Financing of industrial innovations in India, How effective are tax incentives for R&D?

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The paper surveys the instruments that are available for innovation financing in India. It identifies three such instruments, namely research grants and loans, venture capital and tax incentives. The effectiveness of all these instruments are then examined in some general fashion, but one of the instruments, namely tax incentives are subject to a detailed empirical scrutiny in terms of its effectiveness. The resulting analysis showed that while the instruments have been targeted well, its actual effectives is a bit unambiguous due essentially to the quirks of methodology and indeed the dataset used.

Introduction: The government in India is on a major innovation drive like the governments across the developing world and especially that of China. This drive could be found in several policy measures enunciated over the past ten years or so and especially in the Science and Technology Policy of 2003, where in it is stated that the government targets the expenditure on S&T to be about 2 per cent of GDP and this is to be largely contributed by the industry through significant increases in industrial R&D. Industrial R&D, therefore, may have to be incentivized through the provision of a variety of fiscal incentives such as tax incentives. This thinking again reflects the worldwide move toward using non-interventionist, but market-friendly forms of increasing investments in industrial R&D and within this scheme of things tax incentives form an important instrument. In India, even as early as 2001, the existing tax treatment of R&D had undergone some upward revisions, but targeted more specifically at around eight high and medium technology based industries. Although a few studies are available on the financing of industrial innovation, with rare exceptions, most of these have been descriptive, merely, cataloguing the various schemes available for encouraging investments in industrial R&D. However no analytical studies on the effectiveness of these incentives in the specific Indian context are available. This is significant as recent estimates by the Ministry of Finance showed that the amount of corporate tax foregone consequent to the tax treatment of R&D has been increasing at a rate of 2.4 per cent per annum over the last four fiscal years until 2007-08: in 2004-5 about Rs 23180 million of corporate tax revenue had been foregone as a result of the operation of this scheme, but this is expected to be marginally down to about Rs 20240 million in 2007-08. In the

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[1]Tel: +91-471-2448881; Fax: +91-471-2448942; and E-mail: Mani@cds.ac.in. This will eventually be a joint paper with Pinaki Chakraborti and discussions with him at the initial stages have been useful. I received excellent help from M.Parameswaran for estimating the cofefficient of elasticity of R&D expenditure wrt tax foregone. An initial version of the paper was presented as a lecture at the PGP-PMP course at the Indian Institute of Management- Ahmedabad and the comments received from the students are gratefully acknowledged. Research assistance was provided by Riju Prakash J S. But none of them are to be implicated for any errors that may still remain.

context, the purpose of the present study is to analyse the effectiveness of a specific tax scheme that has been in operation since 2001. In very specific terms, this is accomplished by computing the elasticity of industrial R&D expenditure in India in response to a unit reduction in the cost of performing R&D. Such estimates of elasticity of R&D will be very helpful in judging whether the tax incentive for R&D is effective in stimulating proportionate investments in R&D.

The paper is structured into four sections. Section 1 analyses the innovative performance of India by employing a number of conventional and new indicators. The second section surveys the various financial instruments that are available for financing of innovation. The third section measures the effectiveness of tax incentives for financing R&D expenditures. The fourth and final section sums up the main findings of the study and identifies the policy conclusions that may emanate from this exercise.

I. India's innovative performance

India is generally referred to as an emerging knowledge superpower although her current record on this issue is rather mixed. We seek to analyse this record by employing a variety of conventional indicators as new indicators such as those emanating from innovation surveys are not available in the Indian context for the present[2]. I consider three conventional indicators:

i. Trends in R&D investment;
ii. Trends in patenting;
iii. Trends in technology trade balance

To the extent possible, the analysis is conducted in a comparative fashion by taking China as the comparator country.

[2] The Department of Science and Technology (DST), Government of India is in the process of conducting a pilot innovation survey by employing a CIS compliant survey instrument. The results of this pilot survey may become available through June 2008 and this is to inform a larger nation wide innovation survey to be conducted during the latter half of 2008.

Trends in R&D Investment: See Table 1 .

Table 1: Trends in R&D Investment, 1980-81 through 2003-04 (Rs in Millions)

	Gross Expenditure on R&D (Rs in Millions)				
	At Current Prices	At Constant Prices (Base Year:1993-94)	Nominal growth rate (%)	Real Growth rate	GERD to GDP ratio
1980-81	7605.2	23421.6			
1981-82	9407.3	26297.1	23.70	12.28	0.58
1982-83	12060.3	31175.4	28.20	18.55	
1983-84	13811	32786.4	14.52	5.17	
1984-85	17815.5	39386.3	29.00	20.13	
1985-86	20687.8	42611.4	16.12	8.19	0.83
1986-87	24354	46868.1	17.72	9.99	0.88
1987-88	28530.7	50202.3	17.15	7.11	0.91
1988-89	33472.6	54345.1	17.32	8.25	0.9
1989-90	37257.4	55858	11.31	2.78	0.86
1990-91	39741.7	53972.4	6.67	-3.38	0.78
1991-92	**45128.1**	**53867.9**	**13.55**	**-0.19**	**0.77**
1992-93	**50046**	**54947.8**	**10.90**	**2.00**	**0.79**
1993-94	**60730.2**	**60730.2**	**21.35**	**10.52**	**0.78**
1994-95	**66224.4**	**60425.3**	**9.05**	**-0.50**	**0.70**
1995-96	**74838.8**	**62634.4**	**13.01**	**3.66**	**0.70**
1996-97	**89136.1**	**69497**	**19.10**	**10.96**	**0.72**
1997-98	**106113.4**	**77507.6**	**19.05**	**11.53**	**0.76**
1998-99	**124731.7**	**84362.6**	**17.55**	**8.84**	**0.78**
1999-00	**143976**	**93751**	**15.43**	**11.13**	**0.82**
2000-01	**161988**	**101962.8**	**12.51**	**8.76**	**0.85**
2001-02	**170381.5**	**103720.9**	**5.18**	**1.72**	**0.82**
2002-03	**180001.6**	**105225.7**	**5.65**	**1.45**	**0.80**
2003-04*	**197269.9**	**111989.3**	**9.59**	**6.43**	**0.78**
Average rate of growth (pre reform)			18.17	8.91	0.81
Average rate of growth (post reform)			**13.22**	**6.57**	**0.77**

