of global knowledge through channels such as FDI. FDI has become an important source of private foreign capital and plays an important role in economic transformation and accelerating economic growth. In addition, it is a means for transfer of production technology, innovative capacity, and organizational and managerial practices between locations.

The FDI inflows into India increased from US$4,029 in FY 2000-2001 to US$27,024 in FY 2010-2011. The cumulative total for FDI for the above refereed period was $197,935 from April 2000 to April 2011[6]. The services sector (financial and non-financial) attracted highest equity inflows followed by computer software and hardware and telecom (radio paging, cellular mobile, basic cell phone services).

Studies (Joshi, 2010) point out there has been a perceptible increase in foreign investment in the tertiary sector after 1991. The share of the tertiary sector in total FDI stock rose significantly from 5 percent in 1990 to 59 percent during 1991-1997. In the post-1991 period, there were several measures undertaken by the government to develop the services sector, especially through deregulation of some sub-sectors of the service sector like IT and ITES, tourism, financial sector (banking and insurance), trade, organized retail and other services like the entertainment industry, etc. FDI, varying between 26 and 100 percent, has been permitted in various sub-sectors of the services sectors. There are other complementary measures taken by the government to sustain the growth of this sector.

FDI markets recorded a total of 3,188 investment projects in the services sector from 1,633 companies between January 2003 and May 2011. The average number of jobs created per project was 274. The leading sector was software and IT services, which accounted for 36 percent of projects. The leading business activity was sales, marketing and support, which accounted for 20 percent of projects. The top ten companies accounted for 8 percent of all investment projects with IBM (USA), Deutsche Post (Germany) and General Electric (USA) among the top ten companies. The top three source markets for outward investment were the USA, UK and Germany, providing 48, 12 and 5 percent of investment projects respectively (FDI Intelligence, 2011).

The top three destination cities for inward investment were Bangalore, Mumbai and Chennai, providing 19, 12 and 9 percent of investment projects, respectively. Between 2003 and 2011, FDI markets recorded a total of 3,188 investment projects in the selected services sector as has been shown in Table I. Software and IT services accounted for the highest number of projects, with a total of 1,158, representing

Table I. Investment projects in selected services sector

Year	Number of projects	Percentage growth
2003	263	
2004	419	59.3
2005	343	−18.1
2006	538	56.9
2007	363	−32.5
2008	498	37.2
2009	367	−26.3
2010	308	−16.1
2011	89	n/a
Total	3,188	
Average	354	

Notes: Service sector here comprises of software and IT services, business services, financial services, communications, transportation, real estate, hotels and tourism, leisure and entertainment, warehousing and storage and other sector. Though electronic components are a part of manufacturing sector but have been included in the service sector
Source: FDI Intelligence from Financial Times Ltd

36 percent of the investment projects. The average project size was 274 jobs per project. The total number of jobs created during 2003-2011 stood at 870,165.

It is important to emphasize here that the formation of human capital is vital for the continued growth of FDI inflows, for building up human base for R&D and also for having well functioning and efficient NIS. Herein comes the role of education. The next section, therefore, focusses on the role of higher education system of India in the NIS, its size and challenges faced by it.

III. Role of universities as producers of knowledge and suppliers of higher education and research

It is quite evident from the foregoing that knowledge and skill generation and also university-industry linkages are an important part of NIS. "The role of education in facilitating social and economic progress is well recognized." It is empirically verified that education which is one of the components of human capital impacts economic growth positively (Stiglitz, 1998; Dreze and Sen, 1996). This current era of globalization has offered immense opportunities. But people must have the necessary knowledge, skills, capacities and capabilities to seize those opportunities (Joshi, 2004). Herein lies the role of education and especially higher education in building up and improving human capital. In India, elementary education has received a major push through Sarva Shiksha Abhiyan during Tenth Five Year Plan (2002-2007). But the higher education remained neglected till Eleventh Five Year Plan (2007-2012) (see Joshi, 2012). In 2004-2005 as per revised estimates, just 3.68 percent of GDP was spent on education and 0.66 percent of GDP on higher education (see Kapur and Mehta, 2007, p. 50). It is important to mention here that knowledge is critical for promoting economic growth. The growth potential of any knowledge economy will depend on its capacity to produce knowledge. The universities of the twenty-first century have to become producers of knowledge. University system is an integrated element in a broader national innovation system as they are the suppliers of higher education and research in innovation systems in developing countries (Brundenius *et al.*, 2009). How rightly it has been observed by Beteille (2010, p. 193), "An institution will scarcely deserve to be called a university if it undertakes only teaching and no research, or only research and no teaching." Universities are important institutions in the knowledge society. They can serve industry through direct flows of information from ongoing research. Besides, university-industry relationships can help promoting innovation (Brundenius *et al.*, 2009). Therefore, there is a need to lay greater emphasis on research and development in higher education.

