ISID
Working Paper
209

FDI in R&D in India: An Analysis of Recent Trends

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June 2019

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CONTENTS

List of Figure(s)

List of Table(s)

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*Reji K. Joseph, Biswajit Dhar, Akoijam Amitkumar Singh**

[***Abstract***: *This paper aims to estimate the quantum of inflow of FDI in R&D in India, identify the sectors which receive FDI in R&D, identify the nature and characteristics of investors and investee firms and examine the innovation performance of investee firms in terms of R&D expenditure, patents and publications. It is found that FDI in R&D constitutes only a meagre part of total FDI inflows to India, although India has been characterised as a leading destination for offshore corporate R&D globally. ICT, natural sciences & engineering and pharmaceuticals are the leading sectors receiving FDI in R&D. Only a few investee firms, out of the 298 investee firms identified in this study, have DSIR recognised in-house R&D units, which is the essential requirement for availing Govt. of India's schemes for incentivising investments in R&D. Most of the investee firms do not report R&D expenditure. Whatever R&D reported, the activities appear to be part of 'R&D in networks' wherein the outcome of R&D is transferred to lead firms/parent firms in foreign countries. The growing trend of India being recognised as inventor country in the patent applications in USPTO and at the same time declining share of it being recognised as assignee country point to this. About a fourth of investee firms have publications to their credit, mostly in areas of natural science & engineering, clinical research and pharmaceuticals]*

Keywords: Foreign direct investment, research and development, innovation, patents, R&D services

JEL Classifications: F21, O30, O34, L60

1. Significance of FDI in R&D

Productive knowledge plays a critical role in the growth of a country. It includes technical knowledge (research and development (R&D), design and process engineering) as well as knowledge of management, organisation, inter-firm and international relationships, much of which are tacit in nature (UNCTAD 1999). Role of productive knowledge is critical in both the high-tech industries and traditional activities in the primary sector (UNCTAD

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Acknowledgements: This working paper forms part of the study, "FDI in R&D and Development of National Innovation Capabilities: A Case Study of India", sponsored by Indian Council of Social Science Research (ICSSR), Ministry of Human Resource Development, Government of India. Views expressed in the paper are of authors and should not be attributed to any institution.

1999). Capital allows investments in the generation of new knowledge and technology, which enables an economy to attain higher levels of growth. Although foreign and domestic capital both contribute to the development of new ideas, foreign direct investment (FDI) is considered to have a much better impact for that combines capital with advanced technology, know-how and managerial, organisational and marketing skills. Therefore, inviting FDI into a country, especially developing country, is expected to hasten the pace of augmenting the productive knowledge base of the host country. The process of augmenting productive knowledge base through FDI would be faster and deep rooted, when such investments are in R&D.

2. Literature on India as a Destination of FDI in R&D

There only a few studies, which have looked into the inflow of FDI in R&D (RDFDI) to India. The study by National Institute of Science, Technology and Development Studies (NISTADS 2011) estimates the RDFDI inflows to India and the impact of such inflows. This was the first major attempt to compute the quantum of RDFDI inflows to India and its impacts. Researchers involved in the study have published papers, using the data collected for the study, which provides new insights on RDFDI in the Indian contexts[1].

Mrinalini et.al. (2013) found that the share of RDFDI in total FDI inflows into India was quite significant. During the period between 2003 and 2009 the RDFDI inflows was $29.2 Bn, which constituted 8.3 per cent of the FDI inflows into India during the same period. The authors have used data from another study (CSIR-NISTADS-TIFAC 2011) to arrive at this estimate. The source of total FDI inflow data, which the authors have used for computing the share of RDFDI, is not clear. If one uses the UNCTAD data on total FDI inflows to India, the RDFDI inflow as estimated by Mrinalini et.al. (2013), would constitute 20 per cent of FDI inflows to India[2].

The RDFDI estimate of Mrinalini *et.al.* (2013) seems to be an overstated figure. If RDFDI constitutes such a proportion of total FDI inflows, one would expect it to have considerable positive impact on the India's national innovation system (NIS). However, the expenditure on R&D as percentage of GDP, the widely used indicator to represent the innovation efforts in a country, has been stagnant around 0.8 per cent since the 1990s. Data on the RDFDI published by the Department of Industrial Policy and Promotion (DIPP) in its 'FDI Newsletter' (erstwhile SIA Newsletter), suggests that RDFDI accounts for only a very small share of total FDI inflows. The latest issue of FDI Newsletter, which provides the amount of RDFDI inflows from January 2018 to December 2018, reports that the share of RDFDI in total FDI inflows is very low, i.e., 0.20 per cent[3]. Mrinalini et.al. (2013) have compiled

[1] Publications include Mrinalini et.al. (2012), Mrinalini et.al. (2013), Sandhya et.al. (2014), and NISTADS (2011).

[2] FDI inflow data provided in Annex Table 1 of World Investment Report 2017 shows that FDI inflows to India during 2003 to 2009 was $.146134.7 million.

[3] Table No.8, FDI Newsletter, Vol. XXVII No. 3, January, 2019.

RDFDI data from various sources such as FDI Newsletters, Foreign Investment Promotion Board (FIPB), Datamonitor database, FDI Markets database of Financial Times, Cygnus database, data supplied by Centre for Monitoring Indian economy (CMIE), Online search of EE Times Asia, Silicon India, company websites, industry associations and newspapers. Some of these sources, for example FDI Markets database, provide data on the intended investment, not the actual investment that has taken place.

Sandhya et.al. (2014) found that RDFDI tend to be concentrated in certain clusters. Bangalore, Hyderabad, Chennai, Mumbai/Pune and Delhi/National Capital Region (NCR) accounted for 92 per cent of the amount of inflows in the three sectors—software and IT, pharmaceuticals/biotech and automotive[4]. They provided a detailed analysis of RDFDI in these three sectors. The three sectors accounted for 69 per cent and 83 per cent of the RDFDI received and jobs created, respectively. While the objective of investors of RDFDI was the same in all the three sectors, the strategies adopted varied in these sectors, which implies that the nature of impact of RDFDI would also vary across sectors. The primary objective of investors was to reduce their cost of R&D by taking advantage of lower costs of conducting R&D in India. Availability of engineers and IT professionals and firms specialising in R&D services (contract research) were the factors attracting investors.

They also found that out of the 706 firms investing in R&D in India during the period between 2003 and 2009, only 74 firms were granted patents in India. The 1166 patents granted to the 74 firms, constituted less than 5 per cent of global patents of their parent firms. About two-third of the 1166 patents in India was held by firms in the software and IT sector. However, they did not explain why firms in the software and IT sector were leading in terms of the number of patents granted. It is important because section 3(k) of the Patents Act of India restricts patentability of computer programmes unless they are combined with hardware. This clause prevents patenting of innovations in software *per se*, unless they are integrated into a hardware. Basant and Mani (2012) had found that almost all foreign firms engaged in R&D in the ICT sector are patenting their innovations in US and not in India. They point out that this is due to the difficulty in getting patents on innovations in software in India.

The study by Pohit and Biswas (2016), using data on announcement of Greenfield FDI of 'FDI Markets' (by Financial Times) found that RDFDI accounted for 10 per cent of FDI inflows during the period from 2003 to 2011. They have relied on the data provided by FDI Markets for estimating RDFDI and total FDI inflows to India. This estimate of the share of RDFDI in FDI inflows to India is very close of the one provided by Mrinalini et.al. (2013). As FDI Markets data is based on the intentions revealed by the investors and not the realised investment, their estimate of RDFDI inflows seems to be an inflated one. Pohit and Biswas (2016) have classified data available under three heads in FDI Markets as R&D: (a) 'Design, Development & Testing' (DDT), (b) 'Education and Training' (E&T) and (c)

[4] Computed by using cluster wise data on the three sectors and sector wise RDFDI data from Sandhya et.al. (2014).

'Research and development', which authors attributed as core R&D. They found that the share of core R&D has been declining and that of DDT is rising in RDFDI to India.

Basant and Mani (2012) analysed patenting behaviour of 639 foreign R&D centres in India during the period between 2010 and 2016 and found that only 10 per cent of them take patents either in India or in US. The remaining 90 per cent do some R&D in India, but do not take patent in India or US. They also did a detailed study of 120 foreign R&D centres in India, based on primary survey, to understand their motivations for the investments in India and the nature of R&D conducted in India. They have identified 120 firms from a study of TIFAC and reports of Zinnov. Although they haven't defined what a foreign R&D centre is, it appears that those firms having foreign investments in equity have been considered as foreign R&D centre[5]. Their study shows that utilising local human resources is the most important motive of their investments in India. Lower costs on personnel and overall R&D activities were the leading factors providing competitive advantage for the foreign R&D centres. A survey conducted by Economist Intelligence Unit in 2004 (EIU 2004) also came to the same conclusion that MNCs are interested in investing in R&D in India due to lower costs in India.

These studies have focused on three aspects of RDFDI inflows to India: (a) quantum of RDFDI inflows to India, (b) leading sectors and locations in terms of receiving RDFDI, and (c) impact of RDFDI in terms of number of jobs created and patents granted. As the estimates of RDFDI in these studies seem to be an overestimate, there is a need to look at RDFDI inflows more carefully. As the impact of RDFDI also depends on the nature of investor and investee firms, there is a need to identify the key characteristics of investor and investee firms. Information on patents granted certainly helps in capturing the impact of RDFDI; inclusion of more indicators would help one in developing a better understanding of the impact. This paper is an effort to address some of the gaps in the existing studies and to build on the work that has already been done.

3. Objectives of this Paper

(1) Estimate the inflow of FDFDI in India

(2) Identify key characteristics of foreign investors and investee firms

(3) Assess the innovation performance of RDFDI firms

[5] Table 16 in Basant and Mani (2012) provides distribution of 120 foreign R&D centres based on foreign ownership. There are six firms having less than 50% foreign ownership.

4. RDFDI Inflows to India: Some Key Aspects

4.1. Amount of RDFDI Inflows

The data on FDI inflows is compiled from FDI Newsletter, various issues. FDI Newsletter provides the details of foreign investor and investee firms, amount of investment and a description of intended activity of investment. All the inflows in which the activity was mentioned as R&D or any combination of words which represent R&D activities have been categorised as RDFDI[6]. Some inflows, which do not explicitly mention R&D or related activities in the intended activity details, are likely to be related to R&D. For example, inflows into a firm, which is fully engaged in R&D, is in all likelihood is RDFDI. Such inflows have been filtered in using various criteria such as the core business activity of the investee firm and core activity of the foreign investor. The RDFDI inflow data was compiled from September 2004 to March 2016. A list of 298 investee firms was prepared using this methodology.