Source: Department of Science and Technology (2006)

Note: Pre reform refers to the period 1980-81 through 1990-91 and post reform refers to the period 1991-92 through 2003-04; For the pre reform period it is GERD to GNP ratio, but given the fact that in India the ratio of GDP to GNP works out to unity, it does not really matter whether one takes to ratio of GERD to GDP or GNP.

The following inferences can be drawn from the above Table: (a) Both in nominal and in real terms, there has been a decline in the overall GERD; and (b) Even the GERD to GDP ratio too have declined during the post reform period. From this, one has to be very cautious in drawing any strong inferences about the innovative potential of the country. This is because much of the overall R&D (GERD) of the country is performed in the public sector in defense, space, atomic energy, health and agriculture. Industrial R&D forms only about 20 per cent of the GERD. However the share of the industrial sector has shown much increase (Table 2) during the period.

Sector of performance of R&D: See Table 2. In India much of the R&D is actually performed by the government or public sector. However the share of the business enterprises sector has shown some sharp increases. It now accounts for about 20 per cent of the R&D. The corresponding figure for China is as much as 64 per cent. The higher education sector represented by universities and research institutes accounts for only 5 per cent of total R&D performed in the country. Notwithstanding the data problems, it is clear that the share of this sector has only shown some slight increases during this period.

Table 2: Sector of performance of GERD in India, 1970-70 through 2004-05 (percentage shares)

	Government	Industry	Higher Education
1970-71	89.55	10.45	
1975-76	88.13	11.87	
1980-81	84.13	15.87	
1985-86	87.82	12.18	
1990-91	86.16	13.84	
1995-96	78.26	21.74	
1998-99	75.79	21.17	3.04
1999-00	77.21	18.46	4.33
2000-01	77.94	18.05	4.02
2001-02	76.48	19.33	4.20
2002-03	75.56	20.27	4.17
2003-04	75.44	20.05	4.51
2004-05	73.92	19.81	4.88

Source: Department of Science and Technology (2006)

Growing privatization of Industrial R&D: Mani (2007) had shown that increasingly much of the industrial R&D is actually expended by private sector enterprises. I extend this analysis to the most recent period for which data are available (Table 3) and finds that this is indeed the case. An important hypothesis that these data (as contained in Table 1 through 3), is that one sees a decline in the growth rate of industrial R&D when increasingly that R&D is performed by private sector enterprises. Does this mean that the private sector is experiencing any *Arrowian appropriability* problems? This hypothesis makes the study of external financing of industrial R&D in India a relevant one. During this phase when investments in R&D are declining one sees that the government is putting in place a number of financial support measures that seeks to reverse this declining trend. A study of the effectiveness of these financial measures thus assumes much significance.

Table 3: Growing privatization of industrial R&D in India, 1985-86 to 2002-03 (Rs in Millions at current prices)

	Government			Private Sector enterprises	Industrial R & D	Share of Private Sector In Total Industrial Development
	Public Sector Enterprises	Govt.Research Institutions	Total government			
1985-86	1986.18	1622.7	3608.88	2519.44	6128.32	41.11
1986-87	2356.99	1723.36	4080.35	2916.33	6996.68	41.68
1987-88	2884.66	1851.29	4735.95	3102.67	7838.62	39.58
1988-89	3421.24	2093.28	5514.52	4176.25	9690.77	43.10
1989-90	4129.01	2395.21	6524.22	4905.94	11430.16	42.92
1990-91	4145.33	2491.88	6637.21	5499.81	12137.02	45.31
1991-92	4843.88	2745.50	7589.38	6369.44	13958.82	45.63
1992-93	5139.50	2993.65	8133.15	8362.47	16495.62	50.70
1993-94	5428.11	NA	NA	9825.37		
1994-95	4146.09	3564.00	7710.09	13188.70	20898.79	63.11
1995-96	4275.76	4116.99	8392.75	16270.69	24663.44	65.97
1996-97	5360.52	4440.00	9800.52	23307.50	33108.02	70.40
1997-98	5392.40	5641.30	11033.70	24382.50	35416.20	68.85
1998-99	6738.70	7133.20	13871.90	21766.10	35638.00	61.08
1999-00	7576.30	7808.82	15385.12	21781.10	37166.22	58.60
2000-01	8428.80	8641.20	17070.00	24114.00	41184.00	58.55
2001-02	7673.70	8922.60	16596.30	27874.80	44471.10	62.68
2002-03	8089.50	9512.50	17602.00	30649.30	48251.30	63.52

