INDIA, BEHIND IN GLOBAL INNOVATION: AN ANALYSIS OF R&D EXPENDITURE IN INDIA AND ITS EFFECTS

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Abstract

Investments in R&D are important for countries as a whole and individual companies. R&D stimulates innovation, and it's main objective is to create new products or services that are beneficial to society and bring profits to that company or economic growth to a country. This study aims to analyze the situation of R&D expenditure in India and to answer the basic question of whether investment in R&D is actually of any benefit to India. It also looks at the situation of individual researchers.

The main conclusions reached are: Increasing R&D expenditure is important - at least to the level of being able to compensate researchers (especially those in academia - or in the public sector) for their efforts. It is necessary to ensure job satisfaction and productivity, and more importantly their social welfare. However, the focus has to shift from purely generating science to setting up the R&D environment to create patentable innovations.

Keywords

- R&D
- Innovation
- India
- Expenditure
- GERD
- Patent output
- Job satisfaction

Introduction

Globally most countries are focusing on increasing their economic growth, and in the belief that R&D spending will help them in this regard, there has been a constant effort to improve the R&D expenditure every year. Most developed countries spend significant amounts on R&D spending.

R&D can be defined as a set of innovative activities undertaken by corporations or governments in developing new services or products and improving existing ones. R&D differs

from the vast majority of corporate activities, in that it is not intended to yield immediate profit, carries a greater risk and has an uncertain return on investment

In this country (India), for the most part we are dependent on technologies from other countries to supplement our needs. We do have some indigenously produced technologies (the PSLV used by ISRO being one), although such innovations are far and few - and most do not lie in the field of Science & Technology. Therefore, either due to lack of funds or lack of interest, India has been on the backfoot in R&D for many years. However off late, there has been a renewed interest in the field, with many MNCs setting up their R&D centres in India, rather than in their country of origin - since it is much cheaper for them.

Despite R&D spending increasing in this field, most academicians or scientists prefer to go abroad and do research - due to the availability of much better facilities and better pay. Although many problems in R&D may not be specific to India, and may be present in R&D divisions around the world - there are some issues which are specific to the Indian context, which this study aims to cover,

This study was done to get a clear view of how much India's private sector and public sector spends on R&D, and to see whether the said expenditure has had any effects on R&D output. Also, the author wanted to obtain a picture of how much researchers in India are being paid - and whether there has been any local or national issues regarding the same.

Review of literature

The current R&D investment framework (a general perspective)

A key characteristic of large high-technology firms like Google, Apple, Amazon or Facebook is the huge amount of cash reserves which they hold. The main reason behind this is the importance of R&D to these firms, and the requirement of cash rather than capital to finance R&D projects (Bakker, 2013). The reason for maintaining such huge case reserves is the high degree of uncertainty involved in R&D investment, and the lack of any bankable collateral.

Given the lack of said collateral, the absence of a cash flow from which to make regular interest payments, and given that the amount needed is not precisely known before-hand, banks are generally unwilling to provide loans for R&D. Also to be noted is that most R&D costs are

sunk costs, i.e costs that are incurred once and that cannot be recovered upon exit. Another risk is that, in the case that the R&D project doesn't produce a marketable product, there is little residual value left in the project.

An implication of the study by Gerben Bakker (2013) is the importance of a flexible legal framework and institutional flexibility, which are important factors which stimulate the growth in R&D spending. They allow for organisational experimentation and for a law making process which would allow the adjustment of the legal framework, which could bring changes over time that are conducive for R&D.

According to Scherer, F.M (2001), the pharmaceutical R&D industry (which is a major spender) is best described by a "virtuous" rent-seeking model. That is, as profit opportunities expand, firms compete to exploit them by increasing R&D investments, until the increases in costs dissipate most, if not all, above-normal profit returns. Then the firms cut back on their R&D spending, and hike it up again as the profits improve.

Why the need for R&D spending?

- ***the benefits of publicly funded research***

A growing body of empirical work demonstrates that there are substantial benefits to publicly funded research, and these benefits seem to be increasingly important as we move into a knowledge intensive and competitive era. (Martin and Tang, 2007). Martin and Tang (2007) have generated results which point to the evidence of substantial benefits flowing to the economy and society through various channels, due to investment and development of publicly funded research.

This report also makes an important point: for many years the focus of science policy has been on the "science push" aspect of innovation rather than "demand pull." i.e beyond focusing on the strength of their science base, companies need to work on using the results of their research to be used bring benefits through the following channels:

1. new useful knowledge that is directly incorporated into a new product or process.
2. recruitment of trained graduates and researchers.

3. creation of new scientific instrumentation and methodologies.
4. development of networks and stimulation and social interaction.
5. enhancement of problem solving capacity.
6. creation of new firms.
7. provision of social knowledge.

To put it more clearly, instead of focusing on solely generating new science research, companies need to adopt a need based approach - having some foresight on what benefits the said research will actually bring to society.

- ***The benefits of government spending on Business R&D***

A study by Guellec and Pottelsberghe (2000), has shown some promising results on the effect of government spending on Business R&D. Some of the main takeaways are as follows:

1. Direct government funding of firms (through either grants or procurement) have a positive effect on business R&D (1 dollar given to firms results in 1.5 dollars of research on average).
2. Tax incentives have a positive (although short lived) effect on business financed R&D.
3. The above measures are more effective when they are stable over time.
4. Direct government funding and R&D tax incentives are substitutes: increased intensity of one reduces the effect of the other on business R&D.
5. The stimulating effect of government funding varies with respect to its generosity: it increases up to a certain threshold (about 13% of business R&D) and then decreases beyond.

- ***A critical view of R&D spending***

A paper by Das (2020) explores the long-run associations and short-run dynamics among R&D spending, number of patents and per capita income growth in a panel of countries and groups for the period 1996–2017.

The study concludes that the 3 variables: R&D share, number of patents and per capita income growth, do not have any long term associations.The short-run relationships show that per capita income growth positively affects R&D share, but R&D share does not affect number of patents and the number of patents does not affect income growth rates.

Further, the short-run interplays among the three shows that the number of patents (along with another variable) makes significant cause to R&D share, which means the primary objective of R&D spending is to obtain patent rights of invented intellectual property.