RDFDI inflows into India during the period of analysis was Rs. 54862.6 Mn. This constitutes 0.4 per cent of total FDI inflows into India. Table below (Table 1) provides details of FDI and RDFDI inflows.

Table 1
FDI and RDFDI Inflows to India

Year	*FDI (Rs. Mn.)*	*RDFDI (Rs. Mn.)*	*Share of RDFDI (%)*
Sept.-Dec. 2004	112805.2	185.0	0.2
2005	192706.0	1047.1	0.5
2006	503572.1	1304.8	0.3
2007	654950.4	4844.0	0.7
2008	1351452.2	3986.8	0.3
2009	1309797.7	1922.6	0.1
2010	960149.4	3764.4	0.4
2011	1202384.9	4146.8	0.3
2012	1215914.4	2665.6	0.2
2013	1294825.1	7512.8	0.6
2014	1753133.7	7852.8	0.4
2015	2525614.7	14063.5	0.6
Jan.-March 2016	513112.2	1566.3	0.3
All the years above	13590418.0	54862.6	0.4

Source: Compiled by Authors from FDI Newsletter, DIPP, various issues

[6] Prof. K.S. Chalapati Rao, ISID, has developed a database on FDI inflows using the FDI Newsletters. This database was used for the identification of RDFDI inflows.

Our estimate shows that RDFDI constitutes only a very small share of total FDI inflows to India. This is very different from the estimates of Mrinalini et. al. (2013) and Pohit and Biswas (2016) who relied on the data provided by FDI Markets. This indicates that there is a big gap between the intended investment and realised investment in RDFDI.

4.2. Focus sector of RDFDI Firms

As a first step to identify the focus sector of RDFDI firms, we traced the Corporate Identification Number (CIN) of all 298 firms from the website of Ministry of Corporate Affairs. CIN is an identity number containing 21 characters, which provides listing status, industry to which the firm belongs, state where the firm is registered, year of incorporation, ownership details and registration number of the firm. CIN was matched with National Industrial Classification 2004 of India to identify the industry to which the firms belong. Identification of industry focus of a firm using this method has some limitations. There are instances where the industry component of CIN does not capture the core activity of a firm. For example, the CIN of Honda R&D India Pvt. Ltd. is U51202HR2003PTC035129. The industry code of this CIN – '51202', belong to the category of wholesale agricultural raw material, live animals, food beverages and tobacco. But Honda R&D India Pvt. Ltd. is part of the automobile sector. There may be discrepancies between the industry/sector as represented by the industry code of CIN and the actual industry focus of a firm. It is also possible that the actual focus area of a firm might change due to change in the core activity of a firm as an outcome of restructuring or takeover and subsequent revision in industrial classification. Therefore, the current core activity of firms was also taken into consideration while identifying the industry/sector of the 298 RDFDI firms. The R&D focus of firms was identified with that of the current core activity of the firm. The R&D focus areas of 298 firms, thus identified, are classified into 13 broad categories. Table 2 provides the details of the 13 R&D focus areas.

RDFDI was concentrated in four sectors—ICT, natural sciences and engineering (NSE), pharmaceuticals and clinical research, which accounted for more than 80 per cent of total RDFDI. In terms of distribution of RDFDI firms, i.e., firms based in India and received RDFDI, the four sectors account for three-fourth (75%) of total RDFDI firms (Table 3).

4.3. Location of RDFDI Firms

The 'Directory of Recognised In-House R&D Units' of Department of Scientific and Industrial Research (DSIR) provides the name and address of companies whose R&D units have been recognised and the address of the R&D unit. Location of RDFDI firms was identified from the address of the companies. In most cases, the registered address of companies and the location of their R&D units belonged to the same locality/city. Location of firms which are not listed in the DSIR directory[7] was traced from the details of the firms available at www.zaubacorp.com. There are 25 locations where the 298 firms are located. Table 4 provides the location details of firms.

[7] Directory of Recognised In-House R&D Units, 2015.

Table 2
R&D Focus of RDFDI Firms in India

Focus Area of R&D	*Description*
Agriculture	Seeds/Horticulture/Animal Husbandry
Automobiles	Automobiles
Chemicals excluding pharmaceuticals	Chemicals
Clinical Research	Clinical Research/Trials/Health care services/human health related
Defence	Defence
Design	Design Office/Architectural/Design drawings of semiconductors and metal sheets/chip design/design of automobiles
ICT	Computer Software development/Hardware Development/Website maintenance/data processing/semiconductors, etc.
Natural Sciences and Engineering	Scientific Testing & Analysis/Laboratory/Bio-tech/Natural Sciences/Engineering
Machinery	Manufacturing machinery/materials/general purpose machinery/special purpose machinery
Medical Devices	Medical Devices
Pharmaceuticals	Allopathic pharmaceuticals/ Bio pharma/Vaccines
Renewable Energy	Renewable Energy/Carbon Emission Reduction
Social Sector	Market Research/publishing of books/research and experimental developments in social sciences and humanities

Source: Compiled by Authors from company CINs available at the website of Ministry of Corporate Affairs; National Industrial Classification of India 2004; and internet search

Table 3
Sector-wise Distribution of RDFDI

Sector	*RDFDI Inflows*		*No of RDFDI Firms*	
	Amount (Rs. Mn.)	*Share (%)*	*No Firms*	*Share (%)*
ICT	15604.6	28.4	42	14.1
Natural Sciences and Engineering	10642.2	19.4	76	25.5
Pharmaceuticals	9462.9	17.2	49	16.4
Clinical research	9022.5	16.5	55	18.5
Chemicals excluding Pharmaceuticals	4436.8	8.1	10	3.4
Agriculture	1900.5	3.5	16	5.4
Defence	1133.8	2.1	1	0.3
Automobiles	762.1	1.4	6	2.0
Machinery	724.0	1.3	8	2.7
Petroleum and Oil	578.9	1.1	1	0.3

Sector	*RDFDI Inflows*		*No of RDFDI Firms*	
	Amount (Rs. Mn.)	*Share (%)*	*No Firms*	*Share (%)*
Medical Devices	340.9	0.6	4	1.3
Social Sector	111.0	0.2	14	4.7
Renewable Energy	101.0	0.2	14	4.7
Design	41.5	0.1	2	0.7
	54862.6	100.0	298	100.0

Source: Compiled by Authors from FDI Newsletter, Various Issues

Table 4
Location-wise Distribution of RDFDI inflows

Location	*RDFDI (Rs. Mn.)*	*Location*	*RDFDI (Rs. Mn.)*
Bengaluru	18842.6	Vishakhapatnam	211.2
NCR	8112.5	Vadodara	102.8
Mumbai	6593.5	Kochi	38.9
Hyderabad	5484.3	Rajkot	20.0
Kolkata	4595.7	Thane	19.7
Ahmedabad	3798.8	Coimbatore	6.0
Surat	2801.6	Balasore	5.9
Pune	1530.3	Denkanikottai	2.5
Chennai	1167.9	Patna	2.2
Mysuru	582.7	Thiruvanthapuram	0.2
Goa	402.6	Aurangabad	0.1
Jaipur	318.0	Nashik	0.1
Chandigarh	222.8		
Total			**54862.6**

Source: Compiled by Authors from FDI Newsletter, Various Issues; Directory of Recognised In-House R&D Units 2015, DSIR; and www. zaubacirp.com

5. Nature of Foreign Investors

The widely used definition of FDI globally is the one provided by the IMF in its *Balance of Payments and International Investment Position Manual*[8] and OECD in *The OECD Benchmark Definition of FDI*. IMF defines FDI as "a category of cross-border investment associated with a resident in one economy based on control and influence"[9]. It also states that the IMF's definition of FDI is the same as the one provided by OECD in its fourth edition of benchmark definition of FDI. The fourth edition of the OECD benchmark definition of FDI

[8] IMF, Balance of Payment and International Investment Position Manual, 6 Edition, 2013.
[9] *Ibid*, p100-101.

(OECD 2008) defines FDI as "a category of cross-border investment made by a resident in one economy (the direct investor) with the objective of establishing a lasting interest in an enterprise (the direct investment enterprise) that is resident in an economy other than that of the direct investor"[10]. It elaborates that "the main motivation of the direct investor is to exert some degree of influence over the management of its direct investment enterprise(s) whether or not this entails exercising a controlling interest. However, in many, if not most cases, the relationship is strong enough that the direct investor will control the direct investment enterprise. ... Direct investment relationships, by their very nature, may lead to long-term and steady financing and technological transfers with the objective of maximising production and the earnings of the MNE over time"[11].

IMF and OECD propose a 10 per cent voting power criteria to identify FDI flows; direct investment relationship is assumed to have taken place if the direct investor owns, directly or indirectly, at least 10 per cent of the voting power in the investee firm. This cut off is proposed to ensure statistical consistency across different countries. It has been acknowledged that there is nothing sacrosanct in the 10 per cent criteria. The third edition of the OECD Benchmark Definition of FDI (1999) acknowledges that in some cases, ownership of 10 per cent voting rights need not necessarily grand significant influence or control over the direct investment firm and in some other cases the direct investor may have an effective voice in the management with ownership of less than 10 per cent voting rights[12].

The concept of FDI used in the *Consolidated FDI Policy of India* is similar to the one provided by IMF and OECD. The Consolidated FDI Policy of August 2017 makes a clear distinction between FDI and FPI that FDI "has the connotation of establishing a 'lasting interest' in an enterprise that is resident in an economy other than that of the investor"[13]. But the approach adopted by India in identifying foreign investment inflows is quite different from what has been proposed by IMF and OECD. Any investment by a resident outside India through capital instruments (i) in an unlisted Indian company, or (ii) 10 per cent or more of post issue paid-up equity capital on a fully diluted basis of a listed Indian company, is considered as FDI in India. Any investment made by a person resident outside India in capital instruments where such investment is (i) less than 10 per cent of the post issue paid-

[10] *Ibid*, p.22.

