

R&D and Innovation in Corporate India

**Law Reform Proposals for Making India
an R&D Powerhouse**

Report | November 2021



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Acknowledgements

We would like to thank former Union Finance Secretary **Mr. Sumit Bose** (Chairman of Vidhi's Board of Directors) for his very helpful inputs and comments on earlier drafts of this report.

The views expressed in the report and errors, if any, are the authors' alone.

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Executive Summary

Industrial research and development (R&D) and corporate innovation are traditionally recognized as drivers of economic growth and social welfare. The adversities inflicted by the COVID-19 pandemic have reinforced the importance of R&D for sustainable growth given that nations with a robust track record of innovation and R&D were able to develop remedies for their citizens more effectively than others. R&D initiatives in the digital services sector also played a key role in counteracting economic disruptions caused by the pandemic and ensuring seamless continuity of economic activities. Historically, the private sector remains the pivotal contributor to R&D in countries recognized as global R&D leaders. While India Inc. played a very important role in developing and supporting responses to the crisis, most knowledge-based solutions came from countries whose businesses (and universities) innovate more. Even if this issue were to be evaluated outside the framework of the crisis, on the face of it, the track record of Corporate India on innovation and R&D does not appear to be in sync with India's long-term economic aspirations.

We find by analyzing statistics published by the Indian government, international surveys, and additional research that the Corporate India contributes sub-optimally to innovation activity in the country, falling short on key indicators like R&D spending, employing research personnel and generating research outputs. We then explore key reasons that contribute towards such underperformance and examine linkages between organizational governance factors that could be impacting the innovative efficacy of Indian enterprises. Finally, we present certain recommendations and reforms to India's prevailing corporate governance framework with the intent of promoting further debate and deliberations on the importance of encouraging corporate innovation through strengthening internal governance norms. Some key governance reforms we recommend are requiring identified classes of listed entities to (a) constitute 'research and development' committees, (b) appoint a chief innovation officer and (c) make enhanced R&D related disclosures to inculcate a culture of consistency and promote a race to the top among large public companies. Other suggestions include

deployment of a single-window platform for management of government R&D funding and developing targeted regulatory frameworks to address bottlenecks impacting university research collaborations in India and R&D initiatives in strategically significant sectors.

This Report is structured as follows: Chapter 1 provides the contextual background of the report and outlines its objectives. Chapter 2 discusses key trends regarding R&D spending of public listed companies in India and outlines the prevailing legal and policy landscape pertaining to incentivizing corporate innovation initiatives. Chapter 3 discusses the relationship between identified corporate governance factors and standards and R&D investments, by analyzing applicable corporate governance theories, and the manner and extent to which they assist (as well as hamper) R&D corporate decision-making. Chapter 4 concludes by presenting key learnings and provides informed recommendations for improving the corporate R&D investment landscape in India based on the analysis and findings in the preceding chapters. While private limited companies (including startups) play a very important role in contributing to a nation's R&D output, they are often cash-strapped and their ability to invest in R&D on a sustainable basis is limited by design. Having said that, recent research indicates that globally, private limited companies (especially those operating in the pharmaceutical sector) contribute immensely to the development of new products and technologies (albeit even they get acquired by large public companies eventually). Therefore, to get a complete picture of Corporate India's contribution to R&D and innovation in India, it would be important to study trends in private limited companies as well. Nevertheless, the scope of this report is largely limited to the R&D and innovation performance of publicly listed companies (including government owned companies / PSUs) given their more readily measurable and arguably greater impact potential. The phrases 'Corporate India' or 'India Inc.' as used in this report in relation to Indian businesses should be construed accordingly. We intend to study R&D trends in private limited companies in subsequent studies.

Chapter 1: Introduction - Setting the Context



Introduction - Setting the Context

Innovation and R&D – a Primer

Technological and scientific innovation is widely recognized in scholarly literature as a major determinant of economic competitiveness and growth potential of commercial enterprises in an economy.¹ Studies also suggest that enterprises which can viably innovate are usually better placed to outperform their (global) competitors and create value for investors, customers and other stakeholders alike.² As a result, promoting innovation by reforms to the regulatory and institutional framework in which innovative activities occur in an economy has been a key policy objective both nationally and internationally. In this part, we examine some key concepts relating to business innovation and R&D and the mechanisms through which R&D and innovation are measured.

Defining 'innovation' & 'R&D'

The Oslo manual³ published by the Organisation for Economic Co-operation and Development (OECD) (a widely recognised set of indicators for conceptualizing and measuring business innovation) defines 'innovation' as "*a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process).*" Four facets of innovation are identified in the manual which include 'knowledge', 'novelty', 'implementation', and 'value creation'.⁴ Also, eight 'business innovation' activities (defined to include all "*developmental, financial and commercial activities*")⁵ which are

intended to result in an innovation), which can be undertaken by enterprises to pursue innovation have also been detailed. Research and experimental development is identified as one such activity which can "*generate innovations, or through which useful knowledge for innovation can be acquired.*"⁶

Various frameworks have attempted to define R&D and identify the activities that fall within its ambit. In this context, OECD has developed a prominent and globally recognized framework for recording and measuring R&D activity in an economy, the 'Frascati manual'. As per this manual, R&D consists of "*creative and systematic work undertaken in order to increase the stock of knowledge – including knowledge of humankind, culture and society – and to devise new applications of available knowledge.*"⁷ For an activity to be classified as R&D it must necessarily be novel, creative, uncertain, systematic, transferable and/or reproducible.⁸ Further, R&D activities are sub-classified into 'basic research', 'applied research' and 'experimental development'. Basic research involves experimental or theoretical work undertaken with the prime objective of acquiring "*new knowledge of underlying foundations of phenomena and observable facts*" without any particular application or use in view.⁹ Applied research on the other hand, is targeted towards a specific practical aim or objective. Experimental development "*draws on knowledge gained from research and practical experience and producing additional knowledge...directed to producing new products or processes or to improving existing products or processes.*"¹⁰

¹ Roger M. Barker & Iris H- Y Chiu, "Corporate Governance and Firm Innovation: Are Conventional Corporate Governance Standards a Hindrance", (2018), Geo. Mason J. Int'l Com. L., 143-144. See also, John Cantwell, Innovation and Competitiveness in Jan Fagerberg and David C Mowery (eds.), "The Oxford Handbook of Innovation", (2006), Oxford University Press.

² Roger M. Barker & Iris H- Y Chiu (n-1), 143.

³ Organisation for Economic Co-operation and Development, "Oslo Manual 2018 (Guidelines for Collecting, Reporting and Using Data on Innovation)" (2018) 20.

⁴ Ibid 46.

⁵ Roger M. Barker & Iris H- Y Chiu (n-1), 143.

⁶ Ibid 68. Other business innovation activities include engineering, design, and other creative activities; marketing and brand equity activities, IP-related activities, employee training activities, software development and database activities, activities related to the acquisition or lease of tangible assets, and innovation management activities are also instrumental in enabling innovation.

⁷ Organisation for Economic Co-operation and Development, "Frascati Manual 2015, Guidelines for Collecting and Reporting Data on Research and Experimental Development" (2015), 44.

⁸ Ibid 45.

⁹ Ibid.

¹⁰ Ibid.

Other perspectives on the meaning of R&D emerge from global standards and systems of financial accounting. The System of National Accounts (SNA) 2008 published by the United Nations defines R&D as “creative work undertaken on a systematic basis to increase the stock of knowledge, and use this stock of knowledge for the purpose of discovering or developing new products, including improved versions or qualities of existing products, or discovering or developing new or more efficient processes of production.”¹¹ On similar lines, the International Accounting Standard (IAS) 28 (on ‘Intangible Assets’) defines ‘research’ as “original and planned investigation undertaken with the prospect of gaining new scientific or technical knowledge and understanding”, and ‘development’ “as the application of research findings or other knowledge to a plan or design for the production of new or substantially improved materials, devices, products, processes, systems or services before the start of commercial production or use”.¹²

In the Indian context, a central government scheme¹³ relating to benchmarking industrial R&D identifies the following activities as falling within the meaning of R&D: “development of new technologies, design & engineering, process/product/design improvements, developing new methods of analysis & testing; research for increased efficiency in use of resources, such as, capital equipment, materials & energy; pollution control, effluent treatment & recycling of waste products or any other areas of research.”¹⁴ On the other hand, the following activities are not regarded as R&D activities: “market research, work & methods study, operations & management research, testing & analysis of routine nature for operation, process control, quality control and maintenance of day-to-day production, maintenance of plant.”¹⁵ From an accounting perspective, the Indian Accounting Standard adopts the definition of ‘research’ and

‘development’ from the IAS 28 as mentioned above.¹⁶

Measuring R&D Performance

An extensive body of economic literature identifies different measurements and determinants of R&D ‘performance’. As R&D activities are deemed to be critical indicators of an enterprise’s productivity, growth, and competitive advantage, “measuring R&D performance has become the core of attention of R&D managers”¹⁷ in several jurisdictions. Also, given that enterprises incur substantial costs and take on significant risks while undertaking R&D, developing R&D performance metrics and “measuring [an enterprise’s R&D] performance and contribution [of such activities] to value becomes critical.”¹⁸ Studies also suggest that increasing complexity and variety of technical and scientific knowledge has further added to the increased cost and risk of undertaking R&D which in turn creates a heightened impetus for measuring R&D performance.¹⁹

R&D performance is evaluated by measuring ‘innovation indicators’, which can be classified as ‘input’ or ‘output’ indicators.²⁰ Input indicators represent the innovation efforts of an enterprise, and are generally measures of “expenses, human capital allocation, or innovative initiatives” that an enterprise undertakes.²¹ Output indicators measure “different aspects of the innovative outcome ... [and] determine the degree of innovation generated.”²² These can involve for e.g., measuring data relating to sales of innovative products, new product announcements, intellectual property rights (like patents, trademarks or designs) applied for and granted in a specified duration etc. By using input and output innovation indicators, measures of R&D activity levels can be determined at the level of individual enterprises, at sectoral level or even for the economy as a whole.

¹¹ United Nations, “System of National Accounts, 2008” (2008), 119.

¹² IFRS Foundation, “International Accounting Standard 38 (Intangible Assets)” (2021), para 8.

¹³ Department of Scientific and Industrial Research, “Guidelines for Recognition and Registration of In-house R&D units of Corporate Industries” available at <https://dsir.gov.in/#files/12plan/bird-crf/fisr.html>.

¹⁴ Ibid.

¹⁵ Ibid.

¹⁶ The Institute of Chartered Accountants of India, “Indian Accounting Standard 38 (Intangible Assets)” available at <https://indasaccess.icaai.org/download/2021/compendium-indas-2021-22/476/476asb-cias-2021-22-vol2-37.pdf>.

¹⁷ Negin Salimia and Jafar Rezaei, “Evaluating firms’ R&D performance using best worst method”, 2018, Evaluation and Program Planning Vol 66 147.

¹⁸ Valentina Lazzarotti, Raffaella Manzini, Luca Mari, “A model for R&D performance measurement”, 2011, International Journal of Production Economics, 134(1), 212.

¹⁹ Negin Salimia and Jafar Rezaei (n-17), 147.

²⁰ Fernando Taques, Manuel Lopez, Leonardo Basso and Nelson Areal, “Indicators used to measure service innovation and manufacturing innovation”, 2021, Journal of Innovation and Knowledge Vol 6, 15.

²¹ Ibid.

²² Ibid.

Yet, a much-discussed issue is if an increase (or reduction) of the magnitude of an innovation indicator actually represents an increase (or reduction) of R&D activity in a reference unit. As such, the measurement of the 'productivity' or 'performance' R&D undertaken by enterprises has been described as a ' Gordian knot'.²³ Studies highlight that while enterprise managers routinely rely on input and output 'innovation indicators' to measure R&D levels, yet "*literature is unclear, how a firm can measure its R & D performance with respect to these criteria.*"²⁴ One study also notes that "*none of [these indicators] ... give a good idea of how well the R&D function is performing...nor...why (or when) any given project might suddenly prove a failure*"²⁵ though it had earlier shown every promise of success". Similarly, another issue is deciding which indicators are comparatively superior or more accurate determinants of the R&D performance of an enterprise, which is also a subject matter of considerable debate.

However, despite these conceptual and practical difficulties, various international benchmarks exist that have been periodically assessing and measuring R&D performance at different levels (entire economies or specific sectors or companies) over several years. Private enterprises (like companies) also at a unit level periodically measure their R&D performance (through innovation indicators), and such data is also routinely reported in regulatory filings.

Benchmarks measuring R&D investment. A prominent benchmark that generally gets featured and provides an estimate of R&D activity at the level of an economy is gross domestic expenditure on R&D (or GERD), which is determined as per the methodology developed in OECD's Frascati manual. GERD is a measure of an input indicator i.e., expenditure on R&D, and is formally defined as the "*total intramural expenditure on R&D performed in the national territory during a specific reference period*".²⁶ GERD is effectively a measure of the R&D

spending of the resident companies, research institutes, universities, government laboratories etc. of a nation, which includes foreign funded R&D but excludes domestic funds expended for R&D activities undertaken abroad.

There are also other benchmarks that measure private sector R&D investments in a more granular manner. One notable example is the European Union Industrial R&D Investment Scoreboard (EU Scoreboard) published by the Joint Research Center of the European Commission. The EU Scoreboard "*identifies main industrial players in key industrial sectors, analyses their R&D investment and economic performance and benchmark EU companies against their global counterparts*". The EU Scoreboard considers data relating to 2500 global corporations investing largest sums in R&D and has datasets on R&D investments for various enterprises from 2015 onwards. The R&D investment data is collected from the annual financial statements of the reviewed companies. The findings in the EU Scoreboard in context of R&D investments by Indian listed companies between 2015 to 2019 are discussed in detail in the next Chapter.