In the end the author comes to the conclusion that huge expenses on R&D and generating patent rights lead to unnecessary growth of market imperfections in the R&D head which generates social cost or deadweight loss (implying large sunk costs). He recommends that a part of the R&D funds be used for other income-generating activities to ensure sustained development of the individual as well as the country itself.

- ***An important consideration most organizations forget when focusing on R&D.***

An article in the Harvard business review puts forward some pertinent points as to why so many companies have low levels of innovation performance - despite investing heavily in their R&D division.

Based on the findings in Markovitch, O'Connor and Harper (2015), the article posits that companies have to realise that R&D is only one part of the ‘discovery’ process, which is only of the three things required in the process that is innovation.

In reality, innovation is much bigger than R&D. It involves three distinct capabilities: Discovery, Incubation, and Acceleration (DIA). Corporate leaders need to recognize that developing business applications, revenue models, and markets for new products often requires as much time and resources and deserves as much emphasis, as inventing the technologies themselves.

- ***Why is job satisfaction important?***

  Sharma and Gupta (2020) conducted a study across 7 industries, to understand what factors affect the productivity of an employee. The job satisfaction (which in turn affects motivation) that an employee takes in his or her job is the only factor that can improve the productivity of that employee for the organization.

  A survey and analysis conducted on the insurance, banking and finance, travel and tourism, outsourcing, education, healthcare and logistics industries generated the following results. It was found that the healthcare industry employees had the highest levels of job satisfaction, followed by education and travel and tourism industry. The least job satisfaction was visible in the industries related to outsourcing business, followed by insurance business.

  The outsourcing, banking and finance and logistics industries showed a high variance in the level of job satisfaction - from which the authors inferred that there were a few employees with the right skill set, who were more satisfied that others.

Research gap

There is a lack of papers actually analyzing the situation of R&D expenditure in India. Also there are very few studies conducted on the actual job satisfaction of academicians in India, despite many studies showing that motivation and job satisfaction have an important effect on the productivity of the individual researcher.

There is a lack of consensus in the literature, on whether increase in R&D spending actually contributes to patent output (a measure of innovation success), and economic growth in the country. There are not many studies which look at all these issues as a whole, and which try to address them. This study attempts to do that.

Research problem

This paper looks into the level of R&D expenditure by both the private sector and the government, both in the recent past and also over the last 15 years (trends). The paper also aims to show whether the investments in this sector have been of any effect. It also looks to ascertain

whether there is a lack of financial support to the R&D community, and if there are other contributing factors to the current lack lustre image of the R&D sector as a whole.

Research questions

The following are some research questions that I formulated based on the above research problem. I attempt to answer all these in this paper.

- Is the government and private companies spending enough (as per their ability) in R&D?
- Is the money being funneled into R&D being used to its maximum potential?
- Which areas of R&D require more focus?
- Is expenditure the main issue in India? Or is there a deeper reason behind why R&D in India in general has a lackluster image?
- Are the researchers being paid enough and are they happy with their jobs?

Objectives

1) Describe the current state of R&D expenditure in India (government and private sector) and how it's faring relative to other countries.
2) To find out whether India's research output has been growing, and also whether India is producing a comparable amount of patentable innovations as compared to it's growth in research output.
3) Conduct a brief analysis of the average salary of a researcher in India and to get an idea of the job satisfaction among indian scientists (the average salary of a researcher is also a measure of R&D expenditure, at the microeconomic level).

Hypothesis

In order to judge whether R&D investments in India are being used appropriately, and whether the researchers are being treated fairly - this study will test the hypothesis on how much the average researcher in India is being paid.

The null hypothesis suggests that the average salary is less than or equal to ₹2,66,400 per annum (which is the global low income category).

The alternate hypothesis suggests that the average salary is above or equal to ₹5,32,800 per annum (which is the global upper middle class category).

Methodology

I make use of interpretive research in my methodology. Although I do test the hypotheses of the current average researcher salary being high or low as compared to global standards - my main aim, is not to test the theory of whether R&D in India underpays or not. Instead, by analyzing the given data on how much the country is spending on R&D and it's innovation output and success, as well as the current level of job satisfaction among indian researchers - I present my interpretation of the current reality.

Through the use of quantitative data taken mostly from government sources and websites such as payscale and glassdoor - I try to make sense or interpret the current R&D expenditure scenario by reconciling the subjective interpretations of the various participants of the R&D sector, in the socio-economic context of India.

9 research papers and articles were consulted, to inform my view on this subject. Some news articles and social media posts (for example the ones on #hikeresearchfellowship), were consulted to understand the general sentiment about R&D spending in the researcher fraternity.

Data

Three governmental publications were consulted, these were by namely - the Economic Advisory Council to the PM, the department of Science and Technology (DST) and CTIER. For global data the data on the uis.unesco website was used. The time series, the tables and graphs for a single year are mostly from the years 2014-2015 and 2018-2019.

