Technology Development In India: An Evaluation

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ABSTRACT

Technology is a key driver of economic growth. Its role in the growth process has attracted a great deal of attention in the literature. Although countries may achieve a higher standard of living e.g., through a higher rate of capital accumulation, but they will not be able to enjoy continuously high economic growth without technological development progress. The present paper attempts to examine the various phases of technological development in India since independence. The paper reveals that India had relied on the policy of import substitution for a long period. As a result, India's economy grew slowly for many years. The paper also examines the crucial role of foreign direct investment (FDI) as a channel to gain access to technology developed abroad. It is observed that FDI has been widely recognized as a key modality for the acquisition of sophisticated latest technologies by developing nations. It also helps to increase the productive capacity of the economy. Although government of India has brought a paradigm shift in the FDI policy since 1991 still more efforts are required to encourage the foreign investors.

INTRODUCTION

Technology is a key driver of economic growth. The role of technology in the growth process has attracted a great deal of attention in the literature. Since the onset of the first industrial revolution, economists have struggled to understand why growth proceeds slowly at some times and in some nations, but rapidly in others. During the past two decades, a new growth theory has taken the economic profession by storm, identifying technological change as a key factor in economic development (World Economic Forum, 2003). Today, technology has been recognized as the most dynamic force, shaping destiny of countries all over the world. It plays a very important role in the economic development of a country. The literature has shown that economic growth of any nation depends upon two factors i.e., accumulation of factors of production and technological development. Out of these two factors, technological development has emerged as a dominant factor of long-run economic growth due to the limitation of the factor accumulation. As per UNCTAD (1977) report, "technological transformation is being regarded as the core of development and its absence is being equated with perpetuation of economic backwardness".

According to World Economic Forum (2003) technology plays a critical role at all stages of economic development but the way this driver affects economic growth varies according to the level of economic prosperity a country has already achieved. At early stages of economic development, a country's ability to launch its economy on a steeper growth path depends primarily on the transfer of technology that has been developed abroad, a process known as technological diffusion. At more advanced stages of economic development, technological diffusion becomes increasingly important for countries to sustain rapid economic growth. In the high income countries, each new technological innovation triggers yet further innovation, in a kind of chain reaction that fuels long–term economic growth.

Technological progress and economic development are interdependent. Today technology has come to be almost universally recognized as a factor of production of par excellence (UNCTAD, 1975). As technology is a significant factor in economic development, developed countries spend considerable amount on research and development for further advancement of technology. Germany spends 50 per cent of its R&D budget on product innovation and the remaining 50 per cent on process innovation. Japan spends 30 per cent on product innovation and the remaining 70 per cent on process innovation. There is no single instance in the world, where a country has attained development without attaining technological progress.

And in order to attain technological progress, there are two alternatives for any nation. One is development of technology indigenously and the other is to import technology from the other nations. The investment in development of technologies is concentrated largely in developed countries. The developing countries are lacking in the development of indigenous technology due to various practical constraints such as financial problem, lack of professionals etc., hence, the only choice left for them is to import technology. In this regard, Scherer (1999) reported three main barriers in the developing countries. The most important one is the lack of or critical shortcoming in a legal and institutional framework that encourages vigorously independent risk-taking and dynamic competition. The second barrier lies in the scarcity of business entrepreneurs willing and able to take advantage of the opportunities for development offered by modern technology. And third, because developing countries have, by definition, low real per capita incomes, they face particularly harsh constraints in allocating funds to research and development whose benefits tend to accrue only after considerable lags.

Considering the importance of technology in the economic growth, the present paper attempts to examine the following two aspects, namely, progress made in the field of technology in India since independence and the role of Foreign Direct Investment (FDI) to gain access to technology developed abroad. In the light of above objectives, the present paper is based on the secondary sources of data. For this purpose, various issues of economic surveys, government of India and the reports published by the government and non-government agencies were considered. The present study has been carried out in three sections. The progress of technological development since independence is presented in section-I. The role of FDI for the promotion of technology is discussed in section-II. And the summary, conclusions and recommendations are presented in section-III.