[11] *Ibid*, p.22-23

[12] The EC in its submission to WTO on the definition of investment, acknowledges the probability of a direct investor influencing the management of direct investment enterprise with less than 10% voting power and proposes a case-by-case approach taking into consideration various parameters, which would indicate the influence of direct investor on the direct investment enterprise, to determine whether direct investment relationship exists[12]. For details see, *Concept Paper on the Definition of Investment*, Communication from EC Community and its member States, WT/WGTI/W/115, 16 April 2002, http://trade.ec.europa.eu/doclib/docs/2004/july/tradoc_111123.pdf (accessed on 2 December 2017).

[13] Chapter 1.1.1 of Consolidated FDI Policy 2017.

up equity capital on a fully diluted basis of a listed Indian company, or (ii) less than 10 per cent of the paid-up value of each series of capital instruments of a listed Indian company is considered as FPI (RBI 2018)[14].

Although the 10 per cent criterion provides a simple and easy method for identifying direct relationships or FDI, there have been instances of other investments getting classified as FDI. There are individual primary investors investing in collective investment institutions (CII) which acquire sufficient voting power to qualify as FDI. CIIs are intermediary institutions and they do not have the advantages which an MNC would carry in the case of FDI. They consist of incorporated investment companies and unincorporated entities such as mutual funds. They invest in financial assets such as securities and bank deposits using the funds raised from investors by issuing shares (other than equity) (OCED 2008). The motivations of investments of CII may be very different from FDI. Private equity (PE) funds are a variety of CII which participate in equity share holding. They are "financial service firms or institutions that purchase equity shares in companies ..."[15] PE funds have become a growing source of FDI flows, especially in mergers and acquisitions (M&As). In 2014, it accounted for 24 per cent of the total number of cross-border M&As. In 2007, 30 per cent total value of cross-border M&As was accounted by PE funds.[16] Therefore, the FDI statistics we come across need not truly indicate the control, influence or lasting interest which characterise FDI conceptually.

As the current FDI statistics has limitations in representing the typical characteristics of FDI, Rao and Dhar (2016)[17] propose that these characteristics are most likely to be represented if the investment is made in the same line of business, which they term 'Realistic FDI'. For example, an investment made by a foreign MNC operating in the pharmaceuticals sector in an Indian firm operating in the pharmaceuticals sector would be RFDI. They do not apply any percentage cut off, as done by IMF and OECD, to identify RFDI relationship. A study conducted by them (Rao and Dhar 2016), adopting a case-by-case approach to identify RFDI relationship, covering the period from 2004-05 to 2013-14 finds that only half of the officially reported FDI inflows to India is RFDI.

In this study, we follow a case-by-case approach to identify the nature of foreign investors. Each of the investor was examined to identify whether it is an MNC, PE firm, NRI or

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[14] https://rbidocs.rbi.org.in/rdocs/notification/PDFs/MD11_04012018B4D0DB4E6DA04CC4B7AF62AA03D902BE.PDF (30.08.2018)

[15] UNCTAD, World Investment Report 2006, FDI from Developing and Transition Economies: Implications for Development, p.18.

[16] UNCTAD, World Investment Report 2015, Reforming International Investment Agreements.

[17] Study *India's Post-1991 Inward FDI Experience: Looking Beyond Aggregates*, sponsored by ICSSR, presented during the ISID-ICSSR National Seminar on *India's Post-1991 Inward FDI Experience: Looking Beyond the Aggregates* held on 11-12 March 2016 at ISID, New Delhi.

foreign national[18]. There are MNCs, private equity (PE) firms, and individuals (NRIs and foreign nationals) investing in RDFDI in India. Details of investments made by various types of investors are shown in Table 5 and 6.

Table 5
Nature of Foreign RDFDI Investors

Nature of Investor	*Inflows (Rs. Mn.)*	*Share (%)*
Realistic RDFDI	45625.4	83.2
Private Equity	6841.4	12.5
Individual (Foreign)	471.1	0.9
Individual (Indian)	568.8	1.0
Others	1355.9	2.5
Grand Total	**54862.6**	**100.0**

Source: Compiled and categorised by Authors using FDI Newsletters, DIPP, various issues.

Table 6
Sector-wise Nature of RDFDI Investors (Share %)

Sector	*Realistic RDFDI*	*PE*	*Individual Indian*	*Individual Foreign*
Agriculture	3.9	0.0	2.0	6.4
Automobiles	1.7	0.0	0.0	0.0
Chemicals excluding pharmaceuticals	9.6	0.0	0.0	0.0
Clinical Research	9.8	23.3	59.8	58.9
Defence	2.5	0.0	0.0	0.0
Design	0.1	0.0	0.0	0.0
ICT	31.0	19.9	0.8	0.3
Natural Sciences and Engineering	18.9	47.5	27.2	5.1
Machinery	1.6	0.0	0.0	2.0
Medical Devices	0.7	0.0	0.2	0.0
Petroleum and Oil	1.3	0.0	0.0	0.0
Pharmaceuticals	18.7	9.2	8.7	20.0
Renewable Energy	0.2	0.0	0.5	2.4
Social Sector	0.2	0.1	0.7	4.9
Grand Total	**100.0**	**100.0**	**100.0**	**100.0**

Source: Compiled and categorised by Authors using FDI Newsletters, DIPP, various issues.

[18] In the case of individuals, classification of them into NRI and foreign national was based on internet search using their names. All those investors whose identity we could not establish were categorised as 'others'.

Realistic RDFDI accounts for more than four-fifth of RDFDI inflows into India. In the light of the findings of Rao and Dhar (2016) discussed above, it appears that in R&D, it is the MNCs who invest most. Therefore, one may expect that RDFDI would have positive impact on the innovation capability of India. But it depends on the nature of R&D activities done in India.

Table 6 shows that ICT is the leading sector to receive Realistic-RDFDI followed by NSE and pharmaceuticals. Nearly half of PE investments came to NSE. Individual investors, whether NRIs or foreign nationals, seems to prefer clinical research for their investment.

Most of the firms, 208 out of 298, received realistic RDFDI, i.e., RDFDI from foreign firms operating in the same line of business. Nineteen firms received investments from individuals, both NRIs and foreign nationals, who are professionals in the same field abroad[19]. In most cases, firms received investments from more than one type of foreign investors. Therefore, it is difficult to identify an investee firm with a particular type of foreign investor.

6. Recognition by DSIR

Government of India (GoI) has various schemes – financial incentives and R&D funds, for incentivising investment in industrial R&D. The Industrial R&D Promotion Programme (IRDPP) of DSIR is the only programme of GoI to benchmark industrial R&D. It aims at promoting R&D intensity in the industry, public funded R&D institutions, and scientific and industrial research organisations (SIROs). It also provides fiscal incentives to scientific research. Under this scheme, various Ministries grant R&D funds to corporate companies, public funded R&D institutions and SIROs. The GoI has also various fiscal incentives to support R&D. Major such incentive schemes are given below.

(i) Weighted tax deduction of 150 per cent on contribution for research programmes in approved national laboratories, universities and IITs (under section 35(2AA) of Income Tax Act 1961) and weighted tax deduction of 150 per cent R&D expenditure by DSIR recognised in-house R&D units (under section 35(2AB) of Income Tax Act 1961).
(ii) Writing-off of 100 per cent capital and revenue R&D expenditure under section 35(1) of Income tax Act 1961.
(iii) Accelerated depreciation allowance up to 40 per cent on investment on new plants and machinery based on indigenous technology.
(iv) Exemption from custom duty on goods imported for R&D by public and private funded institutions.

[19] This was established by searching the details of individual investors along with the name of the company into which they have made the investment in the internet including social media platforms such as LinkedIn.

(v) Exemption from central excise duty on indigenous goods purchased for R&D by public and private funded institutions.
(vi) Exemption from custom duty on imports for Government funded R&D projects by companies.

An essential requirement for availing these schemes is recognition by DSIR or registration with DSIR. Corporate companies are required to get their in-house R&D units recognised by DSIR. There are various requirements which a R&D unit has to meet in order to become eligible for recognition by DSIR. The requirements include:

(i) The R&D unit should have a separate identifiable infrastructure for carrying out R&D activities; R&D activities should be separate from routine activities.
(ii) The in-house R&D unit is preferred to be located outside factory premises or in a separate building or separate floor within the factory premise.
(iii) Presence of qualified staff engaged in R&D; companies seeking recognition of their in-house R&D units should be engaging in manufacturing or rendering services.
(iv) Companies engaged fully in contract research are eligible for recognition provided independent facility is available for R&D activities.

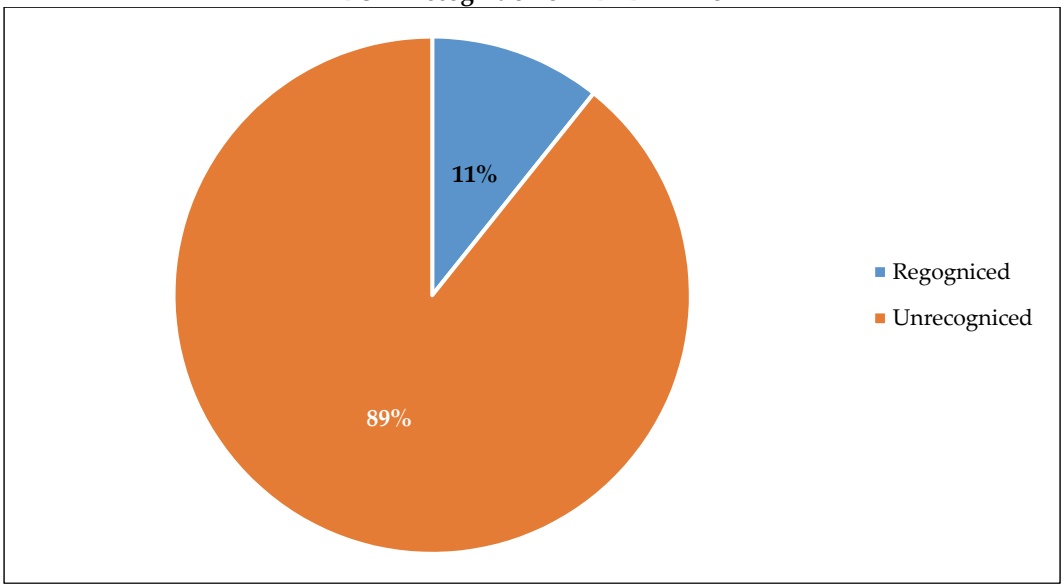
Recognition by DSIR implies that a R&D unit has well established infrastructure and is seriously engaged in R&D. However, non-recognition by DSIR does not necessarily mean that a R&D unit is not seriously into R&D and does not have adequate infrastructure. As in November 2016, there were 1880 in-house R&D units recognised by DSIR. Out of this, 115 firms had invested more than Rs. 500 Mn each in R&D. The total R&D expenditure (annual) by DSIR recognised R&D units has increased from Rs. 3000 Mn in 1980-81 to Rs. 345000 Mn in 2016-17. The number of R&D personnel employed by them has increased from 30000 in 1980-81 to 160000 by 2016-17[20].