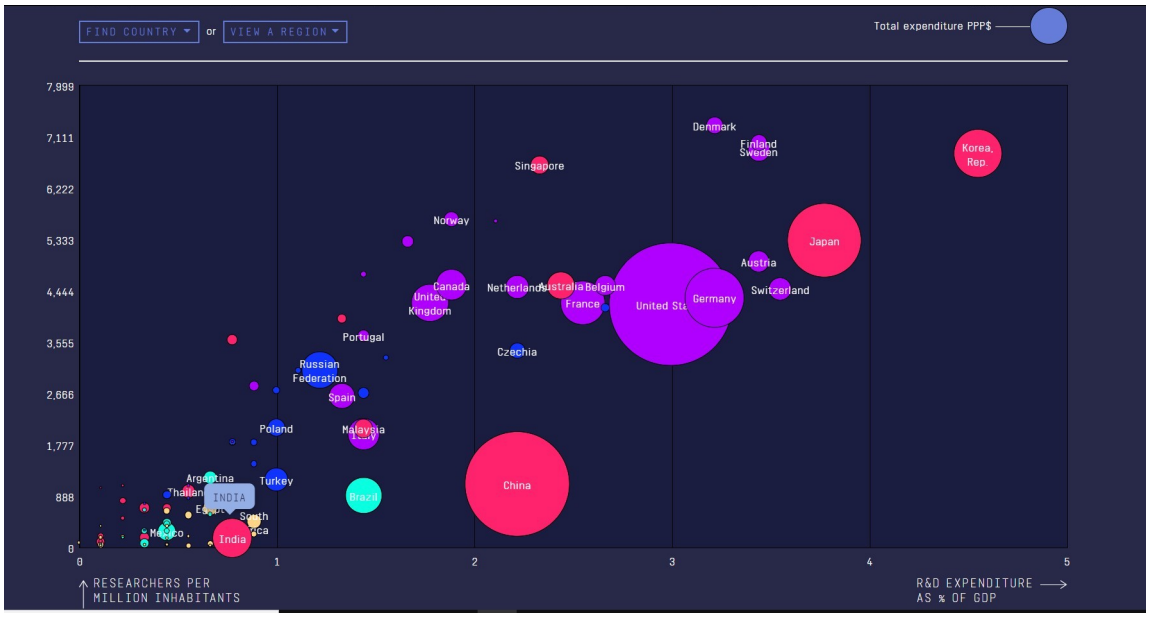
Area of Study

This study focuses on India, although the R&D expenditure in other countries (especially China and US) are also analyzed, while comparing expenditures in other countries to that in India.

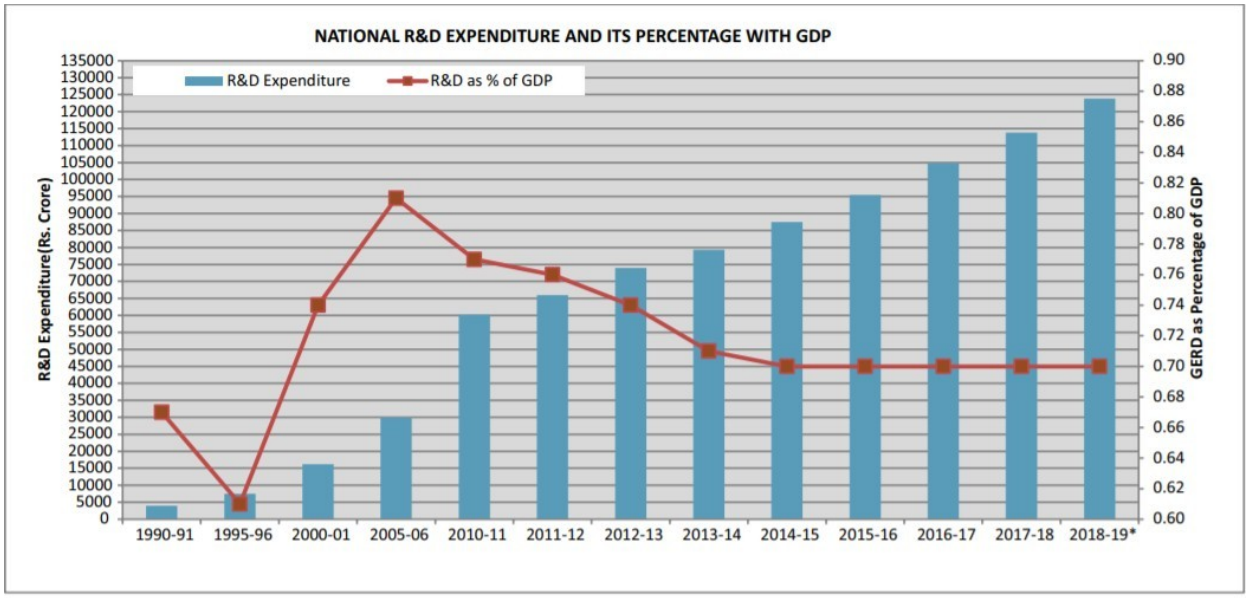
Analysis

1. **India lagging global leaders in R&D spending (in either %GDP share or in PPP billions)**

Spending on R&D around the world has been increasing, an estimate in 2017 shows that it had reached a record high of almost US$ 1.7 trillion. About 10 countries account for 80% of spending. As part of the Sustainable Development Goals (SDGs), countries have pledged to substantially increase public and private R&D spending as well as the number of researchers by 2030. India's share in global expenditure is around 2.8%.



As seen from the above chart, India seriously lags behind most of the world in terms of spending as %GDP and also in terms of researchers per million inhabitants. Although the second point seems to be the case in most populous countries, regardless of actual spending.



* Estimated. Source: NSTMIS, Department of Science & Technology, Government of India

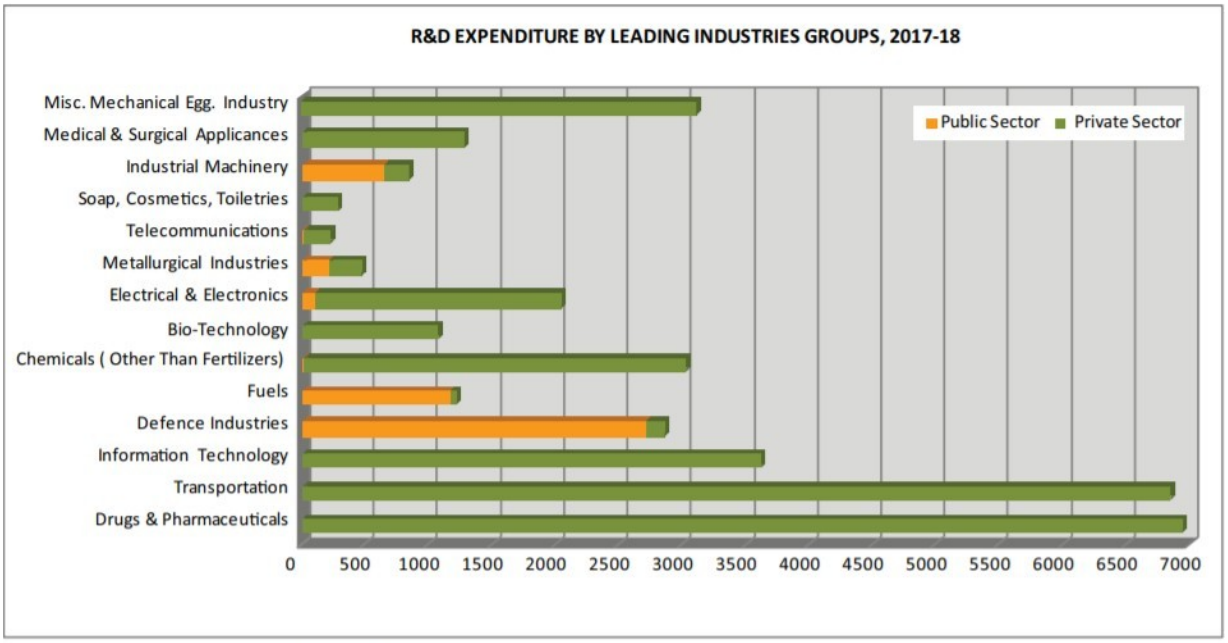
Gross Expenditure on R&D (GERD) has shown a consistently increasing trend over the years. It has nearly tripled from Rs. 39,437.77 crore in 2007- 08 to Rs. 1,13,825.03 crore in 2017-18. It is estimated to be Rs. 1,23,847.70 crore in 2018-19. In terms of Purchasing power parity (PPP) dollars, this corresponds to an increase in spending of PPP $ 47.2 billion in 2017-18 from PPP $ 29.2 billion in 2007-08. This is an encouraging trend, and it indicates that the country has become more receptive to R&D opportunities.

