ADB sponsored RETA Project in India

ICT and Emerging Technologies: Lessons from Indian Policy and Success

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1. Introduction

Indian success in ICT and emerging areas of technologies has remained moderate. Young companies including start-ups have scripted the success. Old incumbents from other industrial fields, most of who are large, did not enter the business of ICT or other emerging technologies. It was for the young companies to prove that ICT and emerging technologies offered immense opportunities for growth and profit. In the early years when the ICT was yet to be proven, the public policy too remained very restrictive; hand-holding for grooming the start-ups was not the policy-type. The heroic small companies were highly entrepreneurial. They sensed business opportunities. As appears the growth of these start-ups depended more on business innovation in the early years, and on organizational innovational as well as on raising capability in the matured phase of the business; and the innovation of these companies depended less on novel technological solutions. These are the key features of innovation in ICT and emerging technologies in the Indian context.

A mixed bag of rapid strides in select areas burdened with relatively slow or nearly nil growth in many related areas characterize recent Indian story. No less importantly even within the high growth areas there coexist brilliant patches and gray areas indicating institutional ruptures disallowing rapid diffusion. In similarity to many developed countries the incumbent large companies stayed away from the success stories, and the weighty presence of currently large incumbents in the scrips turnover market dwarfed only naturally the young smaller new technology companies. The latter in many cases could not raise enough capital required for growth. State directed and state supported growth through exports was indeed missing and critical dependence on domestic market remained tied up with the federated governance and democratic institutions. In the following sections we will quickly browse through certain key features of the Indian story.

2. Recent Features in ICT

India has retained a lead position in export of software and information services. A look at Table – 1 shows how Indian companies have continuously retained this lead

over competitors with both technological and early-movers' advantages hailing mostly from the developed countries. Capability exhibited by the Indian companies from private sector, most of who are young non-incumbent, specialist firms is well established against other competitors from Asia as well.

Table-1: Global Comparison: Exports of Computer & Information Services (in billions US$)

Country	2007	2006	2005	2004	2000
India	37.0	29.2	22.0	16.3	6.3
Ireland	26.1	21.0	19.6	18.8	7.5
UK	14.1	13.0	11.2	11.7	4.3
US	12.7	10.3	7.3	6.7	5.6
Germany	12.2	9.7	8.4	8.3	3.8
Seden	6.5	3.6	2.7	2.5	1.2
Israel	5.8	5.3	4.5	4.4	4.2
Spain	5.3	4.0	3.6	3.0	2.0
Canada	4.4	4.3	3.6	3.0	2.4
China	4.3	3.0	1.8	1.6	0.4

One important pillar of this capability is the knowledge workers of Indian origin but working in advanced countries. As evident from Table-2, the remittances data from India is indicative of high value adds. In comparison, inward remittances for many other Asian countries are of low values but high volumes of immigrants. The knowledge of such value-added workers constituted an important resource for the growth of Indian ICT companies first and then of the BT companies. The pharma companies, however, depended little on the knowledge of immigrant knowledge workers, instead these companies sourced know-how from domestic sources.

Table-2: Asian Comparison of Workers' Remittances (in millions US$)

Country	2007	2006	2005	2004	2003	2002
India	38219	29247	23909	20012	21885	16285
Philippines	13266	12481	10668	8617	7081	7167
China	10679	6830	5495	4627	3343	1679
Bangladesh	6593	5418	4302	3572	3180	2848

The invisibles therefore constitute an important indicator of India's gains and competence in ICT and emerging technologies. Table-3 exhibits the growth of trades in invisibles, on both receipts and payments. Software services clearly enjoy supremacy. So have been the business management and consultancy services. To recall such consultancy services are sourced from the competencies generated in the software services. The payments aspects of invisibles exhibit the feature that domestic companies are most often net earners.

Table-3: Invisibles in India's Balance of Payments (in millions US$)

Invisibles	**2007-8**	**2006-7**	**2005-6**	**2004-5**	**2003-4**	**2002-3**	**2001-2**	**2000-1**	**1999-00**
Invisibles Receipts	148604	114558	89687	69533	53508	41925	36737	32667	30312
Financial services	3217	3106	1209	512	299	676	292	347	361
Software services (1)	40300	31300	23600	17700	12800	9600	7556	6341	3962
IT services of (1)	29400	22900	17300	13100	9200	7100	6061	5411	3397
ITES-BPO of (1)	10900	8400	6300	4600	3600	2500	1495	930	565
Royalties, copyright, license fees	157	97	191	71	32	23	22	60	54
Business Mgt consultancy services	4433	4476	2320	1556	1296	807	519	334	643
Inward remittances from workers abroad	21920	14740	10455	9973	10379	9914	6578	7747	7423
Invisibles Payments	74012	62341	47685	38301	25707	24890	21763	22473	17169
Business mgt & consultancy	3653	3486	1806	1279	814	648	533	546	795
Maintenance of offices abroad	3496	4032	2074	2618	1736	1164	968	476	357

3. Nature of High Technology Trade

We will not go into the WTO related issues including the TRIPS related issues here. TRIPS have, however, significantly influenced the innovation strategies and expenditure by Indian pharma companies. The trade policy often has very little inputs from the ICT or other emergent technology sector ministries/ departments. To provide one example, software export from the country suffered badly from trade and tax related issues at least till mid-1990s. Section 80-HHC of the Income Tax Act provided exemptions to exports profits available to merchandise and this was extended to software exporters through section 80-HHE. However, while the former section remained valid for 5 years the software related later section remained valid for only one year. Apart from the uncertainty arising from annual these sections computed the 'profit' in such a manner as dis-incentivising software exports.

Another related issue is the policy on import of technology-embedded machineries for sectors requiring quick growth and sectors having domestic R&D. A clear break between these two modes could result in disparate attempts at modernization and India seems to have suffered badly from that. In fact the worst sufferer has been the electronics hardware sector. Another related de-link could be observed between two other sets of policies: cheapening of import duties in select sector having domestic capability and domestic R&D. A case in point has been the machine tools and several areas of electronics hardware. Large number of Indian companies imported second hand machineries and the domestic growth suffered badly.

India's high technology trade has increased from US$ 1021 million in 1995 to US$ 4463 million in 2006. The share of high technology trade in domestic GNP at 0.49% in 2006 is the lowest among the group of select developing countries. India's share of global high technology trade increased only marginally from 0.14% in 1995 to 0.23% in 2006. India's import of high technology has jumped in recent years following liberalization, and this import jumped from US$ 2621 million in 1995 to US$ 23 billion in 2006, which is 1.16% of global high technology import. Considerable increase in such high technology machineries indicates increasing contemporary capacity. Such imports

often resulted from the commerce ministry's initiative unrelated to the policies being pursued by the respective line ministry, for example, of the information technology.

In some of the high technology product export markets India is virtually absent. Contrarily, in such areas as computer office equipments Indian presence in global export market is relatively better. Similarly, in electronic telecommunication equipments India's export share increased about three times between 1995 and 2006, while the imports surged close to eleven times. In pharmacy Indian presence is significant. In 2006 India's share was about 5%, highest among the developing countries and the import share is less than 1%.

A point of concern in terms of both import and export is in the area of scientific instruments. India's share in global import in 2006 was only 1.05%; the export was abysmally low. This informs us about the poor market of scientific instruments in India, which in turn has caused closure of several instruments making companies and has otherwise limited both growth and innovation in this sector. It was observed from the ASI data relating to six most industrialized states of India that number of factories manufacturing scientific instruments was 158 in 2004-05, 286 in 2003-04 and 227 in 2002-03, and the output in nominal values increased only marginally during this period. It is worth noticing that a scientific instrument is not the business of only one ministry.

Public policies on payment of royalties and license fees have changed significantly in recent years. In the pre-liberalisation period government approvals were necessary for licenses and limits on royalties remained significant. Over the last decade subsequent to liberalization and deregulation this mode of payment under services trade has jumped up significantly. In most cases the line ministry does not specify the quantum of payments or the rates of payments. The issue of avoidance double taxation has been taken up with multiple countries. An important issue is regarding the transfer pricing and taxation related to that. The public policy in this regard is missing. Emergence of hundreds of R&D centers owned or invested in by the global businesses and otherwise the traffic of outsourcing business have generated multiple forms of transfer pricing or cases where arms length might not have been maintained.

