

Resource, Development and Innovation in the Indian Industry

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ABSTRACT

Research and Development (R&D) has a major role in economic development. While developed countries give much importance to research and innovation, these remain as relatively unexplored areas in less developed countries. In the current global scenario, Indian firms have to reorient themselves to R&D-based innovation, as their products have to compete with highly technology-based products of advanced nations in local and international markets. Against this background, this article attempts to examine whether there has been significant increase in R&D expenditure in the Indian industry after the introduction of the new economic policy in 1991. The study reveals that low priority attached to R&D in India is a matter of concern. Out of the total national R&D expenditure, the share of the Industrial sector is very low. The pharmaceutical group appears to be the most innovative segment among various groups of industries. In comparison with their counter parts in the public sector, private sector firms focus more on R&D activities.

Keywords: R&D Expenditure, Innovation, Industrial R&D

Introduction

There is widespread recognition that Research and Development (R&D) is

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a key and vital component of economic development. It is a set of related activities undertaken to create innovations. OECD *Frascati Manual* defines (OECD, 1963) R&D as 'creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use this stock of knowledge to devise new applications'. R&D activities are essential for design and development of new products, improvement in the quality of products, introduction of new raw materials, energy conservation, etc. Many empirical studies (Griliches, 1984; Mansfield, 1995) have pointed out that investment in R&D is positively associated with economic growth. The existence and strength of the association between R&D activities and economic growth, however, depend on the capacity of each region to transform R&D investment into innovation¹ and eventually innovation into economic growth.

In this era of globalisation, countries and firms have to reconfigure their competencies (Mahajan, 2011) to survive and succeed in the rapidly changing business environment. Success depends on the capacity to generate new scientific knowledge, and to transform it to commercial applications. R&D-based innovations are essential for firms to survive and compete in the global market. While developed countries give much importance to research and innovation, these remain as relatively unexplored areas in less developed countries. Given the limited financial resources, developing countries have been slow in using technology to produce good quality and low cost products to compete with highly technology-based products of advanced nations in local and export markets.

Against this background, like other developing countries, India also needs to gear up local R&D to enhance its technological capability. For business enterprises that have paid little attention to innovative activities, reorienting themselves to R&D-based innovation is a difficult task. The government has been encouraging industrial units to take up R&D activities by paying special attention to promotion and support to R&D. It has implemented several fiscal measures, like tax incentives, tax holidays, excise and customs duty schemes, special incentives to emerging sectors, etc. India has declared 2010–20 as the 'Decade of Innovation' and has also established the National Innovation Council. The Science,

Technology and Innovation Policy of 2013 (STIP, 2013) aims to bring further perspectives to bear on innovation in the Indian context.

Financial and human resources represent the principal inputs to R&D and, often, they are used as indicators of the commitment of industry to innovation. Level of R&D expenditure and ratio of R&D expenditure to Gross Domestic Product (GDP) are the most commonly used measures of innovativeness as they capture the resources devoted to improve technological capabilities in the future.

There are only a few attempts (Mani, 2008; Bhattacharya and Lal 2008; Sheeja, 2004) to examine whether there has been significant increase in R&D expenditure in the Indian industry after the introduction of the new economic policy in 1991. In this context, the main objective of this article is to throw light on the important trends and pattern of R&D expenditure in the Indian industry in the post-liberalisation period. Such an exercise is essential for understanding whether the R&D efforts in India are keeping pace with the expansion of the industry and the economy in general. The present study is based on the official statistics² on R&D published by the Department of Science and Technology (DST), Government of India.

The structure of the article is as follows: The second section describes trends and pattern of R&D investment in India with a focus on industrial R&D. The third section compares the innovative efforts of private and public sectors. The fourth and concluding section sums up the main findings of the article.

Trends and Pattern of R&D Investment in the Indian Industry

Aggregate R&D expenditure in India increased considerably during the post-liberalisation period (Table 1). It increased from Rs. 4,513 crore in 1991–92 to Rs. 37,778 crores in 2007–08. In terms of absolute amount, there is substantial increase in R&D investment. However, the priority a nation attaches to a particular sector can be assessed in terms of its relative share in GDP. The relative share of R&D in India's GDP is very low as it is only around 0.8 per cent of GDP. As shown in Table 1, it was less than 0.80 per cent in the 1990s and slightly improved from 2000 onwards, and by 2007–08 it became 0.88 per cent of GDP. Here, it is

worth reminding ourselves that the Science, Technology and Innovation Policy of 2003 (STIP 2003) had targeted to raise the expenditure on R&D to 2 per cent of GDP by the end of tenth five year plan. The National Innovation System failed miserably in achieving this target. The new STIP 2013 also envisages enhancing R&D expenditure to 2 per cent of GDP. As the business sector is gripped by recessionary conditions, again this is a difficult task (Mani, 2013).