Scientific and industrial research organisations (SIROs) in the area of agriculture, medical, natural and applied sciences, and social sciences have the option of registering with DSIR. Once registered with DSIR, they become eligible for customs duty exemption on the imports and central excise duty on the purchase of technical instruments and consumables for R&D. There are 673 SIROs registered with DSIR[21]. Similarly, public and private and institutions are also expected to register with DSIR for availing the schemes.

We checked with the Directory of Recognised In-House R&D Units 2015 of DSIR to understand how many of the RDFDI firms have DSIR recognised in-house R&D units. It is found that only a few firms have in-house R&D units recognised by DSIR. Figure 1 and Table 7 give the details of recognition by DSIR.

[20] Information available in DSIR Annual Report 2016-17.
[21] *Directory of Recognised Scientific and Industrial Research Organisations (SIROs)*, December 2017, DSIR.

Figure 1
DSIR Recognition of RDFDI Firms



Source: Compiled by Authors using data from *FDI Newsletter*, DIPP, various issues and *Directory of Recognised In-House R&D Units*, 2015, DSIR

Table 7
Sector-wise Distribution of DSIR Recognised RDFDI Firms

	No. of Firms			*Amount of RDFDI (Rs. Mn.)*		
	RDFDI Firms	*DSIR Recognised*	*Share (%)*	*RDFDI Inflows*	*RDFDI Inflows to DSIR recognised firms*	*Share (%)*
Agriculture	16	4	25.0	1900.5	965.9	50.8
Automobiles	6	0	0.0	762.1	0.0	0.0
Chemicals excluding pharmaceuticals	10	1	10.0	4436.8	1200.0	27.0
Clinical Research	52	6	11.5	9003.4	3517.9	39.1
Defence	1	0	0.0	1133.8	0.0	0.0
Design	2	0	0.0	41.5	0.0	0.0
ICT	42	0	0.0	15604.6	0.0	0.0
Natural Sciences and Engineering	78	7	8.9	10642.3	2379.9	22.4
Machinery	8	0	0.0	724.0	0.0	0.0
Medical Devices	4	1	25.0	340.9	1.4	0.4

	No. of Firms			*Amount of RDFDI (Rs. Mn.)*		
	RDFDI Firms	*DSIR Recognised*	*Share (%)*	*RDFDI Inflows*	*RDFDI Inflows to DSIR recognised firms*	*Share (%)*
Petroleum and Oil	1	0	0.0	578.9	0.0	0.0
Pharmaceuticals	50	13	26.0	9481.9	5611.6	59.2
Renewable Energy	14	0	0.0	101.0	0.0	0.0
Social Sector	14	0	0.0	111.0	0.0	0.0
Grand Total	**298**	**32**	**10.7**	**54862.6**	**13676.6**	**24.9**

Source: Same as Figure 1

Table 7 shows that only one-fourth of RDFDI has come to DSIR recognised firms. An immediate conclusion one may tend to draw is that rest of RDFDI has come into firms, which are not serious about R&D. That need not be the case. There could be some reasons, especially those having foreign collaboration, for not seeking recognition by DSIR. They may not find the incentives offered by GoI as attractive or they may have confidentiality considerations while disclosing certain information to DSIR or there could be restrictions imposed by foreign partner in applying for DSIR recognition[22]. Although Hyundai has R&D facility in Hyderabad, India, it hasn't applied for recognition by DSIR. The Texas Instruments India Pvt. Ltd., first MNC R&D centre established in India in 1985, has a major R&D facility in Bengaluru, India, for R&D in semiconductors and employs over 1000 R&D personnel. But it has not sought DSIR recognition due to the reason that the company does not consider the incentive schemes of GoI to be significant[23]. Similarly, one of the leading two-wheeler manufacturers in India, which had a joint venture with a foreign firm, was not allowed by the foreign collaborator to furnish the documents to DSIR for its recognition; the company had approached DSIR, a few times, for recognition but it was constrained in submitting the documents to DSIR. It was only after the break-up of the joint venture that the company was able to submit documents and get the recognition of DSIR[24].

It is interesting to note that none of the firms in the ICT sector, which received the maximum RDFDI inflows, has DSIR recognised in-house R&D units. In general, there is a tendency of ICT firms finding it a little more difficult as compared to firms in other sectors, to meet the eligibility criteria for DSIR recognition. One of the criteria is that the R&D facility should be separately identifiable. As many firms in this sector also engage business process outsourcing (BPO) activities, it is difficult for them to show separate facility for R&D and other business activities[25]. It doesn't mean that no firm in this sector receive DSIR

[22] This came out during interaction with a DSIR official (Retired) who handled recognition of in-house R&D units.

[23] Came out during interaction with Managing Director, Texas Instruments India Pvt. Ltd.

[24] *op. cit.* 22.

[25] *Ibid*.

recognition. Infosys, Tata Consultancy Services (TCS), WIRPO, etc. have been recognised by DSIR. Figure 1 shows that out of 298 firms, only 11 per cent (32 firms) are recognised by DSIR for their R&D activities.

7. Innovation Performance of RDFDI firms

Efforts a firm makes at innovation is related to its capability to innovate. The indicators for assessing innovation capability should ideally reflect the efficiency and effectiveness in the generation of knowledge, its diffusion and translation of it into goods and services of economic value. Such indicators are yet to be well developed. However, scholars have used different input and output measures to capture various aspects of innovation capability. The widely used input indicator is the expenditure on R&D and output indicator is the number of patents granted. These indicators have some limitations as well. R&D expenditure as the input indicator does not capture the other inputs, which go into the innovation process. Similarly, not all innovations be eligible for patents. Nevertheless, these indicators are powerful enough to reasonably capture the innovation capability. A firm would invest in R&D only when complementary innovation inputs exist and innovation infrastructure is conducive. Of late, publications have been used as an important innovation output indicator. One of the indicators used in the 'Global Innovation Index' published by Cornell University, INSEAD and WIPO is the country-wise number of publications. The Economic Survey 2017-18 of Government of India has used publications as one of the output indicators in the chapter on 'Transforming Science and Technology in India'[26]. We analyse the innovation performance of 298 RDFDI firms in terms of R&D expenditure, patents granted and publications.

7.1. Expenditure on R&D

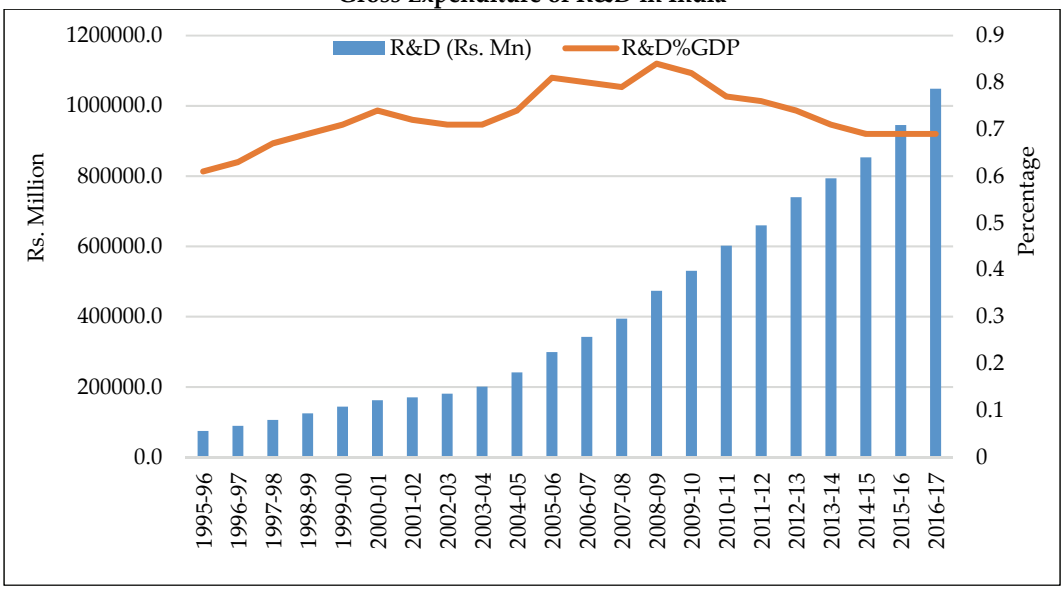
The Department of Science and Technology (DST), Ministry of Science and Technology, Government of India, publishes the *Research and Development Statistics* (R&D Statistics), which provides a macro view of R&D scenario in the country. It provides the data on aggregate R&D spending, sector-wise (private and public) distribution of R&D spending, major agencies involved in R&D, personnel engaged in R&D, among others. The latest R&D Statistics, published in 2017, shows that the gross expenditure on R&D (GERD) as percentage of GDP is still less than 1 per cent. Figure 2 gives the details of GERD over two decades since 1995-96.

The GERD in absolute terms has increased over the years from Rs. 74.8 Bn in 1995-96 to Rs. 1048.6 Bn in 2016-17. However, GERD as percentage of GDP, has shown a declining trend since 2009-10. India's investment in R&D (as percentage of GDP) is lowest among advanced developing countries. A comparison of BRICS countries in terms of sleeted

[26] http://mofapp.nic.in:8080/economicsurvey/pdf/119-130_Chapter_08_ENGLISH_Vol_01_2017-18.pdf

innovation input, output and ecosystem indicators is made in Table 8. In most of the indicators, India's performance is lowest among the BRICS countries.