However, despite success on that front - the %GDP spending of the country has gone down steadily since 2005, despite the increase in GDP in successive years.

The below chart further illustrates how India (along with the rest of the South and West Asian regions), have a growth rate (in R&D spending) that is miniscule compared to the leading regions of the world (in R&D spending)

Also to be noted is that since 2009-2010, GDP annual growth rate has surpassed the annual rate of growth of R&D (by about a difference of 1% to 7%, in the year 2018-2019 it was around 2% difference). (Refer Appendix)

2. In most sectors India is lagging behind the global average (Sector Wise analysis)



Source: NSTMIS, Department of Science & Technology, Government of India.

Above is a chart showing the R&D expenditure classified according to the Leading Industry groups during 2017-18. As shown below, Public Sector R&D was led by Defence Industries followed by Fuels and Industrial Machinery while Drugs and Pharma, Transportation, Information Technology, Mechanical Engineering Industries etc dominated the Private Sector R&D. Thus, private sector participation is seen the most in industrial R&D.

R&D products in the industry are generally commercialized and prepared for the market. Thus returns on R&D investment in the industry is likely to be more than in other less profitable sectors. This gives further justification for increase in private sector participation. Since the private sector is the major spender in Industrial R&D, and the government generally is unlikely to majorly increase investments in profit-making ventures - increase in private sector spending will boost Industrial R&D expenditure and thus produce larger returns on investment, which will further increase commitment towards R&D expenditure.

R&D by top 10 Sectors (Derived from top 2500 Global R&D Spenders)

CTIER

Rank	Sector	R&D expenditure 2014 USD (million)	R&D % of Total (top 2500 spenders)	Total No. of Companies	No. of Indian Companies	No. of Chinese Companies	No. of US Companies
1	Pharmaceuticals & Biotechnology	145401	18%	316	8	21	161
2	Automobiles & Parts	125136	16%	155	6	28	24
3	Technology Hardware & Equipment	124813	16%	316	0	37	130
4	Software & Computer Services	83743	10%	275	5	32	161
5	Electronic & Electrical Equipment	60773	8%	229	0	39	50
6	Industrial Engineering	32300	4%	199	1	30	41
7	Chemicals	27817	4%	133	1	10	38
8	Aerospace & Defence	26829	3%	56	0	6	19
9	General Industrials	23417	3%	96	0	15	24
10	Health Care Equipment & Services	17361	2%	100	0	5	60

Source: EU R&D Scoreboard 2015

The above table compares the number of companies from India, China and US who fall in the category of top 2500 R&D spenders (globally), classified by which sector they are in. These 10 major sectors contain 1875 of the top 2500 companies in the world (by R&D spending). Of these, 708 are US companies, 223 are Chinese companies and 21 are Indian companies. From this it's very clear that in every sector, Indian companies are lagging the world leaders in R&D spending, despite India being one of the largest economies in the world.

We can also compare the Sector Wise R&D spending of India's companies as compared to the global average (data available in appendix). This comparison is based on R&D spending as

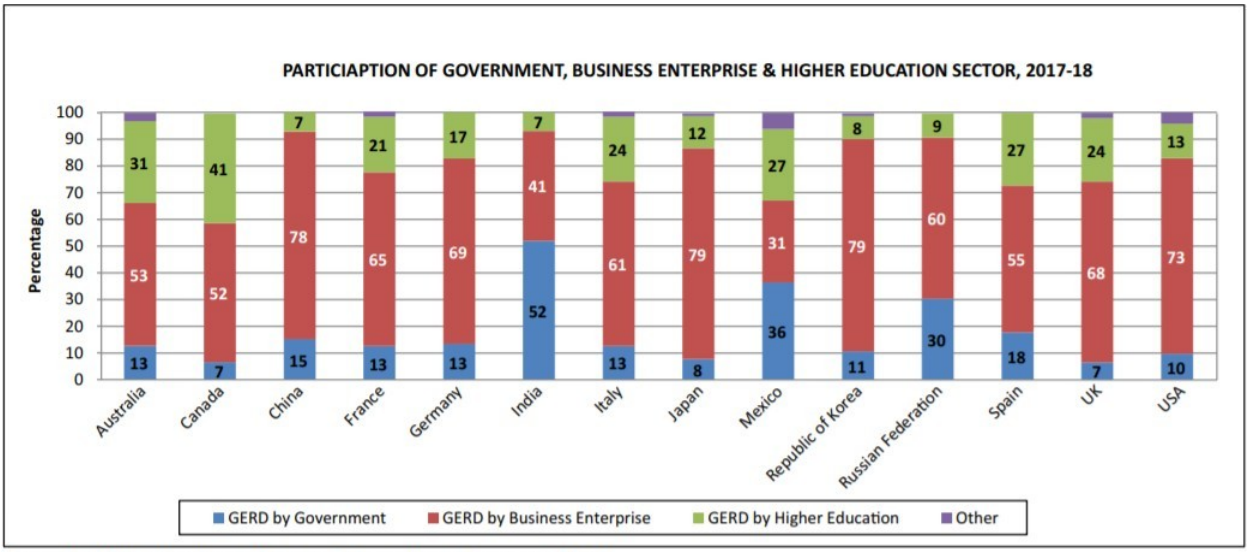
a percentage of sales, and represents “R&D intensity”. Despite having a few companies like Tata Motors, RAMCO Systems LTD., Suzlon Energy and Hindustan Aeronautics LTD. having R&D intensity equal to or higher than the global average, the vast majority of Indian companies are lagging behind in R&D intensity as compared to the global average. This is especially seen in the IT sector, where other than RAMCO Systems LTD, all the rest are spending less than or equal to 1% of their sales on R&D, which is dismal compared to the global average of 18%.