Average growth rates in total expenditure have been worked out. Indian R&D expenditure showed an average growth rate of 14.42 per cent during 1991–2008. The average annual growth rate was 15.74 per cent during 1991–2000 and 13.09 per cent in 2000–08.

Table 1: R&D Expenditure in India Since 1991 (Rs. crores)

<i>Year</i>	<i>R&D Expenditure</i>	<i>R&D Expenditure as Percentage of GDP</i>
1991–92	4,512.81	0.78
1992–93	5,004.60	0.76
1993–94	6,073.02	0.79
1994–95	6,622.44	0.73
1995–96	7,483.88	0.71
1996–97	8,340.17	0.72
1997–98	10,611.34	0.77
1998–99	12,473.17	0.79
1999–2000	14,397.62	0.82
2000–01	16,198.78	0.86
2001–02	17,038.15	0.82
2002–03	18,088.16	0.80
2003–04	19,726.99	0.79
2004–05	21,639.58	0.84
2005–06	28,776.65	0.89
2006–07	32,941.64	0.87
2007–08	37,777.90	0.88

Source: Various reports of DST, GOI.

An international comparison (Table 2) of relative shares of R&D expenditure of some developed, as well as developing countries shows that India is in the lowest spending category (less than 1 per cent category). China's position is in the second category as it spends more than 1.4 per

cent of GDP for R&D. Most of the developed countries spend a higher proportion of GDP for R&D activities. While Israel spends more than 4.5 per cent of GDP for R&D, countries like Japan and Sweden spend 3.4 per cent and 3.8 per cent of GDP respectively on R&D. Given the international trend, the declining importance attached to R&D in India is a matter of serious concern. This widens the already existing technology gap between India (Kumar and Aggarwal, 2000) and other industrialised countries. Gearing up of R&D expenditure is the need of the hour as far as the Indian economy is concerned.

Table 2: Relative Share of R&D: An International Comparison

<i>0.0 –1.0 (%)</i>	<i>1.1–2 (%)</i>	<i>above 2%</i>
Brazil (0.82)	Netherlands (1.69)	France (2.12)
India (0.88)	Canada (1.97)	Germany (2.52)
Pakistan (0.44)	China (1.42)	Israel (4.53)
Sri Lanka (0.19)	UK (1.80)	Japan (3.40)
Mexico (0.50)	Australia (1.78)	Sweden (3.82)
Argentina (0.49)	Netherlands (1.69)	USA (2.61)

Source: R&D Statistics 2007–08, DST, GOI.

In India the central government continues to shoulder the major share of financial resources devoted to R&D activities. Out of the total national expenditure, the central sector (central government inclusive of public sector industry) with its contribution of nearly 59 per cent accounts for the bulk of R&D expenditure.. The share of private sector³ is only around 30 per cent. An examination of the pattern of R&D expenditure in India in the post-liberalisation period (Table 3) reveals that, during 1991–92 to 2000–06, around 70 per cent of R&D expenditure was incurred by the institutional sector, and the industrial sector accounts for nearly 25–30 per cent. The small share of industrial sector in the national R&D expenditure is one of the major handicaps of Indian R&D system. In most of the developed countries, the share of industrial⁴ sector

in national R&D expenditure is more than 50 per cent (R&D statistics 2007–08, DST, GOI).