Figure 2
Gross Expenditure of R&D in India



Source: Compiled and computed by Authors from DST 2017 (for R&D expenditure) and RBI Handbook of Statistics on Indian Economy (for GDP)

Table 8
Comparison of BRICS Countries in Key Innovation Indicators (Rankings)

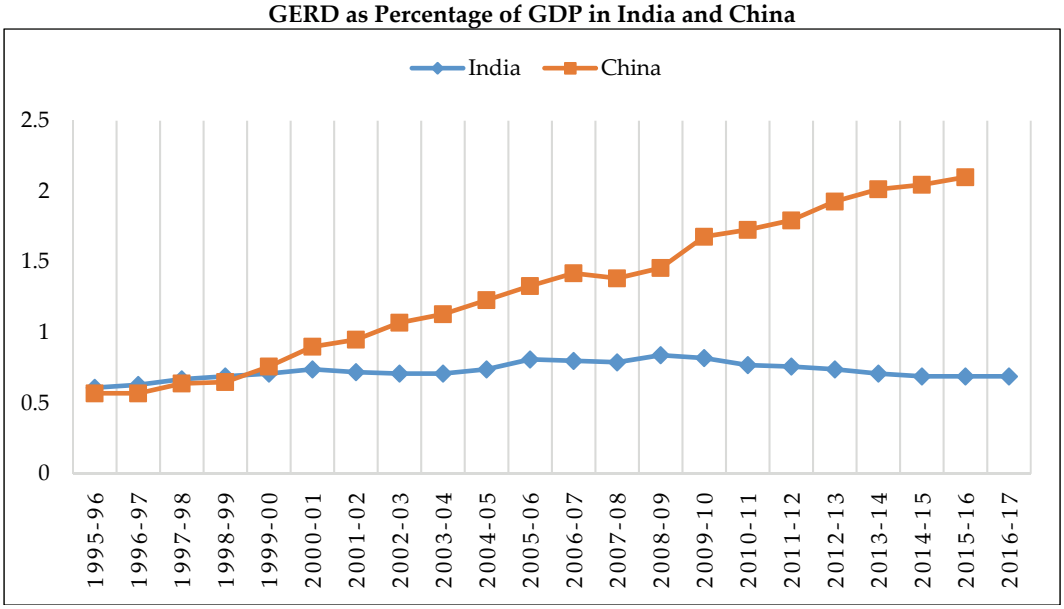
Country	*GII Ranking 2018*	*Innovation Input*	*Innovation Output*				*Innovation Ecosystem*		
		GERD % GDP	*Patents**	*Trademarks***	*Industrial Designs****	*S&T Publications*****	*Knowledge Intensive Employment#*	*ICT Use##*	*High & Medium Tech Manufacturers###*
China	17	14 (2.1)	1 (56.6)	3 (165.7)	1 (29.7)	42 (11.7)	n.a.	63 (52.7)	12 (0.5)
Russia	46	33 (1.1)	16 (7.0)	51 (50.0)	78 (0.8)	64 (7.2)	17 (43.8)	46 (61.3)	48 (0.2)
India	57	52 (0.6)	55 (1.5)	75 (30.4)	76 (0.8)	73 (5.6)	91 (14.2)	110 (16.2)	34 (0.3)
South Africa	58	42 (0.8)	64 (1.0)	73 (30.8)	59 (1.5)	46 (10.9)	64 (23.6)	80 (39.1)	40 (0.3)
Brazil	64	27 (1.3)	52 (1.7)	60 (43.9)	67 (1.1)	54 (9.8)	63 (23.9)	52 (56.9)	30 (0.3)

Source: Compiled by Authors from Global Innovation Index 2018 Report

Note: Figures in brackets are scores. * Number of patent applications by residents (per billion PPP$ GDP); ** Number of trademark applications by residents (per billion PPP$ GDP); *** number of designs contained in industrial design application by residents (per billion PPP$ GDP); **** Number of scientific and technical journal articles (per billion PPP$ GDP); # percentage of workforce in knowledge intensive services; ## Index based on percentage of individuals using internet, fixed broadband internet connections per 100 inhabitants and active mobile broadband internet subscription per 100 inhabitants; ### High-tech and medium-high tech output as percentage of total output by manufacturers.

A comparison of GERD of India and China would be interesting. Figure 3 provides a comparison of the two countries in terms of GERD as percentage of GDP. The share of GERD in GDP in both countries were same in the second half of 1990s. But from the beginning of 2000s, the share of GERD in GDP of China began to increase. It increased from less than 1 per cent to above 2 per cent by 2013 in about 12 years. Gao and Gary (2008) call such an abrupt increase in R&D spending as 'science and technology' take off a country. Most OECD countries experienced an abrupt increase in their R&D spending, from less than 1 per cent to more than 2 per cent of GDP in about a decade.

Figure 3
GERD as Percentage of GDP in India and China

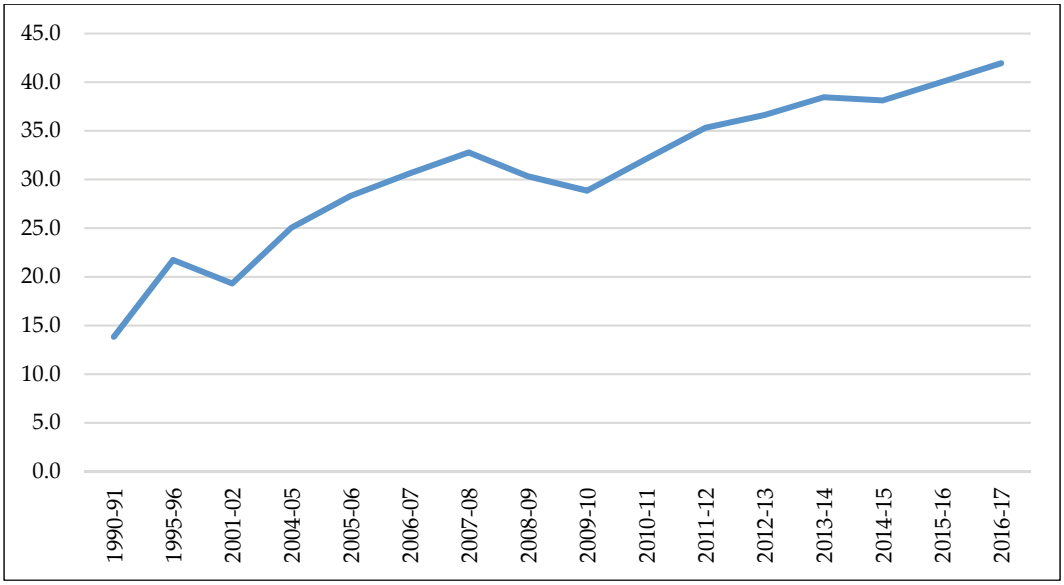


Source: Compiled by Authors from Mani (2010); DST (2017); Economic Survey, Government of India (various years); and World Bank (https://data.worldbank.org)
Note: Information on China is in calendar year.

Although the share of GERD in GDP is very low and is declining, the share of private sector in GERD has been increasing; increased from 14 per cent in 1991-92 to 42 per cent in 2016-17 (Figure 4).

The R&D statistics, however, does not provide the details of spending on R&D by foreign firms and Indian firms. The *Finances of Foreign Direct Investment Companies*, published by Reserve Bank of India (RBI), based on annual audits of select non-financial FDI companies, provides the expenditure on R&D by FDI firms. This report of RBI for various years shows that R&D expenditure as percentage of sales is very low, i.e., less than 0.5 per cent for the FDI firms taken as a whole (Table 9). In fact, the FDI firms tended to spend less on R&D but more by way of royalty payments; the latter being the expenditure incurred for the using foreign technology or trademark. However, it is not possible to know as to how much of the royalty payments were made on account of use of foreign technology.

Figure 4
Share of Private Sector in Total GERD



Source: Computed by Authors using DST (2017).

Table 9
R&D by Select FDI Companies (Rs Million)

Years	*Sales*	*Royalty*	*R&D*	*Ratio of Royalty Payments to sales (%)*	*Ratio of R&D to sales (%)*
2011-12	7489364	37205	36052	0.5	0.5
2012-13	8555154	44629	48950	0.5	0.6
2013-14	10235620	74781	9657	0.7	0.1
2014-15	11647532	87135	10915	0.7	0.1
2015-16	12449011	101887	12696	0.8	0.1

Source: Computed by Authors using Statement 4, Finances of Foreign Direct Investment Companies (various years), RBI.

Note: This data is based on selected sample of FDI companies, the number of which may vary across years. Data for the years 2011-12 to 2013-14 is based on 957 non-government and non-financial FDI companies. Data for the remaining years is based on 6433 non-government and non-financial FDI companies.

A comparison of the data on R&D of FDI companies provided by RBI and R&D expenditure by the private sector by the DST, would give an idea of the contribution of FDI companies in corporate sector R&D in India. The R&D expenditure of FDI companies compiled from the latest release of 'Finances of Foreign Direct Investment Companies', 2015-16, is provided in the table below (Table 10). It is found that the share of FDI companies in corporate sector R&D is only 3 per cent.

Table 10
Share of R&D by FDI Companies in GERD by Private Sector

	R&D Expenditure by Non-Government, Non-Financial (NGNF) FDI Firms in India (Rs. Million)	*GERD Private Sector (Rs. Million.)*	*Share of R&D by FDI companies in GERD by the private sector (%)*
2013-14	9657.0	305148.0	3.2
2014-15	10915.0	325383.9	3.4
2015-16	12696.0	378356.4	3.4

Source: Compiled and computed using data available in Finances of *Foreign Direct Investment Companies* 2015-16, RBI, https://dbie.rbi.org.in/DBIE/dbie.rbi?site=statistics#!2_46 and DST 2017 (GERD private sector)

In order to gauge the R&D spending by the RDFDI firms, we attempted to collect the firm wise information. But to our disappointment, it is found that only a few firms report R&D expenses. Out of 298 firms, only 45 are listed in the Prowess database of CMIE. This is probably because almost all of 298 firms are unlisted firms. Among these 45 firms, only seven firms reported R&D expenditure. We also checked the annual reports of 46 selected RDFDI firms[27] for their R&D expenditure. Only four firms out of this 46 firms reported R&D expenditure. Thus, out of the 91 firms, we got information on R&D expenditure on only 11 firms. Details of the 11 firms are given in the following table (Table 11).

Cancyte Technologies is a small firm with authorised capital of Rs. 1 Mn and is specialising in the supply of R&D services. It was incorporated in 2013. Its entire turnover is coming from R&D services. Viral diagnosis is one area of focus of this firm, as it comes out from its publications. It could be possible that firms in their early stage of growth tend to invest more in R&D. However, the FDI it has received is Rs. 0.1 Mn from an individual who seems to be of Indian origin based in US and specialising in biochemistry. He is also in the Board of Directors of two companies specialising in R&D. It could be possible that Cancyte may benefit from the professional experience of the investor. Out of the 11 firms, six have R&D intensity of more than 10 per cent.