Source: Department of Science and Technology (2006)

Industry-wide distribution of R&D: Within the industrial sector six industries (pharmaceutical, automotive, electrical and electronics, chemicals and defence **)** account for about two-thirds of the total industrial R&D (Table 4). Among these various industries one just stand out from the rest, namely the pharmaceutical industry as the industry alone accounts for about 20 per cent of the total R&D expenditures. In fact later on I will show that even in the case of output indicators it is the pharmaceutical industry that is the best. In short it may not be incorrect to say that India's national system of innovation is dominated by the sectoral system of innovation of the pharmaceutical industry. Another second in the line is the automotive industry. This industry is composed of both the vehicle manufacturers and the auto parts sub sectors. Both the industries are also charecterised by competitive structures with a number of foreign and domestic manufacturers co-existing and competing with each other. The auto parts subsector of the industry has a rather high export intensity of nearly 20 per cent and this meant that the subsector has been continuously investing in technology to upgrade itself and meeting the technological challenges posed by its foreign buyers.

Trends in Patenting

I consider both US and triadic patents secured by Indian inventors. I start with the US patents. Among the BRICS (Brazil, Russia, India, China and South Africa) countries, India has registered the highest growth rate in patenting (Table 5). From an earlier analysis (Mani, 2007), it is seen most of the Indian patents are by domestic companies and that too in the pharmaceutical area[3]. However in the more recent period, the share of patents secured by affiliates of MNCs based in India is on the increase.

Table 4: Industry-wide distribution R&D (cumulative share in per cent 1998-99 through 2002-03)

Industry	Share
Drugs & Pharmaceuticals	19.30
Transportation	15.16
Electricals & Electronic Equipment	8.94
Chemicals(other than Fertilisers)	8.35
Defence Industries	8.32
Fuels	6.12
Information Technology	4.69
Metallurgiical Industries	4.21
Telecommunications	3.75
Miscellaneous Industries	2.38
Soaps, Cosmetics &Toilet Preparations	2.37
Industrial Machinery	1.84
Biotechnology	1.59
Food Processing Industries	1.39
Agricultural Machinery	1.33
Misc. Mechanical Engineering Industries	1.22
Textiles(Dyed, Printed, Processed)	1.21
Consultancy Services	1.05
Other industries	6.77
Total	100.00

Source: Department of Science and Technology (2006)

Table 5: Trends in US Patenting of Indian Inventors, 1994-2007 (number of utility patents)

	Pre 1994	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Compound rate of growth
China, P.Rep	431	48	62	46	62	72	90	119	195	289	297	404	402	661	772	23.82
South Africa	2390	101	123	111	101	115	110	111	120	113	112	100	87	109	82	-1.59
China, Hong Kong	702	57	86	88	81	160	155	179	237	233	276	311	283	308	338	14.67
India	428	27	37	35	47	85	112	131	178	249	342	363	384	481	546	26.02
Russian Federation	3	38	98	116	111	189	181	183	234	200	203	169	148	172	188	13.09
Brazil	752	60	63	63	62	74	91	98	110	96	130	106	77	121	90	3.17

Source: USPTO (accessed on April 11 2008)

Triadic patent data (patents secured by an inventor from three different patent offices (namely the USPTO, European Patent Office and Japanese Patent Office) also shows that India has registered one of the highest growth rates in Triadic patent grants during the period 1975 through 1995.

The performance of the country in patenting thus confirms the results obtained in R&D investments, namely that most of the patents are secured by domestic private sector

[3] Bulk of the US patents granted to Indian inventors are in two US patent classes namely, in 532 Organic Compounds (includes Classes 532-570), and in 424 Drug, Bio-Affecting and Body Treating Compositions (includes Class 514).

companies that too in the area of pharmaceutical technologies. In other words the patenting data further supports the evidence that I found earlier in terms of India's innovation system being dominated by the sectoral system of innovation of her pharmaceutical industry.

Trends in technology trade balance: India's technology trade balance has been has been negative and rising all through the more recent years (Table 5). However during the

Table 6: Trends in technology trade balance, 2000-2006 (in millions of US $)

	Payments	Adjusted Payments	Receipts	Adjusted Receipts	TBoP	Adjusted TBoP
2000	311		54		-257	
2001	236		60		-176	
2002	361		22		-339	
2003	352		23		-329	
2004	444		32		-412	
2005	712	1890	71	1709	-641	-181
2006	729	2514	129	5288	-600	2774