SECTION-I

ECHNOLOGICAL DEVELOPMENT IN INDIA SINCE INDEPENDENCE

Recognizing the importance of technology for a country's economic growth, the Indian government has given a vital role to technology in the economic planning since independence. Specifically, India's technology policy can be divided into four phases. The first phase, which lasted from independence to the end of 1960s, was a phase of relatively liberal policies. The second one, which lasted from the end of 1960s to the early 1980s, was the phase of intensified import substitution. The third phase, which began in 1980s and lasted till the end of 1990s, was the phase of initial deregulation. And the last one i.e., the fourth phase, which began in 1991, is considered as the phase of full-scale liberalization and integration of Indian economy with global economy.

According to Sridharan (1998), the first phase, which is also known as early post independence phase of the technology policy, was characterized by relatively liberal broad front import of technology without restrictions on the terms and conditions of contracts. It was the period of building up a diversified heavy and capital goods industrial base by public sector-led import substitution. Initially, due to lack of technology, India had to import technology on liberal terms. However efforts were made to develop a scientific base for the promotion of indigenous technology. A chain of institutions based upon India's science and technology policy were created. This includes institutes like Council for Scientific and Industrial Research (CSIR), Department of Atomic Energy

DAE), the Indian Council for Agriculture Research (ICAR), the ndian Council for Medical Research (ICMR), the Defence esearch and Development Organization (DRDO), the epartment of Space (DOS) and Electronics (DOE) etc. urthermore, Science Policy Resolution was adopted in 1958 hose main objective was to promote the science and cientific research in all aspects and to ensure for the people of he country all the benefits that can accrue from the cquisition and application of scientific knowledge. Thus it ecognized science and technology as the key to national rosperity.

The second phase of Indian technology policy was the period that lasted from the end of 1960s to the early 1980s. This was the phase of import substitution. In May 1971, the department of science and technology was set-up with the key objective of promoting research in the new areas and to play the role of a nodal department for organizing, coordinating and promoting science and technology activities in the country. There was greater thrust for indigenization of technology and movement for self-reliance. Restrictive rules were followed in case of import of technology and foreign investments. Moreover, the external wars of 1962, 1965 and 1971 highlighted the importance of technological self – reliance for security reasons. This period has also been characterized as a period of "closed technology policy" with great emphasis on self-reliance. Despite following a very strict policy of import substitution it could not result in big achievement for Indian industries. The international competitiveness of Indian goods was suffering from growing technological obsolescence and inferior product quality and high cost due to highly protected local market. The government wanted to come out of this situation by putting emphasis on the modernization of industry with liberalized imports of capital good and technology, exposing the Indian industries to foreign competition by gradually liberalizing trade regime and assigning the greater role to MNCs in the promotion of manufactured exports. This strategy was reflected in the policy pronouncements that were made in the 1980s (Sharma and Chandan, 2002) i.e., in the third phase of technology development. The Technology Policy Statement (TPS) issued by government in the January 1983 contained two key points. It stated that technological self – reliance did not mean technological self – sufficiency thereby justifying import of technology where appropriate. The technology policy statement focused on making India self-reliant and competitive in technological field. It ensures efficient absorption and adaptation of imported technology appropriate to national priorities and availability of resources. It also proposed the creation of a National Register on Foreign Collaboration.

The last phase of technology development was the phase of substantial liberalization of technology policies along with attractive invitation to foreign investment in India. In 1991 The New Industrial Policy (NIP) was formulated in such a way to liberalize the Indian policy towards foreign investment and technology. In order to inject the required level of technological dynamism in Indian industry, the policy provides automatic permission to foreign technology agreements for royalty payments up to 5 per cent of domestic sales or 8 per cent of export sales or for lump sum payments of Rs. 10 million. Automatic approval for all other royalty payments will also be given if the projects can generate the required foreign exchange internally. No permission will be required for hiring foreign technicians or for testing of indigenously developed technology abroad.

Automatic approval has been allowed for technology agreements related to high priority industries within specified parameters. 51 per cent foreign equity is also allowed in these industries. 35 industries have been specified in the category such as electrical equipment, telecommunication equipments, industrial and agricultural machinery, hotel and tourism industry, transportation, food processing, metallurgical and industrial investments. Earlier foreign equity participation was restricted normally to 40 per cent and foreign investment and technology needed prior approval. Further, according to a new guideline by government of India issued in January 1997, foreign companies may be allowed to set-up 100 per cent companies where sophisticated technology is proposed to be brought in.

