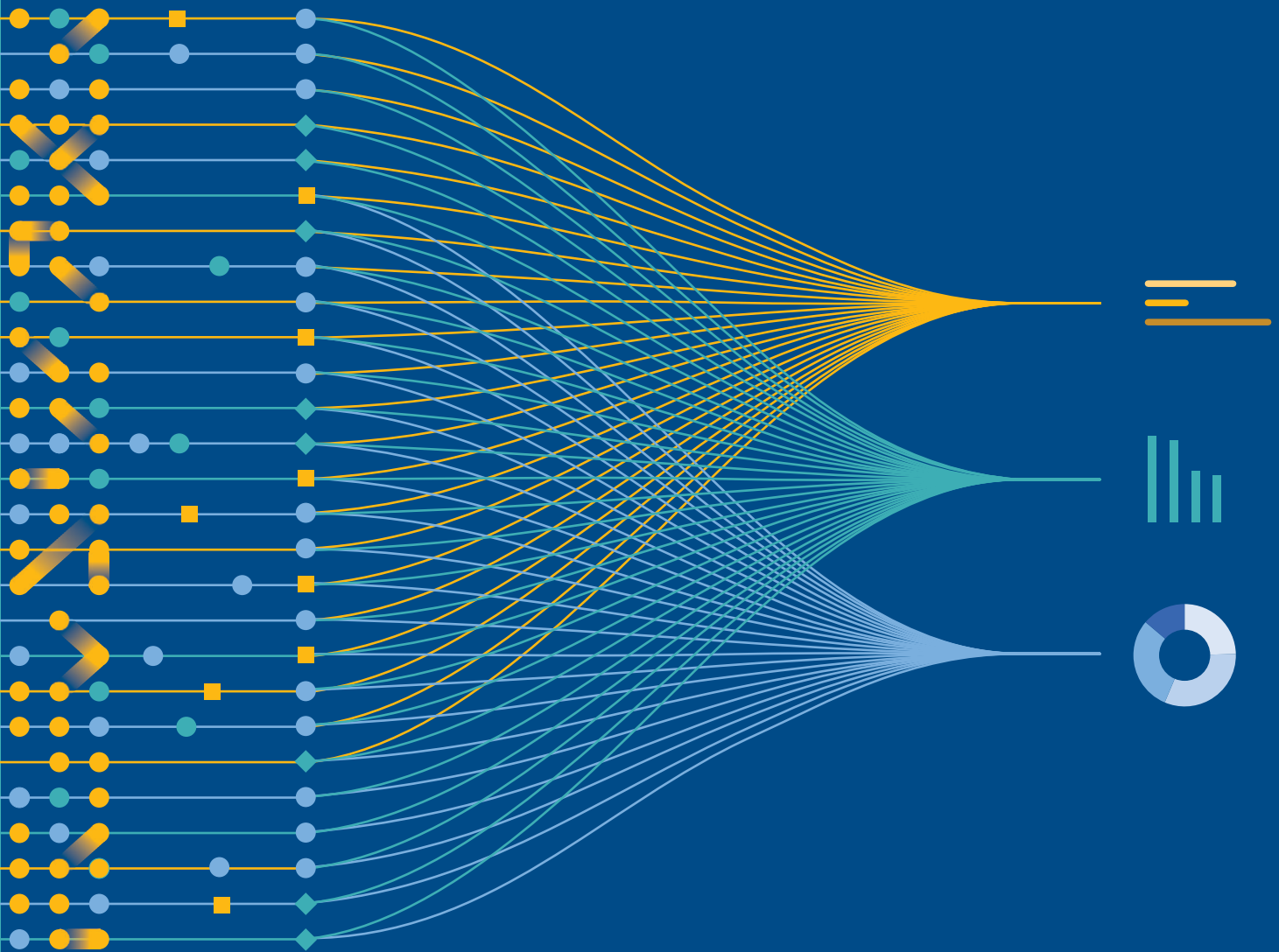


CTIER Handbook: Technology and Innovation in India 2025



**CTIER Handbook:
Technology and Innovation in India
2025**

Praise for Previous CTIER Handbooks

"Technology and innovation are critical for accelerated economic growth. The CTIER Handbook is an authentic and comprehensive source of good quality data on the subject, presented in an interesting and user-friendly way. All of us are proud of the fact that this decade belongs to India, and in our mission to accomplish our aspirations, the CTIER Handbook awakens us to the facts and figures pertaining to R&D and innovation. Extraordinarily rich in content, this unique compendium will be immensely useful to not only the policy makers but also the business leaders in equal measure."

B. Thiagarajan

Managing Director
Blue Star Limited

"The 2023 edition of the CTIER Handbook on Technology and Innovation is, like its predecessors, a one-of-its-kind compilation of macro and granular data on everything to do with India's R&D and innovation. The data is accompanied by analysis of outlays, source of funding (government, industry and universities), patents, sector-wise performance, and also information on start-ups. The compendium includes essays that frame the issues needing attention, along with strong advocacy on the kind of reform required to make India a technology and innovation powerhouse. For anyone interested in this broad field, the Handbook will be an invaluable reference volume."

T N Ninan

Former Chairman And Editor
Business Standard

"The CTIER Handbook provides a comprehensive picture of the state of innovation and research and development in the Indian economy. It offers the tantalizing prospect of systematic data on different facets of innovation, research and development, and technology adoption in India; how this varies across states and sectors, and how it compares to the global economy. Simply put, this is a very valuable public service to scholars and policy makers, and CTIER deserves our gratitude and our heartiest congratulations."

Ashish Arora

Senior Associate Dean for Strategy and Rex D. Adams Professor of Business Administration at the Fuqua School of Business at Duke University

"Congratulations to CTIER on the release of the Handbook on Technology and Innovation in India. Once again, CTIER has shown how its commitment to quality brings out distilled analysis and advice on our science and technology landscape. This handbook will be very useful, from policy-makers to those in the front-line. Kudos to all involved."

Prof. K. VijayRaghavan

Principal Scientific Adviser to the Government of India

"Advanced Research, Technology and Innovation coupled with indigenous Intellectual Property (IP) is at the core of the Government's Atmanirbhar Bharat Mission. Amidst the disruptive technological forces that are defining a New Normal in the Digital Age, it is imperative for India and Indian companies to focus on in-house Research and Capability Development towards sustained growth and economic prosperity. The CTIER Handbook is thus a timely initiative offering an excellent compendium of India's standing in the global technology & innovation landscape and the imperatives thereof."

Baba Kalyani

Chairman & MD
Bharat Forge Ltd.

"With the Government's impetus on Atmanirbharta, Innovation and R&D, it becomes critical to benchmark our innovation and funding landscape against that of other countries such as the US, Germany and Israel. The CTIER handbook is a brilliant compendium of innovation related metrics, which helps us understand what is "best in class", and enables us to build a roadmap for a better innovation and R&D ecosystem in the country. Further, the introductory essays set a strong context and provide perspective on how innovation and macroeconomic outcomes are closely interrelated. The handbook is a must read for policy makers and industry leaders looking to drive the innovation agenda of our nation."

Satish Reddy

Chairman

Dr Reddy's Laboratories Ltd.

"In a rapidly evolving and uncertain industrial world, from corporate giants to startups, each one is in the race to ensure relevance by endeavouring to stay ahead of the curve through continual technological innovation. The collective of each of these, viz. the creation of Intellectual Property, is ultimately the wealth of a Nation. The second handbook being released by CTIER is an extremely impressive source of data points that will help the readers – as individuals and as institutions - in formulating a path forward for sustained competitive advantage. We at Ashok Leyland resonate with this, as Ashok Leyland has always tried to challenge the 'tech status quo'. I am sure, this handbook by CTIER will serve as a 'one stop shop' for business and tech practitioners."

Vipin Sondhi

Managing Director & CEO

Ashok Leyland Limited

"The biennial CTIER Handbook has emerged as the most accessible and comprehensive source of high-quality data on research and innovation in India. The range of data on the research and innovation enterprise in India, its variation across Indian states, and putting India in a global context, all make the CTIER Handbook an indispensable resource for anyone interested in understanding how research and innovation is driving India's future."

Devesh Kapur

Starr Foundation Professor of South Asian Studies and Director of Asia Programs, Paul H Nitze School of Advanced International Studies, Johns Hopkins University

"The CTIER Handbook is very useful and relevant as India progresses in increasing its innovation intensity. Technology innovation will be key to India's development and this Handbook is an important addition to catalyse this process."

Nandan Nilekani

Co-founder and Chairman of Infosys and
Founding Chairman UIDAI (Aadhaar)

"The CTIER Handbook provides many unique indicators on India's innovation landscape. At Bajaj Auto, we export about 40 percent of our output to over 70 countries. Our success derives from developing products that consumers love worldwide, so innovation is at the heart of what we do. The CTIER Handbook will enable us to benchmark ourselves against global leaders, and will serve as a useful companion in our journey."

Rajiv Bajaj

Managing Director

Bajaj Auto

“Data-driven innovation is the key to India’s economic future. By compiling data on R&D related inputs and outcomes in India into an extensive list of indicators, this Handbook provides a good overview of India’s technology and innovation sector, appropriately placed in a global context. This is a timely and valuable resource that will be of great use to both government and business leadership as we forge a new path for India in the Fourth Industrial Revolution.”

N. Chandrasekaran

Chairman
Tata Sons

“The CTIER Handbook is a brilliant compendium of contemporary, comprehensive, and comparative data based evidence of the state of technological innovation in India. It also draws sharp insights into issues that link firm and sector level innovation driven outcomes to macroeconomic outcomes. It is the most definitive reader for all those who wish to understand how innovation and related government policies are tied to economic growth and well being of the people of India.”

Pankaj Chandra

Vice Chancellor
Ahmedabad University

“The CTIER handbook is an impressive review of the level, range and types of innovation ongoing in the Indian economy. Previously analyzing this required scouring almost a dozen different data-sources, so bringing this together into one document with insightful analysis is a huge step forward – anyone interested in modelling and predicting the growth of the Indian economy should read this.”

Nicholas A Bloom

William Eberle Professor of Economics at Stanford University, Co-Director of the Productivity, Innovation and Entrepreneurship program at the National Bureau of Economic Research

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Foreword

India is home to some excellent institutions, high calibre talent and successful enterprises. What is missing is the full realisation of our innovation potential. Ten years ago we established CTIER to bring technical capability and innovation to the forefront of policy discussion and base it on data. We have seen modest but encouraging change since, be it in the policy space or within Indian industry.

This Handbook, now in its fourth edition, is a wealth of information and data on innovation and technology in India. Over the years it has brought together various stakeholders, including industry, government bodies and academia, to derive insights to strengthen India's R&D and innovation ecosystem. It has helped shape academic thought in the economics of innovation. It has helped design programmatic interventions to build the capabilities needed to transform Indian industry into an innovation powerhouse.

The potential for Indian firms to lead globally in technology is real. Many of our large Indian firms are profitable by international standards; they just invest very little in R&D. For policymakers, the key imperative is to identify who should fund what research (scientific research as well as technological research) and where it is best performed, whether in industry or academia. Unlike the rest of the world, public R&D in India is mostly performed in autonomous government laboratories, which are cut off from our higher education institutes and industry. By doing much more of our public research in our higher education system, we would simultaneously train more advanced talent needed by our industry. And strong inhouse investment within industry is a precondition for taking advantage of public research.

The essays in this edition start with a comparison of data on key innovation parameters between India and the two technology giants, the US and China. In the current environment of intense competition for technology and talent, the essay serves as a reminder of the need for India to capitalise on her strengths in key sectors like pharmaceuticals & biotechnology and automobiles & parts among others, while growing her capabilities in sectors like electronic & electrical equipment. The subsequent essays focus on building a bold ambition for the pharmaceuticals & biotechnology sector and exploring and expanding opportunities in the emerging sectors of semiconductors and electric vehicles.

As before, the CTIER Handbook makes available the most current and useful data on technology and innovation in India. Companies over time tell us about progress we made. International companies tell us how far we have to go. Janak and his young team at CTIER do us all a great service by producing these excellent Handbooks.

Coinciding with our tenth anniversary, this is a special edition for the CTIER team.

Naushad Forbes

Chairman CTIER, Co-Chairman Forbes Marshall, Past President CII

Pune, October 2025

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The CTIER team extends its heartfelt gratitude to Rakesh Basant, Pankaj Chandra, and Sunil Mani for their continued guidance, support, and generosity of time.

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We are also deeply grateful to Pankaj Chandra for granting us access to various databases at Ahmedabad University, which supplemented CTIER's own database subscriptions. Adil Ahamed Hasan provided excellent research assistance on data related to Indian industry. Additionally, we acknowledge the valuable assistance of Saurabh Srivastava, Anamika Chourasia, Hari Vignesh A S, Nilesh Puntambekar, Aman Verma and Abhishek Goel with respect to various data on publications, startups, and patents. Our past interns Rajas Ponkshe, Shriya Deshpande, Satej Zunjarrao and Nayan Mane made important contributions in compiling data for this Handbook. We would like to acknowledge the support of Sameer Karmarkar and Kartiki Jagtap at Satisfice Designs and Girish Rao and his team at AkruTi.

Finally, we are immensely grateful to our families for their constant encouragement, patience, and unwavering support, which enables us to continue our work at the Centre.

Janak Nabar, Swati Joshi, Chaitanya Lekharaju, Soumya Misra, Yash Karmarkar, Neha Kumari, Nishant Dewaney, P J Nishok and Shrimoyee Mukherjee

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About the Handbook

The CTIER Handbook: Technology and Innovation in India, a biennial publication, brings together key indicators of India's R&D and innovation ecosystem. The data captured in the Handbook allows for a comparison of India with the global economy, covers indicators on regional innovation systems and encourages a deeper study of industrial R&D and innovation in India. The Handbook is intended for use by policymakers, industry leaders and academics. The purpose of having these indicators in one place is to encourage the reader to draw her own conclusions about India's innovation ecosystem. It also hopes to draw the reader into the debate on the need for greater R&D and innovation in India, its importance for India's economic development, and how this could best be fostered.

Structure of the Handbook

The CTIER Handbook: Technology and Innovation in India 2025, builds on the set of indicators captured in previous editions of the Handbook. As with our previous editions, we have introduced some new indicators in this edition which have been captured in Table 2. The Handbook comprises two main sections – 'Section 1: Technology and Innovation in India: Essays' that expand upon or use data that appears in Section 2 and builds on conversations at various forums that CTIER has organised or participated in, and 'Section 2: Technology and Innovation in India: Indicators' that consists of three data chapters. The three data chapters cover 'India and the Global Economy', 'Regional Innovation Systems' and 'Industry in India'. The data in Section 2 has been organised to showcase 'input' and 'output' indicators with respect to R&D and innovation in India. Examples of the input and output indicators we have considered can be found in Table 1 below.

Table 1 | Examples of Input and Output Indicators

Input Indicators	Output Indicators
• R&D expenditure as percent of GDP • Charges for the use of intellectual property (payments) • Foreign Direct Investment • Venture Capital Investment • Researchers per million • Manpower employed in R&D • Policies introduced by state governments • Pupil teacher ratio and gross enrolment ratio in higher education • Number of incubation centres • MNC R&D presence in India	• Publications by country, including share of industry-academia collaborations • Patents, trademarks, copyrights filed domestically and abroad • Patents granted • Share of high technology products in manufactured exports • Number of startups by state

In 'India and the Global Economy', India's national spending on R&D has been constructed by the CTIER team, having referred to several Union Budget documents for data on spending by key scientific ministries, budget accounts for all state governments, and annual reports of various Indian companies. India's R&D spending continues to be dominated by the government sector that accounted for 55 percent of India's total R&D expenditure in 2023, while Industry's share in total R&D expenditure edged slightly lower to 36 percent in 2023 compared to 39 percent in 2021. The Defence Research and

Development Organisation (DRDO) continues to be the largest spender on R&D amongst the major government scientific agencies. With respect to global industry, Indian firms remain absent in 6 out of the top 10 global industrial R&D sectors. The structure of industrial R&D in India has seen the appearance of the electronic & electrical equipment sector in the top 10 R&D sectors for India in 2023. Globally, software & computer services has surpassed pharmaceuticals & biotechnology as the leading industrial R&D spender. With respect to foreign direct investment (FDI) into India, the top sectors in 2023-24 and 2022-23 have been reported and have been identified based on cumulative FDI that has come into these sectors since the year 2000. If one simply considers the top 10 sectors that attracted FDI in 2023-24 alone, then non-conventional energy, hospital & diagnostic centres and sea transport are seen to make it to the top 10 sectors that attracted FDI in 2023-24. India was one of the top destinations for VC funding after the US, China, and the UK and saw total VC funding of around USD 15.8 billion in 2023. In this edition, we have introduced new indicators related to the outward mobility of tertiary students as well as publication retractions. The data shows that from 2013 to 2023, China and India consistently had the highest numbers of outbound tertiary students. For the retractions data, China and India recorded retraction rates above 2 per 1,000 papers. India ranks fifth in global publication output even after journals from the Web of Science's Emerging Sources Citation Index (ESCI) are taken into consideration. The number of patents granted to India by the USPTO was 6,544 in 2023 from 2,424 in 2013.

The 'Regional Innovation Systems' chapter is intended to provide an overview of the innovation systems of India's states. It considers data on various policies that have been introduced by the states to promote innovation across different sectors. A new indicator introduced in the CTIER Handbook 2025 concerns policies on critical and emerging technologies introduced by the states. Around 13 states have either a dedicated semiconductor policy or have it as a part of their electronics policy. While 7 states have a standalone green hydrogen policy, 4 states have included it as part of their renewable energy or power policies. Some of the other data in the chapter include the distribution across states of industrial R&D units recognised by the Department of Scientific & Industrial Research (DSIR), FDI by states, funding for startups across states, the number of startups (and new companies) that have been established in 2023, government supported incubators across states and the distribution of top ranked education institutes across states. Maharashtra has the highest number of DSIR recognised industrial R&D units. It was also the leading state in terms of the number of startups (and new companies) that were established in 2023 and the state that secured the highest funding for companies in 2023. Tamil Nadu ranked highest for the number of government supported incubators as well as for the number of educational institutions in the top 100 institutions in India. Uttar Pradesh is the top state when it comes to the number of institutes of national importance like the Indian Institutes of Technology (IIT), the National Institutes of Technology (NIT), the Indian Institutes of Science Education and Research (IISER) etc that are present in a state. Given the varying degrees of innovation capabilities and challenges across states, this chapter aims to encourage the study of regional innovation systems by emphasising the innovative potential of firms and the institutions around them.

In 'Industry in India', one of the key indicators is the list of the top 100 R&D spenders in India. In 2022-23, Reliance Industries Ltd recorded the highest spending on R&D by a firm in India. The top 100 spenders account for around 78 percent of industrial R&D in India. Nvidia, which is ranked 26 in the list of the top 2,500 global R&D spenders, spends nearly as much as all of Indian industry on R&D. The chapter also features data on R&D intensity (R&D expenditure as a percent of sales) of select Indian firms within India's top R&D sectors in comparison with the global average R&D intensity for each of these sectors. With respect to the R&D spending by multinational corporation (MNC) R&D centres, we have estimated this to have totalled around USD 15.1 billion in 2023. In our previous edition we had also introduced an indicator to capture funding towards technology incubators and public research institutions through corporate social responsibility (CSR) by Indian industry. If we consider the data from the 2023 Handbook¹ and the current edition of the Handbook, we can see that the CSR funding towards

¹ CTIER Handbook: Technology and Innovation in India 2023

technology incubators and public research institutions has slowed significantly in recent years, and was USD 0.2 million in 2022-23. The startup sectors that were among the larger recipients of funding in 2023 included the consumer, retail, fintech, and the enterprise applications sector. The sub-sectors that dominated the funding landscape within the consumer sector was B2C e-commerce while alternative lending dominated the fintech sector. The chapter also presents a sectoral breakdown of patents obtained abroad and in India in 2022-23 by the top 100 R&D spenders in India. A higher share of patents were granted abroad for the pharmaceuticals & biotechnology, chemicals, oil & gas, and software & computer services sectors, while the automobiles & parts sector had a significantly higher share of patents granted by the Indian patent office. In this edition of the Handbook, we have introduced a new indicator on exports as a share of sales for top Indian R&D spenders in each sector. Firms in the software & computer services sector on average saw the highest exports as a share of sales, with 4 firms having more than 90 percent exports as a share of sales.

Data and Methodology

The data in the Handbook has largely been collated from secondary sources.

For global indicators, we have used publicly available databases from the World Bank, the World Intellectual Property Office, the United States Patent and Trademark Office, UNESCO Institute for Statistics, Organisation for Economic Co-operation and Development, the US National Science Board, the EU Industrial Investment R&D Scoreboard, and Retraction Watch Database.

Data pertaining to India were compiled from various Union Budget documents, reports, publications, websites and databases of Government of India departments and ministries such as the Department of Science and Technology (DST), Department of Scientific and Industrial Research (DSIR), Department for Promotion of Industry and Internal Trade (DPIIT), the Reserve Bank of India (RBI), Ministry of Human Resource Development (MHRD), Startup India, Invest India, state government department websites, budget accounts of state governments and various annual reports published by companies. We have also used third party subscription databases such as Prowess, Web of Science, XLSCOUT and Tracxn where required.

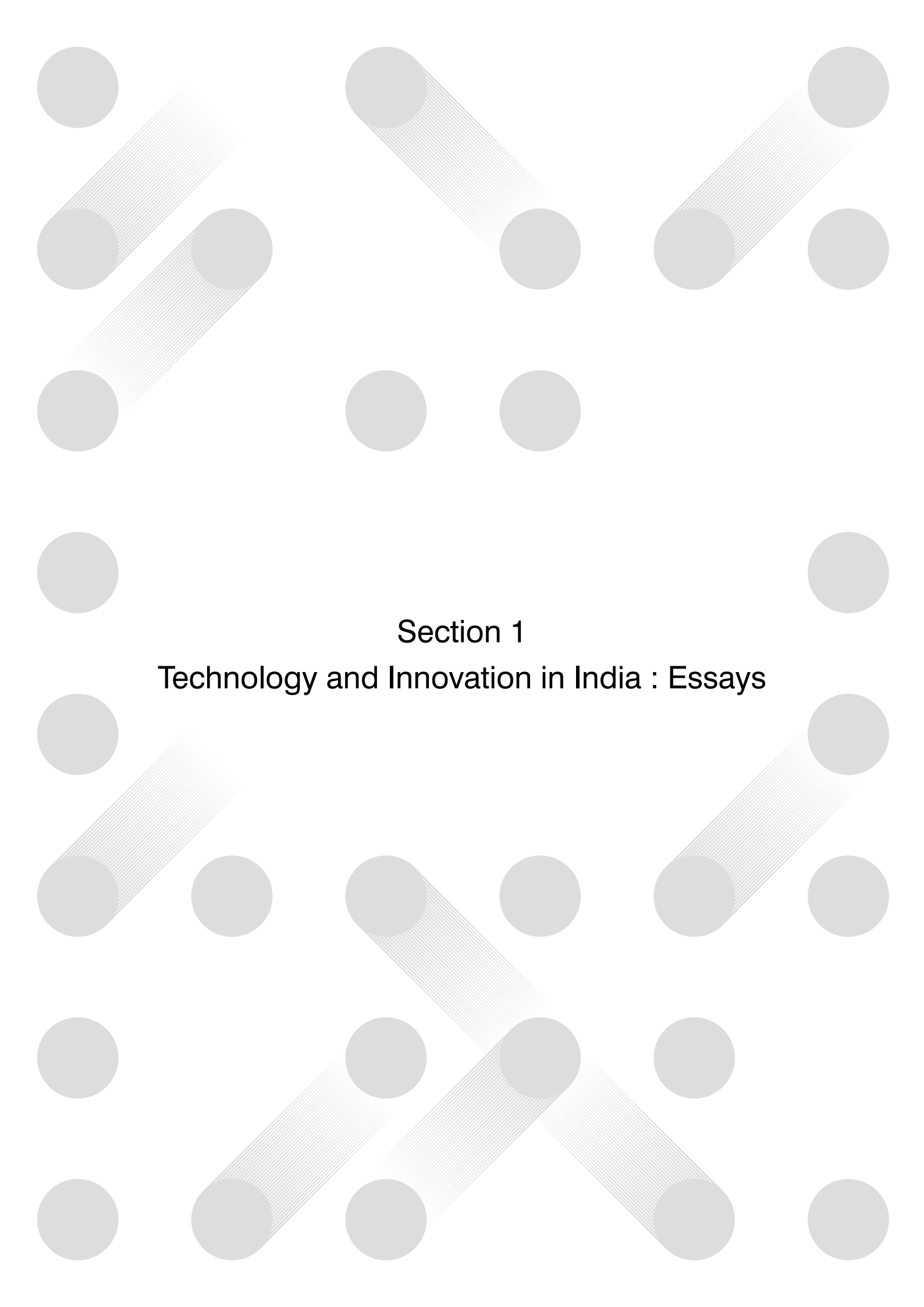
The data in Chapters 6, 7 and 8 have been presented in the form of charts, tables and maps, along with accompanying text on facts observed in the data. The Handbook contains certain indicators that have been developed by CTIER – such as the top 100 industrial R&D spenders in India, the top R&D sectors in India, the number of higher technology R&D centres in different states, number of Indian and global patents by industrial sector based on patents obtained by India's top 100 R&D spenders. This edition also sees new indicators that capture data on outward mobility of tertiary students, publication retractions by select economies, critical and emerging technologies policies introduced by Indian states, and exports as a share of sales for select Indian firms. For the indicators that have been developed by CTIER, the accompanying text contains a brief description of the methodology used to construct the indicator.

Changes from CTIER Handbook 2023

The table below captures the changes that have been introduced in the CTIER Handbook: Technology and Innovation in India 2025.

Table 2 | Changes Introduced in Current Handbook

Indicator Number	Indicator Name	Nature of Change
6.10	Country-wise Outward Mobility of Tertiary Students	This is a newly introduced indicator on outward mobility of tertiary students. This indicator captures the data for individuals that have moved to a country other than their own for tertiary education.
6.11	Persons Employed (full-time equivalent) as Researchers by R&D Establishments in India	This indicator was reported in the 2019 and 2021 handbooks. It was later moved to the appendix in the 2023 edition. The said indicator was then replaced by the indicator 'Persons Employed as Researchers at Select R&D Institutions in India' from the study 'Evaluation of Innovation Excellence Indicators; Report on Public Funded R&D Organizations' undertaken by the Office of the Principal Scientific Adviser to the Government of India, CII, and CTIER. It has now been reintroduced in the current handbook, which is based on the data from the Department of Science and Technology.
6.14	Country-wise Comparison of Publication Retractions (2019 - 2023)	This is a newly introduced indicator to capture publication retractions across select economies.
7.1.1	Critical and Emerging Technologies Policies Introduced by States	In this edition we have introduced this indicator to separately showcase the different policies brought out by states to support critical and emerging technologies.
8.12	Exports as a Share of Sales for Select Indian Firms	This is a newly introduced indicator that captures exports as a share of sales for top Indian R&D spenders in the top 10 industrial R&D sectors in India.
A.10	Critical and Emerging Technologies Policies Introduced by Union Territories	In this edition we also capture critical and emerging technologies policies for the National Capital Territory of Delhi and details for other union territories.

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Section 1

Technology and Innovation in India : Essays

The United States for several decades post-World War II was unequivocally considered the global leader in science, technology and innovation. Backed by well implemented science and technology policies and a strong university research ecosystem, the resulting output in terms of talent and private sector led technologies has been evident for the world to see. While the US continues to dominate in a number of technology sectors, China's quest for technology dominance and her remarkable rise has posed a serious challenge in recent years to the US' leadership position. The announcements in February 2025, regarding planned federal research funding cuts in the US to organisations like the National Institutes of Health (NIH) and the National Science Foundation (NSF), could hasten China's rise to the top.

India in the next few years is projected to be the third largest economy globally. On the innovation front though, India still has some way to go. This essay provides a comparison between India, the US and China on key innovation indicators. It seeks to identify opportunities that India should focus on in this global technology race and lessons more broadly from a policy implementation standpoint that will help India strengthen her own innovation system.

Importance of Policies and Why Getting Them Right Matters: Lessons from the US and China

In the US, although the establishment of the NIH and the expansion of the institutes took place through the 1930s, it is the report by Vannevar Bush, 'Science: The Endless Frontier' in the 1940s that laid the blueprint for the role of science and technology in the US economy post-World War II. The contribution of the funding from agencies like the NIH, the NSF, the National Aeronautics and Space Administration (NASA) and the Defense Advanced Research Projects Agency (DARPA) towards furthering basic research at universities and towards development of civilian and defence technologies in industry have been well documented. Several of these initiatives propelled the US to the leadership position in global science and technology.

Other initiatives, captured in Table 1, like the Bayh-Dole Act and the Small Business Innovation Research (SBIR) programme helped consolidate the US leadership position. Starting in 2011, there has been an increased focus on critical and emerging technologies through specific policies. Several of the new initiatives appear to be geared towards trying to maintain technological leadership and counter China's technological ascent.

There are three key science and technology policy lessons out of the US that have served its innovation ecosystem well thus far. First, the role of government agencies primarily being funders. A large share of the research funding from these agencies has been performed in academia and industry. Second, the separation of federally funded basic research which was performed largely at universities and federally funded applied research and technology development that was performed largely by industry. In other words, the importance of who funds what research (scientific as well as technological research) and where it is best performed, has been well understood in the US. Third, the introduction of newer initiatives to address bottlenecks in the ecosystem. For example, situating basic research within universities helped build the talent pool and provided industry with skilled manpower, while initiatives like the Bayh Dole Act smoothed out the path for lab research to be commercialised and scaled through the creation of new ventures or technology licensing.

Table 1 | Select Policies and Key Highlights from the US

Policies	Key Highlights
Bayh-Dole Act, 1980	Allowed federally funded institutions and individuals to retain and license IP
Small Business Innovation Research (SBIR), 1982	This programme allowed small businesses to participate in US government missions through R&D related activities, also helped consolidate the US's leadership position
National Robotics Initiative (NRI), 2011	A programme to develop the next generation of robots, advancing their capabilities and usability and supporting the full life cycle from fundamental research to manufacturing and deployment
National Strategic Computing Initiative (NSCI), 2015	The objective is to advance high-performance computing by accelerating exascale systems, developing new computing architectures and enhancing data analytics, simulation and modeling capabilities
American AI Initiative, 2019	Focused on accelerating AI R&D, expanding access to federal data and computing resources, lowering barriers to innovation, building an AI-ready workforce, promoting international engagement and implementing trustworthy AI in government services
CHIPS and Science Act, 2022	Aims to revitalise the US semiconductor manufacturing, advance R&D in critical technologies, strengthen national security and economic competitiveness and drive innovation through regional tech hubs
AI Action Plan, 2025	Focused on strengthening the US leadership in AI as well as building the necessary infrastructure for data centres and semiconductor manufacturing facilities

Source: Bayh-Dole Act of 1980, available at <https://www.govinfo.gov/content/pkg/USCODE-2011-title35/html/USCODE-2011-title35-partII-chap18.htm>; Small Business Innovation Research Program 1982, available at <https://www.dhs.gov/science-and-technology/sbir>; National Robotics Initiative 2011, available at <https://nsf.gov-resources.nsf.gov/solicitations/pubs/2011/nsf11553/nsf11553.pdf?VersionId=jF4xyEnwpiRkEnEnl5TOxqomlBkWk5l>; National Strategic Computing Initiative 2015, <https://obamawhitehouse.archives.gov/sites/whitehouse.gov/files/images/NSCI%20Strategic%20Plan.pdf>; American Artificial Intelligence Initiative 2019, available at <https://www.nitrd.gov/nitrdgroups/images/c/c1/American-AI-Initiative-One-Year-Annual-Report.pdf>; CHIPS and Science Act 2022, available at <https://www.congress.gov/bill/117th-congress/house-bill/4346>; America's AI Action Plan 2025, available at <https://www.whitehouse.gov/wp-content/uploads/2025/07/Americas-AI-Action-Plan.pdf>

China's emphasis on science and technology as a driver of the country's long term economic agenda is evident starting from the 1980s. Successive policies, plans and announcements seen in Table 2 focused on high technology sectors, transforming China's public funded research institutions, improving collaborations between research institutes and enterprises, strengthening China's indigenous innovation capabilities and working on frontier technologies (Nabar et al., 2023).

The lessons from China's science and technology policies include prioritising technology areas of interest and setting R&D investment targets. Another important takeaway is the reform in the mid 1980s that concerned China's public funded research institutes. It set in motion the restructuring of these research institutes and how government funding was to be allocated. More recently, public funded institutes and academic institutions have been brought closer through the University of the Chinese Academy of Sciences.

Table 2 | Select Policies and Key Highlights from China

Policies	Key Highlights
National Program for Key Science & Technology Projects, 1982	Remains an important part of China's five year plans. Focused on development of high technology sectors, strengthening China's S&T capabilities and overall economic development
1985 Decision on the Reform of the Science and Technology Management System	The Decision was a watershed moment in transforming China's government funded research institutes Laid the ground for programmes that targeted breakthroughs in a number of high technology areas Set in motion the restructuring of these institutes and how government funding would be allocated Core funding was reduced depending on whether the institutes focused on 'public goods' or industrial technologies One of the aims was to push institutes to obtain funds through competitive grants and from industry
National High Technology Research and Development, 1986	Also known as 863 programme Pushed for breakthroughs in biotechnology, space technology, information technology, lasers, automation, energy and advanced materials
Torch Programme, 1988	Focused on the creation of high and emerging technology industry zones
Decision on Accelerating Scientific and Technological Progress, 1995	Stressed the importance of catching up with advanced economies in a number of areas such as electronic communications, biology, new materials, aeronautics etc
National Medium and Long Term Program (MLP) for Science and Technology (2006-2020)	Announced in 2006, increasingly focused towards indigenous innovation Set target for China's R&D as a percent of GDP to reach 2.5 percent by 2020 and for China to be among the top 5 nations in terms of patents granted to her residents.
Made in China 2025	Introduced in 2015 Policy sets clear intent to reduce dependency on technology imports and increase the domestic focus on developing advanced information technology, new energy vehicles, medical devices etc
14th Five Year Plan, 2021	Most recent five year plan for National Economic and Social Development (2021-2025) and Long-Range Objectives for 2035 Emphasised strengthening China's S&T capabilities in artificial intelligence, quantum information, innovative drugs etc¹

Source: National Program for Key Science & Technology Projects 1982 and The Torch Program 1988, available at https://lt.china-office.gov.cn/eng/kxjs/kxjsfz/200405/t20040530_2911360.htm; 1985 Decision on the Reform of the Science and Technology Management System, available at https://archive.unu.edu/hq/library/Collection/PDF_files/INTECH/INTECHwp17; National High Technology Research and Development 1986, available at <https://en.most.gov.cn/programmes1/>; Decision on Accelerating Scientific and Technological Progress 1995, available at <https://nuke.fas.org/guide/china/doctrine/stddec2.htm>; National Medium and Long Term Program (MLP) for Science and Technology (2006-2020), available at <https://www.nature.com/articles/s41599-021-00895-7#citeas>; Made in China 2025, available at <https://www.isdp.eu/wp-content/uploads/2018/06/Made-in-China-Backgrounder.pdf>; 14th Five Year Plan 2021, available at <https://cset.georgetown.edu/publication/china-14th-five-year-plan/>

¹ For more details on China's S&T policy initiatives, refer to Singhania & Nabar (2023), "Public R&D in India: Pathways to Increasing its Effectiveness" and Nabar et al (2023), "S&T as a Driver of China's Economic Agenda, published in CTIER Handbook 2023.

Implementation of these policies and pursuing these targets have yielded significant results for China over the past few decades. For example, the National Medium and Long Term Program (MLP) for Science and Technology (2006-2020) announced in 2006 set out very clear targets for China's R&D as a percent of GDP to reach 2.5 percent by 2020 as well as for China to be among the top 5 nations in terms of patents granted to her residents. China has now managed to achieve these targets. Furthermore as we shall see in Figure 4, Chinese firms have a presence in several of the top global high technology R&D sectors that had been identified as key sectors in earlier policies. The past decade and a half has also seen other initiatives such as the Belt and Road Initiative (BRI) announced in 2013 and Made in China 2025 announced in 2015, that reflect her resolve to strengthen indigenous innovation and expand her market through the BRI initiative by building economic and cultural ties with other economies.

Mindset Shift and Bold Reforms Needed for Science, Technology and Innovation in India

India needs bold reforms when it comes to her science, technology and innovation policy. This would need to be along the lines of the New Industrial Policy of 1991 that kickstarted the liberalisation of the Indian economy. While there was a shift in the mindset of policymakers with respect to industry starting in the late 1970s and early 1980s, the science and technology policy discourse has largely remained the same over the past 8 decades. The approach adopted in the science and technology policies seems to have been a linear model of innovation i.e. expectations that government research would result in technologies that would address socio-economic issues and which could be transferred to industry. A transformation in science and technology policy thinking would mean a change in the understanding of the role of public funded science and technology research and where is it best performed (whether in academia or industry).

The transformation in industrial policy began in the late 1970s and early 1980s with the introduction of more market oriented announcements and reforms, which ultimately led to the landmark 1991 reforms. Until the late 1970s, self-reliance had been a key theme and the policies after India gained independence had focused on the development of heavy industries and the accumulation of capital. Public sector enterprises had played a dominant role and while the private sector too was encouraged, the activities of the private sector were meant to largely support national priorities and plans laid out by the government.

Self reliance and meeting the needs of the population have been consistent themes across the science and technology policy resolutions starting with the Science Policy Resolution in 1958. Table 3 captures some of the key highlights across the various policy resolutions and announcements.

Table 3 | Policies and Key Highlights from India

Policies	Key Highlights
Scientific Policy Resolution (SPR), 1958	Emphasised the importance of skills and training that would be needed for science, education, agriculture, industry and defence
Technology Policy Statement, 1983	Focused on self-reliance and building indigenous technologies (the import of technologies was however permitted selectively provided a need had been justified and the technology could not be developed domestically) The technology areas of focus included food, health, housing and energy including non-conventional sources of energy Biotechnology, electronics and materials science were also identified as emerging and frontier areas that would be given attention Industrial R&D finds a mention. Talks about incentivising industry to set up R&D units
Science and Technology Policy, 2003	Technology areas of interest remained largely the same as those mentioned above in the 1983 Technology Policy Statement Explicitly mentions the need for fiscal measures to support industry to undertake R&D Focus on public private partnerships in areas like agriculture, healthcare, education, water etc Talks about establishing an IPR regime to incentivise IP generation and protection Ambitious target of investment in science and technology reaching 2 percent of GDP (to include spending by government and industry) by 2007
Science, Technology and Innovation Policy, 2013	Emphasis on enhancing private sector R&D Calls for establishing large R&D facilities through public private partnerships Focus on areas like agriculture, healthcare, water, telecommunications and environment
Draft 5th National Science, Technology and Innovation Policy, 2020	Talks about accelerating research (including multidisciplinary research) and innovation in higher education institutions Promoting open science and enable access to all outputs and data from public-funded research Emphasis on sustainable technologies, strategic technologies and mega science Technological self-reliance and for India to be among top three scientific superpowers in next decade Strengthening water, agriculture, food and nutrition security. Build a clean and equitable energy system Sets a target for the number of full time equivalent researchers and contribution of the private sector to national R&D to double every 5 years

Source: Scientific Policy Resolution, 1958, available at <https://indiabioscience.org/media/articles/SPR-1958.pdf>; Thematic Policy Statement 1983. The Science Policy Forum, available at <https://thesciencepolicyforum.org/wp-content/uploads/2020/05/TPS-1983.pdf>; Science and Technology Policy 2003. Ministry of Science & Technology, available at <https://indiabioscience.org/media/articles/STP-2003.pdf>; Science, Technology & Innovation Policy 2013 (English). Department of Science & Technology, available at <https://dst.gov.in/sites/default/files/STI%2520Policy%25202013-English.pdf>; Draft 5th National Science, Technology and Innovation Policy (STIP) for public consultation. Department of Science & Technology, available at <https://dst.gov.in/draft-5th-national-science-technology-and-innovation-policy-public-consultation>

Drawing some lessons from the US and China, a few things stand out with respect to India's science and technology policies. Firstly, for a growing and developing nation, there have been just four main science and technology policy resolutions, while the fifth remains a draft policy. Secondly, the performance of publicly funded science and technology research has largely been undertaken by autonomous laboratories belonging to key scientific ministries (see Indicator 6.3). Thirdly, there is a mention of the need for incentives and fiscal measures to support industrial R&D, but not direct funding of technology development in industry. Fourthly, there were targets set that are yet to be met. An ambitious target for investment in science and technology to reach 2 percent of GDP (that was to include spending by government and industry) by 2007 was first mentioned in the 2003 policy, while the 2020 Draft policy has outlined targets for the number of full time equivalent researchers in India and private sector's contribution to national R&D.

Over the years, India has indeed enjoyed scientific and technological success in certain domains like the space programme, the green revolution that benefited Indian agriculture in the 1960s or the achievements in industrial sectors like pharmaceuticals & biotechnology, software & computer services and automobiles & parts. In the past decade, the need for sustained innovation has increasingly gained attention. As can be seen in Table 4, the measures announced since 2015 have focused on boosting entrepreneurship and strengthening the innovation ecosystem. The table also captures some sector specific innovation policies and missions that have been announced to address frontier and emerging technologies. The establishment of the Anusandhan National Research Foundation (ANRF) and the USD 12 billion Research Development and Innovation fund to support R&D projects in Indian industry and startups hold immense potential.

For India to truly catch-up and surpass some of the more innovative global economies however, there is a need for structural changes in the national innovation system. This includes who leads the performance of national R&D in India (i.e. a need for Indian industry to take the lead), as well as a transformation in the way public research is funded and undertaken.

Table 4 | Need for Sustained Innovation Gaining Attention: Recent Policies Introduced

Policies	Key Highlights
Startup India policy, 2016	Focussed on nurturing innovation and startups to drive sustainable economic growth and generate large scale employment
Atal Innovation Mission (AIM), 2016	Focussed on promoting a culture of innovation and entrepreneurship across the country Targeted programmes such as Atal Tinkering Labs, Atal Incubation Centres and Atal Community Innovation Centres addressing various stakeholders by building an innovation mindset in schools, enabling incubation centres to build sustainable business enterprises and supporting grassroots innovators Incentivising innovations in areas like education, health, water, sanitation, mobility etc. through the Atal New India Challenge
National Intellectual Property Rights (IPR) policy, 2016	Framework to encompass all IPRs (patents, trade marks, copyrights etc) in a single document and establish a mechanism to implement, monitor and review IP laws Create awareness of the socio-economic benefits of intellectual property rights (IPR) Support for startups and MSMEs through reduction in fees and expediting examination of IPRs Improving IP commercialisation through Technology Innovation Support Centres

Policies	Key Highlights
India Semiconductor Mission, 2021	Intended to develop sustainable semiconductors and display ecosystem Focussed on integrated circuit design and manufacturing, semiconductor packaging and assembly, testing and validation of semiconductor devices, advanced materials and process technologies, design automation and tool development, skill development and human resource capacity building Financial support through design linked incentive scheme and product deployment linked incentive scheme
National Quantum Mission, 2023	Develop intermediate scale quantum computers with 50 - 1000 physical qubits in 8 years Satellite based secure quantum communications between ground stations over a range of 2000 kilometres within India, long distance secure quantum communications with other countries Four Thematic Hubs (T-Hubs) to be set up in top academic and national R&D institutes for quantum computing, quantum communication, quantum sensing & metrology and quantum materials & devices Areas of focus include health, finance, energy, drug design and space applications
National Policy on Research and Development and Innovation in Pharma-MedTech Sector in India and Scheme for promotion of Research and Innovation in Pharma MedTech Sector (PRIP), 2023	Emphasises on promotion and co-ordination of basic, applied and related research in the pharmaceutical sector Aims to support research in six key areas: new chemical entities, complex generics (including biosimilars), medical devices, stem cell therapy, orphan drugs and antimicrobial resistance
Anusandhan National Research Foundation (ANRF) Act, 2023	To encourage investments from the private and public sector and enhance their research collaborations Focus areas include natural sciences, mathematical sciences, engineering and technology, environmental and earth sciences, health and agriculture and scientific and technological interfaces of humanities and social sciences
IndiaAI Mission, 2024	Aims to catalyse AI innovation Strategic programs and partnerships with IndiaAI Compute Capacity for compute infrastructure of 10,000 or more Graphics Processing Units (GPUs); IndiaAI Innovation Centre for development and deployment of indigenous Large Multimodal Models; IndiaAI Datasets Platform for access to quality non-personal datasets; IndiaAI Application Development for applications in critical sectors; IndiaAI FutureSkills; and IndiaAI Startup Financing
Research, Development and Innovation (RDI) Scheme, 2025	To spur a private sector driven R&D ecosystem, the announcement of the USD 12 billion RDI Fund will support R&D projects in Indian industry and startups through a fund of fund mechanism

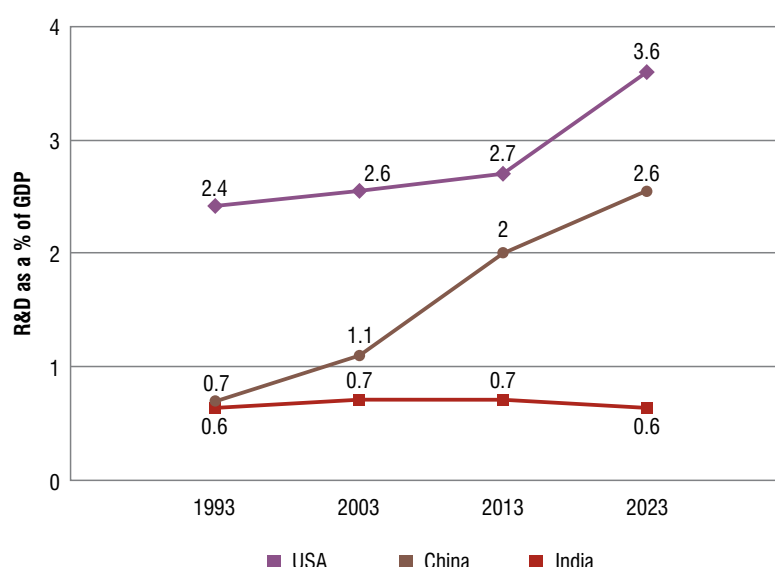
Source: Startup India 2016 available at <https://www.pib.gov.in/PressReleasePage.aspx?PRID=1703787>; Atal Innovation Mission 2016, available at <https://www.niti.gov.in/sites/default/files/2024-04/Manual%20%20%281%29.pdf>; National Intellectual Property Rights (IPR) Policy 2016, available at <https://pib.gov.in/PressReleasePage.aspx?PRID=1941489>; National Quantum Mission 2023, <https://www.pib.gov.in/PressReleasePage.aspx?PRID=1917888>; National Policy on Research and Development and Innovation in Pharma-MedTech Sector and Scheme for promotion of Research and Innovation in Pharma MedTech Sector (PRIP) 2013, available at <https://pib.gov.in/PressReleasePage.aspx?PRID=196081>; National Research Foundation Act 2023, available at <https://anrfonline.in/ANRF/About?HomePage=New>; IndiaAI Mission 2024, available at <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2012357>; Research, Development and Innovation (RDI) Scheme 2025, available at <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2150818>

In the sections that follow, we highlight the gaps that currently exist between India and the two science and technology leaders, the US and China. The data shows that the building blocks for India to fully realise her science and technology ambitions exist. While India must chart her own path to becoming a science and technology leader, a closer look at the data may provide the necessary guidance to achieving those ambitions.