India received royalties amounting to US$ 626 million in 2006 and paid out US$ 1056 in the same year. The evidence suggests that there is a strong correlation between royalties' payment and high technology trade. Apart from the technology balance of payments issues, Indian export in communication services was moderate, and not very significant in insurance services.

Trade in the area of computer and information services signifies India to be a non-minor player. India captured 16% of global export trade of 15 large economies and Indian import under this category was in dollar terms about 8% of export. This is the only segment where India has a significant global presence.

4. Experience from Software

Till about early 1990 India had little policy support for this sector. In the early years the MNCs had a dominant position and till late 1970s Indian market was under their control and it was a market of obsolete technologies. After their exit under government stipulation since early 1980s Indian public sector companies and a few from the private sector slowly effected the change or the switch over. Most part of the IT R&D was however, under the public sector. A few global majors retained insignificant presence although. Within the next decade the situation changed significantly. Both public sector and private sector large incumbent companies slowly lost business and mostly new start-ups continued growth.

A new growth and business strategy was adopted by these start-ups. In the formulation of this new business model public policy played little direct role. In the initial years the capital market too did not play any role. Social capital mostly in the form of vertical specialists and young human resources from engineering provided the real fillip.

Often spill over from large global players have been indicated as potential source of knowledge. It is not, however, verified by the facts. Most software entrepreneurs started on their own and had little, if any, knowledge spill over from experienced manpower from large global incumbents who contrarily were following alternate and

older business models. Indeed absence of public policy, public funds at cheap rate and foreign clients' hand-holding could not deter the emergence of this business model.

The software firms could not spend much on R&D in the early years. Even more importantly and unlike their global counterparts the domestic companies did not include trifles under the head of 'R&D'. The absence of R&D and presence of strong cash flows and reserves made most such companies the hottest in the capital market. In short less of public policy and more of market orientation helped the emergence of Indian software. In recent years these firms have undertaken R&D and spent on knowhow as shown in the Fig. 1.

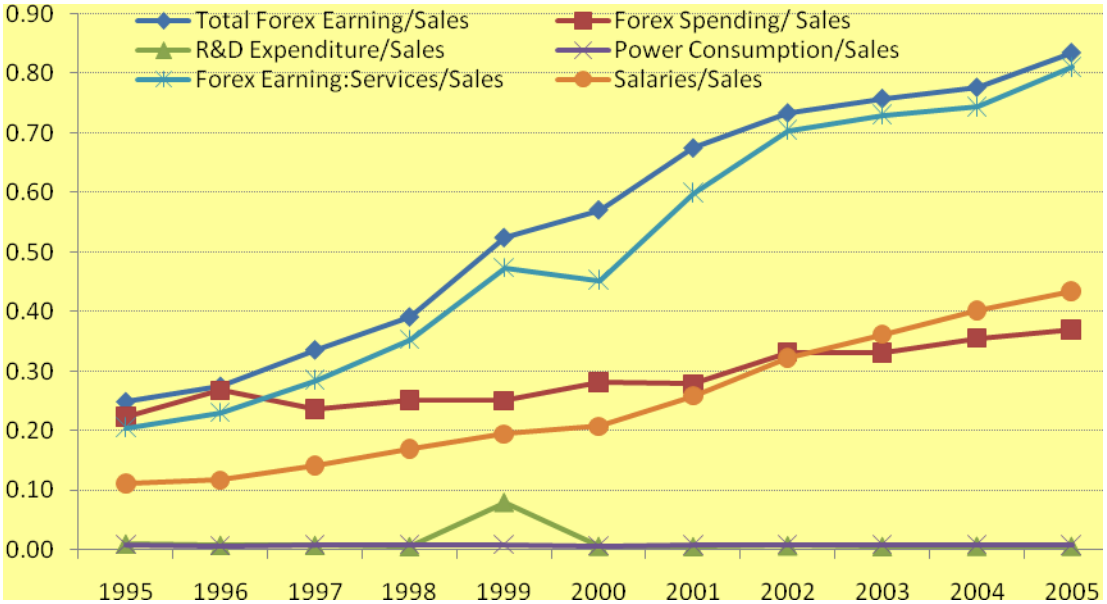

Fig. 1: Indicators of innovation in the software industries in India

5. Social capital & policies

The nature and structure of industrial R&D have remained closely determined by the industrial organization. A shift in the locus of knowledge production should thus indicate a corresponding shift in the institution of industrial organization. Both sectoral structure and the overall industrial organization have positioned till date the location, size, objectives and the style of management of the R&D. Till recently industrial

knowledge production has been channeled principally through the in-house R&D. In-house R&D in this perspective has been carried out by the incumbents first for raising a barrier to entry or as a deterrence to the prospective entrants; second as a deterrence to potential competition; and third as an internal competence raising instrument to organize and exploit knowledge-resources distributed over the entire manufacturing process or else for shaping tangible manufacturable products out of intangible and often public good of publicly available knowledge flowing out of research. Such R&D had to be thus departmentalized as an internal unit of the firm, had to be deployed and linked with both the industrial organisation reflecting as it did the nature of product market competition, and the internal organization of the firm. In other words, structure and position of this R&D remained determined by the structure, conduct and performance paradigm (SCPP) of industrial organization; and it has been shaped by the market structure and the co-ordination activity internal to the firm. A departure now can be noticed – firms especially from the ICT, biotechnology and other emergent sectors of the economy are generating knowledge not as much in-house as from the social milieu and from social partnerships; and even while knowledge is gathered in-house it is achieved primarily from the distributed activities. Indian software firms, we observe, have nearly done away with in-house R&D.

This fact of in-house R&D has been conditioned by several features of the industry and its sectoral type, its technology in operation and the nature of financing, competition and organizational structure of the firm owning R&D.

Such R&D system never could explain the location of R&D in services or the logical and technological specific relationships that knowledge had with providing improved or innovated services. As a result this system of R&D could not offer any institutional solution to utilization of knowledge in providing services. Software writing involved co-production of knowledge and the product or services. Such a concurrency was also observable in a few other networked high-technology production modes. Individual knowledge, career concern and social esteem of the knowledge worker, who is the contemporary king of resources, appear to be influencing both the progress of knowledge as in the open source modes or its knowledge products and the strategic

responses of the knowledge firms in redrawing and restructuring the structural modes of knowledge production.

A software manager faces very high manpower turnover, a socially diffused knowledge production and a system of production which is largely dependent on social investment on manpower, R&D and infrastructure. Knowledge co-ordination amongst competing or potentially competing firms assumes importance. Such a knowledge co-ordination takes place through social linkages, which are not owned exclusively by a firm. In our study on some small Indian software companies respondent managers/entrepreneurs could not define their understanding of the nature and the thrust of R&D in software. R&D in software differs from other technology R&D because there is no tooling or manufacturing phase of product development. With R&D finished, software is ready to copy, ship and use. Indian software, skeptics have remarked, thrives on an unevenness and the rising software export is more due to wage differentials than higher skills, as well as due to providing services and 'body shopping' – little of exports can be attributed to exports of products in packages or to outsourced R&D. It is important to emphasize that both domestic and global demands of software consists of a few types – such as published software (often known through packaged items), software for information systems or services, and the embedded software. All three broad types, in turn, require varieties of levels of skills, from programming to content writing, or from system architect to project management. Export of software therefore necessarily consists of a mix of all types of skills, and body-shopping once prevalent has now dwindled down. Several large multinationals who have opened up their exclusive R&D centers in India; and there are another group of such large global companies who through joint ventures or through tie-ups regularly outsource their core and critical software components from India; and then there is the third group of companies from abroad who frequently buy through contracting out software from India. These are, as observed above, critical and core components of software packages. In fact the outsourcing of embedded software too has experienced a sharp growth though software services remained all along the period the largest foreign exchange earner.