Thus the New Industrial Policy has clearly identified foreign investment as an important channel for technology transfer into India. According to NIP "Foreign investment would bring attendant advantages of technology transfer, marketing expertise, introduction of modern managerial techniques and new technologies for promotion of exports. There is a great need for promoting an industrial environment where the acquisition of technological capability receives priority. In the fast changing world of technology, the relationship between the suppliers and users of technology must be continuous one. Such a relationship becomes difficult to achieve where the approval process includes unnecessary governmental interference on a case-to-case basis involving endemic delays and fostering uncertainty. The Indian entrepreneur has come out from the era of restrictions and is free from such bureaucratic clearances for commercial technology relationships with foreign technology suppliers".

The foregoing discussion reveals that India had relied on the policy of import substitution for a long period. As a result, India's economy grew slowly for many years, with GDP growth averaging just 1.6 per cent per capita annually during the post-independence period till the mid 1980s. However, averaged GDP growth was 2.6 per cent up to the end of 1990s. After the substantial policy liberalization in 1991 and onwards, the rate of GDP growth reached up to 4.2 per cent per capita a year. India is still no tiger, but it is certainly exhibiting a healthier growth than in earlier years (World Economic Forum, 2003). The government of India has made numerous efforts to build up science and technology field at par with the developed countries. In September 1996 the Technology Development Board (TDB) was constituted to provide financial assistance to industrial concern and other agencies for attempting development and commercial application of indigenous technology or adapting imported technology for wider domestic application. Since its formation, the board has signed 91 agreements with commercial enterprises and three other agencies spread over 15 states / UTs. Out of total project cost of Rs. 1,007.40 crore the board had committed Rs. 363.50 crore as financial assistance. Further, TDB instituted a 'National Award for Successful Commercialization of indigenous technology' for an industrial concern to be given

away on the Technology Day i.e., 11th May every year commencing from 1999. Moreover, in order to promote innovation among entrepreneurs, Technopreneur Promotion Programme (TePP) has been initiated with the main aim of to trap the vast untapped innovative potential of the Indian innovators (Reference Annual, 2003).

The importance of science and technology can be adjudged from the allocation of resources for its promotion during the post-reform period.

Table 1 shows the annual expenditure on science and technology in India from the period starting 1990 – 91 to 2006 – 07. Table 1 clearly depicts the increase in the expenditure on science and technology with each passing year, the expenditure being Rs. 758.7 crore during 1990 – 91 and Rs. 8394.7 crore during 2006 – 07. Although the expenditure on science and technology exhibited a growing trend over the years still it does not match with the developed countries' expenditure on science and technology.

A comparative analysis of technological competitiveness of countries in the following table clearly shows the dominance of developed world in regard to developing countries.

TABLE 1: Annual Expenditure on Science and Technology in India

Year	Science & Technology Expenditure (Rs. Crore)	Percentage Increase
1990 – 91	758.7	-
1991 – 92	861.7	13.57
1992 – 93	929.9	7.91
1993 – 94	1153.4	24.03
1994 – 95	1407.4	22.02
1995 – 96	1764.8	25.39
1996 – 97	1854.0	5.05
1997 – 98	2004.0	8.09
1998 – 99	2442.5	21.88
1999 – 00	2941.7	20.43
2000 – 01	3248.5	10.43
2001 – 02	3669.7	20.28
2002 – 03	4159.7	13.35
2003 – 04	4356.1	4.72
2004 - 05	5521.1	26.74
2005 - 06	6410.6	16.11
2006 - 07	8394.7	30.95

Source : Various issues of Economic Surveys.