Other than comparing the sector wise R&D spending of Indian companies, we can also look at the Indian central government expenditure and the US Federal Expenditure (as percentage of national R&D expenditure) and note the priority differences - based on how much funding the different scientific agencies are getting. A major point of difference is the amount of R&D expenditure the medical or healthcare agencies are getting. The Indian government spends about 2% (as of total R&D expenditure) as compared to the 6.5% spent by the US Federal government in this area. This is concerning, especially since India being a more populous country, has a larger healthcare problem and more need for medical resources as compared to a developed country such as the US. However this may be due to more focus being given to basic medical necessities, rather than more advanced needs like R&D - since India is still a developing country (at least in regards to healthcare).

3. **The large spenders in R&D have strong participation from the private sector**

The common trend among the leading countries in R&D expenditure whether in terms of %GDP or in PPP dollars is the significant contribution of the business sector (or private sector). In India, Gross Expenditure on R&D (GERD) is mainly driven by the Government sector and the distribution is as follows: Central Government 45.4%, State Governments 6.4%, Higher Education 6.8% and Public Sector Industry 4.6% with Private Sector Industry contributing 36.8% during 2017-18.

Below is a more precise overview of the participation of various sectors in R&D spending:

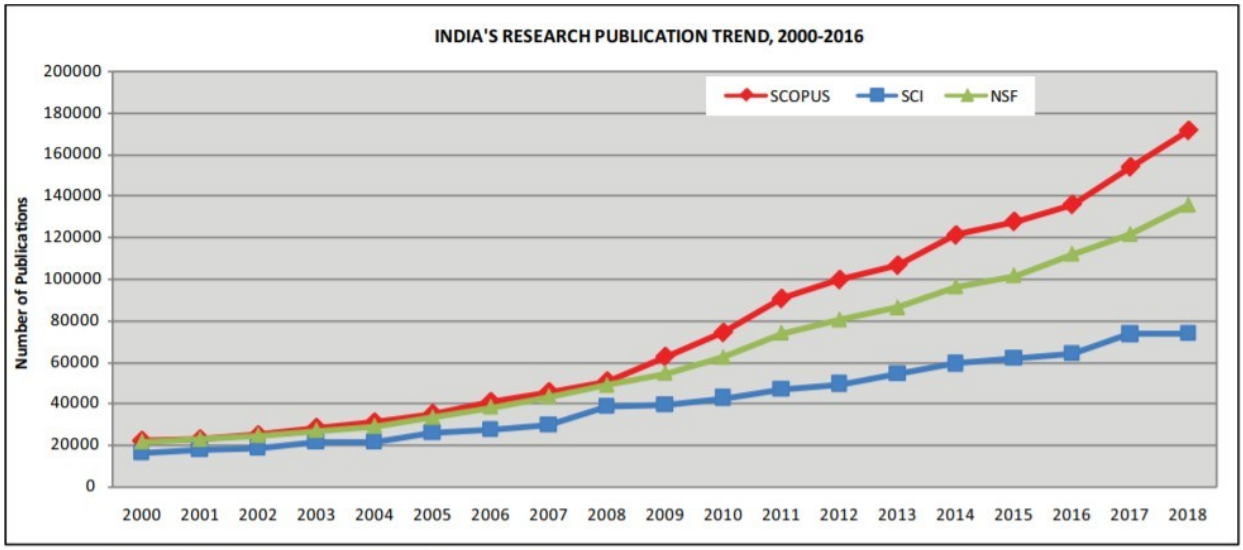


Source: NSTMIS, Department of Science & Technology, Government of India.

In contrast to the other developed and emerging countries, India has nearly 60% participation in GERD (Gross Expenditure on R&D) by the government. However, the participation of the higher education sector is quite low among the selected countries.

Also to be noted is that, public sector R&D units spent 0.29% of their sales turnover on R&D as compared to 1.48% by the private sector in 2017-18. This shows that the private sector is more willing to spend in R&D, and hence the need for more participation.

4. **How India's R&D sector is doing - with respect to patent output and indian % share of patent output.**



Source: NSTMIS, DST Commissioned Study (SCOPUS; SCI Database), 2019 and NSF database, Science and Engineering Indicators, 2020.
Note: Data for the years 2017 & 2018 for SCOPUS and SCI database is as per Advanced trends.

Over the last decade India has seen a significant rise in research output, as is indicated by the growth of indian publications in the publication databases of SCOPUS, SCI and NSF. India's share in global research publication has also increased by around 3% to 4% in all three publication databases. Also, at the very top end of the excellence scale - India has shown a significant amount of growth. The highly cited Indian publications were mainly concentrated in the fields such as Physics & Astronomy, Engineering, Material Science and Computer Science.

However the percentage share of indian patents among the patents filed in India has gone down significantly to around 15% in 2018 from 30% in 2001.

5. **Is the money reaching the researchers?**

- ***Average researcher salary in india***

As per data available on payscale.com, the average salary for a research scientist is ₹ 6,97,375 per annum and the base pay is around ₹ 3 lakh per annum. This is based on a survey of 690 induviduals. If we assume most research scientists' salaries lie close to this, compared to India's per capita income of around ₹ 1.05 lakh (in 2019), this income is above average, and as per global standards it is an upper middle class income.

However it is to be noted that there is a wide variety of ‘researchers’ in India, based on whether they work in the public or private sector, and at which level they work at. Generally the trend is that, with experience your salary increases.

Generally working as a researcher in academia involves putting in more hours due to other commitments, and as a result generally research jobs in academia pay less.

- ***The movement of #hikeresearchfellowship***

#hikeresearchfellowship was a movement in 2018 in which many students from national institutes (where research is conducted) such as IITs and IISERs protested against the low amount of stipend (around ₹ 25,000 per month) which was given to the research scholars in these institutes.