Industrial R&D Driving Increases in National R&D Spending in US and China

The spending on R&D as a percent of GDP has seen increases in both the US and China over the past three and a half decades. More so in China where the increase over this period has been rather sharp, spurred by the target set in her National MLP (2006-2020) policy. The US too has seen a sudden increase in R&D spending as a percent of GDP from its levels in 2013, possibly to counter China's quest for global technology dominance. While China's R&D spending as a percent of GDP was 2.6 percent in 2023, R&D spending by the US as a percent of GDP was 3.6 percent in 2023. India's R&D spending as a percent of GDP on the other hand has remained in a range between 0.6 percent and 0.9 percent over the past three and a half decades. As the data shows, in 1993, India and China had the same spend on R&D as a percent of GDP.

Figure 1 | R&D Expenditure as a Percent of Gross Domestic Product

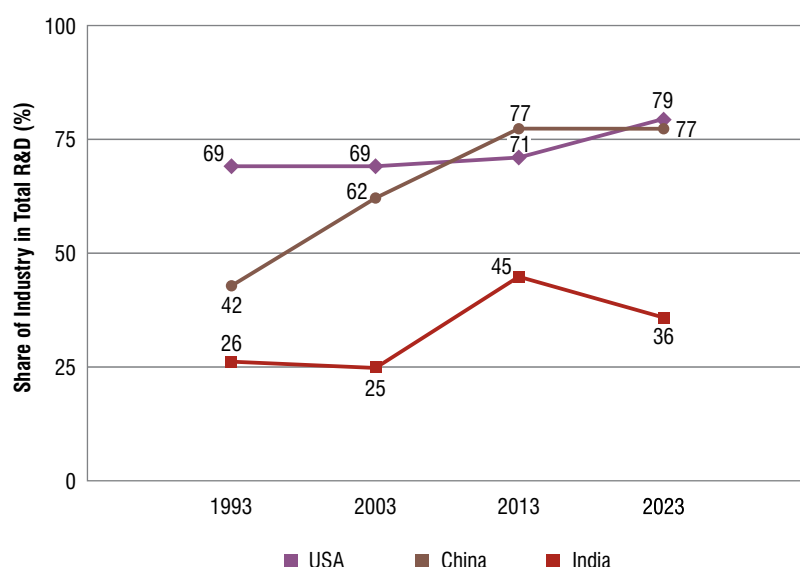


Source: OECD, Science, Technology and Innovation Scoreboard available at <https://www.oecd.org/en/data/datasets/science-technology-and-innovation-scoreboard.html> for data on US and China for 1993 - 2023; Department of Science and Technology (DST), S&T Indicators Tables 2022-23, available at <https://dst.gov.in/sites/default/files/Updated%20ST%20INDICATORS%20TABLES%202022-23.pdf>; for data on India for 1993 - 2013; Notes on Demand for Grants (various Ministries), Union Budget 2024-2025, available at <https://www.indiabudget.gov.in/>; Forty Third Report, Standing Committee on Defence, available at https://eparlib.nic.in/bitstream/123456789/2963533/1/17_Defence_43.pdf; Detailed Demand for Grants of Ministry of Agriculture & Farmers Welfare for 2024-2025, available at https://agriwelfare.gov.in/sites/default/files/DDG_2024_25.pdf; Detailed Demand for Grants of Department of Atomic Energy for 2023-2024, available at <https://cdnbbsr.s3waas.gov.in/s35b8e4fd39d9786228649a8a8bec4e008/uploads/2023/05/2023051932.pdf>; Detailed Demand for Grants of Ministry of Science and Technology for 2024-2025, available at <https://dst.gov.in/sites/default/files/MST%20DDG%202024-2025.pdf>; State Budget Accounts (2024-2025) (for all Indian States); Annual Reports (2022-23) of Indian companies; Prowess, data downloaded on 28 May 2024 from the platform; Centre for Technology, Innovation and Economic Research (CTIER)

Note: (i) 1993 data reported for India is for 1995-96
(ii) 2023 data reported for India is for 2022-23 is based on CTIER calculations
(iii) 2023 figures for India calculated using Gross Domestic Product (GDP) figures for 2022-23 as per the Economic Survey 2023-24

As a share of national R&D spending, R&D spending by industry dominates in the case of both the US and China. For China, this was not the case in 1993, when the share of industrial R&D in national R&D spending was 42 percent. As we have highlighted above, both the 1985 Decision on the Reform of Science and Technology Management System that kickstarted the process of transforming China's public funded research ecosystem and the Decision on Accelerating Scientific and Technological Progress announced in 1995 that emphasised catching up with advanced economies in several R&D intensive sectors, provided the necessary fillip for industry to take the lead when it came to R&D spending. In China, while in the initial years several of the top R&D spenders may have been state owned enterprises, over time a significant number of private enterprises too have become top technology leaders across several sectors. India is an outlier as government spending continues to dominate the share in national R&D spending. The share of industrial R&D spending in India accounted for 36 percent of national R&D spending in 2023.

Figure 2 | Share of Industry in Total R&D Expenditure (%)



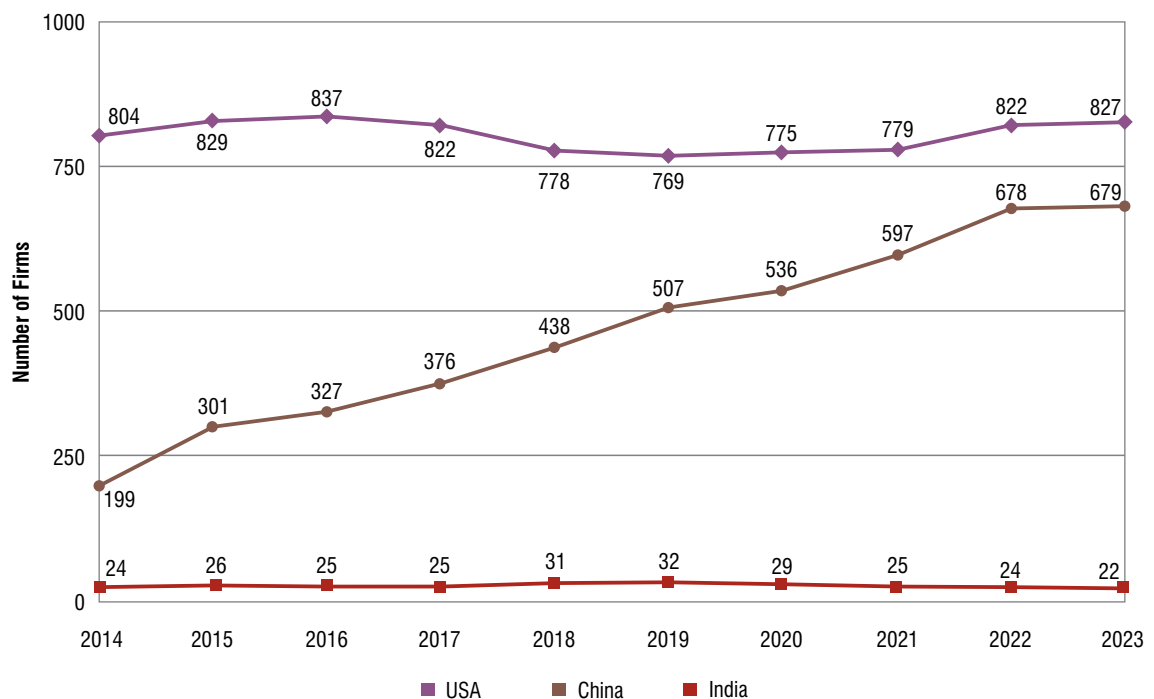
Source: OECD Main Science and Technology Indicators, available at <https://www.oecd.org/en/data/datasets/main-science-and-technology-indicators.html> for data on US and China; Department of Science and Technology (DST), Research and Development Statistics 1992-93, available at http://digitalrepository-nstmis-dst.org/files/stats/1992-93/Full_Text_1992-93.pdf; Research and Development Statistics at a Glance 2017-18 for 2003, available at <https://www.nstmis-dst.org/Pdfs/Statistics-Glance-2017-18.pdf>; Research and Development Statistics at a Glance 2022-23 for 2013, available at <https://dst.gov.in/sites/default/files/Updated%20RD%20Statistics%20at%20a%20Glance%202022-23.pdf>; S&T Indicators Tables, Research and Development Statistics 2022-23, Department of Science and Technology, available at <https://dst.gov.in/sites/default/files/Updated%20ST%20INDICATORS%20TABLES%202022-23.pdf>; CTIER Handbook: Technology and Innovation in India 2021; Notes on Demand for Grants (various Ministries), Union Budget 2024-2025, available at <https://www.indiabudget.gov.in/>; Forty Third Report, Standing Committee on Defence, available at https://eparlib.nic.in/bitstream/123456789/2963533/1/17_Defence_43.pdf; Detailed Demand for Grants of Ministry of Agriculture & Farmers Welfare for 2024-2025, available at https://agriwelfare.gov.in/sites/default/files/DDG_2024_25.pdf; Detailed Demand for Grants of Department of Atomic Energy for 2023-2024, available at <https://cdnbbsr.s3waas.gov.in/s35b8e4fd39d9786228649a8a8bec4e008/uploads/2023/05/2023051932.pdf>; Detailed Demand for Grants of Ministry of Science and Technology for 2024-2025, available at <https://dst.gov.in/sites/default/files/MST%20DDG%202024-2025.pdf>; State Budget Accounts (2024-2025) (for all Indian States); Annual Reports (2022-23) of Indian companies; Prowess, data downloaded on 28 May 2024 from the platform; Centre for Technology, Innovation and Economic Research (CTIER)

US and Chinese Firms Present in Each of the Top 10 Global R&D Sectors

There are currently 827 US firms in the top 2,500 global R&D spenders list. The number of Chinese firms in this list is 679. There has been a strong increase in the number of Chinese firms in this list from 2014 onwards when there were just 199 firms among the top 2,500 global R&D spenders. This remarkable increase is a reflection of the increased spending on R&D by industry in China. The share of industrial R&D in national R&D spending in China has consistently been around 77 percent since 2013. With respect to Indian firms, the total number of Indian firms has never been above 32 in the top global R&D spenders list and was 22 in 2023.

The top 10 global R&D sectors by spending has been captured in Figure 4. There are US and Chinese firms present in each of the top 10 global R&D sectors. While the software & computer services and pharmaceuticals & biotechnology sectors have a significantly higher number of US firms compared to those from China, we see a significantly higher number of Chinese firms in the electronic & electrical equipment, automobiles & parts, industrial engineering, construction & materials, chemicals and general industrials. Despite the higher number of Chinese firms in some of these sectors, the total industrial R&D spending by Chinese firms in sectors such as automobiles & parts, chemicals and general industrials is lower than the total spending by US firms in these respective sectors. Indian firms on the other hand are absent from 6 of the top 10 global R&D sectors. On the global stage, Indian firms are largely present in the pharmaceuticals & biotechnology, automobiles & parts and software & computer services sectors.

Figure 3 | Number of Firms in Top 2500 Global R&D Spendings



Source: EU Industrial R&D Investment Scoreboard (various years); Centre for Technology, Innovation and Economic Research (CTIER)

Table 5 | Sector-wise Number of Firms from the US, China and India in the Top 10 Global Sectors (2023)

Sector	USA	China	India
Software & Computer Services	186	71	2
Pharmaceuticals & Biotechnology	268	83	10
Technology Hardware & Equipment	71	57	0
Automobiles & Parts	37	48	4
Electronic & Electrical Equipment	46	104	0
Construction & Materials	4	36	0
Health Care Equipment & Services	51	16	0
Chemicals	20	34	1
General Industrials	13	16	0
Industrial Engineering	19	44	0

Source: EU Industrial R&D Investment Scoreboard (2023); Centre for Technology, Innovation and Economic Research (CTIER)

Structure of Industrial R&D Spending Differs Across the US, China and India

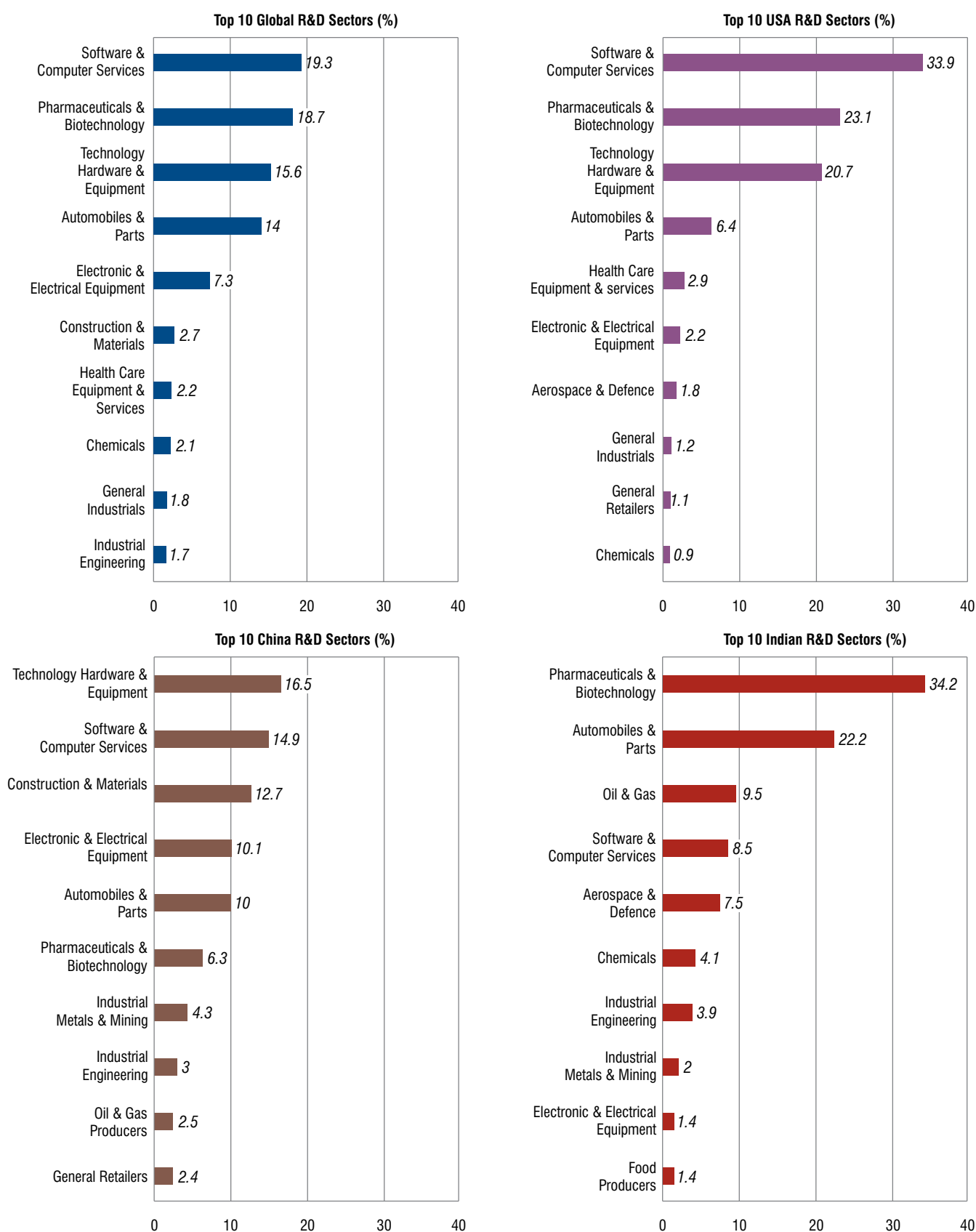
The structure of industrial R&D spending in the US and the structure of global industrial R&D have 8 sectors in common, with the top 4 sectors being exactly the same. This reflects the dominance on the global stage by US firms in sectors such as software & computer services, pharmaceuticals & biotechnology and technology hardware & equipment.

There has been a structural shift in global R&D spending. The global R&D software & computer services sector has become the top ranked global sector with total R&D spending crossing the USD 250 billion mark. It had been ranked fourth in 2015 with spending on R&D having totaled USD 86 billion. The significant jump in R&D spending in the global software & computer services sector possibly reflects the global push in AI and other related technologies (Nabar & Forbes, 2024).

China has around 7 sectors in common with the structure of global industrial R&D spending, but differs when it comes to the structure of R&D spending. The top ranked sector in China is technology hardware & equipment followed by software & computer services. For China, construction & materials and industrial metals & mining are also among the top R&D sectors. The structure of China's R&D investments suggests a concerted effort to push for high technology sectors like technology hardware & equipment and electronic & electrical equipment along with the goal of transitioning to a low carbon economy. R&D investments in sectors like industrial metals & mining and construction & materials highlight the role of science and technology in addressing environmental concerns due to mining of rare earths and the carbon emissions being caused by rapid urbanisation and infrastructure development (Nabar et al., 2023).

In India's case, pharmaceuticals & biotechnology and automobiles & parts account for over 50 percent of industrial R&D. India has 6 sectors in common with the structure of global industrial R&D spending. While aerospace & defence is one of India's top sectors, it does not appear in the list of top global R&D sectors. A sector that is a great opportunity for India and features in the global top R&D sectors list but missing from India's industrial R&D structure is health care equipment & services.

Figure 4 | Sectoral Share of R&D Spending by Firms Globally and in the US, China and India (2023)



Source: CTIER Handbook 2025; EU Industrial R&D Investment Scoreboard (2023)

Note: For global and Indian industrial R&D spending see Indicator 6.4.1. R&D spending by 827 US firms was USD 558 billion and by 679 Chinese firms was USD 235 billion

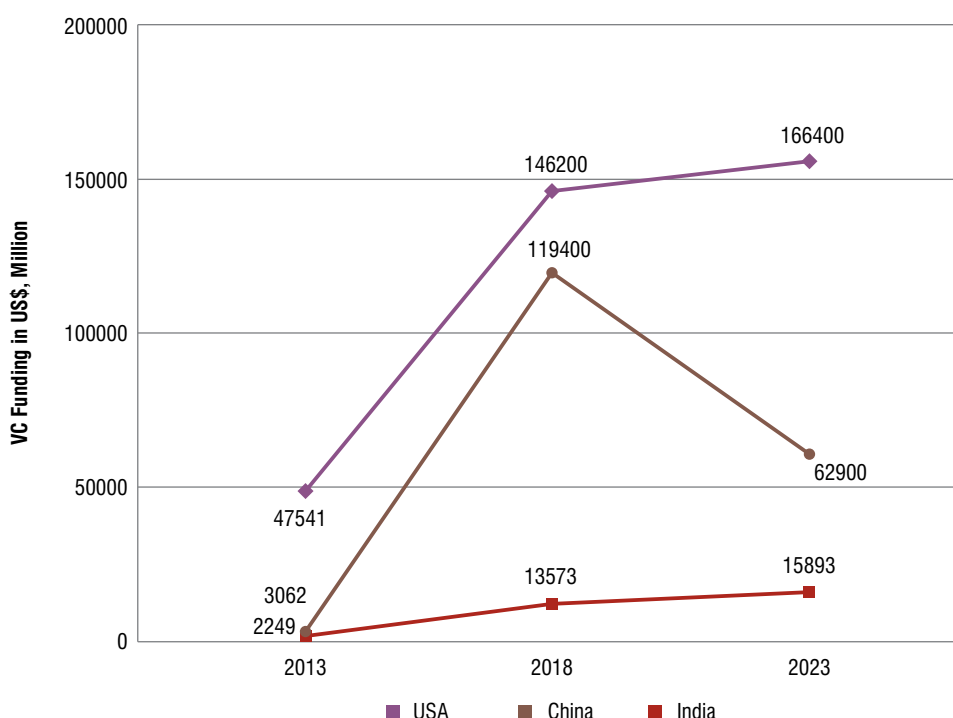
Venture Capital (VC) and the Sectors in which Unicorns are Emerging

Global VC funding has slowed since peaking in 2021. In the US, VC funding stood at USD 166 billion in 2023 while in China it was USD 63 billion. In both cases, VC funding in 2023 was significantly below levels seen in 2021. India too experienced a drop in VC funding to USD 16 billion in 2023 from USD 49 billion in 2021. India has been one of the top destinations for VC funding globally after the US and China and as of 2023 accounted for the fourth highest amount of VC funding globally.² Amid this recent slowdown in funding, it is instructive to see the sectors in which unicorns³ have emerged across these three countries.

The Hurun Global Unicorn Index⁴ for 2025 registered over 750 unicorns from the US, 340 unicorns from China and over 60 unicorns from India. The largest number of US unicorns are in sectors like software as a service (SaaS), fintech, health tech and artificial intelligence while those in China are in sectors such as semiconductors, artificial intelligence and new energy. For India, the top sectors are fintech and e-commerce. The global push in AI and allied technologies reflected in global R&D spending mentioned above, has also seen the emergence of newer ventures in these areas as captured by the Hurun Index.

In India, the deep tech sector is only just starting to gain attention and the Government of India has announced new funding opportunities to spur the development of new sectors built on deep science and deep tech.

Figure 5 | Venture Capital Investment (USD Million) in USA, China and India



Source: Data reported as 2023 and 2018 for the US and China except India is from Venture Pulse Q2 24: Global Analysis of Venture Funding, KPMG Private Enterprise; Data reported as 2013 for the US and China except India is from National Science Foundation (NSF), Science & Engineering Indicators 2020, Invention, Knowledge Transfer and Innovation - Global Venture Capital Investment, by financing stage, selected region, country or economy: 2010-18; Tracxn data for India for 2023, data downloaded on 30 September 2024; Data for India for 2013, 2018 is from the CTIER Handbook 2021

² See Indicator 6.7

³ Startups that are privately owned and valued above USD 1 billion

⁴ The index compiled by the Hurun Institute comprises companies founded from the year 2000 onwards, have a current valuation of USD 1 billion or more and have not been listed on a stock exchange

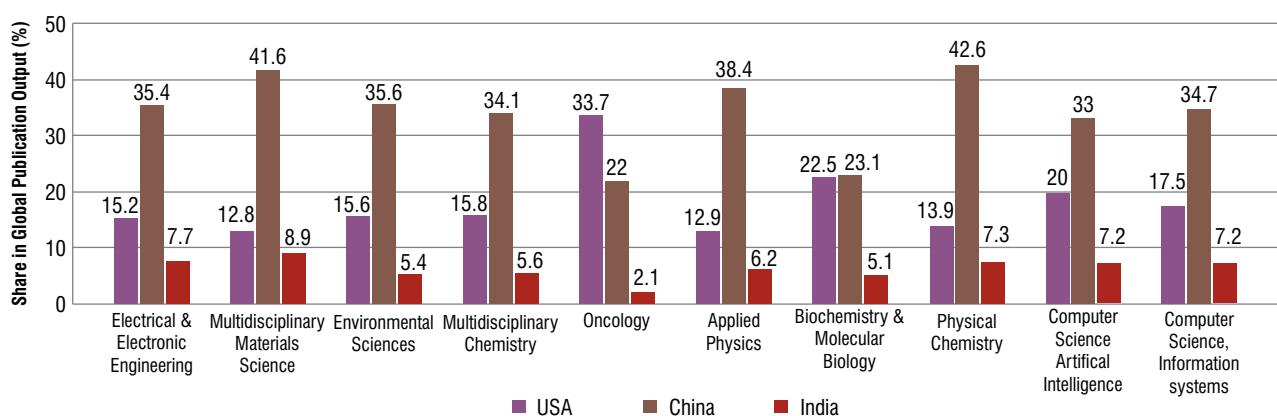
China Dominates in Areas of Top Global Publications

In the top areas of global publication output between 2019 and 2023, China dominates in terms of its share of publications in each of the areas except oncology. China's own top areas of publications have 8 in common with the areas mentioned in Figure 6. Several of the publication areas are key scientific areas relevant to emerging technologies that China is seeking global dominance in. The emphasis placed on environmental sciences is another indication of China balancing her goals of focusing on high technology sectors while transitioning to a low carbon economy and addressing its environmental concerns.

While the US too is a major contributor to global publication output in each of the areas mentioned in Figure 6, the top areas of US publication output is tilted towards areas of healthcare such as oncology, surgery, neurosciences, biochemistry & molecular biology and cardiac & cardiovascular systems. The planned federal funding cuts to organisations like the NIH will have implications for much of the research being undertaken in several of these critical areas for global health. The top US areas of publications have just 4 in common with the top 10 areas of global publication output. It is interesting to note that while the US is a major contributor to global publications in computer science, artificial intelligence, this area does not feature among the top 10 areas of publications for the US. A possible explanation for this is that private firms in the US are at the forefront of AI research as opposed to universities. This is because private firms have access to large data sets, have the ability to invest in necessary infrastructure needed for increased computational power and are also able to draw top AI researchers away from universities and into the private sector (Ahmed et al., 2023).

India has 8 areas in common with the top 10 areas of global publication output. In many of the global areas, India is among the top 5 countries in terms of publication output. India ranks third in areas like electrical & electronic engineering, physical chemistry and computer science, artificial intelligence. However, in terms of impact, the Category Normalized Citation Impact (CNCI) score as measured by Web of Science is below one, i.e. below the world average, for most of the top areas of publications except for multidisciplinary materials science and environmental sciences. The US and China have CNCI scores of one or more, i.e. above the world average, for their respective areas as well as the global top areas of publications.

Figure 6 | Comparison by Share in Global Publication Output (2019 - 2023)



Source: InCites (based on data from Web of Science), data downloaded from the platform on 6 January 2025; Centre for Technology, Innovation and Economic Research (CTIER)

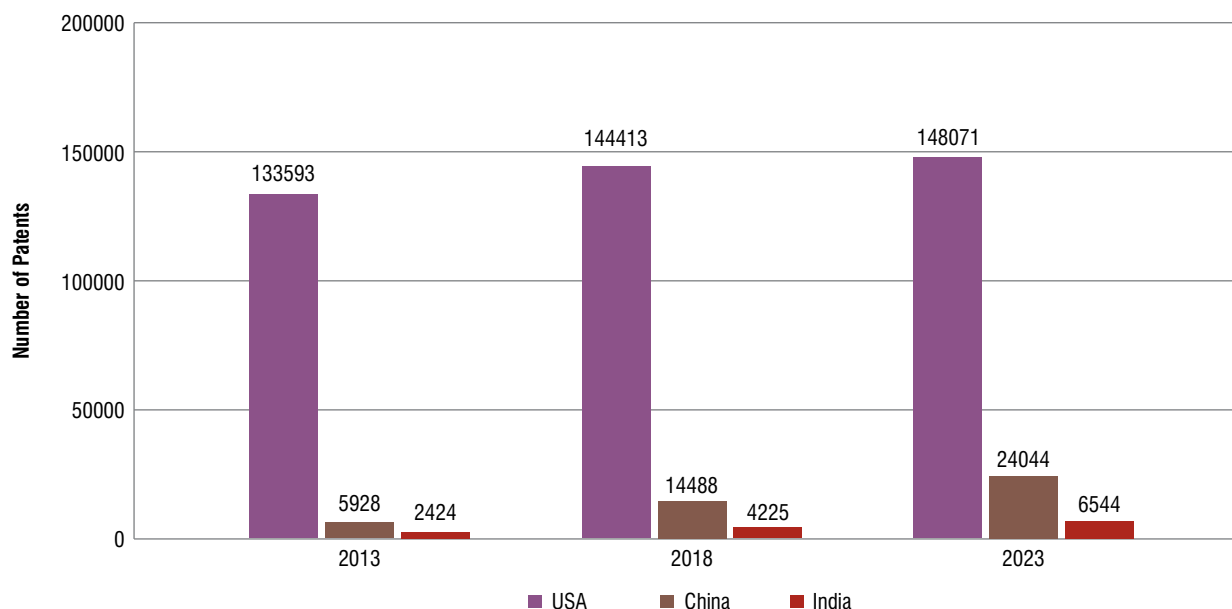
Note: Data is based on cumulative publications by each country (2019 - 2023)

Patents Granted to the US, China and India

The US had the highest number of patents granted by the USPTO as seen in Figure 8, while residents in China were granted over 800,000 patents by the China National Intellectual Property Administration (CNIPA). China saw a four fold increase in the number of patents granted by the USPTO in 2023 compared to 2013. The number of patents granted to India by the USPTO in 2023 was 6,544, having increased steadily since 2013. Of these 6,544 patents granted, multinational corporations based in India accounted for over 70 percent. Patents granted to residents in India by the Indian Patent Office (IPO)⁵ was close to 17,000 but well below the number of patents granted to non residents.

As noted in the CTIER Innovation Report, the top industrial R&D spenders in India account for a small share of the patents granted abroad and by the IPO. (Centre for Technology, Innovation and Economic Research, 2025) Given the rapid pace of technological change and the blurring of industry boundaries, Indian firms would need to increasingly focus on using patents to protect their intellectual property when competing globally as well as find opportunities to monetise their IP through licensing agreements or spinouts.

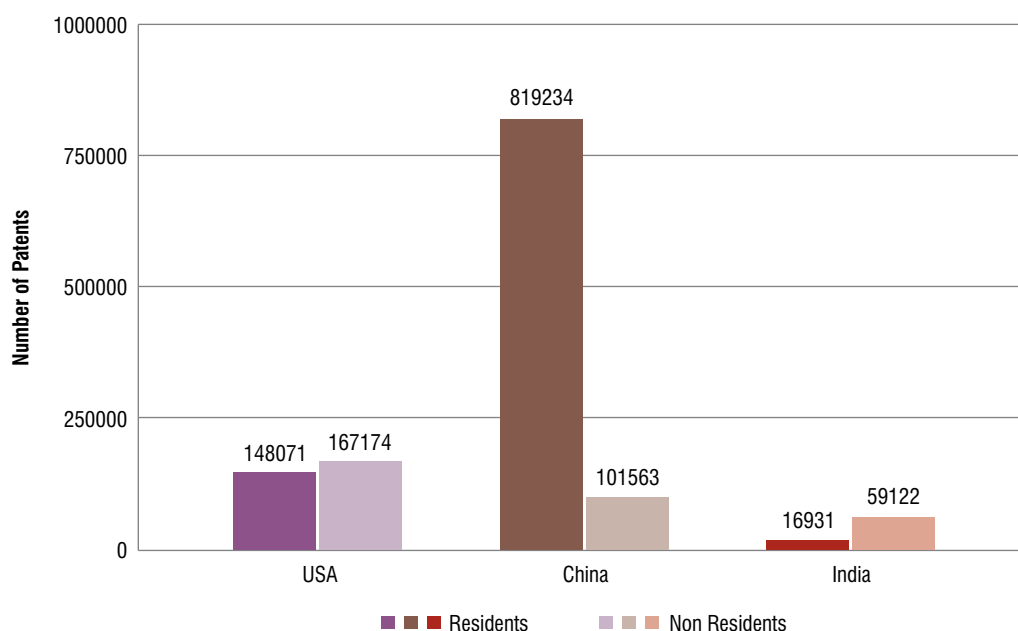
Figure 7 | Patents Granted by the United States Patent and Trademark Office (USPTO) to US, China and India



Source: World Intellectual Property Organization (WIPO) IP Statistics Data Center available at <https://www3.wipo.int/ipstats/index.htm?tab=patent>; Centre for Technology, Innovation and Economic Research (CTIER)

⁵ Office of the Controller General of Patents, Designs and Trademarks (CGPDTM)

Figure 8 | Comparison of Patents Granted by Respective Domestic Patent Offices (2023)



Source: World Intellectual Property Organization (WIPO) IP Statistics Data Center available at <https://www3.wipo.int/ipstats/ips-search/search-result?type=IPS&selectedTab=patent&indicator=23&reportType=11&fromYear=2015&toYear=2023&ipsOffSelValues=BR,CN,DE,IN,IL,JP,KR,GB,US&ipsOriSelValues=&ipsTechSelValues=901,902>

Note: (i) Resident includes domestic filings
(ii) Non-resident includes filings coming in from overseas

Priorities for India's R&D and Innovation Ambitions

For India to fully realise her R&D and innovation ambitions, building the talent pipeline for the future will be critical. Drawing lessons from the US and China, there is a compelling need to transform and prioritise public funding of R&D. This would require well equipped policymakers to firstly identify opportunities for scientific and technological research and secondly to fund it where it is likely to be best performed, i.e. basic research in academia and technology development in industry. Increasingly funding public research within universities through competitive grants, will prepare the advanced talent that is needed by Indian industry. The roll back in federal research funding announced in February 2025 to agencies like the NIH and NSF will have a long term impact on the talent pipeline in the US. The EU and other geographies like Australia and Canada have already begun the process to attract researchers and scientists affected by the funding cuts in the US (Economic Times, 2025) India too must do its utmost to attract some of this talent.

Indian industry on its part must push for greater technology deepening in pharmaceuticals & biotechnology, automobiles & parts, aerospace & defence and software & computer services, building on its existing strengths and capabilities in these sectors. It must also look to diversify and strengthen its capabilities in sectors like electronic & electrical equipment, while seeking new opportunities in health care equipment & services given the very clear domestic demand for healthcare.

Given the fundamental shift underway in the global industrial R&D landscape, the rapid advancements in AI and increasing focus on sustainability globally, India's policymakers would need to make science and technology central to its economic thinking and development agenda. Announcements like the ANRF and the RDI fund by the Government of India are a significant step in this direction. However, India needs a multi-policy approach that goes beyond these funding models and focuses on building the talent pipeline, identifies and addresses regulatory bottlenecks that is stifling innovation across sectors, considers trade policies that will support innovation, focuses on building resilient supply chains, equips the workforce with AI complementary skills and guides firms on good management practices to integrate into global value chains.

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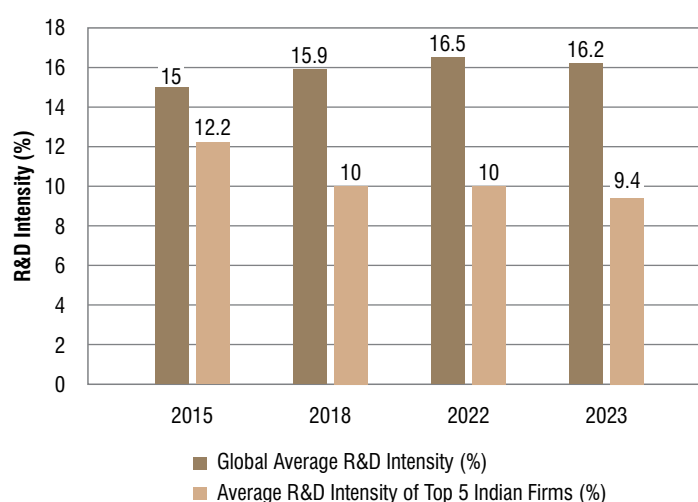
A Sense of Urgency and Bold Ambition Needed: Reimagining India's Pharmaceuticals and Biotechnology Industry¹

Chaitanya Lekharaju, Soumya Misra, Janak Nabar

The Indian pharmaceutical industry is currently valued at USD 50 billion and has set itself an ambitious target of growing to USD 450 billion by 2047 (Department of Pharmaceuticals, 2024; IBEF, 2025). It supplies 60 percent of global vaccines and 20 percent of global generic drugs (Press Information Bureau, 2023). In volume terms, it is the third largest pharma industry accounting for around 10 percent of the global market. However, in value terms it accounts for a mere 1.5 percent (RBI, 2021). Although India's contribution to global vaccines and generic drugs is impressive, a worrying trend is the drop in the average R&D intensity of India's top pharmaceuticals & biotechnology firms since 2015. The average R&D intensity for the top 5 Indian pharmaceutical firms has declined from 12.2 percent in 2015 to 9.4 percent in 2023 (see Figure 1). If the target of USD 450 billion by 2047 is to be achieved, a sense of urgency and bold ambition is needed from India's pharmaceuticals & biotechnology industry as well as from our policymakers.

Technology in this sector is changing rapidly. Over the period from 2015 to 2023, we have seen the average global R&D intensity rise from 15 percent to 16 percent (see Figure 1). Indian pharmaceuticals & biotechnology firms need to increase their investments in R&D significantly to be able to compete globally. To spur innovation, there is a need to reform the regulatory framework, bring about better coordination between agencies and put in place well informed regulators. There is a need to create greater access to biological research infrastructure. Focusing on joint industry-masters and industry-PhD programmes with substantial government research funding will help build a strong talent pipeline that is needed by industry.

Figure 1 | R&D Intensity of Top Pharmaceuticals & Biotechnology Firms (%)



Source: EU Industrial R&D Investment Scoreboard (various years); Centre for Technology, Innovation and Economic Research (CTIER)

¹ We are grateful to the participants of the CTIER Ananta series on India's R&D Ambitions: Challenges and Imperatives for Innovation in India's pharmaceuticals & biotechnology sector and CTIER-World Without GNE Myopathy (WWGM) roundtable on Innovation and Policy for Rare Diseases Drug Development in India for their insights at roundtables conducted in 2023 and 2024

Realigning the Regulatory Framework

In recent years, the pharmaceuticals & biotechnology sector has seen a shift in focus from chemistry to biology. This transition has triggered calls from industry to reform the regulatory framework by introducing biotechnology regulations alongside existing pharmaceutical regulations. With more products emerging from cutting edge technologies like cell and gene therapy, industry has been urging policymakers to ensure that regulations are in-line with international standards. Such reforms will help fast track processes and ensure global best practices within the sector.

There have been some positive developments that suggest an intent on the part of policymakers to ensure that regulations are being streamlined with international standards. The revised guidelines on similar biologics released in early May 2025 is one such example (CDSCO, 2025). The recent changes to the guidelines are in close alignment with similar regulations by the US Food and Drug Administration (FDA), European Medicines Agency (EMA) and the UK Medicines and Healthcare products Regulatory Agency (MHRA) (Niazi, 2025). China has already proven the merit of reforming its regulatory processes in-line with global standards. By streamlining its processes with the International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use (ICH) guidelines, it has ensured that domestic clinical trials conducted in China are recognised globally (Tong et al., 2024).

Given the rapid pace of technological changes impacting the industry, from the likes of gene therapy and artificial intelligence, the regulatory framework would need to become more systematic and transparent.

Better Coordination Across Various Agencies and Better Equipped Regulators Needed

There is a need for improved coordination between multiple agencies as well as regulators who are up to date with global strategies and guidelines for drug development and clinical trials. We highlight through a few examples the ambiguity and lack of clarity in some of the recent guidelines and the urgency of reform required on multiple fronts.

Continuing with the earlier example on guidelines on similar biologics, it is worth noting that these guidelines were first introduced in 2012, followed by revisions in 2016 and 2025 (Thacker & Dandekar, 2025). The 2025 guidelines remain in draft stage, with no clear timeline for finalisation. To keep pace with the evolving industry landscape, it is essential to reduce the intervals between regulatory updates and ensure ongoing review and oversight.

Another example is the draft National Guidelines for Gene Therapy Product Development and Clinical Trials, introduced in 2019 by the Ministry of Health & Family Welfare and Ministry of Science and Technology. Comments and suggestions were invited prior to 1 August 2019, but no updates have been provided since on the status of these guidelines. In 2024, the government announced that India had successfully conducted her first gene therapy trial for Haemophilia by BRIC-inStem² (Press Information Bureau, 2025). Though the New Drugs and Clinical Trials Rules (2019) introduced by Central Drugs Standard Control Organisation (CDSCO), Ministry of Health & Family Welfare, include gene therapeutic products within the definition of new drugs (CDSCO, 2019), the regulatory landscape remains fragmented. Better coordination between departments and ministries, along with greater clarity on rules governing clinical trials for gene therapy would immensely benefit the industry.

Indian regulators should closely track developments around guidelines for drug development in other countries. For instance, the US FDA in 2021 introduced guidelines

² The Institute for Stem Cell Science and Regenerative Medicine (inStem) is a research institute under the Biotechnology Research and Innovation Council (BRIC) in Bangalore. Their research scope is in stem cells and regenerative biology, with a focus on clinical translation.

for N of 1 trials (Age, 2022). The N of 1 trials is an approach, especially beneficial for rare diseases trials, wherein multiple clinical trials are conducted over a period of time on a single patient (Lillie et al., 2011). Such forward looking strategies should be explored in India for which appropriate guidelines would need to be put in place. This would enable industry to carry out trials using newer approaches especially for drug development for rare diseases.

Creating a Robust Biological Infrastructure

Focusing on the infrastructure needs of the sector will greatly benefit the research ecosystem. Much work needs to be done on biobanks in India, increasing the number of clinical sites, enabling easy access to biological infrastructure and boosting domestic production of regular research material.

Calls for the development of platforms similar to the National Center for Biotechnology Information (NCBI) in the US and the UK Biobank are yielding results. This is evident with the inauguration of the National Biobank at the Council of Scientific & Industrial Research-Institute of Genomics and Integrative Biology (CSIR-IGIB), fashioned after the UK Biobank framework (Press Information Bureau, 2025). India has 19 other biobanks belonging to various government organisations like the Department of Biotechnology (DBT), Indian Council of Medical Research (ICMR) and Council of Scientific and Industrial Research (CSIR). Better coordination between these biobanks and the recently announced National Biobank would vastly improve access to large amounts of data and samples to researchers across the country.

Furthermore, there is a need to expand the number of clinical sites. This can be achieved by transforming medical schools and hospitals into active research sites. Better accessibility to research infrastructure is equally important. Increased communication and coordination between public institutions like National Institute of Pharmaceutical Education and Research (NIPER), Department of Biotechnology (DBT) and others will help scale up access to public research infrastructure. There was much excitement following the Union Budget FY2023 announcement of opening up of ICMR research facilities to researchers at universities and private sector (Mascarenhas, 2023). However, a recent study conducted by the Centre for Technology, Innovation and Economic Research (CTIER) and Confederation of Indian Industry (CII) under the aegis of the Office of the Principal Scientific Adviser to the Government of India (O/o PSA) shows that the research and testing facilities of around 4 percent of ICMR labs were utilised by industry in FY2023. Follow up measures to promote wider utilisation of the public research facilities, along with government support to enable access to private laboratory infrastructure, would significantly benefit startups emerging in this sector.

Indigenous manufacturing of research material for cell culture and monoclonals will also help accelerate research. It is important that raw materials crucial for development of biologics are readily available to smaller players at affordable prices.

Nurturing a Talent Base Equipped for Industry Needs

A revamp of academic curriculums at higher education institutions is needed to align them with industry requirements. It would be essential for academia to stay updated with the rapid changes in technology in the global economy. Investments in programs that bring together information technology and biotechnology (IT-BT) will help the sector immensely. Collaborative programs like joint Industry-masters and industry-PhDs through government support will also help build a robust talent pipeline.

The government currently spends just 6 percent of its central R&D budget towards healthcare, supporting research in the autonomous laboratories belonging to DBT and ICMR (Indicator 6.3). This is low when compared to some of the other economies like the US and the UK where healthcare research receives more than 20 percent of their respective government R&D budgets (Panjwani, 2023; Research America, 2022). As a first step, the government should look to increase the amounts allocated to health care

research. By shifting a significant portion of this funding into universities and integrating the work done in the DBT and ICMR laboratories with the higher education sector will also bolster the talent output and stimulate innovation within the pharmaceutical industry.