Other key benchmarks. Other benchmarks are derived through measuring innovation indicators other than expenditure on R&D. This could involve for e.g., measuring "*size, availability and demographic characteristics of human resources that directly contribute to the R&D activities of institutions, economic sectors and nations as a whole*". In this regard, based on the methodology detailed in the Frascati manual, the UNESCO Institute of Statistics (UIS) routinely publishes statistics on R&D personnel in different economies like total number of R&D personnel per million inhabitants, R&D personnel by function, total R&D personnel by sector of employment etc. (measured in 'full-time equivalents' or 'headcounts'). Similarly, other benchmarks like the Global Innovation Index (GII) aim to take a broader view regarding

²³ Eric Hamon, Sander Smits and Florian Weig, "Brightening the Blackbox of R&D" (April 2015), McKinsey Quarterly, available at <https://www.mckinsey.com/business-functions/operations/our-insights/brightening-the-black-box-of-r-and-d>. As this study notes: "The question of R&D's productivity has long resembled a Gordian knot. Look nearly anywhere else in today's corporations, and there's far less difficulty measuring productivity and performance. In manufacturing and logistics, you can get a sense of things just by looking around the production floor, the inventory room, or the loading dock. Even the performance of the advertising budget—once famously opaque—is now, thanks to digital technology, much easier to see. But the R&D department provides fewer clues. There's no flow of tangible goods through the process, for one thing, but rather a stream of ideas and concepts that resist the efforts of efficiency experts and innovation gurus alike."

²⁴ Negin Salimia and Jafar Rezaei (n-17), 147.

²⁵ Fernando Taques, Manuel Lopez, Leonardo Basso and Nelson Areal (n-20), 15.

²⁶ Organisation for Economic Co-operation and Development (n-7), 144. Intramural expenditure consists of "all current expenditures plus gross fixed capital expenditures for R&D performed within a statistical unit [e.g., an economic sector] during a specific reference period, whatever the source of funds."

innovation and to "find and determine metrics and methods that could better capture the richness of innovation in society, going beyond the traditional measures of innovation such as the number of research articles and the level of research and development (R&D) expenditures".²⁷ The parameters covered in the GII attempt to measure aspects like market and business sophistication, strength of the economy's institutions and infrastructure, and innovation outputs (including knowledge and technology outputs and creative outputs) etc.

Data Sources. Data on the GERD of various economies is maintained by global institutions like the World Bank, UIS and World Intellectual Property Organization. Such databases also collect information regarding private sector's contribution to the R&D initiatives in an economy for e.g., capturing overall statistics regarding GERD as performed by business enterprises and GERD financed by business enterprises. UIS maintains a database regarding R&D personnel in various countries. Apart from global institutions, national level statistical offices also collect R&D related data. Business enterprises are also generally required to report such data to the government under applicable frameworks including in their financial statements. In the Indian context, R&D data is collected by government departments and ministries including Department of Science and Technology (DST), Ministry of Statistics and Programme Implementation (MoSPI) and Ministry of Corporate Affairs (MCA).²⁸

Business Sector's involvement in R&D

An economy's R&D and innovation performance depends on the actions of a diverse set of actors including businesses, the government, higher education institutions and other non-profit organizations.²⁹ It may be noted that governments remain key stakeholders of the R&D ecosystem and play a pivotal role in catalyzing private sector

R&D activities for e.g., by enacting enabling policies and legislation (such as tax incentives for R&D activities), operating efficient institutions, providing funding (through grants and other transfers) and ensuring access to outcomes of publicly funded research.³⁰

However, historical trends suggest that countries with consistently high records of R&D performance have seen the emergence of private enterprises as predominant performers and funders of R&D activities.³¹ As an example, in economies which are considered to be global R&D leaders (e.g., US, China, or Japan), the share of the private sector in the overall R&D spending varies between 68% to 78%. This trend is particularly evident in the case of newly industrialised economies like South Korea³² and China³³ where successive governments have been implementing aggressive and sustained policy interventions from decades to promote private sector R&D activities. As a result, private enterprises operating in these regions have been able to attain high and sustained levels of R&D performance and spending, which has ultimately catapulted these economies in the position of being global R&D leaders. However, as we examine in greater detail in Chapter 2, in India's case, the R&D performance of Indian businesses leave much to be desired, with the public sector funding a much larger share of R&D activities compared to the corporate sector. Aside from innovation spending, Corporate India also significantly underperforms on other innovation indicators, in comparison with large businesses in leading economies.

Relationship between Business Sector Innovation and Corporate Governance

Scholarly studies suggest that the innovation potential of companies is shaped not just by market or regulatory incentives but is also a function of governance structures that are internal

²⁷ World Intellectual Property Organisation, "The Global Innovation Index (GI) Conceptual Framework", available at https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2020-appendix1.pdf.

²⁸ Economic Advisory Council to PM, "R&D Expenditure Ecosystem – Current Status & Way Forward", July 2019, available at <https://www.psa.gov.in/psa-prod/publication/RD-book-for-WEB.pdf>

²⁹ Research and Development: U.S. Trends and International Comparisons, (January 15, 2020), National Science Board, Science and Engineering Indicators 2020, 7.

³⁰ See for e.g., The Economist, "The case for more state spending on R&D", 2021, available at <https://www.economist.com/briefing/2021/01/16/the-case-for-more-state-spending-on-r-and-d>.

³¹ Fernando Taques, Manuel Lopez, Leonardo Basso and Nelson Areal (n-20), 15

³² Nature, "How South Korea made itself a global innovation leader", 2020, available at <https://www.nature.com/articles/d41586-020-01466-7>.

³³ Fang, Lerner, Wu and Zhang, "Corruption, Government Subsidies, and Innovation: Evidence from China", (2018), Harvard Business School – Working Paper 19-031, available at https://www.hbs.edu/ris/Publication%20Files/19-031_e00c9459-f8a5-462b-8527-60f816aefe4c.pdf.

to the company.³⁴ Resultantly, a number of corporate governance (CG) variables like ownership patterns, board composition, incentive systems etc. have been shown to impact on the level of a company's commitment to innovation and the scale of R&D activities undertaken by it.

R&D activities are characterized as being inherently risky and difficult to monitor, due to which they pose certain corporate governance issues, particularly, agency problems revolving around controlling managers' opportunities behavior as well as information asymmetry that in turn influences corporate R&D decision-making.

Academic literature as well as empirical evidence also demonstrates that underinvestment in R&D can largely be attributed to the existence of shareholder 'myopia' or 'short-sightedness'.³⁵ Such short-sightedness may take many forms: shareholders who make up an increasing percentage of company ownership are 'short-term' oriented and are therefore disinclined towards R&D investments relative to other long-term investments.³⁶ Shareholder or investor myopia inevitably results in management myopia whereby managers adopt the myopic perspective of their shareholders by underinvesting in R&D.³⁷ Having said that, internationally, the jury is still out on whether shareholder short-termism affects R&D investment negatively.

In Chapter 3 of this Report, we explore various facets of the interrelationship between corporate governance norms and levels of innovative activity in an enterprise.

Impact of COVID-19 on Innovation and R&D

The years 2020 and 2021 have been extraordinarily challenging given the catastrophic impact of the COVID-19 pandemic. In India, besides causing a massive loss of human life and suffering at an unprecedented scale, the pandemic

also bootstrapped a severe economic downturn. In the early months of the onset of the pandemic in 2020, businesses across most sectors faced critical issues like lack of raw materials, insufficient staffing, productivity losses, curtailed operations due to lockdowns and transport restrictions, reduced demand for end products and low cashflows.³⁸ In this period, many sectors witnessed layoffs of personnel. After the first wave receded, the Indian economy started showing signs of recovery. The pace of economic recovery was dampened by the devastating second wave of the virus in early 2021, which infected large swathes of India's population, causing fatalities, and suffering at a tremendous scale. It appears that in most parts of the country, the second wave has receded, and restrictive measures are being lifted. Press releases issued by the Indian government also suggest economic impact of the second wave has been 'muted' and economic activity is showing signs of picking up once again.³⁹

The period between 2020 and 2021 also witnessed a surge of research activity throughout the world.⁴⁰ Such endeavors were directed towards finding curative medical remedies for treating patients infected with the coronavirus disease, and for developing preventive vaccines for inoculating the global population against future outbreaks of the virus. Further, with the pandemic necessitating a drastic shift to 'work from home' models in many industries and a rising reliance on digital services, significant R&D activities were witnessed in the digital services sector as well.

In this context, one key aspect is to understand R&D performance of Corporate India during the 'pandemic years'. We have attempted to conduct this analysis in the next Chapter by examining trends relating to corporate R&D expenditure of key R&D spenders during the financial year (FY) 2020-21.

³⁴ Roger M. Barker & Iris H-Y Chiu (n.1), 143-44.

³⁵ Steven S. Cherensky, Shareholders, Managers and Corporate R&D Spending: An Agency Cost Model, (1994), 10 Santa Clara Computer & High Tech L.J. 299, 300-303.

³⁶ Ibid.

³⁷ Ibid.

³⁸ See ASSOCHAM, "COVID-19 impact on Indian Industry", April 2020, available at https://www.assochem.org/latest_publication_img/1628264775.pdf.

³⁹ Business Standard, "Economic impact of 2nd Covid-19 wave likely to be muted: Finance Ministry", August 10, 2021, available at https://www.business-standard.com/article/current-affairs/economic-impact-of-2nd-covid-19-wave-likely-to-be-muted-finance-ministry-121081001674_1.html.

⁴⁰ Goda Naujokaitytė, "Research intensity up as COVID-19 infects corporate R&D spending, Science Business", March 2021, available at <https://sciencebusiness.net/news-byte/research-intensity-covid-19-infects-corporate-rd-spending>.

Objective of this Report

Against this background, in this Report, we attempt to underscore the following: (i) there is an intimate connection between corporate governance and R&D (and consequently innovation) in companies; (ii) in addition to market incentives, a number of corporate governance variables (such as ownership concentration, board composition and executive remuneration systems), affect a company's investment or spending in R&D, and the level of innovation output, and internal governance structures play a significant role in shaping innovative capacity, development and harnessing of innovation in companies; and (iii) it is critical to examine the extent to which certain well-accepted corporate governance standards implemented in India hinder as well as promote innovation in Corporate India in order to explore efficient structures that could potentially enhance innovative activity.

In doing this, we analyze academic literature on corporate R&D investments, study regulatory frameworks and statutory programs for encouraging such investments, and examine applicable corporate governance theories, standards and factors and their relationship with R&D spending. We then present recommendations relating to the prevailing corporate governance framework in India, from a policy and regulatory point of view, in the hope that this will further stir the debate on the importance of encouraging corporate innovation through strengthening governance norms.

Chapter 2: Corporate R&D in India: Trends and Policy Landscape



Corporate R&D in India: Trends and Policy Landscape

This Chapter examines certain key trends regarding Corporate India's contribution to its R&D and innovation enterprise and provides a snapshot of Indian laws and policies that have been implemented for incentivizing corporate R&D initiatives and investment.

As outlined in Chapter 1, R&D performance can be estimated through certain 'innovation indicators' which are typically measures of 'innovation efforts' or 'innovation outputs' of an enterprise. In the initial section of this Chapter, and for setting the context, we broadly highlight the findings noted in the Economic Survey report for 2020-21 (Survey Report)⁴¹ released by the Ministry of Finance highlighting India's performance on various innovation indicators, with a specific focus on the R&D performance of India Inc. We then shift our focus to identifying Corporate India's granular R&D spending trends. We have only considered R&D spending (and not other innovation indicators) for evaluating R&D performance due to the availability of updated quality datasets on corporate R&D investments for the period under study (2015-2021). In this regard, we were unable to find comparable datasets on Corporate India's performance on other innovation indicators (e.g., levels of R&D manpower).

As noted earlier, one key objective of this report is to further the understanding of the impact of COVID-19 pandemic on India Inc.'s R&D performance. We did not come across studies that have explored this aspect specifically for India. However, in other developing economies (like South Africa), an overall downward trend in R&D input indicators like expenditure on R&D and hiring of R&D manpower has been observed particularly with respect to private sector.⁴² In a subsequent section of this Chapter, we have gathered data on R&D investments of key Indian R&D spenders in FY 2020-2021 to derive indicative trends about their R&D performance during the 'pandemic years'.

Finally, we briefly describe the extant legal & regulatory framework in India that provides incentives and support to corporate R&D initiatives. India arguably has a generous framework for promoting private R&D activity. The framework broadly comprises of various central and state level laws and schemes that grant businesses engaged in R&D activities deductions, exemptions and tax holidays on applicable direct and indirect taxes and other concessions and waivers. Also, there are multiple schemes in various sectors through which grants, and soft loans are disbursed to businesses for undertaking R&D activities. In the last section of this Chapter, we examine some potential causes behind the Corporate India's dismal performance on R&D performance indicators.