6. S&T Parks

Science, technology or research parks, being part of a country-innovation system, should be dependent on the country institutional factors. Such institutional factors are part of a legal-political economic system namely the technical labour market, the venture capital market and the structure of buyer-supplier ties, as determining differently various incentive constraints for both incumbent and the start-up firms. Science parks representing a novel innovation institution varied across countries depending on a mix of the history and the prevailing institutional factors. Business in software is not only dependent on knowledge produced globally, but is also dependent on buyer-supplier ties and the market-demands that are global.

Indian science parks have provided infrastructure facilities, but provided little of knowledge transmission links. Incubation of innovation too, figured little in their scopes. Entrepreneurship seems to have been nurtured by general features of country-institutions and science parks, as for example the STPI, could prove effective because an otherwise deficient infrastructure forced the innovators to seek infrastructure support from such parks. Such infrastructure facilities, we argue, attracted both the incumbents and the start-ups. Incumbents benefited more from the tax benefits while the start-ups saved upon capital investment, which would have been otherwise necessary, to invest their little wherewithal in cash-flow management of software projects. The latter type of project-based export of knowledge-products, in turn is determined by an international instead of a ‘national’ situation. A situation of default in infrastructure proved effective. In other words, while science parks by default incubated start-ups by way of entitling them with savings on capital investment, the start-ups in turn could prove to be innovative because a set of international factors did demand so. There had been little flow of knowledge from universities or otherwise from research centres to the units in STPI. Our observation on science parks of India emphasises this infrastructure aspect, and finds little knowledge link as well as flow of knowledge from universities to the start-ups inside these parks. Inter-alia, we argue that science parks while being part of the innovation institution of a country are also defined by global situations.

A case study on Software Technology Park (STPI) in India provides some interesting hints as a departure from experiences abroad. Software Technology Parks in India, as data indicate, were established as an infrastructure to promote/facilitate software exports. Thrust of STPI was not to encourage entrepreneurship of knowledge workers; it was neither to set-up strategic links amongst the research centres, universities and other technology transfer agencies. Software parks in India did not also have an objective to promote start-ups exclusively, or in other words such parks were not built for promoting start-up based innovations and enhance competition in the sector; although, Indian parks de facto promoted start-ups. STPIs were set up in the context of an overall strategy to promote industrial R&D and develop high tech industry in India; however, we observe that STPI's could not induce such R&D, or else could not promote research links especially with domestic educational/research bodies. STPI's knowledge-intensive production was facilitated by a global situation of knowledge-intensive production.

Before we discuss in detail the performance of the STPI in relation to promotion of software business, it would be meaningful to examine the characteristics of infrastructure provided by the STPI. Indian government was too busy deploying regulations on the hardware during the 1980s and till about mid-1990s, while largely neglecting the case of software, excepting perhaps by making the science park provision. Software export growth rate was 70% in 1981 but from an abysmally small base of US $ 4.0 million only. This growth rate varied over the next decade from about 99% in 1982 to only 9% in 1985 – however, mostly this remained in the proximity of 40%, till about mid-1990s, by which time the export reached a modest US $ 997 million in 1996/97 to see a growth in the following year of 65%, etc. In the initial years as also in the years following, virtually no large existing corporate (except the Tata's) got engaged with software, and the export was undertaken by small firms.

By 1998 regional concentration of software houses was much visible though; for example, out of total 558 software firms Bangalore had 152 headquarters, Mumbai 122, Chennai 93, Delhi/New Delhi 86, Hyderabad 34, Calcutta 27 and Pune 22. The governmental attempt to promote export of software just as it was following in case of

other manufactories, through the SEEPZ for example since the 1970s, began crumbling by the mid-1980s. Exports boomed from the non-export processing cities enjoying other 'infrastructures', such as, good market of professionals, good ambience of informal links, etc. It was around this time that software parks came up.

Software Parks, a variant of Science Park though, appeared on the Indian scene at a time when the telecommunications infrastructure was in a state of shambles. The start-ups who were appearing or the small firms who have been on the software export business, were suffering immensely from the lack of a rudimentary telecommunication infrastructure – they were suffering not as much from power crisis, surely not so much also from scarcity of developed real estate and surely the least from an absence of tie-ups/linkages with research-centres/universities. The government till then used to expect export of software to continue through merchandise (such as tapes, diskettes, etc. – through ports and by making entries of physical volumes and prices, etc.), and there was no ISDN, or even other broad band facilities. Satellite links were yet to be provided. Leased lines too were not so much available. The STPI filled in this gap an availability of comparatively better telecommunication. Larger software firms by early or mid-1990s had secured for themselves satellite links or leased lines, etc., although the capital cost of such provisions were beyond the reach of most small or start-up firms. Moreover, cost of space in large cities such as at Mumbai, was huge. However, it was much less in Bangalore or at Chennai. South and West India also suffered less from power crisis. This absence of basic telecommunications and other infrastructures were joined by the absence of a vibrant capital market – especially an active stock exchange, market-makers, and surely the venture financing. Start-ups and small firms could offer anything but paltry 'receivables' as pledge to a bank, which was in the wont of exercising a very strict and highly manufacturing-oriented credit rationing. The result of all this was a hungry software innovators and businesses.

Larger firms were using more of corporate data networks. Some were using integrated (voice and data) networks. Availability of PSDN (public switched data network) was not abundant, and was definitely not competitive. Small or start-up firms could with difficulty thus access the PSDN only if they had adequate computing

equipment, which it may be recalled, was still priced much higher than the international prices owing to governmental regulations on hardware. The STPI however, did not offer any 'ducting' such that a business could compare competitive prices from telecommunications firms; instead, an user of STPI had to accept what prices were being offered.

Government identified as an area of focus and announced a policy in 1986 making "Software Exports, Software Development and Training" as a major thrust area. It further identified some of the factors impeding the growth of the software industry and formulated Software Technology Park (STP) scheme with a view to boost software exports from the country. To meet this objective, a suitable framework was formulated covering aspects like simplifications/rationalization of procedures, providing single-point contact services to the industry, providing basic amenities needed for export operations with a very short gestation period and sharing captive infrastructure facilities like computing resources and data communication services in a cost effective manner. The framework was designed to help software export industry in general and Small and Medium Enterprises (SMEs) in particular enabling them to remain competitive in the global market. Government of India on May 22, 1998 also constituted a "National Task Force on Information Technology and Software Development" to recommend steps to remove bottlenecks in the path of rapid development of information technology. Software Technology Parks of India (STPI) was set-up to implement the STP Scheme and to promote software exports by providing infrastructural facilities including High Speed Data Communication (HSDC) links. The offshore development through HSDC links by STPI had increased from 5% in 1991-92 to around 70% during 1998-99. STPI set-up 18 centres in nine years at the following places: Bangalore, Pune, Bhubaneswar, Hyderabad, Noida, Gandhinagar, Thiruvananthapuram, Chennai, Mohali, Jaipur, Navi Mumbai, Coimbatore, Manipal, Mysore Guwahati*, Vizag*, Indore*, Calcutta** (*then under implementation; **then under State Government of West Bengal). STPI has also established Business Support Centre in the Silicon Valley, USA in the year 1999. STPI centres act as 'single-windows' in providing services to the software exporters. Some of the STP centres provide incubation infrastructure to Small & Medium Enterprises (SMEs), enabling them to commence operations without any delay. The centres are

equipped with basic facilities like back-up power, EPABX, security, training aids, library, photocopier, fax etc. with a built-up space. Due to the weak capital market for the Indian Software industry, lending institutions including banks are reluctant in taking risks especially for new entrepreneurs. In these circumstances, the incubation centres give an indirect short-term shelter to SMEs to establish themselves in the market by reducing the investment required for a start-up. STPI is working closely with the respective State Government/local authorities for creation of more space, equipped with state-of-the-art infrastructure facilities, for development of the software industry and increasing exports

Software Technology Park (STP) is a 100% export oriented scheme for the development and export of computer software using communication links or physical media and including export of professional services. This scheme is unique in its nature as it focuses on one product/sector i.e. computer software. The scheme integrates the concept of 100% Export Oriented Units (EOUs) and Export Processing Zones (EPZs) of the Government of India and the concept of Science Parks/Technology Parks as operating elsewhere in the World.