Table 3: Structural Pattern of R&D Expenditure in India (Rs. crores)

<i>Year</i>	<i>Institutional R&D expenditure</i>	<i>Industrial R&D expenditure</i>	<i>Total R&D expenditure</i>
1991–92	3,391.48 (75.15)	1,121.33 (24.85)	4,512.81 (100)
1992–93	3,654.4 (73.02)	1,350.2 (26.98)	5,004.6 (100)
1993–94	4,547.67 (74.88)	1,525.35 (25.12)	6,073.02 (100)
1994–95	4,888.96 (73.82)	1,733.48 (26.18)	6,622.44 (100)
1995–96	5,429.23 (72.55)	2,054.65 (27.45)	7,483.88 (100)
1996–97	6,007.16 (72.03)	2,333.01 (27.97)	8,340.17 (100)
1997–98	7,735.67 (72.9)	2,875.67 (27.10)	10,611.34 (100)
1998–99	9,158.25 (73.41)	3,314.92 (26.6)	12,473.17 (100)
1999–2000	10,982.16 (76.28)	3,415.46 (23.72)	14,397.62 (100)
2000–01	12,432.57 (76.75)	3,766.21 (23.25)	16,198.78 (100)
2001–02	12,978.09 (76.17)	4,060.06 (23.83)	17,038.15 (100)
2002–03	13,630.97 (75.36)	4,457.19 (24.64)	18,088.16 (100)
2003–04	14,164.69 (71.80)	5,562.30 (28.20)	19,726.99 (100)
2004–05	14,342.74 (66.28)	7,296.84 (33.71)	21,639.58 (100)
2005–06	20,028.18 (69.60)	8,748.47 (30.40)	28,776.65 (100)

Note: figures in brackets indicate percentage.

Source: Various reports of DST, GOI.

The following pages focus only on R&D expenditure carried out in the Indian industry. Table 4 shows the distribution of R&D units and R&D expenditure among the important segments of the Indian industry. Out of the 1220 R&D units, the largest number (176) of units was in the chemical industry group. On the basis of number of R&D units, Drugs and Pharmaceuticals (161) and Electrical and Electronic (144) equipment occupied the second and third positions respectively. The highest percentage share (37.36 per cent) of R&D expenditure was incurred by the Drugs and Pharmaceutical group. The Pharmaceutical group is one of the most innovative industries in the Indian manufacturing sector. The Transportation segment occupied the second position by contributing 14.74 per cent. These two industrial groups together contributed around 52 per cent of the total industrial R&D. It is interesting to observe that these two segments of the Indian industry together account for more than half of the total industrial R&D.

Table 4: Distribution of Industrial R&D Among Major Industrial Groups

<i>Industry Group</i>	<i>No. of R&D Units</i>	<i>Percentage Share of total Industrial R&D Expenditure</i>
Drugs and Pharmaceuticals	161	37.36
Transportation	64	14.74
Defence Industries	16	6.89
Electricals and Electronics	144	5.68
Chemicals (other than fertilizers)	176	4.35
Fuels	23	4.32
Information Technology	21	4.21
Bio-Technology	71	3.68
Metallurgical Industries	61	3.07
Industrial Machinery	31	1.84
Telecommunications	32	1.83
Others	420	12.05
Total	1,220	100

Source: R&D Statistics 2007--08, DST, GOI

The average growth rates of R&D expenditure of major industrial groups in the Indian industry during 1991–2006 have been calculated (Table 5). The highest average growth of 49 per cent was observed in the Information

Technology segment. Drugs and pharmaceuticals occupied the second position with a growth rate of 30 per cent, followed by Transportation which experienced 20.6 per cent growth in R&D expenditure. Among these nine segments of the Indian industry, Drugs and Pharmaceuticals is the only sector in which R&D expenditure increased at a substantially higher rate during 2000–06 in comparison with the previous period. Fuels experienced almost the same growth rate during these two time periods. It is quite distressing to see that in the case of all other segments the average growth rate of R&D expenditure declined during the second period.

Table 5: Average Growth Rate of R&D Expenditure of Major Segments of the Indian Industry

<i>Industry Group</i>	<i>Industrial Sector</i>		
	<i>1991–2000</i>	<i>2000–06</i>	<i>1991–2006</i>
Metallurgical Industries	13.14	7.74	10.44
Fuels	14.18	14.42	14.30
Electrical and Electronic Equipment	11.49	9.24	10.37
Telecommunication	12.94	9.05	11.00
Transportation	22.57	18.71	20.64
Information Technology	76.85	21.63	49.24
Chemicals	18.16	3.41	10.79
Drugs and Pharmaceuticals	24.89	34.96	29.89
Defence	17.48	10.61	14.05

Note: Figures indicate percentage.

Source: Calculated from various reports of DST, GOI.