A scholar in IIT Roorkee, reported that research scholars generally end up working around 50 hours per week (although officially only around 35 hours are required), which corresponds to earnings of around ₹ 125 per hour (based on the ₹25,000 paid per month) - which is clearly a dismal amount, considering how much effort is put in.

In 2019, the government finally announced around 20%-25% hikes in these institutes. Considering that this was the lowest hike in salary since 2010, the general response of the scholars has been that of disappointment.

Results and Discussion

Although India's Gross Expenditure on R&D (GERD) has been steadily increasing - indicating the growing interest towards innovation, as per global standards India lags far behind the global leaders in terms of R&D spending as % share of GDP and in PPP dollars. Also the rate of increase GERD is quite meagre as compared to US, China, Japan and South Korea (among other countries). Also to be noted that the number of researchers per million inhabitants is at 156 (extremely low as compared to the rest of the major countries) in India, a problem also shared by other populous countries.

The sector wise analysis of R&D expenditure has shown that other than a few exceptional indian companies, in most sectors India lags behind in R&D spending - both in the number of indian companies among top 2500 spenders globally and in the actual R&D intensities (spending as % share of sales) of the indian companies in each sector. Also to be noted is the major role the private sector plays in Industrial R&D.

Another point is that compared to the US's 6.5% (of total spending), India spends only 2% on medical and healthcare R&D.

The common factor among the world leaders in R&D spending is that they have strong private participation. Furthermore, the private spent 1.48% of it's sales in R&D while the public sector R&D units spent 0.29% of their total sales.

India's research output has been seen to increase along with the increase in India's R&D expenditure over the past decade. India's share of global research output has increased as has it's share at the very top of the excellence scale (of research publication quality). Although, the % share of indian patents among all the patents filed
in India has gone down.

The alternate hypothesis which was proposed has been proven to be true. Although, despite being paid a middle class amount (as per global income standards), academic scholars feel that they are not being compensated enough for the amount of effort which they have to put in. This reflects poorly on the part of the government and Indian institutions, despite having less than 4% of the world’s researchers (not a large employee base), they are not able to compensate the Indian researcher sufficiently.

If we do an approximate calculation of how much money per researcher, India can pay (assuming we use the full amount of yearly R&D expenditure) - assuming that the total number of researchers in India to be 2,06,622 (2016 UNESCO estimate) and assuming total R&D expenditure to be ₹1.23847 lakh crore (2019 figure) - we arrive at a figure of around ₹6 lakh per researcher. Thus the low amount of R&D spending in India may be a cause for the low salaries of researchers.

Conclusion

As the comparative study of India's R&D spending with respect to other countries showed, India lags behind the world leaders in R&D. However, this result does not give proper cause for significantly ramping up India's R&D expenditure - since it's simply to match the global leaders level of spending and not because this proves that R&D spending will make the country's economy grow.

The fact that the number of researchers per million inhabitants is at 156 (extremely low as compared to the rest of the major countries), although a common problem among populous countries, may point to a lack of interest in entering R&D either in academia or in the business sector. The government should make efforts to improve the image of R&D in india, by reducing the problem of bureaucracy, in the public R&D sector (which is the major spender), due to which many executive decisions take a long time and thus progress in this sector is very slow.

India's companies should make efforts to improve R&D spending, as this will increase the private participation in the R&D sector, and thus increase returns on R&D investments. This is due to the private sector dominating in industrial R&D (which provides more commercial returns) and also because the private sector spends a higher share of their turnover in sales on R&D, than the public sector.

The fact that %share of indian patents among all the patents filed in India has gone down from 30% to 15% implies that despite an increase in research output, the amount of actually patentable innovations has not increased on a scale compared to other countries around the world. This implies that the major goal of research (Das, R.C., 2020), which is to obtain a patent on a new innovation is not being met for most of the research being published in India.

The job satisfaction of researchers around the country are at an average level, and their salaries are seriously lagging behind most countries in the world. There is also lack of comprehensive studies and data on issues such as researcher salary and the major issues which researchers are facing in the job places and which is causing most academicians to prefer a career in research abroad.

In India a major increase in R&D spending is required - if atleast to properly pay the researchers who drive innovation in our country. However, simply large growth in R&D spending is not enough - as seen from the decrease in the share of Indian patents among the

patents filed in India, despite a significant increase in the publications of indian research and increase in GERD. Companies and Research Institutes must shift focus from simply generating more science, to also having the foresight to look for a market for the product, and hence design the product for the said market with suitable benefits. For this to happen, the companies and institutes should provide additional divisions which focus on the incubation and acceleration of the product.

This study has a few limitations. Since most of the major comparisons have been done in the year 2014-2015, some of the results obtained may not be representative of the current scenario. Also the amount of overworking alleged by the scholar in IIT Roorkee may not be an exact representation of the situation of all Indian research scholars in academia - although the amount of pay is around the same.