R&D Trends in India

Overall Trends

Despite studies hailing India as an attractive destination for corporate R&D (given India's generous R&D incentive framework, developed outsourcing industry and qualified low-cost labor),⁴³ the current trends relating to Corporate India's R&D initiatives do not provide a promising outlook. Multiple reports issued by government as well as industry bodies repeatedly suggest that improving on key innovation indicators (like overall R&D spending and R&D manpower etc.) and increasing business sector's participation in innovation initiatives are the key to unlocking India's growth potential.⁴⁴ Most recently, the Survey Report has made key observations regarding India's prevailing R&D and innovation situation. A finding is that "India seems to be underperforming in innovation [with respect to] the size of its GDP".⁴⁵ Another finding is that the Indian government's contribution to GERD (around 56%) is significantly higher as compared to GERD contributions by governments of other top economies who are leaders in R&D and innovation (less than 20%).⁴⁶ The Survey Report also states that

⁴¹ Government of India, Ministry of Finance, Department of Economic Affairs, "Economic Survey- 2020-21 (Volume 1)", available at https://www.indiabudget.gov.in/economicsurvey/doc/vol1chapter/echap08_vol1.pdf, 244. It may be noted that the Economic Survey is the Government of India's flagship economic document providing insights into key economic trends and developments over the past year and is presented in the Parliament alongside the yearly budget.

⁴² Atoko Kasongo and Nazeem Mustapha, "R&D the biggest business casualty of Covid-19?", Human Sciences Research Council Policy Brief-June 2021, available at <http://197.221.55.67/bitstream/handle/20.500.11910/16260/12075.pdf?sequence=1&isAllowed=y>.

⁴³ See for e.g., Kazuyuki Motohashi, "Global Business Strategy Multinational Corporations Venturing into Emerging Markets" (2015) Springer Publications, 199.

⁴⁴ See for e.g., FICCI and Edelman India, "Harnessing Private Sector Investment in R&D", 2020, available at <https://ficci.in/spdocument/20884/R&D-Industry-Report.pdf>.

⁴⁵ Government of India, Ministry of Finance, Department of Economic Affairs (n-41), 244.

⁴⁶ Ibid 267.

*“India’s business sector contributes a much smaller per cent to total GERD (about 37 per cent) than the business sector in all the other large economies such as China, US, Japan and UK (68 per cent on average)”.*⁴⁷ This is critical since GDP and business contributions to GERD have been shown to be positively correlated while government GERD contributions and GDP have been shown to have a negative co-relationship. This is⁴⁸ arguably as *“the probability that the research results are converted into commercialisable products, and processes are higher compared to research being done by the government.”*⁴⁹

Besides GERD, the Survey Report has noted similar trends on other input innovation indicators as well. One finding is that *“India has amongst the lowest number of R&D manpower as compared to other top ten economies”*⁵⁰ and that India’s business sector’s contribution to R&D personnel is the second lowest in the top-ten global economies (Brazil being the lowest).⁵¹ Regarding availability of equity and debt financing (including to Indian businesses) for innovation (including R&D), the Survey Report notes that India ranks much below expectation compared to the level of the equity and debt market development.⁵² With respect to innovation outputs, the Survey Report has also noticed a need for India to increase its share in total number of patents to levels commensurate with its status as the fifth largest economy.⁵³

The Survey Report concludes on a dismal note and states that *“the government sector contributes a disproportionate large share in total GERD ... however, the business sector’s contribution to GERD is amongst the lowest ... This situation has prevailed despite the tax incentives for innovation having been more liberal than other economies ... This points towards the need for India’s business sector to significantly ramp up investments in R&D.”*⁵⁴

Trends relating to corporate R&D expenditure in India

This section derives some granular trends relating to R&D expenditure of Corporate India. For this

purpose, we rely on EU Scoreboard which records R&D spending data of top 2500 global R&D spenders (as disclosed in their annual financial statements), covers data of several prominent Indian listed companies. We have examined data forming part of the 2016, 2017, 2018, 2019 and 2020 iterations of the EU Scoreboard (for the years 2015, 2016, 2017, 2018 and 2019 respectively).

Overall R&D expenditure trends

At the outset, Indian listed companies surveyed in the EU Scoreboard cumulatively spent 4866.4 million Euros (or 424.4 billion Indian rupees) on R&D activities in 2019. **Table 1** details the spending of surveyed Indian enterprises over the five-year period under review (2015-19). During this period, there was an overall increasing trend in the R&D spending of Indian listed companies (in line with the global trend), but such increases were not consistent as reduced R&D outlays were reported in 2016 and 2018 (as compared to the previous year values). In 2017, Indian corporate R&D expenditure was at its highest during the five-year period. An important point is that the EU Scoreboard dataset does not contain R&D spending data for 2020 and thus trends regarding the impact of the economic downturn and research activity in the wake of COVID-19 pandemic cannot be derived from this dataset. However, as noted earlier, a downward trend in R&D expenditure has been reported in other developing jurisdictions, and consequently, it would be important to examine such developments from an Indian perspective as well.

Table 1

R&D Expenditure of Indian Corporates (in million euros)

2015	2016	2017	2018	2019
4573.5	4210.5	4934.1	4642.4	4866.4

Source: EU R&D Scoreboard 2016-2020

⁴⁷ Ibid.

⁴⁸ Ibid.

⁴⁹ Sunil Mani, *India’s Performance in Science, Technology and Innovation: The Post 2000 Scenario* in Sunil Mani & Chidambaram G. Iyer (eds.), *“India’s Economy and Society: Lateral Explorations”*, (2021), Springer, 127.

⁵⁰ Government of India, Ministry of Finance, Department of Economic Affairs (n-41)268.

⁵¹ Ibid.

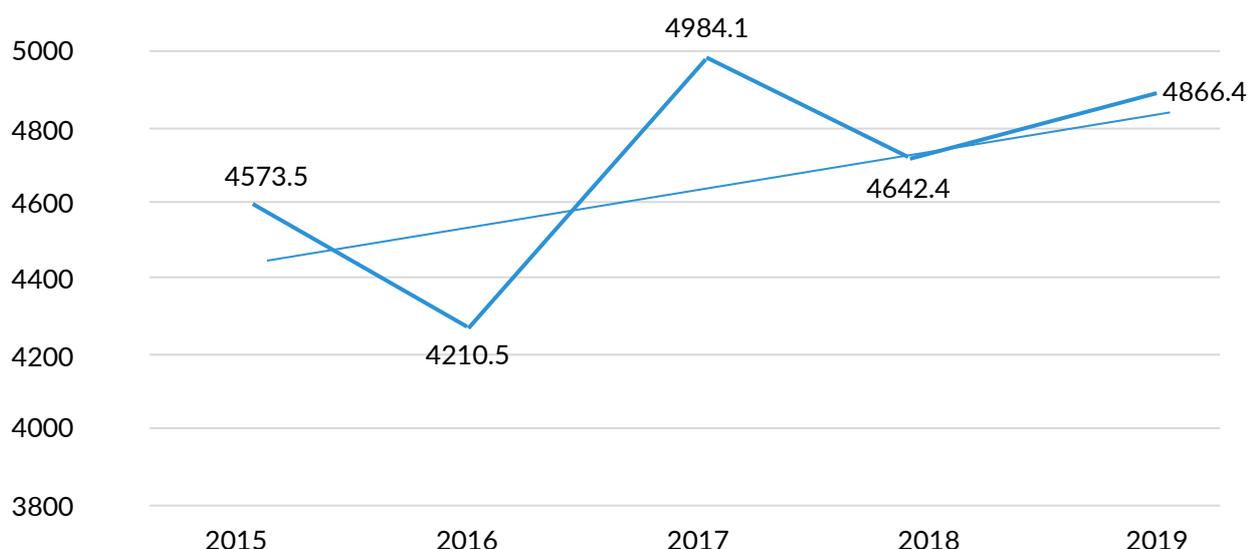
⁵² Ibid 272 and 274.

⁵³ Ibid 238.

⁵⁴ Ibid 238.

Graph

R&D Spending of Indian Corporates (2015-2019)



Source: EU R&D Scoreboard 2016-2020

Some international trends are also noteworthy. In 2019, the top five companies with the largest R&D outlays (Alphabet, Microsoft, Huawei Investment & Holding, Samsung Electronics and Apple) spent 17 times more on R&D than the combined spending of all surveyed Indian listed companies. Businesses situated in United States spent 71 times more on R&D as compared to Indian listed companies in 2019. Similarly, EU businesses spent 38 times more, and Chinese and Japanese businesses spent nearly 24 times more than Indian entities. In 2019, the contribution of Indian listed companies to the global corporate spending on R&D was merely 0.5% percent, and only one Indian entity (Tata Motors Limited) figures in the top 100 global spenders on R&D in 2019. The above highlights the pressing need of policy interventions and commitment from India Inc. to bring Corporate India's R&D spending in line with the global levels.

Table 3

Top 5 Corporate R&D Spenders

R&D Rank	Company Name	R&D Spending (2019 in million euros)
1.	Alphabet	23160.1
2.	Microsoft	17152.4
3.	Huawei Investment & Holding	16712.7
4.	Samsung Electronics	15525.0
5.	Apple	14435.6

Table 4

Countries/ Regions with largest corporate R&D spending

R&D Rank	Country/Region	R&D Spending (2019 in million euros)
1.	United States	347664.076
2.	European Union	188879.0
3.	China	118809.9
4.	Japan	114867.9
NA	India	4866.4

Source: EU R&D Scoreboard 2020

Sectoral Trends

From a sectoral perspective, Indian listed companies operating in the following sectors⁵⁵ spent significant sums on R&D in the five-year period between 2015-2019: (i) automobiles and parts, (ii) pharmaceuticals & biotechnology, (iii) software and computer services, (iv) chemicals, (v) industrial metals & mining, (vi) oil equipment, services & distribution, (vii) industrial engineering construction and (viii) materials oil & gas producers.

Table 2 sets out the sectoral R&D spending data.

Automobile companies spent the largest R&D amounts in all five years followed by the pharmaceuticals and biotechnology sector. A notable trend is that listed companies in some sectors spent R&D amounts which were several orders of magnitude higher than other sectors. For instance, R&D spending of 'automobiles and parts' companies in 2019 was nearly 8 times that of the 'software & computer services' companies and nearly 1.8 times the spending of the 'pharmaceuticals & biotechnology' companies. However, at a global level and in case of economies which are R&D leaders, the above sectors contribute a largely similar shares to total spending on R&D. This may suggest that in India (unlike in such other regions), R&D initiatives in sectors like software and pharmaceuticals have not developed to the scale of their global counterparts.

Another significant issue is that Corporate India does not appear to have any significant presence in sectors which have attracted R&D investments

globally. These particularly include strategically significant areas like aerospace,⁵⁶ defense⁵⁷ and technology hardware and equipment.⁵⁸ Thus, policy interventions may be required to bolster commerce and R&D activity in such key areas.

In the defence sector in particular, Corporate India's participation in defence manufacturing and R&D is not at par with jurisdictions like the US and Israel.⁵⁹ In these countries, it is mainly the private sector that supports and invests in defence production.⁶⁰ Corporate India's relatively weak participation can largely be attributed to the fact that up until 2001, the domestic private industry was not permitted to invest or undertake manufacturing in the sector.⁶¹ In May 2001, the defence sector was opened up to 100% for Indian private sector participation, with foreign direct investment (FDI) up to 26%, but both were subject to licensing. In 2016, FDI under automatic route was allowed up to 49%, and above 49% where it was likely to result in access to modern technology.⁶² In 2020, the government relaxed the FDI limit under the automatic route to 74%, but it also inserted a 'national security' clause, retaining the right to review any deal.⁶³ Against this brief background, it should be noted that despite being the world's third-largest defence spender, arguably, India does not have the defence R&D capabilities it desires and this is where Corporate India can play a significant role in terms of investing in the sector for building long-term capabilities.

⁵⁵ EU Scoreboard classifies companies based on the main sector in which they undertake business. The Scoreboard notes that this information is typically indicated by the companies in their annual reports, using taxonomies like the International Classification Benchmark (ICB). The definitions in the footnotes below are taken from FTSE Russell, "Industry Classification Benchmark", available at <https://research.ftserussell.com/products/downloads/ICBStructure-Eng.pdf>.

⁵⁶ These consist of manufacturers, assemblers and distributors of aircraft and aircraft parts primarily used in commercial or private air transport. Excludes manufacturers of communications satellites.

⁵⁷ These are producers of components and equipment for the defense industry, including military aircraft, radar equipment and weapons.

⁵⁸ These are producers and distributors of computer hardware (i.e., computers, servers, mainframes, workstations and other computer hardware and subsystems, such as mass-storage drives, mice, keyboards and printers), electronic office equipment (like photocopiers and fax machines), semiconductors (including integrated chips and other products related to the semiconductor industry, such as semiconductor capital equipment and motherboards) and telecommunications equipment (i.e., high-technology communication products, including satellites, mobile telephones, fibres optics, switching devices, local and wide-area networks, teleconferencing equipment and connectivity devices for computers, including hubs and routers).

⁵⁹ Rahul Nath Choudhury, Big Barriers on FDI in Indian Defence, East Asia Forum (August 19, 2021), available at <https://www.eastasiaforum.org/2021/08/19/big-barriers-on-fdi-in-indian-defence/>.

⁶⁰ Ibid.

⁶¹ Government Opens Defence Sector to 74% FDI via Automatic Route, Adds 'National Security' Clause, The Wire (September 10, 2020), available at <https://thewire.in/government/defence-national-security-clause-fdi>; Arjun Srinivas, Private defence business gets one more nudge, Mint (October 1, 2020), available at <https://www.livemint.com/news/india/private-defence-business-gets-one-more-nudge-11601460654397.html>.