Lessons from China and South Korea

There are lessons to be learnt from countries like China and South Korea who have introduced policies to provide support in infrastructure, finance and regulations. They have helped establish bulk drug parks, expand contract development and manufacturing organisations (CDMOs) and adopt a cluster approach to increase collaborations to boost their position in the global pharmaceuticals & biotechnology supply chain.

China has dedicated policy initiatives to establish bulk drug parks which are supported by common utilities such as electricity, steam, chilled water and effluent treatment systems. These clusters have been strategically located to optimise operating costs and ensure ancillary industries provide a continuous supply of raw materials for API production. This infrastructure-first approach, combined with necessary utilities and financing, has lowered unit costs and made China a globally competitive manufacturing base (CII & KPMG, 2020). India is currently setting up bulk drug parks in Andhra Pradesh, Telangana, Gujarat and Uttar Pradesh (PTI, 2025). These should be monitored closely to ensure they are equally effective in pushing India's R&D ambitions in the pharmaceuticals & biotechnology sector.

Important learnings can also be gleaned from how Chinese CDMOs have positioned themselves as global service providers offering scale and proximity to key markets. The Chinese CDMOs increased their presence overseas by building integrated R&D and biologics manufacturing facilities, aimed at serving regional markets and meeting regulatory requirements more efficiently (Algazy et al., 2022). A similar CDMO push in India, where AI/ML tools can be built along with drug discovery support, biologics and other kinds of services, will help better integrate with the global pharmaceutical research ecosystem.

Through its Bio-Vision 2016 policy, South Korea provided a vital policy push to enter the global biotechnology supply chain. It was a ten year roadmap launched in 2006 that aimed to strengthen domestic capabilities in R&D, infrastructure, human capital, bio-clusters and international collaborations (Hyeon et al., 2008). South Korea's dedicated bio-clusters have enabled close coordination between regulators and industry. These bio-clusters house various national agencies including the Korea Disease Control and Prevention Agency and the Ministry of Food and Drug Safety (Invest Korea, 2022). The important lesson for India here is that having these agencies close to industry has allowed regulatory processes to support research and commercial activities in a seamless manner.

Towards a World-Leading Pharma & Biotech Hub

Realising the pharmaceuticals & biotechnology sector's long term ambition of growing to USD 450 billion by 2047 will require a coordinated and strategic push towards regulatory reform, strengthening research infrastructure, a focus on talent development and global integration. This calls for a diverse and capable group of researchers, policymakers, academic leaders and industry professionals to facilitate knowledge exchange, foster investment and co-create forward looking solutions.

India already has the key pieces in place. What is needed is urgency and bold ambition to ensure that regulatory frameworks keep pace with emerging technologies like gene therapy and AI-driven drug discovery, biological infrastructure must be made accessible, curriculums are revamped and academia-industry linkages are enhanced to address evolving skill requirements.

The time has come for India to become a hub for high value pharmaceuticals & biotechnology innovation.

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Globally, the need for semiconductors has intensified in recent years due to their indispensable role in emerging technologies like artificial intelligence, machine learning and the Internet of Things. The varied use of semiconductors across sectors like automotive, electronics, defence and space adds to its strategic relevance in the global market. India seeks to position herself as one of the emerging semiconductor hubs of the world.

The focus of this essay is to outline how India's existing strengths can propel her to become a worthy contender in the global semiconductor value chain.^{1,2} The first section looks at various policy initiatives at the national level, state level and in the form of bilateral agreements, followed by a description of the current presence of semiconductor firms and startups in India. The last section looks at different priority areas that India can focus on to grow the domestic semiconductor ecosystem.

Policy Resolve and a Multipronged Approach

There have been a number of initiatives introduced at the national level, state level and in the form of bilateral Memorandums of Understanding (MoU) to build the semiconductor ecosystem in India. These initiatives are a significant step in the right direction. Building on these and providing the necessary policy implementation support would contribute to building a comprehensive semiconductor ecosystem that plays to the country's strengths.

While the national measures are a start, the scale of funding would need to be increased and sustained over a longer period. The state government initiatives on talent would need to be supplemented with an explicit focus on talent development through research in the higher education sector. Lastly, the bilateral initiatives need to be actioned urgently to address the various lacunae the nation faces when it comes to talent and infrastructure development.

At the national level, the Government of India launched the India Semiconductor Mission in 2021 and has allocated USD 10 billion for various schemes. The mission includes a design linked incentive scheme that offers financial support of up to 50 percent of eligible expenditure. The mission also provides for a product deployment linked incentive on net sales for five years covering different stages of semiconductor design. It proposes fiscal support for establishing fabrication units for semiconductors, display, compound semiconductors, silicon photonics, sensors and discrete semiconductors. The government plans to provide incentives for ATMP/ OSAT facilities under the mission (Press Information Bureau, 2024).

Furthermore, around USD 1 billion has been set aside to modernise the Semiconductor Laboratory (SCL) in Mohali. SCL is an autonomous body under the Ministry of Electronics and Information Technology (MeitY), Government of India. The Ministry intends to do this through a joint venture with the private sector (Aryan & Agarwal, 2024).

¹ While our focus in this essay on the semiconductor value chain, it is important that India also focus separately and urgently on growing EMS. This will not only contribute to the growth of the semiconductor industry but a broader EMS industry will play a huge role in job creation and bring immediate benefits to the wider economy.

² We are grateful to the participants of the CTIER Ananta roundtable discussion on India's R&D Ambitions: Challenges and Imperatives, India's Potential in Semiconductors, held in November 2024.

A review of state policies is telling. 13 states have introduced dedicated semiconductor policies or integrated semiconductor-related measures within their electronics policies (see Indicator 7.1.1). The timeline of introduction of some of these policies predates the current national focus on semiconductors.

Table 1 highlights the focus areas covered under each of the policies. All policies focus on infrastructure development. While most policies have a mix of different areas of focus, Gujarat is an exception where the policy is entirely focused towards infrastructure for the semiconductor sector.

Different states are adopting varied initiatives for talent development. For example, Odisha is focusing on updating electronics curriculum with a special focus on VLSI Design at both undergraduate and graduate levels and emphasising on skill development through industry-academia collaborations. Tamil Nadu has a target of creating a talent pool of 200,000 within the Semiconductor sector by 2030 through training incentives and by facilitating high-end electronics design research. Uttar Pradesh is providing fiscal incentives for developing industrial housing along with curriculum upgrades and skill development workshops.

As more of these policies roll out, consideration must be given to the idea that while it may not be possible for each state to embed itself in the semiconductor value chain, given differences in resources, infrastructure and logistics, every state could at least contribute to building the talent pool.

Table 1 | Focus Areas under State Policies

State	Policy	Year	Infrastructure	Talent	R&D	Startup Support	IPR Support
Andhra Pradesh	Electronics Manufacturing Policy	2024 - 2029	✓	✓	✓	✓	
Assam	Electronics (Semiconductor etc.) Policy	2023	✓	✓			✓
Gujarat	Semiconductor Policy	2022 - 2027	✓				
Haryana	Draft ESDM Policy	2024	✓	✓	✓	✓	✓
Karnataka	Engineering Research and Development Policy	2021			✓		✓
	Semiconductor Policy	2010	✓	✓	✓	✓	✓
Madhya Pradesh	IT, ITes & ESDM Investment Promotion Policy	2023					✓
	Semiconductor Policy	2025	✓	✓	✓	✓	✓
Maharashtra	Industrial Policy	2019	✓	✓	✓	✓	✓
Odisha	Semiconductor Manufacturing and Fabless Policy	2023	✓	✓	✓	✓	✓
Rajasthan	Electronics Manufacturing Policy	2021	✓	✓	✓	✓	
Tamil Nadu	Semiconductor and Advanced Electronics Policy	2024	✓	✓	✓	✓	✓
Uttar Pradesh	Semiconductor Policy	2024	✓	✓	✓		✓
West Bengal	Information & Communication Technology	2012	✓	✓			✓

Source: CTIER Analysis, various state government websites

With respect to the bilateral initiatives, India needs to urgently action the intentions laid out in MoUs with Singapore, Taiwan, the USA and Japan. The MoU with Singapore (ANI, 2024) aims to create a semiconductor cluster and focus on talent development in semiconductor design and fabrication. Similarly, through our MoU with USA (U.S. Embassy and Consulates in India, 2023), we seek to build research opportunities, talent and upskill the semiconductor workforce. The National Science Foundation (NSF) of the US and the Department of Science and Technology (DST) of India have announced joint research collaborations in applied research areas of emerging technologies which includes semiconductors (ibid). India's MoU with Taiwan (ANI, 2024) emphasises on person-to-person interactions with a focus on mitigating the shortfall of workforce in Taiwan's semiconductor industries, which we should leverage to benefit India's own semiconductor talent.

Semiconductor Presence: Where are we?

While India's policy initiatives and strategic collaborations captured above hint at positioning India as a desirable global hub across the semiconductor value chain, an analysis of the capabilities residing in India reveals a significant focus on design related activities at present. It has been reported that India contributes around 20 percent of the world's semiconductor design talent (Bansal, 2024; Varadarajan et al., 2024).

To better understand India's presence in the global semiconductor value chain, we mapped major firms by their activities in the value chain in Table 2. We then looked at how many of these firms have a presence in India. Nearly half of the major global companies with a semiconductor presence in India seem to be working on their design capabilities while others are working on ATMP and R&D for semiconductors. (See Table 3)

Table 2 | Major Companies in the Global Semiconductor Value Chain

Activity	Firm Name
Design	Alphabet, Meta, Microsoft, Apple, Tencent, Qualcomm, Alibaba Group Holding, Nvidia, Stellantis, Cisco Systems, NTT, IBM, Siemens, Advanced Micro Devices, Broadcom, Nokia, Ericsson, Mediatek, Hon Hai, Baidu, Tesla, LG Electronics, ZTE, Hyundai Motor, Arm Holdings
Fabrication	Taiwan Semiconductor Manufacturing Company (TSMC)
Assembly, Testing, Marking and Packaging (ATMP)	ASML Holding, Applied Materials (AMAT), Hitachi
Integrated Device Manufacturer	Huawei Investment & Holding, Samsung Electronics, Intel, Toyota Motor, Robert Bosch, Sony, Denso, SK Hynix, Micron Technology, Hitachi, Western Digital, NXP Semiconductors

Source: CTIER Analysis, various news reports and company websites

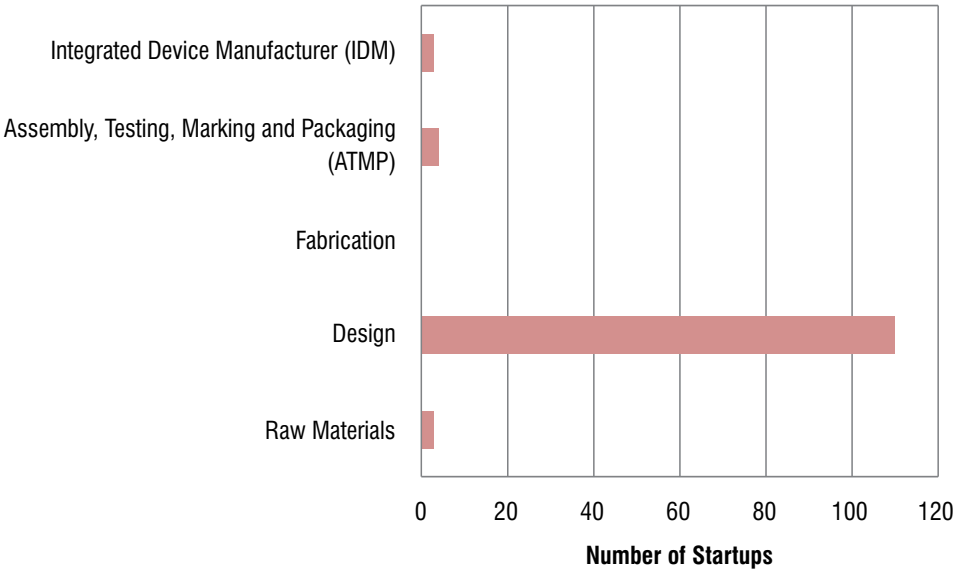
Table 3 | Major Global Companies with Semiconductor Presence in India

Semiconductor Work Done in India	Firm Name
Design	Qualcomm, Advanced Micro Devices, Intel, Nvidia, Meta, NXP Semiconductors
Assembly, Testing, Marking and Packaging (ATMP)	Micron Technology, Foxconn (Hon Hai)
R&D	Samsung Electronics, Mediatek, Applied Materials (AMAT), Broadcom

Source: CTIER Analysis, various news reports and company websites

There seems to be a similar phenomenon with startups working in the semiconductor space in India. Of the 120 Indian startups that we identified in the semiconductor value chain, around 90 percent are carrying out design related activities. (See Figure 1)

Figure 1 | Semiconductor Startups In India



Source: CTIER Analysis, Tracxn

Priority Areas for Growing India’s Semiconductor Industry

In this section we outline priority areas for growing India’s semiconductor industry that policy should focus on. We look at how India’s current design and fabrication capabilities can be adapted to gain advantage. We highlight the various ways in which India’s talent can become the defining factor in the success of India’s semiconductor industry.

Making India the Global Design Centre for Chips

Design is a crucial part of the semiconductor value chain. It is foundational to defining the functionality, performance and efficiency of a chip (Palma et al., 2022).

A potential area within chip design that India should capitalise on and challenge global competitors in, would be in developing specialised chips designed for Generative AI (GenAI), Large Language Models (LLMs) and Diffusion Models. Given the disruptive nature of such technologies in the current global landscape, India should focus on R&D and design of these specialised chips in order to gain an edge over others in the global semiconductor value chain.

India should focus on developing Application-Specific Integrated Circuits (ASICs) or sensors. Sensor chips have varied usage in IoT, gas sensing, security and diagnostics. India can gain comparative advantage in such high design and low volume chip manufacturing which have a significant market potential in intelligent electronics. Currently, Indian academia is carrying out research in sensors which can be used by industry.

Typically, critical semiconductor IPs are developed by the major firms (See Table 1) and licensed out to chipmakers. Given that there is an ongoing movement of open source chip architecture, India can also consider using this to her advantage. (Kotasthane & Sahu, 2024)

Strengthening Fabrication Capabilities

For India to become a notable player in the fabrication space, India will either need to bring a dominant player like TSMC to the country to capitalise on a significant portion of the semiconductor value chain or develop similar fabrication capabilities. To build fabrication capabilities of this scale, attention would need to be paid to ensuring clear air, ultrapure water (James, 2024), continuous power supply (Galbrun-Noel, 2021) and a well developed logistics infrastructure.

As India strives to attract or develop its high fabrication capabilities, there are three immediate areas policymakers could focus on: leverage its strategic partnerships to improve fabrication capabilities, tap into relatively niche areas of fabrication and scale up low value added processes within the semiconductor value chain.

Recently there have been efforts to establish fabrication capabilities in India. For instance, Tata Electronics and PSMC have signed an agreement worth USD 11 billion to set up a chip fabrication unit in Dholera, Gujarat (Press Trust of India, 2024). India should also leverage its strategic partnerships to fabricate chips designed in India in these partner countries.

India should tap into the relatively niche areas of fabrication like manufacturing compound semiconductors. Indichip Semiconductors Limited and Yitao Micro Technology Limited (YMTL) of Japan signing an MoU with the Andhra Pradesh government to set up a Silicon Carbide (SiC) fabrication facility in the state is a welcome step in this direction (Rao M., 2025). Other ongoing efforts include the manufacturing of compound semiconductors like Gallium Nitride which are more energy efficient compared to their Silicon counterparts by startups like Agnit Semiconductors (Sur, 2024).

Lastly, India should also focus on scaling up the low value added processes within the semiconductor value chain like ATMP. Recent efforts of firms like Micron Technology and Tata Electronics to set up ATMP facilities in Gujarat (Press Trust of India, 2025) and Assam (Financial Express, 2024) respectively are a right step in this direction.

Doubling Down on Talent

India will need to devise strategies for talent development. To begin with, SCL can act as a training centre to build India's in-house talent capabilities for her semiconductor ecosystem.

India's academic programs must be reoriented to offer hands-on exposure and foster an innovation mindset. It would be important to introduce programs like specialised degrees in VLSI and semiconductor technology, along with expanded laboratory facilities where students get hands-on exposure. Embedding these cutting-edge training programmes within academic institutions would ensure that students are well prepared to contribute to the industry in an innovative capacity. Initiatives such as industry mentored PhD programs should also be introduced to align research efforts with industry needs.

Every effort should also be made to bring advanced talent from the diaspora back to India. There should be attractive enough incentives for Indians working abroad in the semiconductor industry to return. Countries like Malaysia, that are facing similar manpower shortage have introduced policies to attract its semiconductor talent back to their respective countries (Lin, 2025). Policies like these would need to be studied. Other opportunities to provide international exposure to Indian professionals through programs under the India-Taiwan MoU should also be taken advantage of as a route to talent development.

In Conclusion

In the current geopolitical context, India has a window of opportunity to become a worthy contender in the global semiconductor race. Government support can help — instead of a one time investment effort, there is a need to continuously invest a yearly amount of USD 10 to 20 billion for the next 10 years to meaningfully develop the ecosystem. Industry will have to play its part and amp up on capabilities across the value chain.

Building design capabilities will be pivotal to India's progress in this industry. These capabilities will require to be developed over not just chip design, but could also be extended to the design of fab facilities.

India can strengthen fabrication capabilities through tapping into niche areas of fabrication, scaling up the low value added processes within the semiconductor value chain like ATMP besides ramping up existing efforts on building fabrication capabilities.

Projections suggest that the Indian semiconductor sector may face a shortfall of approximately 300,000 professionals over the next five years (Singh, 2024). India will need to devise strategies to counter this outward talent loss. We will need to double down on talent development.

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India stands on the cusp of an electric vehicle (EV) revolution, driven by an intricate web of government policies and institutional support at both national and sub-national levels. As the country aims to transform its automotive landscape, various initiatives have been implemented to foster the growth of the EV industry. However, significant challenges persist, particularly in developing the technological capabilities needed for battery cells, powertrains and charging infrastructure.

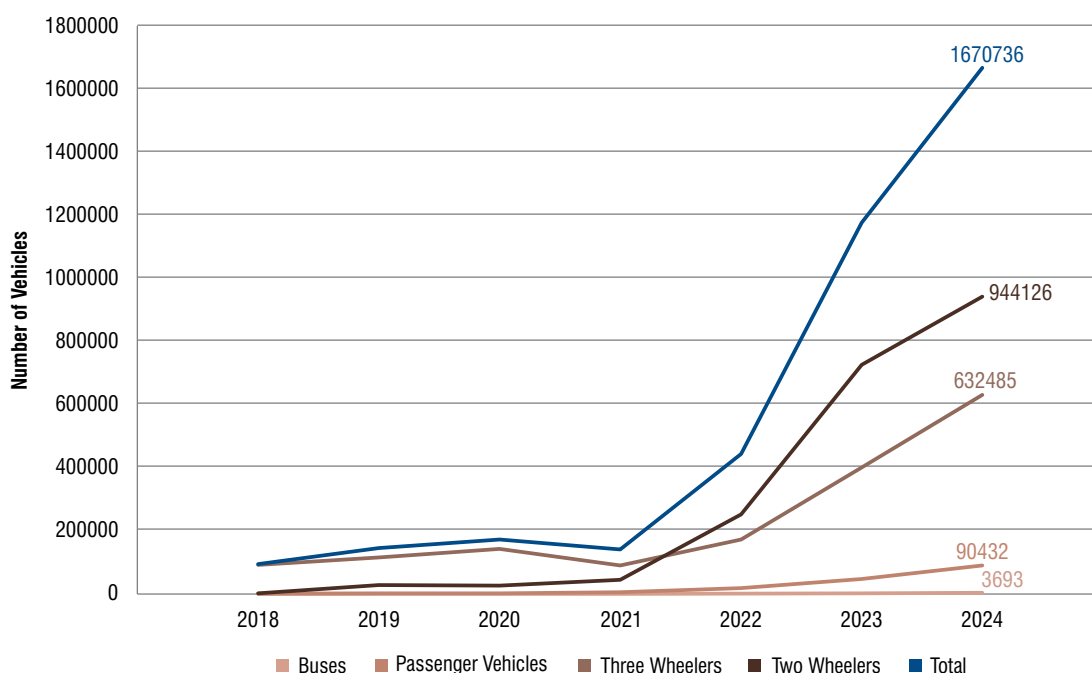
Emergence and Growth of the EV Industry in India

The journey of the Indian EV industry began with the launch of the Reva Electric Car in 2001 by the Reva Electric Car Company, now known as Mahindra Electric. Despite its pioneering status, Reva faced several challenges, including high pricing and a limited dealer network, which hampered its market penetration.

The turning point came with the introduction of the National Electric Mobility Mission Plan (NEMMP) 2020 in 2013, aiming to promote manufacturing and R&D in the EV sector. This was followed by the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme in 2015, which provided financial incentives for EV adoption and the development of charging infrastructure.

These policy initiatives were crucial in setting the stage for the EV industry in India. By 2023-24, electric cars accounted for 2 percent of total car sales in India, with over 90,000 electric cars sold out of 4.22 million passenger vehicles. This growth, averaging an annual rate of 79 percent between 2018 and 2024, underscores the effectiveness of the policies in place. See Figure 1 for trends on sales of EVs in India.

Figure 1 | Type Sales of EVs in India (in numbers)



Source: Compiled from the website of Society of Manufacturers of Electric Vehicles

¹ Visiting Professor, Centre for Development Studies, Trivandrum, Kerala, India and Ahmedabad University. The views expressed are personal. This is a summarised version of a larger paper by Mani, Sunil (2024), State and its technological solution to Climate Change in India, Solar PV Module Manufacturing in India.

Structure of the EV Industry: Dominance of Two-Wheelers and Three-Wheelers

Unlike the global EV landscape, which is predominantly dominated by passenger cars, the Indian EV industry is characterised by the dominance of two-wheelers and three-wheelers. This unique structure is largely driven by the demand for affordable and efficient mobility solutions in urban and semi-urban areas.

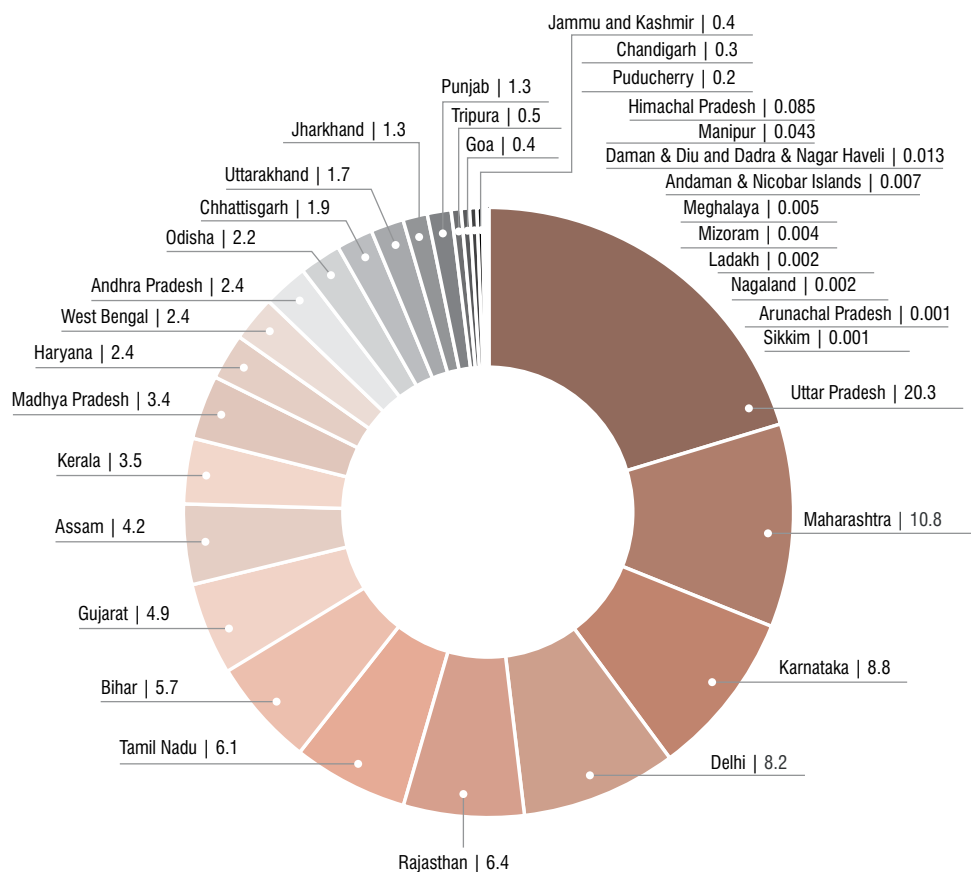
Two-wheelers account for the majority of EV sales in India, driven by the need for cost-effective and efficient transport options for the masses. The low cost of ownership, ease of use and government incentives have spurred the adoption of electric scooters and motorcycles. Companies like Hero Electric and Okinawa have capitalised on this demand, leading the market with their extensive range of electric two-wheelers.

Three-wheelers, particularly electric rickshaws, also play a significant role in India's EV ecosystem. They are widely used for short-distance transport and goods carriage, especially in urban and peri-urban regions. The affordability and economic benefits of electric three-wheelers have driven their popularity, with companies like Mahindra Electric and Piaggio spearheading innovations in this segment.

This focus on two-wheelers and three-wheelers contrasts sharply with the EV markets in countries like the US, China and Norway, where passenger cars dominate. The Indian approach reflects the specific needs of its population and urban infrastructure, highlighting the importance of tailored strategies in promoting EV adoption.

Further, most of the EVs are concentrated in a few states (Figure 2).

Figure 2 | Distribution of the Stock of EVs in India Based on Vehicle Registration Data



Source: Ministry of Transport and Highways, Government of India, <https://pib.gov.in/PressReleasePage.aspx?PRID=1947389> (Retrieved on July 29, 2024)

Indian Policy Landscape

India's policy framework for EVs is comprehensive, focusing on reducing the cost of EVs, promoting domestic manufacturing and building necessary infrastructure. The NEMMP 2020 and the FAME scheme are pivotal in addressing the high upfront costs of EVs and fostering market demand.

In addition to these initiatives, the Production-Linked Incentive (PLI) Scheme launched in 2021 has been instrumental in promoting the domestic manufacturing of advanced automotive technology products, including EVs. The reduction of Goods and Services Tax (GST) on electric vehicles from 12 percent to 5 percent and on chargers from 18 percent to 5 percent, further illustrates the government's commitment to making EVs more affordable.

At the state level², various governments have introduced additional incentives to boost EV adoption. For instance, states like Delhi, Maharashtra and Gujarat offer subsidies on the purchase of EVs and incentives for setting up charging infrastructure. These sub-national policies complement the central initiatives, creating a conducive environment for the growth of the EV industry across the country.

Technological Advancements and Domestic Innovation

While policy support has been robust, technological advancements and domestic innovation remain critical to the success of India's EV industry. Globally, leaders in EV technology like Tesla and BYD have set high benchmarks in battery efficiency and production scalability. India, though making strides, still has a gap to bridge in terms of technological advancements.

The Indian government has recognised the importance of domestic innovation in EV technology. Efforts are being made to enhance battery manufacturing capabilities, electric drivetrains and charging infrastructure. Notably, Tata Motors, one of the largest electric car manufacturers in India, has been granted numerous patents in diverse automotive technologies, reflecting significant domestic efforts to innovate.

Dependence on Foreign Suppliers

Despite these efforts, India remains heavily dependent on foreign suppliers, especially from China, for critical EV components and materials. This reliance spans battery cells, electric motors and various electronic components that are vital for EV manufacturing. Over 80 percent of the lithium-ion batteries used in Indian EVs are imported from China, underscoring the vulnerability of India's EV supply chain to geopolitical tensions and supply disruptions.

The dependence on Chinese imports is driven by China's dominance in the global EV supply chain, supported by its significant investments in battery technology and rare earth materials. This dependence not only affects the cost competitiveness of Indian EVs but also raises concerns about the long-term sustainability of India's EV industry.

To mitigate these risks, the Indian government has been encouraging investments in local battery manufacturing through initiatives like the PLI Scheme. Collaborations with international players for technology transfer and joint ventures are also being pursued to build domestic capabilities. However, building a self-reliant EV supply chain will require sustained efforts and significant investment in R&D and infrastructure development.

² The reader can find details of state policies for EVs in Indicator 7.1.1

Barriers to EV Adoption

Despite the progress, several barriers continue to hinder the widespread adoption of EVs in India. One of the primary challenges is the high cost of acquiring an EV, driven largely by the expensive battery technology. Batteries account for approximately 40-50 percent of an EV's cost, making them less affordable for the average consumer.

Another significant barrier is the lack of adequate charging infrastructure. As of 2024, India had about 12,146 public EV chargers, a stark contrast to countries like China, which has over 1.2 million public chargers. The uneven distribution of these chargers, particularly in rural areas, further exacerbates the issue. The high upfront investment costs for fast charging stations and the lack of standardisation in charging equipment are additional challenges that need to be addressed.

Consumer perceptions also play a role in slowing down EV adoption. Range anxiety, or the fear of running out of battery power without access to a charging point, remains a significant concern. Although the range of EVs has been improving, the convenience of quick refuelling with internal combustion engine (ICE) vehicles still makes them a more attractive option for many consumers.

Comparative Analysis with Global Leaders

Benchmarking India's progress against global leaders like Norway, China and the US provides valuable insights. These countries have seen significant EV penetration due to strong policy support, financial incentives and stringent emission regulations. For instance, Norway's aggressive policies, including substantial subsidies and the development of extensive charging infrastructure, have resulted in EVs accounting for more than 50 percent of new car sales.

China's focus on domestic manufacturing and large-scale investment in charging infrastructure has made it the largest market for EVs in the world. The US, with its emphasis on technological innovation and public-private partnerships, has also made significant strides in EV adoption. India³ can learn from these experiences, particularly in areas of policy design, public-private partnerships and consumer incentives.

The Road Ahead

India's EV industry shows significant promise, but achieving its full potential will require concerted efforts in policy implementation, technological innovation and infrastructure development. Increased investment in R&D to develop indigenous technologies, along with strategic policy support, is essential for reducing reliance on imports and enhancing the global competitiveness of Indian EVs.

The evolving policy landscape, especially regarding charging infrastructure, suggests potential for accelerated development with appropriate support and investment. As India continues to pursue its ambitious goals in the EV sector, the interplay between policy, technology and market forces will be crucial in shaping the future of electric mobility in the world's third-largest automotive market.

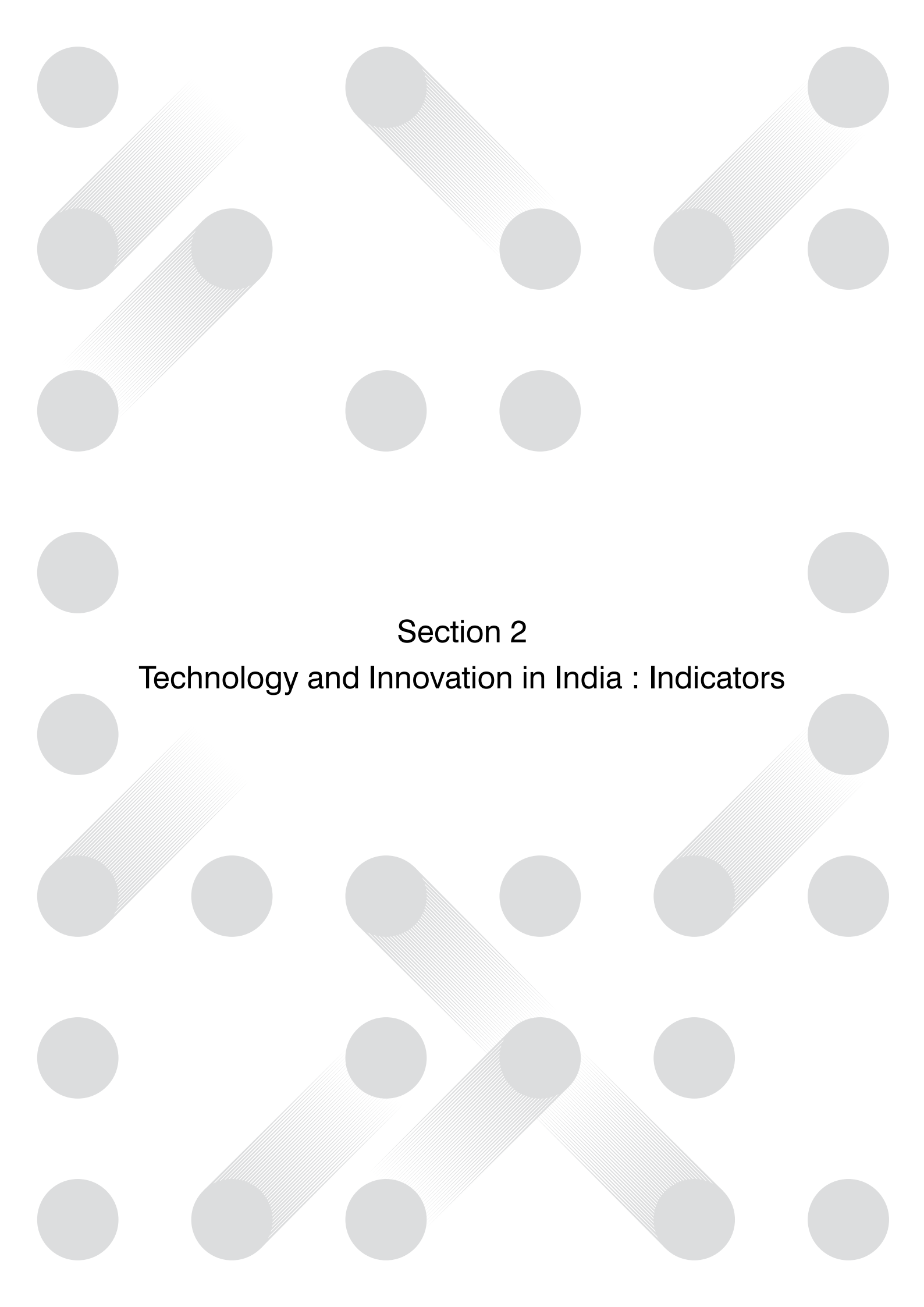
In conclusion, while India has made significant strides in promoting the EV industry, overcoming the technological and infrastructural challenges remains critical. With sustained policy support and a focus on innovation, India can position itself as a major player in the global shift towards sustainable transportation.

³ See Indicator 6.4.1 for a comparison of India's top R&D sectors

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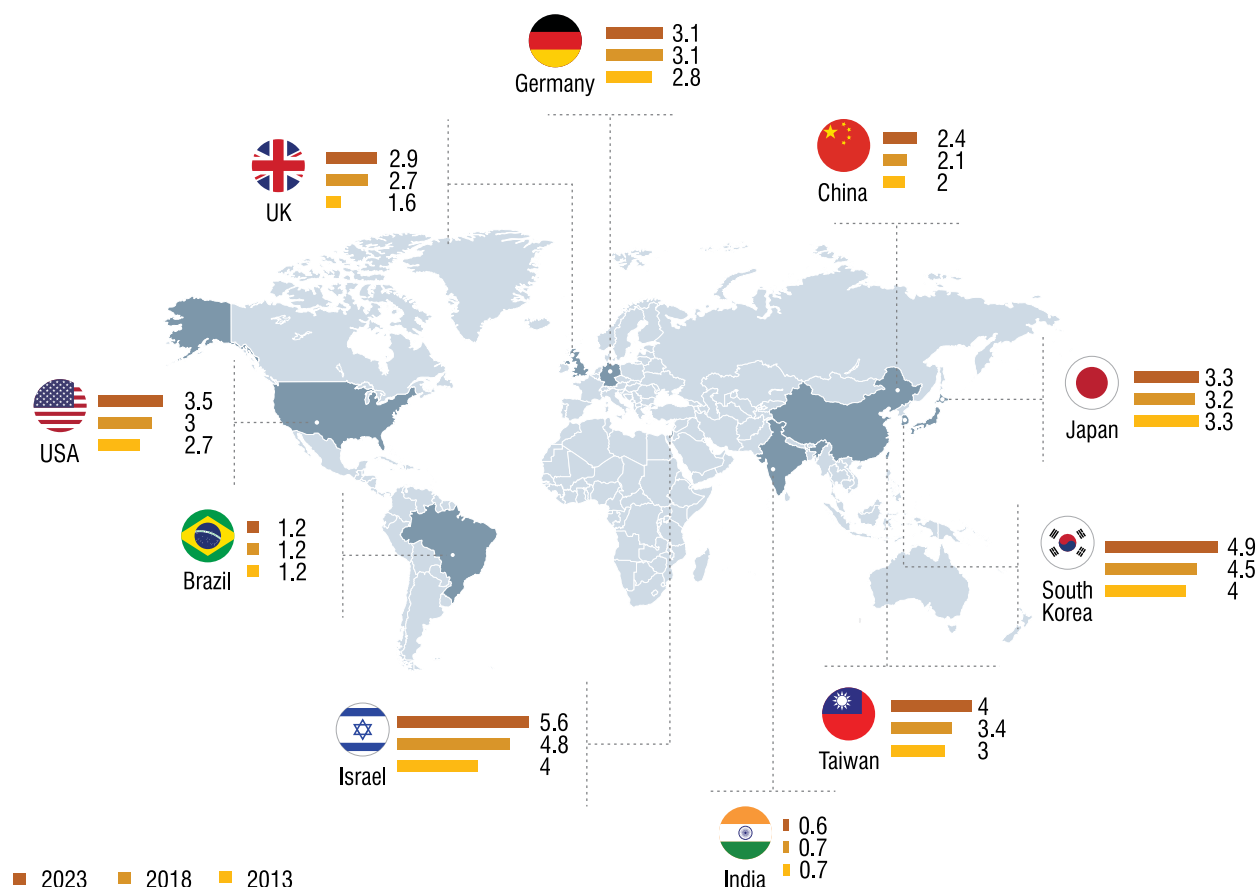
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The background of the page is decorated with a pattern of gray circles and lines. The circles are of two sizes and are scattered across the page. Some circles are connected by thin, light gray lines, creating a network-like structure. The lines are composed of many closely spaced parallel lines, giving them a textured appearance. The overall design is minimalist and modern.

Section 2

Technology and Innovation in India : Indicators

6.1 | R&D Expenditure as a Percent of Gross Domestic Product across Select Countries



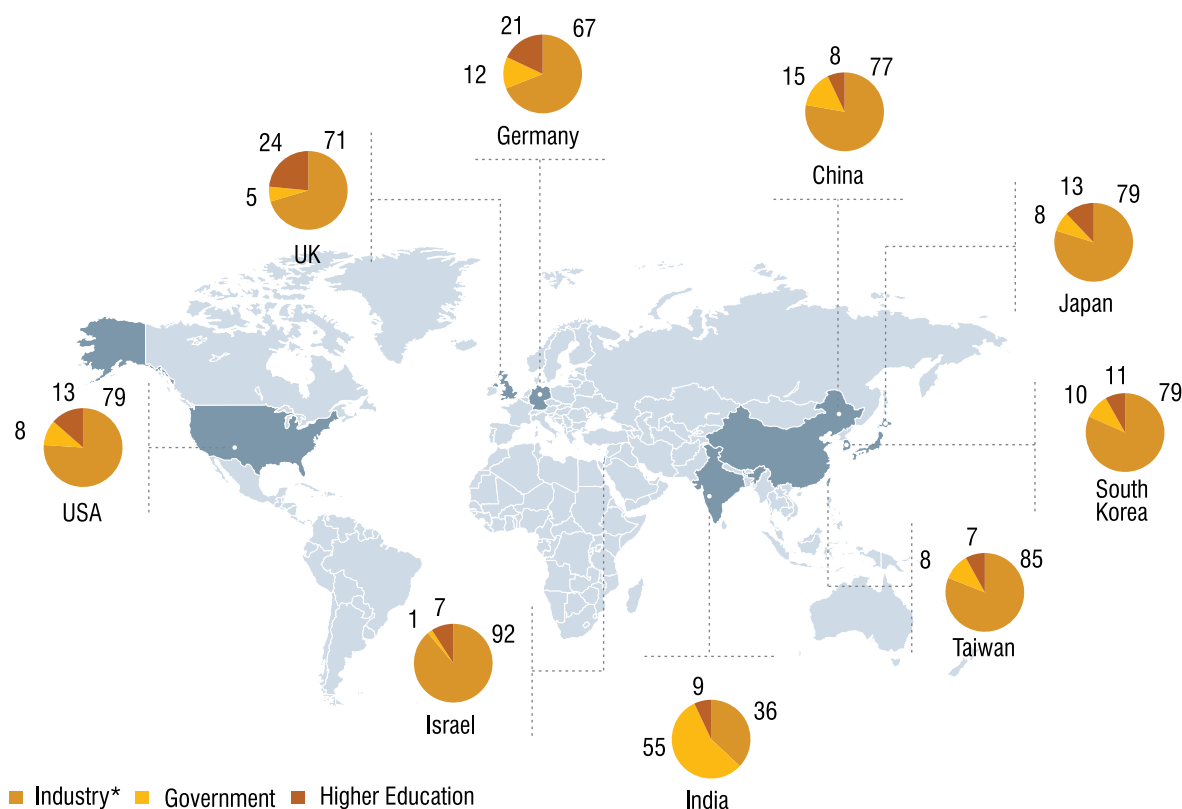
Source: OECD, Science, Technology and Innovation Scoreboard available at <https://www.oecd.org/en/data/datasets/science-technology-and-innovation-scoreboard.html> for data on UK, USA, Germany, Japan, Brazil, China, Israel and South Korea; Department of Science and Technology (DST), S&T Indicators Tables 2022-23 available at <https://dst.gov.in/sites/default/files/Updated%20ST%20INDICATORS%20TABLES%202022-23.pdf>; for data on India for 2013 and 2018; Statistical Yearbook of the Republic of China 2023 for data on Taiwan available at <https://ws.dgbas.gov.tw/001/Upload/466/refile/11503/233937/yearbook2023.pdf>; Notes on Demand for Grants (various Ministries), Union Budget 2024-2025, available at <https://www.indiabudget.gov.in/>; Forty Third Report, Standing Committee on Defence, available at https://eparlib.nic.in/bitstream/123456789/2963533/1/17_Defence_43.pdf; Detailed Demand for Grants of Ministry of Agriculture & Farmers Welfare for 2024-2025, available at https://agriwelfare.gov.in/sites/default/files/DDG_2024_25.pdf; Detailed Demand for Grants of Department of Atomic Energy for 2023-2024, available at <https://cdnbbsr.s3waas.gov.in/s35b8e4fd39d9786228649a8a8bec4e008/uploads/2023/05/2023051932.pdf>; Detailed Demand for Grants of Ministry of Science and Technology for 2024-2025, available at <https://dst.gov.in/sites/default/files/MST%20DDG%202024-2025.pdf>; Economic Survey 2023-24, available at <https://www.indiabudget.gov.in/economicsurvey/doc/Infographics%20English.pdf>; State Budget Accounts (2024-2025) (for all Indian States); Annual Reports (2022-23) of Indian companies; Prowess, data downloaded on 28 May 2024 from the platform; Centre for Technology, Innovation and Economic Research (CTIER)

Note: (i) 2023 data reported for Brazil is for 2020
(ii) 2023 data reported for United Kingdom and Taiwan is for 2022
(iii) 2023 data reported for India for 2022-23 is based on CTIER calculations
(iv) 2023 figures for India calculated using Gross Domestic Product (GDP) figures for 2022-23 as per the Economic Survey 2023-24

The R&D expenditure as a percent of Gross Domestic Product (GDP) for India was 0.6 percent in 2023 and has remained the lowest amongst the select countries in the chart above. It has been in a range from 0.6 percent and 0.9 percent for over three decades.¹ Between 2013 and 2023, Israel, South Korea, USA, UK, Germany, Taiwan and China have seen a noticeable increase in their expenditure on R&D as a percent of GDP. Israel and South Korea continue to be top spenders on R&D as a percent of GDP.

¹ The Struggle and the Promise: Restoring India's Potential. Forbes N (2022)

6.2 | Country-wise Comparisons of Share of R&D in National R&D Expenditure by Sector of Performance in 2023 (%)



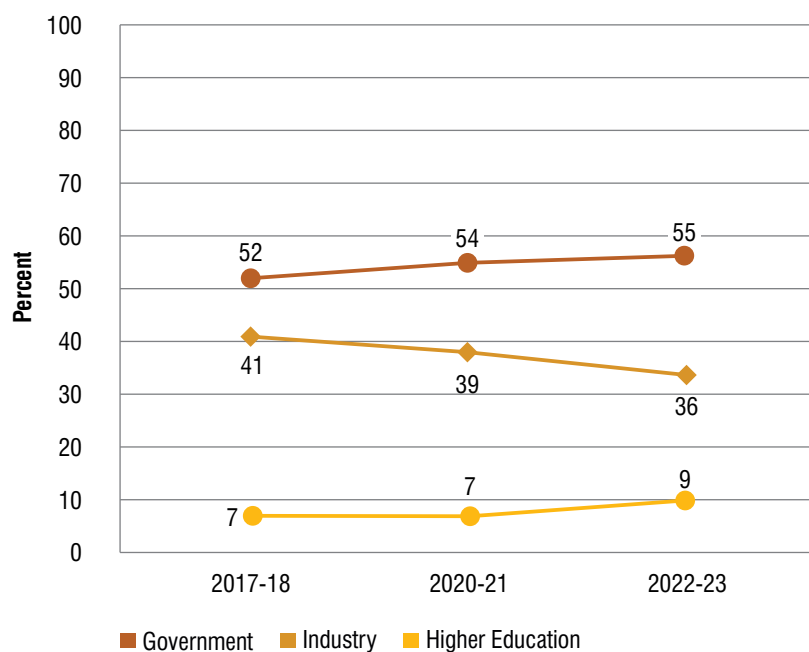
*OECD uses the term business enterprises.