Since economic growth of India in recent years is driven primarily by services sector and within services sector by IT and information technology-enabled services (ITES); therefore, to keep alive India's ambition of becoming knowledge powerhouse, the sustainable development of higher education is not an option but imperative. Without expansion of higher education system and improvement in its quality, India will not be able to sustain the overall growth (Joshi, 2012).

a. Expansion of the higher education system

The full policy support and allocation of substantial public funds by Government of India over the past 50 years has resulted into the creation of the largest higher education system in the world in terms of number of institutions and third largest (after China and the USA) in terms of enrollment in India.

At the time of independence, we were having 20 universities, approximately 500 colleges and total enrollment was 0.2 million. By December 2011, there were 43 central universities, 129 deemed universities and 297 state universities, 65 institutes of national importance and other university level institutions. A total of 100 private universities and 33,023 colleges .Not only the number of institutions has expanded in India but the tertiary student's enrollments too have increased. The students enrollment by stages in higher education was highest at graduation level (86 percent of the total) followed by post-graduation level (12 percent of the total). Research and diploma/certificate courses accounted for just 1-1 percent share in total student's enrollment by stages in higher education[7].

Overall enrollment in India has gone up during the period 1950-1951 from 43,000 to 16,975,000 by 2010-2011 (provisional estimates) – an increase of 393.767 percent yet the gross enrollment ratio (GER) of India compares poorly with that of developed countries like the USA and UK. Even Brazil, Phillipines, Malaysia were having higher GER as compared to India.

The tertiary enrollments are highest in case of arts followed by science and commerce or management. The enrollment in science discipline was just 18.42 percent which is a cause of concern.

It is important to point out here that in spite of India's mammoth higher education system, demand for higher education outstrips its supply. Indian higher education system is grappling with several problems like accessibility, affordability, uneven distribution of private institutes, participation and low R&D output, etc.

Krishnan (n.d.) points out in his paper regarding higher education system in India that "While the higher education system is broad in scale and scope, its research output is poor. The higher education system accounted for just 4.2% of the national R&D expenditure in 2002-03. According to a prominent member of a task force set up by the government to look at basic scientific research in India's universities, there has been a complete neglect of research culture in universities. In spite of the large size of India's R&D and higher education sectors, India accounted for only 2.19% of the world's scientific publications in1993-97 and this declined to 2.13% for the period 1997-2001[8]. India's share of highly cited scientific publications was 0.32% in 1993-97 and 0.54% in 1997-2001. Among the 31 countries accounting for 98% of the world's most cited scientific publications, India ranks No. 30 on citation rate per paper. The crisis in the state of the sciences in the universities is matched by an equally serious one in the social sciences. The university system has been adversely affected by inadequate funding, failure to recruit faculty, political interference, and a weak accreditation system."

The decade 2010-2020 has been declared as the Decade of Innovation. Hopes have been expressed that India will become an innovation superpower by 2030. However, Krishnan (n.d.) points out that there is "[…] a lack of dynamism of the government R&D system, poor research output of higher education system, absence of a vibrant high-technology sector, limited scope and impact of government support programmes for R&D, a science-technology divide, and inadequate spillovers of foreign direct investment in R&D."