TABLE 2: Technological Competitiveness of Countries

S. No.	Indicators	Country	Rank	Score	Criteria of scoring
1.	Technological Sophistication	USA	1	6.8	Country's position in technology (1=lags behind most other countries, 7=is among the leaders)
		Israel	2	6.7	
		Finland	3	6.4	
		China	39	3.9	
		India	42	3.8	
2.	FDI and tech. transfer	Ireland	1	6.2	FDI in country (1=brings little new tech, 7=is an important source of new tech.)
		Hungary	2	6.1	
		Costa Rica	3	6.0	
		India	15	5.4	
		China	44	4.8	

3.	Prevalence of foreign tech. Licensing	India Israel Thailand Singapore China	1 2 3 4 54	5.9 5.8 5.7 5.6 4.6	Licensing of foreign tech is (1=uncommon, 7= common means of acquiring new tech)
4.	Firm-level tech absorption	Israel USA Japan India China	1 2 3 16 48	6.6 6.6 6.3 5.5 4.7	Companies in country are (1=not interested in absorbing new tech, 7=aggressive in absorbing new tech)
5.	Company spending on R&D	USA Sweden Germany India China	1 2 3 32 34	6.1 5.9 5.8 3.6 3.6	Companies in country (1=do not spend money on R&D, 7=heavily spend on R&D relative to international peers)

Source : Global Competitiveness Report, 2002-2003

Table 2 depicts India's position in the field of technology in comparison with world leaders. In addition, India is also compared with China. In recent years, the world's two most populous countries, India and China have registered substantial improvements in their economic growth. Data in table 2 reveals that India lags far behind as compared to the world leaders USA, Israel, and Finland in technological sophistication. China too, stands far behind the leaders in this category. As regards FDI and technology transfer is concerned, India is ranked at 15th position and is far ahead of its competitor China. India outperformed all other countries in case of licensing of foreign technology. Licensing of foreign technology has become an important source of new technology and India has taken the maximum benefit of this mode of acquiring new technology. India has attained 16th rank in firm-level technology absorption. However, in case of company spending on R&D, India's position is not good. Jacobsson and Ghayur (1994) observed that the response of industry in particular the private sector is quite discouraging in regard to its commitment to R&D under the new economic environment. Whereas, Sinha (1994) noted that Indian R&D was predominantly directed to materials technology in order to minimize imports rather than product development.

SECTION-II

OREIGN DIRECT INVESTMENT (FDI) AND TECHNOLOGY DEVELOPMENT

The importance of foreign capital and technology for a developing country like India needs no special explanation. A number of other developing countries like China, Ireland, and former communist countries in Europe etc. have already changed their attitude of hostility to the entry of FDI. These countries have made sharp policy changes and now they are competing with each other to attract the foreign firms. Emphasizing the importance of foreign firms Romer (1993) suggested that for a developing country trying to keep up with or gain on more advanced countries, the main obstacle was the gap in knowledge, or ideas, rather than in physical capital. Much of that intellectual gap was the human or organizational capital of multinational firms, which is what enabled them to be multinational. For more rapid growth in a developing country, "one of the most important and easily implemented policies is to attract foreign firms to close the idea gap".

According to Cherunilam (2000), FDI refers to investment in a foreign country where the investor retains control over the investment. It typically takes the form of starting a subsidiary, acquiring a stake in an existing firm or starting a joint venture in the foreign country. Besides financial flows, FDI is seen as an important vehicle for the transfer of technology to its affiliates. The advantages of spillovers of technology from foreign firms to local one seems too great e.g. local firms might learn by imitating the foreign firms etc. It is also argued that the foreign firms' technology that is presumably superior one might raise the domestic firms' productivity.

The Planning Commission constituted a steering committee on FDI in August 2001 to recommend policy and governance reforms for attracting private investment, both domestic and foreign. In its report, submitted in August 2002, the steering committee on FDI suggests: FDI flows are usually preferred over other forms of external finance because they are non-debt creating, non-volatile and their returns depend on the performance of the projects financed by the investors. FDI facilitates international trade and transfer of knowledge, skills and technology. In a world of increased competition and rapid technological change, their complimentary and catalytic role can be very valuable.