Some highlights of the STP Scheme are:

- Approval under single window clearance mechanism
- 100% foreign equity permitted.
- Imports in the STP units are completely duty free.
- Second hand capital goods may also be imported.
- Custom Bonding period shall be 5 years, but may be extended to 10 years in case of products requiring significant capital investment and infrastructure.
- Exemption of local taxes for domestic purchases.
- The sales in the domestic market are permissible upto 50% of the exports.
- Exemption from corporate income tax.

Comparing telecommunications infrastructure provided by the STPI with the available bandwidth for most international parks or of the large corporate, we observe

that data transfer rate of STPI is small enough. Moreover, competitive domestic carriers have not been allowed to offer their services through ducts at the STPI establishments. A tenant is forced to share/use the services provided by the park authority. Apparently this authority has not been led to design the offered telecommunications services by the current and potential market demand; in fact estimation of such demands have apparently not been made. Large exporters of software / services have established in the recent years their own satellite connections. An interesting feature of STPI scheme is that firms registered with a park, need not hire/buy space at the park itself – allowing de-linking of the use of STPI space from registration, which offers benefits of taxes. A firm registered with STPI but not located in the park premises, can use STPI provided communications links. This scheme has thus provided a 'virtual' park, with registered users using spaces often privately held and at great distances from the park. Communications links and export obligations are the twin abiding features, entitling a registered user to claim tax benefits. Very often large corporate units have put up one small office in the park premises while maintaining several other offices at distant locations. With telecommunications being liberalised and with the emergence of seamless market offering competitively priced very large data/voice/image transfer-rates (this has indeed begun), the attractiveness of STPI is likely to diminish significantly.

STP Scheme, which is a 100% export oriented scheme, has attracted many entrepreneurs in the area of software and services. Till March 2000 there were 6,792 registered units, substantial number of these units commenced operations and are exporting at present, while many units are at various stages of establishment. The growth of registered units continued at an even pace, often measuring at an annual 50%, which however shot up dramatically over the year 1998/99 to 1999/'00 (Ref. Table-4). Such a rush for STP registration followed a rather dull period of growth in the previous year at about 25%. STP was becoming unattractive as it seemed to be, and the government apparently was losing clue to the exact amount of export of software.

Table 4: Number of registered units with the STPI

Years	Number of registered units
Upto March 92	164
1992-93	227
1993-94	269
1994-95	364
1995-96	521
1996-97	667
1997-98	844
1998-99	1196
1999-2000	5,582

With real tax benefits offered in the 1999/'00 budget for the registered units at the STPs, the growth in registered units shot up to about 500%. In line with rise in such registrations, export through STPs too has been rising, as seen from Tables 5(a) and 5(b), though the export growth through STP has never been commensurate with the growth in numbers of registered units. Apparently, registration itself is beneficial, or else most newly registered units are start-ups, who are yet to commence export. These units have exported software of over Rs.6300 crores during the year 1998-99, which was about 84% higher than the previous year. The export figure of Rs.6300 crores from STP units represents approximately 60% of the national software exports. Export figures for the year 1999-2000 was Rs.11,600 crores from STP units while total national software export was Rs.17,000 crores - more than 60% of the national software exports were thus from the STP units. The Software Exports by STP units has grown about 400 times from Rs.17 crores in 1991-92 to Rs.6300 crores in 1998-99. It must be noted that the growth rate of export through STP over the last two years has been about 60%, which has also been the average trend of growth rate of total Indian software. Thus STP units, though these are 100% export oriented units, did not fare any better in terms of growth in export, when compared to national trend. In other words, STPs have not been able to achieve any higher growth compared to the national trend. In fact, in the early years of 1990s, the percent share of export through STPs was rather low, mostly remaining below 20% of the total national export.

Table-5 (a): Export-size break-up of firms registered at STP, Noida

Software export (in Rs. Lakh)	No. of firms, 1998	No. of firms, 1999	No. of firms, 2000
Below 50 lakh	14	21	185
51-100 lakh	13	11	20
101-500 lakh	40	41	60
501-1000 lakh	7	15	18
Above 1000 lakh	9	12	25

Table-5(b): Export size break up of newly registered firms, 1999-2000, at STP, Noida

Software export, in Rs. lakh, by firms registered in 1999-'00	No. of firms
Below 5	9
Above 5 and upto 10	17
Above 10 and upto 20	16
Above 20 and upto 50	58
Above 50 and upto 100	39
Above 100 and upto 500	225
Above 500 and upto 2000	43

Size of most units at STPs has remained rather small. This could be owing to several likely reasons: (1) there has been real growth in software entrepreneurship, resulting in several start-ups; (2) large commercial interests have floated several companies/start-ups, resulting in an inflated statistics of very small businesses; (3) there are very few large domestic businesses, most exporters are either small or medium – thus registered units at STPs too have shown this trend.

Next, we may look at the statistics of start-ups during 2000 at the Noida Park alone. There have been a total of 409 units newly registered during 2000 at Noida. However, quite a few of these, such as the NIIT, the SISL, et al are fairly old and are not at all start-ups. Number of businesses registered at Noida and exporting continuously for the last three years is only 61. Most of these are well known exporters. This statistics thus cannot represent accurately the start-ups, though if we take a look at those businesses who while being newly registered could also export but very little, the probability of them being start-ups would be higher. We observe that businesses who could export below Rs. 5 lakhs were 9 in numbers, between Rs 5 to Rs. 10 lakhs were 17 in number, between Rs. 11 lakhs to Rs. 20 lakhs were 16 in number, etc. We have total numbers of firms exporting below Rs.50 lakhs in their first year of registration at

101. It is likely that most such businesses are start-ups and are extremely small. The knowledge level and the types of software/services exported by these tiny ‘start-ups’ however, are not known.

7. The Pharmaceutical & Biotechnology

Indian pharmaceutical industry has made a long and successful journey. In the 1950s India did not have virtually any presence in the manufacturing and the prices of drugs were too high and at nearly the level of developed countries. Today, India is amongst the top in few segments such as the API, the generics and doing fairly well in drug discovery, vaccine, and clinical research. Prices of drug in India are the lowest and India has several manufacturers with GMP certification. Almost all the pharma manufacturers were newcomers and as start-ups the businesses grew from nearly nothing. The public policy at that time in 1960s and 1970s did not provide for cheap credit, R&D grant, subsidies, export credits and guarantees, venture financing or even cheap land or readymade floors.

Public R&D support remained strong. Indian chemical industry, which too grew as from startups provided good engineering support. The public R&D especially from the CSIR laboratories provided several technologies. Most importantly the IP regime did not allow product patents and the enactment of Hatch-Waxman Act in the USA provided later great opportunities for exporting the generics. The domestic public policy however, restrained profit making especially by the domestic firms in several areas through the drug price control regime and for rather long through controls over collaboration with foreign partners (including financial and marketing alliances), over royalty repatriation and over technology import.

Policies on pharmaceutical in as much as the industrial sector of drugs is concerned remained with the line executive of chemicals ministry, the clinical aspects, however, remained with the medical council and the biotechnology, when the sector emerged remained as a separate department. Further, other science departments including the CSIR continued their distinct and separate presence. Often regulatory dilemmas emerged especially in the area of drug regulation, which moreover is

controlled by both the central and the state regulators. Related issues on toxicity, epidemiology or health remained with multiple ministries or otherwise research organizations.

Much part of Indian health expenditure is out of pocket. Most part of health market is unregulated and beyond the control of insurers and the organized hospitals. In fact general practitioners serve a very large segment. As a result regulators have little power over the states of affairs in the clinical practice, which often therefore remains under the influence of large marketing companies. Such a state in turn helps continuation of the de-link between the clinical practice and research on the one hand with the mostly chemistry-led pharmaceuticals research.