A Comparison between Public and Private Sectors

The break-up of aggregate industrial R&D expenditure by public and private sectors in the post-liberalisation period is shown in Table 6. Data show that, within the Indian Industry, the private sector's contribution was higher than that of the public sector throughout the period. While the share of private sector was less than 65 per cent during 1991–94 and it increased to almost 80 per cent during 1995–96. There was further increase in the percentage share of the private sector and from 1997–98 onwards, and by the year 2005–06, almost 85 per cent of industrial R&D was undertaken by the private sector. As compared to the public sector, the private sector has more number of R&D units also. According to

latest available data (R&D Statistics 2007–08, DST), out of 1,755 R&D units in the Indian industry 1,643 units (93.6 per cent) are in the private sector and there are only 112 units (6.4 per cent) in the public sector. So both in terms of number of units and share of R&D expenditure, private sector is the major player within the Indian industry.

Table 6: Break-up of R&D Expenditure Within the Industrial Sector
(Rs. crores)

<i>Year</i>	<i>Public Sector</i>	<i>Private Sector</i>	<i>Industrial Sector</i>
1991–92	484.39 (36.67)	836.25 (63.33)	1,320.64 (100)
1992–93	513.95 (38.06)	836.25 (61.94)	1,350.20 (100)
1993–94	542.81 (35.59)	982.54 (64.41)	1,525.35 (100)
1994–95	414.61 (23.92)	1,318.87 (76.08)	1,733.48 (100)
1995–96	427.58 (20.81)	1,627.07 (79.19)	2,054.64 (100)
1996–97	512.73 (22.20)	1,796.96 (77.81)	2,309.69 (100)
1997–98	539.24 (18.11)	2,438.25 (81.89)	2,977.49 (100)
1998–99	651.02 (18.92)	2,790.41 (81.08)	3,441.42 (100)
1999–2000	730.76 (17.82)	3,365.38 (82.16)	4,096.14 (100)
2000–01	820.28 (16.81)	4,058.83 (83.19)	4,879.11 (100)
2001–02	NA	NA	NA
2002–03	1,078.07 (23.56)	3,498.30 (76.44)	4,576.37 (100)
2003–04	1,091.03 (19.61)	4,471.27 (80.39)	5,562.30 (100)
2004–05	1,257.88 (17.24)	6,038.96 (82.76)	7,296.84 (100)
2005–06	1,304.26 (14.91)	7,444.21 (85.09)	8,748.47 (100)

Note: Figures in brackets indicate percentage.

Source: Various reports of DST, GOI.

The average annual growth of R&D expenditure in the industrial sector (Table 7) during 1991–2006 is 16 per cent. While the private sector experienced a high growth rate of 19 per cent, the corresponding figure for the public sector was only less than 9 per cent. However, compared to the 1990s, the average growth rate was lower in the industry and its private sector during 2000–06.

Table 7: Average Growth of R&D Expenditure in the Indian Industry (Percentage)

<i>Sector</i>	<i>1991–2000</i>	<i>2000–06</i>	<i>1991–2006</i>
Public	7.35	10.29	8.82
Private	22.79	15.41	19.10
Industrial Sector	17.91	14.24	16.08

Note: Figures indicate percentage.

Source: Calculated from various reports of DST, GOI.

A comparison between the average growth rates in R&D expenditure of major industrial groups within the public sector and private sector is presented in Table 8. Within the public sector, the highest average growth was found in transportation (44 per cent) while the pharmaceutical group exhibited a negative growth rate. All industrial groups, except Transportation, Drugs and Pharmaceuticals, and Chemicals, experienced a lower average growth of R&D expenditure during 2000–06 in comparison with the previous period. Within the private sector, the highest growth rate in R&D expenditure was observed in Information Technology (61 per cent), followed by Fuels (33 per cent) and Drugs and Pharmaceuticals (31.6 per cent). In segments like Fuels, Telecommunication, and Drugs and Pharmaceuticals, the growth rate of R&D was higher in the second period (2006–07) as compared to the previous period. Here, it is worth noting that even though Fuels experienced a high growth rate, the absolute amount spent on R&D was much less, whereas, sectors like Drugs and Pharmaceuticals incurred a sizeable amount for R&D. The private sector investment in R&D is concentrated in two or three industries, namely, the Pharmaceuticals, Chemicals and Automotive industries.