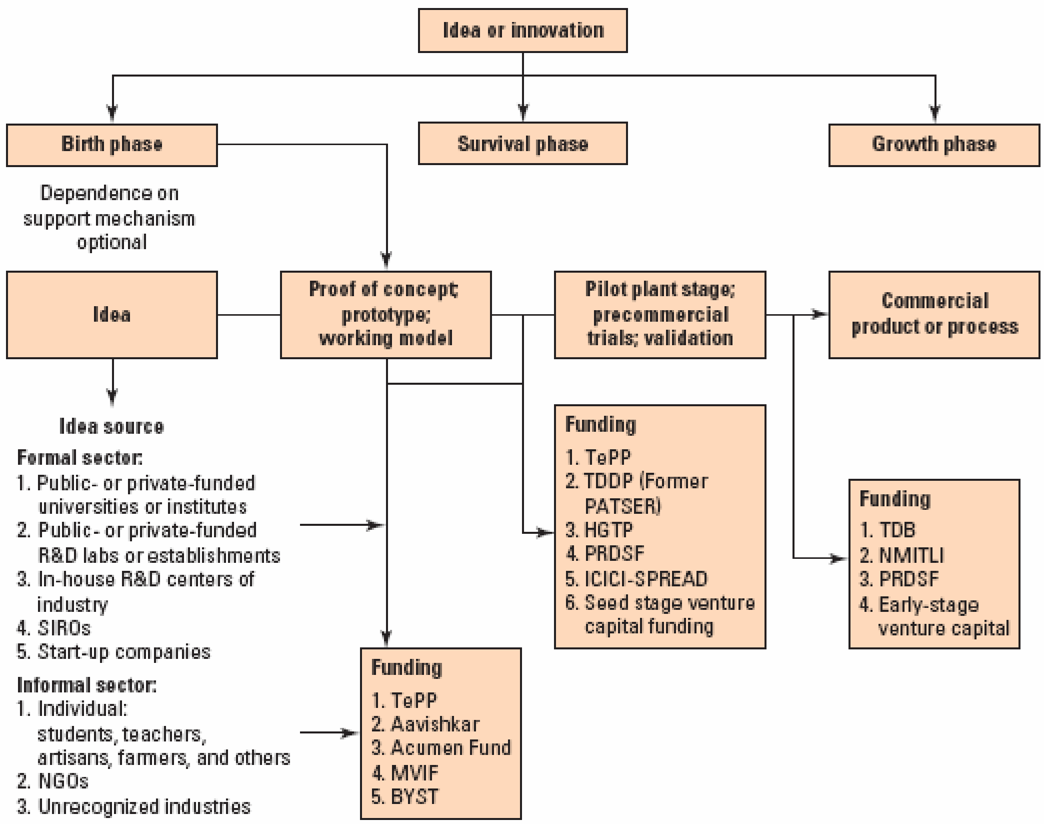
Note: Adjusted payments and receipts are arrived at after adding the payments and receipts under R&D, architectural, engineering and technological services to the payments and receipts of royalties and technical know-how fees.

Source: Reserve Bank of India (2008)

period since 2005, it has turned positive essentially due to the receipts under R&D outsourcing. India, along with China has now become a major recipient of R&D outsourcing deals. Most of India's R&D outsourcing deals is in the areas of pharmaceutical and telecommunications industries.

Thus, based on the evidence presented it can safely be concluded that India's innovation performance has actually improved if one takes the output measure of R&D. But the investments in R&D, both in the country as a whole and in the industrial sector have actually declined. Another point that came out of the analysis was that the country's innovative performance is concentrated in certain specific industries such as the pharmaceutical one and as such is not widespread. In fact we tend to demonstrate that the government too has targeted this industry for enhancing its innovative output by offering a variety of financial incentives. In the following we survey these various instruments for financing innovation.

II. Survey of instruments for financing innovations: The country has three different types of financial arrangements for financing innovations. They are: (i) Research grants; (i) Tax incentives; and (iii) Venture capital. The former two are almost entirely provided by various governmental agencies while the latter is now very much in the private sector. Implicitly the innovation policy makers in the country has adopted a linear view of innovation with three distinct phases: birth, survival and growth phases All the research grants and venture capital are in the birth phase of the innovation chain while the tax incentives are almost entirely in the growth phase. See Figure 1. Although this might appear to be a very idealistic picture from the financing of innovation point of view with research grants and venture at the birth stage where the market failures are great and tax incentives at the growth phase when firms have established themselves and are in a position to engage in formal intramural R&D activities, in actual operation the research grants and venture capital financing does address only a small segment. Most of the research grants are either addressed to public sector enterprises or individual researchers. There are of course notable exceptions to this. The venture capital in the industry although growing by leaps and bounds is increasingly intertwined with the private equity industry and is therefore cannot be taken in its entirety as equivalent to technology financing. With these caveats we attempt at a survey of the various instruments that are available. The purpose here is to just map out the plethora of instruments that are available for technology financing actually available in the country at present. In the next section, we take one of these namely the tax instruments for some in depth examination in terms of its effectiveness in driving up R&D investments.



Source: World Bank; adapted from UN ESCAP (2005).

Note: BYST = Bharatiya Yuva Shakti Trust; HGTP = Home Grown Technology Program; ICICI = ICICI Bank; MVIF = Micro Venture Innovation Fund; NGOs = nongovernmental organizations; NMITLI = New Millennium Indian Technology Leadership Initiative; PATSER = Programme Aimed at Technological Self-Reliance; PRDSF = Pharmaceutical Research and Development Support Fund; SIROs = scientific and industrial research organizations; TDDP = Technology Development and Demonstration Program; and TePP = Techno-entrepreneurs Promotion Program.

Figure 1: Financing of innovation in India (c2007)
Source: Dutz (2007)

We organize our discussion of these schemes into three broad areas by type of instruments, namely (a) research grants; (b) venture capital; and (c) tax incentives.

(a) **Research grants:** Under this we consider three grant or loan schemes. They are: (i) Finances from the Technology Development Board (TDB); (ii) Techno-entrepreneurs Promotion Programme (TePP); and (iii) the New Millennium India Technology Leadership Initiative (NMTLI).