Source: OECD Main Science and Technology Indicators, available at <https://www.oecd.org/en/data/datasets/main-science-and-technology-indicators.html> for data on UK, USA, Germany, China, Japan, South Korea, Taiwan and Israel; S&T Indicators Tables, Research and Development Statistics 2022-23, Department of Science and Technology, available at <https://dst.gov.in/sites/default/files/Updated%20ST%20INDICATORS%20TABLES%202022-23.pdf>; CTIER Handbook: Technology and Innovation in India 2021; Notes on Demand for Grants (various Ministries), Union Budget 2024-2025, available at <https://www.indiabudget.gov.in/>; Forty Third Report, Standing Committee on Defence, available at https://eparlib.nic.in/bitstream/123456789/2963533/1/17_Defence_43.pdf; Detailed Demand for Grants of Ministry of Agriculture & Farmers Welfare for 2024-2025, available at https://agriwelfare.gov.in/sites/default/files/DDG_2024_25.pdf; Detailed Demand for Grants of Department of Atomic Energy for 2023-2024, available at <https://cdnbsr.s3waas.gov.in/s35b8e4fd39d9786228649a8a8bec4e008/uploads/2023/05/2023051932.pdf>; Detailed Demand for Grants of Ministry of Science and Technology for 2024-2025, available at <https://dst.gov.in/sites/default/files/MST%20DDG%202024-2025.pdf>; State Budget Accounts (2024-2025) (for all Indian States); Annual Reports (2022-23) of Indian companies; Prowess, data downloaded on 28 May 2024 from the platform; Centre for Technology, Innovation and Economic Research (CTIER)

- Note: (i) Higher Education includes Higher Education sector and Private Non-Profit sector
(ii) India data is for 2022-23 and is based on CTIER calculations
(iii) Data reported for USA, Germany, China, Japan, South Korea, Taiwan and Israel is for 2022
(iv) UK data is for 2021
(v) Data not available for Brazil

In India, R&D spending continues to be dominated by the government sector that accounted for 55 percent of national R&D spending in 2023. R&D spending by Indian industry (that includes private sector and public sector business enterprises) accounted for 36 percent while the share of spending in the higher education sector was 9 percent. For the select countries in our sample, R&D spending is dominated by industry. Israel's industry accounted for 92 percent of spending on national R&D in 2023, whereas the share of spending by industry in other countries, excluding India, ranged between 67 percent to 85 percent.

6.2.1 | Share of India's R&D Expenditure by Sector of Performance (%)

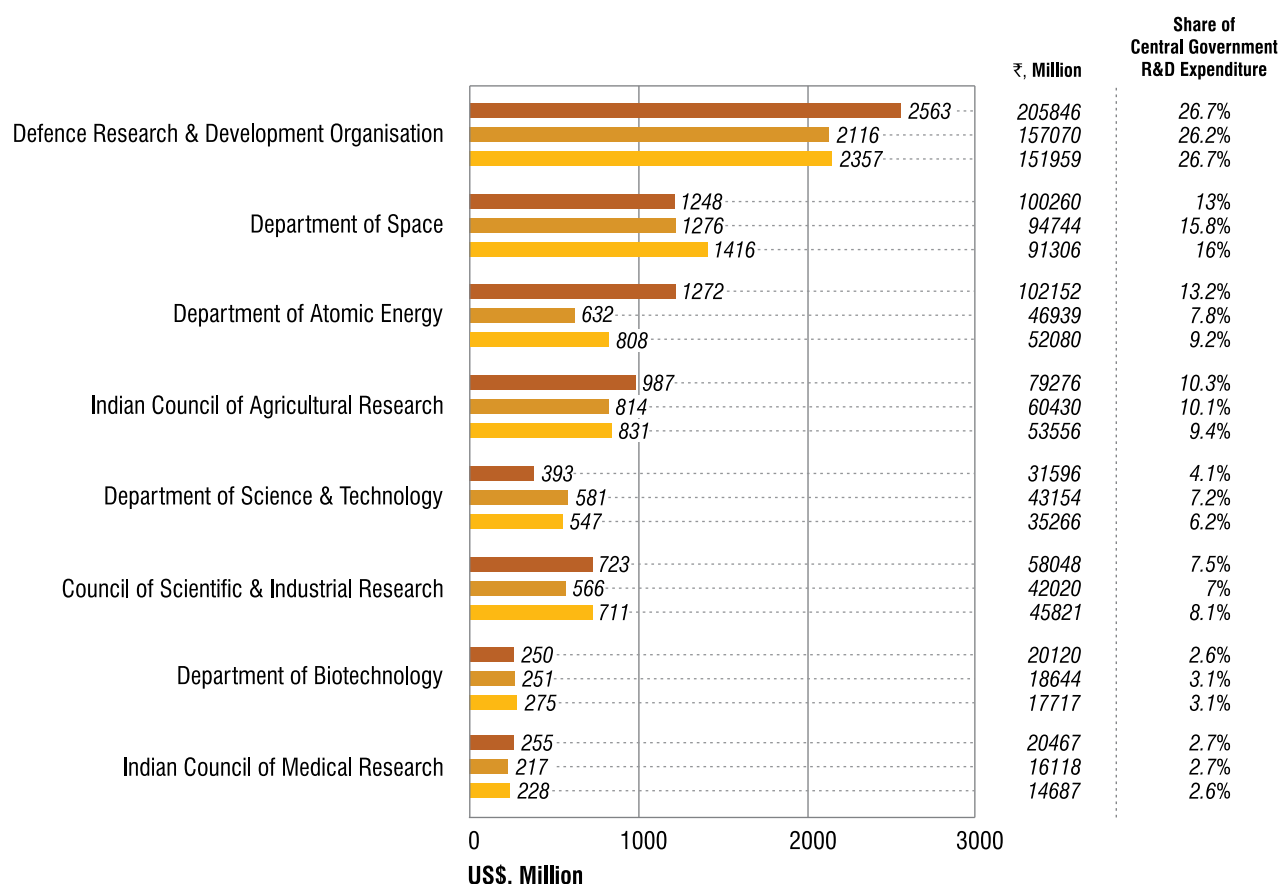


Source: CTIER Handbook: Technology and Innovation in India 2023; S&T Indicators Tables, Research and Development Statistics 2022-23, Department of Science and Technology, available at <https://dst.gov.in/sites/default/files/Updated%20ST%20INDICATORS%20TABLES%202022-23.pdf>; CTIER Handbook: Technology and Innovation in India 2021; Notes on Demand for Grants (various Ministries), Union Budget 2024-2025, available at <https://www.indiabudget.gov.in/>; Forty Third Report, Standing Committee on Defence, available at https://eparlib.nic.in/bitstream/123456789/2963533/1/17_Defence_43.pdf; Detailed Demand for Grants of Ministry of Agriculture & Farmers Welfare for 2024-2025, available at https://agriwelfare.gov.in/sites/default/files/DDG_2024_25.pdf; Detailed Demand for Grants of Department of Atomic Energy for 2023-2024, available at <https://cdnbbsr.s3waas.gov.in/s35b8e4fd39d9786228649a8a8bec4e008/uploads/2023/05/2023051932.pdf>; Detailed Demand for Grants of Ministry of Science and Technology for 2024-2025, available at <https://dst.gov.in/sites/default/files/MST%20DDG%202024-2025.pdf>; State Budget Accounts (2024-2025) (for all Indian States); Annual Reports (2022-23) of Indian companies; Prowess, data downloaded on 28 May 2024 from the platform; Centre for Technology, Innovation and Economic Research (CTIER)

Note: (i) Government Sector includes Centre and State expenditure on R&D
(ii) Industry includes private sector industries, public sector industries and Scientific and Industrial Research Organisation (SIRO)
(iii) Data for 2020-21 and 2022-23 are based on CTIER calculations
(iv) Industry includes private sector industries and public sector industries

The government sector in India accounted for 55 percent of total R&D expenditure in 2023, industry accounted for 36 percent and higher education accounted for 9 percent. Industry's share in national R&D expenditure has dropped from 41 percent in 2018 to 36 percent in 2023 while the share of higher education has seen a gradual increase from 7 percent in 2018 to 9 percent in 2023.

6.3 | R&D Expenditure by Select Key Scientific Agencies under Government of India



		Total for Select Key Scientific Agencies	Total Central Government R&D Expenditure	Total National R&D Expenditure
2022-23	US\$, Million	7690	9613	20589
	₹, Million	617765	772206	1653874
2020-21	US\$, Million	6453	8068	16568
	₹, Million	479119	598899	1229876
2017-18	US\$, Million	7173	8830	17658
	₹, Million	462392	569200	1138250

Source: S&T Indicators Tables, Research and Development Statistics 2022-23, Department of Science and Technology, available at <https://dst.gov.in/sites/default/files/Updated%20ST%20INDICATORS%20TABLES%202022-23.pdf>; CTIER Handbook: Technology and Innovation in India 2021; Notes on Demand for Grants (various Ministries), Union Budget 2024-2025, available at <https://www.indiabudget.gov.in/>; Forty Third Report, Standing Committee on Defence, available at https://eparlib.nic.in/bitstream/123456789/2963533/1/17_Defence_43.pdf; Detailed Demand for Grants of Ministry of Agriculture & Farmers Welfare for 2024-2025, available at https://agriwelfare.gov.in/sites/default/files/DDG_2024_25.pdf; Detailed Demand for Grants of Department of Atomic Energy for 2023-2024, available at <https://cdnbbsr.s3waas.gov.in/s35b8e4fd39d9786228649a8a8bec4e008/uploads/2023/05/2023051932.pdf>; Detailed Demand for Grants of Ministry of Science and Technology for 2024-2025, available at <https://dst.gov.in/sites/default/files/MST%20DDG%202024-2025.pdf>; State Budget Accounts (2024-2025) (for all Indian States); Annual Reports (2022-23) of Indian companies; Prowess, data downloaded on 28 May 2024 from the platform; Centre for Technology, Innovation and Economic Research (CTIER)

Note: (i) Figures in rupees were converted to dollars using the USD-INR exchange rate of 64.46 calculated as an average for fiscal year 2017-18, USD-INR exchange rate of 74.23 calculated as an average for the fiscal year 2020-21 and the USD-INR exchange rate of 80.33 calculated as an average for the fiscal year 2022-23 based on data from Federal Reserve Bank of St Louis
(ii) For 2017-18, the total Central Government R&D Expenditure is the sum of the R&D Expenditure by Select Major Scientific Agencies and Central Ministries/Departments other than Major Scientific Agencies
(iii) For 2020-21 and 2022-23, the total Central Government R&D Expenditure is estimated

R&D expenditure by major scientific agencies increased to USD 7.6 billion in 2023 from USD 6.4 billion in 2021. The Defence Research and Development Organisation (DRDO) continues to be the largest spender on R&D. The key scientific agencies listed above accounted for around 80 percent of total central government R&D expenditure. The data on R&D expenditure by major scientific agencies has been collated from Union Budget 2024-25 documents. The total central and national R&D expenditures are based on CTIER calculations.

6.4 | Sector-wise Global Industrial R&D Expenditure and Country-wise Number of Firms (2023)

Sector	R&D Expenditure (US\$, Million)	Total Number of Firms	Number of Firms									
			Select Advanced Economies				Select Emerging/Asian Economies					
			USA	UK	Germany	Japan	Brazil	China	India	Israel	South Korea	Taiwan
Software & Computer Services	255804	327	186	8	6	6	1	71	2	15	1	1
Pharmaceuticals & Biotechnology	247649	486	268	17	8	24	0	83	10	1	9	0
Technology Hardware & Equipment	206238	216	71	1	2	17	0	57	0	4	3	42
Automobiles & Parts	183068	172	37	5	18	26	0	48	4	1	9	1
Electronic & Electrical Equipment	96219	254	46	8	9	30	0	104	0	2	4	24
Construction & Materials	35229	66	4	0	2	10	0	36	0	0	2	0
Health Care Equipment & Services	29476	98	51	4	8	6	0	16	0	0	0	0
Chemicals	28338	112	20	2	8	28	1	34	1	0	4	0
General Industrials	24200	63	13	1	5	12	0	16	0	1	5	1
Industrial Engineering	23092	140	19	4	17	20	1	44	0	0	1	0
Top 3 sectors	709691	1029	525	26	16	47	1	211	12	20	13	43
Top 10 sectors	1129313	1934	715	50	83	179	3	509	17	24	38	69
Total	1324392	2500	827	95	113	229	5	679	22	29	47	77

Source: EU Industrial R&D Investment Scoreboard (2023); Centre for Technology, Innovation and Economic Research (CTIER)

Note: Figures in euros were converted to dollars using the EUR-USD exchange rate of 1.06 as at 31 December 2022 and as mentioned in the EU Industrial R&D Investment Scoreboard

There were 22 Indian firms in the list of top 2,500 global R&D spenders in 2023 compared to 24 in 2021.² The top 10 sectors by R&D spending saw 17 firms from India, that included 10 firms in the pharmaceuticals & biotechnology sector, 4 in the automobiles & parts sector, 2 in software & computer services sector and 1 in the chemicals sector. Indian firms were absent in 6 out of the top 10 global industrial R&D sectors.

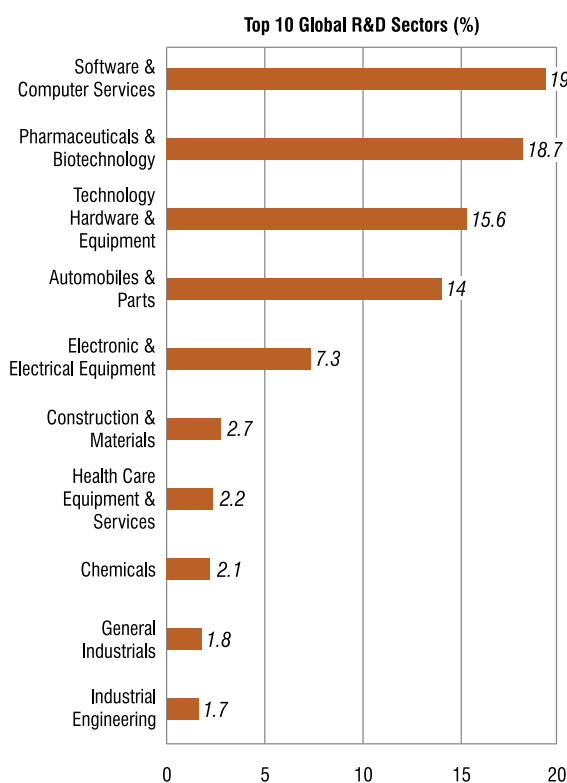
USA, China, Japan and Germany have firms present in each of the top 10 industrial R&D sectors. While firms from USA and China have seen an increased presence in the latest 2,500 global R&D spenders list compared to that previously reported, the number of firms from South Korea and Taiwan have seen a decline.

These top 2,500 global R&D spenders accounted for around 85 percent of the total global industrial R&D and the top ten sectors accounted for around 70 percent of the total global industrial R&D.³

² CTIER Handbook: Technology and Innovation in India 2023

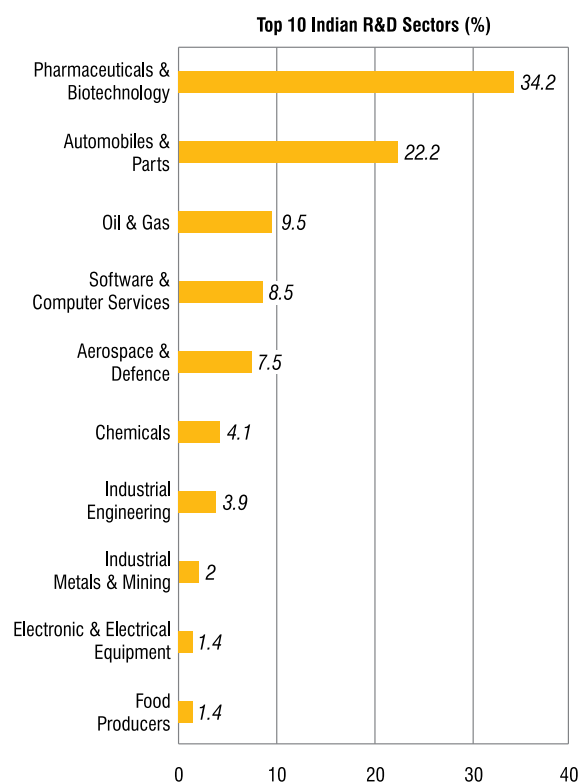
³ Estimates based on data from 'The Struggle and the Promise: Restoring India's Potential,' Forbes N (2022), Centre for Technology, Innovation and Economic Research (CTIER) and IMF World Economic Outlook Database, April 2023

6.4.1 | Comparison of the Structure of Global and Indian Industrial R&D (Sector Share of Total Industrial R&D Spending)



Source: EU Industrial R&D Investment Scoreboard (2023); Centre for Technology, Innovation and Economic Research (CTIER)

Note: (i) Total for the top 2500 companies according to EU Industrial R&D Investment Scoreboard (2023) for the year was USD 1324 billion
(ii) Figures in euros were converted to dollars using the EUR-USD exchange rate of 1.06 as at 31 December 2022



Source: Annual Reports (2022-23) of Indian companies; Prowess, data downloaded on 28 May 2024 from the platform; Centre for Technology, Innovation and Economic Research (CTIER)

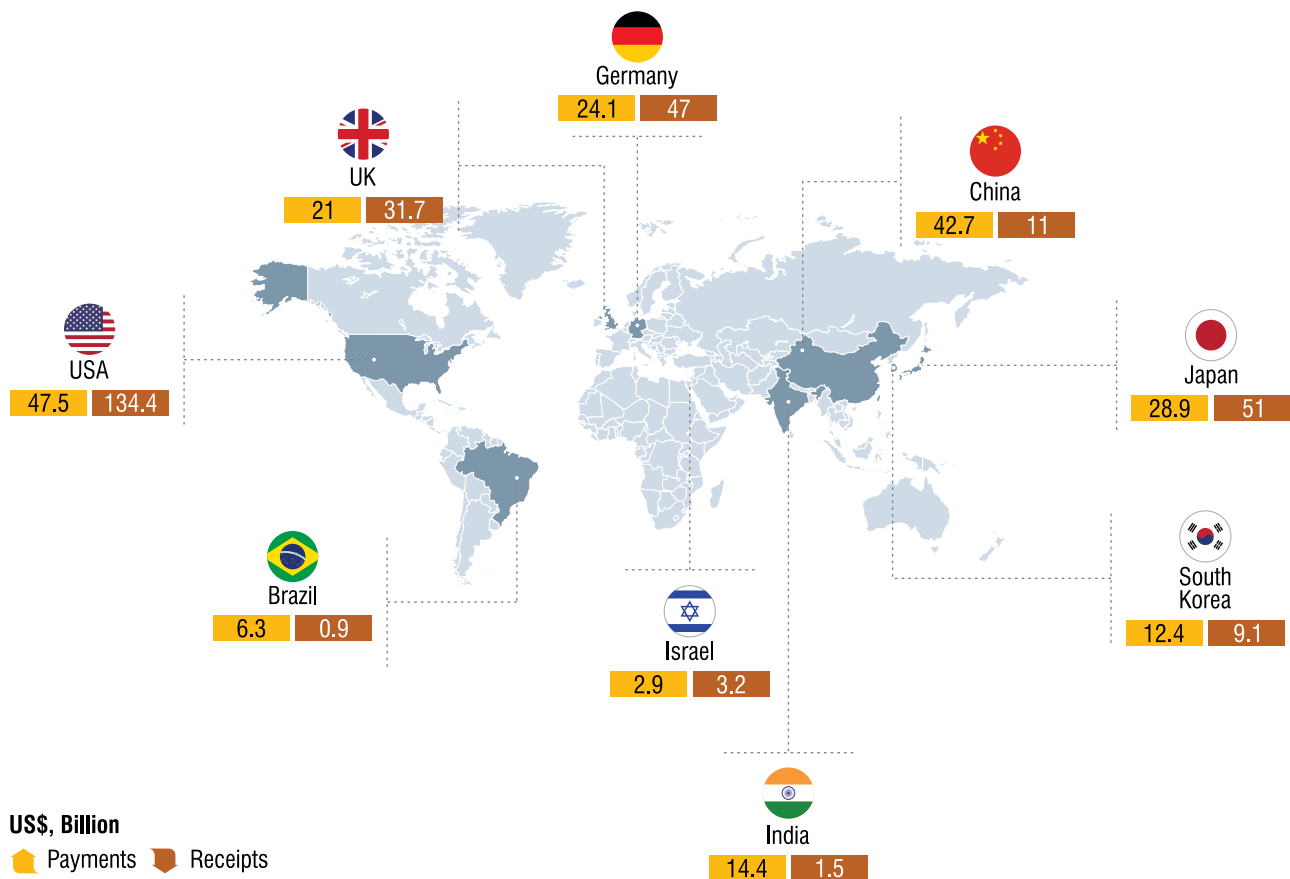
Note: (i) Total for the sample selected for the year was USD 7380 million (INR 592 billion). This sample of 430 R&D spending firms represented 94.1 percent of total industrial R&D spending in 2022-23
(ii) Figures in rupees were converted to dollars using the USD-INR exchange rate of 80.30 calculated as an average for the fiscal year 2022-23 based on data from Federal Reserve Bank of St Louis

India's industrial R&D is dominated by the pharmaceuticals & biotechnology and automobiles & parts sectors. These top two sectors contribute to around 56 percent of the total industrial R&D spending in India. Some of the other major sectors contributing to industrial R&D in India include oil & gas, software & computer services and aerospace & defence. Global industrial R&D on the other hand is dominated by software & computer services, pharmaceuticals & biotechnology, technology hardware & equipment, automobiles & parts and electronic & electrical equipment. The structure of India's industrial R&D has 6 sectors in common with the top global sectors of industrial R&D.

Top global sectors such as technology hardware & equipment, construction & materials, health care equipment & services and general industrials are absent from India's top industrial R&D sectors. In 2023, the electronic & electrical equipment sector has made an appearance in the top 10 R&D sectors for India having replaced general industrials that was present in the top 10 sectors in 2021.⁴ With respect to global industrial R&D, software & computer services has surpassed pharmaceuticals & biotechnology as the leading global industrial R&D sector by spending.

⁴ CTIER Handbook: Technology and Innovation in India 2023

6.5 | Payments and Receipts for Intellectual Property (2023)

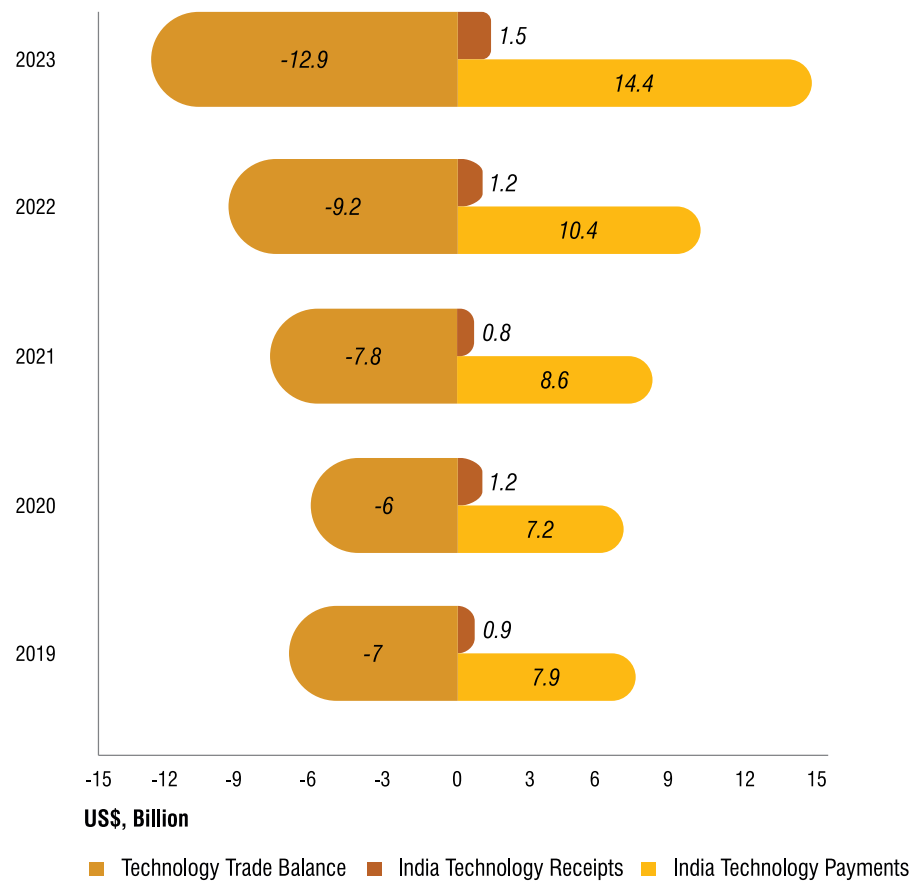


Source: Reserve Bank of India (RBI), Balance of Payment (various years) available at https://www.rbi.org.in/scripts/SDDS_ViewDetails.aspx?SDDSID=254&ID=5 for data on India; World Development Indicators (2019), Indicators, available at <https://databank.worldbank.org/source/world-development-indicators> for data on Brazil, China, Germany, Israel, Japan, South Korea, UK and USA; Centre for Technology, Innovation and Economic Research (CTIER)

Note: (i) Payments for IP here means “Charges for the use of intellectual property, payments (BoP, current US\$)” in WDI, World Bank
(ii) Receipts for IP here means “Charges for the use of intellectual property, receipts (BoP, current US\$)” in WDI, World Bank

India's technology trade deficit continued to widen in 2023. India's technology trade deficit came in at USD 13 billion while China's technology trade deficit was USD 32 billion. In 2023, the technology trade surplus increased for USA, Germany, Japan and the UK compared to 2019, among the selected advanced economies in the sample under consideration. The data for 2019 for our sample of countries can be found in the Appendix (Table A.1).

6.5.1 | India's Technology Trade Balance (2019 - 2023)

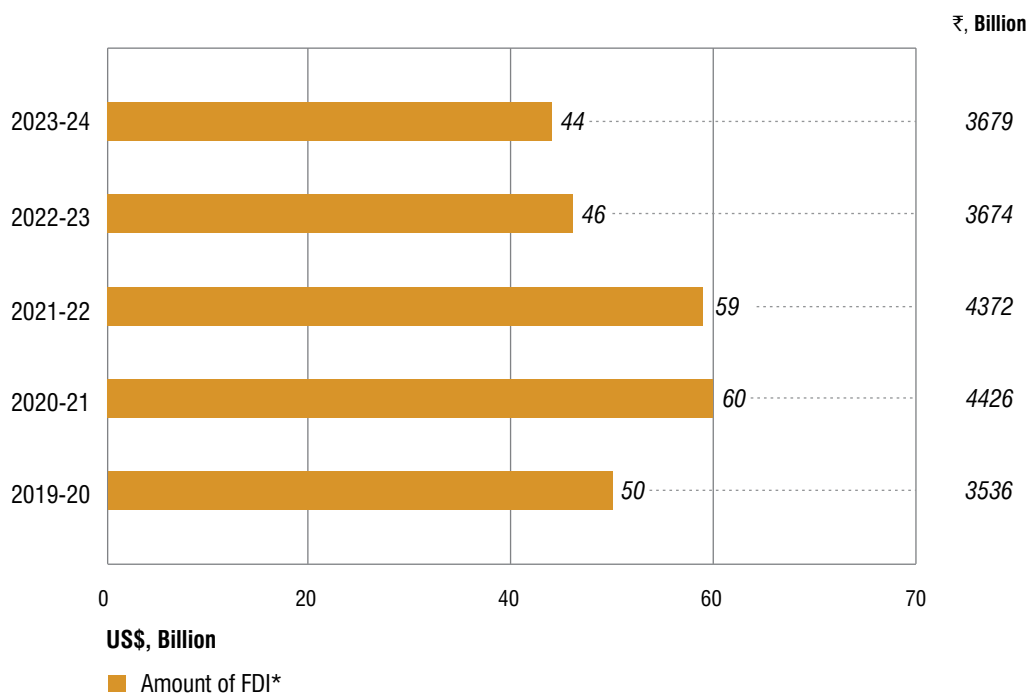


Source: Reserve Bank of India (RBI) Balance of Payment (various years) available at https://www.rbi.org.in/scripts/SDDS_ViewDetails.aspx?SDDSID=254&ID=5; Centre for Technology, Innovation and Economic Research (CTIER)

Note: Figures reported above are calculated for calendar years. The Reserve Bank of India (RBI), Balance of Payments captures fiscal year data on Charges for the Use of Intellectual Property (CIP). CIP for the fiscal year 2022-23 was USD 9.4 billion and for the fiscal year, 2023-24 was USD 13.4 billion.

India's payments for the use of intellectual property was USD 14.4 billion in 2023 compared to USD 7.9 billion in 2019. The technology receipts have seen an increase from USD 0.9 billion in 2019 to USD 1.5 billion in 2023.

6.6 | Annual Foreign Direct Investment Equity Inflows into India (2020 - 2024)

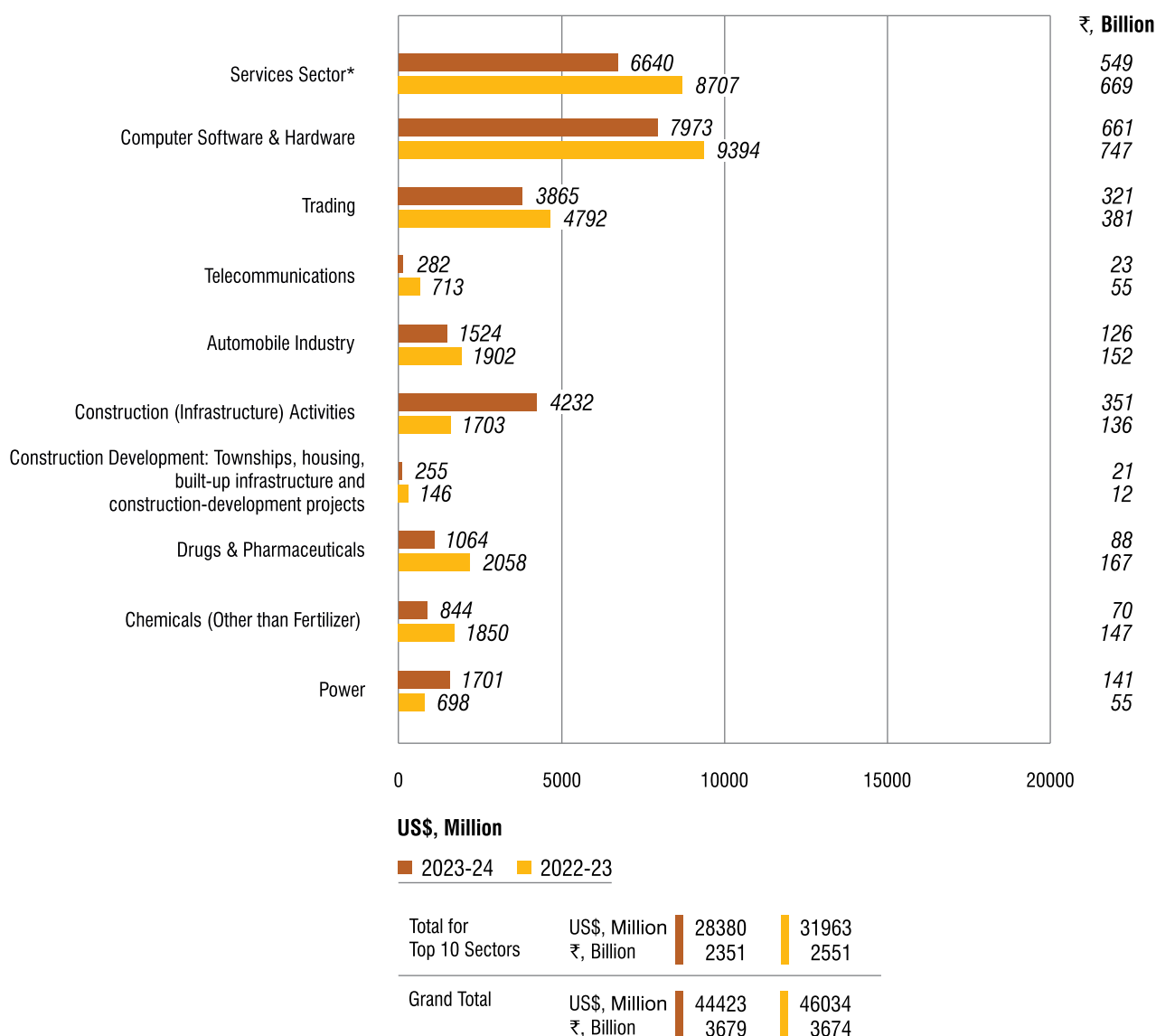


*Amount of FDI doesn't include reinvested earnings and other capital. This amounted to around USD 27 billion in 2023-24.

Source: Department for Promotion of Industry and Internal Trade (DPIIT), Government of India, Quarterly FDI Factsheet, March 2024 available at https://dpiit.gov.in/sites/default/files/FDI_Factsheet_30May2024.pdf; Center for Technology, Innovation and Economic Research (CTIER)

The Foreign Direct Investment (FDI) equity inflows in 2023-24 amounted to USD 44 billion, as reported by the Department for Promotion of Industry and Internal Trade (DPIIT). The equity inflows reported above include FDI received through the government route, RBI's automatic route and acquisition of shares route. The FDI received in 2023-24 was lower than the amount received in 2022-23. The amount received as FDI through reinvested earnings, equity capital of unincorporated bodies and other capital amounted to USD 27 billion in 2023-24. The various components of FDI as reported by the RBI can be found in the Appendix (Table A.2).

6.6.1 | FDI Equity Inflows into India by Sector (2022-23 and 2023-24)



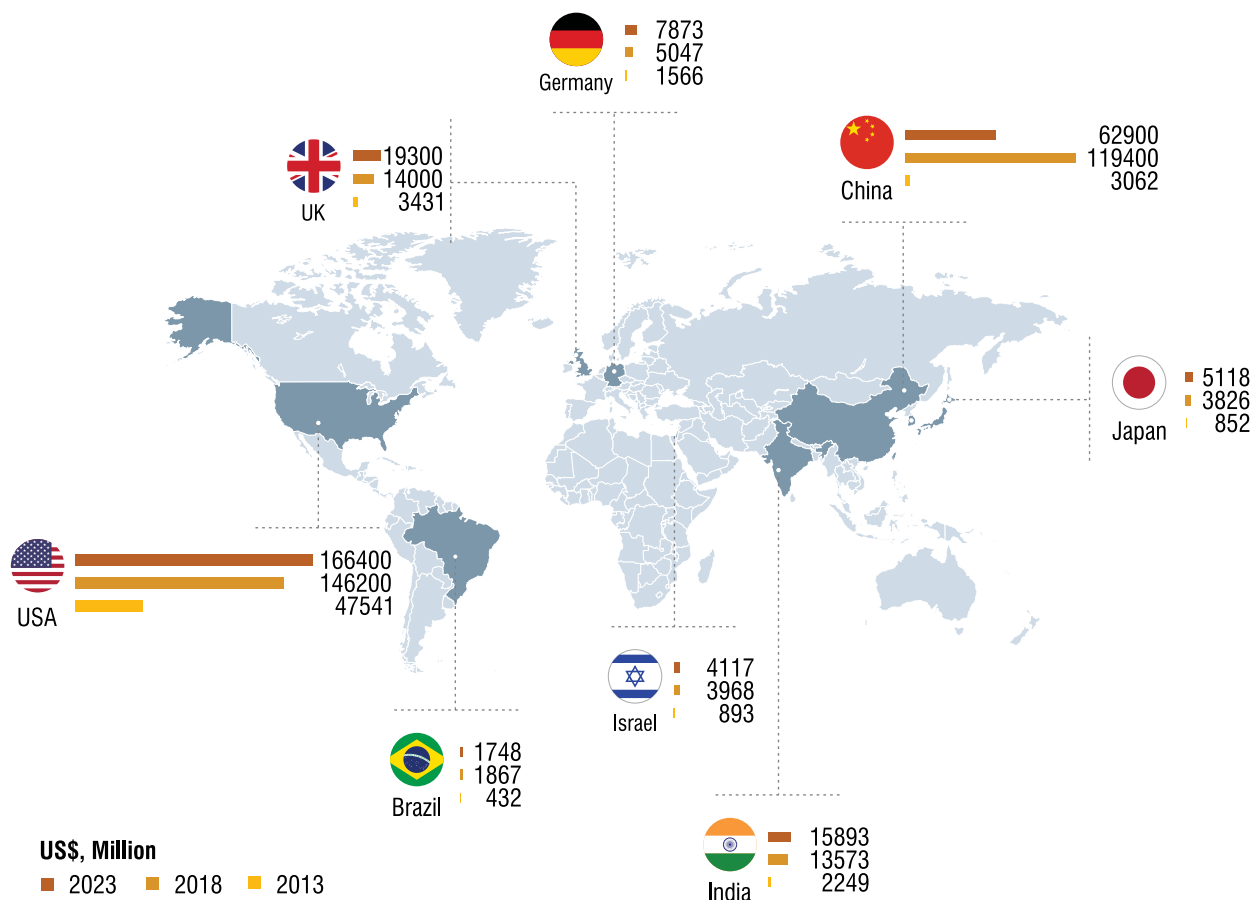
*Services sector includes Financial, Banking, Insurance, Non-Financial / Business, Outsourcing, R&D, Courier, Tech. Testing and Analysis

Source: Department for Promotion of Industry and Internal Trade (DPIIT), Government of India, Quarterly FDI Factsheet, March 2024 available at https://dpiit.gov.in/sites/default/files/FDI_Factsheet_30May2024.pdf

FDI equity inflows excluding reinvested earnings etc. came in at USD 44 billion in 2023-24. The figure above captures FDI inflows for ten sectors in 2023-24 and 2022-23. These ten sectors have been organised based on the highest amount of FDI attracted (on a cumulative basis for each sector) since the year 2000. The figure for the top 10 sectors that attracted FDI in 2023-24 alone can be found in the Appendix (Table A.3). The computer software & hardware sector was the highest recipient of FDI inflows in 2023-24 amounting to USD 7.9 billion, followed by the services sector at USD 6.6 billion.

Sectors such as telecommunications, construction development (including townships, housing, built-up infrastructure and construction-development projects) and chemicals (other than fertilizers) did not feature in the top 10 sectors that attracted highest FDI in 2023-24 alone. The sectors that dropped off were replaced by non-conventional energy, which attracted USD 3.7 billion, hospital & diagnostic centres that attracted USD 1.5 billion and sea transport that attracted around USD 1 billion in 2023-24.

6.7 | Venture Capital Investment (USD Million) in Select Countries

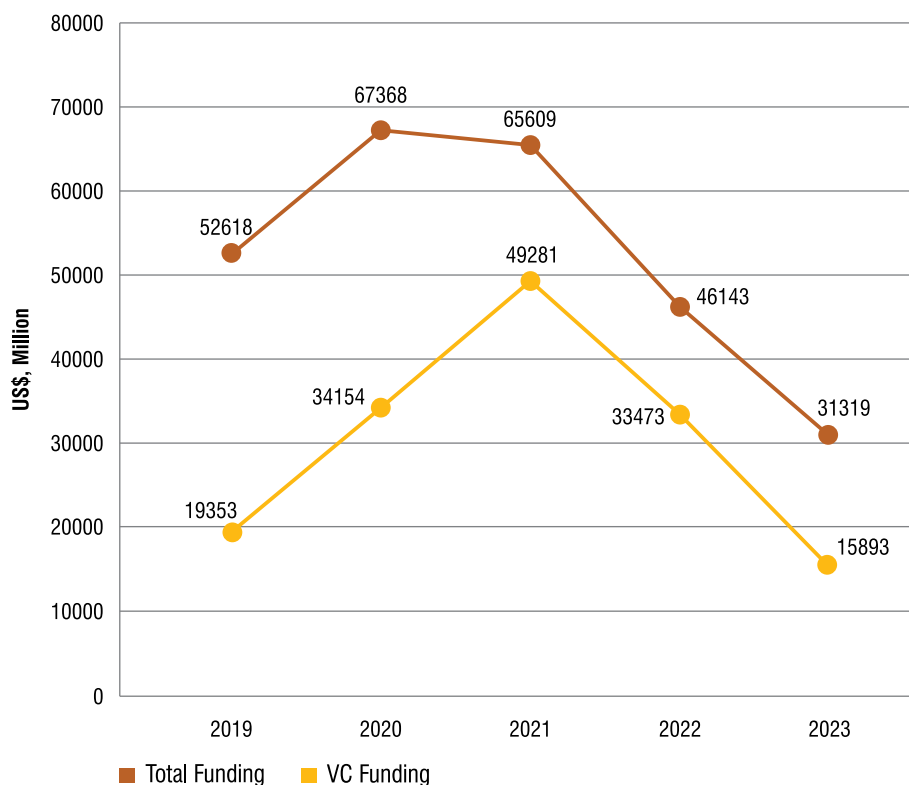


Source: Data reported as 2023, 2018 for all countries except India is from Venture Pulse Q2 24: Global Analysis of Venture Funding, KPMG Private Enterprise; Data reported as 2013 for all countries except India is from National Science Foundation (NSF), Science & Engineering Indicators 2020, Invention, Knowledge Transfer and Innovation - Global Venture Capital Investment, by financing stage, selected region, country or economy: 2010-18; Tracxn data for India for 2023, data downloaded on 30 September 2024 from the platform; Data for India for 2013, 2018 is from the CTIER Handbook 2021

India was one of the top destinations for VC funding after the US, China and the UK and saw total VC funding of around USD 15.8 billion in 2023. The US recorded VC funding of USD 166.4 billion followed by China that saw VC funding of USD 62.9 billion and the UK received USD 19.3 billion. For all countries except India we have used data from the KPMG Venture Pulse Q2 2024 report, while the data for India is from the Tracxn database. The VC data for India includes growth stage funds and funding for all companies including startups.

The 2013 data above uses NSF S&E Indicators 2020 for all countries except India. While data for 2013 is unavailable in the KPMG Venture Pulse Q2 2024 report (which reports data from 2018 onwards), the data reported in NSF S&E Indicators 2020 is comparable with the KPMG Venture Pulse report especially for the overlapping years i.e 2018 to 2022 and hence has been used to report data for 2013. The data for South Korea and Taiwan in the latest source used here were unavailable and hence have been excluded in the chart above. The data on India from Tracxn includes growth stage funds which may be excluded in other sources. To compare VC funding for USA, China and India based on KPMG and NSF S&E Indicators 2024, please refer to the Appendix (Table A.5)

6.7.1 | Total and VC Funding for Companies (USD Million) in India (2019 - 2023)



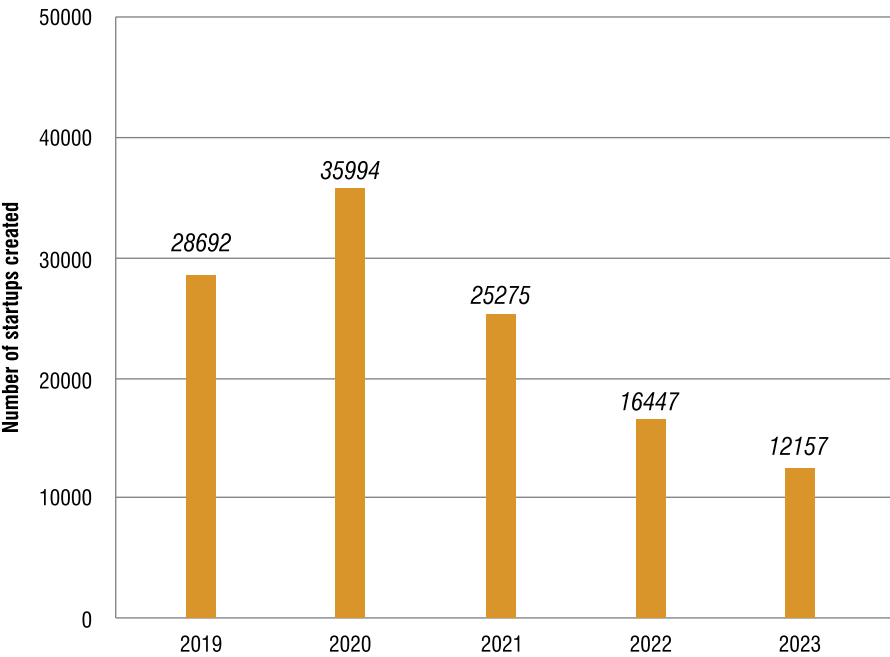
Source: Tracxn (various years), data downloaded on 30 September 2024 from the platform; Centre for Technology, Innovation and Economic Research (CTIER)

Note: Total Funding includes Venture Capital, Private Equity, Angel and Debt

Total funding in terms of Private Equity (PE), Venture Capital (VC) and debt in India was USD 31 billion in 2023 compared to USD 52 billion in 2019. There has been a consistent decline in total funding from USD 67 billion in 2020 to USD 31 billion in 2023. In 2023, VC funding accounted for around 51 percent of total funding while conventional debt accounted for 27 percent. Private equity accounted for very little of the total funding in 2023. The details of the breakup of funding into categories like seed funding, various series rounds, etc. can be found in the Appendix (Table A.4). The data on VC funding includes rounds from seed funding onwards to series K.