Table 8: Average Growth of R&D: A Comparison Between Public and Private Sector (Percentage)

Industry Group	Public Sector			Private Sector		
	1991–2000	2000–06	1991–2006	1991–2000	2000–06	1991–2006
Metallurgical Industries	9.74	5.28	7.51	21.84	9.94	15.89
Fuels	14.70	14.01	14.36	15.26	52.30	33.30
Electrical and Electronic Equipment	34.08	-3.63	15.25	15.41	13.89	14.65
Telecommunication	13.35	-7.27	3.04	18.20	30.32	24.26
Transportation	-12.89	101.72	44.42	10.56	17.65	14.11
Chemicals	-0.66	14.13	6.73	6.39	3.19	4.79
Drugs and Pharmaceuticals	-7.05	-4.19	-5.62	27.86	35.29	31.58
Defence	15.98	10.23	13.11	NA	53.38	NA
Information Technology	NA	6.63	NA	99.54	23.07	61.31

Source: Calculated from various reports of DST, GOI.

Resource and development intensity⁴ is an indicator used to assess the relative importance given by industries to R&D. R&D intensity in the

Table 9: R&D Intensity in the Indian Industry

Year	Public Sector	Private Sector
1991–92	0.47	0.60
1992–93	0.44	0.67
1993–94	0.44	0.71
1994–95	0.26	0.62
1995–96	0.25	0.65
1996–97	0.30	0.64
1997–98	0.32	0.60
1998–99	0.35	0.54
1999–2000	0.34	0.48
2000–01	0.32	0.50
2001–02	0.27	0.61
2002–03	0.38	0.46
2003–04	0.35	0.54
2004–05	0.33	0.62
2005–06	0.30	0.66

Source: Various reports of DST, GOI.

Indian industry is only 0.55 which implies that the industry spends only 55 paise per 100 rupees of sale on R&D activity. This clearly indicates that Indian firms assign low priority to R&D activities. In most of the developed countries, the R&D intensity varies between 3–4 percent ('R&D statistics 2007–08').

A comparison between public and private sectors with respect to R&D intensity is shown in Table 9. Throughout the period, compared to the public sector, R&D intensity was higher in the private sector. In 2005–06, R&D intensity is 0.66 in the private sector and 0.30 in the public sector. This implies that while the firms in private sector spent 66 paise per 100 rupees of sale on R&D activity, firms in the public sector spent only 30 paise out of 100 rupees sales.

Conclusion

Even though there has been substantial increase in the aggregate amount devoted to R&D in the post-liberalisation period, its relative share in GDP is very low. This is a matter of concern especially in view of the critical role that R&D and innovations have in the growth process. As the industrial sector accounted for a comparatively smaller share of national R&D, gearing up of industrial R&D is essential for the Indian economy. Within the industry, R&D is concentrated in two segments, namely, Drugs and Pharmaceuticals, and Transportation. The Pharmaceutical group is the most innovative segment of the Indian manufacturing sector. The analysis also revealed that R&D intensity is very low in the Indian industry. Low R&D intensity indicates that Indian firms are not spending even one rupee out of hundred rupees of sales turnover on R&D.

Within the industry, in terms of both the number of R&D units and amount of R&D expenditure, the private sector outweighs the public sector. Moreover, the average growth of R&D expenditure in the private sector was more than twice the corresponding figure for the public sector. Compared to the public sector, the private sector has higher R&D intensity also. All these findings suggest that by realizing the vital role of R&D, industrial units in the private sector focused more on R&D efforts while their public counterparts failed to devote sufficient attention to R&D activities.

The findings of the study confirm that, in today's knowledge-based global environment, the low priority attached to R&D activity in the Indian industry is a critical issue. Expansion of industrial R&D activities is the need of the hour as far as a developing country like India is concerned.

Notes

1. Innovation is the transformation of new knowledge and ideas into commercial applications.
2. The most authentic source of data regarding R&D expenditure in India is 'Research and Development Statistics', published by the National Science and Technology Management Information System (NSTMIS), Department of Science and Technology (DST), Government of India. This report is prepared at periodic intervals. At present, the latest available report of DST is the 'R&D Statistics 2007–08'. This report contained data on R&D expenditure regarding the national economy up to the year 2007–08 and the industrial sector up to 2005–06.
3. See R&D Statistics 2007–08, [http:// nstmis-dst.org/rndststop07-08.htm](http://nstmis-dst.org/rndststop07-08.htm), accessed on 30 May 2013.
4. R&D intensity is R&D expenditure expressed as a percentage of sales turnover.

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