The tendency of RDFDI firms not to report R&D expenses needs a detailed examination. On the one hand, foreign investors state that their investments are for R&D related activities,[28] but the investee firms do not report expense on R&D. ICT is the sector that received largest share of RDFDI inflows. But none of the RDFDI firms in this sector we analysed reported that they were spending on R&D. In most cases of RDFDI inflows into the ICT sector, the activity mentioned in the FDI newsletter contained the words R&D, design, development, etc. Although ICT sector would be an extreme case of no firm reporting R&D expense, the rate of reporting is very low in other sectors also.

[27] 17 firms in IT and software (Bengaluru), 20 firms in NSE (Bengaluru), 12 firms in Pharmaceuticals (Mumbai) and 7 firms in Clinical Research (Mumbai).

[28] As disclosed in the application of investments, which is presented in the FDI Newsletter.

Table 11
Details of R&D Expenditure Reporting RDFDI Firms

Name of the Firm	*Focus sector of the firm*	*Whether in-house R&D units recognised by DSIR*	*R&D % turnover (Average of 2013-14 to 2015-16)*
Cancyte Technologies Pvt. Ltd.	Natural Sciences and Engineering	No	907.1
A G Research Pvt. Ltd.*	Pharmaceuticals	No	71.0
Apotex Research Pvt. Ltd.	Natural Sciences and Engineering	No	32.2
Fresenius Kabi Oncology Ltd.*	Pharmaceuticals	Yes	27.1
Veeda Clinical Research Pvt. Ltd.*	Clinical Research	Yes	20.8
Devgen Seeds & Crop Technology Pvt. Ltd.*	Agriculture	No	10.0
Achira Labs Pvt. Ltd.	Natural Sciences and Engineering	Yes	9.0
Connexios Life Sciences Pvt. Ltd.	Natural Sciences and Engineering	Yes	7.69
Solvay Specialities India Pvt. Ltd.*	Chemicals excluding pharmaceuticals	No	5.3
Metahelix Life Sciences Pvt. Ltd.*	Natural Sciences and Engineering	No	3.5
Sai Life Sciences Ltd. *	Pharmaceuticals	Yes	2.3

Source: Prowess, CMIE and Annual Returns of Companies to Ministry of Corporate Affairs
Note: * R&D expenditure data of these firms is obtained from Prowess, CMIE.

The Companies Act 1956, and the Companies Act 2013, of India require companies incorporated in India to provide a "true and fair view of the state of affairs" [29] in their profit and loss accounts and balance sheets, complying with the accounting standards of India. The Companies Act 1956, empowers the Central Government to appoint National Advisory Committee on Accounting Standards to advice on the formulation of accounting policies and standards[30]. The Companies Act 2013, empowers the Central Government to prescribe accounting standards based on the recommendation of the Institute of Chartered Accountants of India (ICAI).

India formulated an accounting standard (AS)[31] for the treatment of expenditure on R&D in 1985, compliance of which was made mandatory since 1 April 1991[32]. The standard for accounting of R&D expenditure underwent two revisions since its formulation. The

[29] Section 129 of the Companies Act 2013.
[30] Section 210A of the Companies Act 1956.
[31] Accounting Standard 8. This was replaced by Accounting Standard 26 in 2003.
[32] Addendum to the Thesis 'Accounting for Research and Development Expenditure in the Corporate Sector – Indian Panorama' by Uttam Kumar Datta, submitted for the award of PhD degree in the University of Calcutta, available at http://shodhganga.inflibnet.ac.in/bitstream/10603/158853/19/19_addendum.pdf (05 January 2019).

accounting standard 8 (R&D) of 1985 defined research as "original and planned investigation undertaken with the hope of gaining new scientific or technical knowledge and understanding" and development as "the translation of research findings or other knowledge into a plan or design for the production of new or substantially improved materials, devices, products, processes, systems or services prior to the commencement of commercial production"[33]. It required companies in India to declare all costs related to R&D such as salary, cost of materials consumed, depreciation of building and equipment, etc. in the profit and loss account for the concerned period and R&D expenses which are deferred for future period in the balance sheet under the head 'miscellaneous expenses'[34]. It excluded expenses on 'routine or periodic minor modifications to the existing products, production lines, manufacturing processes and other ongoing operations and routine or promotional costs of market research' from the purview of R&D expenditure[35].

A limitation of accounting standard 8 was that it did not provide for recognition of intangible assets arising out of R&D activities. As the cost of generation of intangible assets arising from R&D has already been accounted in the balance sheet under miscellaneous expenses, valuation of intangible assets, when they were to be recognised, became as issue of concern. Therefore, a new accounting standard, i.e., accounting standard 26, dealing with recognition of intangible assets was issued in 2002, which came into force on 1 April 2003. This standard has been replaced by the International Financial Reporting Standards (IFRS) - converged Indian Accounting Standard (Ind AS) No. 38, which came into force on 1 April 2015. Both accounting standard 26 and Ind AS 38 provide that no expense at research level be recognised as asset; expenditure at research phase has to be reported as expense. Expenses at the development phase would also be reported as expense, unless the outcomes of development activities meet the criteria of recognition of intangible assets. Both these accounting standards follow a similar definition of R&D as provided in the accounting standard 8 of 1985. However, certain category firms have been exempted from complying with these standards. Those unlisted firms whose annual turnover was less than Rs.50 core were not required to comply with the accounting standard 26. Similarly, companies listed in SME exchange and those companies having net worth of less than Rs. 250 crore are not required to comply with the Ind AS 38 (ICAI 2018).

As Indian accounting standard for the reporting of R&D expenditure has evolved over a period of three decades, and some firms have been exempted from complying with these standards, collection of R&D data from the financial statements of companies and comparison of companies based on their R&D spending becomes difficult. In the case of RDFDI firms, even those firms which are expected to report their R&D expenditure is not doing so despite the fact that reporting of such expenses would enable them to benefit from

[33] Sections 3 (i) and 3 (ii) Accounting Standard 8.
[34] Sections 15 and 16 of Accounting Standard 8.
[35] Section 4.3 Accounting Standard 8.

tax exemptions. Government of India has introduced various tax incentives to encourage investments in R&D. The capital and revenue expenditures on 'scientific research'[36] is allowed to be deducted from taxable income under section 35 (1) of Income Tax Act, 1961. This act also provides for weighted deduction of R&D expenditure for those firms engaged in the manufacturing and having DSIR recognised in-house R&D units.[37] It defines manufacturing as "change in non-living physical object". This definition of manufacturing excludes software firms, whose products are non-physical, from availing the tax incentives. Therefore, it is not possible for IT and software firms to avail the incentives under this section.

Although the definition of 'scientific research' provided in the Income Tax Act, 1961, is sufficient to include software under its purview, companies seems to be facing difficulties in availing income tax benefits in R&D expenditure under section 35 (1). In the dispute between TCIL Bellsouth and Deputy Commissioner of Income Tax regarding availing of tax benefits on the expenses on software development, Income Tax Appellate Tribunal in 2003 held that expenditure on the development of software meets the criteria of 'expenditure on scientific research' provided in the Income Tax Act, 1961[38]. The main objection from the income tax assessing officer was that accounting standard 8, which was in force then, did not deal with whether development of software is R&D activity. The Appellate Tribunal pointed out that the Expert Advisory Committee of ICAI had opined in favour of considering expenditure on development of software as R&D expenditure and the definition of 'scientific research' in the Act brings expenditure on the development of software under the purview of such expenditure.

It is probable that firms in the ICT sector tend to capitalise their R&D expenditure. Many firms in this sector like Hewlett Packard Enterprises India Pvt. Ltd., Cadence AMS Design India PVt. LTD., SNAP Networks Pvt. Ltd. do not report R&D expenditure, but provide annual addition to the intangible assets. Capitalising the R&D expenses increases the asset value of firms. The fact that majority of the RDFDI firms did not report R&D expenditure calls for further research on this aspect.

Some firms may import technology and know-how rather than developing them in-house. In such cases, they would be making payments towards royalty, know-how fees and license fees. But they may also be spending some resources on R&D for adaptation purposes. We attempted to collect the data on payment towards royalty, know-how fees and license fees from the Prowess database. Out of the 45 firms listed in the database, only

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[36] Scientific research is defined as "any activities for the extension of knowledge in the fields of natural or applied science including agriculture, animal husbandry or fisheries". All expenditure incurred for the prosecution, or the provision of facilities for the prosecution, of scientific research is eligible for income tax benefits (Section 43 (4) of Income Tax Act, 1961.

[37] Section 35 (2AB) of Income Tax Act 1961.

[38] 'Software development expenditure considered as R&D', May 15 2003, http://nishithdesai.com/information/news-storage/news-details/newsid/5119/html/1.html

six reported such payments (Table 12) in 2016-17. Among these six firms, only one (Metahelix Life Sciences Ltd.) reported expenditure on R&D. All the other five firms are subsidiaries of foreign firms and more lights needs to be thrown into the issue of payments towards royalty and license fees.

Table 12
Expenditure on R&D and Payments towards Royalty, Know-how and License Fees in 2016-17
(Rs. Million)

Name of the Firm	*R&D*	*Royalty, Technical Know-How Fees and License Fees*
Accutest Research Laboratories (India) Pvt. Ltd.		6.5
Eaton Industrial Systems Pvt. Ltd.		410.5
Faurecia Interior Systems India Pvt. Ltd.		46.8
Metahelix Life Sciences Ltd.	212.5	0.4
Schindler India Pvt. Ltd.		586.2

Source: Compiled by Authors from Prowess

7.2. Patents Granted

In order to capture the patenting behaviour of RDFDI firms, we collected the information on patents granted by the Indian Patent Office (IPO) to the 298 firms during the period between 1 Sept. 2004 and 30 June 2018. Though this study covers the period until March 2016, we extended the period for the collection of patents data as there will be a gap between the performance of R&D activity and taking patent on the outcome of the R&D. We also collected the information on patent granted in the United States, from the United States Patent and Trademark Office (USPTO), which could be used to get some useful trends about the patenting behaviour of the RDFDI firms across jurisdictions.