There is a need to reform the higher education sector if India wants to become knowledge powerhouse of the world. Education, training and ICT are three pillars of knowledge economy. In fact the government is aiming at strengthening these three pillars as is evident from the Eleventh Five Year Plan documents (Vol. I and Vol. II) which emphasizes on the need for massive expansion of university system ands also on creation of competitive world class institutions of higher education. There is a need for regulatory and accreditation mechanism to ensure the quality of higher education system. In addition, there is need for public-private initiatives and strengthening of university-industry linkages too to encounter the growing demand of tertiary education and the subsequent lack of resources. The next section deals with the role of private initiatives in higher education sector of India.

IV. Role of private initiative in higher education in India

According to NSS data, the government's share in overall education expenditure has been declining steadily, from 80 percent in 1983 to 67 percent in 1999. For states like Kerala, the decline is steep, from 75 to 48 percent, while for Madhya Pradesh it is from 84 to 68 percent. Indeed, while private expenditure on education rose 10.8 times between 1988 and 2004, that for the poor rose even faster, by 12.4 times. Many students who formally enroll in publicly funded colleges and universities barely attend classes there. Instead, they pay considerable sums to the burgeoning private sector vocational IT training firms such as NIIT and the Aptech or in new professions such as the "'Aviation University' being set up by the UB group."

Privatization of higher education is a highly debatable issue. There are people like Professor Yash Pal who take a cynical view of privatization. But economist like Kausik Basu feel privatizations is a reality. Basu says, "Those that are interested in profit would not be interested in good education is a fallacy. We should allow private investment in education, and if it becomes a success, it will attract infusion of funds into our higher education system."

Biswanath Pattanayak, Founder Director, Asian School of Business Management, Bhubneswar notes, "Most of the US centers of excellence are private initiatives, be it Wharton or Harvard" (Sanghi, 2009).

It is important to mention here that even Eleventh Five Year Plan document recognizes the role played by private mechanism in setting up of some first-rate institutions like Indian Institute of Science, Bangalore; Tata Institute of Fundamental Research, Mumbai; Xavier Labour Relations Institute, Jamshedpur; The Tata Institute of Social Sciences, The International Institute of Information Technology, Hyderabad, Vidyanagari in Baramati.

In recent years, private sector institutes like the Manipal Institute of Technology in Karnataka have played up an important role in bridging up demand-supply gap in higher education. With overwhelming demand for engineering seats and dismal record of government expansion, the private sector now accounts for 84 percent of the seats. Similar increase is taking place in medicine as well. In addition to Bangalore, Pune is rapidly developing into the educational capital of India. Nearly 200,000 students from across India study in its educational institutes that are over 100 in number and its nine universities (Kaul, 2006).

One thing is quite obvious that with the increase in per capita income, growing middle income class of India is willing to pay for educating its children and the private institutes can help filling this gap provided proper standards are maintained (Kaul, 2006).

Kiran Karnik of National Association of Software and Services Companies (NASSCOM) (2008) suggested the creation of "Special Education Zones" on the lines of special economic zones which are away from unnecessary regulations and bureaucratic hassles. Corporatized entities can function here, attracting faculty and students from around the world, with fees based on market forces but with scholarships and subsidized loans for needy students. (see *The Hindu*, December 1, 2005).

There is IT boom in India. The IT ITES industry in India accounted for 5.2 percent share of GDP in the FY 2007, earned $40 billion through exports and absorbed two million by the end of FY 2008. A study done by NASSCOM Deloitte (2008) study reveals that supply of IT professionals outstripped their demand till 2004 but now there is a shortfall of 62,697. The demand for IT professional is expected to increase to 430,000 by 2011-2012. Since the public higher education system is not able to supply the requisite number of trained people required for the industry and their curriculum could not keep pace with the changing trends in technology, the top five companies like Infosys, Wipro[9], TCS, HCL technologies and Satyam came forward and invested close to $430 million in 2007-2008 to train around 100,000 engineers hired during this period. Companies on an average conduct 163 training programmes annually and spend 80 percent of the budget on training entry level hires.

NASSCOM has undertaken various initiatives targeting three levels of talent requirement.