The VC funding captured above is from the Tracxn platform and includes funding for technology and offline companies. The Appendix (Table A.5) provides a comparison of the VC funding data for India as reported by NSF. When one applies the criteria for startups (and new companies) i.e. founded in the last 10 years, the total funding amount was USD 14.7 billion in 2023.

6.7.2 | Number of Startups Created in India (2019 - 2023)



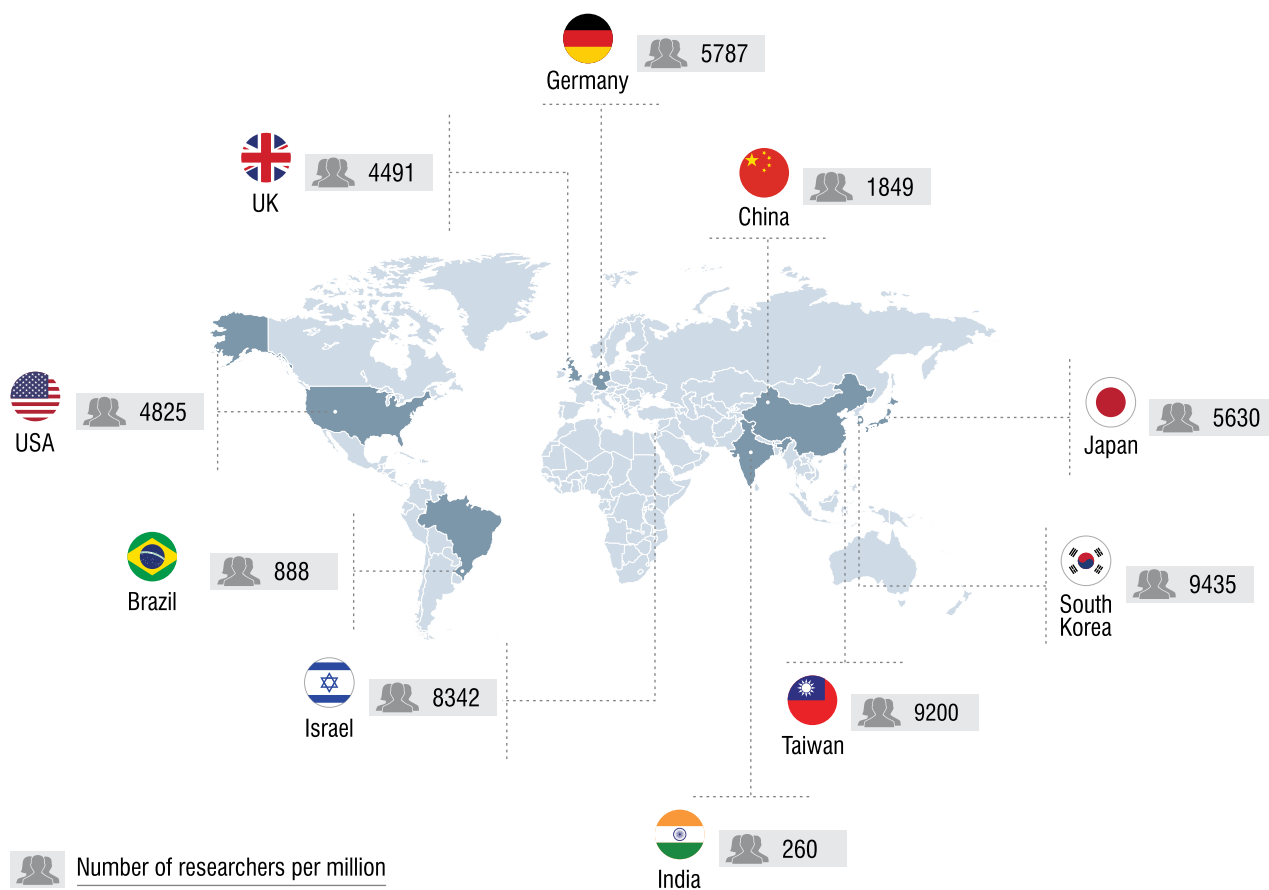
Source: Tracxn (various years), data downloaded on 13 September 2024 from the platform; Centre for Technology, Innovation and Economic Research (CTIER)

The startups (and new companies) created in India have witnessed a steady decline from 2020 to 2023. The reported startup data (as of September 2024) is subject to change as the database may get updated when new startups founded in a particular year are identified. For instance, the number of startups (and new companies) including offline startups previously reported⁵ were 18,252 and 22,579 in 2019 and 2020 respectively, compared to 28,692 and 35,994 in 2019 and 2020 as seen in the chart above. The numbers may also vary depending on the source of the data on startups. Entities that conform to the definition of a startup⁶ and have been recognised by the Department for Promotion of Industry and Internal Trade (DPIIT) can be found on the Startup India website.

⁵ CTIER Handbook: Technology and Innovation in India 2023

⁶ See Glossary B.27

6.8 | Country-wise Comparisons for Full Time Researchers per Million (2023)

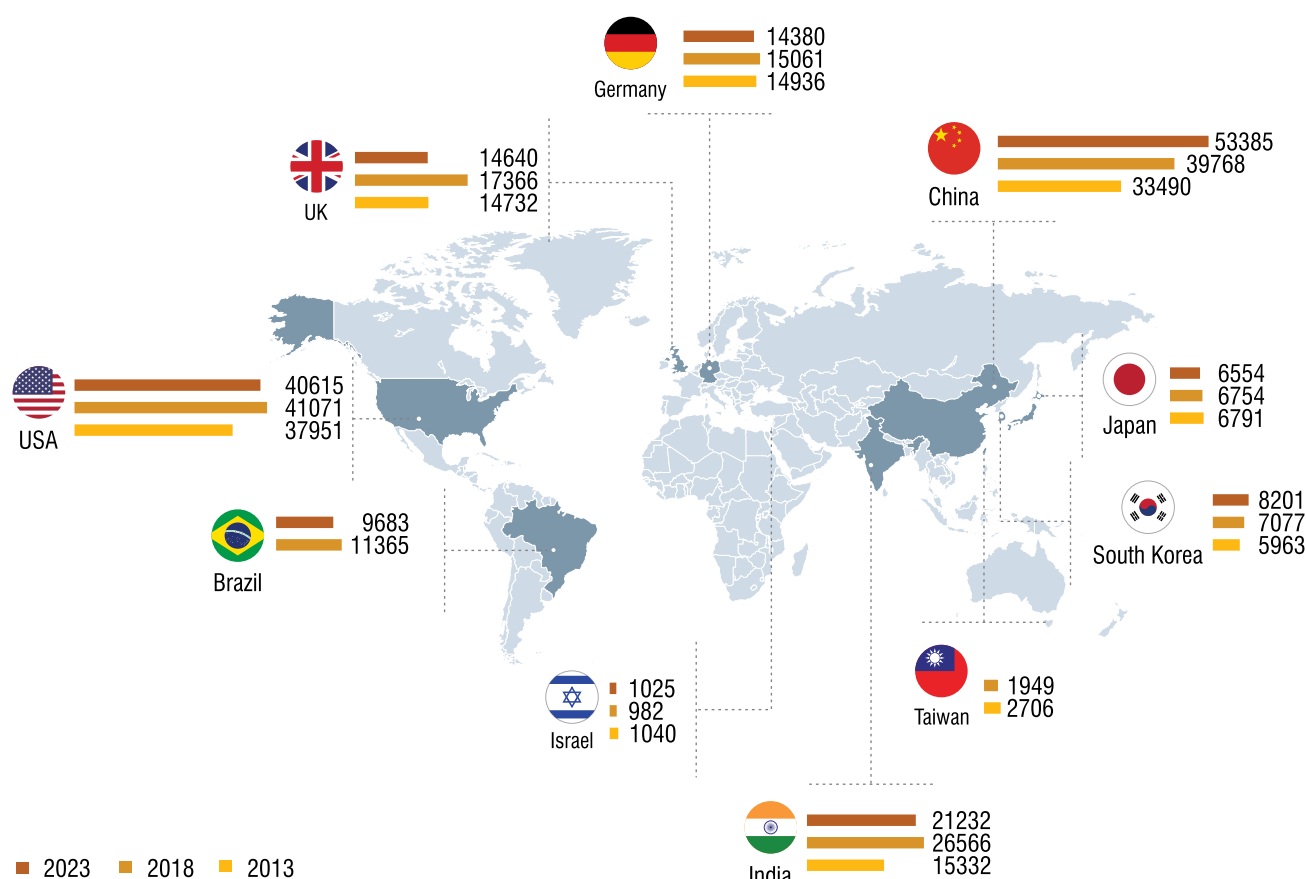


Source: UNESCO Institute of Statistics (2022), UNESCO Institute for Statistics, available at <http://data.uis.unesco.org/> for data on Brazil, China, Germany, India, Israel, Japan, South Korea, UK and USA; Statistical Yearbook of the Republic of China for data on Taiwan (2023) available at <https://ws.dgbas.gov.tw/001/Upload/466/refile/11503/233937/yearbook2023.pdf>; Centre for Technology, Innovation and Economic Research (CTIER)

Note: (i) Data reported for USA is for 2021
(ii) Data reported for India is for 2020
(iii) Data reported for UK is for 2017
(iv) Data reported for Brazil is for 2014
(v) Data reported for Israel is for 2012

In 2022, India had 260 full-time researchers per million compared to 1,849 researchers per million in China and 4,825 researchers per million in the US. India's number of researchers per million is significantly below that of all select economies in the chart above. South Korea had the highest number of researchers per million at 9,435. This was followed by Taiwan which had 9,200 researchers per million.

6.9 | Country-wise Comparison of Global Science and Engineering (S&E) PhDs



Source: OECD Data Explorer, Graduates by field, available at https://stats.oecd.org/Index.aspx?DataSetCode=EDU_GRAD_FIELD#; Ministry of Human Resource Development, Department of Higher Education, All India Survey on Higher Development (AISHE) Report (various years), National Science Foundation (NSF), Science & Engineering Indicators 2024, International S&E Higher Education and Student Mobility, S&E doctoral degrees awarded, by selected country: 2011–20, available at <https://nces.nsf.gov/pubs/nsb20243/talent-u-s-and-global-stem-education-and-labor-force>; National Science Foundation (NSF), Science & Engineering Indicators 2022, Higher Education in Science and Engineering, S&E doctoral degrees by selected region, country, or economy and field: 2010–18, available at <https://nces.nsf.gov/pubs/nsb20221/u-s-and-global-stem-education-and-labor-force>; Ministry of Education for data on China; Statistical Yearbook of the Republic of China for data on Taiwan (2023) available at <https://ws.dgbas.gov.tw/001/Upload/466/refile/11503/233937/yearbook2023.pdf>

Note: (i) Data for 2013 for Brazil not available
(ii) Data for 2023 for Taiwan based on CTIER estimates
(iii) Data reported as 2023 for India and China is as of 2022
(iv) Data reported as 2023 for US, UK, Germany, Japan, Brazil, Israel, South Korea is as of 2021 based on OECD Data Explorer

In 2023, China had 53,385 S&E PhDs followed by the US that had 40,615 S&E PhDs. India's S&E PhDs at 21,232 was the third highest among the select economies. India's share of S&E PhDs in total PhDs was 65 percent in 2023, comparable to that in China and Israel and significantly higher than that for Japan and South Korea.

The data for India is based on the PhD numbers reported in the annual reports of the All India Survey of Higher Education (AISHE). The categories considered from the AISHE reports include Science, Engineering & Technology and IT & Computer, Agriculture, Veterinary & Animal Sciences, Social Science, Fisheries Science and Marine Science/Oceanography. These categories are in line with data that has thus far been reported by NSF. The NSF uses the International Standard Classification of Education (ISCED) 2011 to define S&E subject categories. Based on NSF data the following categories were considered when computing S&E PhDs - physical and biological sciences and mathematics and statistics, computer sciences, agricultural sciences, engineering and social and behavioural sciences. For all other countries, the data has been taken from the NSF Science & Engineering Indicators, 2024, NSF Science & Engineering Indicators, 2022 and OECD Data Explorer.

6.9.1 | Degrees Awarded in S&E Degree Programmes in India (2023)

Field	Degrees Awarded in S&E				
	PhD	Postgraduate	Undergraduate	M.Phil	Total
Natural Science	7408	260862	1197333	1141	1466744
Agriculture, Fisheries, Marine, Veterinary & Animal Sciences	2372	15503	69063	3	86941
Engineering & Technology	6891	134952	1087830	205	1229878
Medical Science	2073	71936	293528	112	367649
Social Science	4561	386618	263974	1408	656561
Non S&E	9261	905967	4842495	3118	5760841
Grand Total	32566	1775838	7754223	5987	9568614

Source: Ministry of Human Resource Development, Department of Higher Education, All India Survey on Higher Education (AISHE) Report 2021-22 available at <https://cdnbbsr.s3waas.gov.in/s392049debb566ca5782a3045cf300a3c/uploads/2024/02/20240719952688509.pdf>

Note: Engineering & Technology also includes degrees awarded in IT & Computer

As seen in the previous indicator, the number of S&E PhDs awarded in India in 2022 stood at 21,232 and accounted for 65 percent of the total PhDs awarded. The S&E PhDs awarded were largely dominated by the natural sciences at 7,408 followed by engineering & technology at 6,891. S&E postgraduate⁷ degrees, excluding the degrees awarded in medical science, accounted for 45 percent of the total number of postgraduate degrees awarded in 2022. The S&E postgraduate degrees were dominated by social science at 3,86,618 followed by natural science at 2,60,862. The S&E undergraduate degrees, excluding the degrees awarded in medical science, accounted for 34 percent of the total number of undergraduate degrees awarded in 2022. For the undergraduate S&E degrees, the degrees awarded in natural science were the highest at 11,97,333 followed by engineering & technology at 10,87,830. In the computation of S&E PhDs, postgraduate and undergraduate degrees, the degrees awarded in medical science have been excluded for the purpose of international comparability based on data reported by NSF.

⁷ Programme after Graduation and generally having the duration of 2/3 years in General/Professional courses (AISHE)

6.9.2 | Enrolment in S&E Degree Programmes in India (2023)

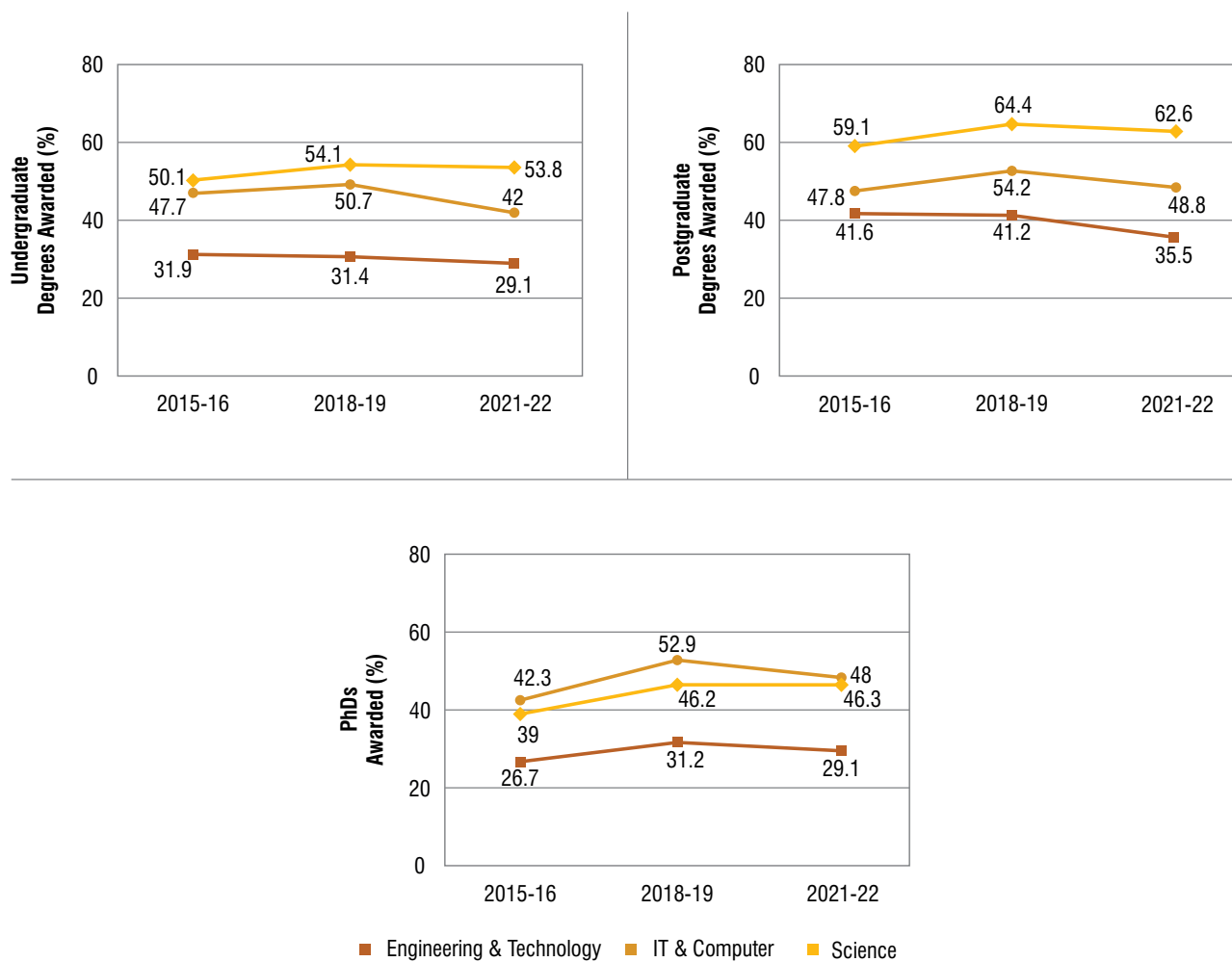
Field	Enrolment in S&E Degree Programmes				
	PhD	Postgraduate	Undergraduate	M.Phil	Total
Natural Science	45324	752807	4918425	1629	5718185
Agriculture, Fisheries, Marine, Veterinary & Animal Sciences	8549	42636	327694	4	378883
Engineering & Technology	56935	403406	4832527	171	5293039
Medical Science	15081	248171	1705701	208	1969161
Social Science	26057	1080202	1284628	2547	2393434
Non S&E	60528	2592643	20058754	4958	22716883
Grand Total	212474	5119865	33127729	9517	38469585

Source: Ministry of Human Resource Development, Department of Higher Education, All India Survey on Higher Education (AISHE) Report 2021-22 available at <https://cdnbbsr.s3waas.gov.in/s392049debbbe566ca5782a3045cf300a3c/uploads/2024/02/20240719952688509.pdf>

Note: Engineering & Technology also includes enrolment in IT & Computer

The table above reports the data on enrolment in S&E PhD, postgraduate and undergraduate programmes. The number of S&E PhD enrolments stood at 1,36,865 and accounted for 64 percent of total PhDs enrolled in 2022. The S&E PhDs enrolments are largely dominated by engineering & technology at 56,935 and natural sciences at 45,324. S&E postgraduate degree enrolments, excluding enrolments in the medical science programme, accounted for 45 percent of the total number of postgraduate. Social science had the highest number of enrolments at 10,80,202 followed by natural sciences at 7,52,807 and engineering & technology 4,03,406. S&E undergraduate enrolments, excluding enrolments in the medical science programme, accounted for 34 percent of the total number of enrolments in undergraduate programmes. Enrolment in natural science dominates at 49,18,425 followed by engineering & technology at 48,32,527. In the computation of enrolment in S&E PhDs, postgraduate and undergraduate programmes, the enrolments in the medical science programmes have been excluded for the purpose of international comparability based on data reported by NSF.

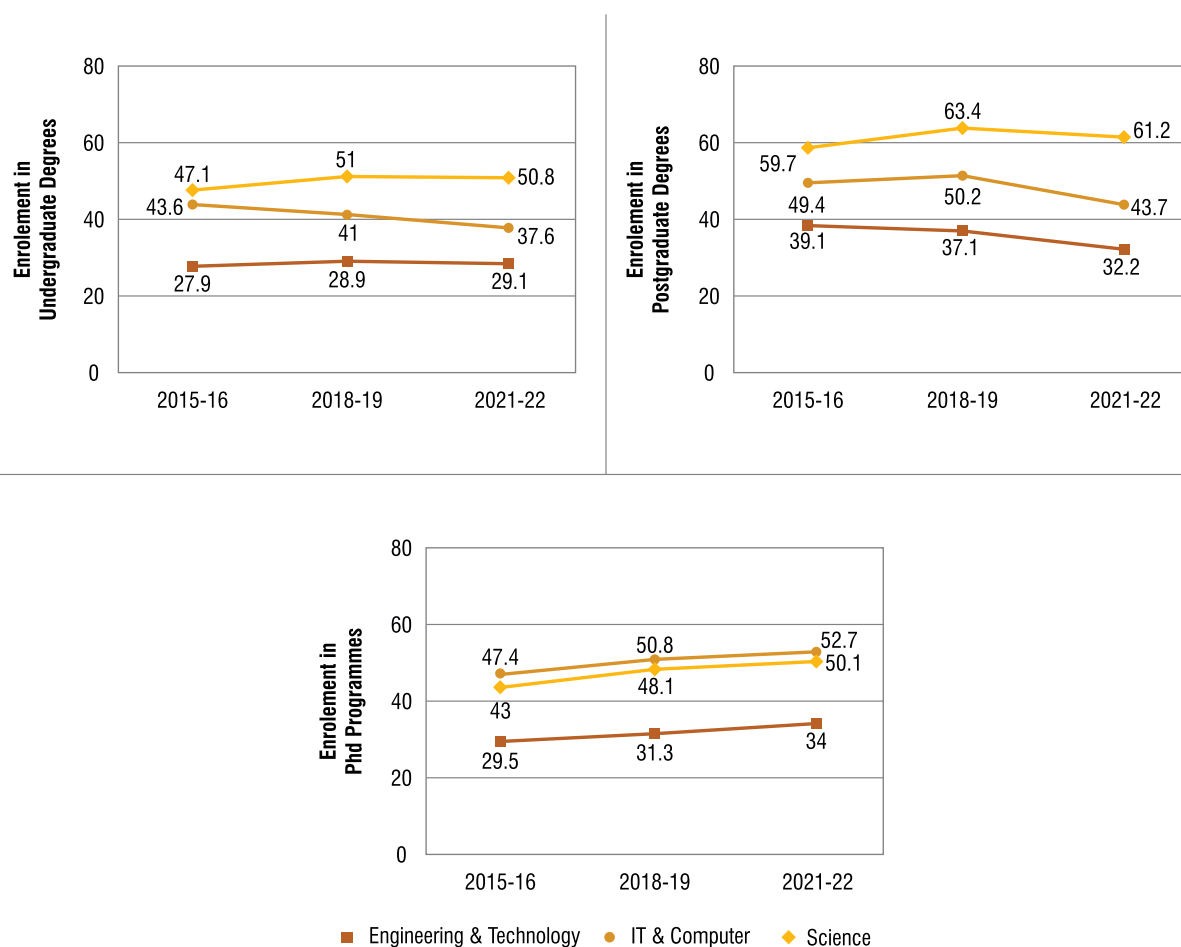
6.9.3 | Degrees Awarded to Women in STEM Degree Programmes in India



Source: Ministry of Human Resource Development, Department of Higher Education, All India Survey on Higher Education (AISHE) Report (various years), Centre for Technology, Innovation and Economic Research (CTIER)

For STEM degrees awarded at the undergraduate level in 2022, women accounted for 54 percent in the science field, 42 percent in the IT & computer field and 29 percent in the engineering & technology field. In the science field, the share of women receiving undergraduate degrees has seen a slight drop from 2019 to 2022. When considering postgraduate degrees in 2022, women accounted for 63 percent of degrees awarded in the science field, 49 percent in the IT & computer field and 36 percent in the engineering & technology field. The share of women in postgraduate degrees awarded in science have also seen a slight drop from 2019 to 2022. At the PhD level, women accounted for 46 percent of PhD degrees awarded in science, 48 percent of degrees awarded in the IT & computer field and 29 percent of the PhD degrees awarded in the engineering & technology field. There has been a noticeable drop in the share of women in PhDs awarded in the IT & computer field from 2019 to 2022.

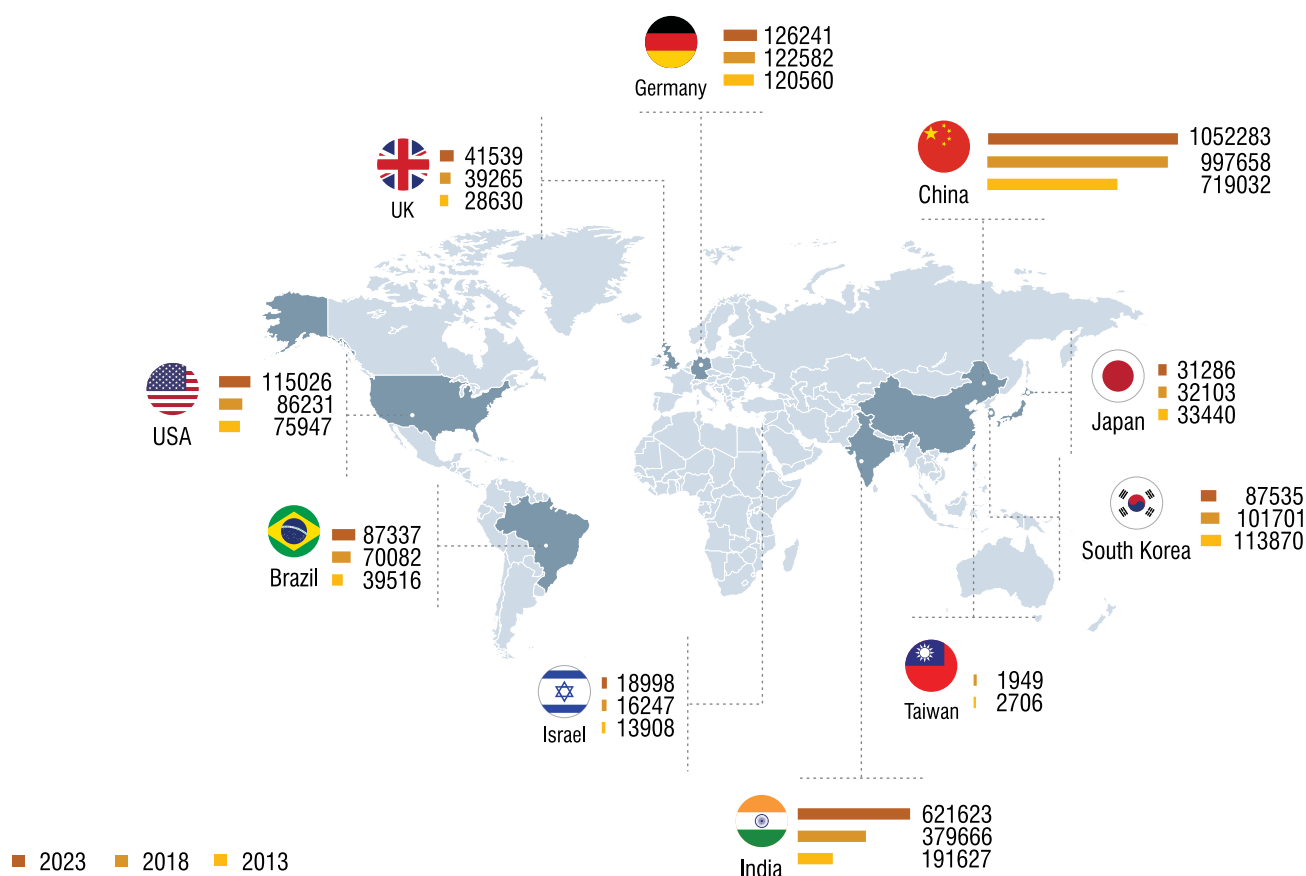
6.9.4 | Enrolment of Women in STEM Degree Programmes



Source: Ministry of Human Resource Development, Department of Higher Education, All India Survey on Higher Education (AISHE) Report (various years), Centre for Technology, Innovation and Economic Research (CTIER)

The share of women in total enrolment at the undergraduate level in 2022 was 51 percent in the science field, 38 percent in the IT & computer field and 29 percent in the engineering & technology field. For enrolment in the science field, the share of women has seen an increase from 47 percent in 2016 to 51 percent in 2022, whereas for the IT & computer field the share has decreased from 44 percent in 2016 to 38 percent in 2022. At the postgraduate level, the share of women in total enrolment was 61 percent in the science field, 44 percent in the IT & computer field and 32 percent in the engineering & technology field. There has been a decline in share of women in engineering & technology degree enrolment from 39 percent in 2016 to 32 percent in 2022. At the PhD level, the share of women in total STEM enrolment was 50 percent for the science field, 53 percent for the IT & computer field and 34 percent for the engineering & technology field. There has been a steady increase in the share of women in PhD enrolment for all three fields from 2016.

6.10 | Country-wise Outward Mobility of Tertiary Students



Source: UNESCO Institute of Statistics, available at <https://data.uis.unesco.org/index.aspx?queryid=3804#>

Note: 2023 data reported is for 2022

China and India have consistently seen the highest number of outbound tertiary students from 2013 to 2023. Around 57 percent of the outbound students from China and 71 percent of the outbound students from India went to study in North America and Western Europe.

Both South Korea and Japan have seen a decrease in the number of outbound tertiary students between 2013 and 2023.

Outbound tertiary students are individuals that have moved to a country other than their own for tertiary education.

6.11 | Persons Employed (full-time equivalent) as Researchers by R&D Establishments in India

Name of Establishment	2015			2018			2021		
	Researchers	Total Staff*	Researchers as share of total (%)	Researchers	Total Staff*	Researchers as share of total (%)	Researchers	Total Staff*	Researchers as share of total (%)
A. Institutional Sector									
Major scientific agencies	54331	135179	40.2	53891	122165	44.1	57137	122948	46.5
Central government ministries/departments	10030	50070	20	8790	30429	28.9	10157	26585	38.2
State governments	21450	78172	27.4	16376	48794	33.6	18211	49008	37.2
Total institutional sector (A)	85811	263421	32.6	79057	201388	39.3	85505	198541	43.1
B. Higher Education Sector (B)**	113074	113074	-	124702	124702	-	137526	137526	-
C. Industrial Sector									
Public sector including joint sector	10400	15879	65.5	9291	12035	77.2	7568	9378	80.7
Private sector	64446	111459	57.8	107003	155489	68.8	103445	134114	77.1
SIRO ***	9263	24386	38	21765	59355	36.7	27880	75152	37.1
Private + SIRO	73709	135845	54.3	128768	214844	59.9	131325	209266	62.8
Total industrial sector (C)	84109	151724	55.4	138059	226879	60.9	138893	218644	63.5
Total (A + B + C)	282994	528219	53.6	341818	552969	61.8	361924	554711	65.2

*Total Staff includes manpower engaged in R&D, auxiliary and administrative activities

**Data on manpower engaged in auxiliary and administrative activities is unavailable for the higher education sector

***Scientific and Industrial Research Organisation

Source: Department of Science and Technology (DST), Government of India, S&T Indicators Tables, Research and Development Statistics 2022-23, available at <https://dst.gov.in/sites/default/files/Updated%20ST%20INDICATORS%20TABLES%202022-23.pdf>; Research and Development Statistics 2019-20, available at https://dst.gov.in/sites/default/files/Research%20and%20Development%20Statistics%202019-20_0.pdf; Research and Development Statistics 2017-18, available at http://digitalrepository-nstms-dst.org/files/stats/2017-18/Science_&_Technology_Indicators_2017-18.pdf; Centre for Technology, Innovation and Economic Research (CTIER)

The table above considers manpower at R&D establishments in India as reported by the Department of Science & Technology (DST). The number of employees engaged in R&D activities as a share of total manpower has increased to 65 percent in 2021 from 62 percent in 2018. The private sector and SIROs saw a combined increase in the number of researchers around 2 percent in 2021 compared to 2018. The number of researchers in the higher education sector increased around 10 percent in 2021 compared to 2018, while the number of researchers in major scientific agencies, central government ministries/departments and state governments saw a 8 percent increase in the number of researchers in 2021 compared to 2018.

The total number of full-time equivalent researchers in India was 3,61,924 in 2021 and as seen in Indicator 6.8, the number of full-time researchers per million population remains low compared to many countries. The data on manpower engaged in auxiliary and administrative activities is unavailable for the higher education sector.

6.12 | Country-wise Comparisons by Share of Publications, Impact and Share of Industry Collaborations in Total Publications (2019 - 2023)

Country		Global Rank	Share in Global Publication Output (%)	Category Normalized Citation Impact	Share of Industry-Academia Collaborations (%)	Share of International Collaborations (%)
Select Advanced Economies	USA	1	23.6	1.3	4.5	35.6
	UK	3	7.3	1.4	4.7	59.1
	Germany	4	5.9	1.3	6.3	55.7
	Japan	7	3.9	0.9	6.4	33.6
Select Emerging Economies	Brazil	13	2.4	0.9	2.1	40.8
	China	2	22.8	1.2	2.3	22.8
	India	5	4.6	0.9	1.2	30.3
	Israel	32	0.8	1.3	3.8	51.4
	South Korea	12	2.9	1.1	4.3	33.5

Source: InCites (based on data from Web of Science), data downloaded from the platform on 6 January 2025; Centre for Technology, Innovation and Economic Research (CTIER)

Note: Data is based on cumulative publications by each country (2019 - 2023)

With respect to global publication output, India ranked fifth with 7,14,016 publications or around 5 percent of the cumulative global publication for the years 2019 to 2023.⁸ The impact of these global publications is measured using the Category Normalized Citation Impact (CNCI) devised by the data analytics software 'InCites'.⁹ India, together with Japan and Brazil, has the lowest CNCI score among the select countries in the table above. A reading of above one for CNCI indicates the impact of publications is above world average.

In terms of industry collaborations, India has the lowest share of industry collaborations among the select economies. India's share of industry collaborations is around 1 percent of its total publications. Japan has the highest share of industry collaborations at around 6.4 percent followed by Germany at 6.3 percent. The share of industry collaborations is calculated by dividing publications that have at least one industry co-author by the total number of publications. Within the sample of select countries, the UK and Germany have the highest share of international collaborations at around 59 percent and 56 percent respectively, while China has the lowest share of international collaboration at nearly 23 percent. India's share of international collaborations was around 30 percent.

If one includes publications between 2019 and 2023 that appear in journals that are part of the Emerging Sources Citation Index (ESCI)¹⁰, India's rank in global publication output remains in fifth position. The country-wise comparisons of publication output when ESCI journals are included can be found in the Appendix (Table A.7).

⁸ Values are based on cumulative publication output from 2019 - 2023. Five year cumulative values have been considered to account for the lag between the year a paper is published and when it starts being cited.

⁹ See Glossary B.1

¹⁰ Journals included in the Emerging Sources Citation Index (ESCI) cover all disciplines and range from international and broad scope publications to those that provide deeper regional and specialty area coverage. These journals are part of the Web of Science Core Collection™ and have been selected by experts from Clarivate for their editorial rigour and best practice at a journal level.

6.13 | Country-wise Comparison by Share of Publications, Impact, Share of Industry Collaborations and Share of International Collaborations by Top Subject Categories (2019 - 2023)

Rank	Sector	Output Indicators	Global Average	Select Advanced Economies				Select Emerging Economies				
				USA	UK	Germany	Japan	Brazil	China	India	Israel	South Korea
1	Electrical & Electronic Engineering	Share in Global Publication Output (%)	-	15.2	4.9	4.5	4.5	1.6	35.4	7.7	0.5	4.7
		Category Normalized Citation Impact	1	1.5	1.4	1.1	0.8	0.7	1.1	0.8	1.1	1
		Industry Collaborations (%)	5	9.5	5.7	11.9	10.8	2.3	4.7	1.6	7.7	8.8
		International Collaborations (%)	23.4	42.2	70.5	44.4	28.8	38.1	24.1	24.4	48.9	29.2
2	Multidisciplinary Materials Science	Share in Global Publication Output (%)	-	12.8	4	5.6	4.5	1.5	41.6	8.9	0.5	5.8
		Category Normalized Citation Impact	1	1.3	1.1	1	0.8	0.6	1.3	1	1	1
		Industry Collaborations (%)	2.4	4.4	4.8	4.7	7.3	1.3	1.8	0.8	2	5.1
		International Collaborations (%)	26.2	53.8	75.6	63.7	46.1	43	23	27	60.8	37.2
3	Environmental Sciences	Share in Global Publication Output (%)	-	15.6	5.8	4.9	2.6	3	35.6	5.4	0.5	3.3
		Category Normalized Citation Impact	1	1.1	1.3	1.2	1	0.8	1.3	1.1	1	1
		Industry Collaborations (%)	1.4	2.9	2.5	3.1	3.4	1	1.4	0.5	1.4	2
		International Collaborations (%)	30.6	55.8	78.6	69.9	57.9	45.4	26.9	39.2	57.2	41.6
4	Multidisciplinary Chemistry	Share in Global Publication Output (%)	-	15.8	4.3	6.1	4.9	1.5	34.1	5.6	0.7	5.6
		Category Normalized Citation Impact	1	1.2	1.2	1.1	0.8	0.6	1.4	0.8	1	0.9
		Industry Collaborations (%)	2	3.9	6	4.5	4.8	1.4	1.3	0.9	1.6	2.9
		International Collaborations (%)	25.2	44.2	71	59.1	37	43.3	22.8	36.3	54.7	32.7
5	Oncology	Share in Global Publication Output (%)	-	33.7	6.6	7.1	7	1.3	22	2.1	1	3.2
		Category Normalized Citation Impact	1	1.5	2.1	1.8	1.5	2	1	0.8	2.3	2.7
		Industry Collaborations (%)	4.4	9.8	16.2	16.3	11.2	12.6	1.9	3.6	16.3	16.7
		International Collaborations (%)	19.2	33.5	64.8	55.2	23.7	52.2	14	32.8	66.4	33.9

Source: InCites (based on data from Web of Science), data downloaded from the platform on 7 January 2025; Centre for Technology, Innovation and Economic Research (CTIER)

Note: Data is based on cumulative publications by each country (2019 - 2023)

Rank	Sector	Output Indicators	Global Average	Select Advanced Economies				Select Emerging Economies				
				USA	UK	Germany	Japan	Brazil	China	India	Israel	South Korea
6	Applied Physics	Share in Global Publication Output (%)	-	12.9	4.1	6.3	6.1	1	38.4	6.2	0.7	6.4
		Category Normalized Citation Impact	1	1.3	1.2	1.1	0.8	0.7	1.3	0.9	1	1
		Industry Collaborations (%)	2.8	5.4	4	5.4	8	1.2	1.9	0.9	2.9	5.5
		International Collaborations (%)	25.9	52.6	76	62.2	37.8	56.2	21.6	33.7	56.6	32.6
7	Biochemistry & Molecular Biology	Share in Global Publication Output (%)	-	22.5	5.8	6.8	5.1	2.5	23.1	5.1	0.9	3.7
		Category Normalized Citation Impact	1	1.3	1.6	1.3	0.9	0.8	1.1	0.9	1.3	1
		Industry Collaborations (%)	1.7	3.4	5.2	4.6	4.3	1	0.8	1	2.8	1.4
		International Collaborations (%)	25.7	44.5	70.6	61.4	33.9	44.7	21	35.8	57.7	30.8
8	Physical Chemistry	Share in Global Publication Output (%)	-	13.9	4.1	6	4.4	1.7	42.6	7.3	0.7	5
		Category Normalized Citation Impact	1	1.1	1	0.9	0.8	0.6	1.4	0.7	0.9	1.1
		Industry Collaborations (%)	2.2	4	4.6	4.3	5.7	1.3	1.7	0.7	1.3	4.2
		International Collaborations (%)	27.5	52.2	74.3	65.3	45.8	43	23.5	33.5	62.3	42.4
9	Computer Science, Artificial Intelligence	Share in Global Publication Output (%)	-	20	6.3	5.4	3.9	1.5	33	7.2	0.8	2.8
		Category Normalized Citation Impact	1	1.6	1.2	1.1	0.6	0.5	1.3	0.7	1.1	1.2
		Industry Collaborations (%)	5.9	14.5	7.6	9.3	9	1.8	6.6	2.1	14.6	9.8
		International Collaborations (%)	24.3	40.8	66.4	44.7	32.6	36	27.3	23.3	50.9	34.4
10	Computer Science, Information Systems	Share in Global Publication Output (%)	-	17.5	5.3	4.6	3.7	1.9	34.7	7.2	0.7	4.8
		Category Normalized Citation Impact	1	1.5	1.4	1.2	0.7	0.6	1.1	0.9	1	1
		Industry Collaborations (%)	4.9	10.8	6.8	9.6	9.6	2.3	5.2	2	11	6.1
		International Collaborations (%)	27.1	46.4	72.9	46.9	33.5	37.7	27.6	31.5	52.6	34.4

In the table, we have considered the top 10 subject categories by cumulative global publication output between 2019 and 2023. By subject category, electrical & electronic engineering has the highest number of global publications. India with around 8 percent of the total global output in this category continues to be the third largest contributor to electrical & electronic engineering publications after China and USA. India is also the third largest contributor for other top subject categories like multidisciplinary materials science, physical chemistry, computer science artificial intelligence and computer science information systems, ranking above advanced economies like the UK, Germany and Japan.

As seen in Indicator 6.12, India's share of publications in total global publications is around 5 percent. In the top 10 subject categories apart from oncology India's share in global publications is greater than 5 percent. Looking at the impact of India's publications, except for subjects like environmental sciences and multidisciplinary material sciences, the impact of India's publications in each of the other top sectors as measured by the CNCI score is below the global average for these subject categories. India's CNCI score for the top subject categories ranges between 0.7 to 1.1.

India's industry collaborations as a share of its total publication output as mentioned in Indicator 6.12 was around 1 percent. For top subject categories like oncology, computer science artificial intelligence, computer science information systems, electrical & electronic engineering and biochemistry & molecular biology, India's share of industry collaborations was 1 percent or higher. When it comes to the share of international collaborations¹¹, India's share was low in subjects like computer science artificial intelligence, electrical & electronic engineering and multidisciplinary materials science, compared to the average share of international collaborations of nearly 30 percent as captured in indicator 6.12 for its total publication output.