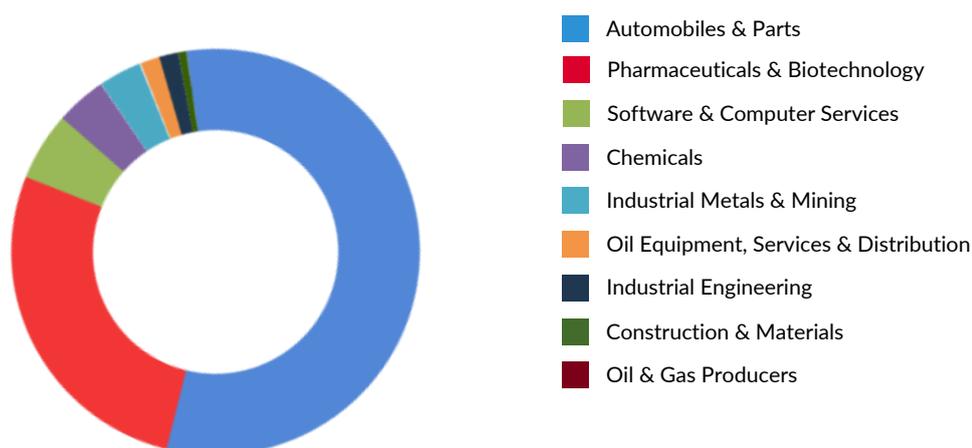
⁶² Ibid.

⁶³ Ibid.

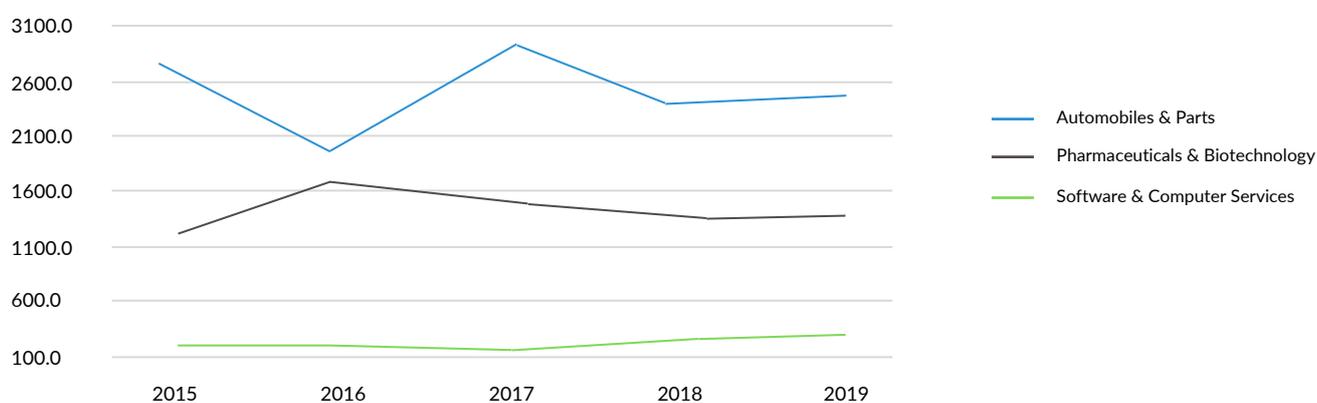
Table 2 Sectoral Trends in Corporate R&D Spending (2015-2019)

Industry	R&D Spending (in million euros)				
	2015	2016	2017	2018	2019
Automobiles & Parts	2700.3	1904.4	2880.9	2377.1	2530.3
Pharmaceuticals & Biotechnology	1252.9	1637.0	1425.3	1398.1	1391.1
Software & Computer Services	187.4	202.1	175.7	300.4	315.5
Chemicals	174.4	196.0	104.1	196.7	272.6
Industrial Metals & Mining	144.3	152.1	177.8	210.9	197.9
Oil Equipment, Services & Distribution	75.4	82.6	77.2	56.0	55.9
Industrial Engineering	38.9	36.2	33.8	49.2	49.1
Construction & Materials	NA	NA	31.0	NA	NA
Oil & Gas Producers	NA	NA	28.3	54.2	54.0

Source: EU R&D Scoreboard 2016-2020

Graph Sectoral Trends in Corporate R&D Spending in India (2015-2019)

Source: EU R&D Scoreboard 2016-2020

Graph Spending trends in Sectors with Highest R&D Expenditures (2015-2019)

Source: EU R&D Scoreboard 2016-2020

Box 1**Corporate R&D Expenditure Trends in India in 2020-21: A Preliminary Study**

Introduction

As noted, the Indian economy witnessed a substantial downturn in this period in the wake of the COVID-19 pandemic. For context, some developing economies (like South Africa) have reported a reduction in R&D spending during this period.

At the same time, there appears to have been a surge of R&D activity across the globe, particularly in the pharmaceutical sector, with public and private institutions rushing to develop treatment strategies and inoculation mechanisms for combating the virus and in the digital services sector.

In this initial study, we have attempted to derive trends regarding R&D spending of Indian listed companies during the year 2020-21. We record the R&D spending as reported by 22 Indian listed companies in their Annual Reports for 2020-21, which were the largest R&D spenders (as per the 2020 iteration of the EU Scoreboard), and then compare it with their R&D outlays in the past 3 years (2017-18, 2018-19 and 2019-20).

Methodological Notes

1. R&D expenditure values reported in the 'consolidated financial statements' have been considered. However, in some cases values mentioned in: (i) 'Board's Report' are considered, since R&D expenditure was not specifically identified in financial statements, (ii) values mentioned in the standalone financial statements are considered, as consolidated financial statements did not report these figures.
2. In cases where depreciation and amortization expenditure has been separately identified in the financial statements, this has been excluded from total R&D spending in the particular year. However, capital expenditure towards R&D incurred in a financial year has been included (if reported separately).
3. For some entities, annual reports of different years provide different R&D expenditure values for the same period. In such cases, the values reported in the latest report have been considered.
4. Periods under consideration are FY 2017-18, FY 2018-19, 2019-20 and 2020-21. We have gathered R&D expenditure data reported by listed companies on their websites (e.g., in financial statements or annual reports). We have not relied on the MCA 21 portal of the Ministry of Corporate Affairs to collect data for this study.

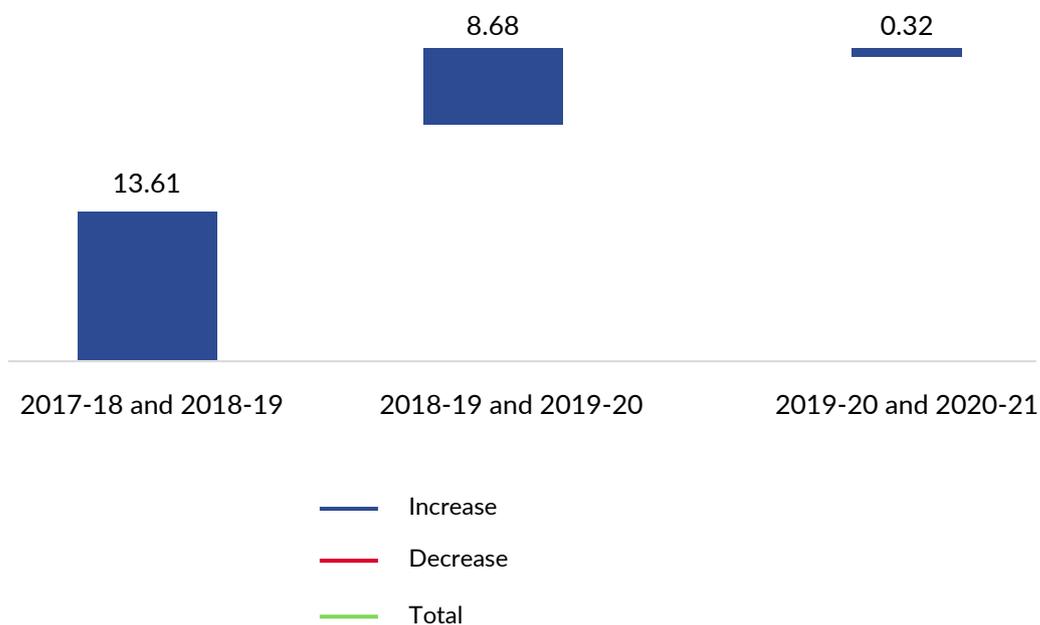
Key Findings

- The R&D spending of the surveyed listed companies showed an increasing trend in FY 2020-21.

- However, the rate at which corporate R&D spending increased in FY 2020-21 was significantly lower as compared to previous years (change rate for FY-2020-21: 0.32%, as compared to 13.61% and 8.68% in FY 2017-18 and FY 2018-19 respectively).
- Over a four-year horizon (between FY 2017-18 to FY 2020-21), it seems that corporate R&D expenditure has been increasing, but at a declining rate. However, a more comprehensive study may be required to confirm this trend.
- The rate of increase of corporate R&D spending declined in all sectors in FY 2020-21. In some sectors (automobiles and industrial metals and mining) there was a substantial contraction in corporate R&D spending in FY 2020-21 as compared to earlier years. Corporate R&D expenditure increased in the following sectors: pharma, chemicals, and software and computers, yet the percentage increases were smaller as compared to earlier years.

Graph

Percentage increase in in R&D Expenditure



APPENDIX		Dataset		R&D Expenditure (in Million INR)			
S No	Company	Type	FY 2017-18	FY 2018-19	FY 2019-20	FY 2020-21	
1.	SUN PHARMA ⁶⁴	Pharma	22340.00	19775.30	19690.30	21443.30	
2.	MAHINDRA & MAHINDRA	Automobile	20553.90	26903.00	29958.80	21313.40	
3.	LUPIN	Pharma	18150.40	15012.60	15537.90	14324.20	
4.	DR REDDY'S	Pharma	17392.00	14389.00	14696.00	15468.00	
5.	RELIANCE INDUSTRIES ⁶⁵	Chemicals	18240.00	23770.00	25380.00	25720.00	
6.	CIPLA ⁶⁶	Pharma	8642.20	10475.50	10213.30	7910.50	
7.	AUROBINDO PHARMA	Pharma	7916.20	9808.90	9895.80	15993.30	
8.	HCL TECHNOLOGIES	Software and Computers	1410.00	9310.00	12860.00	14000.00	
9.	CADILA HEALTHCARE ⁶⁷	Pharma	6900.00	7482.00	8501.00	9184.00	
10.	UPL	Chemicals	4030.00	4810.00	8890.00	9070.00	
11.	INFOSYS	Software and Computers	7480.00	7690.00	8290.00	9450.00	
12.	TATA STEEL	Industrial Metals & Mining	6722.80	8650.10	7563.10	7383.10	
13.	BIOCON	Pharma	2662.00	2899.00	4392.00	5531.00	
14.	ALEMBIC PHARMA	Pharma	3905.20	4681.40	5817.80	6263.30	
15.	HINDALCO INDUSTRIES ⁶⁸	Industrial Metals & Mining	220.60	268.30	290.00	230.00	
16.	ALKEM LABORATORIES	Pharma	3646.20	4621.50	4725.70	5322.10	
17.	INDIAN OIL ⁶⁹	Oil and Gas Producer	3166.30	4373.40	4280.40	5089.50	
18.	BAJAJ AUTO	Automobile	3726.90	4563.50	4750.60	4244.70	
19.	TORRENT ⁷⁰ PHARMACEUTICALS	Pharma	439.60	365.00	222.50	267.30	
20.	APOLLO TYRES	Automobile	3227.40	4113.80	3882.24	3248.90	
21.	TATA CONSULTANCY	Software and Computers	2980.00	3080.00	3060.00	3030.00	
22.	HERO MOTORCORP	Automobile	4968.10	4645.30	5433.70	4521.50	
Total			168719.80	191687.60	208331.14	209008.10	

Source: Refer to points no. 1 and 4 of the 'Methodological Notes'

⁶⁴ Standalone R&D expenditure has been considered as consolidated figures are reported only for recognised R&D entities.

⁶⁵ Standalone R&D expenditure have been considered as consolidated figures are not reported.

⁶⁶ Consolidated R&D expenditure not reported for FY 2017-18. Therefore, standalone expenditure values have been considered for all years.

⁶⁷ R&D expenditure figures mentioned in the Board's report have been considered.

⁶⁸ Standalone R&D expenditure figures have been considered as consolidated figures are not reported.

⁶⁹ Standalone R&D expenditure figures have been considered as consolidated figures are not reported.

⁷⁰ Standalone R&D expenditure figures have been considered as consolidated figures are not reported.

Tabular Analysis

R&D Expenditure % increase or decrease

Formula

$$\% \text{ Change} = (\text{Total R\&D expenditure in a year} - \text{Total R\&D expenditure in previous year}) / \text{Total R\&D expenditure in previous year} * 100$$

S. No.	Financial Years	% Change
1.	2017-18 and 2018-19	13.61
2.	2018-19 and 2019-20	8.68
3.	2019-20 and 2020-21	0.32

R&D Expenditure % change industry sector-wise

Notes:

1. The sector classifications for these companies are as per EU Scoreboard.
2. As only 1 entity in the Oil and Gas Producer sector is in the data set, the findings for this sector have not been included.