A few of the large domestic firms continued R&D (thus receiving small benefit in tax) which shot up in recent years. In the early years amongst all sectors of industry the drug alone undertook R&D, and even by 2002 there were more than 115 companies doing R&D often at about 4% to 5% of sales turnover. In recent years especially after India's entry into the TRIPS the R&D figures have gone up and patent litigations too shot up. Unlike the software sector, this sector has undertaken patenting of large number of claims in both domestic and the USPTO. Fig. 2 gives an idea about the trend of innovation in the drug & pharma industries in India

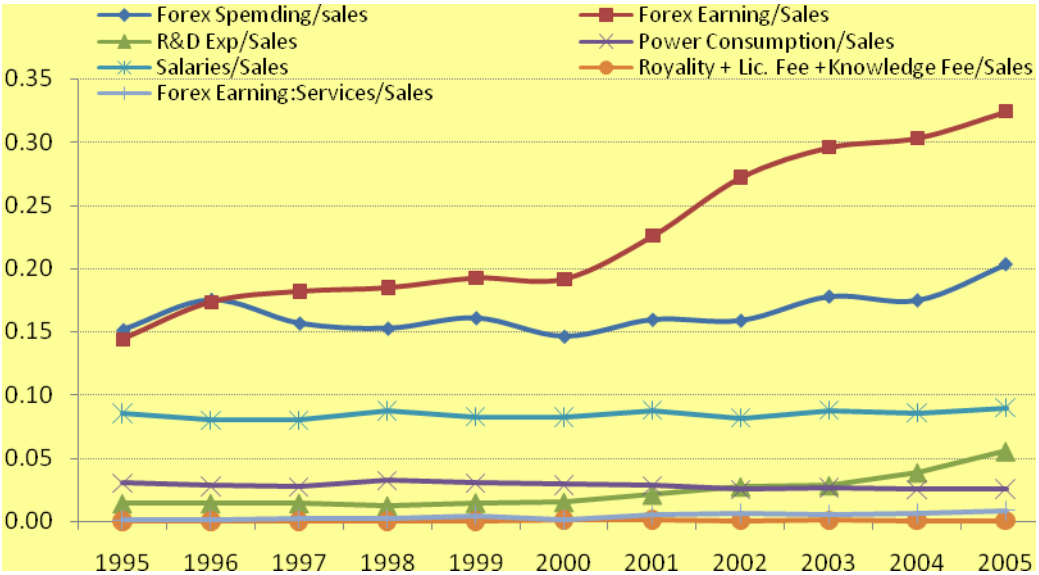

Fig. 2: Indicators of innovation in the drug & pharma industries in India

Absence of policies integrative of multiple complementarities existing in organizations belonging to different departments or to different disciplines signifies the biomedical scene of India. Disease targetting is one potential area of integrative policy. In the following two sets of data we exhibit how different R&D organizations from public as well as private have taken patenting and how such patents failed to form a pool of IPR or even a pool of complementarities. In fact on some of the following disease areas, such as malaria or TB, there are public programs on R&D, on surveillance and epidemiology, and on clinical practice. However, the IPs and even research publications remained separate and distinct. The absence of IP strategy is stark. Apart from the IPRs in drugs area other areas under patenting does not cite even related domestic patents, sometimes even from the same departmental patent. Lack of policies on patent portfolio and research publication as well as that relating to geographically widely distributed R&D capacities and capabilities inform us on missed potential outcomes. The data on patents in this sector may be seen in Tables- 6 and 7 and Fig. 3.

Table 6: Patents and Authors as P/A in USPTO from Indian Organizations (Multiple Entries Considered)

	Br	Drg	Jnd	Lng	Mcb	Mlr	Mob	0gc	pep	phm	pol	prt	srg	TB
AIIMS		1/1							2/ 2		1/1			1/ 1
CSIR	15/73	127/624	3/20	24/102	21/139	21/113	28/134	32/131	19/83	92/541	58/209	77/323	5/39	17/102
Dabur	1/7	22/93	1/3	16/83			7/35	7/35	6/36	14/71	8/43		2/11	1/3
DBT	1/13	2/10			2/26						2/10		2/21	
DRL	18/111	36/210		1/ 4						24/120	14/51		1/ 6	
Lupin	1/ 2	1/ 2						1/5						
MACS	1/ 2								1/ 2	1/ 2	1/ 2			
MAMC	1/1						1/1				2/ 2		2/ 2	
NII	1/7	6/24		4/13		1/5	2/10		3/11	1/ 7	7/25			1/ 6
Orchid	1/3	4/14						5/20		1/ 3	1/ 3			
Ranbax	2/18							3/14	2/8	14/56	3/9		5/25	1/ 6
Reddy-Chemin	14/84	23/138								5/ 33	11/53	2/11		
Biocon										1/ 4	2/4			
Aurobi		1/ 4						1/ 4						
Cadilla		1/ 3												
DU		3/16		2/12						2/ 8	2/8			
DST		3/21						1/ 3		5/23	2/6			
Ind Herbs	1/1	3/5				1/1		1/ 1	2/ 2	4/ 4	3/3			
IICT		1/ 4												
IISc		1/ 3			1/ 3									
NICED		1/ 8					1/ 8				1/8	1/ 8		
Nichol Piramal		1/ 3								1/ 3				
Panace		8/17		5/10	4/8	3/6				1/ 2	2/4			
RPG		1/ 3												
Allaha Univ		1/ 3					1/ 3				1/ 3			

University of Madras participated twice with two authors

(BR= brain; Drg= drug; Jnd= jaundice; Lng= lung; Mcb= microbiology; Mlr= malaria; Ogc= organic compounds; pep= peptides; phm= pharmaceutical; pol= polymer; prt= protein; srg= surgery; TB= tuberculosis)

Table- 7: Number of Patents as per ICN and ABST in USPTO

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Clinical				1	1				1	1	1		1
Cancer						2	2	1	3	6	3	9	3
Drug				1	1	4		2	4	7	5	8	5
Pharmaceutical	6	1		3	1	5	3	13	16	18	28	34	18
Skin	2	1							3	1	5	4	6

(When counted on search in 'Specifications', the numbers of patents change from above)

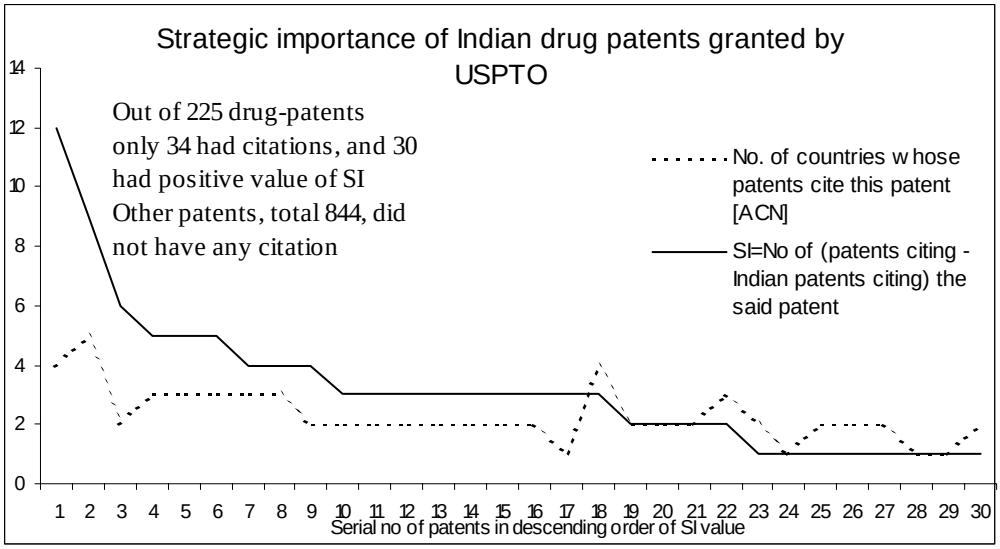

Fig. 3: Strategic Importance of US-Granted Patents to Indian Applicants

The chart in Fig. 4 exhibits the widely distributed R&D capabilities in Indian biomedical research. We have followed a disease classification mode. The advantage of this classification could be that public policies relating to public health and especially relating to specific 'poor man's diseases' could be the driver of coordination between widely distributed multi departmental resources. In fact in germinal form such programs exist. However, such programs did not so far adopt any fund-based coordination or drug-targeted coordination or disease-reduction as outcome-based coordination.