(**i) TDB:** The TDB was created by an Act of the Parliament in 1995 and commenced operation from 1996. TDB basically seeks to support financially the commercialization of indigenous technology (whether obtained or developed from a publicly funded R&D or not including aspects such as improvements, modifications replacement of imported inputs, conformance to domestic and global regulatory standards, etc. and even for adapting and commercializing imported technology that entail crucial modifications to suit domestic markets and or further development of a 'proof of concept or design'. The TDB provides financial support through: a) a loan of up to 50 per cent of the project costs at simple interest (of 6% earlier and now lowered to 5%) with repayment in five years after project completion (and a royalty payment during the period of loan, which has now been dropped); b) participation in equity of companies up to 25% of paid up capital; and c) Grants-in-aid. As of March 2005, TDB had supported around 141 projects with an estimated project cost of Rs.20450 million (of which TDB sanctioned assistance is of around only Rs.6650million). This means that the TDB assistance works out to only a third of the total project costs. TDB has predominantly used the loan instrument for support; it has participated in equity of only one company and given just three grants-in-aid;. The grant of Rs 540 million by TDB to National Aerospace Laboratories (NAL) for development and type certification of a 14 seater aircraft is the largest project support ever made by TDB – normally no private sector venture capital fund would have financed the NAL development. TDB's reluctant use of equity as a mechanism for support is a clear indication that it has been risk averse in funding start-ups and new ventures.

The Health and Medical sector accounts for 25 per cent of TDB funding followed by Engineering (15 per cent) and Road Transport (14 per cent). Some successful projects supported by TDB are: development and production of Hepatitis B vaccine (as a result of which the domestic price has dropped to one tenth), Recombinant Streptokinase (second in the world), corDECT, the Wireless in Local Loop access technology, Bharat II variant of Indian car Indica, the first Indian electric vehicle REVA and so on.

Hitherto has been only one review of its first five year of its operation- by the Administrative Staff College of India, Hyderabad (ASC). The ASCI survey showed that around 50 per cent of the agreements were successful i.e., products released in the markets and repayments to TDB commenced, another about 12 per cent were foreclosed but payments were committed/received, 8 per cent were failures and the rest about 20 per cent were those where success was doubtful. Of the successful projects, in over 70 per cent of the cases, the technology originated outside of publicly funded R&D system.

(ii) TePP: The programme was launched in 1998 to help realize the vast latent innovative potential of the people. The basic objective of TePP is for individual innovators to emerge as technopreneurs – technology oriented entrepreneurs. TePP support is provided for in all areas except software development for which there are other avenues of support.

It helps the inventor to identify and network with an appropriate R&D/academic institution for guidance, technical consultancy, development of models/prototypes, etc., assists in for filing and securing of intellectual property rights and finally linking up with appropriate source of finances for commercialisation of the product. TePP by itself provides financial support of up to Rs.1 million as a grant-in-aid to prove the idea and a similar amount for the second phase for commercialisation. Since its inception seven years ago, the programme has received over 5500 applications of which around 1200 have been assessed and of these, 207 projects supported.

(iii) NMTILI: The scheme was announced at the dawn of the Millennium in February 2000 by the then Finance Minister in his budget speech of 2000. The objective was to catalyse innovation-centered scientific and technological developments as a vehicle for select Indian industry to attain a global leadership position. The state run Council of Scientific and Industrial Research (CSIR) was assigned to manage the scheme. The Scheme departed from the past practice and policy and adopted a strategy of identifying, selecting and supporting technological and industry winners. The Government funds the entire project (in most cases) as a grant-in-aid for publicly funded R&D/academic partners and as a soft loan (3 per cent simple interest payable in 10 installments) to the industry partner and also underwrites the risk of failure. Intellectual property rights aspects are equitably managed – generally IPRs belongs to the group (s) developing it, which are licensed on a first right of refusal basis to the industrial partner on mutually agreed terms with NMITLI managers as the umpire.

During 2000-2006 period, it has funded 42 projects with an outlay of about Rs.3000 million, involving 222 publicly funded R&D/academia groups and 65 industrial firms as partners. Predominantly the projects have been in the broad area of biotechnology (40 per cent) and in drugs and pharmaceuticals and chemicals (15 percent each) – areas in which CSIR has recognized core competencies. NMITLI projects, which are wholly funded by the government, enjoy an average of about Rs.70 million project funding – highest of all government technology development programmes**.** From the projects funded three products have been developed, viz.,

- Biosuite,
- a versatile portable software for bioinformatics,
- A PC based high end 3D visualization platform for computational biology; and
- Sofcomp, a simple and cost effective office-computing platform under Rs.10000 ($ 220 or so)

(b) Venture capital: The history of the venture capital industry in India may be traced to 1988 when a few (mostly state owned) venture capital funds were established on a loan from the World Bank. The industry is now one of the fastest growing in the world and according to some estimates the VC industry in India will overtake the UK one by 2009 or so. However increasingly the VC industry in India is only a small portion of the total private equity industry: in fact its relative share has gone down from 7 per cent in

2006 to about 4 per cent in 2007 although in number terms it works out to about a quarter of all such deals.

Table 7: Share of Venture Capital in Total Private Equity Industry in India, 2006 and 2007

Stage of Company Development	Volume/No. of Deals	Column	Value/Amount (In million US$)	Column2	Column3	Column4
	2006	2007	2006	Percent share-2006	2007	Percent Share 2007
Venture Capital	94	98	505	7.06	542	3.81
Growth PE	14	32	364	5.09	1321	9.28
Late	104	136	3396	47.46	5070	35.62
Pre IPO	4	14	43	0.60	434	3.05
PIPE	60	80	1401	19.58	4210	29.58
Buyout	13	7	370	5.17	173	1.22
Buyout-Large	1	3	765	10.69	474	3.33
Other	8	17	312	4.36	2010	14.12

Source: Indian Venture Capital Association (2008)

Much of the VC investments are in the Banking, Financial Services and Insurance industries followed by telecom, IT and ITES sectors.