AUTOMOBILES SECTOR

S. No.	Financial Years	% Change
1.	2017-18 and 2018-19	23.86
2.	2018-19 and 2019-20	9.45
3.	2019-20 and 2020-21	-24.30

PHARMA SECTOR

S. No.	Financial Years	% Change
1.	2017-18 and 2018-19	-2.70
2.	2018-19 and 2019-20	4.67
3.	2019-20 and 2020-21	8.55

CHEMICALS SECTOR

S. No.	Financial Years	% Change
1.	2017-18 and 2018-19	28.33
2.	2018-19 and 2019-20	19.91
3.	2019-20 and 2020-21	1.52

SOFTWARE AND COMPUTERS SECTOR

S. No.	Financial Years	% Change
1.	2017-18 and 2018-19	69.17 ⁷¹
2.	2018-19 and 2019-20	20.57
3.	2019-20 and 2020-21	9.38

INDUSTRIAL METALS AND MINING SECTOR

S. No.	Financial Years	% Change
1.	2017-18 and 2018-19	28.44
2.	2018-19 and 2019-20	-11.94
3.	2019-20 and 2020-21	-3.06

⁷¹ This change rate may not be representative of the sectoral position and is due to a nine-fold increase in R&D expenditure of one of the surveyed companies. This pattern may be unique to this entity.

Legal and Policy Landscape

Review of Central R&D Policies

The central policy framework regarding R&D and innovation initiatives in India finds its roots in successive Five-Year Plans (up to 2017) and various industrial and science and technology (S&T) policy statements. Scholarly studies distinguish between various paradigms of India's innovation policy.⁷² In the initial years (up to 1980s) only publicly funded institutions conducted scientific research. During this period, "India achieved significant technological learning in the industry (both public and private)"⁷³ and there was a significant impetus to achieve technological self-reliance. This is contrasted with the period following economic liberalisation (1991 onwards), where the emphasis shifted to internationally integrating the S&T sector (through economic policy reforms), promoting industrial R&D, and identifying synergies between public and private sector to achieve innovation goals.⁷⁴ The Science, Technology, and Innovation Policy, 2013 (which is the latest centrally issued S&T policy), identifies attracting private sector investments in R&D as a key objective. Various focus areas are identified including: (i) treating private sector at par with public institutions for availing public funds, (ii) facilitating private sector investment in R&D centers (in India and overseas), (iii) permitting multistakeholder participation in Indian R&D system, (iv) allowing co-sharing of IPRs generated under public private partnerships and (v) providing incentives for commercialisation of innovations etc.⁷⁵

In 2020, the DST released a draft Science Technology and Innovation Policy 2020⁷⁶ for public consultation. This draft policy specifically notes that private sector invests inadequately in R&D

activities highlights the inadequacy of investment 'enablers' (like direct financial support, public procurement strategies, R&D incentives, hybrid funding models etc.) to boost private R&D.⁷⁷

Various measures are proposed to address this issue including requiring private companies and startups to set up STI units and earmarking a minimum budget for R&D activities, encouraging private financing of R&D through CSR funds or voluntary contributions, incentivising collaborative R&D by industry clusters, and leveraging the support of foreign multi-national corporations in R&D funding.⁷⁸ The draft policy also highlights the need for various reforms to India's framework of fiscal incentives (such as incremental R&D based tax incentives, tax credit for investing in facilities for commercialization, tax holidays, tax waivers, target-based tax incentive for specific domains, tax deduction, expatriate tax regimes, re-modelling of patent box regime and reviving weighted deduction provisions) and enhancing financial support for the industry (particularly MSMEs).⁷⁹ Presently, there is no clarity as to when the final revised S&T policy will be notified.

Central Level Fiscal Incentives

The Indian legal framework at the central level provides various incentives to businesses undertaking R&D activities⁸⁰ and various central statutes (like the Income Tax Act, 1961 and the Customs Act, 1962) contain provisions granting fiscal incentives such enterprises.⁸¹ Key fiscal benefits that can be availed inter alia include (i) tax deductions for capital and revenue expenditure incurred for R&D activities and contributions made to Indian companies or notified institutions for R&D purposes, (ii) reduced tax rate of 10% on

⁷² See for e.g., Biswajit Dhar and Sabyasachi Saha, "An Assessment of India's Innovation Policies", Research and Information System for Developing Countries - Discussion Paper, 2014, available at http://ris.org.in/images/RIS_images/pdf/DP%20189%20Dr%20Biswajit%20Dhar%20and%20Sabyachai%20Saha.pdf.

⁷³ Ibid 16.

⁷⁴ Ibid 19.

⁷⁵ Department of Science and Technology, "Science, Technology and Innovation Policy 2013", available at <http://dst.gov.in/sites/default/files/STI%20Policy%202013-English.pdf> 11.

⁷⁶ Department of Science and Technology, "Science, Technology and Innovation Policy-December 2020", available at https://dst.gov.in/sites/default/files/STIP_Doc_1.4_Dec2020.pdf.

⁷⁷ Ibid 19.

⁷⁸ Ibid 19-20.

⁷⁹ Ibid 19-20.

⁸⁰ An analysis of state level incentives and funding / capacity building schemes is not covered in the scope of this report.

⁸¹ A related point is that for benchmarking industrial R&D, the Government of India (through DSIR) runs a scheme for recognising and registering 'in-house R&D units' established by corporate industry. Corporate in-house R&D units registered under this scheme are eligible for receiving fiscal incentives provided under central laws and can also additionally obtain funding from various governmental ministries.

royalty income earned from patents developed and registered in India and (iii) customs duty exemptions on import of specified components for R&D activities. A list of some key benefits is tabulated in the **Annexure** to this Report.

A notable aspect is that the government has been progressively curtailing the ambit of tax incentives provided to businesses for investing in R&D and is signaling a shift to rewarding R&D output (e.g., patents) over inputs (e.g., spending). For instance, provisions that allowed businesses to claim super deductions (from taxable income) of up to 200% of R&D expenditure incurred in a year, now only allow deductions up to the amounts actually spent. At the same time, a number of new incentives, particularly the reduced tax rates on patent royalties have been simultaneously introduced by the government. The net effect of these reforms on improving Corporate India's R&D performance will need to be tested going ahead.

Central Funding and Capacity Building Programs

Various programs and schemes operated by central government departments / bodies (like the DST, DSIR, Department of Biotechnology, Ministry of Environment, Forest, and Climate Change, Ministry of New and Renewable Energy, Ministry of Food Processing Industries, Council of Scientific and Industrial Research, and Technology Development Board etc.) aim to provide funding (in form of soft loans, equity capital and grants) to businesses undertaking R&D activities. Some other central schemes instead of focusing on funding, target improving the overall research and infrastructural facilities (including for e.g., through development of common R&D facilities to be used by industry clusters) and augmenting the professional skills of the country's R&D manpower. Moreover, various states have also launched programs under the aegis of their industrial and start-up policies for providing funding and institutional support to enterprises engaged in R&D activities. Details of some key central level funding schemes and

programs that can be availed by businesses are tabulated in the **Annexure** to this Report.

State Level Policies, Incentives and Programs

Various state governments in India have also notified (or are in the process of adopting) dedicated state level R&D policies recognising the significance of having well-developed industrial R&D and innovation capabilities in the state. Such policies have typically targeted specific sectors and aim to provide concessions like soft loans, subsidies, and exemptions etc., to corporate entities undertaking R&D activities. Measures to develop long-term innovation capacity building in targeted sectors have also been envisaged in these policies. For instance, the government of Telangana had notified a 'Life Sciences Policy 2015-2020' for the life sciences sector that provided additional incentives to foster "development of the [life sciences] sector, while increasing long-term capacities to produce and commercialize new ideas."⁸² The nature of benefits under this policy included subsidies on lease rentals and fixed capital investments, co-financing and grants for industrial R&D research, capacity building measures like scholarships for attracting talent and setting up of a government run technology acquisition fund.⁸³ Similarly, the government of Karnataka has introduced⁸⁴ the *Engineering Research & Development (Engineering R&D) Policy* in 2021 providing incentives to multinational companies, engineering service providers and global capacity centers in Karnataka undertaking engineering RD in sectors like aerospace and defence; auto, auto components & EV; biotechnology, pharma & medical devices; semiconductor, telecom, ESDM & software products.⁸⁵ The benefits under the policy include rental reimbursements, establishment of common testing and prototyping infrastructure, funds for setting up corporate led engineering innovation labs etc.⁸⁶ The government of Maharashtra has also announced R&D and innovation incentives in the forthcoming policy for the IT/ITeS sector.⁸⁷

⁸² Government of Telangana, "Life Sciences Policy for the State of Telangana (2015-2020), available at <https://tsiic.telangana.gov.in/pdf/Life-Sciences-Policy.pdf>, 17.

⁸³ Telangana Investors, "R&D Incentives", available at <http://www.telanganainvestors.org/rdi.php>.

⁸⁴ The Hindu, "Karnataka launches engineering research policy" (March 3, 2020), available at <https://www.thehindu.com/news/national/karnataka/karnataka-launches-indias-first-erd-policy/article33974154.ece>.

⁸⁵ Government of Karnataka, "Engineering Research & Development (Engineering R&D) Policy, 2021", 17.

⁸⁶ Ibid, 19-23.

⁸⁷ The Hindu Business Line, Upcoming ITES policy to focus on right ecosystem for technology companies: Maharashtra CM (19 February 2021), available at <https://www.thehindubusinessline.com/news/national/upcoming-ites-policy-to-focus-on-incentives-for-innovation-rd-and-close-working-relationship-with-the-industry-maharashtra-cm/article33881029.ece>.

However, a recent governmental study has identified challenges in the context of state level R&D initiatives, including paucity of funds for research and lack of attention of state level government departments in fostering R&D and innovation ecosystems.⁸⁸ Also, not all states appear to have dedicated, long-term policies to foster R&D and develop innovation ecosystems, and the existing policies appear to be fragmented, short termed and sector specific. The efficacy of extant R&D programs of state governments is also unclear and a comprehensive analysis is required to determine their effectiveness. Such issues suggest that a comprehensive overhaul of a legal and policy framework for facilitating state level R&D initiatives is overdue.

University-Industry R&D Collaborations

Indian universities currently make relatively minor contributions to R&D activities in the economy, which can be contrasted from advanced countries where “universities play a critical role in creating the talent pool for research and generating high quality research.”⁸⁹ Government studies suggest that university-industry linkages (UILs)⁹⁰ are comparatively nascent and weak in India. Even international benchmarks like the Global Competitiveness Index (for the period 2017-18) suggest that levels of industry-university R&D collaboration in India are significantly below major global R&D contributors.⁹¹ This scenario has deprived Indian businesses and universities from reaping advantages of such collaborative engagements like “skill development, innovation and technology transfer, promotion of entrepreneurship and start-ups”, which have proved to be immensely beneficial in other economies and catalyzed socio-economic growth.⁹² Presently, the reasons due to which the potential of UILs has remained untapped in India, range from limited opportunities of interdisciplinary work, constraints in research capacity, institutional deficiencies, low enrolment in Doctor of Philosophy (PhD) programs, weak

innovation ecosystem in academia and structural challenges etc. Additionally, as the DSIR has noted, “biggest bottleneck... [is] absence of clear policy for strengthening linkages between the university and industry.”⁹³ At the same time, efforts are also needed to institutionalize private sector driven direct funding mechanisms for R&D activities in universities and promote industry-academic collaborations for development of indigenous technologies, funding of projects in key sectors, training of R&D manpower and establishment of world-class R&D infrastructure. Suitable regulatory and policy interventions are therefore required to address such aspects.

Causes of Corporate India's Under investment in R&D

There are substantial gaps in existing literature on identifying the underlying factors which result in Corporate India's dismal R&D performance. In particular, there is a notable absence of studies conducted by the government in the public domain exploring this aspect.

It seems that some quarters within the government view the corporate sector's underinvestment in R&D as resulting from inadequacy of policy measures geared towards incentivising such investments. A good example is the draft S&T policy (2020) that was released by jointly by the Office of the Principal Scientific Adviser and DST.⁹⁴ This draft policy notes that there is inadequate business sector investment in R&D and that the current 'enablers' of investment like “direct financial support, public procurement strategies, incentives to carry out and participate in R&D activities, ... mechanisms for hybrid funding models...., limited leveraging of foreign STI investment and weak overall financial management of the ecosystem” are also inadequate. However, whether such conclusions are supported by data oriented analytical studies is unclear.

⁸⁸ Economic Advisory Council to PM (n-28), 43.

⁸⁹ Economic Advisory Council to PM (n-28), 31.

⁹⁰ See, Department of Scientific and Industrial Research, “Framework of Industry-University Linkage in Research”, 2019, available at https://www.phdcci.in/wp-content/uploads/2019/10/Framework-of-University-Industry-Linkages-in-Research-DSIR-16-Oct_-Forweb.pdf.

⁹¹ World Economic Forum, “12.04 University-industry collaboration in R&D” in “Global Competitiveness Index 2017-18”, available at https://reports.weforum.org/pdf/gci-2017-2018-scorecard/WEF_GCI_2017_2018_Scorecard_EOSQ072.pdf.

⁹² Department of Scientific and Industrial Research (n-90), 9.

⁹³ Ibid 22.

⁹⁴ Ibid 22.

At the same time, some other quarters within the government (particularly the Ministry of Finance) seem disinclined with the view that additional incentives to boost corporate 'investments' in R&D would lead to increased innovative activity in the corporate sector and seem to favor incentivising R&D 'outputs' over 'investments'. Thus, measures have been introduced to curtail 'investment' (or input) incentives (e.g., super deduction for R&D spends) while increasing outputs incentives (reduced tax rate on patent royalties).

However, as one author notes, "*whether the government is justified in becoming less generous towards R&D investments by firm requires a systematic analysis of the elasticity of R&D expenditures with respect a reduction in the unit cost of performing R&D*",⁹⁵ and without such holistic evaluation, identifying which policy approach is superior and will boost corporate R&D is difficult. Yet no such evaluations seem to have been undertaken and there is no clear answer to the question as to why India Inc is consistently underinvesting in R&D.