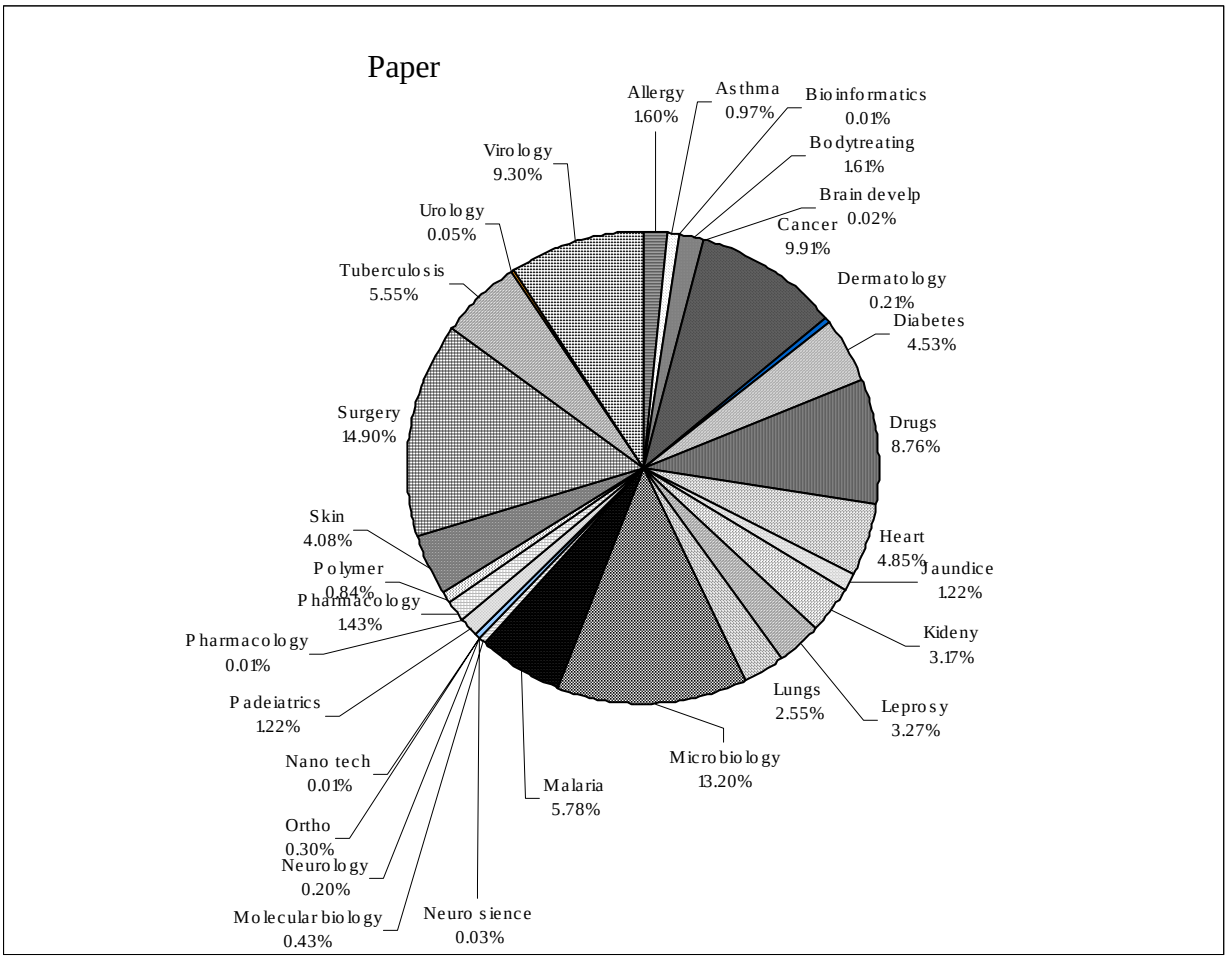

Fig. 4: Distribution of Papers over Areas in India

Recent policies have taken up the following issues as central: advancing the knowledge frontiers of the manufacturing as well as the research/ teaching; supporting incubation and hand holding of startups; supporting company R&D through fiscal and fund based mechanisms; assisting transfer of technologies lab to company or to land, as well as from advanced countries.

The data in Tables-8(a), (b) & (c) exhibits certain patterns of knowledge flows through collaborations, and number of companies undertaking R&D while perhaps paying simultaneously royalties for know how. The data also suggests the pattern of employment of technical manpower that is indicative of the absorptive and learning capacities of such companies, who are often small.

Table 8(a): Number of Biotech Firms with Distribution of Foreign and Domestic Collaborations over Four Indian Cities

	No collaboration	1	2	3	4	5	6	7	8	9	10	11
Bangalore	No foreign coll (FC) firms	19	3			1						
Bangalore	No domestic coll (DC) firms	9	5	2				1				
Delhi	FC	8	1					1				
Delhi	DC	6	2	2		1						
Hyderabad	FC	14	2									
Hyderabad	DC	6		3	1		1					
Mumbai	FC	23	1					1				
Mumbai	DC	7	5	6	1		1					1

Table 8(b): Number of Biotech Firms and Their Intensity of Employing Technical Employee over Indian Cities

[(Tech employee)/(Total employee)] in %	Mumbai	Bangalore	Delhi	Pune	Chennai
0-25%	40	22	16	8	9
26-50%	8	12	11	4	3
51-75%	5	5	7	2	4
76-100%	4	9	3	0	4

Table 8(c): Number of Firms doing R&D and paying for Royalty & Know-How from the List of 115 firms

Item	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
R&D capital account	24	32	38	37	44	42	44	37	43	43
R&D current account	28	34	38	48	52	49	53	56	57	70
Both capital & current account	21	28	33	33	39	40	42	36	41	43
Royalty & know-how expenses	5	5	7	10	13	15	14	15	14	15

(Source: CMIE)

8. Funding of S&T/ R&D

Below presented are three Tables, respectively indicating in the first Table 9(a) the growth in direct funding of core S&T departments by the central government, in the second Table 9(b) the funding by state government ministries, and in the third Table 9(c) the investment in R&D made by companies listed in the stock exchange. Departments receiving funds in Table 9(a) are primarily responsible for S&T in the country and this investment by the central government which has been growing nearly steadily but at a very modest rate captures the policy thrust on core S&T. About 86% of the central government R&D expenditure during 2005-06 was incurred by 12 major scientific departments. The national R&D expenditure as a percentage to GNP was about 0.77 in 1990-91 and grew to 0.89 in 2007-08 in between, however, falling down to the lowest in 1995-96 and has remained nearly steady during 2005-08 period at around 0.88. The sector wise R&D in 2005-06 was: central government 57.5% of the total, public sector industry 4.5%, private sector 25.9%, state government 7.7% and higher education 4.4% of the total.

The industrial sector (both public and private) R&D expenditure was 30.4% of national total. The industrial sector spent 0.55% of sales turnover on R&D. The maximum R&D expenditure was by the drugs and pharmaceuticals with 37.4% of total, followed by transportation at 14.7%. In 2005-06 the electrical and electronics sector spent about Rs. 500 crores, the information technology sector spent about Rs. 300 crores, the biotechnology about Rs. 250 crores, the telecommunication about Rs. 100 crores and the metallurgical industries about Rs. 150 crores.

In limited cases only the central departments have provided for grants for research and for development. Most policy instruments are fiscal in nature. Developmental funds have operated for development of instrumentation infrastructure or for the development of home grown technology, for supporting entrepreneurship in high tech areas and for incubation. Venture financing for high tech and for home grown technologies or sometimes for the transfer of technologies from the research

laboratories are almost always public and are operated mostly by the central government departments.