(c) Tax incentives : India offers a variety of tax incentives to enterprises for committing resources to domestic R&D, both intramural and extramural. They can broadly be classified into those which are input based and those which are output based (Table 8). Of these two broad categories, the input based one is more popular. Within the input based category although there are eight different types of tax incentives, the one which has a long history and which enjoyed by maximum number of companies is the one that provides a weighted deduction of 150 per cent on any expenditure on intramural R&D (See A (a) in Table 8). This has been in operation in its present form since 1998 and it applies to about 10 different types of industries[4] although the 8^{th} and the 9^{th} industries (namely seeds and agricultural implements) were added only in the latest budget for the fiscal year 2008-09.

This is not a permanent scheme and the incentives under this head are available according to the term stipulated in the successive Union budgets. Given that this is the most comprehensive tax scheme for R&D, we undertake an analysis of its effectiveness.

[4] The ten industries are pharmaceuticals, biotechnology, chemicals other than pharmaceuticals, electronic equipment, computers, telecommunications equipments, automobiles , auto parts, seeds and agricultural implements.

Table 8: Input and output based tax incentives for R&D in India (c2008)

A. Input based tax incentives
(a) a weighted deduction of 150 per cent on any expenditure on in-house scientific research
(b) weighted tax deduction for sponsored research in publicly funded R&D and on approved in-house R & D projects;
(c) customs duty exemption on capital equipment, spares, accessories and consumables imported for R & D by approved R&D units, institutions and SIROs;
(d) excise duty waiver on indigenous items purchased by approved institutions/ SIROs for R & D;
(e) accelerated depreciation allowance on plant and machinery setup based on indigenous technology;
(f) customs duty exemption on imports for R & D projects supported by the Government;
(g) ten year tax holiday for commercial R & D companies; and
(h) a weighted deduction of 125 per cent on any payment made to companies engaged in research and development
B. Outcome based tax incentive
(a) excise duty waiver for 3 years on goods produced based on indigenously developed technologies and duly patented in any two of the following countries: India, European Union (one country), USA and Japan.

Source: Department of Scientific and Industrial Research (2007); and Ministry of Finance (2008)

III. Effectiveness of R&D tax incentives in India: An excellent review of the evidence on effectiveness of tax incentives for R&D and the methodologies used is found in Hall and Van Reenen (2000) and Mohnen (2007). However much of this evidence is based on the experience of OECD countries and notably that of the United States. The authors both describe and criticize the methodologies used to evaluate the effect of the tax system on R&D behaviour and the results from different studies. In the current (imperfect) state of knowledge Hall and van Reenen conclude that a dollar in tax credit for R&D stimulates a dollar of additional R&D. Studies on the effectiveness of tax incentives in the context of developing countries are rare[5].

[5] There is a recent study evaluating the performance of R&D support programmes in the context of Turkey. See Özçelika and Taymaz (2008)

The specific type of R&D tax incentive followed in India conforms to those that are in proportion to the level of the expenses on R&D. Further it manifests itself as an immediate write-off or expensing.

Within the specific context of India no such studies are available. The government itself has been rather concerned with the revenue foregone as a result of various tax concessions given to the corporate sector. Consequently beginning with the Union Budget for 2004-05, the government has been publishing data on the amount of tax revenue foregone as result of various tax incentives or concessions given to the corporate sector. The revenue foregone as result of R&D tax incentives has been computed and this is presented in Table 9.

Table 9: Tax foregone due to R&D tax incentives in India (Rs in Millions)

	R &D tax incentives	All tax incentives	Share of R&D tax incentives in all tax incentives
2004-05	23180	578520	4.01
2005-06	28390	346180	8.20
2006-07	15540	450340	3.45
2007-08	20240	586550	3.45

Source: Government of India, Ministry of Finance (various issues)

With the exception of 2005-06, it has averaged around Rs 2 billion per year and works out to about 3.5 to 4 per cent of the total revenue foregone. As result of the operation of these tax incentives the effective corporate tax rate for some of the industries covered under the scheme is significantly lower with the pharmaceutical industry garnering much of the incentives (Table 10).

Table 10: Effective corporate income tax rate for those industries covered under the R&D tax incentive scheme, 2006-07

Sl No:	Industry	Statutory Corporate Income Tax Rate (in per cent)	Effective Tax Rate (in per cent)
1	Drugs and pharmaceuticals	33.66	13.91
2	Electronics, including computer hardware	33.66	17.04
3	Fertilizer, chemicals and Paints	33.66	22.17
4	Automobile and Auto parts	33.66	26.03

Source: Government of India, Ministry of Finance (2008), p. 59

Based on these our hypothesis is that the effect of this tax incentive will vary across industries according to the effective tax rate. Although the incentive is same across the targeted 10 industries the effective rate can vary according to whether the firms in the industry has actually taken advantage of this scheme or not. Further it must also be borne in mind that the effective rate is a function of the sum of tax incentives enjoyed by a particular industry. It may be the fact that the pharmaceutical industry also enjoys a number of other tax concessions that their overall tax commitment is much lower than other industries in our sample.