¹¹ See Glossary B.13

6.13.1 | India's Top Areas of Cumulative Publications (2019 - 2023) - Impact, Industry Collaborations, International Collaborations and Comparisons with Global Averages

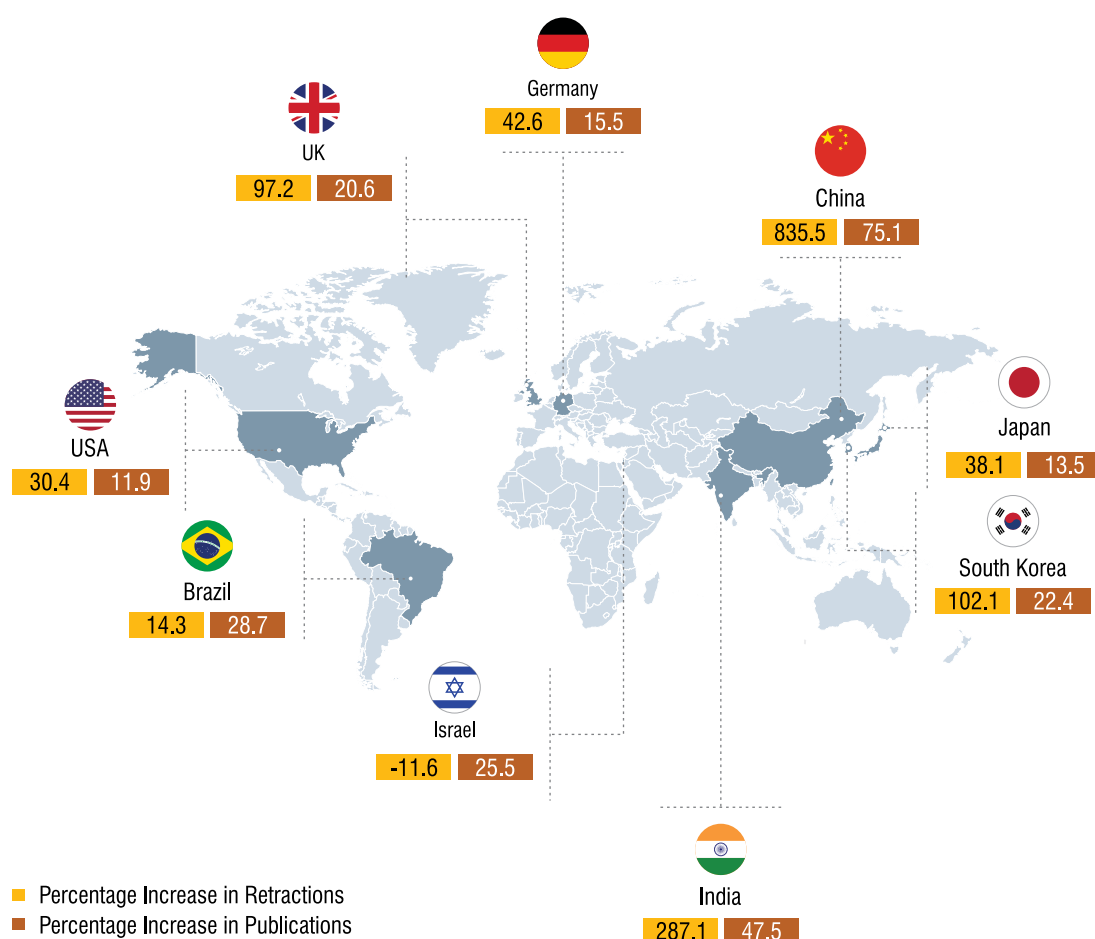
Rank	Top Areas of Indian Publications	Indian Publications	Indian Share of World Publications (%)	Category Normalized Citation Impact		Industry Collaborations (%)		International Collaborations (%)	
				World	India	World	India	World	India
1	Multidisciplinary Material Science	79418	8.9	1	1	2.4	0.8	26.2	27
2	Electrical & Electronic Engineering	70059	7.7	1	0.8	5	1.6	23.4	24.4
3	Physical Chemistry	34516	7.3	1	0.7	2.2	0.7	27.5	33.5
4	Environmental Sciences	33959	5.4	1	1.1	1.4	0.5	30.6	39.2
5	Applied Physics	33044	6.2	1	0.9	2.8	0.9	25.9	33.7
6	Multidisciplinary Chemistry	32912	5.6	1	0.8	2	0.9	25.2	36.3
7	Telecommunicaitons	30009	9.4	1	0.8	5	1.5	25.8	23.7
8	Computer Science, Artificial Intelligence	29845	7.2	1	0.7	5.9	2.1	24.3	23.3
9	Computer Science, Theory & Methods	28849	8.5	1	0.7	5.4	2.2	24.1	19.9
10	Computer Science, Information Systems	28163	7.2	1	0.9	4.9	2	27.1	31.5

Source: InCites (based on data from Web of Science), data downloaded from the platform on 7 January 2025; Centre for Technology, Innovation and Economic Research (CTIER)

Note: Cumulative publication output for India during the period 2019 to 2023 was 714016

India's total cumulative publication output during the period 2019 to 2023 was 7,14,016. By subject category multidisciplinary materials science has the highest share with 79,418 publications or 9 percent of India's total publication output during the period under consideration. This is followed by electrical & electronic engineering science with 70,059 publications or 8 percent of India's total publication output. India's top areas of publication output has eight subject categories in common with the top 10 global areas of publication output. The CNCI scores, with the exception of multidisciplinary materials science and environmental sciences, are below the respective global averages. The share of industry collaborations across India's top subject categories by publication output are also below their respective global averages. The share of international collaborations for the top subject categories for India, apart from telecommunications, computer science theory & methods and computer science artificial intelligence, are higher than the global averages.

6.14 | Country-wise Comparison of Publication Retractions (2019 - 2023)



Source: Retraction Watch Database, data downloaded on 11 November 2024, available at <http://retractiondatabase.org/RetractionSearch.aspx?>; Scopus database, data downloaded on 15 November 2024

Note: (i) Data is based on cumulative publications and retractions by each country
 (ii) Data for publications and retractions is only for research articles

India and China saw large increases in the number of publication retractions between 2019 and 2023 compared to the previous five year period. Only Israel saw a decrease in the number of publication retractions in the same period.

Retractions are a process to remove literature published in academic journals due to serious flaws or errors. Articles may be retracted due to plagiarism, misconduct, or violations of ethical guidelines.¹²

The retraction index is a measure of publication quality which is calculated by looking at the number of retractions in a time period per 1000 papers published in the same period. Of the countries shown in the chart above, only China and India had a retraction rate more than 2 per 1000 papers published. China had a retraction rate of 4 and India a rate of 2.5 retractions per 1000 papers published.

¹² 'Editorial Policies', Nature, available at <https://www.nature.com/nature-portfolio/editorial-policies/correction-and-retraction-policy>

6.15 | Ranking of Institutions in India by Number of Publications (2019 - 2023)

Rank	Name	Number of Publications	Category Normalized Citation Impact	Industry Collaborations (%)	International Collaborations (%)
1	Council of Scientific & Industrial Research (CSIR) - India	30998	0.94	0.91	24.22
2	Indian Council of Agricultural Research (ICAR)	19673	0.81	0.73	20.9
3	Vellore Institute of Technology (VIT)	14206	1.06	0.53	36.07
4	Indian Institute of Technology (IIT) - Delhi	13713	0.95	2.25	28.45
5	Indian Institute of Technology (IIT) - Madras	13688	1.01	2.15	35.05
6	Department of Science & Technology (India)	13601	0.97	0.79	33.77
7	Indian Institute of Science (IISc) - Bangalore	13590	0.94	2.69	36.79
8	Indian Institute of Technology (IIT) - Bombay	13428	0.96	2.52	34.52
9	Indian Institute of Technology (IIT) - Kharagpur	13154	0.94	1.79	28.18
10	All India Institute of Medical Sciences (AIIMS) New Delhi	11873	1.12	1.33	21.64
11	Homi Bhabha National Institute	11803	0.87	0.55	28.53
12	University of Delhi	11036	0.94	0.44	30.77
13	Indian Institute of Technology (IIT) - Roorkee	9747	1.02	1.1	25.69
14	SRM Institute of Science & Technology Chennai	9690	0.93	0.43	36.7
15	Banaras Hindu University (BHU)	9420	1.21	0.79	28.47

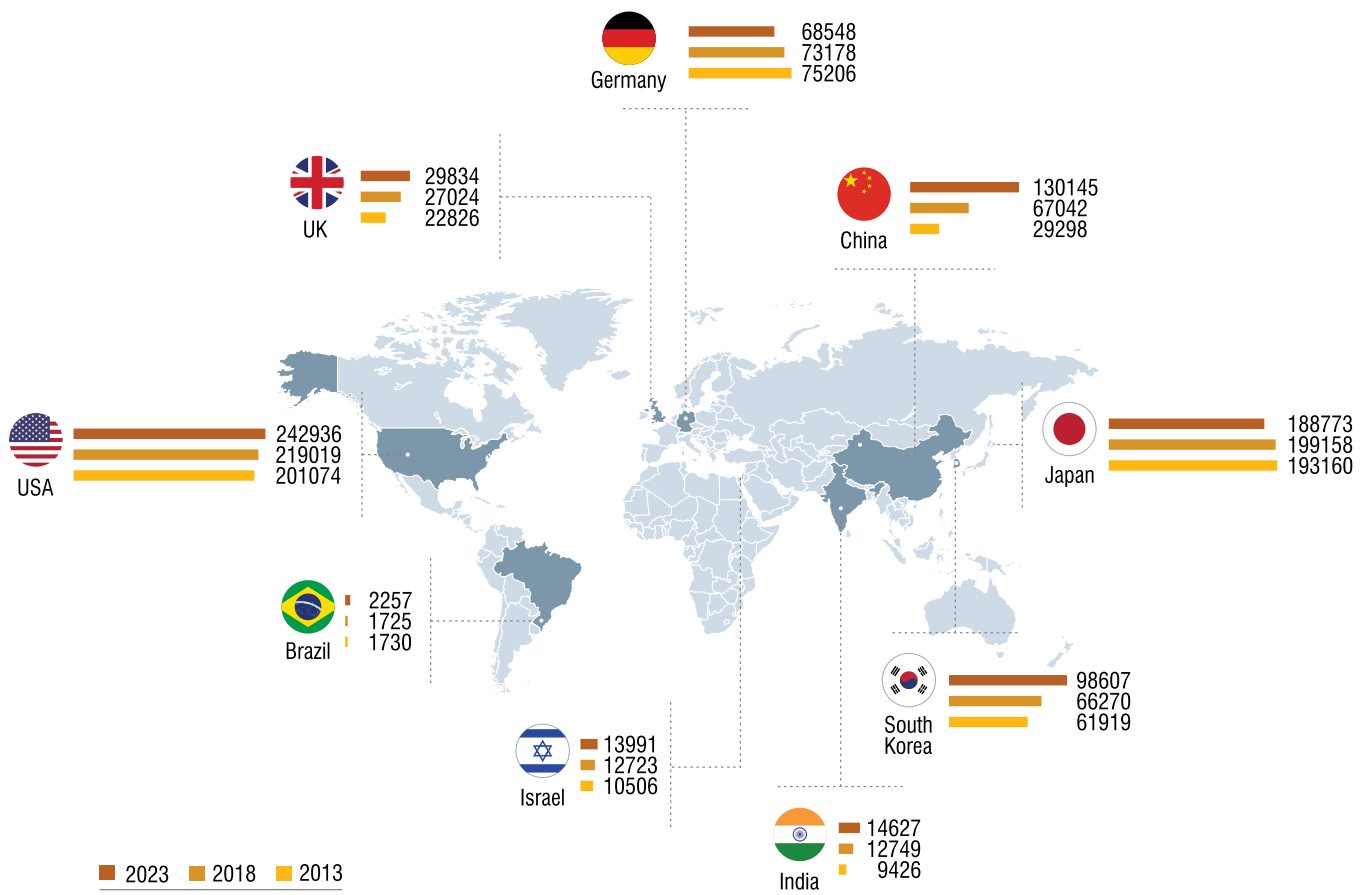
■ Highest Rank ■ Lowest Rank

Source: InCites (based on data from Web of Science), data downloaded from the platform on 7 January 2025; Centre for Technology, Innovation and Economic Research (CTIER)

Note: (i) Data is based on cumulative publications by each institution (2019 - 2023)
(ii) The data for Council of Scientific & Industrial Research (CSIR) is representative of 41 CSIR research laboratories and institutes
(iii) The data for Indian Council of Agricultural Research (ICAR) is representative of 101 ICAR research laboratories and institutes
(iv) Academy of Scientific & Innovative Research (AcSIR) had 13731 publications during the period under consideration. However, they have not been considered in the table above as a significant share of AcSIR publications are possibly covered under the aegis CSIR

The table above ranks the top 15 Indian institutions based on cumulative publication output for the years 2019 to 2023. The Council of Scientific & Industrial Research (CSIR) ranked first in terms of publication output, followed by the Indian Council of Agricultural Research (ICAR). The Vellore Institute of Technology and SRM Institute of Science & Technology Chennai are the only private institutions that feature in this list of the top 15 institutions. In terms of impact as measured by the CNCI score, Banaras Hindu University (BHU) was the top institution with a CNCI score of 1.21. With respect to industry collaborations as a share of publications, the Indian Institute of Science (IISc) Bangalore had the highest share at 2.69 percent, followed by Indian Institute of Technology (IIT) Bombay and Indian Institute of Technology (IIT) Delhi with 2.52 percent and 2.25 percent respectively. In terms of international collaborations as a share of publications, IISc Bangalore has the highest share at 36.79 percent, followed by SRM Institute of Science & Technology Chennai and Vellore Institute of Technology with 36.7 percent and 36.07 percent respectively.

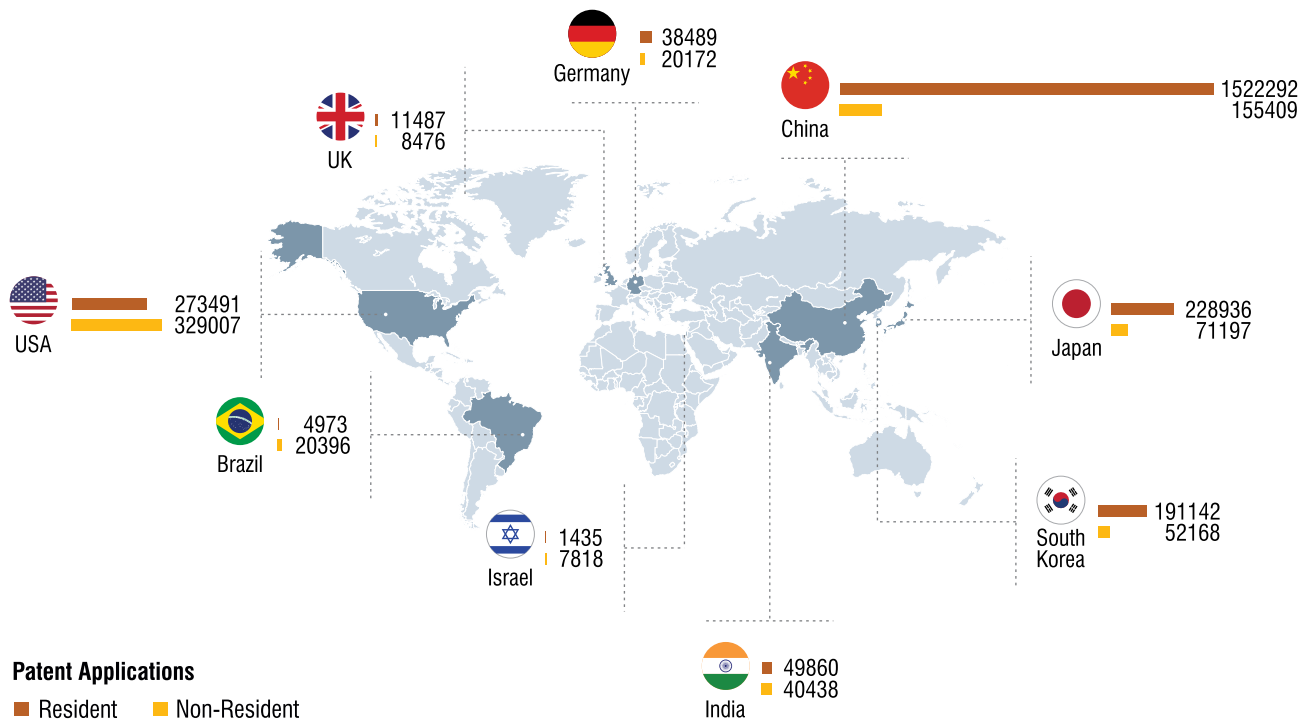
6.16 | Country-wise Comparisons for Patent Applications Filed Abroad



Source: World Intellectual Property Organization (WIPO) IP Statistics Data Center, available at <https://www3.wipo.int/ipstats/ips-search/patent>

India's patent applications filed abroad increased to 14,627 in 2023 from 9,426 in 2013 while China's patent applications filed abroad increased to 1,30,145 in 2023 from 29,298 in 2013. China recorded the strongest growth in patents filed abroad amongst the select countries during the period under consideration. In absolute numbers, the US and Japan continue to dominate the number of patent applications filed abroad, followed by China. The patent applications filed abroad by China have surpassed that of Germany and South Korea in recent years, while India has surpassed the number of patent applications filed abroad by Israel.

6.17 | Country-wise Comparisons for Patent Applications with Respective Domestic Patent Offices (2023)



Source: World Intellectual Property Organization (WIPO) IP Statistics Data Centre, available at <https://www3.wipo.int/ipstats/ips-search/patent>

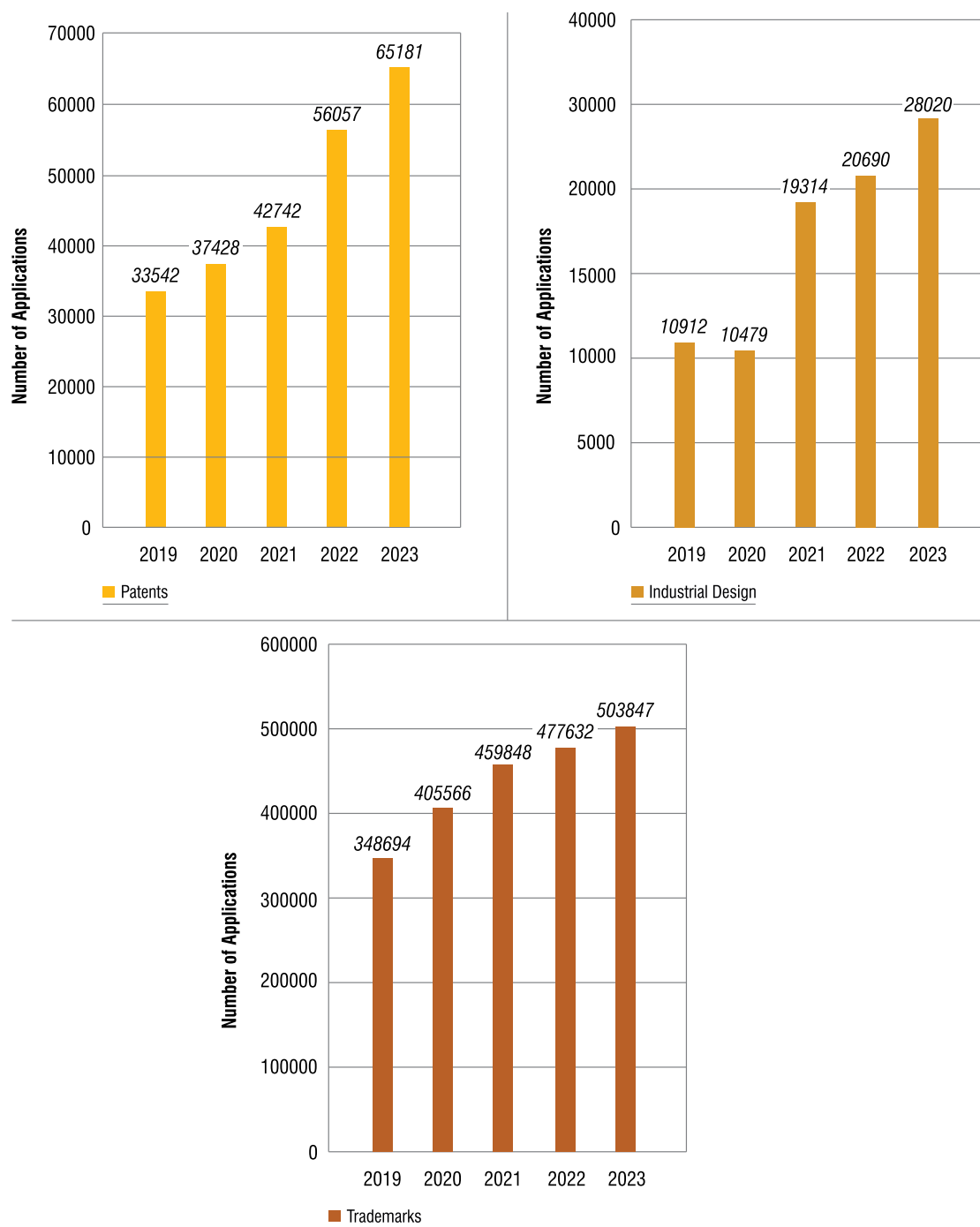
Note: (i) Resident includes domestic filings
 (ii) Non-resident includes filings coming in from overseas

Resident patent applications with the Indian Patent Office (IPO) were higher than the non-resident patent applications in 2023 which is in line with a majority of select countries as given in the figure above. Whereas, in both 2018¹³ and 2021¹⁴, the non-resident patent applications with the IPO were higher than the resident patent applications. China's resident patent applications continued to significantly outnumber the non-resident patent applications in 2023.

¹³ CTIER Handbook: Technology and Innovation in India 2021

¹⁴ CTIER Handbook: Technology and Innovation in India 2023

6.18 | Applications for Patents, Industrial Design and Trademarks from India (2019 - 2023)

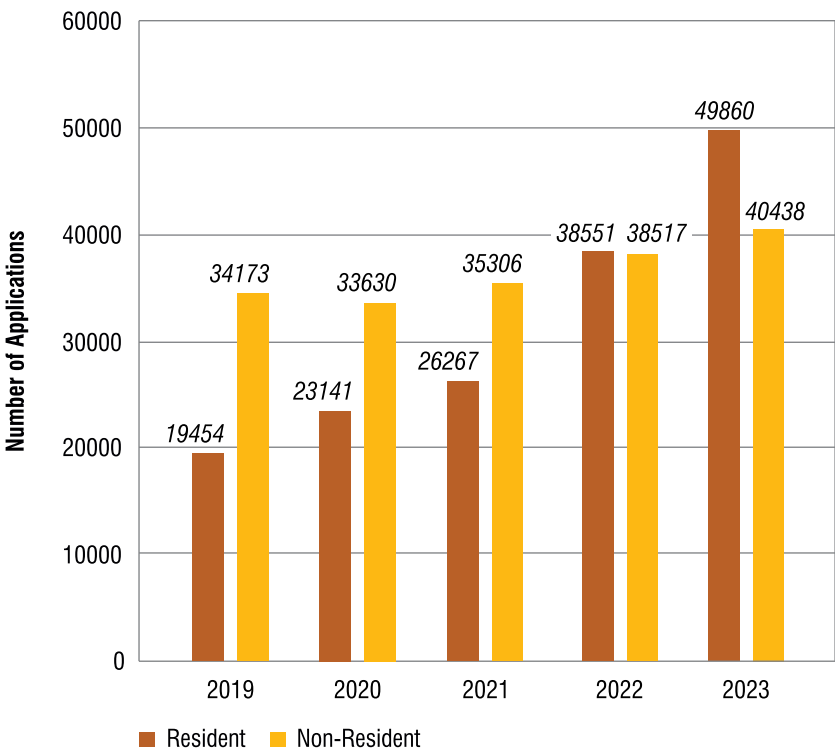


Source: World Intellectual Property Organization (WIPO) IP Statistics Data Centre, available at <https://www3.wipo.int/ipstats/keyindex.htm>

Note: Intellectual Property filings include resident and abroad

The patent applications in the figure above include filings by residents with the Indian Patent Office and filings with patent offices abroad. There has been a steady increase in India's patent applications between 2019 and 2023. Applications for industrial design saw a jump in 2021 after having slowed in 2020. The applications for trademarks continued to increase during the period under consideration.

6.19 | Patent Applications with Indian Patent Office by Residents and Non-Residents
(2019 - 2023)

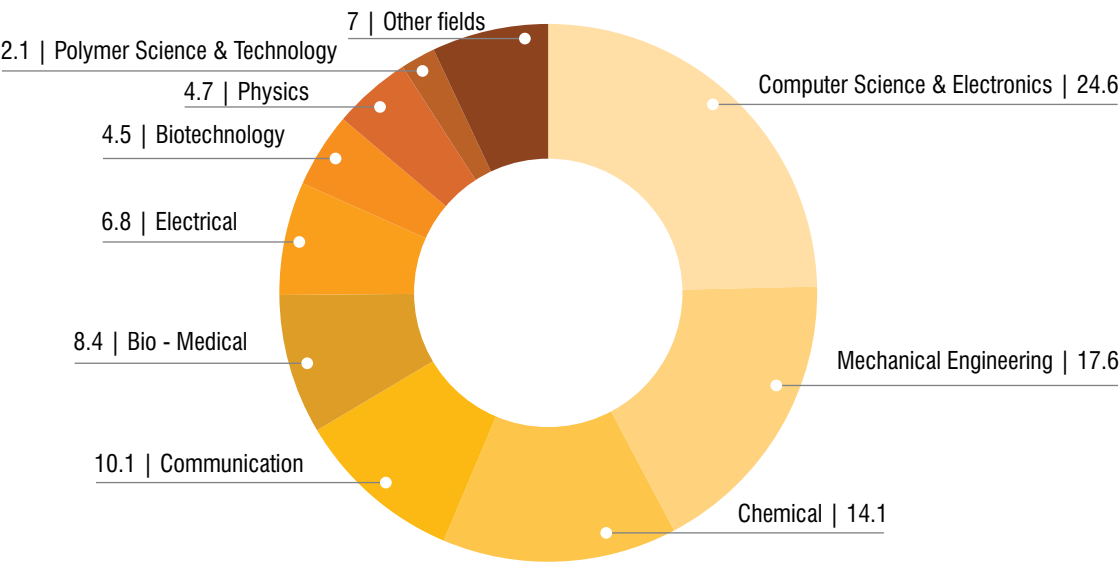


Source: World Intellectual Property Organization (WIPO) IP Statistics Data Centre, available at <https://www3.wipo.int/ipstats/ips-search/patent>

Note: (i) Resident includes domestic filings
(ii) Non-resident includes filings coming in from overseas

The number of resident patent applications with the Indian Patent Office has been higher than that of non-resident patent applications since 2022. The share of resident patent applications in total patent applications with the Indian Patent Office has increased to 55 percent in 2023 from 36 percent in 2019.

6.20 | Patent Applications with Indian Patent Office by Sector (2023)

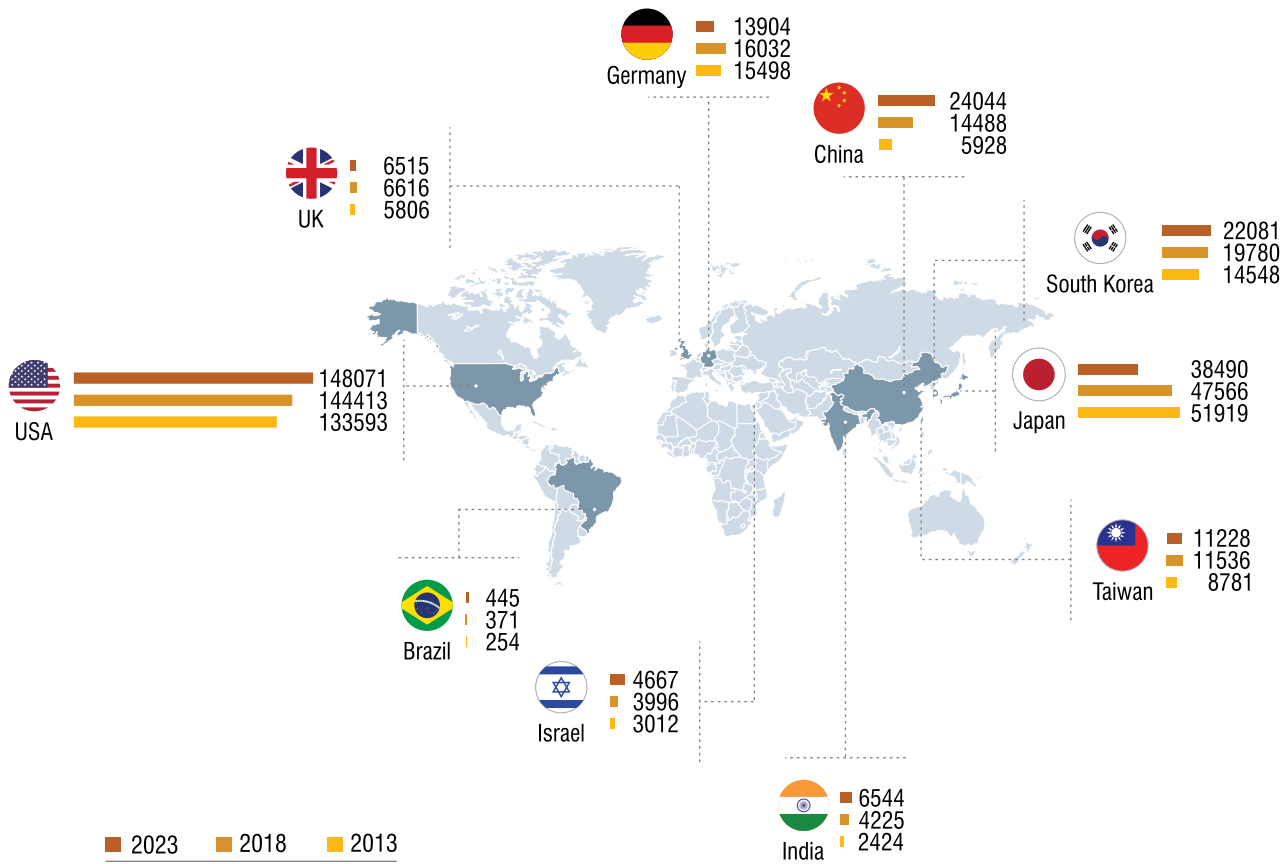


Source: The Office of the Controller General of Patents, Designs, Trademarks and Geographical Indicators, Government of India, Annual Report 2022-23, available at https://ipindia.gov.in/writereaddata/Portal/IPOAnnualReport/1_114_1_ANNUAL_REPORT_202223_English.pdf

Note: Chemical sector also includes pharmaceutical sector

In 2023, patent applications by field of technology were largely concentrated in sectors such as computer science & electronics, mechanical engineering, chemical and communication, that accounted for over 66 percent of the total patent applications filed in India. While the computer science & electronics and electrical sectors saw an increase, most other sectors experienced a slight decrease, except for bio-medical, compared to 2021.

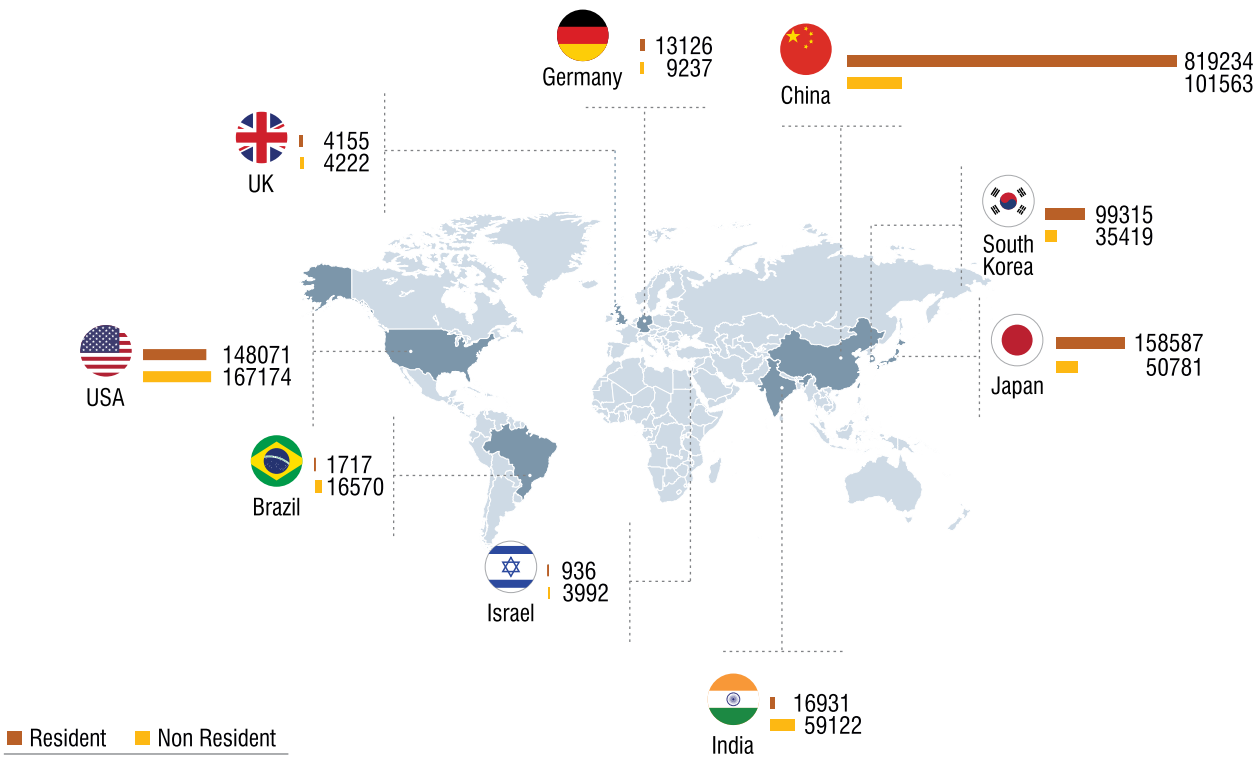
6.21 | Patents Granted by the United States Patent and Trademark Office (USPTO) to Select Countries



Source: World Intellectual Property Organization (WIPO) IP Statistics Data Center, available at <https://www3.wipo.int/ipstats/index.htm?tab=patent>

Patents granted by the USPTO to applicants from India increased to 6,544 in 2023 from 2,424 in 2013. The list of the top Indian and top MNC patentees present in India can be found in Indicator 8.11. Data on the number of patents granted abroad for our sample of countries using WIPO data can be found in the Appendix (Table A.8).

6.22 | Country-wise Comparisons for Patents Granted by Respective Domestic Patent Offices (2023)

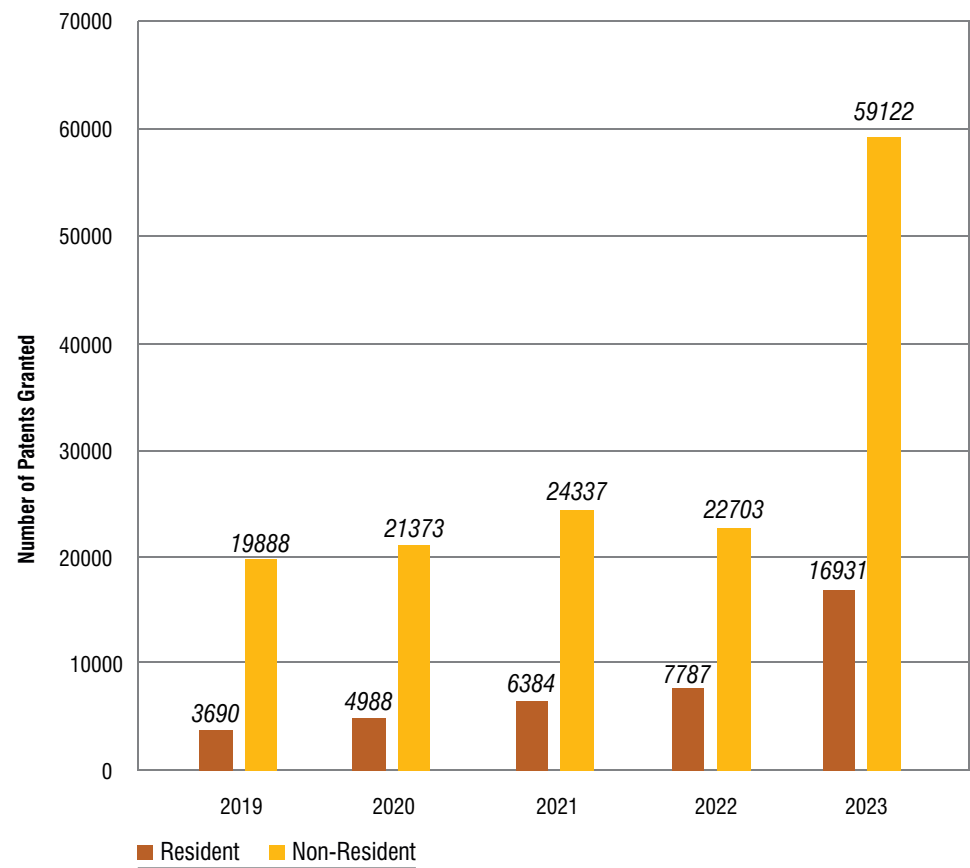


Source: World Intellectual Property Organization (WIPO) IP Statistics Data Center, available at <https://www3.wipo.int/ipstats/ips-search/patent>

Note: (i) Resident includes domestic filings
(ii) Non-resident includes filings coming in from overseas

The number of patents granted by the Indian Patent Office to resident applicants was 16,931 in 2023, while the number granted to non-resident applicants was 59,122. In China, the number of patents granted to residents was eight times the number of patents granted to non-residents by its domestic patent office, while in Japan and South Korea the number of patents granted to residents was three times the number of patents granted to non-residents by their respective domestic patent offices.

6.23 | Patents Granted by the Indian Patent Office to Residents and Non-Residents (2019 - 2023)

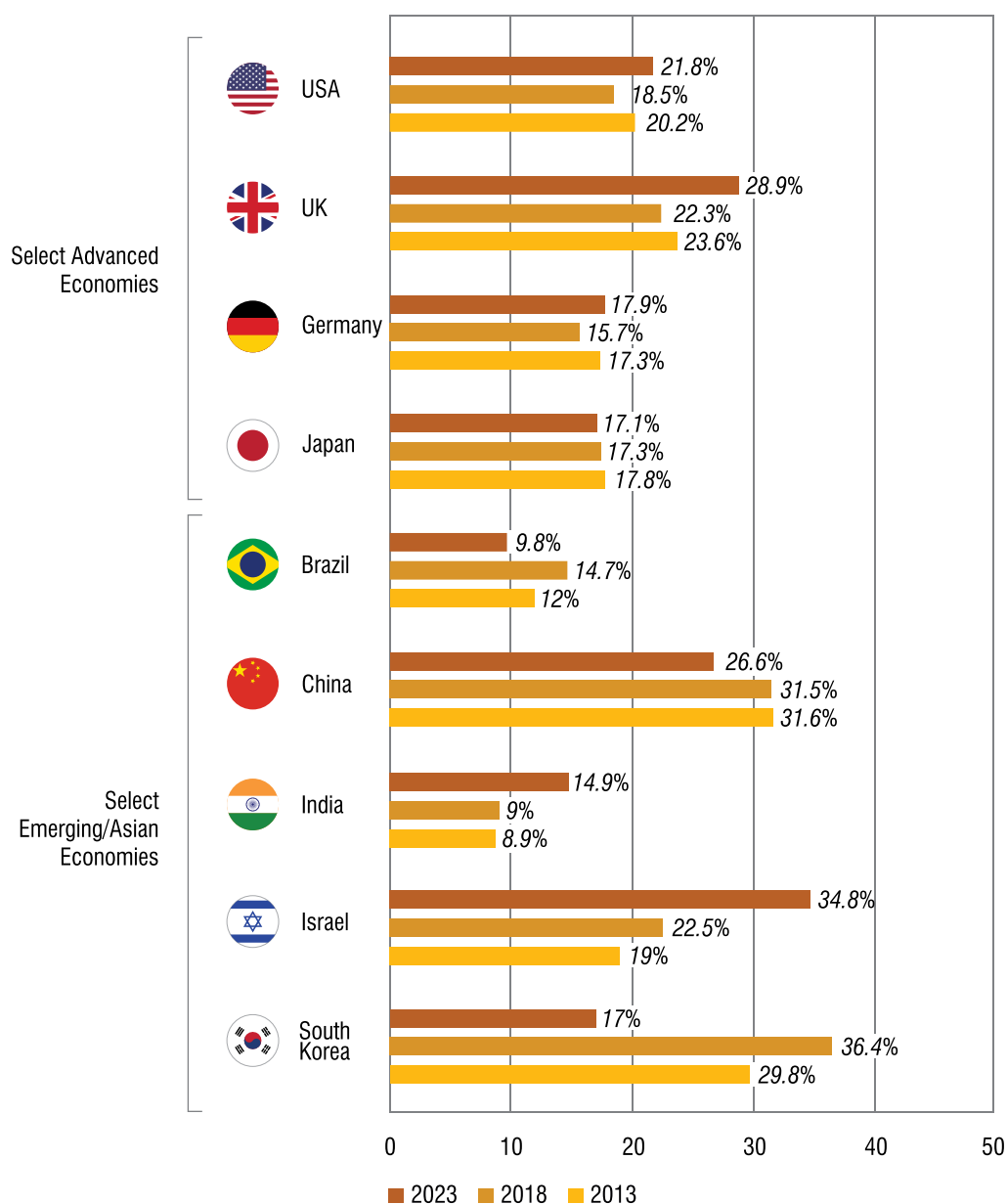


Source: World Intellectual Property Organization (WIPO) IP Statistics Data Center, available at <https://www3.wipo.int/ipstats/ips-search/patent>

Note: (i) Resident includes domestic filings
(ii) Non-resident includes filings coming in from overseas

The number of patents granted by the Indian Patent Office to non-residents was higher than the patents granted to residents in 2023. The gap between the patents granted to non-residents and the patents granted to residents continued to widen between 2019 and 2023.

6.24 | High Technology Exports as Share of Manufactured Exports for Select Countries



Source: World Development Indicators (various years), available at <https://databank.worldbank.org/source/world-development-indicators>; Centre for Technology, Innovation and Economic Research (CTIER)

India's share of high technology exports in manufactured exports was 14.9 percent in 2023 compared to 8.9 percent in 2013. In comparison to other advanced and emerging economies, India continues to have a low share of high technology exports in manufactured exports. For the advanced economies, the share reported for the UK was above 25 percent in 2023 while for the USA it was above 20 percent. Israel saw a jump in the share of high technology exports in manufactured exports from 22.5 percent in 2018 to 34.8 percent in 2023.

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7.1 | Select Policies Introduced by States

State	Biotech Policy	Industrial Policy	IT, ITeS, ICT, Electronics, ESDM Policy	MSME Policy	
Andhra Pradesh	-	2023 - 2027	Electronic Policy (2021 - 2024), IT Policy (2021 - 2024)	-	
Arunachal Pradesh	-	2020	-	-	
Assam	-	2023	Electronics (Semiconductor, etc.) Policy (2023)	2020	
Bihar	-	2022	ICT Policy (2011)	-	
Chattisgarh*	-	2019 - 2024	Electronics, IT, ITes Investment Policy (2014 - 2019)	2019 - 2024	
Delhi	-	-	-	-	
Goa	2006	2022	Information Technology Policy (2018)	-	
Gujarat	2022 - 2027	2020	IT/ITeS Policy (2022-27), Electronics Policy (2022 - 2028)	-	
Haryana	2002	2011	IT & ESDM Policy (2017)	2019	
Himachal Pradesh	2014	2022	IT, ITeS and ESDM Policy (2019)	2019	
Jharkhand	-	2021	IT and ITeS Policy (2016)	2023	
Karnataka	-	2020 - 2025	IT Policy (2020-2025), ICT(2011)	-	
Kerala	2003	2023	Information Technology Policy (2023)	-	
Madhya Pradesh	2003	2018	IT, ITeS, ESDM Investment Promotion Policy (2023)	2021	
Maharashtra	2001	2019	IT, ITeS Policy (2023)	-	
Manipur	-	2022	Information Technology Policy (2022)	-	
Meghalaya	-	2024	IT & ITeS Promotion Policy (2024)	2020	
Mizoram	-	2021	IT Policy (2001)	-	
Nagaland	-	2000	IT Policy (2011)	-	
Odisha	2024	2022	IT Policy (2022)	2022	
Punjab	-	2022	IT Policy (2013)	-	
Rajasthan	2015	2019	E-Governance IT & ITeS Policy (2015)	2022	
Sikkim	-	-	Information technology, Electronics and Telecommunication Policy (2020)	2022	
Tamil Nadu	2014	2021	ICT Policy (2018)	2021	
Telangana	-	2016	2nd ICT Policy (2021 - 2026)	-	
Tripura	-	-	IT/ITeS Policy (2022)	-	
Uttar Pradesh	2014	2022	IT & ITeS Policy (2022), Electronics Manufacturing Policy (2017)	2022	
Uttarakhand	2018 - 2023	2021	ICT & Electronics Policy (2016 - 2025), IT Policy (2018)	2023	
West Bengal	2013	2013	Information Technology & Electronics Policy (2018)	-	

*Year of Biotechnology policy for Chattisgarh could not be verified

Source: Startup India, available at: <https://www.startupindia.gov.in/>; Invest India, available at: <https://www.investindia.gov.in/>; Various State Government Websites; Centre for Technology, Innovation and Economic Research (CTIER)

As seen in the table above, most states have an industrial policy, an IT policy and a startup policy. Around 5 states have also introduced separate electronics policies, while

	Start-Up Policy	Renewable Energy Policy	Automobile & Auto-components Policy	Aerospace & Defence Policy
	-	Renewable Energy Export Policy (2020), Solar (2018), Wind(2018), Wind Solar Hybrid (2018)	-	-
	-	Hydro Power Policy (2008)	-	-
	2018	Renewable Energy Policy (2022)	-	-
	2022	Biofuel Production Promotion Policy (2023)	-	-
	2019 - 2024	Solar Policy (2017)	-	-
	2019	Solar Policy (2016)	-	-
	2021	Solar Policy (2017)	-	-
	-	Renewable Energy Policy (2023)	-	2016
	2022	Solar Power Policy (2023)	-	2022
	2016	Energy Policy (2021)	-	-
	2016	Solar Policy (2022)	2016	-
	2022 - 2027	Renewable Energy Policy (2022 - 2027)	-	Draft (2024 - 2029), 2013 - 2023
	2014	Solar Energy Policy (2013), Small Hydro Power Policy (2012)	-	-
	2022	Renewable Energy Policy (2022)	-	2022
	2018	Unconventional Energy Generation Policy (2020)	-	2018
	2022	Solar (2014), Hydro (2012)	-	-
	2018	Power Policy (2024)	-	-
	2019	Solar Power Policy (2017)	-	-
	2019	-	-	-
	2018	Renewable Energy Policy (2022)	-	2018
	-	New and Renewable Sources of Energy Policy (2012)	-	-
	2022	Renewable Energy Policy (2023)	-	-
	2019	Solar Policy (2019)	-	-
	2023	Solar Energy Policy (2019)	2014	Space Industrial Policy (2024), 2022
	-	Wind Power Policy (2016)	-	SpaceTech Framework (2022), 2022
	-	Policy for Promoting Generation of Electricity through New and Renewable Energy Sources (2019)	-	-
	2022	Solar Energy Policy (2022)	-	2022
	2023	Solar Policy (2023)	-	2020
	-	New and Renewable Energy Manufacturing Promotion Policy (2023)	-	-

in some states the electronics policy has been combined with the IT policy. With respect to renewable energy policies, several states have introduced a solar policy. For some of the other higher technology policies, there are around 13 states that have a biotech policy while around 10 states have also introduced an aerospace & defence policy.