Table 9(a): Tenth Plan Outlays / Expenditures of Central Scientific Ministries /Departments / Agencies

S&T Deptt. /Agencies	10th Plan (2002-07)	Annual Plan 2002-03		Annual Plan 2003-04		Annual Plan 2004-05		Annual Plan 2005-06		Annual Plan 2006-07			10th Plan (2002-07)	10th Plan (2002-07)
	Outlay	BE	Actual	BE	Actual	BE	Actual	BE	Actual	BE	RE	Actual	BE	Actuals
Deptt. of Atomic Energy (R&D Sector)	3501.35	535.00	405.56	464.00	409.94	703.58	609.52	872.74	770.80	1003.	1032.72	991.24	3578.32	3187.06
Ministry of Earth Sciences/ Deptt. of Ocean Development	1125.00	175.00	138.69	175.00	147.38	200.00	198.88	340.00	225.05	438.0	417.49	334.44*	1328	1044.44
Deptt. of Science & Technology	3400.00	625.00	537.10	800.00	602.37	900.00	896.26	1250.0	1024.24	1367.	964.16	938.15	4942	3998.12
Deptt. of Biotechnology	1450.00	225.00	203.25	260.00	248.76	310.00	319.27	445.00	386.36	521.0	496.00	488.85	1761	1646.49
Deptt. of Scientific & Industrial Research inclu. CSIR	2575.00	440.00	366.96	520.00	380.15	650.00	596.25	846.00	730.33	975.0	775.00	820.58	3431	2894.27
Deptt. of Space	13250.00	1950.00	1846.71	2050.00	1941.00	2400.00	2194.7	2800.0	2294.30	3220.	2600.00	2594.17	12420	10870.88
Grand Total	25301.35	3950.00	3498.27	4269.00	3729.60	5163.58	4814.88	6553.74	5431.08	7524.	6285.37	5832.99	27460.32	23641.26

** Excluding Capital works components*
 # Excluding Agricultural Research, Medical Research other than Scientific Ministries
@ Excluding Scientific survey & Dev. Division
*** excluding NTH & Environment*
! Including Ocean Development

Funds available with the state governments under the head of S&T are very small. Moreover, often such funds are not directed to a specific sector. Thus the sector funds and sector policy instruments play important roles. The state governments enjoy only limited fiscal power and nearly all the funds are received from the central government. The latter, moreover, deploys fund-based large programs marked for specific purpose and the states enjoy only limited roles in selection and monitoring of such programs. Line ministry of a state government therefore can exercise limited policy role for the nurturing of a specific sector. Most states do not have line ministry for such areas as science and technology, information technology or biotechnology. However, several states have board structures for this purpose. The planning boards of state governments too often under the ministry of finance prepare state plans in the relevant

areas. Only few states have created policies for the development of IT and BT, and even fewer states have made provisions for developmental or research grants.

Table-9(b): State Plan Outlays under S&T Sector

(Rs. in lakh)

S. No.	States/UTs	7th Plan 1985-90 Outlay	7th Plan 1985-90 Actuals	8th Plan (1992-97) Outlay	8th Plan (1992-97) Actuals	9th Plan (1997-02) Outlay	9th Plan (1997-02) Actuals	10th Plan (2002-07) Outlay	10th Plan (2002-07) Anti. Expdr.	Annual Plan (2007-08) Outlay
1	A.P.	610.00	208.00	200.00	114.00	937.00	556.00	500.00	261.10	
2	Arun. Prad	12.00	19.92	47.00	67.00	105.00	303.00	420.00	2055.69	1012.00
3	Assam	300.00	376.00	462.00	644.00	1350.00	348.00	750.00	979.25	416.00
4	Bihar	300.00	430.00	782.00	227.00	2154.00 @	607.00	0.00	3124.00	0.00
5	Chhattisgarh							300.00	1733.69	695.00
6	Goa	110.00	127.20	300.00	153.00	308.00	182.00	175.00	941.37	136.00
7	Gujarat	450.00	88.00	550.00	262.00	3125.00	8802.00	29835.00	34504.27	3689.00
8	Haryana	165.00	310.00	662.00	352.00	642.00	506.00	565.00	2945.00	225.50
9	H.P.	100.00	79.00	275.00	276.00	600.00	601.00	592.00	220.03	37.00
10	J&K	100.00	38.00	190.00	136.00	320.00	1114.00	3619.00	2265.63	536.00
11	Jharkhand					0.00	1298.00	33000.00	19516.01	145.00
12	Karnataka	200.00	312.00	800.00	1196.00	2500.00	1066.00	1293.00	11347.12	1849.00
13	Kerala	1700.00	2302.00	2193.00	3995.00	7500.00	8028.00	12000.00	23241.73	5373.00
14	M.P.	650.00	626.00	641.00	767.00	935.00	556.00	858.00	4598.97	1888.00
15	Maharashtra	200.00	193.00	568.00	365.00	885.00	1226.00	4325.00	2103.46	---
16	Manipur	200.00	202.00	400.00	382.00	720.00	330.00	1227.00	1179.02	100.00
17	Maghalaya	150.00	61.00	193.00	213.00	450.00	430.00	515.00	961.18	125.00
18	Mizoram	10.00	54.00	195.00	196.00	291.00	387.00	513.00	628.00	220.00
19	Nagaland	80.00	57.00	100.00	95.00	400.00	97.00	350.00	993.49	136.00
20	Orissa	216.00	479.00	4556.00	1344.00	1655.00	3515.00	2281.00	6719.74	287.00
21	Punjab	400.00	199.00	750.00	160.00	3619.00	225.00	3303.00	2751.38	565.00
22	Rajasthan	344.00	130.00	700.00	639.00	1051.00	575.00	753.00	3902.19	178.77
23	Sikkim	22.00	36.00	250.00	195.00	800.00	330.00	600.00	1754.89	350.00
24	Tamil Nadu	450.00	575.00	1000.00	888.00	2010.00	1208.00	4735.00	3820.04	312.38
25	Tripura	200.00	208.00	225.00	233.00	222.00	163.00	904.00	628.69	558.81
26	U.P.	1000.00	1414.00	1000.00	1955.00	3080.00	9237.00	5950.00	2140.00	---
27	Uttaranchal					0.00	980.00	304.00	9673.95	9762.02 **
28	West Bengal	320.00	186.00	1833.00	615.00	988.01	4814.00	13831.00	7248.09	483.00
	Total States	8289.00	8710.12	18872.00	15469.00	36647.01	47484.00	123498.00	152237.98	29079.48
	U.Ts.									
1	A&N Islands	26.00	58.54	135.00	122.70	199.85	119.54	212.00	186.43	40.00
2	Chandigarh	20.00	57.23	15.00	25.13	37.00	45.40	60.00	377.85	27.00
3	D & N Haveli	14.00	1.55	38.00	22.00	30.00	29.41	35.00	40.61	7.00
4	Delhi	56.00	10.24	30.00	71.49	15.00	374.04	700.00	83.77	20.00
5	Daman & Diu	@@		40.00	43.76	47.00	46.17	80.00	226.00	25.00
6	Lakshadweep	25.00	29.24	127.61	100.83	643.81	164.20	307.64	548.28	353.00
7	Pondicherry	36.00	1.03	13.00	14.81	60.00	119.16	140.00	658.71	45.00
	Total UTs.	177.00	157.83	398.61	400.72	1032.66	897.92	1534.64	2121.65	517.00
	Grand Total	8466.00	8867.95	19270.6	15869.7	37679.6	48381.9	125032.6	154359.	**29596.48**

A large number of Indian companies under-report R&D expenditure. The R&D reporting company gains in tax saved, however, the stock market often reacted negatively to reported expenditure on R&D. Several pharma companies therefore have hived off R&D into separate entities and have reduced or checked the growth in R&D spent. Capital gains tax and also gains through carryover have been limited to only a

few select sectors of technology companies/ start-ups resulting into poor interest by the venture capital firms in hi-tech start-ups. In fact few large domestic companies have participation in VC syndicated funds or otherwise spinning off of new small scale hitech ventures.