We find that out of the 298 firms, only 11 firms obtained patents in India. Table 1 gives the details of the patents granted to these 11 firms. Company wise patents granted data was collected from the Indian Patent Advanced Search System (INPASS) of Indian Patent Office. Since company wise search output sometimes contain patent information of other companies, each of the search output was separately examined to ensure that the result belonged to the company that was searched for. Details of the 11 firms are given in Table 13.

Cadence AMS Design India Pvt. Ltd. (Cadence India) is the only firm in the ICT sector, which got patents granted in India. It specialises in the area of electronic design automation and it's patents are in the areas of high-resolution analogue digital converters, electrical circuits, etc. Cadence India is the earlier Cosmic Circuits Pvt. Ltd., which was taken over by the US based Cadence Design Systems, Inc, in May 2013. All the eight patents were filed and granted prior to the takeover of the company. Cadence India also has six patents granted by the US Patents and Trademark Office (USPTO) (Table 15). Applications for all these six patents were filed prior to the takeover by Cadence Design Systems, Inc. The fact

Table 13
Number Patents Granted by Indian Patent Office between 1 September 2004 and 30 June 2018

Name of Company	*Sector*	*No. patents granted*
Cadence AMS Design India Pvt. Ltd.	ICT	8
Stempeutics Research Pvt. Ltd.	Clinical Research	6
Avesthagen Ltd.	Natural Sciences and Engineering	3
Cliantha Research Ltd	Natural Sciences and Engineering	3
Metahelix Life Sciences Pvt. Ltd.	Natural Sciences and Engineering	2
Vlife Sciences Technologies Pvt. Ltd.	Natural Sciences and Engineering	2
Bijam Bio Sciences Ltd.	Agriculture	3
Fresenius Kabi Oncology Ltd.	Pharmaceuticals	1
Concept Medical Research Pvt. Ltd.	Pharmaceuticals	1
Azatrius Pharma Pvt. Ltd.	Pharmaceuticals	1
S Zhaveri Pharmakem Pvt. Ltd.	Chemicals excluding pharmaceuticals	1
Total Number of Patents		**31**

Source: Computed by Authors using company-wise patents granted data retrieved from the Indian Patent Advanced Search System (IPASS), Indian Patent Office.

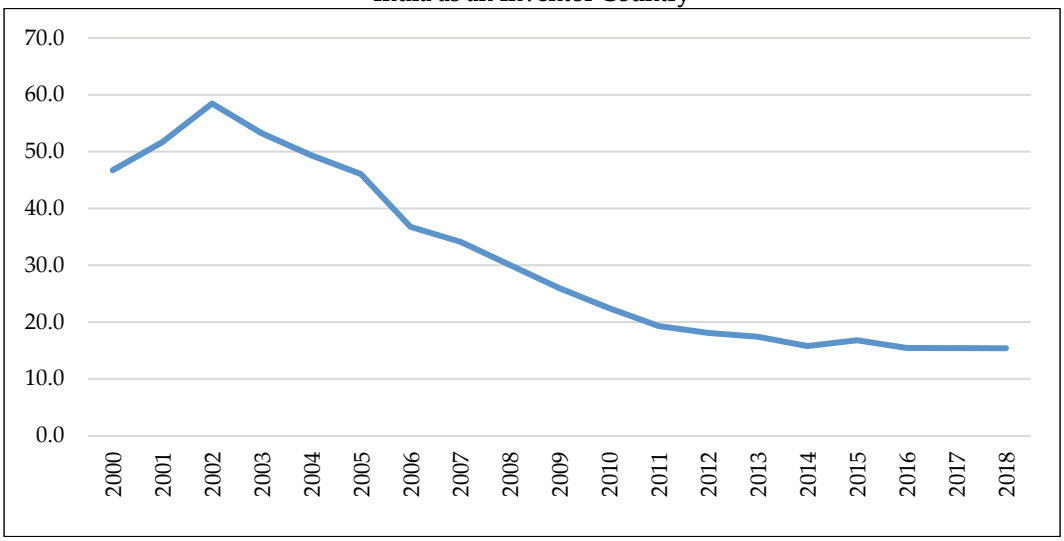
that there is no patent filed in the name of Cadence India after 2013, does not necessarily mean that it is not engaging in R&D. Some of the patents granted to its parent firm, i.e., Cadence Design Systems, Inc, after May 2013 by the USPTO shows that R&D is indeed taking place in Cadence India, but the output have been patented by the parent firm. Cadence Design Systems, Inc, has patent on "system and method for generating and using sibling nets model for shared delay calculation across multi-instantiated blocks in the circuit design" (US Patent No. 9529962), granted in December 2016. All the five inventors of this invention are Indians, based in Noida, India. A search in the LinkedIn, a business and employment oriented social networking website, shows that four of them are working in the headquarters of the Cadence India, located in the Noida Special Economic Zone[39]. However, the assignee of this patent is Cadence Design Systems, Inc. Similarly, in it's patent on "method, system, and computer program product for implementing a multi-fabric electronic design spanning across multiple design fabrics" (US Patent No. 9361415, granted in June 2016) there are two Indian inventors working in Cadence India out of the total three inventors. In this case also, the patent was assigned to the parent firm.

Data collected from USPTO on number of patents granted in which India is an inventor country and assignee country shows that there is a growing trend of companies based in foreign countries taking patent on the outputs of R&D conducted in India (Figure 5 and Table 14). Since 2002, there has been a steady decline in the share of India based inventions

[39] Most probably, the fifth inventor is also an employee of Cadence India in its Noida office. However, we could not verify this as this inventor did not have a LinkedIn account.

receiving India as the assignee country status. Of late, only 15 per cent of the patents granted by USPTO in which India is mentioned as an inventor country, having India as the assignee country; this share was 58 per cent in 2002.

Figure 5
Share of US Patents where India is the Assignee Country in the total number of Patents with India as an Inventor Country



Source: Compiled by Authors from USPTO, http://patft.uspto.gov/netahtml/PTO/search-bool.html

Table 14
Number of Patents Granted by USPTO in which India is an Inventor Country and the Assignee Country

Year	*India as Inventor Country*	*India as Assignee Country*
2000	184	86
2001	234	121
2002	342	200
2003	445	237
2004	460	227
2005	519	239
2006	699	257
2007	779	266
2008	888	267
2009	979	254
2010	1617	363
2011	1796	347
2012	2449	443
2013	3382	589

Year	*India as Inventor Country*	*India as Assignee Country*
2014	4201	663
2015	4667	784
2016	5218	806
2017	5996	924
2018	5995	923

Source: Compiled by Authors from USPTO, http://patft.uspto.gov/netahtml/PTO/search-bool.html

Table 15
Number Patents Granted by USPTO between 1 September 2004 and 30 June 2018

Name of Company	*Nature of R&D*	*No. of patents granted*
Fresenius Kabi Oncology Ltd.	Pharmaceuticals	18
Cadence AMS Design India Private Ltd.	ICT	6
Agtec Innovations Pvt. Ltd.	Agriculture	6
KBC Research Foundation Pvt. Ltd.	Natural Sciences and Engineering	6
Concept Medical Research Pvt. Ltd.	Pharmaceuticals	5
Achira Labs Pvt. Ltd.	Natural Sciences and Engineering	4
Connexios Life Sciences Pvt. Ltd.	Natural Sciences and Engineering	4
Biogenomics Ltd.	Pharmaceuticals	4
Stempeutics Research Pvt. Ltd.	Clinical Research	3
Vlife Sciences Technologies Pvt. Ltd.	Natural Sciences and Engineering	3
Faurecia Interior Systems India Pvt. Ltd.	Automobiles	3
Octonus Dia Tech Pvt. Ltd.	Machinery	3
Avesthagen Ltd.	Natural Sciences and Engineering	2
Amneal Pharmaceuticals PRIVATE Ltd.	Pharmaceuticals	2
Vitas Pharma Research Pvt. Ltd.	Pharmaceuticals	2
Oncostem Diagnostics Pvt. Ltd.	Clinical Research	1
SNAP Networks Pvt. Ltd.	ICT	1
IMEC India Pvt. Ltd.	Natural Sciences and Engineering	1
Amrita Therapeutics Ltd.	Pharmaceuticals	1
Vyome Biosciences Pvt. Ltd.	Pharmaceuticals	1
MSD Wellcome Trust Hilleman Laboratories Pvt. Ltd.	Clinical Research	1
Neuland Health Sciences Pvt. Ltd.	Natural Sciences and Engineering	1
Strand Life Sciences Pvt. Ltd.	Clinical Research	1
Total Number of Patents Granted		**79**

Source: Compiled by Authors from USPTO website, using its advance search facility

Overall it appears that although firms covered in our study are relatively more R&D intensive, their R&D outputs are increasingly being patented abroad by their parent firms/affiliate firms. Similar observation was made by Mrinalini et.al. (2013), who studied the patenting behaviour of 706 RDFDI firms in India. However, in this study, we find that the share of firms belonging to the ICT sector is very small.

Although ICT is the largest sector in terms of RDFDI inflows, it's very low share in the patents granted in India need not come as a surprise. The Patents Act of India does not permit patenting of innovations in software *per se* unless they are combined with hardware. Section 3(k) of Patents Act maintains, "a mathematical or business method or a computer programme *per se* or algorithms" are not patentable. The interpretation of this clause is that while mathematical methods, business methods, computer programmes and algorithms are not patentable, computer programmes combining hardware are patentable[40]. Much of the research in India is in software and they alone are not patentable. If firms doing R&D in the ICT sector do not get patents granted in India, they would most probably be getting patents granted in the US, where such restrictions are not placed. However, the company-wise patents granted data compiled from USPTO shows that only a few of the RDFDI firms in the ICT sector have patents granted in the US (Table 15). This indicates the probability of outputs of R&D carried out in India being patented by firms based in foreign countries.

Twenty-three firms were granted 79 patents by the USPTO. Most of the firms belong to the pharmaceuticals and NSE sectors. In pharmaceuticals, less number of patents have been granted in India probably due to the section 3(d) of Patents Act of India, which prevents patenting of frivolous innovations in the pharmaceuticals sector. This clause stipulates that besides the three basic criteria of patentability, namely, novelty, non-obviousness and industrial application, patent applicants must demonstrate enhancement of therapeutic efficacy in their innovations in order to lay their claims for grant of patent rights in the country. A study by Ali et.al. (2008) shows that 45 per cent of the pharmaceuticals patent applications rejected by IPO during the period between 2009 and 2016 was on the application of section 3(d). Firms in the natural NSE, which is a major provider of R&D services, may have a compulsion to prove their credentials in the mature US market. According to Kiran Mazumdar Shaw, Chairperson and MD of Biocon Ltd., there is compulsion on the technology firms from India which are in the process of scaling up to establish their credentials in the US market to source funds[41].