In this regard, a crucial factor that has been known to impact the innovation potential of enterprises are their internal processes and decision-making structures.⁹⁶ This is based on the reasoning that an organization's innovation intensity is not only a factor of the level of external innovation incentivisation in an economy but also on internal modalities and attitudes that drive organisational decision making on aspects like innovation investment levels, frequency, and innovation management. However, we again did not come across studies that have considered the impact of these factors on R&D performance of Indian enterprises, and this is also an area where further research is required. In the next Chapter, we further consider the impact of some of these organisational governance aspects on R&D performance of enterprises.

⁹⁵ Sunil Mani (n-49), 139.

⁹⁶ See, Sunil Mani & Janak Nabar, "Is the Government Justified in Reducing R&D Tax Incentives?", *Economic and Political Weekly*, 2016, Vol LI No 30.

Chapter 3: R&D Investment and Corporate Governance



R&D Investment and Corporate Governance

This chapter examines the relationship between corporate governance (CG) factors (such as ownership structures, board of directors and incentive systems) and R&D investment. The following key attributes are generally associated with companies that innovate well: (i) dedication of investment in R&D in terms of advancing scientific research generally and also towards specific innovations; and (ii) a long-termist approach to growing and developing.

Studies also note that innovative capacity, development and harnessing of innovation in companies is shaped not just by market incentives but also⁹⁷ by internal company governance structures. It is thus arguable that a number of CG variables such as ownership structures, board composition, incentive systems etc. could potentially impact a company's expenditure on R&D, the level of innovation output and the company's overall approach to growth.⁹⁸ Therefore, analyzing the relationship between such variables and R&D inputs can potentially generate useful insights on ways of strengthening frameworks for better coordination between technology innovation and governance innovation.

Further, R&D activities are typically characterized as high risk and yielding cross-period income and are often viewed as posing serious agency problems revolving around controlling managers' opportunistic behavior as well as information asymmetry which in turn influence corporate R&D decision-making. As highlighted earlier in Chapter 1, linked to such agency problems is the fact that underinvestment in R&D can arguably be attributed to the existence of shareholder 'myopia', or 'short-sightedness' (also referred to as short-termism) which may take many forms: shareholders who make up an increasing percentage of company ownership are 'short-term' oriented and are therefore disinclined towards R&D investments relative to other long-term investments. The fact that appropriate corporate governance mechanisms can address these concerns makes it even more important to understand the relationship between relevant CG variables and R&D investment.

That being said, it is difficult to draw generalized conclusions regarding whether particular CG factors (e.g., specific kinds of corporate ownership structures) impact R&D investments positively or otherwise, and literature review suggests that these assessments can usually be made within the framework of a specific economic and legal / regulatory context.

In this Chapter, we initially examine the theoretical and normative underpinnings of the model of CG that is prevalent in India and identify factors due to which this framework may be lacking in the fillip to boost R&D activities in India. In the subsequent part, we review literature and identify three key CG factors that have been generally documented as impacting (i.e., promoting or hindering) R&D inputs (particularly R&D expenditure by companies): (i) ownership structure, (ii) board of directors and (iii) incentive mechanisms. We then attempt to assess (through review of material secondary sources) whether in the Indian context, there is a likelihood that such factors could potentially impact R&D spending of Corporate India.

Indian Corporate Governance Framework and R&D: Theoretical Underpinnings

A survey of literature suggests that corporate governance standards have increasingly become convergent around a shareholder-centered model of accountability globally.⁹⁹ This shareholder-centered agency-based model of corporate governance is most closely reflected in Anglo-American corporate law and corporate governance standards maintained by securities markets in the UK (India's corporate governance standards are largely based on the UK model) and the United States of America (US).¹⁰⁰

While the extent of shareholder powers employed in the UK is more than in the US, the US corporate sector accepts the legitimacy of shareholder value creation as a key corporate objective and accountability lies to shareholders for the exercise of managerial powers.¹⁰¹ The dominance of the

⁹⁷ Roger M. Barker & Iris H- Y Chiu (n.1), 143-44.

⁹⁸ Ibid.

⁹⁹ Roger M. Barker & Iris H- Y Chiu (n.1), 144.

¹⁰⁰ Roger M. Barker & Iris H- Y Chiu (n.1), 149.

¹⁰¹ Roger M. Barker & Iris H- Y Chiu (n.1), 150-52.

agency-based perspective of corporate governance in leading global securities markets such as London, New York and Hong Kong have shaped both the content of corporate governance standards as well as international standardization to some extent. Even countries that have adopted stakeholder-oriented models of corporate governance, such as Japan, are driving greater shareholder empowerment in a bid to reinvigorate the corporate sector and weed out the malaises of executive entrenchment.¹⁰²

Although the shareholder-centered agency-based model has influenced global standards, it is in essence a model based on individualistic economic behavior within the company, premised on opportunistic assumptions of human behavior.¹⁰³ It fails to take into account the fact that economic behavior adjusts in relation to the context of the collective enterprise that is pursued by multiple constituents of a company.¹⁰⁴ It therefore lacks insight into how economic constituents engage in and organize productive activities for the purposes of the company, as a result of which its link with corporate innovation is relatively weak.

The shareholder-centered agency-based corporate governance standards may hinder innovation in the following ways:

- i. as they key component of the model is based on 'monitoring' i.e., boards monitor CEOs and executives, and shareholders monitor boards (e.g., to ensure that managers or controlling shareholders do not expropriate assets), such monitoring creates an environment of critical scrutiny and risk aversion which is ultimately discouraging in terms of enhancing the potential for innovation;
- ii. a corporate governance model based on monitoring not only focuses on financial performance monitoring as a key component of its monitoring process, but also often places the

onus of such monitoring on independent directors who do not have inside knowledge for such monitoring to be impactful.¹⁰⁵ Moreover, emphasis on financial monitoring creates incentives for minimizing expenditure, and results in investment in R&D being considered costly and not yielding quick returns; and

- iii. a monitoring model focused on financial performance monitoring tends towards managerial and shareholder short-termism which is widely accepted as hindering long-term growth and success.¹⁰⁶ Shareholders focused on short-termist monitoring tend to discourage companies from undertaking long-termist expenditures and development that may not generate results in the short-term.¹⁰⁷

Academic literature and empirical studies on the impact of this shareholder-centered agency-based model on innovation suggest that these globally accepted standards require a moderated form of standardization whereby these standards may be adjusted to reflect the need for promoting corporate innovation.¹⁰⁸ Essentially, such standardization entails incorporating a resource-based theoretical perspective which has the same objectives as the shareholder-centered agency-based model of corporate governance i.e., corporate success, but it takes into account holistically the productive activities and enterprise of the company.¹⁰⁹ The resource-based theory of the company was first developed by commentators in business management literature who sought to shed light on why certain companies maintain a sustained competitive advantage over other companies and are consequently successful in the long-term.¹¹⁰ It embodies both, individualistic and collective economic behavior in order to better cater to the need for promoting innovation for long-term success.¹¹¹

This also includes re-imagining boards, shareholders, and stakeholders differently i.e., from

¹⁰² Ibid.

¹⁰³ Ibid.

¹⁰⁴ Ibid.

¹⁰⁵ Roger M. Barker & Iris H- Y Chiu (n.1), 152.

¹⁰⁶ Roger M. Barker & Iris H- Y Chiu (n.1), 152-54.

¹⁰⁷ Ibid.

¹⁰⁸ Roger M. Barker & Iris H- Y Chiu (n.1), 145-146.

¹⁰⁹ Ibid.

¹¹⁰ Roger M. Barker & Iris H- Y Chiu (n.1), 157.

¹¹¹ Ibid.

resource-based perspective and developing a new basis for requisite adjustment of corporate governance standards. More specifically, it includes making certain key adjustments in relation to boards by ensuring that companies have adequate access to a range of resources for innovation and also have a role to play in monitoring the utilization of such resources. Related to such re-characterization of boards' role and responsibilities is the inclusion of sustainability or environment, social and governance (commonly referred to as ESG) considerations into investment/boardroom decision-making processes. Embedding ESG considerations while making investment decisions will self-evidently enhance investment in R&D and consequently add to company value in the long-term.¹¹² In other words, adjusting provisions on board structures, composition, responsibilities, and accountability are critical to ensuring that boards better serve the purposes of company innovation effectively.

Corporate Governance factors & R&D investment

In this part we review literature and identify three key CG factors that have been generally documented as impacting (i.e., promoting or hindering) R&D inputs (particularly R&D expenditure by companies): (i) ownership structure, (ii) board of directors and (iii) incentive mechanisms.

Ownership structures

Studies indicate that differences in ownership structures may lead to differences in strategic actions and outcomes which can also include a company's R&D strategy.¹¹³ While such studies show mixed results (as a result of jurisdictional specificities within which companies operate), a significant number of them conclude that companies with controlled ownership have lower

R&D intensity as compared to companies with dispersed ownership patterns.¹¹⁴

In such cases, the risk preferences of promoters / major shareholders can also play an important role when analyzing the relationship between R&D investment and ownership concentration. In this regard, many studies highlight a link between concentrated ownership patterns and the presence of large shareholders which can impact R&D investment.¹¹⁵ Typically, the risk preference of shareholders is heterogeneous and thus the attitude of large shareholders to risky projects is uncertain and difficult to ascertain.¹¹⁶ Therefore, in cases where large shareholders / promoters are risk-averse, they tend to prevent managers from carrying out risky R&D projects.

In this context, companies in India can be characterized as having concentrated ownership and control as it is the norm rather than the exception.¹¹⁷ In such companies which are primarily controlled by promoters, it is the promoters who typically end up overseeing managerial behavior, including arguably, decisions regarding R&D activities. As discussed in Chapters 1 and 2, Indian companies are characterized by low levels of R&D expenditure and innovation spending, issues relating to ownership concentration in Indian companies and studies into the type and risk profiles of large shareholders / promoters owning such companies may be a critical aspect required to be looked at from a governance and policy perspective for boosting the low R&D investment levels in India.¹¹⁸

Board of directors

The impact of the board of directors on R&D investment is self-evident given that it is the board that is responsible for, amongst other things, compensating management and safeguarding invested capital, which are important components of corporate governance.¹¹⁹ Some research studies

¹¹² Luh Luh Lan, Director's Duties and Climate Change Risk – Standard of Care, Foreseeability and Enforceability, (July 8, 2021), Oxford Business Law Blog, available at <https://www.law.ox.ac.uk/business-law-blog/blog/2021/07/directors-duties-and-climate-change-risk-standard-care-foreseeability>; Charles Nathan and Kal Goldberg, The Short-Termism Thesis: Dogma vs. Reality, (March 18, 2019), Harvard Law School Forum on Corporate Governance, available at <https://corpgov.law.harvard.edu/2019/03/18/the-short-termism-thesis-dogma-vs-reality/>.

¹¹³ Krishnamurti Chandrasekar and Haiyun Ren, Review of Relationship between Corporate Governance and R&D Input, (2012), Journal of Applied Financial Research, 38-40.

¹¹⁴ Ibid.

¹¹⁵ Ibid 39.

¹¹⁶ Ibid.

¹¹⁷ Ownership Structure of Listed Companies in India, OECD (2020), available at <https://www.oecd.org/corporate/ownership-structure-listed-companies-india.pdf>.

¹¹⁸ Ibid.

¹¹⁹ Ibid.

indicate that large boards have a wider range of expertise which in turn can bring in diversity in viewpoints and experience and are therefore better equipped to promote R&D investments. However, there is research that indicates otherwise and concludes that large boards can be less effective than smaller boards as they are relatively more prone to facing agency problems.¹²⁰

There is also research that demonstrates that while board size may be a critical component related to R&D expenditure, there are many other variables such as company size, business scope, business complexity, nature of industry and business environment and therefore, the focus should be on minimizing agency problems between the board and shareholders through better governance practices rather than on board size.¹²¹

Related to the concern around mitigating agency problems, considerable research has focused on board composition and its relationship with R&D investment, particularly, the importance of outside or independent directors. Outside directors by virtue of the role they are expected to perform are expected to alleviate agency problems between management and shareholders. While there is no conclusive evidence on the effectiveness of boards with a majority of independent directors in increasing R&D intensity, various studies point to the positive correlation between them.¹²²

However, it is important to note that there is research which shows that outside directors are at a disadvantage compared to inside directors in terms of the manner in which they receive company information (the former obtain business information primarily through financial statements whereas the latter have access to critical information by participating in decision-making processes) and hence, owing to information shortage, they cannot effectively enhance a company's R&D investment.¹²³

Further, while the importance of appointing board members with specialist knowledge in at least one

domain that is critical to the company seems self-evident, this aspect is often ignored.¹²⁴ Knowledge and expertise in industry experience, financial literacy, information technology, R&D qualifications and more generally, board management experience should be factors accounted for when appointing board members, especially given that there is empirical evidence to support that expertise of board members positively impacts R&D investment and consequently company value.¹²⁵

In India, board size, board composition, board independence and board diversity of publicly listed companies are governed by the Companies Act, 2013 (Companies Act) and the Securities and Exchange Board of India (Listing Obligations and Disclosure Requirement) Regulations, 2015 (SEBI LODR Regulations) for listed companies. Regulation 17 of the SEBI LODR Regulations provides that the minimum percentage of non-executive directors on boards of listed companies should be fifty percent. Section 149(4) of the Companies Act provides that every public listed company should have at least one-third of the total number of directors as independent directors on their boards. Regulation 4(2)(f)(ii) of the SEBI LODR Regulations requires diversity to be a factor when nominations are made to the board of directors. Rule 3 of the Companies Act (Appointment and Qualifications of Director) Rules, 2014 provides that every listed company and every company with a paid-up share capital of one billion rupees or a turnover of three billion rupees must appoint at least one female director. Clause 49 of the Equity Listing Agreement requires boards of listed companies to have at least one female director on their boards.