While the policies for National Capital Territory of Delhi have been captured in the table above, policies for other union territories can be found in the Appendix (Table A.9). The data on state policies has been collated from individual state government websites, Invest India and the Startup India websites.

7.1.1 | Critical and Emerging Technologies Policies Introduced by States

State	Advanced Digital Production Technologies*	
Andhra Pradesh	Information Technology Policy (2021 - 2024)	
Arunachal Pradesh	-	
Assam	State Data Policy (2022), Cyber Security Policy (2020)	
Bihar	Information Technology Policy (2024)	
Chattisgarh	Industrial Policy (2019 - 2024)	
Delhi	White Paper on Industrial & Economic Development Policy (2023 - 2033), Startup Policy (2019)	
Goa	-	
Gujarat	IT/ITeS Policy (2022 - 2027)	
Haryana	Draft IT & ITeS Policy (2024), Draft AVGC-XR Policy (2024)	
Himachal Pradesh	Science, Technology and Innovation Policy (STIP) (2021)	
Jharkhand	IT Data Center and BPO Investment Promotion Policy (2023), Policy for the Internet of Things (2017)	
Karnataka	Cybersecurity Policy (2024 - 2029), Draft Global Capability Centre Policy (2024 - 2029) IT Policy (2020 - 2025), Engineering Research & Development Policy (2021), AVGC-XR Policy 3.0 (2024 - 2029)	
Kerala	14th Five-Year Plan (2022 - 2027), AVGC-XR Policy (2024), Industrial Policy (2023)	
Madhya Pradesh	IT, ITeS & ESDM Investment Promotion Policy (2023)	
Maharashtra	IT-ITES Policy (2023), Cloud Computing Policy (2018)	
Manipur	Information Technology Policy (2022)	
Meghalaya	IT/ITeS Policy (2024)	
Mizoram	-	
Nagaland	-	
Odisha	IT Policy (2022), State Data Center Policy (2022)	
Punjab	Industrial and Business Development Policy (2022)	
Rajasthan	Startup Policy (2022)	
Sikkim	IT Policy (2020)	
Tamil Nadu	Safe and Ethical Artificial Intelligence Policy (2020), Blockchain Policy (2020)	
Telangana	Cloud Adoption Policy (2020), AI Framework (2020), IoT Policy (2017), Cyber Security Policy (2016), Data Analytics Policy (2016), Blockchain Framework (2019)	
Tripura	-	
Uttar Pradesh	Global Capability Centres Policy (2024), Startup Policy 2020 (First Amendment-2022), IT and ITeS Policy (2022)	
Uttarakhand	Startup Policy (2023)	
West Bengal	AI-ML Technology Promotion Guidelines (2020), IT and Electronic Policy (2018), Technology Promotion Guidelines (2020)	

*Includes internet of Things, big data, AI, robotics, cloud computing, blockchain, augmented reality, virtual reality and cyber-physical systems

Source: Startup India, available at: <https://www.startupindia.gov.in/>; Invest India, available at: <https://www.investindia.gov.in/>; Various State Government Websites; Centre for Technology, Innovation and Economic Research (CTIER)

As seen in the table above, most states are focusing on digital technologies such as the internet of things, big data, artificial intelligence, robotics, blockchain and cyber physical systems. However, for many states these are covered under IT-ITes or startup policy. Around 13 states have either a dedicated semiconductor policy or have it as a part of their

	Semiconductors	Green Hydrogen	Drone	Electric Vehicle
	Electronics Manufacturing Policy 4.0 (2024 - 2029)	Green Hydrogen and Green Ammonia Policy (2023)	2024 - 2029	2018 - 2023
	-	-	Drone Framework and Action Plan (2022)	Draft (2021)
	Electronics (Semiconductor etc.) Policy (2023)	-	-	2021
	-	-	-	2023
	-	-	-	2022
	-	-	-	2020 - 2025
	-	-	2022	2021
	2022 - 2027	-	-	2021
	Draft ESDM Policy (2024)	Draft (2024)	-	2022
	-	-	2022	2022
	-	-	-	2022
	ESDM Policy (2017 - 2022), Engineering Research & Development Policy (2021), Semiconductor Policy (2010)	-	-	2017
	-	-	-	2019
	IT, ITes & ESDM Investment Promotion Policy (2023), Analog Semiconductor Fabrication Investment Policy (2015)	Renewable Energy Policy (2022)	-	2019
	Industrial Policy (2019)	2023	-	2021
	-	-	2023	2022
	-	Power Policy (2024)	-	2021
	-	-	-	-
	-	-	-	-
	Semiconductor Manufacturing and Fabless Policy (2023)	Renewable Energy Policy (2022)	Civil Aviation Policy (2022)	2021
	-	2023	-	2022
	Electronics Manufacturing Policy (2021)	2023	-	2022
	-	-	-	2023
	Semiconductor and Advanced Electronics Policy (2024)	-	-	2023
	Electronics Policy (2016)	-	Drone Framework (2019)	2020 - 2030
	-	Energy Vision 2030 Roadmap (2023)	-	2022
	2024	2024	-	2022
	-	-	Drone Promotion & Usage Policy (2023)	2018
	Information & Communication Technology Policy (2012)	2023	Drone Technology Promotion Guidelines (2020)	2021

electronics policy. Around 8 states have a dedicated drone policy and 1 state has its drone policy as a part of its civil aviation policy.

The table includes policies for the National Capital Territory of Delhi and details for other union territories are provided in the Appendix (Table A.10). The data on state policies has been collated from state government websites and Startup India and Invest India websites. The policy areas considered in this indicator are those recognised as critical and emerging technologies by the Initiative on Critical and Emerging Technology (iCET).¹

¹ Joint Fact Sheet: The United States and India Continue to Expand Comprehensive and Global Strategic Partnership available at <https://pib.gov.in/PressReleaseDetailm.aspx?PRID=2057458®=3&lang=1>

7.2 | Expenditure on R&D by Select States

S. No.	State/Union Territory	Expenditure on R&D			
		2021-22		2022-23	
		(US\$, Million)	(₹, Million)	(US\$, Million)	(₹, Million)
1	Maharashtra	213	15868	310	24867
2	Gujarat	244	18156	262	21048
3	Tamil Nadu	133	9876	128	10287
4	Andhra Pradesh	87	6476	111	8894
5	Karnataka	99	7340	95	7660
6	Madhya Pradesh	51	3803	92	7355
7	Kerala	100	7448	85	6829
8	Assam	61	4518	68	5495
9	Odisha	62	4629	61	4918
10	Jammu and Kashmir	65	4824	58	4638
11	Telangana	63	4654	58	4636
12	Punjab	58	4346	55	4428
13	Uttar Pradesh	43	3199	49	3968
14	Bihar	42	3093	45	3637
15	Rajasthan	41	3031	44	3571
Total for Top 15 States		1359	101261	1522	122231
Total for All States		1695	126248	1787	143510

Source: State Finances: A Study Of Budgets, Reserve Bank of India (RBI), available at <https://rbi.org.in/Scripts/AnnualPublications.aspx?head=State%20Finances%20-%20A%20Study%20of%20Budgets>, data as on 3 September 2024; Respective State Budget Accounts; Centre for Technology Innovation and Economic Research (CTIER)

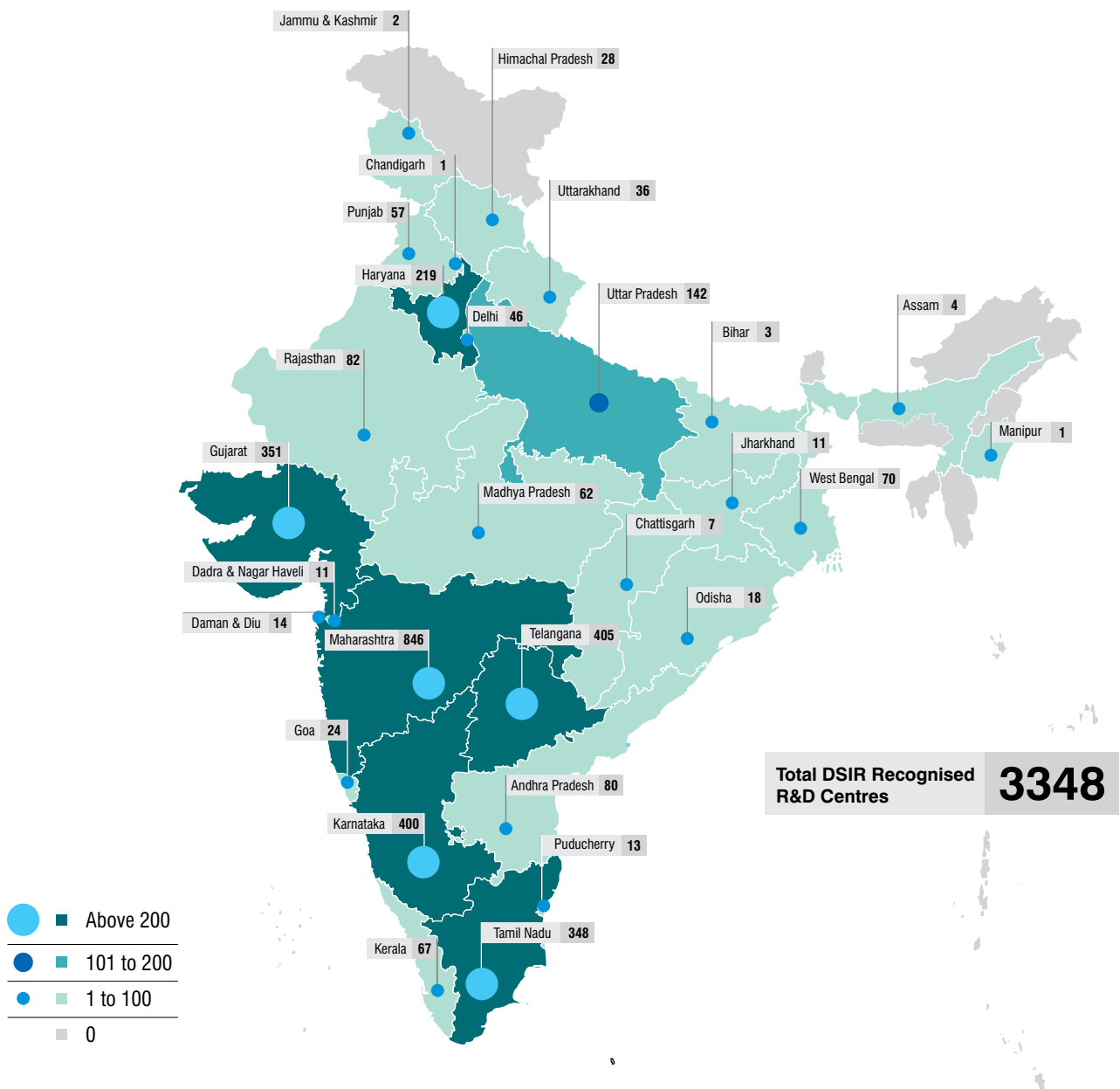
Note: (i) Expenditure on R&D includes Revenue and Capital Expenditure by states on Science, Technology and Environment and Revenue and Capital Expenditure by states on Agricultural Research and Education.

(ii) Figures in rupees were converted to dollars using the USD-INR exchange rate of 74.5 calculated as an average for the fiscal year 2021-22, USD-INR exchange rate of 80.33 calculated as an average for the fiscal year 2022-23 based on data from Federal Reserve Bank of St Louis

This indicator captures R&D expenditure by state governments. R&D expenditure here comprises two components, namely Science, Technology and Environment expenditure and Agricultural Research & Education expenditure.² Both these components have been taken from budget documents of each state. The total R&D expenditure by states in 2022-23 was USD 1,787 million (INR 144 billion) that accounted for around 8.7 percent of India's national R&D expenditure. Agricultural Research & Education expenditure accounted for 73 percent of total R&D expenditure by state governments in 2022-23 while Science, Technology and Environment expenditure accounted for 27 percent. Looking at R&D expenditure by individual states, Maharashtra had the highest expenditure on R&D at USD 310 million in 2022-23 compared to USD 213 million in 2021-22, accounting for 17 percent of total expenditure by all states in 2022-23. Gujarat had the second highest R&D expenditure with USD 262 million in 2022-23 compared to USD 244 million in 2021-22.

² The calculation for state R&D expenditure has been arrived at based on the report 'R&D Expenditure Ecosystem: Current Status and Way forward', EAC-PM, Office of the Principal Scientific Advisor (2019)

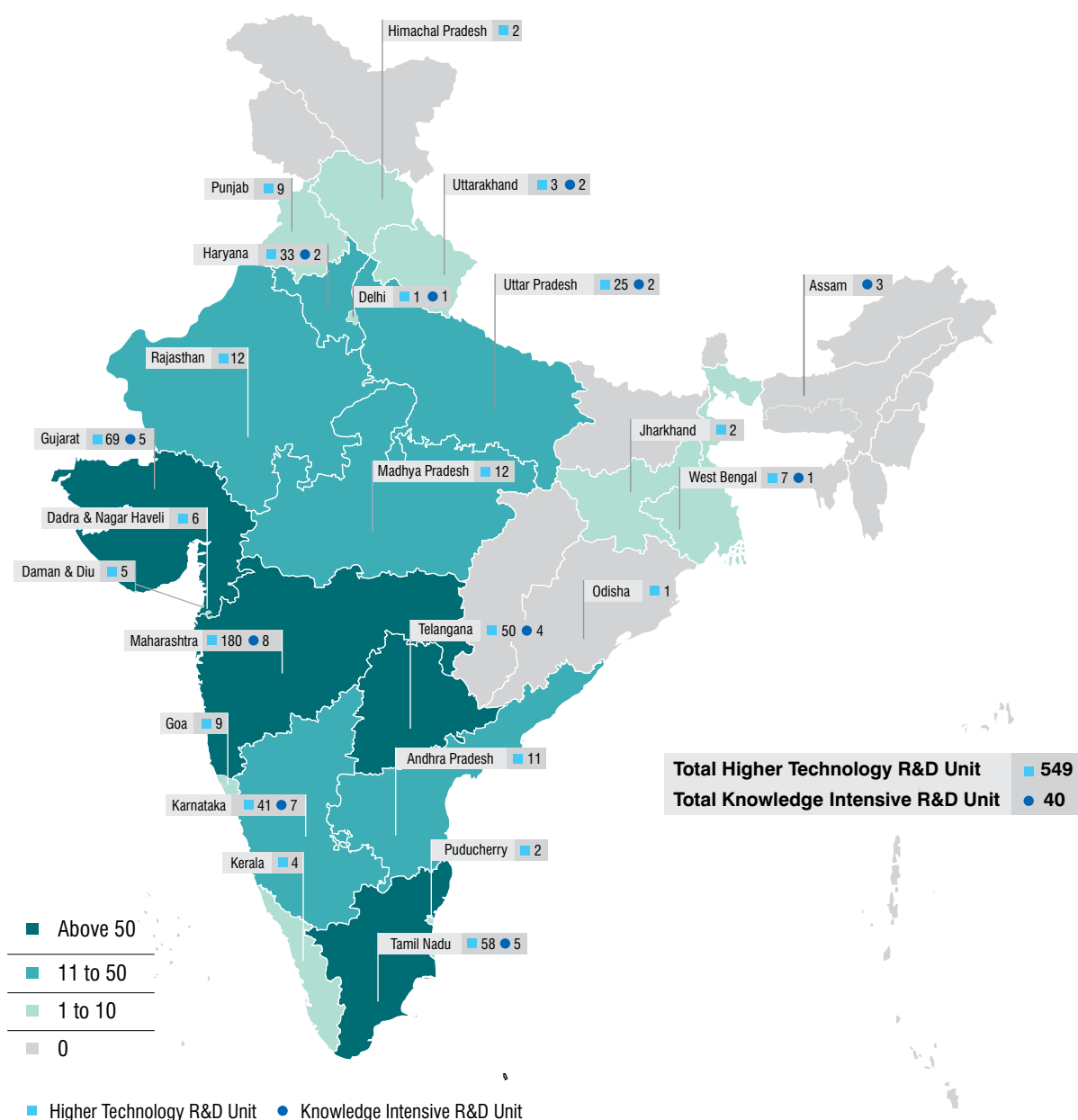
7.3 | State-wise Distribution of Industrial R&D Centres



Source: Department of Scientific and Industrial Research (DSIR), Government of India, Directory of In-house R&D Units (various years); Centre for Technology, Innovation and Economic Research (CTIER)

The directories of in-house R&D units released by the Department of Scientific and Industrial Research (DSIR) in 2016, 2017, 2021 and 2024 published the locations of one or more registered in-house R&D units of 2,754 firms. There were 355 firms that had multiple R&D units across different states in India. The state-wise locations of 3,348 R&D units were identified and have been captured in the figure above. Maharashtra had 846 R&D units, the highest number amongst all states and accounted for 25 percent of the total DSIR recognised R&D units. Some of the other top locations for the DSIR recognised R&D units were Telangana, Karnataka, Gujarat and Tamil Nadu.

7.3.1 | State-wise Distribution of Select Higher Technology and Knowledge Intensive R&D Centres



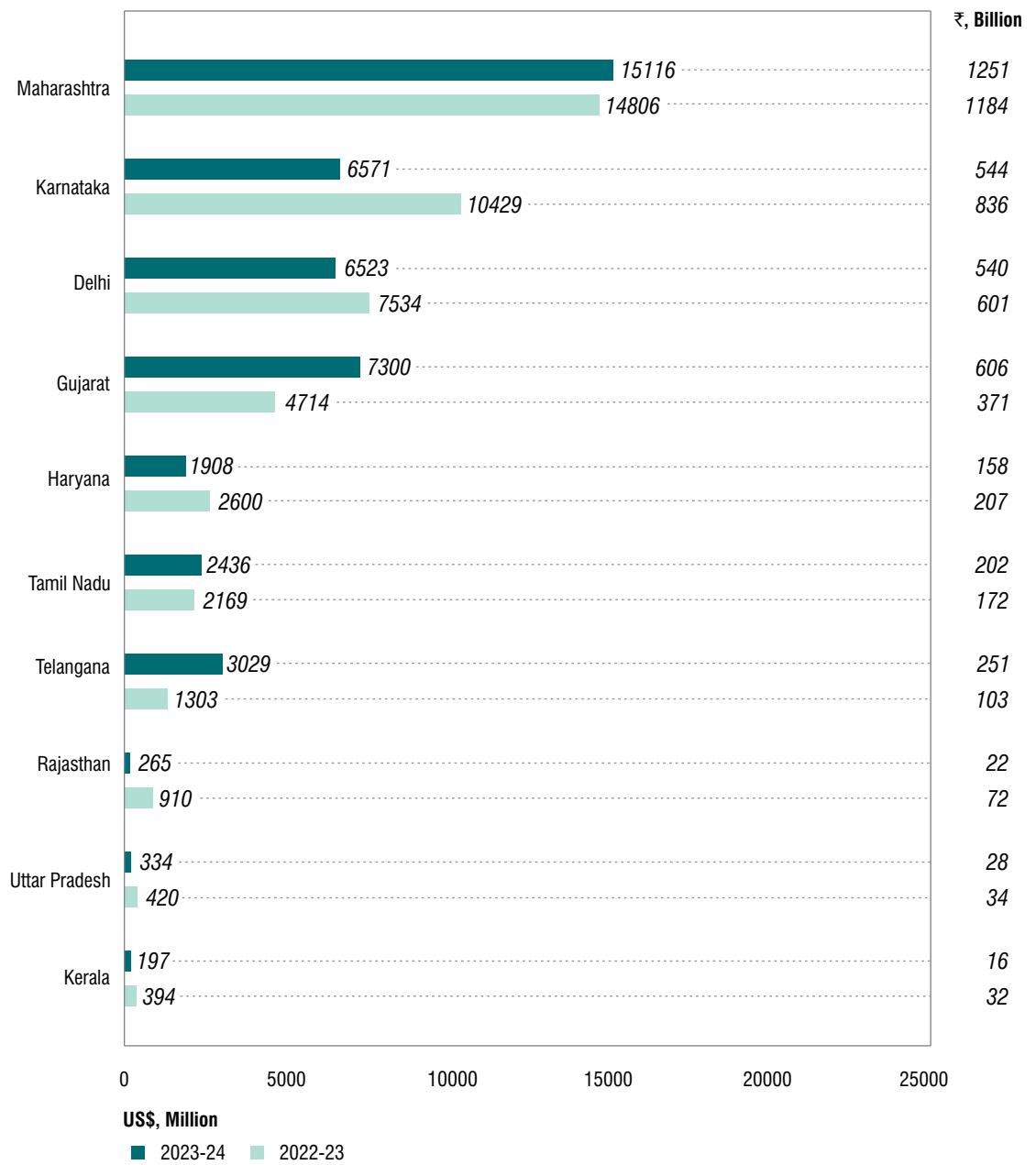
Source: Department of Scientific and Industrial Research (DSIR), Government of India, Directory of In-house R&D Units (various years); Centre for Technology, Innovation and Economic Research (CTIER)

Note: 317 firms from our list of top R&D spenders were identified as higher technology and knowledge intensive R&D firms on the basis of ISIC Rev 4 and mapped to the directory of in-house recognised R&D Units

The R&D units of 317 firms identified as Higher Technology and Knowledge Intensive have been considered in the figure above. These 317 firms are from a sample of 430 firms that account for around 94 percent of the total industrial R&D in India. The Higher Technology and Knowledge Intensive definitions are based on the International Standard Industrial Classification (ISIC) Rev 4.³ As seen above, Maharashtra has the highest number of Higher Technology and Knowledge Intensive R&D units at 180 and 8 respectively.

³ See Glossary B.8 and B.14

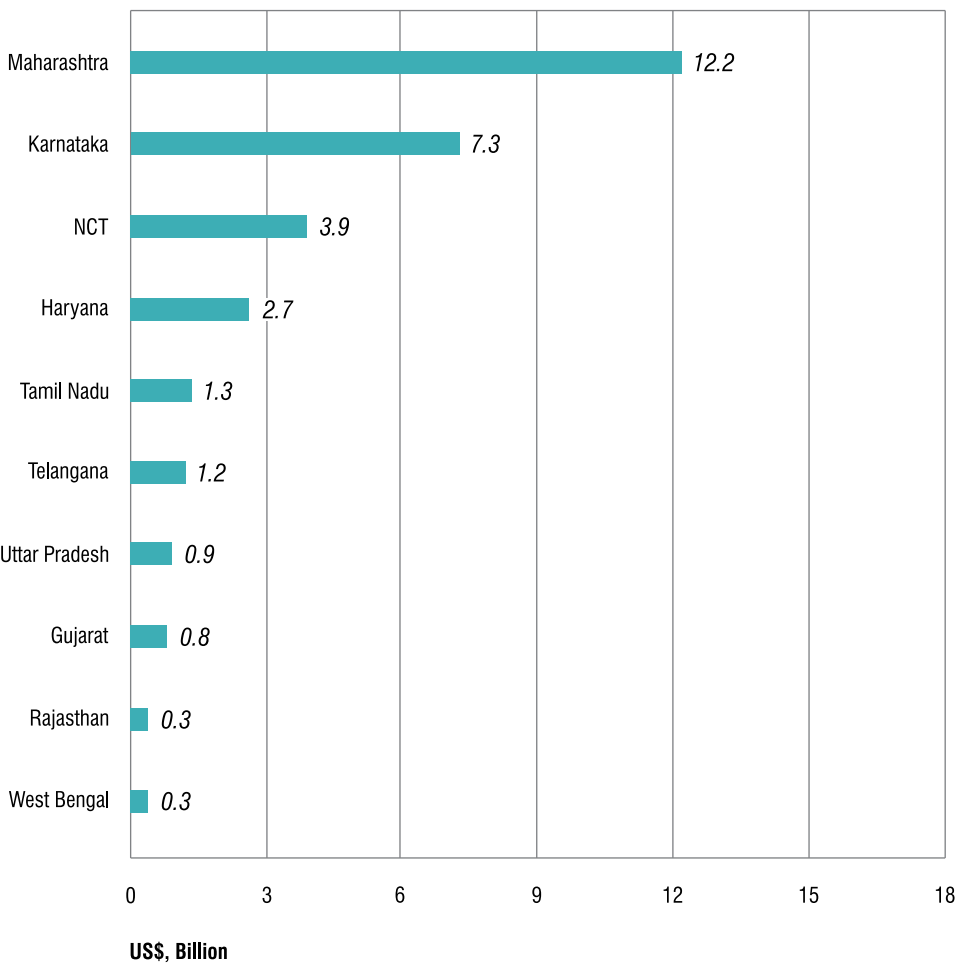
7.4 | Comparison of Foreign Direct Investment into India for Select States (2022-23 and 2023-24)



Source: Department for Promotion of Industry and Internal Trade (DPIIT), Government of India, Quarterly FDI factsheet (various years); Centre for Technology, Innovation and Economic Research (CTIER)

In 2023-24, Maharashtra was the top state to receive FDI in India totalling FDI inflow of USD 15.1 billion. Gujarat received the second highest FDI inflow of USD 7.3 billion. The states of Karnataka and Delhi saw the largest decrease in FDI inflows of USD 3.8 billion and USD 1 billion respectively compared to the previous year.

7.5 | Funding for Companies in Top Indian States (2023)

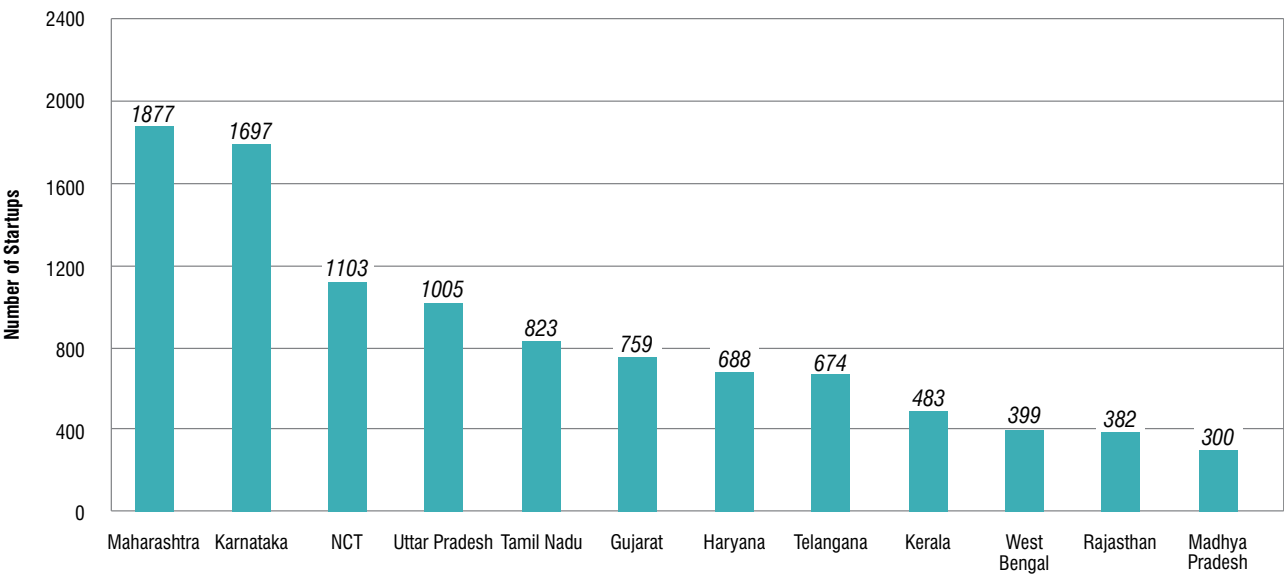


Source: Tracxn (various years), data downloaded on 30 September 2024 from the platform; Centre for Technology, Innovation and Economic Research (CTIER)

In 2023, Maharashtra attracted the most funding for companies amounting to USD 12.2 billion. This was followed by Karnataka that received USD 7.3 billion and National Capital Territory (NCT) that received USD 3.9 billion. Haryana followed in fourth place at USD 2.7 billion. The funding mentioned here is for all companies including startups (and new companies) and covers angel investments, conventional debt, venture debt, private equity, seed funding and various series rounds as provided by Tracxn. Furthermore, the Tracxn data considered here includes funding for technology and offline companies.

When one applies the criteria for startups (and new companies) i.e founded in the last 10 years, the total funding amount received by Maharashtra was USD 2.7 billion in 2023 and the amount received by Karnataka was USD 3.7 billion.

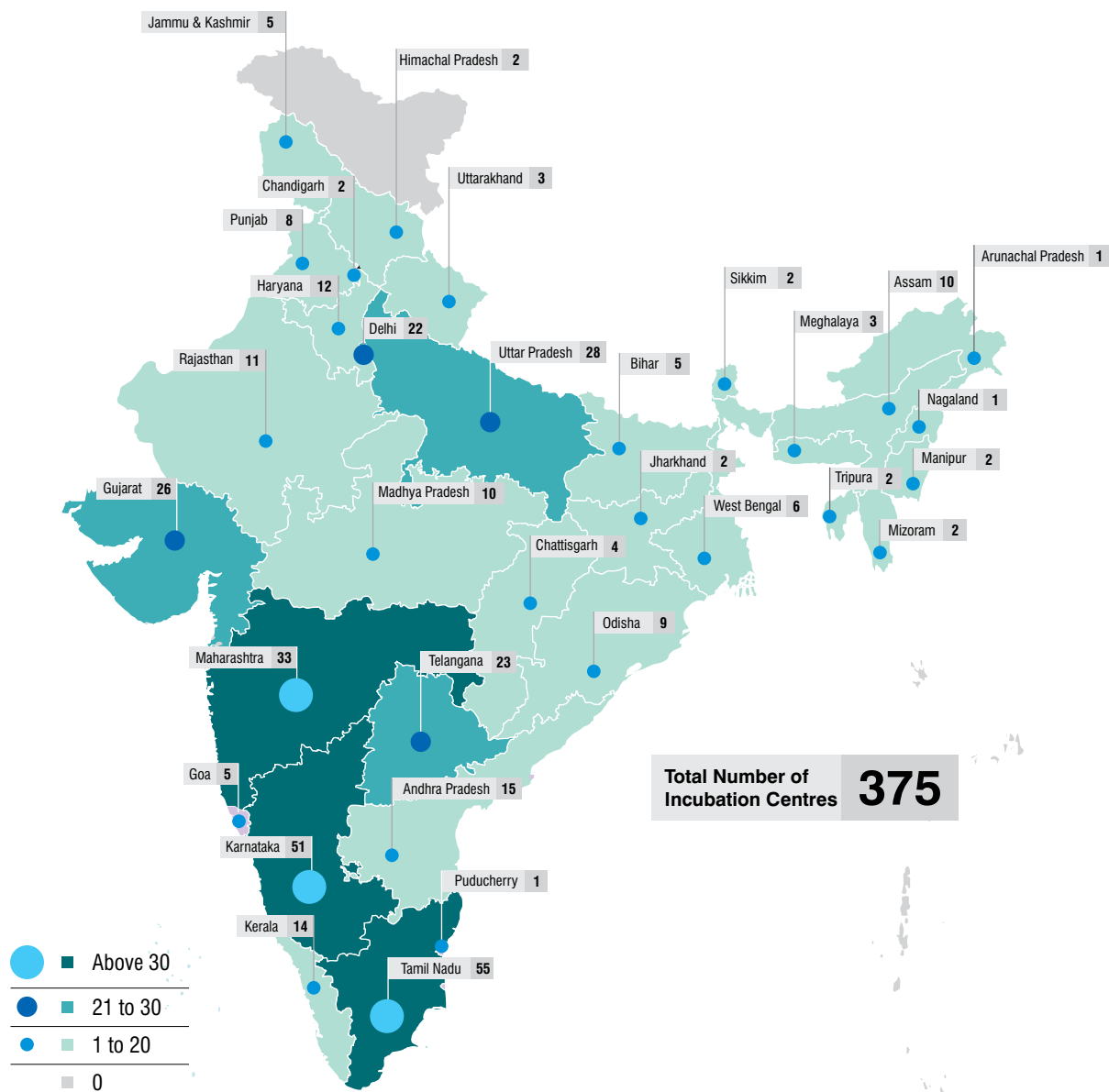
7.5.1 | State-wise Distribution of Startups (and New Companies) (2023)



Source: Tracxn (various years), data downloaded on 13 September 2024 from the platform; Centre for Technology, Innovation and Economic Research (CTIER)

In 2023, Maharashtra saw 1,877 startups (and new companies) being established, followed by Karnataka that saw 1,697 startups (and new companies). The National Capital Territory (NCT) came in third with 1,103 startups, while Uttar Pradesh was fourth with 1,005 startups. Data on the state-wise number of new companies registered with the Ministry of Corporate Affairs (MCA) in 2023 can be found in the Appendix (Table A.11).

7.6 | State-wise Number of Incubation Centres



Source: Technology Business Incubator (TBI), National Science and Technology Entrepreneurship Development, Department of Science and Technology, available at <https://www.nstedb.com/>; Technology Incubation and Development of Entrepreneurs (TIDE), Ministry of Electronics and Information Technology, available at <https://www.meity.gov.in/content/innovation-promotion>; Selected Atal Incubation Centres, Atal Innovation Mission, NITI Aayog, available at <https://aim.gov.in/index.php>; Biotech Parks and Incubators, Department of Biotechnology, available at <https://dbtindia.gov.in/scientific-directorates/bio-wealth-biosafety/biotech-park>; Bioincubators Nurturing Entrepreneurship for Scaling Technologies, BIRAC, Department of Biotechnology, available at <https://www.birac.nic.in/>; STPI Centres of Entrepreneurship, available at <https://stpi.in/en/centre-of-entrepreneurship>; India Science, Technology and Innovation Portal (ISTI), available here <https://www.indiascienceandtechnology.gov.in/innovations/incubators>; Centre for Technology, Innovation and Economic Research (CTIER)

We identified a total of 375 incubators, of which 311 were supported by various government entities like the Department of Science and Technology (DST), the Ministry of Electronics and Information Technology (MeitY), the Atal Innovation Mission (AIM) and the Department of Biotechnology (DBT). Tamil Nadu had the highest number of incubators (55) followed by Karnataka (51).

There were 235 incubators located at academic institutions (see Appendix table A.12). Tamil Nadu had the highest number of incubators located at academic institutions at 43, followed by Karnataka that had 23.

7.7 | Corporate Social Responsibility Funding towards Technology Incubators and Public Research Institutions for Top Indian States

State	CSR funding towards Technology Incubators and Public Research Institutions and their share in total CSR funding										
	2018-19		2019-20		2020-21		2021-22		2022-23		Total 2018-19 to 2022-23
	Amount (US\$, '000)	Share in Total (%)	Amount (US\$, '000)	Share in Total (%)	Amount (US\$, '000)	Share in Total (%)	Amount (US\$, '000)	Share in Total (%)	Amount (US\$, '000)	Share in Total (%)	Amount (US\$, '000)
Maharashtra	526.3	0.1	2622	0.6	2795.4	0.6	324.8	0.05	7.5	0.001	6276
Karnataka	1486	0.8	533.1	0.3	590.1	0.3	26.8	0.01	83.4	0.03	2719.5
Tamil Nadu	672.2	0.5	866	0.6	658.8	0.4	34.9	0.02	47.3	0.02	2279.2
Delhi	193.1	0.2	306.1	0.3	343.5	0.4	324.8	0.2	0	0	1167.5
Telangana	121.6	0.2	108.6	0.2	429.7	0.5	158.4	0.2	3.7	0.003	822
Rajasthan	4.3	0.01	28.2	0.03	397.4	0.4	1.3	0.001	0	0	431.3
Gujarat	173.1	0.1	21.2	0.02	145.5	0.1	48.3	0.02	0	0	388
Uttar Pradesh	145.9	0.2	97.3	0.1	39.1	0.03	6.7	0.004	0	0	289
Kerala	95.8	0.2	5.6	0.01	47.2	0.1	0	0	0	0	148.6
Andhra Pradesh	15.7	0.02	83.2	0.1	9.4	0.01	6.7	0.01	0	0	115.1

Source: National CSR Data Portal, Ministry of Corporate Affairs, Government of India, data as on 27 October 2024; Centre for Technology, Innovation and Economic Research (CTIER)

Note: Figures in rupees were converted to dollars using the USD-INR exchange rate of 69.92 calculated as an average for the fiscal year 2018-19, USD-INR exchange rate of 70.90 calculated as an average for the fiscal year 2019-20 and the USD-INR exchange rate of 74.23 calculated as an average for the fiscal year 2020-21, USD-INR exchange rate of 74.50 calculated as an average for the fiscal year 2021-22 and USD-INR exchange rate of 80.30 calculated as an average for the fiscal year 2022-23 based on data from Federal Reserve Bank of St Louis

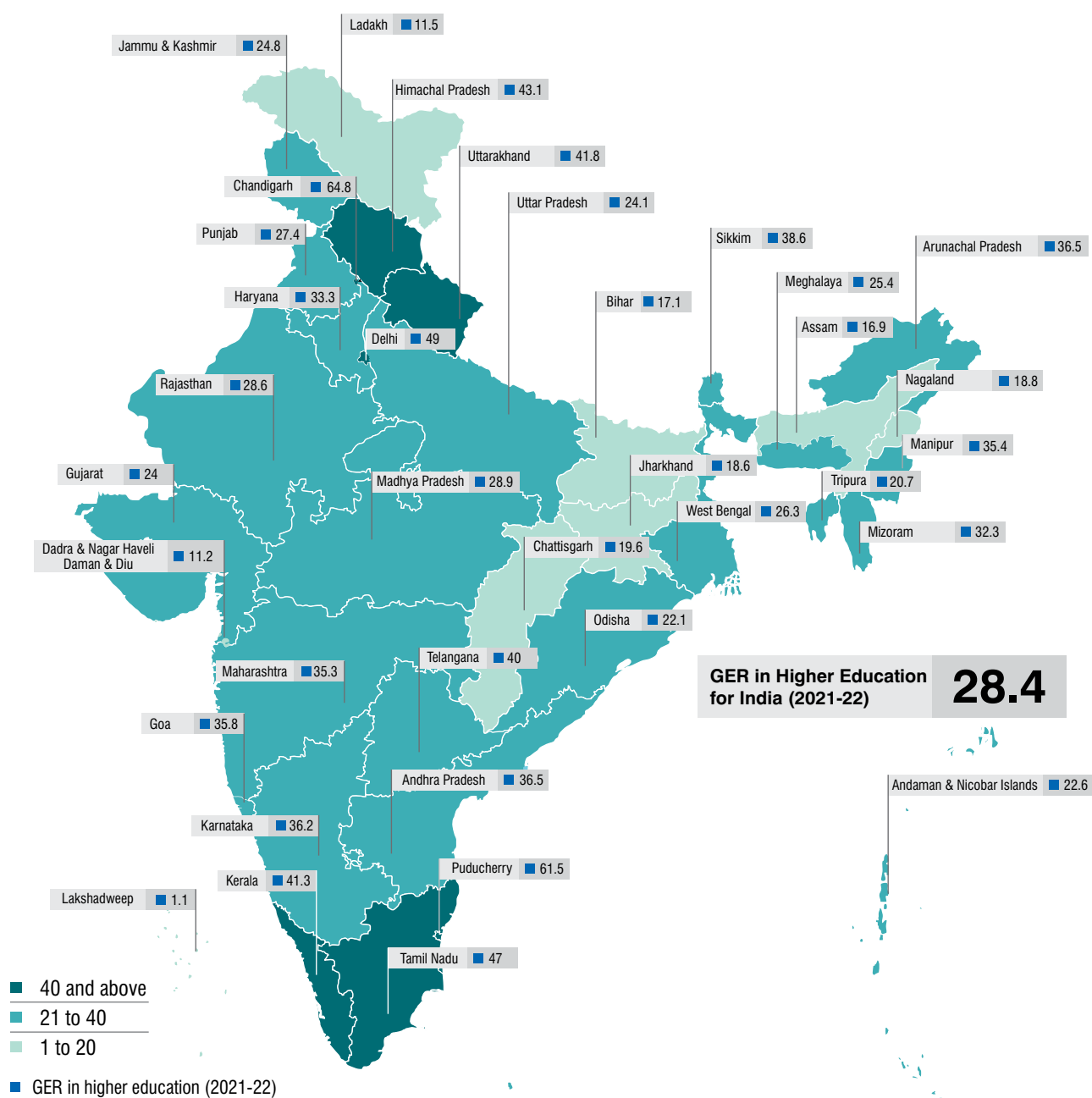
The table above shows the top 10 states that received CSR⁴ funding towards technology incubators and public research institutions. The states above were ranked based on the cumulative CSR funding towards technology incubators and public research institutions received by each state between 2018-19 and 2022-23. Of the ten states only four states received CSR funding in 2022-23 towards technology incubators and public research institutions. Among these four states, Karnataka received the highest amount, totaling USD 0.08 million. Delhi, Rajasthan, Gujarat, Uttar Pradesh, Kerala and Andhra Pradesh did not receive any CSR funding towards technology incubators and public research institutions in 2022-23. This indicator captures the funding towards technology incubators, public funded laboratories and public funded higher education institutions engaged in science, technology, engineering and medicine. The CSR Act was amended in late 2019 to allow companies to make contributions to public funded universities, Indian Institute of Technology (IITs), National Laboratories and Autonomous Bodies established under the auspices of key scientific agencies such as Indian Council of Agricultural Research (ICAR), Indian Council of Medical Research (ICMR), Council of Scientific and Industrial Research (CSIR), Department of Atomic Energy (DAE), Defence Research and Development Organisation (DRDO), Department of Biotechnology (DBT), Department of Science and Technology (DST), Ministry of Electronics and Information Technology. Prior to this amendment, the CSR Act allowed companies to fund 'technology incubators' located within academic institutions and approved by the Central Government. The expanded scope of CSR funding as per the amendment highlighted above continues to be broadly classified under 'technology incubators'.^{5,6}

⁴ See Glossary B.3

⁵ See 'Other Sectors' under the 'CSR Spent: Development Sector-wise' section, available at <https://www.csr.gov.in/content/csr/global/master/home/home.html>

⁶ See item (ix) of Schedule VII of Companies Act 2013, available at <https://www.mca.gov.in/content/mca/global/en/acts-rules/ebooks/acts.html?act=NTk2MQ==>

7.8 | State-wise Gross Enrolment Ratio in Higher Education (2021-22)



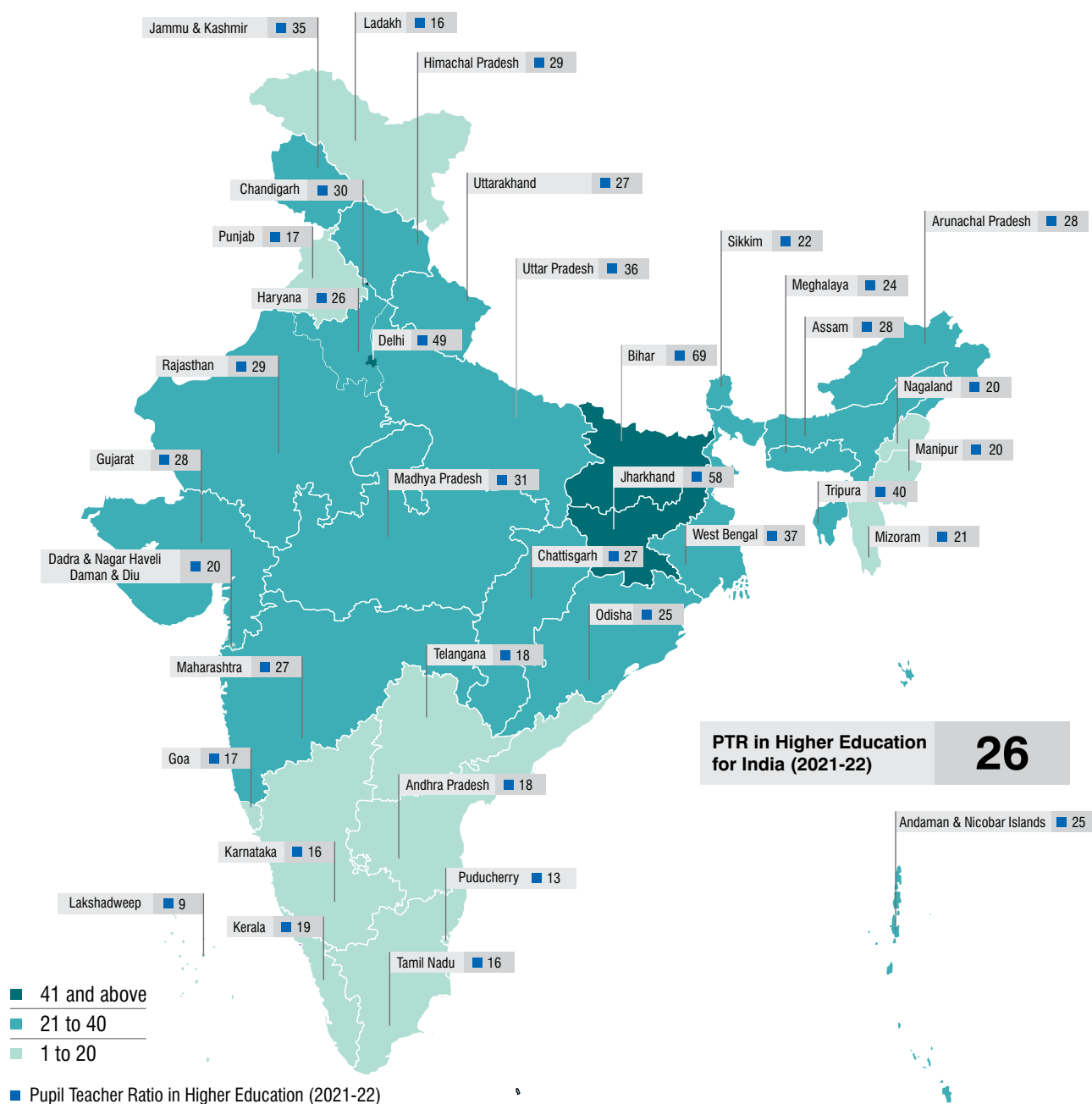
*All India Survey on Higher Education (AISHE) Report 2021-2022 captures the data for the union territories Dadra and Nagar Haveli and Daman and Diu together

Source: Ministry of Human Resource Development, Department of Higher Education, All India Survey on Higher Education (AISHE) Report 2021-2022, available at <https://aishe.gov.in/aishe/gotoAisheReports>

The national average Gross Enrollment Ratio (GER) in higher education increased to 28.4 percent in 2021-22 from 27.3 percent in 2020-21.⁷ The GER varied significantly across states/union territories, ranging from 1.1 percent in Lakshadweep to 64.8 percent in Chandigarh. States/union territories with a relatively higher GER included Puducherry (61.5 percent), Delhi (49 percent), Tamil Nadu (47 percent) and Himachal Pradesh (43.1 percent) while those states/union territories with relatively lower GERs included Dadra & Nagar Haveli and Daman & Diu (11.2 percent), Ladakh (11.5 percent), Assam (16.9 percent) and Bihar (17.1 percent). GER captures the percentage of people between the ages 18 - 23 enrolled in universities, colleges, or other higher education institutes.