The example of initiatives taken by NASSCOM (as shown in Table II) point out that how private sector can help in improving the quality of engineering education by the following:

(1) Developing a de facto certification exam to test the competence of graduates.

(2) Working directly with the universities to reform and update the curriculum.

(3) Training faculty in new technologies and pedagogies.

(4) Putting new entrants through a rigorous boot camp to improve standards (Dahlman, 2010).

The demand from the market is growing for IT professional and the system is under stress to provide adequate number of skilled professionals which are equipped with the required knowledge and technical skills to fill up this demand-supply gap. Recognizing this urgent need, the Eleventh Plan envisages setting up of 30 CUs, eight new IITs and new IIMs, ten new NITs, three IISERs, 20 IIITs and two new SPAs. With the past wonderful experience with private institutes in India and the resource crunch facing higher education sector, the government is likely to explore the scope for public-private partnership in the establishment of the new institutes to cash on India's advantage in technology and knowledge. But here is a note of caution from Beteille (2010), he says that "the challenge before them (universities) today is to become socially more inclusive without relaxing standards of teaching and research."

For the entry level employees	NASSCOM assessment of competence launched in 2006
	Working with universities and colleges to align their curriculum with the needs of the ITES-BPO sector
For the middle level employees	NAC-Tech Test
	Finishing school for engineering students programme
	IT workforce development programme aiming at improving the interaction between the industry and academia
For the top level	Working with MHRD to develop highly specialized professions in "on the horizon" technologies that are not yet mainstream
	Collaboration on the establishment of five new IIITs based on PPP model by the end of 2008

Table II.
Initiatives undertaken by NASSCOM

V. Conclusions

In the decade of 1950s and 1960s the supremacy of the USA in science and technology and innovation was well known. With increasing globalization many new players have come to the forefront including India. India is making its presence felt by undergoing a transition from an imitator to innovator. The scientific and technological landscape in India stands changed with the internationalization of R&D and that of services. India is having large number of R&D institutes and a large pool of scientists, engineers and R&D manpower. FDI is growing and the size and scale of higher education too has expanded over a period of time. The spectacular dynamism shown by the Indian economy in the decade of 1990s has raised visions of India becoming a knowledge and innovation superpower. It is in this background the paper made an attempt to assess the performance of the India's innovation system which comprises of investment, infrastructure, and knowledge and skill generation and relations and linkages. The paper concludes that India is having a well-functioning NIS yet much need to be done if India wants to keep alive her ambition of becoming knowledge powerhouse. The sustainable development of scientific and technological institutions with higher education is not an option but imperative.

Notes

1. As per Mani (2010) knowledge-intensive production refers to knowledge intensive manufacturing like chemical and metal products and machinery including electrical machinery and means of transport and knowledge-intensive services like tele communications, computer-related services and R&D services.
2. See www.dst.gov.in/stsysindia/stp2003.htm
3. file:///C:/Documents%20and%20Settings/Home/Desktop/Higher%20eductaion/NIS-India/FDI%20in%20R&D%20in%20India.htm, FDI in R & D in India.
4. See www.ugc.ac.in/pub/HEglance2012.pdf (accessed May 22, 2012).
5. file:///C:/Documents%20and%20Settings/Home/Desktop/Higher%20eductaion/Universities%20of%20India%202008%20-%20Trends%20in%
6. http://dipp.nic.in/fdi_statistics/india_FDI_April2011.pdf
7. www.ugc.ac.in/pub/HEglance2012.pdf (accessed May 22, 2012).
8. The publication scenario has not changed much even in 2005. India published just 14,608 articles in scientific and technical journals in 2005 (World Bank, 2009, pp. 340-1). More over, research and development expenditures as a proportion of GDP was just 0.80 percent in India during the period 2000-2007.
9. Wipro's trust Mission 10X has tied up with the NASSCOM to enhance skills of engineering graduates in IT and related sectors, the global software major said Monday.