Incentive mechanisms

In addition to the research on the relationship between ownership structures and board of directors and R&D investment, there are some studies on the impact of incentive mechanisms (including share ownership and stock options) on

¹²⁰ Ibid.

¹²¹ Ibid.

¹²² Ibid.

¹²³ Ibid.

¹²⁴ Tom Kirchmaier and Carsten Gerner-Beuerle, "Corporate Governance in South Asia: Trends and Challenges", (January 2021), Asian Development Bank, 28.

¹²⁵ Ibid.

R&D investment.¹²⁶ Research indicates that due to characteristics such as high risk and cross-period income associated with R&D activities, manager stock options or CEO stock options have a significantly positive effect on R&D spending and facilitate managerial risk-taking behavior when compared to CEO share ownership.¹²⁷

Further, there are two major agency problems between managers and shareholders that may influence corporate decisions on R&D expenditure: (i) the first agency problem is goal divergence and risk differential between managers and shareholders; and (ii) the second agency problem related to R&D is hidden information and hidden actions confronted by employers.¹²⁸ Research suggests that in order to solve these agency problems associated with R&D, and consequently encourage companies to make increase R&D expenditures, it is imperative for companies to not only control managers through monitoring mechanisms (as discussed above under ownership structures and board of directors) but to also create incentive-alignment mechanisms to recharacterize managerial risk orientation.

In India, where executive remuneration is concerned, Section 178 of the Companies Act and Regulation 19 of the SEBI LODR Regulations mandate boards to constitute a nomination and remuneration committee with three or more non-executive directors out of which not less than one-half should be independent directors. The committee is responsible for formulating the criteria for determining qualifications, positive attributes and independence of directors and recommend to the board a policy relating to the remuneration of directors, key managerial personnel, and employees.

The above discussion on the relationship between identified corporate governance factors and R&D investment and the legal and regulatory framework governing these factors in India brings to light the inherent shortcomings in India's corporate governance framework which ultimately negatively impact corporate R&D investment. Broadly, corporate governance in India is regulated by a combination of hard-law, binding provisions in company law and securities regulations regulating the basic governance architecture of companies, including board of directors, independence, remuneration systems and soft law, including best practices and standards set out in corporate governance codes. While the corporate governance framework has undergone a process of comprehensive evolution and modernization over the recent years, there is still scope for improvement in terms of meeting global standards and best practices.

¹²⁶ Ibid 40-43.

Chapter 4: Key Learnings and Recommendations



Key Learnings and Recommendations

This Chapter presents key learnings and recommendations for improving R&D investment by Indian listed companies based on the analysis and findings in the preceding chapters. As is clear from Chapter 3, where the relationship between corporate governance factors and their impact on R&D investment is concerned, there are certain inherent shortcomings in the Indian corporate governance framework, for example, controlled ownership patterns, which invariably result in short-termism and consequently underinvestment in R&D despite the presence of several fiscal incentives and funding and institutional support programs highlighted in Chapter 2. Keeping in mind these shortcomings, certain recommendations which may be considered for improving the corporate R&D investment landscape in India have been set out below.

R&D Committee: For a specified class of listed entities (for e.g., the top 500 or 1000 listed entities by market capitalization or companies operating in industrial and technology sectors), SEBI may consider making the constitution of a qualified and independent R&D committee mandatory. The primary purpose of the R&D Committee could be to assist the board of directors in reviewing and assessing the company's R&D programs, overseeing the company's strategy and investment in R&D programs, and to perform such other functions as may be deemed necessary or appropriate in carrying out the foregoing. The R&D Committee should also have the powers necessary to fulfil such duties and responsibilities. Notably, in the past some corporates have voluntarily constituted such committees including to provide strategic direction on R&D and technology issues.

Given that the implementation of the mandatory requirement for listed entities to constitute audit committees has resulted in significantly strengthening corporate governance standards in Indian listed companies,¹²⁹ guidance may be sought

from the provisions on requirements for composition of audit committee in the SEBI LODR Regulations.¹³⁰ Broadly, the requirements on membership and governance may include provisions on the minimum number of directors, minimum number of independent directors, qualifications, functions, manner of conducting meetings and review mechanisms.

Chief Innovation Officer: For a specified class of listed entities, SEBI may consider making the appointment of an executive-level leader responsible for advancing the innovation agenda of companies, namely, a chief innovation officer (CInO) mandatory as this will ensure the incorporation of a formalized system of innovation in companies.¹³¹ Broadly, the primary responsibilities of CInOs may include the following:

- 1. Formulation and execution of an innovation strategy:** CInOs should formulate and implement the long-term innovation strategy for the company, identify emerging market spaces and track and assess emerging technologies that may direct the company's future;¹³²
- 2. Capability building:** CInOs should be responsible for building the innovation capacity of senior leaders through coaching and advocating for the innovation strategy and for mentoring managers directly involved in the innovation process, including training teams to use innovation tools,¹³³ and
- 3. Managing partnerships:** CInOs should manage partnerships that foster innovation. They may also be expected to build and maintain relationships with a strong network of academic institutions, innovation laboratories, startups and industry leaders which are crucial to the company's innovation agenda.¹³⁴

Enhanced R&D Disclosure Requirements: For a specified class of listed entities, SEBI may consider prescribing mandatory enhanced R&D related

¹²⁹ Dr. Ashok D. Parmar, "Role of Audit Committee under New Corporate Governance in India", (2015), Indian Journal of Applied Research, 325-326.

¹³⁰ Regulation 18, SEBI LODR Regulations.

¹³¹ Alessandro di Fiore, "A Chief Innovation Officer's Actual Responsibilities", available at <https://innovationdevelopment.org/sites/default/files/Rise%20innovation%20officer%20WP%20IE.pdf>.

¹³² *ibid.*

¹³³ Chief Innovation Officer: Career Outlook, (November 18, 2019), Michigan State University, available at <https://www.michiganstateuniversityonline.com/resources/leadership/chief-innovation-officer-career-outlook>.

¹³⁴ Alessandro di Fiore (n. 131).

disclosure requirements, as part of the SEBI LODR Regulations. Presently, there do not appear to be detailed requirements that mandate disclosures of R&D related information. However, as a part of prevailing business practice, listed entities typically report information regarding sums expended on R&D (including capital and current expenditures) in their annual reports / financial statements. Also, details about the focus of R&D activity undertaken by the company and notable R&D achievements are often summarized in board reports published by such entities.¹³⁵

Despite this, various lacune exist in the existing disclosure mechanisms. This includes the fact that such information is not uniformly reported by all entities (particularly PSUs). There are no rules / standards prescribing a 'minimum' list of details that need to be mandatorily reported. R&D information reporting is not undertaken in a consistent, accessible and searchable format which easily lends itself to further analysis. Besides R&D spending, information about other key innovation indicators like R&D manpower employed by the entity or research outputs (like patents) generated over a period etc. is not reported etc. Given the current paradigm in which the government is increasingly privatizing publicly held enterprises and limiting its role in conducting business (particularly in strategically significant sectors),¹³⁶ there is a general need to bolster existing financial reporting mechanisms so that R&D performance of private enterprises can be seamlessly monitored, and the collected data can be used for indicative planning, research, forecasting and evidence-based policymaking.¹³⁷ Such data should also be publicly disseminated (in a manner that does not compromise competitive advantages or commercial secrets) so that industry stakeholders can meaningfully contribute to the policy making process. The need to improve financial reporting and monitoring of R&D is particularly acute considering the knowledge-based and highly competitive global economy and the long-term benefits that can accrue to India from a sustained and data driven innovation program. After such mandatory disclosure requirements are put in

place, SEBI may also consider supplementing them with an 'invest or explain' policy wherein profitable corporates operating in specified sectors found to be underinvesting in R&D over a period of time may be required to provide justifications for such underinvestment. While such measures might seem radical, given the structural limitations of India's corporate governance system as described in the previous chapter, such regulatory measures may go a long way in overcoming those limitations and promoting a culture of R&D and innovation in Corporate India, which will only make it more profitable in the long-term (in addition to making India a R&D powerhouse, which will have several associated benefits for the economy).

Pertinently, in addition to reforms to the extant frameworks relating to internal management of corporate enterprises, broader changes and legislative reforms may be necessary to ease systemic bottlenecks that may be throttling Corporate India's R&D potential. These include issues like absence of clear policies (such as on UIIs or in respect of R&D in strategically significant sectors) and extant bottlenecks in the current R&D funding mechanisms. Some suggestions to address such issues are discussed below:

Integrated Innovation Funding Platform for Central and State Level R&D Initiatives with a Separate Statutory Framework: As explained in detail earlier, multiple central government departments / bodies (like the DST, DSIR, Department of Biotechnology, Ministry of Environment, Forest and Climate Change, Ministry of New and Renewable Energy, Ministry of Food Processing Industries, Council of Scientific and Industrial Research, and Technology Development Board etc.) have been operating various funding schemes and programs targeted at providing funding assistance to private entities undertaking R&D activities (in form of soft loans, equity capital and grants).¹³⁸ Similarly, various such funding initiatives exist at the state levels as well.

¹³⁵ See National Statistical Commission, "Corporate Sector Statistics", available at <https://mospi.gov.in/documents/213904/0/Ch+12+07-09-01.pdf/fe75583b-87b8-64a8-cf7d-2bf28ca88f91?t=1599816719747>.

¹³⁶ See Press Information Bureau, "Policy of Strategic Disinvestment announced; Clear Roadmap for Strategic and Non-Strategic Sectors Ministry of Finance", available at <https://pib.gov.in/PressReleasePage.aspx?PRID=1693899>.

¹³⁷ See Ministry of Statistics and Programme Implementation, Standards of Disclosure / Reporting, available at <http://mospi.nic.in/122-standards-disclosurereporting>.

¹³⁸ Refer to detailed analysis in Chapter 2.

Given the decentralized (i.e., at the level of individual ministries and departments) and fragmented manner in which such funding schemes are managed, the process for obtaining R&D funding from the government is not streamlined and information regarding all active funding schemes of different government departments is not readily and centrally accessible.¹³⁹ Entities applying for such funding need to coordinate with different governmental bodies and complete non-standardized (and often physical) application process.¹⁴⁰ There is also limited information regarding the manner in which funding authorities monitor funding outcomes, and the quality of R&D generated, and such information is generally not available publicly.¹⁴¹ Given such challenges, there is a significant need for a single window 'Integrated Innovation Funding Platform' (IIFP) in respect of R&D funding efforts of the government. In other contexts (particularly in relation to foreign direct investment and telecom approvals) similar single window mechanisms have been implemented with considerable success. A central body should be designated as the nodal authority for coordinating with various ministries at central and state levels and managing the IIFP.

We suggest that the IIFP should enable the following functions. Firstly, it should provide updated and accessible information regarding all active government funding schemes for private enterprises (and other entities like non-profits, universities, and research institutions), along with eligibility criteria for each scheme, and should also provide functionality to stakeholders for seeking specific clarifications from the government on the platform itself. Secondly, enterprises and other entities should be permitted to apply for active funding schemes through the platform. For this purpose, a streamlined, digital, and uniform application process should be designed for all funding schemes operated by all ministries and departments, and any redundancies must be addressed. Funding applications should be processed by respective ministries in specified timelines and funds should be disbursed digitally. Thirdly, a robust monitoring mechanism for monitoring research outcomes of governmentally funded R&D should be developed and applicants

receiving fundings should be made subject to specific milestones and reporting requirements. The IIFP should enable digital recording of milestone completion and reporting requirements. Fourthly, to ensure transparency and public accountability, information regarding the grants disbursed, entities funded, and tangible research outputs achieved (e.g., patents) should be made publicly available periodically, and key trends should be regularly reported.

A separate statutory scheme can be designed to operationalize the ideas outlined above and bringing about lasting structural changes.

Devising targeted frameworks to address key bottlenecks. Targeted policy interventions may be required to address bottlenecks in three key areas: (a) university-industry collaborations, (b) R&D in strategically significant sectors, and (c) R&D initiatives at state level. Some suggestions in this regard are below:

- a. Institutionalizing University-Industry Collaborations for R&D and Innovation. There is a need to reorient Indian higher education institutions from their current teaching-focused roles and encourage indigenous and business-linked research activities. As noted earlier, UILs in R&D are comparatively nascent and weak in India and this deprives both Corporate India and Indian universities from the benefits associated with such collaborative ventures including technology transfer, skill development and promotion of entrepreneurship.¹⁴² Also, as discussed, this scenario results broadly from the lack of a clear UIL framework and other institutional and structural deficiencies.¹⁴³

As such, there is a strong case for legally recognizing the societal value of R&D activities (in universities and otherwise) and developing enabling regulatory frameworks which provide (i) clear guiding principles in relation to UILs, (ii) impetus for setting up the structural, institutional and regulatory machinery for establishing and operationalizing UILs and (iii) effective impact monitoring and accountability benchmarks and record keeping and dissemination mechanisms to ensure efficient

¹³⁹ Refer to Annexure for information regarding key central level funding.