Table 9(C): Yearly Expenditure by Listed Companies on R&D alone

Year	Investment (in Rs. Crores)		Year	Investment (in Rs. Crores)
1995	849.20		2002	3854.75
1996	1278.56		2003	4284.12
1997	1707.93		2004	4713.48
1998	2137.29		2005	5142.85
1999	2566.66		2006	5572.21
2000	2996.02		2007	6001.58
2001	3425.39		2008	6430.95

9. Policy: Structures, Types and Instruments

The federal governance structure in India is multi-centered and multi-tiered. The executive at three levels – central government, state government and the district government enjoy corresponding legislative and executive powers. The central characteristic of Indian policy administration could be captured under the following features:

(1) Insignificant role of legislation especially short-term laws in policy formulation;

(2) Separation of executive jurisdictions and dominance of checks and balances;

(3) Near complete absence of omnibus oversight authority presiding over inter-ministerial contests;

(4) Continuation in parallel of multiple policy types, for example, fund-based, fiscal, regulatory, executive rules and market based; and

(5) Central government executive based governance has in general dominated the policy spectrum consisting of often incoherent if not contradictory fiscal

instruments. A related key feature has been the neglect of policies relating to institutions.

The central government dominated the entire episode of policy spectrum. There has been at the central level a slow emergence from the departmental structure and from the commission mode of structure to the ministry mode (as in the case of electronics) while for the biotechnology emergence of a department under the overall umbrella of ministry of science and technology and for nanotechnology or for materials sciences the structure remained latent. Notwithstanding the formation of a ministry the larger part of R&D in electronics remained scattered with multiple ministries and departments. A similar mode of scattered policies and employment of instruments could be observed in the case of biotechnology. Most importantly, fiscal policies, expenditure and budgeting exercises, commerce including export policies remained outside the purview of the concerned ministry or the department such as of electronics or biotechnology. Typically, the social sector central ministries played very important roles. Such ministries, however, are not the nodal ministry.

In parallel to the role of the central government, various state governments played non-dominant role. In the case of ICT a few states initiated executive rules and in the case of biotechnology a few states created special developmental boards albeit in all the cases the states deployed little if any fund. Almost all the states exercised although multiple types of fiscal instruments and budgetary constraints for ICT and sometimes for the biotechnology. The states mirrored the inter-ministerial contests prevalent in the central government and rather often the declared policy of a state on ICT, for example, conflicted with its fiscal instruments. A large number of states have State S&T Councils, often neglected but sometimes under the guidance of the chief executive the Chief Minister. The state councils do not enjoy executive prerogative.

The district administration is dominated by integrated executive structure and hence inter-ministerial contests are minimized. However, districts governments cannot directly legislate in the areas of our concern. As happened, district governments remained mute implementers of schemes containing ICT, if any. Rather often central

executive or central S&T departments controlled implementing bodies at the district bypassing the integrated district administration. Rural ICT kiosks or the KVKs are examples of this type.

The S&T infrastructure of the country is very large. R&D organizations number more than 4000. Beyond this there exists universities, extension centers and similar bodies each reporting to respective line ministries. Coordination between units is definitely weak.

The private sector plays significant role in select areas. In software the NASSCOM plays very significant role in the shaping up of policies. A few business associations, notably the FICCI, the CII, the ASSOCHAM among others, have represented often the industry cases to the executives. Such associations, however, often excluded the start-ups and the tiny or small businesses. Voice of small businesses has been very feeble. Similarly, voices of local business associations and the roles of such associations have remained rather weak.

10. Funding Types

Most of funding of R&D/ S&T happens through planning and budgeting mode of the executive ministry or departments; there is relatively little change with variations in the ownership of executing fund-recipient. Recalling that funding serves multiple purposes, such as for maintenance, asset creation, coordination, and monitoring – the departmental/ ministerial planning/ budgeting mode seeks to serve these purposes through line departmental arms and activities. Planning/ budgeting undertaken at periodic intervals have set up several mechanisms of executive based coordination and monitoring through both hard budget constraints and project/ program monitoring at the central level with the Planning Commission and a few inter-ministerial bodies and with the Prime Minister's or cabinet office.

At lower tiers such allocation functions are undertaken within the department/ ministry through very similar processes, however, the lower the tier in hierarchy the stricter is the constraints on flexibility in budgeting. Most often at about the middle tiers

of hierarchy execution remains as the task and coordination through management of allocations across budget heads or cash flows become difficult.

Demands for grants rise up the hierarchy where at the higher tiers the bundling of demands is undertaken. The current XI Plan, for example, has set the broad principles of bundling and one major norm is ‘Supra’ projects at supra-organizational level, or ‘Mega’ projects at multi-institutional level or at cross-disciplinary level. Budget sets the goals and therefore monitoring standards and modes. Inter-period monitoring of goals achieved and especially the capacity to spend within the pre-fixed parameters of budgetary heads provide the cues to future release of funds. Several documents of the government suggest that the systemic incapacity to spend is a major bottleneck to the growth of S&T budget allocation. The two way process depends crucially upon the interactive mechanisms of bottom-up and head-down flows of information that get bundled at multiple tiers preventing, perhaps often the systemic capacity build up on its own and through this budgetary processes.

Generation of projects, major programs and in short the creation of demand then is another goal of the entire executive process of planning/ budgeting. Relative weakness of the systems to voice demands reflects upon and influences the slow buildup of the systemic capacity. Major projects or mega programs therefore appear to be important. The XI Plan has emphasized amply this dimension. Another related dimension is the capacity of the systems of the stakeholders especially of the society who would voice and which in turn would boot up demands for capacity.

Along with this executive based approaches to using planning/ budgeting a few other approaches have in recent periods been considered as well as initiated by the government. One important landmark of XI Plan regarding S&T is its underlying theme of innovation. Creation of demand pulls through innovations to generate the subsequent flow of allocations that in turn would create from within as well from without the public system of S&T the dynamism to create additional capacity to absorb funds and build up executive capacity is one of the principal pillars of the current Plan.

This approach has therefore created instruments for funding the 'bridging' or linkage functions. The emphasis has been on executive controlled departmental or line ministerial linkages. Other modes of market based or social based linkages too are important. For example, generation of standards or extensive modularization creates the pull for systemic build up through market processes. Another mode less deliberated upon is the advanced standards-based public procurement or utilization of part of public development fund or part of restructuring fund or of the infrastructure fund to advance induction of new technology. The climate fund is such a strategic restructuring fund. In other words planning/ budgeting exercise along with the creation of incentives system for the advanced knowledge/ products create massive restructuring of the system of S&T while simultaneously building up new capacities. In the current Plan such indications have been provided in relation to the district-based system of S&T management or in relation to incubation of new innovations or in inspiring youth into the folds of new sciences.

Another dimension of public investment is the foregone taxes, tariffs and similar others. The ensuing private investment in new plants and machinery, new measures on quality, standards or say, productivity and efficiency and especially on new technologies are to be set off against the forgone revenues. Private investment on all this have not been computed, however, our preliminary observations on investments for on-R&D innovations indicate that instead of setting off the investments in R&D alone the private enterprises have undertaken in a few sectors the systemic build up of innovation capacity.

Following the approach of the Planning Commission, we consider three modes of expenditure:

1) Investment in Public R&D,
2) Investment in S&T by various socio-economic sector ministries of India, such as the Ministry of Agriculture or the Ministry of Health

3) Various state & Union Territory R&D/ S&T investment

However this data would not reflect the large amount of R&D investment carried out at the higher education and technical education level of Indian education system, much of which comes from the R&D done in engineering, doctoral and post doctoral studies. It is therefore inferred that there is an R&D investment based on:

Expenditure in higher education; and
Expenditure in technical education

Apart from that there is a component of R&D investment in terms of Private sector listed firm’s investment in R&D

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