TABLE 3: Total Foreign Technology Agreements (FTAs) During the Pre-Reform Period

Year	No. of FTAs approved	No. of FDI approvals	% Share of technical collaborations
1981 – 85	2,740	688	79.9
1986 – 90	2,853	1,154	71.2
Total	5,593	1,842	75.3

Source : Various Issues of Economic Survey

TABLE 4: Total Foreign Technology Agreements (FTAs) and Foreign Direct Investment (FDI) Approvals During the Post-Reform Period

Year (Jan-Dec)	No. of FTAs approved	No. of FDI approvals	%Share of technical collaborations	Amount approved of FDI (Rs.Crores)	Actual inflow of FDI (Rs.Crores)
1991	661	289	69.6	534	351
1992	828	692	54.5	3,888	675
1993	691	785	46.8	8,859	1,787
1994	792	1,062	42.7	14,187	3,289
1995	982	1,355	42.0	32,072	6,820
1996	744	1,559	32.3	36,147	10,389
1997	660	1,665	28.4	54,891	16,42 5
1998	595	1,191	33.3	30,814	13,340
1999	498	1,726	22.4	28,367	16,868
2000	418	1,726	19.5	37,039	19,342
2001	288	1,982	12.7	26,875	19,265
2002	307	1,966	13.5	11,140	21,286
Total	**7464**	**15,998**	**31.8**	**2,84,812**	**1,29,838**

Source : Various Issues of Economic Survey

Table 3 and Table 4 reveal the decline in technical collaborations from 75.3 per cent during pre-reform period to 31.8 percent during post-reform period. Whereas the number of FDI approvals rose sharply from 24.7 per cent during pre-reform period to 68.2 per cent during post-reform period. There has been a sharp decline in the number of Foreign Technology Agreements (FTAs) since the peak level of 982 achieved in 1995. This is because of the fact that most FDI proposals include foreign technology collaborations. There is a tendency now to convert purely technology transfer agreements later into financial collaborations by buying the equity shares of the concerns. In comparison to FTAs, the number of FDI agreements have been on the increase and reached the high level of 1,982 in 2001.

TABLE 5: Industry–Wise Approvals of FDI During the Post Reform Period (During August, 1991 to March, 2002)

	No. of Approvals		Amount of FDI	Percent
	Technical	Financial	approved	of
			(Rs.Crore)	Total
A.Basic Goods Industries	**1,517**	**1,942**	**107,576**	**38.8**
(i) Power	34	319	43,359	15.6
(ii) Oil Refinery	175	198	30,008	10.8
(iii) Chemicals	800	913	12,734	4.6
(iv) Mining, metallurgy & Other metals	351	338	15,403	5.6
(v) Other fertilizers, cement,etc.	157	174	6,072	2.2
B. Capital Good Industries	**3,237**	**3,301**	**25,117**	**9.0**
(i) Transportation industry	562	610	9,456	3.4
(ii)Electrical equipment	893	768	5,963	2.1
(iii)Electronics	158	327	3,228	1.2
(iv)Others	1,624	1,596	6,470	2.3
C. Intermediate Goods Industries	**251**	**560**	**4,993**	**1.8**
D. Consumer Non-durables	**1,387**	**2,976**	**27,623**	**10.1**
E. Consumer Durables	**37**	**122**	**9,357**	**3.4**
F. Services	**571**	**5,601**	**102,928**	**37.1**
(i) Telecommunications	126	675	55,281	19.9
(ii) Computer software	86	2,267	17,616	6.4
(iii) Financial Services	8	406	11,760	4.2
(iv) Other Services	351	2,253	18,271	6.6
Total	**7,000**	**14,502**	**277,597**	**100.0**

Source : Ministry of Commerce and Industry, SIA News Letter.

The data presented in Table 5 depicts that in case of industry – wise approvals of FDI, the basic goods industries accounted for 38.8 per cent of FDI. Among the list, the main share was appropriated by power (15.6 %) and oil refinery (10.8 %). Whereas mining and metallurgy accounted for 5.6% and chemicals only 4.6%. In the order of importance, the next group was that of services accounting for 37.1 per cent of FDI. Out of this, the major share was of telecommunications (19.9%) and that of computer software (6.4%) whereas financial services contribution was merely 4.2 per cent. As regards other industries concerned, consumer non-durables accounted for 10 per cent and capital good industries accounted for 9 per cent of FDI approvals. However, consumer durables accounted for only 3.4 per cent of FDI approvals and intermediate goods industries contributed barely 1.8 per cent.