¹⁴⁰ This is evident from the application process for the key central level schemes examined as part of the study.

¹⁴¹ We did not come across such information in relation to the key funding schemes examined in this study.

¹⁴² See discussion in Chapter 2 of this Report.

¹⁴³ Ibid.

- b. Corporate R&D in strategically significant sectors. There is a need to develop forward-looking frameworks to increase Corporate India's R&D footprint in strategically significant sectors like defence and aerospace. As explained earlier, corporate sector in other countries contributes heavily to R&D in strategic sectors.¹⁴⁴ However, Corporate India by comparison plays a relatively insignificant role, which is not in India's interests and long-term aspirations and is also not in line with the government's recent push towards self-reliance.¹⁴⁵ In line with the recent reforms aimed to encourage corporate sector participation in the defence sector (e.g., relaxation of FDI limits and import embargos under positive indigenization lists¹⁴⁶), the government should also consider formulating a comprehensive policy for strategic sectors with a focus on boosting corporate participation and developing indigenous R&D capacity in these sectors.
- c. Reimagining state level frameworks for boosting corporate R&D investments. As noted earlier, R&D policies in many states are short term oriented and largely sector specific, whereas some states have not formulated policies to promote corporate sector R&D.¹⁴⁷ States should consider adopting comprehensive, dedicated and streamlined frameworks to promote corporate R&D and modernize their institutional machinery (including by implementing single window clearance mechanisms and integrating 'digital first' approaches) to curb existing bottlenecks. This could be achieved through suitable state level statutory interventions. Also, for greater harmonization of the R&D policy landscape across the country, the central government could also consider issuing guidelines to state governments setting out relevant best practices and key principles in this regard.

¹⁴⁴ Ibid.

¹⁴⁵ Ibid.

¹⁴⁶ See, Rajat Pandit, "India announces second progressive arms embargo list to boost defence production" (June 1, 2021), available at http://timesofindia.indiatimes.com/articleshow/83119389.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst.

¹⁴⁷ See discussion in Chapter 2 of this Report.

ANNEXURE: KEY CENTRAL LEVEL R&D INCENTIVES IN INDIA

Annexure 1 Key Fiscal Incentives

S No.	Incentive Type	Description	Legal Provision
1.	Tax Deduction	This incentive allows eligible assesses to deduct sums equal to the revenue expenditure incurred on R&D from their taxable income.	Section 35(1)(i), Income Tax Act, 1961
2.	Tax Deduction	This incentive allows eligible assesses to deduct sums equal to the capital expenditure incurred on R&D from their taxable income.	Section 35(1)(iv), Income Tax Act, 1961
3.	Tax Deduction	This incentive allows eligible assesses to deduct sums equal to the amount paid for scientific research or social science or statistical research to research associations, universities, colleges, or other institutions from their taxable income.	Section 35(1)(ii) and Section 35(1)(iii), Income Tax Act, 1961
4.	Tax Deduction	This incentive allows eligible assesses to deduct sums equal to amount paid to an Indian company for conducting scientific research from their taxable income.	Section 35(1)(ia), Income Tax Act, 1961
5.	Tax Deduction	This incentive allows eligible assesses to deduct sums equal to amount paid to National Laboratory or a University or an Indian Institute of Technology from their taxable income.	Section 35(2AA), Income Tax Act, 1961
6.	Tax Deduction	This incentive allows a company engaged in biotechnology or any business of manufacture or production of any article or thing to deduct sums equal to expenditure incurred by approved in-house R&D units from their taxable income	Section 35(2AB), Income Tax Act, 1961

7.	Tax Deduction	This incentive allows companies carrying on scientific research and development to deduct sums equal to 100% of profits for a period of 10 years. This incentive can only be availed by companies which were approved in this regard before 1 April 2007.	Section 80(IB)8A, Income Tax Act, 1961
8.	Tax Deduction	This incentive allows accelerated depreciation allowance (up to 40%) on the investments made by assesses in new plant and machinery based on indigenous technology.	Section 35(2AB), Income Tax Act, 1961
9.	Customs Duty Exemption	This incentive exempts payment of the entire customs duty in respect of import of equipment, instruments, raw materials, components, pilot plant and computer software for 'research and development projects' undertaken by a company having an in-house R&D unit for a governmentally funded project.	Section 25, Customs Act, 1962 read with notification no. 50/96-Cus., dated 23 July 1996 (General Exemption No. 135).
10.	Patent Box	This incentive provides that if the total income if an assessee includes any income by way of royalty for a patent developed and registered in India, then such royalty shall be taxable at the reduced rate of 10%.	Section 115BBF, Income Tax Act, 1961

Annexure 2

Key Central Level Funding Schemes

S No.	Name	Nodal Ministry / Department / Board / Council	Targeted Beneficiaries	Funding Type	Other Details
1.	Fund for Technology Development and Application ¹⁴⁸	Technology Development Board	Companies, cooperatives, and other agencies (sole proprietor / partnership concerns are excluded), startups, techno-entrepreneurs	Loans (at 5% simple annual interest up to 50% of the project cost), equity (up to 25% of the project cost) and grants (especially for projects of national importance).	This scheme provides financial assistance to Indian industrial concerns, attempting "development and commercial application of indigenous technology, or adapting imported technology to wider domestic applications." The activities that are funded include development and evaluation of 'proof of applicability' and proof of concept, pilot, industrial product design, field trials, cost of studies, R&D, engineering consulting for prototype, trial and testing etc.
2.	National Initiative for Developing and Harnessing Innovations (NIDHI) ¹⁴⁹	National Science and Technology Entrepreneurship Development Board and Department of Science and Technology	Startups and incubators.	Soft loans, equity or equity linked instruments	The is an umbrella program whose objectives are to nurture ideas and innovations (knowledge based and technology driven) into successful startups. Various initiatives under this program involve setting up incubators and accelerators (to provide 'space, services and knowledge' to startups) and seed support (financial assistance), which can be provided to both incubators and startups.

¹⁴⁸ Technology Development Board, "Funding Guidelines", available at <http://tdb.gov.in/wp-content/uploads/2019/01/Funding_Guidelines_Jan_19-updated.pdf.

¹⁴⁹ See, National Science and Technology Entrepreneurship Development Board, "National Initiative for Developing and Harnessing Innovations (NIDHI)", available at <https://www.nstedb.com/new-programmes.htm>

3.	SRIJAN Scheme / TIFAC – SIDBI Revolving Fund for Technology Innovation ¹⁵⁰	Technology Information, Forecasting and Assessment	Indian MSME units.	Secured loan at flexible terms & softer interest rate (not more than 5% per annum) financing up to 80% of project costs and typically not more INR 100 lakhs	The objective of this scheme is to promote the “development, demonstration, up-scaling and commercialization” of innovative technology-based projects being undertaken by MSMEs.
4.	Technology Mission Programme on Water and Clean Energy ¹⁵¹	Department of Science and Technology	Individual researchers, academic and R&D institutions, industries having recognized R&D, industry associations.	Fellowships, Innovation Grants	This program intends to ensure water and energy security through transformative S&T breakthroughs. The program covers the entire value chain of R&D from “ <i>oriented basic and applied research, pre-competitive technology development, technology-based classification & assessment of technology options, pilot-demonstration of technology.</i> ”
5.	Patent Acquisition and Collaborative Research and Technology Development (PACE) ¹⁵²	Department of Scientific and Industrial Research	All industries registered in India having a healthy financial track record and having DSIR recognized R&D units, R&D organisations, academic institutions, and universities.	Secured loan or grants in aids	This scheme supports the “development and demonstration of indigenous product / process technologies, either by industry or by R&D organizations/ academic institutions/ universities aimed at commercialization of new products and processes”. The projects that are supported under this scheme should be targeted to develop a new product or process with attractive market potential and should

¹⁵⁰ Technology Information, Forecasting and Assessment Council, “Technology Innovation Program (SRIJAN)”, available at https://www.tifac.org.in/images/pdf/brochure_sidbi.pdf.

¹⁵¹ Department of Science and Technology, “Technology Mission Programme - Water and Clean Energy”, available at <https://dst.gov.in/technology-mission-programme-water-and-clean-energy>.

¹⁵² Department of Scientific and Industrial Research, “Patent Acquisition and Collaborative Research and Technology Development”, available at https://dsir.gov.in/#files/12plan/pace/pace_guide_nov2020e.html.

result in raising the technological level the industry concerned, increased turn over, energy and material savings/ recovery, export sales etc.

6.	Promoting Innovations in Individuals, Start-ups and MSMEs (PRISM)	Department of Scientific and Industrial Research	Indian citizens having innovative idea or innovation, publicly funded organisations, autonomous organisations, societies, or trusts engaged in promotion of innovation.	Disbursal of a sanctioned amount (between the range of INR 9 Lakhs to INR 50 Lakhs).	The scheme aims to support aims to provide support to individual innovators for promoting inclusive development. Support is provided under this scheme at various stages including proof of concept / prototypes / models, innovation incubation, enterprise incubation and R&D proposal.
7.	Epidemic preparedness through rapid vaccine development: Support of Indian vaccine development aligned with the global initiative of the Coalition for Epidemic Preparedness Innovations (CEPI) ¹⁵³	Department of Biotechnology and Biotechnology Industry Research Assistance Council	Indian Companies, Not for Profit Limited Liability Partnerships.	Grant in aid without royalty payment obligations	This mission intends to support the development of at-least two to three new vaccines for potential outbreak threats up to Phase 2 testing in four years. It is also targeted to (i) strengthen vaccine development infrastructure through an academia-industry interface, (ii) support capacity building and skill development, (iii) strengthen development frameworks, surveillance and logistics for rapid vaccine development and testing and for use of new vaccines.

¹⁵³ Biotechnology Industry Research Assistance Council, "Guidelines for Ind-CEPI Mission program on Epidemic preparedness through rapid vaccine development", available at https://birac.nic.in/webcontent/1578561123_Guidelines_IndCEPI.pdf.

¹⁵⁴ Biotechnology Industry Research Assistance Council, "National Biopharma Mission Document", available at https://birac.nic.in/webcontent/National_Biopharma_Mission_Document.

8.	National Bio-Pharma Mission ¹⁵⁴	Department of Biotechnology and Biotechnology Industry Research Assistance Council	Academic researchers, bio entrepreneurs, Small and Medium Enterprises, and industry.	Direct funding.	The objective is to make India "a hub for design and development of novel, affordable and effective biopharmaceutical products and solutions." The program aims to boost the development of specific products through de-risking, accelerating product development and providing direct funding to various activities.
9.	Revised Scheme on Research and Development (R&D) For Conservation & Development ¹⁵⁵	Ministry of Environment and Forests	All institutions with experience in identified thematic areas.	Grant in aids.	This scheme support and fund R&D projects in areas like bio-diversity conservation, ecosystems conservation and Management, socio-economic issues of environment, sustainable management of natural resources, climate change etc.
10.	Renewable Energy Research and Technology Development Program ¹⁵⁶	Ministry of New and Renewable Energy	Industry, academic institutions, registered societies, R&D institutions, and startups.	Grants.	This program supports R&D and technology development and demonstration in the field of new and renewable energy (solar thermal systems, solar photovoltaic systems biogas systems, waste to energy systems, wind energy systems, hybrid systems, storage systems, hydrogen, and fuels cells, geothermal, etc.) with the underlying intent of enhancing the share of renewables in India's energy mix.

¹⁵⁵ Ministry of Environment, Forest, and Climate Change, "Guidelines for Revised Scheme on Research & Development (R&D) for Conservation & Development", available at <https://repismoef.nic.in/writereaddata/Public/Guidelines%20for%20R&D%20Scheme%20.pdf>.

¹⁵⁶ Ministry of New and Renewable Energy, "Administrative Approval for continuation of the Renewable Energy Research and Technology Development Programme for the period from 2017-18 to 2019-20", available at <https://mnre.gov.in/img/documents/uploads/f016261ef34a46ab989bf63676e894e3.pdf>.

11. The Scheme of Research & Development in Processed Food Sector During 2017-2020 ¹⁵⁷	Ministry of Food Processing Industries	All Universities, IITs, Central/State Government Institutions, Government funded Organisations, R&D laboratories and CSIR recognized R&D units in private sector.	Grants (up to 50-70% in the private sector)	The scheme intends to promote R&D activity benefitting the food processing industry in terms of "product and process development, improved preservation, packaging, storage and distribution technologies, value addition, standardization of additives, coloring agents, preservatives, pesticide residues, etc. with focus on enhancement of production, quality, consumer safety, public health and trade.
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12. New Millennium Indian Technology Leadership Initiative ¹⁵⁸	Council of Scientific & Industrial Research	Publicly funded R&D institutions, academia, and private industry.	Grant in aid and soft loans (to private sector partners)	This initiative proactively identifies projects having an inverse risk profile (i.e., low investment and high-risk) and invites partners (from institutions, academia, and private sector) to execute the project in a public-private partnership format. The projects are undertaken in the fields of agriculture & plant biotechnology, general biotechnology, bioinformatics, drugs & pharmaceuticals, chemicals, materials, information and communication technology and energy.
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¹⁵⁷ Ministry of Food Processing Industries, "Guidelines for Scheme of Research & Development in Processed Food Sector During 2017-2020", available at https://mofpi.nic.in/sites/default/files/guidelines_latest_30.01.2019.pdf

¹⁵⁸ Council of Scientific & Industrial Research, "New Millennium Indian Technology Leadership Initiative", available at <https://www.csir.res.in/sites/default/files/NMITL%20Information%20in%20brief.pdf>.

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