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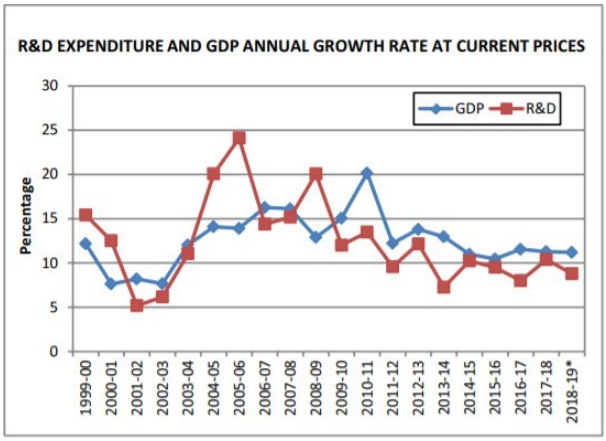
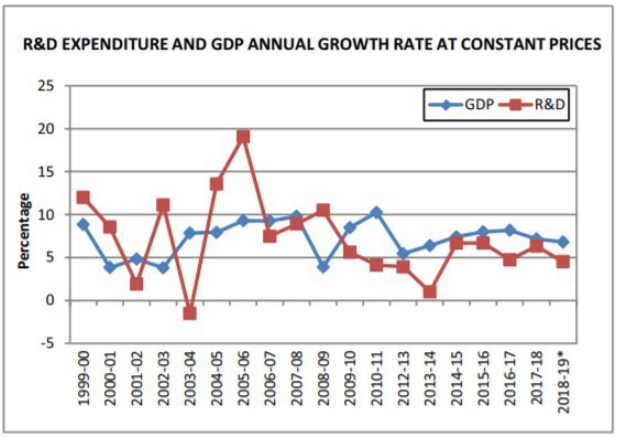
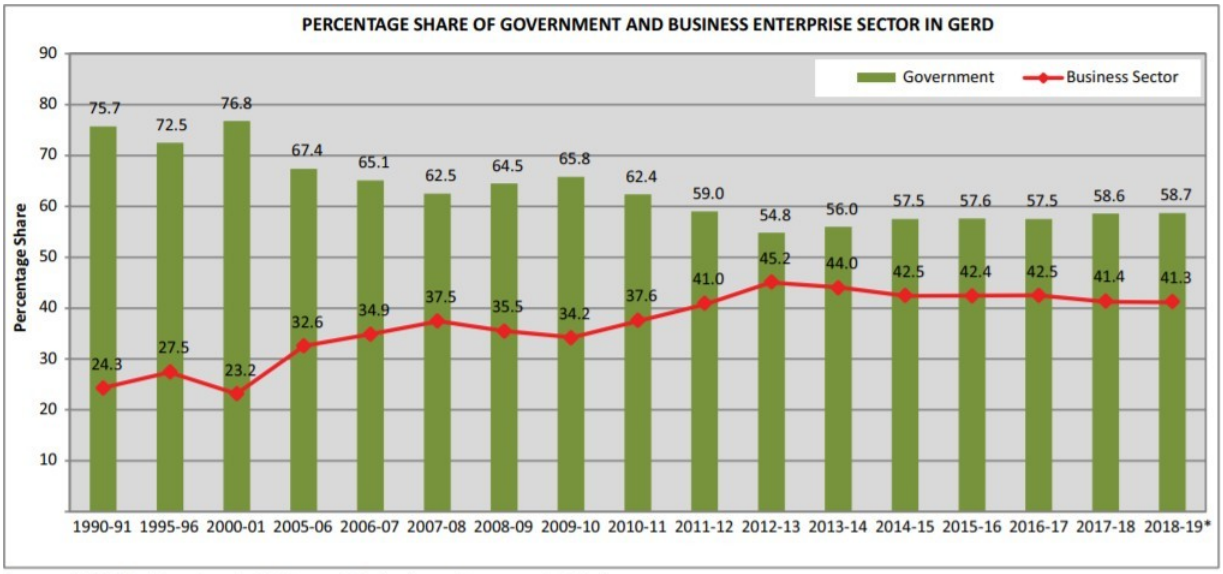
Appendix

. PPP means purchasing power parity. Some amount of a certain currency expressed in PPP dollars, is just the absolute purchasing power of that currency expressed in dollars.

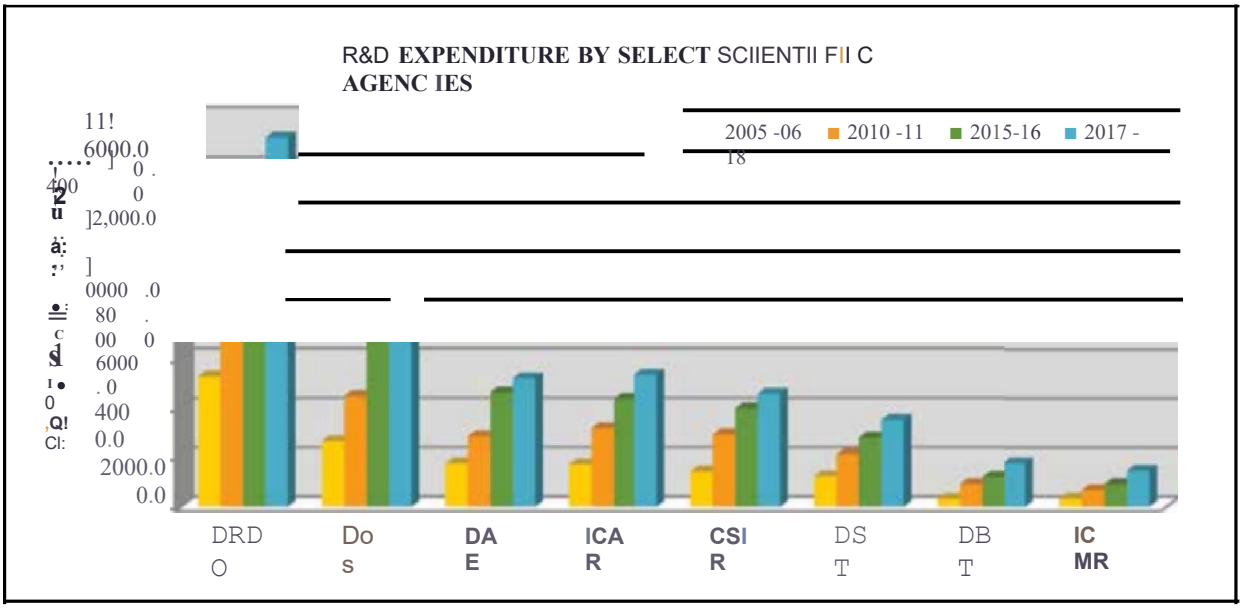




*estimated



Source: NSTMIS, Department of Science & Technology, Government of India.