TABLE 6 : State – Wise FDI Approvals (From Aug 1991 to Nov 2004)

Rank	State	Approvals			Amount of FDI approved		Percentage of total FDI approved
		Total	Tech.	Financial	Rs. In Crore	US $ in million	
1.	Maharashtra	5037	1318	3719	37020	9621	14.80
2.	Delhi	2810	307	2503	30519	8445	12.20
3.	Tamil Nadu	2681	618	2063	22642	5894	9.05
4.	Karnataka	2639	502	2137	19075	4833	7.63
5.	Gujarat	1236	568	668	12437	3273	4.97

Source : Economic Survey 2004-2005

TABLE 7: Sectors Attracting Highest Approvals in Technology Transfer During the Post Reform Period (During Aug, 1991 to Oct, 2002)

Sector	No. of technical collaboration (TC) approved	Percentage with total (TC) approved.
1. Electrical equipment (including computer software and electronics)	1,174	16.4
2. Industrial m achinery	832	11.6
3. Chemicals (other than fertilizer)	813	11.3
4. Transportation industry	604	8.4
5. Metallurgical industry	355	4.9

Source : Various issues of Economic Survey.

Table 6 displays the state – wise FDI approvals with Maharashtra topping the list following by Delhi, Tamil Nadu, Karnataka and Gujarat. Table 7 reveals that the most important sectors attracting highest approvals in technology transfer is electrical equipment, which includes computer software and electronics. Other important sectors are industrial machinery, chemicals, transportation industry and metallurgical industry.

SECTION-III

ECOMMENDATIONS AND CONCLUSIONS

Keeping in view the crucial importance of technology in the economic development in the present globalized economy, efforts on the parts of government and private agencies are needed to assimilate, improve and develop technology that is important for capability building. Although few limited attempts have been made to create a climate conducive to indigenous technological growth and self-reliance, often through building science and technology parks (STP), developing educational and training institutions, building industrial research organizations and providing financial support for the projects, imitating largely similar efforts in the industrialized countries (Subramanian, 1987; Chatterji, 1990) but it is not sufficient to transform the underdeveloped and agrarian economy into a more prosperous industrial economy.

Based upon their experiences and analysis of four organizations, two each from the public and private sectors, Virmani and Rao (1997) drawn the following lessons that may be relevant for other organizations wishing to introduce/upgrade technology successfully.

- Proper assessment of technology gaps by developing an institutional mechanism and use of appropriate database.
- Proper strategies for technology transfer, forecasting, assimilation and development.
- Marketing the technological know how.
- Upgrading the skills of human resources, which can analyse such information.
- Appropriate redeployment policy of the organization with the involvement of trade unions.
- Need based training rather than rewarding senior people with training stint abroad.
- Proper assessment of global competitiveness of technology.
- Close interdepartmental coordination between marketing and R&D which are treated at par.
- Systematic training needs identification, instant reviews of career planning and growth path and continuous training and development to help in assimilation of technology with employees.
- Job rotation and training, following an administrative a two path (advance through managerial/administrative channel or as specialist) career progression and compensation package to keep pace with the market demand for professionals.
- Concentration of value addition to products and processes resulting into a higher level of technology assimilation.
- Well laid out technology development strategy based on corporate plans, internal R&D capability, foreign technological developments and the government research policy.
- Negative impact of the high rates of duties on imports as a major negative influence on technological policy.

In recent period, FDI has been widely recognized as a key modality for the acquisition of sophisticated latest technologies by developing nations. FDI plays as a catalyst in bringing new technologies developed abroad. Moreover it also helps to increase the productive capacity of the economy. Although government of India has brought a paradigm shift in the FDI policy since 1991 still more efforts are required to encourage the foreign investors. The Planning Commission steering group emphasized the need to raise FDI from US $ 3.9 billion in 2001-02 to at least around US $ 8 billion a year during 2002-07. In order to achieve the target, the steering group suggested two ways, i.e., raise FDI through privatization and by removing barriers to FDI flows. Highlighting the importance of FDI through privatization the steering group observed, "Given the slow start of disinvestments in India, there have been little or no foreign inflows into disinvestments this has not enabled India to secure one of the significant advantages of privatization experienced in other countries"(p.18). Regarding the second source of FDI the steering group recommended the change in attitude from regulation to promotion. The steering group points out the need for further removal of restrictions especially the restrictions applicable to foreign nationals and entities.

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