In order to see whether the tax incentives have really lead to increased investments in R&D, we do two exercises. Firstly, we compile data[6] on R&D expenditures of seven of the eight original industries (Table 11). The only industry that is left out is the biotechnology industry as the data on this industry are not available[7]. The growth rate of the R&D expenditure of this sample is then compared with the growth rate of the R&D investments of the entire private corporate business enterprise sector (as contained in Table 3 above). The resulting analysis shows that the average growth rate of the industries receiving tax incentives is much higher than all the industries[8] (with the sole exception of 2000- the decline in R&D expenditure of all the firms enjoying R&D tax incentives in that year may purely be a statistical artifact).

Table 11: R&D expenditure of firms receiving R&D tax incentives, 1996-2006 (Rs in Millions)

Industry	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Pharmaceutical	3954.1	7110.1	4627.3	6075	5674.7	7610.8	8937	11218.4	16609.5	22928.1	29595
Chemical industry other than pharmaceutical	1997.8	4842.9	2377.2	3178.3	2275	2368.2	2094.9	2407.6	2697.1	3303	4791
Electronics including computer	88.4	132.7	41.4	39.2	87.3	108	57.3	12.6	349.6	71.5	417.9
Communication Equipments	112.9	499.9	395.5	383.1	429	641.1	750.4	603.7	1025.1	896.3	727.4
Automobiles	1552.2	2459.6	2856	2143.8	1453.1	1742.9	2878.2	3357.9	4183	7506.9	8848.1
Autoparts	407.2	516	682.9	757.7	947.2	1081.7	1121.1	1485.7	1691.3	2194.6	2505.9
Aircrafts	NA	NA	NA	NA	NA	NA	NA	2650.6	3091.4	3066.3	4336.2
Total	8112.6	15561.2	10980.3	12577.1	10866.3	13552.7	15838.9	21736.5	29647	39966.7	51221.5
Growth Rate(%)		91.82	-29.44	145.1	-13.6	24.72	16.87	37.23	36.39	34.81	28.16
Growth Rate of all Industries(%)		18.01	34.24	6.97	0.63	4.29	10.81	7.98	8.5		
Ratio		5.1	-0.086	2.2.09	-21.72	5.77	1.56	4.67	4.28		

Source: Own compilation based on the Prowess database of Centre for Monitoring Indian Economy (CMIE).

This of course does not mean that the incentive is effective. All that it implies is that the government appears to have targeted the right sort of industries for granting this concession.

Elasticity of R&D expenditure to tax foregone

First of all we estimated the total amount of tax foregone. This is based on the difference between the statutory corporate income tax rate and its effective rate (See the estimates of it in Table 10 above). Two caveats have to be borne in mind. First, the estimates are available only for four of the eight industries receiving tax

[6] The data on R&D expenditures are compiled from the Prowess database of the Centre for Monitoring Indian Economy (CMIE), Mumbai.

[7] We do not consider this as a major problem as much of the Indian biotechnology industry is made up of the Biopharmaceutical industry and since we have the data on R&D expenditures of the Pharmaceutical industry, the data on R&D expenditures of the Biotechnology industry is included as well.

[8] Even according to Table 4, the industries such as pharmaceuticals, automotive and auto ports, chemicals other than pharmaceuticals, electronics and information technology account for over 50 per cent of the total R&D expenditure of the industrial sector a whole.

incentives. Second, the estimates of effective tax rates are on the conservative side as it includes all tax concessions received by the industries and not just R&D tax incentive alone. Consequently the coefficient elasticity of R&D expenditure is likely to be lower than if one were to do these computations using the effective rate just for R&D tax incentives alone. For estimating the elasticity, we fitted the following log linear equation by pooling the data across the four industries over the five year period and we used the OLS estimation procedure:

$LnR\&D_{it} = a + b*\ln Tax\ foregone_{it} + c*time\ trend + u_{it}$ ------------- (1)

Given the fluctuations in the data, we fitted a second functional form with time trend^2 as an additional explanatory variable:

$LnR\&D_{it} = a + b*\ln Tax\ foregone_{it} + c*time\ trend + d*time\ trend^2 + u_{it}$ ------------- (2)

Both (1) and (2) have been estimated using the data on R&D expenditures and the estimated tax foregone with respect to four of the industries during the period 2002 through 2006[9] and the results obtained are presented in Tables 11 and 12.

Table 11: Elasticity of R&D expenditure wrt tax foregone- Specification 1

Source	SS	df	MS		
Model	29.7026467	2	14.8513233	Number of obs =	20
Residual	25.112761	17	1.47722123	F(2, 17) =	10.05
				Prob > F =	0.0013
Total	54.8154076	19	2.88502145	R-squared =	0.5419
				Adj R-squared =	0.4880
				Root MSE =	1.2154

lnrd	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lntaxfor	.8771449	.199374	4.40	0.000	.4565026	1.297787
t	.3536497	.1968202	1.80	0.090	-.0616046	.768904
_cons	-.4154336	1.905677	-0.22	0.830	-4.43606	3.605193