Dachs (2017) points out that R&D services is an area where we do not have adequate information. Only a few countries, prominently the US, provide the data on R&D in services. This data of US shows that about one-third of R&D by foreign owned firms are in services (Dachs 2017). The 'Science and Engineering Indicators 2018' of National Science

[40] Guidelines for Examination of Computer Related Inventions - 2013, Office of the Controller General of Patents, Designs and Trademarks, Government of India.

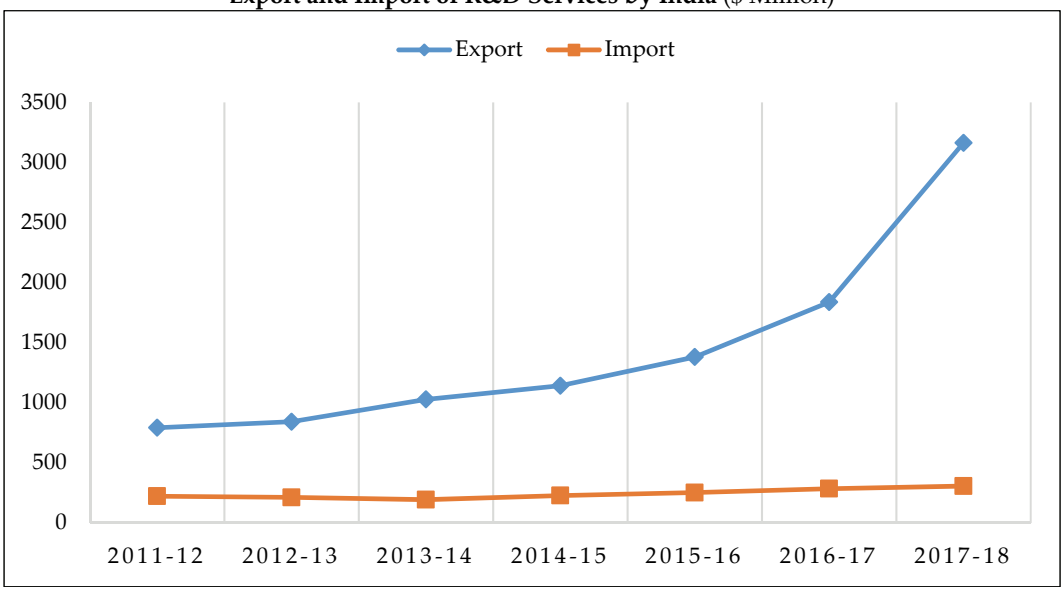
[41] India loses out on innovation quotient: Kiran Mazumdar Shaw, http://www.forbesindia.com /article/india-rich-list-2018/india-loses-out-on-innovation-quotient-kiran-mazumdarshaw/51733/1

Foundation of US shows that 69 per cent of R&D performed by majority owned affiliates of US firms in India in 2014 was in services (non-manufacturing); and in services, two-third of R&D was in 'professional, scientific and technical services'. O'Mahony (2013) argues that the share of services in R&D is increasing for two reasons. One, new technologies such as ICT makes service firms more R&D intensive. Two, services and parts of service value chain have increasingly become tradeable and therefore service firms have become more R&D intensive. Due to increasing 'servicification' of R&D, Ramirez (2013) points out that manufacturing firms outsource R&D to specialised suppliers of R&D services. The most relevant example of this trend is the pharmaceutical industry where clinical trials and other development activities are outsourced to specialised firms.

The Reserve Bank of India's (RBI) data on India's trade in invisibles shows that it's export of R&D services has been growing steadily. Figure below (Figure 6) provides the trends in India's export and import of R&D services.

The fact that firms in the ICT sector takes patents neither in India nor in US points to the fact that the outcomes of R&D done in India is transferred to their parent firms. They are part of the innovation network of their parent firms. During the interaction with one of executives of ICT firms, it was pointed out that they do the R&D in India for their parent firms. The phenomenon of firms in India operating as an actor in the innovation network of MNCs is not just confined to the ICT sector.

Figure 6
Export and Import of R&D Services by India ($ Million)



Source: Compiled by Authors from RBI, Invisible Receipts and Payments by Category of Transactions, https://rbi.org.in/Scripts/Data_IndiasInvisibles.aspx
Note: Data for some quarters are preliminary estimates.

7.3. Publications

Data on publication was compiled from the SCOPUS database of Elsevier. It is a widely used citation database of peer-reviewed literature, published in scientific journals, books and conference proceedings in the areas of science, technology, medicine, social sciences, and arts & humanities[42]. It is found that out of the 298 firms, 84 firms have publications to their credit. These 84 firms together had published 936 articles. Sector-wise distribution of publications by 84 firms are provided in Table 16. Half of the publications were contributed by nine firms. Their details are provided in Table 17. Most of the publications have come from firms in NSE and clinical research.

Most of the 84 firms have publications in collaboration with other institutions in India (and abroad also) which indicate that they engage with other elements of NIS in research. Following are the various categories institutions with whom the 84 firms have joint publications.

(i) *Public Universities*: This category consists of state and central universities, medical colleges and technical universities. For example, Maulana Azad Medical College, New Delhi; All India Institute of Medical Sciences, New Delhi.

(ii) *International Organisations*: It consists of organisations and think-tanks such as World Health Organization, Geneva; Leibniz Institute for Natural Product Research and Infection Biology, Hans Knöll Institute (HKI), Germany; The Royal Institute of International Affairs (commonly known as Chatham House, a think-tank not-for-profit and non-governmental organisation based in London); The Wellcome Sanger Institute (previously known as The Sanger Centre and Wellcome Trust Sanger Institute and a non-profit British genomics and genetics research institute funded by the Wellcome Trust) Cambridge; International Agency for Research on Cancer (WHO-IARC), France; International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, Telangana, India

(iii) *Premier Institutes*: This category consists of those institutes with specific focus and are funded by the Central government such as Indian Institute of Technology (IITs); Indian Institute of Science (IISc) Bangalore; Bose Institute, Division of Molecular Medicine, Kolkata, West Bengal; National Institute of Plant Genome Research (NIPGR), New Delhi; and Indian Institute of Management.

(iv) *Public Research Institutes*: Research institutes supported by either state or central government. For example, Rajiv Gandhi Centre for Biotechnology, Thiruvananthapuram; State Health Resource Centre, Raipur; Tamil Nadu Health Systems Project, Dept. of Health and Family welfare, Government of Tamil Nadu; and Agharkar Research Institute, Maharashtra.

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[42] It covers publications by more than 5000 publishers. More than 1.5 lakh books and 22800 journals covered in Scopus. It also has 16 million author profiles. Information available at https://www.elsevier.com/solutions/scopus/how-scopus-works/content

Table 16
Publication by RDFDI Firms

Sector	*No. of Publications*
Natural Sciences and Engineering	403
Clinical Research	296
Pharmaceuticals	119
Automobiles	29
Design	26
Agriculture	22
Chemicals excluding pharmaceuticals	11
Defence	7
ICT	7
Renewable Energy	6
Machinery	1
Medical Devices	1
Grand Total	**928**

Source: Compiled by Authors from SCOPUS

Table 17
Publication by Leading Firms

Name of Company	*Sector*	*No. of Publication*
GVK Biosciences Pvt. Ltd.	Natural Sciences and Engineering	193
Stempeutics Research Pvt. Ltd.	Clinical Research	74
Strand Life Sciences Pvt. Ltd.	Clinical Research	49
Veeda Clinical Research Pvt. Ltd.	Clinical Research	39
Cellworks Research India Pvt. Ltd.	Natural Sciences and Engineering	28
Connexios Life Sciences Pvt. Ltd.	Natural Sciences and Engineering	27
Apotex Research Pvt. Ltd.	Natural Sciences and Engineering	19
Sai Life Sciences Ltd.	Pharmaceuticals	27
Becker Technologies Pvt. Ltd.	Design	26
Total		**474**

Source: Compiled by Authors from SCOPUS

(v) Foreign Private Sector: Firms established outside India.

(vi) Foreign Universities: Universities established outside India. For example, London School of Hygiene and Tropical Medicine, London.

(vii) Indian Private Sector: Firms established in India.

(viii) Private Academic Institutions in India: This category consists of academic institutions – colleges and research centres owned and operated by private individuals. For example, N.G.S.M Institution of Pharmaceutical Sciences and Jehangir Clinical Development Center, Pune; AER Degree and P G College, Tirupati; Al-Ameen College of Pharmacy, Bangalore; Oxford College of Sciences, Bangalore.

(ix) Non-Governmental Organisations: It consists of non-government and non-profit organisations located across the world. For example, Indian Cancer Society, New Delhi; CanSupport, Kanak Durga Basti Vikas Kendra, New Delhi.

8. Concluding Remarks

As the Statement on Industrial Policy 1991 shows, India had expected that liberalisation of restrictions on FDI would result in inflow of more technology oriented FDI, which would strengthen the technology capability of Indian industries. However, our analysis shows that technology oriented FDI inflows, i.e., RDFDI inflows, is not significant as compared to total FDI inflows. Efforts at innovation made by RDFDI firms is meagre. Against the expectations of Indian policy makers, RDFDI inflows to India is aimed at taking advantage of lower costs of conducting R&D in India (than bringing in advanced technologies). Analysis of patents granted data shows that results of R&D performed in India is transferred to MNCs abroad, who further develop and take patents on the innovations. It appears that the R&D performed in India is part of 'R&D in networks' of MNCs. The nature of spillover effects will be different when RDFDI is part of R&D networks.

India's Science and Technology policy will have be framed more realistically taking into consideration the current realities. In an era of R&D in networks, the possibility of direct technology transfer to host countries is very limited. The policy needs to reflect recognition of the comparative advantage of India in R&D networks and propose concrete measures to take advantage of the comparative advantage. The comparative advantage of India is in availability of scientists and engineers in large numbers and lower costs of doing R&D. Therefore, the chances of accruing benefits of RDFDI through R&D personnel is higher in the case of India. India needs identify the sectors where there is a synergy of spillover effects of RDFDI and domestic manufacturing. Such sectors should be prioritised for building up competence at global level.

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