References

Anand, M. (2008), Changing landscape of innovation systems in India: collaboration and entrepreneurship in emerging technology", Centre for Studies in Science Policy, Jawaharlal Nehru University, Delhi, available at: www.pucsp.br/icim/ingles/downloads/pdf_proceedings_2008/55.pdf (accessed August 20, 2012).

Arora, P. (2007), "Biotechnology innovation system in India: role of government", *Proceedings of the 5th International Conference Globelics Russia*, Sarator, September 20-23.

Baskaran, A. and Muchie, M. (2007), "The making of the Indian national innovation systems: lessons on the specific characteristics of the domestic and external co-evolutions of technologies, institutions and incentives", Working Paper No. 2, Development, Innovation and International Political Economy Research (DIIPER), Aalborg University, Aalborg East.

Beteille, A. (2010), *Universities at the Crossroads*, Oxford University Press, New Delhi.

Bound, K. (2007), *India: The Uneven Innovator*, London.

Brundenius, C., Lundvall, B.-A. and Sutz, J. (2009), "The role of universities in innovation systems in developing countries: developmental university systems-empirical, analytical and normative perspectives", in Lundvall, B.A. *et al.* (Eds), *Handbook of Innovation Systems in Developing Countries*, Edward Elgar, Northampton, MA.

CII (2007), *Innovate India: National Innovation Mission*, Confederation of Indian Industry, New Delhi.

Dahlman, C. (2010), "Education and growth of services", in Ghani, E. (Ed.), *The Service Revolution in South Asia*, Oxford University Press, New Delhi, pp. 261-312.

Department of Science and Technology (2008), *Research and Development Statistics at a Glance 2007-08*, Ministry of Science and Technology, Government of India, New Delhi, October.

Desai, P.N. (2009), "Globalization of innovations: changing nature of India's science and technology cooperation policy", *International Journal of Institutions and Economics*, Vol. 1 No. 1, pp. 52-77.

Desai, P.N. (2011), "Globalization of innovation: India's S & T cooperation policy towards the developing countries", in Allam, A. *et al.* (Eds), *World Sustainable Development Outlook 2011*, World Association for Sustainable Development Publishers, Brighton, pp. 27-43.

Dreze, J. and Sen, A. (1996), *India: Economic Development and Social Opportunity*, Oxford University Press, Delhi.

Dutz, M.A. (Ed.) (2007), *Unleashing India's Innovation: Towards Sustainable and Inclusive Growth*, The World Bank, Washington, DC.

Economist Intelligence Unit (EIU) (2009), *A New Ranking of the World's Most Innovative Countries*, EIU, London, New York, NY and Hongkong, available at: www.eiu.com/sponsor/cisco/innovationindex09c (accessed August 20, 2012).

FDI Intelligence (2011), *Financial Times Ltd*, OCO Monitor, April.

Freeman, C. (1982), "Technological infrastructure and international competitiveness", draft paper, OECD Ad Hoc-Group on Science, Technology and Competitiveness, August, mimeo.

Freeman, C. (1995), "The national innovation systems in historical perspective", *Cambridge Journal of Economics*, Vol. 19 No. 1.

Gupta, A. and Dutta, P.K. (2005), "Indian innovation system – perspective and challenges", available at: www.dsir.gov.in/pubs/te/te200502.pdf

Herstatt, C., Tiwari, R., Ernst, D. and Buse, S. (2008), "India's innovation system: key elements and corporate perspectives", Working Paper No. 51, Hamburg University of Technology, Hamburg, April, available at: www.tu-harburg.de/tim/downloads/arbeitspapiere/Working_Paper_51.pd (accessed August 20, 2012).

Joshi, S. (2004), "Tertiary sector-driven growth in India: impact on employment and poverty", *Economic and Political Weekly*, Vol. 39 No. 37, pp. 4175-8.

Joshi, S. (2010), "From the 'Hindu rate of growth' to 'unstoppable India': has the services sector played a role?", *The Service Industries Journal*, Vol. 30 No. 8, pp. 1299-312.

Joshi, S. (2012), "Sustainable development of higher education for catalyzing services driven economic growth in India", Working Paper No. 2012/01, Maastricht School of Management, Maastricht.