Source: NSTMIS, Departme:nt of Science & echnology, Government of India,

Expenditure on **R&D** by major scienti fic agencies under the Central Governmen

CTIER

Agency	Expenditure in 200 9-10 in Rupees Mi ll ion	As % of tot al cent ra l go vernment expenditure	As % of national R&O expenditure
Defence Resea rch & Develonment Organisation	84754	29	16
Department of Space	41630	14	
Department of Atomic Ener y	38582	13	
Indian Council of Ap:ricult ural Researc h	28813	10	
Coun cil of Scientific and Industrial Research	26664		
Denartment of Science & Tec hno lo ov	22229		
Department of Biote chnolo 11y	7274		
Indian Counoil of Med ical Research	5835		
Minis t rv of Eart h Scienc es	4482		
Ministry of En v ironment & For ests	4156		
Minis trv of Communication & IT (DJTI	3280		
Ministry of New & Rene wable EnerRy	265	0.1	
TOTAL	267964	92.9	50.5

Source: DST

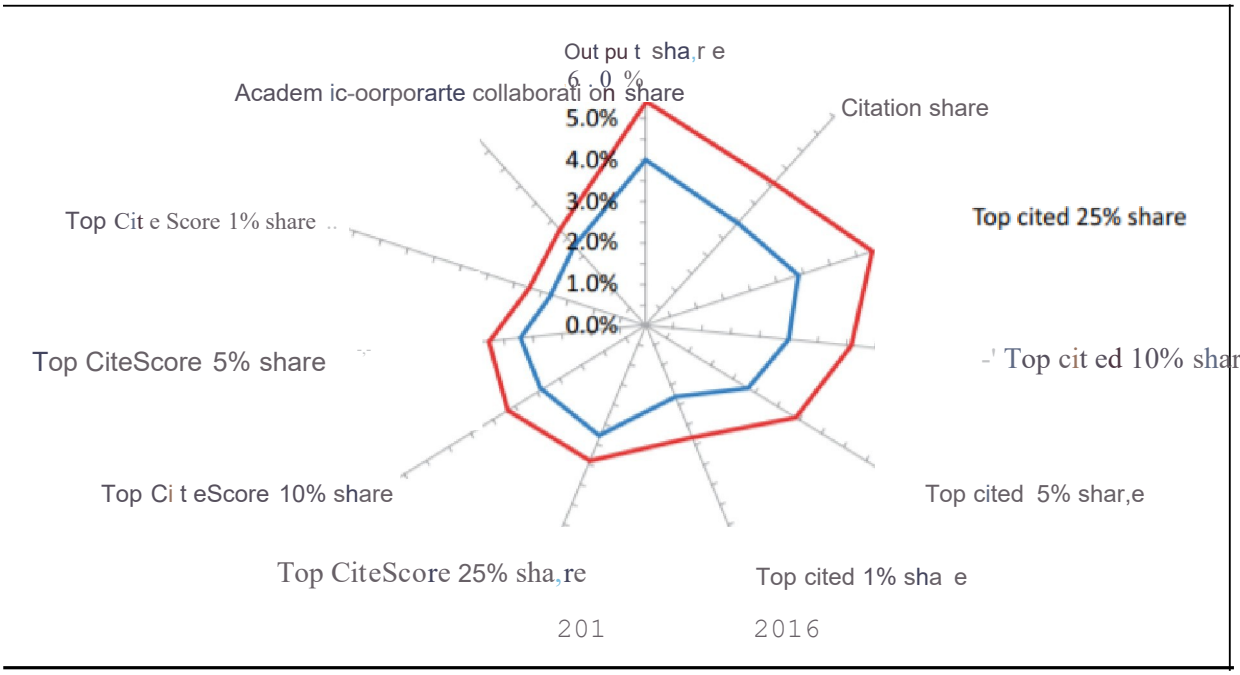
US Federal R&D Expenditure - Priority Differences with India

CTIER

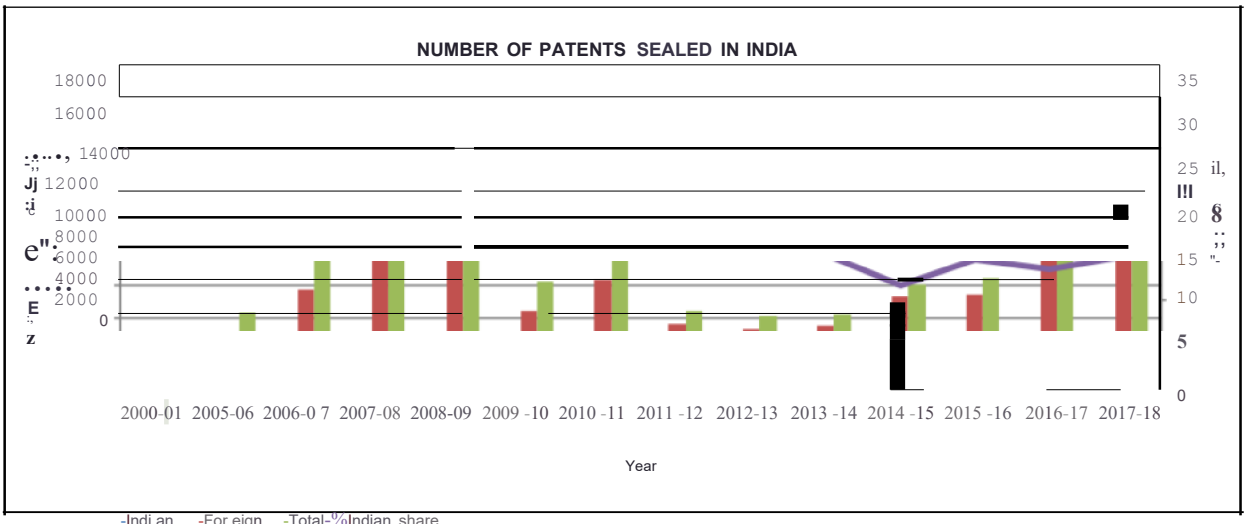
Federal Research and Development Expenditure (includes R&D through Universities)		
/Mandatory and Discretionary budget authority, dollar amounts in millions \		
By Agency	2015 Actual	As a % of national R&D expenditure
Health and Human Services	30453	6.5
Energy		0.
NASA	12145	2.6
National Science Foundation	5944	1.3
Agriculture	2452	0.5
Commerce	1524	0.3
Veterans Affairs	1178	0.3
Interior	863	0.2
Transportation	885	0.2
Homeland Security	919	0.2
Environmental Protection Agency	523	0.1
Patient-Centered Outcomes Research Trust Fund	396	0.1
U.S. Agency for International Development	250	0.1
Smithsonian Institution	246	0.1
Education	279	0.1
Other	320	0.1
Total	138278	29.4

Note: Total US R&D Expenditure ~ USD 470 billion
Source: US Budget Report

INDIA'S OUTPUT, IMPACT AND KNOWLEDGE TRANSFER, 2011-16



Source: NSTMIS, DST Commissioned Study (SCOPUS Database), 2019



Source: Controller General of Patents, Design and Trade Marks-Annua l reports