9 The basic data used for the estimation are presented in Annexure 1.

Table 12: Elasticity of R&D expenditure wrt tax foregone- Specification 2

Source	SS	df	MS		
Model	30.8650372	3	10.2883457	Number of obs =	20
Residual	23.9503705	16	1.49689815	F(3, 16) =	6.87
				Prob > F =	0.0035
				R-squared =	0.5631
				Adj R-squared =	0.4811
Total	54.8154076	19	2.88502145	Root MSE =	1.2235

lnrd	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lntaxfor	.9348086	.2110958	4.43	0.000	.4873055	1.382312
t	1.275171	1.064347	1.20	0.248	-.9811444	3.531486
t2	-.1515374	.171965	-0.88	0.391	-.5160868	.213012
_cons	-1.995622	2.625937	-0.76	0.458	-7.56236	3.571116

The co-efficient of the elasticity of R&D, according to both the specifications are less than unity, but statistically significant at 5 per cent. Although, strictly speaking, this implies that the tax incentive failed to raise R&D expenditures more than proportionately, one should be very careful in drawing such an inference as given the two caveats and especially the second one, the co-efficient was expected to be lower than what it ought to have been. A hypothesis is that not all companies which have availed of this incentive have been able to perform increased R&D with it owing to the shortage of skilled R&D scientists and engineers. The fact that the industry is expressing a skill gaps lends some credence to this hypothesis (Sengupta, 2006). So all that one can say, based on this exercise is that the tax incentive scheme has been targeted well and it has been somewhat successful in raising R&D expenditures of the targeted industries. However it is also important that we need better estimates of tax foregone and thereby the effective tax rate to arrive more robust estimates of the coefficient of elasticity of R&D expenditure. Although we have raised clear question at the beginning of this study namely whether tax incentives for R&D are really effective or not, we are not in a position to provide an unambiguous answer. This is entirely due to the handicaps in data.

IV. **Conclusions:** Our study has shown that there have been improvements in the innovative output of Indian industry during the recent period since economic liberalisation. However this has been restricted to a few industries such as the pharmaceutical industry. India has three different types of financial incentives for R&D: research grants and loans, venture capital and tax incentives. Our analysis showed that the pharmaceutical industry has been a target of most of these financial incentives. There is thus a fine targeting of innovation financing in India. We endeavoured to estimate the coefficient of elasticity of R&D with respect to tax foregone as result of this incentive scheme. The resulting exercise showed that R&D expenditure of the concerned industries was not elastic although they were very close to being elastic. Our hypothesis was that this was largely due to the quirks of methodology and the dataset used for such a computation. So until we have firm data on tax foregone due to the operation of this specific R&D scheme we are not in a position to draw very firm conclusions about its effectiveness. The only safe conclusion that this study allow us to draw is the fact that the government has targeted the right sort of industries for awarding this incentive scheme.

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Annexure 1: Data used for estimating the coefficient of elasticity of R&D

R&D Expenditure of firms receiving R&D tax Incentives(Rs. In Millions)					
Industry	**2002**	**2003**	**2004**	**2005**	**2006**
Pharma	8937	11218.4	16609.5	22928.1	29595
Chemical - Pharma	2094.9	2407.6	2697.1	3303	4791
Electronics, Computers	573	126	349.6	71.5	417.9
Automobiles, Autoparts	3999.3	4843.6	5874.3	9701.5	11354
Tax Forgone(in million Rs.)					
Industry	**2002**	**2003**	**2004**	**2005**	**2006**
Pharma	36668.0963	4334.30063	5767.04348	6572.14789	8523.93883
Electronics Including Computer Hardware	4443.3792	436.75344	689.4756	346.15368	267.51024
Fertilizer, Chemicals & Paints	50910.2487	6454.37241	10481.75577	12706.26237	16308.63261
Automobile & Autoparts	5171.2184	1815.14974	3501.58677	5207.23646	6221.48777
Data used for regression					
				log values	
Industry	**Year**	**R&D**	**Tax foregone**	**lnR&D**	**lnTaxfor**
Pharma	2002	8937	36668.0963	9.097955241	10.50966235
Pharma	2003	11218.4	4334.30063	9.325310566	8.374315545
Pharma	2004	16609.5	5767.04348	9.7177301	8.659914833
Pharma	2005	22928.1	6572.14789	10.04011851	8.790595982
Pharma	2006	29595	8523.93883	10.29536071	9.050633817
Chemical - Pharma	2002	2094.9	50910.2487	7.647261099	10.83781953
Chemical - Pharma	2003	2407.6	6454.37241	7.78638568	8.772513073
Chemical - Pharma	2004	2697.1	10481.75577	7.899932401	9.257391479
Chemical - Pharma	2005	3303	12706.26237	8.102586425	9.449850251
Chemical - Pharma	2006	4791	16308.63261	8.474494437	9.699449855
Electronics, Computers	2002	573	4443.3792	6.350885717	8.399170447
Electronics, Computers	2003	126	436.75344	4.836281907	6.079368825
Electronics, Computers	2004	349.6	689.4756	5.856789644	6.535931309
Electronics, Computers	2005	71.5	346.15368	4.26969745	5.846882838
Electronics, Computers	2006	417.9	267.51024	6.035242169	5.589157846
Automobiles, Autoparts	2002	3999.3	5171.2184	8.293874625	8.550863607
Automobiles, Autoparts	2003	4843.6	1815.14974	8.485413525	7.503923245
Automobiles, Autoparts	2004	5874.3	3501.58677	8.678342183	8.160971508
Automobiles, Autoparts	2005	9701.5	5207.23646	9.180035792	8.557804564
Automobiles, Autoparts	2006	11354	6221.48777	9.337325384	8.735764348