Kalam, A.P.J.A. and Rajan, Y.S. (1998), *India 2020: A Vision for the New Millenium*, Penguin Books, Delhi.

Kapur, D. and Mehta, P.B. (2007), "Mortgaging the future? Indian higher education sector", Brooking-NCAER Indian Policy Forum 2007, Brooking-NCAER, December 26.

Kaul, S. (2006), "Higher education in India: seizing the opportunity", Indian Council for Research on International Economic Relations Working Paper No.178, May.

Krishnan, R.T. (n.d.), Can India become an innovation powerhouse?", available at: demo.netcommlabs.com/innovationgrid/…/Can_India_become_an_Innovation_Powerhouse.pdf (accessed August 20, 2012).

Lundvall, B.-Å. (1985), *Product Innovation and User-Producer Interaction*, Aalborg University Press, Aalborg.

Mani, S. (2006), "Sect oral system of innovation of Indian pharmaceutical industry", Centre for Development Studies, Trivandrum, Working Paper No. 3s82,2006.

Mani, S. (2007), *The Incremental Innovator Vs the Trader : Contrasts between the Sectoral System of Innovation of the Indian Pharmaceutical and Telecommunications Industries*, Centre for Development Studies, Trivandrum.

Mani, S. (2010), "*India*" *in UNESCO Science Report*, UNESCO, Paris, pp. 363-77.

Mitra, R.M. (2007), "India's emergence as a global R & D center: an overview of the Indian R & D system and potential", Swedish Institute for Growth Policy Studies. Working Paper R2007:012.

NASSCOM Deloitte (2008), "Indian IT/ITES industry: impacting economy and society 2007-08", available at: www.slideshare.net/nasscom/indian-itites-industry-impacting-economy-and-society-2007-08 (accessed May 20, 2010).

Nassif, A. (2007), "National innovation system and macroeconomic policies: Brazil and India in comparative perspective", UNCTAD Discussion Paper 184.

Richardson, P. (2002), "New science, technology and innovation developments in India", Proceedings of the STRATA Consolidating Workshop, Brussels, April 22-23.

Sanghi, D. (2009), "Curriculum Design for Excellence", *EDU TECH*, p. 28.

Stiglitz, J.E. (1998), "More instruments and broader goals: moving toward a post-Washington consensus", 1998 WIDER Annual Lecture, WIDER, Helsinki.

TIFAC (2005), "FDI in the R & D sector: study for the pattern in 1998-2003", Report prepared by Academy of Business studies, New Delhi.

World Bank (2009), "World development indicators", The World Bank, Washington, DC.

World Bank (2011), "World development indicators", The World Bank, Washington, DC.

Web references

Available at: www.dst.gov.in/stsysindia/stp2003.htm (accessed May 15, 2011).

Available at: http://dipp.nic.in/fdi_statistics/india_FDI_March2011.pdf (accessed May 20, 2011).

Further reading

Bhardwaj, A.K. and Kapoor, R. (2008), "FDI in R&D in India", *S&T and Industry, India Science and Technology*, Delhi, available at: www.nistads.res.in/indiasnt2008/t4industry/t4ind5.htmwebsite (accessed August 20, 2012).

Dahlman, C. and Anuja, U. (2005), *India and the Knowledge Economy: Leveraging Strengths and Opportunities*, WBI Development Studies, The World Bank, Washington, DC, available at: info.worldbank.org/…/India%20and%20the%20Knowledge%20Economy%20Leveraging

Government of India (2007-2010), *Eleventh Five Year Plan 2007-2012*, Vol. II Planning Commission, Government of India, Delhi.

Organization for Economic Co-Operation and Development, "National innovation systems", available at: www.oecd.org/dataoecd/35/56/2101733.pdf

United Nations Educational, Scientific and Cultural Organization (UNESCO) (2007, 2008), *World Education Digest*, UNESCO, Paris.

Wipro trust (2011), "NASSCOM to hone IT skills of graduates", available at: http://education.in.msn.com/news/article.aspx?cp-documentid=5127847 (accessed April 19, 2011).

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