⁷ CTIER Handbook: Technology and Innovation in India 2023

7.9 | State-wise Pupil Teacher Ratio in Higher Education (2021-22)

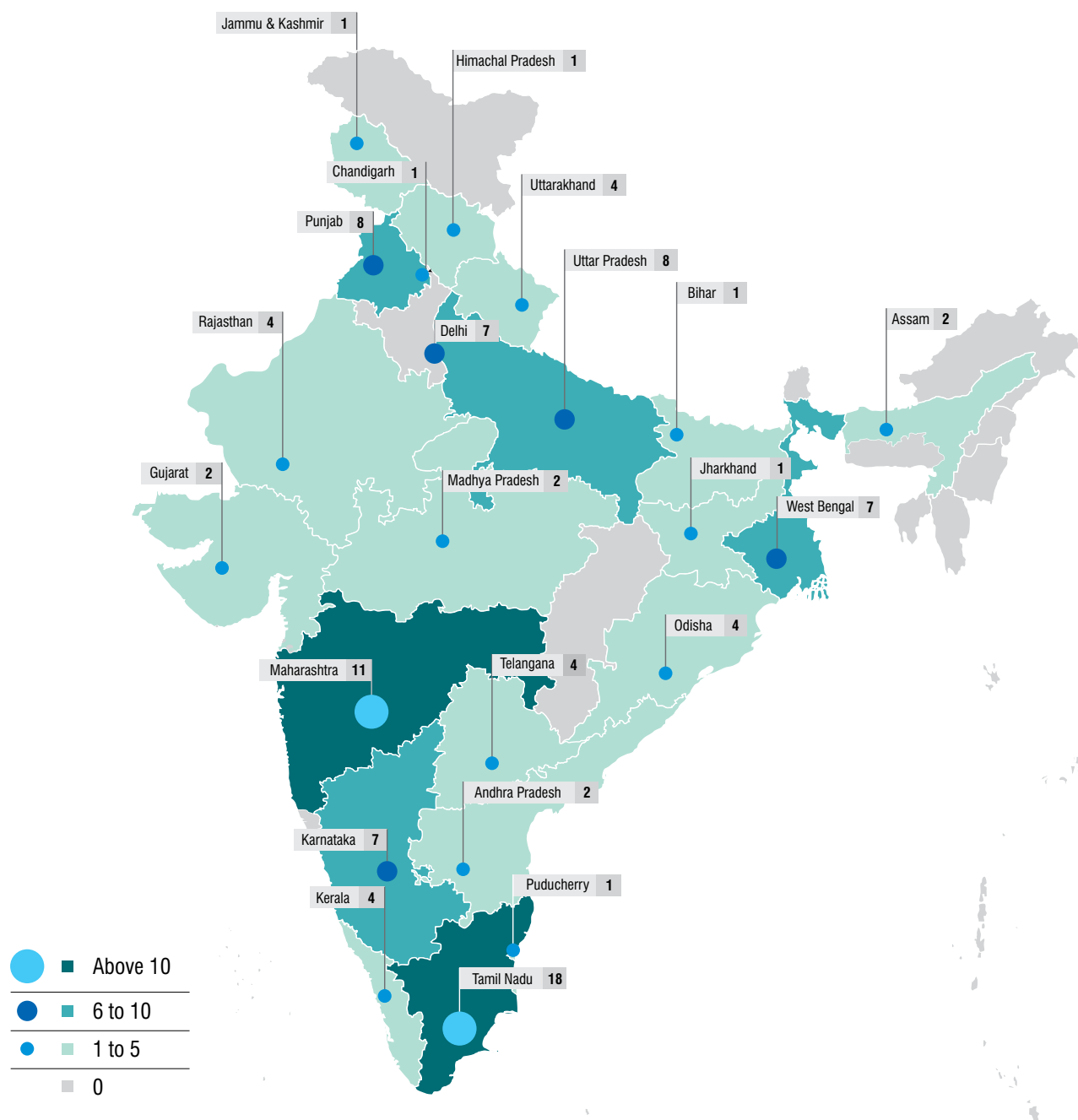


*All India Survey on Higher Education (AISHE) Report 2021-2022 captures the data for the union territories Dadra and Nagar Haveli and Daman and Diu together

Source: Ministry of Human Resource Development, Department of Higher Education, All India Survey on Higher Education (AISHE) Report 2021-2022, available at <https://aishe.gov.in/aishe/gotoAisheReports>

The Pupil-Teacher Ratio (PTR) in Higher Education reported above has considered the Pupil-Teacher Ratio for both 'regular & the distant mode of education' and enrolment in all types of institutions (University, Colleges and Stand-alone Institution). The PTR at the all India level was 26 for the year 2021-22 and ranged from 9 in Lakshadweep to 69 in Bihar. States and Union Territories with very low PTR were Lakshadweep, Puducherry, Karnataka, Ladakh, Tamil Nadu, Goa and Punjab while states with a very high PTR were Bihar, Jharkhand and Delhi.

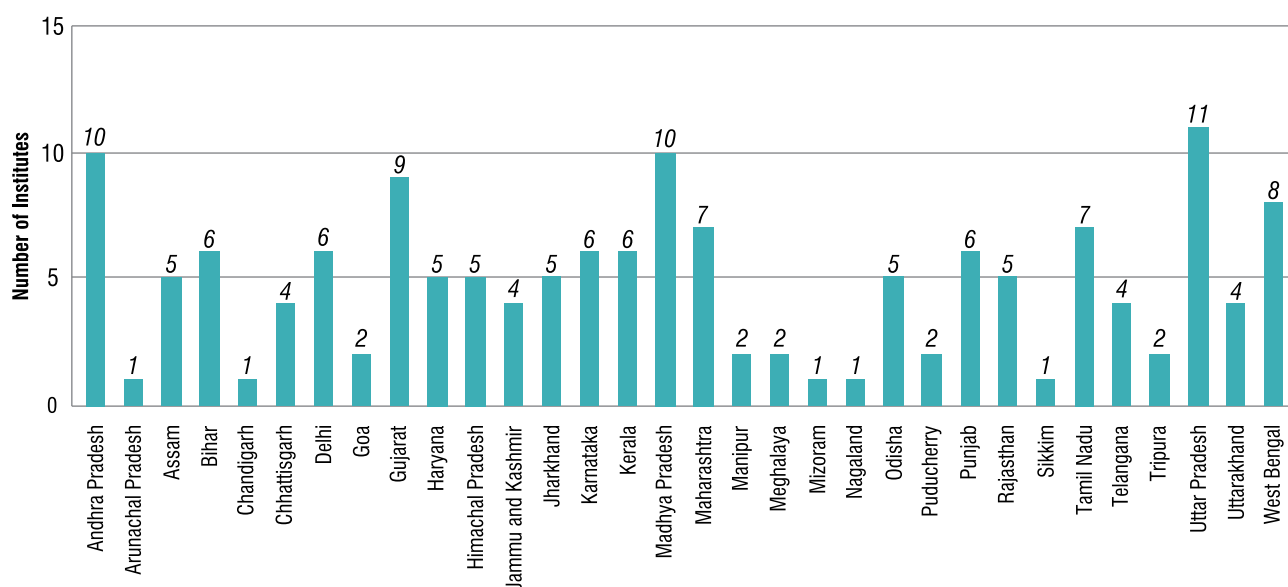
7.10 | State-wise Number of Institutes in Top 100 under the National Institute Ranking Framework (2023)



Source: Ministry of Human Resource Development, National Institutional Ranking Framework (NIRF) for the year 2023 available at <https://www.nirfindia.org/2023/OverallRanking.html>

The figure above considers the top 100 ranked universities and institutes in India according to the National Institute Ranking Framework (NIRF) and their distribution across states. NIRF outlines a methodology to rank institutions across the country on the basis of parameters which broadly cover “Teaching, Learning and Resources,” “Research and Professional Practices,” “Graduation Outcomes,” “Outreach and Inclusivity,” and “Perception”. Tamil Nadu has the highest number of educational institutes ranked in the top 100 with 18 institutes followed by Maharashtra with 11 institutes and Punjab and Uttar Pradesh with 8 institutes each respectively. A total of 22 states/union territories had at least one institute ranked in the top 100.

7.11 | State-wise Number of Institutes of National Importance (2022)



Source: Ministry of Human Resource Development, Department of Higher Education, All India Survey on Higher Education (AISHE) Report 2021-2022 available at <https://aishe.gov.in/aishe/gotoAisheReports>

Note: Institutes of National Importance (INI) are premier public higher education institutions in India established by an Act of Parliament

According to the AISHE Report 2021-22, there were 153 Institutes of national importance (INI) in the country as published by the Ministry of Human Resource Development (MHRD). The institutes of national importance have been established by an Act of Parliament. These include the various Indian Institutes of Technology (IIT)⁸, National Institutes of Technology (NIT)⁹, Indian Institutes of Information Technology (IIIT)¹⁰, Indian Institutes of Science Education and Research (IISER)¹¹, All India Institutes of Medical Sciences (AIIMS)¹² and the Schools of Planning and Architecture¹³, among others. Uttar Pradesh had 11 INIs, the highest number of INIs in any state. In 2021-22, 4 institutes were granted the status of INI, one each from Delhi, Jammu & Kashmir, Himachal Pradesh and Madhya Pradesh.

⁸ Government of India. "The Institute of Technology Act, 1961"

⁹ Government of India. "The National Institutes of Technology Act, 2007"

¹⁰ Government of India. "The Indian Institutes of Information Technology (Public-Private Partnership) Act"

¹¹ Government of India. "The National Institutes of Technology (Amendment) Act, 2012"

¹² Government of India. "All India Institute of Medical Sciences Act, 1956"

¹³ Government of India. "The School of Planning and Architecture Bill, 2014"

7.12 | Patent Applications Filed from Select States with Indian Patent Office

No.	State/UT	Number of Patent Applications Filed				
		2018-19	2019-20	2020-21	2021-22	2022-23
1	Tamil Nadu	2391	3546	3945	5262	7686
2	Maharashtra	4247	4741	4214	4566	5626
3	Uttar Pradesh	972	1176	2317	3622	5564
4	Karnataka	2185	2230	2784	3222	5408
5	Punjab	661	1435	1650	2197	3405
6	Telangana	1045	1239	1662	1750	2438
7	Delhi	1322	1440	1608	1673	1960
8	Uttarakhand	155	209	356	533	1637
9	Andhra Pradesh	323	484	709	934	1445
10	Rajasthan	305	273	449	465	1278
11	Gujarat	868	885	921	1067	1215
12	Haryana	520	672	765	998	959
13	West Bengal	529	612	505	453	808
14	Madhya Pradesh	195	285	398	488	646
15	Odisha	164	301	377	328	567
Total for Top 15		15882	19528	22660	27558	40642
Total for All States		17005	20844	24326	29508	43301

Source: The Office of the Controller General of Patents, Designs, Trademarks and General Indicators, Government of India, Annual Reports (various years), available at <https://ipindia.gov.in/annual-reports-ipo.htm>

Note: (i) Ranking of states done based on 2022-23 filings
(ii) Patents applications filed are the sum of ordinary, convention and national phase applications

The 15 states in the table above accounted for close to 94 percent of the total number of patent applications filed with the Indian Patent Office in 2022-23. The top five states Tamil Nadu, Maharashtra, Uttar Pradesh, Karnataka and Punjab accounted for around 64 percent of the total patent applications in 2022-23. A majority of the states have seen an increase in patent applications in recent years, with Uttarakhand and Rajasthan seeing a sharp increase in 2022-23 compared to the previous year. Among the top 15 states, Haryana is the only state to report a decline in the number of patents filed in 2022-23 relative to the previous year.

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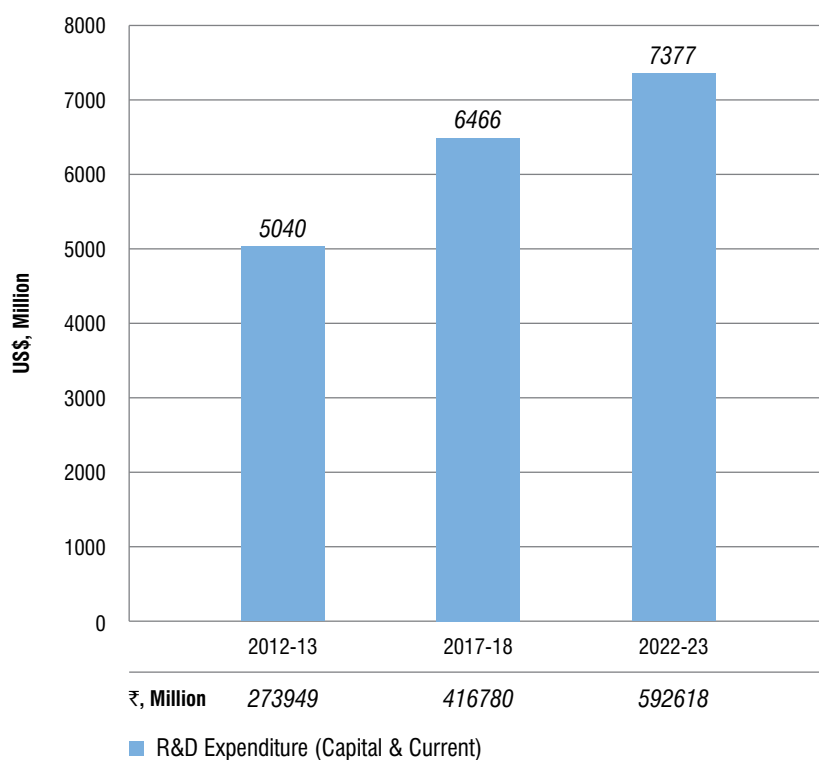
Chapter 8

Industry in India

This chapter features some unique data for India, never available before, such as the list of the top 100 R&D spenders in India. We have also included some introductory data on startups and expect to add newer indicators in forthcoming editions.

Number	Indicator
8.1	Total Industrial R&D Expenditure in India
8.2	Corporate Social Responsibility Funding towards Technology Incubators and Public Research Institutions
8.3	CTIER's Top 100 Industrial R&D Spenders in India (2022-23)
8.4	Comparison of Select Indian Firms' R&D Intensity with Respective Sector Global Average R&D Intensity
8.5	Total Foreign Exchange Spending on Technology Payments by Select Indian Firms
8.6	Import of Capital Goods by Indian Industry
8.7	Global MNCs having R&D Presence in India
8.8	Sector-wise Funding for Companies in India
8.9	Sectoral Breakdown of Patents Granted to India's Top 100 Industrial R&D Spenders (2022-23)
8.10	Top Patentees with the Indian Patent Office (2022-23)
8.11	Top Patentees with the United States Patent and Trademark Office (USPTO) (2023)
8.12	Exports as a Share of Sales for Select Indian Firms

8.1 | Total Industrial R&D Expenditure in India



Source: Annual Reports (2022-23) of Indian companies; Prowess, data downloaded on 28 May 2024 from the platform; Centre for Technology, Innovation and Economic Research (CTIER)

Note: Figures in rupees were converted to dollars using the USD-INR exchange rate of 54.35 calculated as an average for the fiscal year 2012-13, USD-INR exchange rate of 64.46 calculated as an average for the fiscal year 2017-18 and the USD-INR exchange rate of 80.33 calculated as an average for the fiscal year 2022-23 based on data from Federal Reserve Bank of St Louis

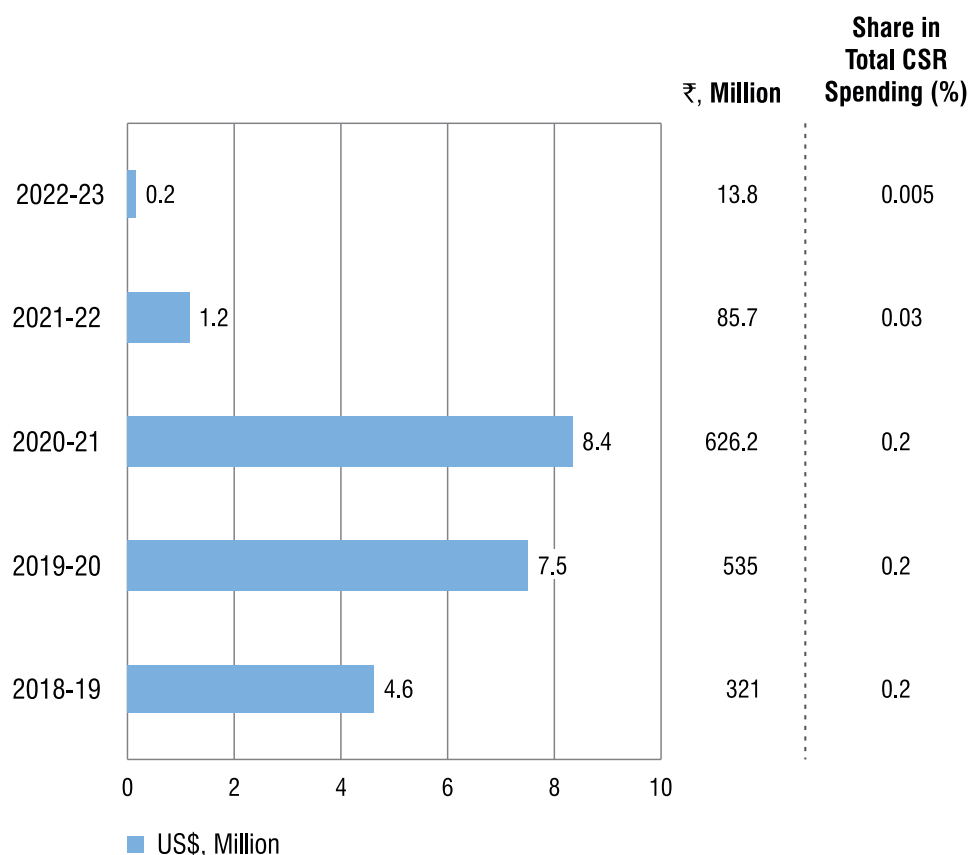
India's industrial R&D expenditure in 2023 was USD 7,377 million. The expenditure by Indian industry remains low by global standards. Nvidia¹, which is ranked 26 in the list of top 2,500 global R&D spenders², spends nearly as much as all of Indian industry on R&D, while Alphabet, the top global R&D spender, spends almost five times that of all of Indian industry.

The R&D expenditure captured above considers capital and current account expenditure on R&D reported by firms in their annual reports. The current account component of R&D expenditure represents around 75 percent of total industrial R&D spending in India.

¹ Nvidia reported USD 7,293.6 million as R&D Expenditure for the year 2022 in the EU Industrial R&D Investment Scoreboard (2023)

² EU Industrial R&D Investment Scoreboard (2023)

8.2 | Corporate Social Responsibility Funding towards Technology Incubators and Public Research Institutions



Source: National CSR Data Portal, Ministry of Corporate Affairs, Government of India, data as on 11 August 2024; Centre for Technology, Innovation and Economic Research (CTIER)

Note: Figures in rupees are converted to dollars using the USD-INR exchange rate of 69.92 calculated as an average for the fiscal year 2018-19, the USD-INR exchange rate of 70.90 calculated as an average for the fiscal year 2019-20, the USD-INR exchange rate of 74.23 calculated as an average for the fiscal year 2020-21, the USD-INR exchange rate of 74.5 calculated as an average for the fiscal year 2021-22 and the USD-INR exchange rate of 80.3 calculated as an average for the fiscal year 2022-23 according to Federal Reserve Bank of St Louis

Between 2018-19 and 2020-21, the amount of CSR funding towards technology incubators and public research institutions³ showed an increasing trend, after which it sharply declined in the following years, reaching USD 0.2 million in 2022-23. CSR spending on technology incubators on average has accounted for around 0.1 percent of total CSR spending by all companies in India over the five years.

³ See Indicator 7.7 for more details on CSR funding towards technology incubators and public research institutions

8.3 | CTIER's Top 100 Industrial R&D Spenders in India (2022-23)

Rank	Company Name	Sector	R&D Spending (₹, Million)	R&D Spending (US\$, Million)	Share in Total Top 100 R&D Spending (%)
1	Reliance Industries Ltd.	Oil & Gas	30010	377.9	6.5
2	Tata Motors Ltd.	Automobiles & Parts	29590	372.6	6.4
3	Mahindra & Mahindra Ltd.	Automobiles & Parts	27805.7	350.2	6
4	Hindustan Aeronautics Ltd.	Aerospace & Defence	24943.3	314.1	5.4
5	Tata Consultancy Services Ltd.	Software & Computer Services	24240	305.3	5.2
6	Dr. Reddy's Laboratories Ltd.	Pharmaceuticals & Biotechnology	17471	220	3.8
7	Sun Pharmaceutical Inds. Ltd.	Pharmaceuticals & Biotechnology	16487.1	207.6	3.5
8	Lupin Ltd.	Pharmaceuticals & Biotechnology	12650.5	159.3	2.7
9	Mylan Laboratories Ltd.	Pharmaceuticals & Biotechnology	11822.9	148.9	2.5
10	Cipla Ltd.	Pharmaceuticals & Biotechnology	11463.7	144	2.5
11	Bharat Electronics Ltd.	Aerospace & Defence	10756.4	135.5	2.3
12	Intas Pharmaceuticals Ltd.	Pharmaceuticals & Biotechnology	10577.4	133.2	2.3
13	Zydus Lifesciences Ltd.	Pharmaceuticals & Biotechnology	8148	102.6	1.8
14	Maruti Suzuki India Ltd.	Automobiles & Parts	7650	96.3	1.6
15	Hero Motocorp Ltd.	Automobiles & Parts	7599.4	95.7	1.6
16	Alembic Pharmaceuticals Ltd.	Pharmaceuticals & Biotechnology	7305.2	92	1.6
17	Indian Oil Corpn. Ltd.	Oil & Gas	6982.1	87.9	1.5
18	Bharat Heavy Electricals Ltd.	Industrial Engineering	6910	87	1.5
19	Aurobindo Pharma Ltd.	Pharmaceuticals & Biotechnology	6788.9	85.5	1.5
20	Infosys Ltd.	Software & Computer Services	6550	82.5	1.4
21	Oil & Natural Gas Corpn. Ltd.	Oil & Gas	5698.5	71.8	1.2
22	H C L Technologies Ltd.	Software & Computer Services	5520	69.5	1.2
23	Bajaj Auto Ltd.	Automobiles & Parts	5250.6	66	1.1
24	Serum Institute of India Pvt. Ltd.	Pharmaceuticals & Biotechnology	5080	64	1.1
25	T V S Motor Co. Ltd.	Automobiles & Parts	4946.2	62.3	1.1
26	Sun Pharma Advanced Research Co. Ltd.	Pharmaceuticals & Biotechnology	4797	60.4	1
27	Alkem Laboratories Ltd.	Pharmaceuticals & Biotechnology	4707.8	59.3	1
28	Glenmark Pharmaceuticals Ltd.	Pharmaceuticals & Biotechnology	4671.9	58.8	1
29	Steel Authority of India Ltd.	Industrial Metals & Mining	4304.8	54.2	1
30	Ashok Leyland Ltd.	Automobiles & Parts	4296.6	54.1	1
31	Bosch Ltd.	Automobiles & Parts	4281	53.9	1
32	Torrent Pharmaceuticals Ltd.	Pharmaceuticals & Biotechnology	4149.6	52.3	1
33	Macleods Pharmaceuticals Ltd.	Pharmaceuticals & Biotechnology	4084.5	51.4	0.9
34	Wipro Ltd.	Software & Computer Services	3675	46.3	0.8
35	Hindustan Petroleum Corpn. Ltd.	Oil & Gas	3192.2	40	0.7
36	Eicher Motors Ltd.	Automobiles & Parts	3095.7	39	0.7
37	Bharat Biotech Intl. Ltd.	Pharmaceuticals & Biotechnology	2970	37	0.6
38	Tejas Networks Ltd.	Technology Hardware & Equipment	2966.4	37.4	0.6
39	N T P C Ltd.	Electricity	2834.5	35.7	0.6
40	Tata Steel Ltd.	Industrial Metals & Mining	2749.2	34.6	0.6
41	Force Motors Ltd.	Automobiles & Parts	2642.8	33.3	0.6
42	Intellect Design Arena Ltd.	Software & Computer Services	2596.9	32.7	0.6
43	Nayara Energy Ltd.	Oil & Gas	2579	32.5	0.6
44	Ajanta Pharma Ltd.	Pharmaceuticals & Biotechnology	2552.1	32.1	0.5
45	P A R Formulations Pvt. Ltd.	Pharmaceuticals & Biotechnology	2317.2	29	0.5
46	Daimler India Commercial Vehicles Pvt. Ltd.	Automobiles & Parts	2250	28.3	0.5
47	V E Commercial Vehicles Ltd.	Automobiles & Parts	2145.9	27	0.5
48	Laurus Labs Ltd.	Pharmaceuticals & Biotechnology	2110	26.6	0.5
49	Watson Pharma Pvt. Ltd.	Pharmaceuticals & Biotechnology	2043.8	25.7	0.4
50	Philips India Ltd.	General Industrials	2020	25.4	0.4

Source: Annual Reports (2022-23) of Indian companies; Prowess, data downloaded on 28 May 2024 from the platform; Centre for Technology, Innovation and Economic Research (CTIER)

51	Gland Pharma Ltd.	Pharmaceuticals & Biotechnology	2013.9	25.4	 0.4
52	Uno Minda Ltd.	Automobiles & Parts	1990.4	25.1	 0.4
53	U P L Ltd.	Chemicals	1960	24.7	 0.4
54	Natco Pharma Ltd.	Pharmaceuticals & Biotechnology	1959	24.7	 0.4
55	Apollo Tyres Ltd.	Automobiles & Parts	1945.8	24.5	 0.4
56	Escorts Kubota Ltd.	Industrial Engineering	1928.1	24.3	 0.4
57	Tata Advanced Systems Ltd.	Aerospace & Defence	1898.9	23.9	 0.4
58	Micro Labs Ltd.	Pharmaceuticals & Biotechnology	1882.8	23.7	 0.4
59	Mankind Pharma Ltd.	Pharmaceuticals & Biotechnology	1881.7	23.7	 0.4
60	P I Industries Ltd.	Chemicals	1856	23.4	 0.4
61	G A I L (India) Ltd.	Oil & Gas	1807.1	22.8	 0.4
62	Hetero Labs Ltd.	Pharmaceuticals & Biotechnology	1798.2	22.6	 0.4
63	Oil India Ltd.	Oil & Gas	1790.3	22.5	 0.4
64	H F C L Ltd.	Telecommunications Equipment	1772.1	22.3	 0.4
65	I T C Ltd.	General Industrials	1709.8	21.5	 0.4
66	Emcure Pharmaceuticals Ltd.	Pharmaceuticals & Biotechnology	1660.9	20.9	 0.4
67	Havells India Ltd.	Electronic & Electrical Equipment	1631.8	20.5	 0.4
68	Ceat Ltd.	Automobiles & Parts	1627.3	20.5	 0.4
69	National Aluminium Co. Ltd.	Industrial Metals & Mining	1615.9	20	 0.3
70	Ipca Laboratories Ltd.	Pharmaceuticals & Biotechnology	1564.9	20	 0.3
71	Bharat Dynamics Ltd.	Aerospace & Defence	1520.3	19.1	 0.3
72	Reliance Life Sciences Pvt. Ltd.	Pharmaceuticals & Biotechnology	1473.4	18.6	 0.3
73	Encube Ethicals Pvt. Ltd.	Pharmaceuticals & Biotechnology	1413	17.8	 0.3
74	International Tractors Ltd.	Industrial Engineering	1398.5	17.6	 0.3
75	Biocon Biologics Ltd.	Pharmaceuticals & Biotechnology	1379	17.4	 0.3
76	Saint-Gobain India Pvt. Ltd.	Construction and Materials	1378.6	17.4	 0.3
77	Jain Irrigation Systems Ltd.	Chemicals	1372.6	17.3	 0.3
78	M R F Ltd.	Automobiles & Parts	1350.7	17	 0.3
79	Larsen & Toubro Ltd.	Construction and Materials	1335.1	16.8	 0.3
80	U S V Pvt. Ltd.	Pharmaceuticals & Biotechnology	1328.9	16.7	 0.3
81	A P L Healthcare Ltd.	Pharmaceuticals & Biotechnology	1323	16.7	 0.3
82	Baxter Pharmaceuticals India Pvt. Ltd.	Pharmaceuticals & Biotechnology	1312.1	16.5	 0.3
83	S R F Ltd.	Chemicals	1293.1	16.3	 0.3
84	Grasim Industries Ltd.	General Industrials	1240	15.6	 0.3
85	Biocon Ltd.	Pharmaceuticals & Biotechnology	1232	15.5	 0.3
86	Micro Life Sciences Pvt. Ltd.	Pharmaceuticals & Biotechnology	1207.3	15.2	 0.3
87	Mukand Ltd.	Industrial Metals & Mining	1181.5	14.9	 0.3
88	Bayer Cropscience Ltd.	Chemicals	1168	14.7	 0.3
89	J K Tyre & Inds. Ltd.	Automobiles & Parts	1160.5	14.6	 0.2
90	Ramco Systems Ltd.	Software & Computer Services	1096.6	13.8	 0.2
91	Asian Paints Ltd.	Chemicals	1080.4	13.6	 0.2
92	Abbott Healthcare Pvt. Ltd.	Pharmaceuticals & Biotechnology	1068.8	13.5	 0.2
93	Fresenius Kabi Oncology Ltd.	Pharmaceuticals & Biotechnology	1039.1	13.1	 0.2
94	Suzlon Energy Ltd.	Electricity	1025.1	12.9	 0.2
95	Indoco Remedies Ltd.	Pharmaceuticals & Biotechnology	1023.7	12.9	 0.2
96	Brakes India Pvt. Ltd.	Automobiles & Parts	1006.1	12.7	 0.2
97	Granules India Ltd.	Pharmaceuticals & Biotechnology	997.2	12.6	 0.2
98	Harman International (India) Pvt. Ltd.	Electronic & Electrical Equipment	988.5	12.4	 0.2
99	Schaeffler India Ltd.	Industrial Engineering	972.2	12.2	 0.2
100	Wockhardt Ltd.	Pharmaceuticals & Biotechnology	970	12.2	 0.2

Note: (i) Figures in rupees were converted to dollars using the USD-INR exchange rate of 79.41 as at 31 December 2022 and based on exchange rates mentioned in the EU Industrial R&D Investment Scoreboard (2023)
(ii) Figures for Tata Motors Ltd. are based on estimates from Annual Reports

8.4 | Comparison of Select Indian Firms' R&D Intensity with Respective Sector Global Average R&D Intensity

Sector	Company	R&D Intensity (%)	Top 2500 Global Average R&D Intensity (%)
Pharmaceuticals & Biotechnology	Dr. Reddy's Laboratories Ltd.	10.3	16.2
	Sun Pharmaceutical Inds. Ltd.	7.9	
	Lupin Ltd.	11.2	
	Mylan Laboratories Ltd.	11	
	Cipla Ltd.	7.9	
Automobiles & Parts	Tata Motors Ltd.	4.5	4.7
	Mahindra & Mahindra Ltd.	3.3	
	Maruti Suzuki India Ltd.	0.7	
	Hero Motocorp Ltd.	2.2	
	Bajaj Auto Ltd.	1.4	
Oil & Gas	Reliance Industries Ltd.	0.6	0.3
	Indian Oil Corpn. Ltd.	0.1	
	Oil & Natural Gas Corpn. Ltd.	0.4	
	Hindustan Petroleum Corpn. Ltd.	0.1	
	Nayara Energy Ltd.	0.2	
Software & Computer Services	Tata Consultancy Services Ltd.	1.3	14.5
	Infosys Ltd.	0.5	
	H C L Technologies Ltd.	1.2	
	Wipro Ltd.	0.5	
	Intellect Design Arena Ltd.	17.7	
Aerospace & Defence	Hindustan Aeronautics Ltd.	9.3	4.4
	Bharat Electronics Ltd.	6.1	
	Tata Advanced Systems Ltd.	5.7	
	Bharat Dynamics Ltd.	6.1	
	Mazagon Dock Shipbuilders Ltd.	1.2	

Source: Annual Reports (2022-23) of Indian companies; Prowess, data downloaded on 28 May 2024 from the platform; EU Industrial R&D Investment Scoreboard (2023); Centre for Technology, Innovation and Economic Research (CTIER)

Note: Figures for Tata Motors Ltd. are based on estimates from Annual Reports and Investor Presentations

The top 10 industrial R&D sectors in India, as captured in Indicator 6.4.1, have been considered above. The table compares the R&D intensities (R&D expenditure as a percent of sales) for top Indian R&D spenders in each sector with the respective global average R&D intensity. Electronic & electrical equipment now features in the top 10 industrial R&D sectors in India and has replaced general industrials that was present in the top 10 R&D sectors in 2021.⁴

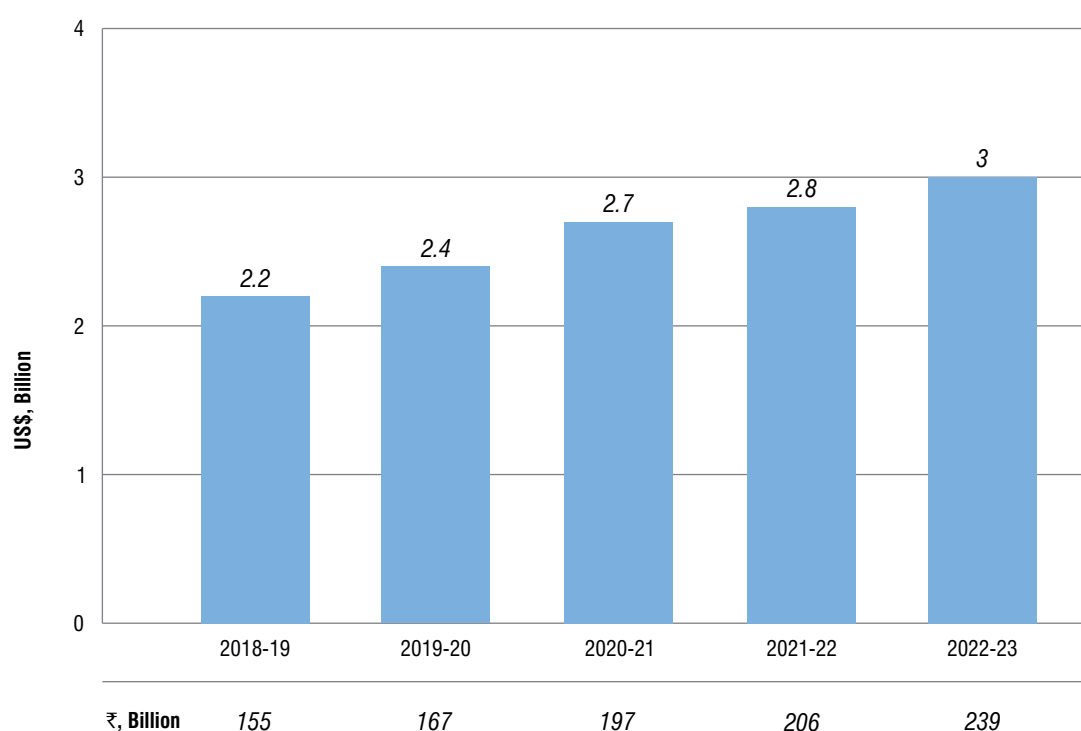
⁴ CTIER Handbook: Technology and Innovation in India 2023

Sector	Company	R&D Intensity (%)	Top 2500 Global Average R&D Intensity (%)
Chemicals	U P L Ltd.	1	2.2
	P I Industries Ltd.	3	
	Jain Irrigation Systems Ltd.	3.8	
	S R F Ltd.	1.1	
	Bayer Cropscience Ltd.	2.3	
Industrial Engineering	Bharat Heavy Electricals Ltd.	3	3.2
	Escorts Kubota Ltd.	2.3	
	International Tractors Ltd.	1.6	
	Schaeffler India Ltd.	1.4	
	Tata Cummins Pvt. Ltd.	1.4	
Industrial Metals & Mining	Steel Authority Of India Ltd.	0.4	1.6
	Tata Steel Ltd.	0.2	
	National Aluminium Co. Ltd.	1.1	
	Mukand Ltd.	2.1	
	J S W Steel Ltd.	0.03	
Electronic & Electrical Equipment	Havells India Ltd.	1	5.1
	Harman International (India) Pvt. Ltd.	2.4	
	Secure Meters Ltd.	7.3	
	Siemens Ltd.	0.3	
	C G Power & Indl. Solutions Ltd.	0.5	
Food Producers	Venco Research & Breeding Farm Pvt. Ltd.	6.4	1.2
	Mahyco Pvt. Ltd.	7.4	
	Kaveri Seed Co. Ltd.	6.3	
	Britannia Industries Ltd.	0.3	
	Rasi Seeds Pvt. Ltd.	3.4	

Reliance Industries Ltd., Tata Motors Ltd. and Hindustan Aeronautics Ltd., feature among the top 10 R&D spenders in India. These firms have R&D intensities that are close to or in some cases even well above the global average R&D intensities for their respective sectors.

Some of the other top Indian firms such as Dr. Reddy's Laboratories Ltd., Sun Pharmaceutical Inds. Ltd., Mahindra & Mahindra Ltd. and Steel Authority of India Ltd., have R&D intensities below the global average for their respective sectors. Top Indian software services firms such as TCS and Infosys have R&D intensities significantly lower than the global average for the software & computer services sector. This is because the global software & computer services sector tends to be dominated by software product firms such as Alphabet, Microsoft and Meta that have higher R&D intensities.

8.5 | Total Foreign Exchange Spending on Technology Payments by Select Indian Firms



Source: Prowess, data downloaded on 2 October 2024 from the platform; ACE Equity, data downloaded on 2 October 2024 from the platform; Ahmedabad University; Centre for Technology, Innovation and Economic Research (CTIER)

Note: (i) 3119 firms have reported foreign exchange spending on technology payments at least once in the five years 2018-19 to 2022-23
(ii) Total excludes firms engaged in mining, quarrying or extraction
(iii) Figures in rupees are converted to dollars using the USD-INR exchange rate of 69.92 calculated as an average for the fiscal year 2018-19, the USD-INR exchange rate of 70.90 calculated as an average for the fiscal year 2019-20, the USD-INR exchange rate of 74.23 calculated as an average for the fiscal year 2020-21, the USD-INR exchange rate of 74.50 calculated as an average for the fiscal year 2021-22 and the USD-INR exchange rate of 80.33 calculated as an average for the fiscal year 2022-23 according to Federal Reserve Bank of St Louis

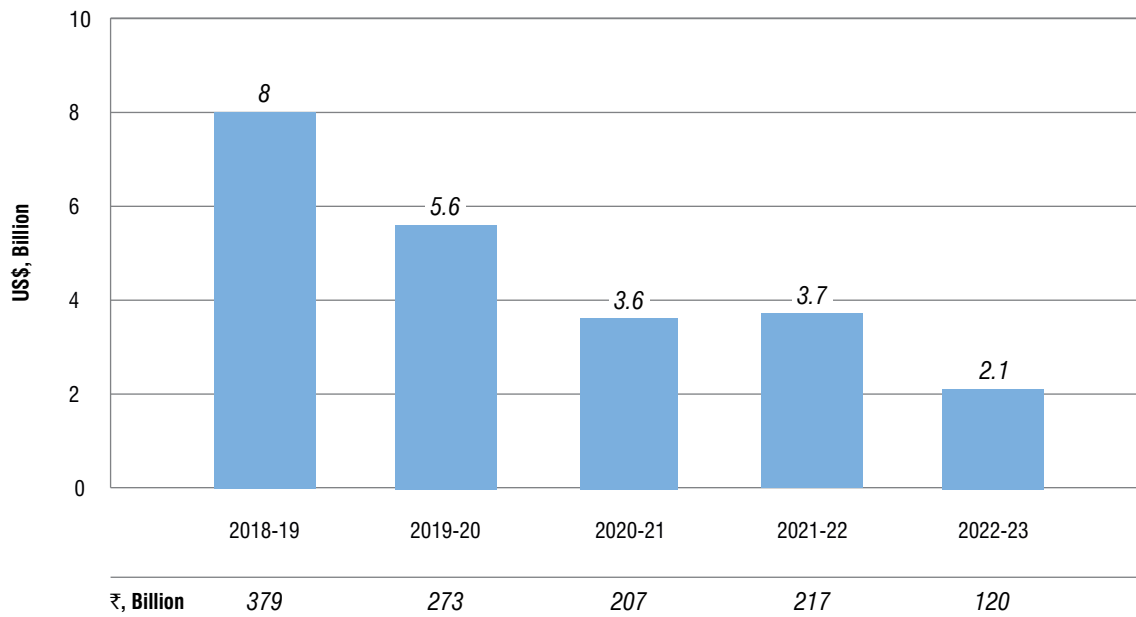
Based on firm level data⁵ available for industry, the figure above shows a steady increase for technology payments (that includes royalty and technical fees)⁶ between 2018-19 and 2022-23. India's total technology payments as reported by the RBI too has seen a steady increase over the same period.⁷ It is unclear whether the difference between the industry level data and the aggregate data has been entirely due to unavailability of firm level data. Currently, a breakdown of RBI's technology payments data by industry is unavailable. Furthermore, it is also difficult to discern from the aggregate level data how much of the payments were towards patented technologies by higher technology or knowledge intensive firms and how much of it may have been towards payments for copyrights and trademarks.

⁵ As reported by Prowess and Ace Equity

⁶ Also known as 'disembodied technology'

⁷ See Indicator 6.5.1

8.6 | Import of Capital Goods by Indian Industry



Source: Prowess, data downloaded on 9 December 2024 from the platform; ACE Equity, data downloaded on 9 December 2024 from the platform; Ahmedabad University; Centre for Technology, Innovation and Economic Research (CTIER)

Note: (i) 3000 firms have reported foreign embodied technology spending at least once in the five years 2018-19 to 2022-23

(ii) Figures in rupees are converted to dollars using the USD-INR exchange rate of 69.92 calculated as an average for the fiscal year 2018-19, the USD-INR exchange rate of 70.90 calculated as an average for the fiscal year 2019-20, the USD-INR exchange rate of 74.23 calculated as an average for the fiscal year 2020-21, the USD-INR exchange rate of 74.50 calculated as an average for the fiscal year 2021-22 and the USD-INR exchange rate of 80.33 calculated as an average for the fiscal year 2022-23 according to Federal Reserve Bank of St Louis

The figure above reports data available for 3,000 firms for whom import of capital goods has been captured at least once between 2018-19 and 2022-23.⁸ The import of capital goods for these firms between the years 2018-19 and 2022-23 saw a steady slowdown. There has also been a steady drop in the number of firms over the five years under consideration for whom data on import of capital goods is available. Separately, India's total import of capital goods in 2022-23 was USD 90.5 billion. The commodity-wise breakdown can be found in the Appendix (Table A.13).

⁸ As reported by Prowess and Ace Equity

8.7 | Global MNCs having R&D Presence in India

Firms	Total R&D Expenditure (US\$, Billion)	Share in Total of Top 2500 (%)
Top 2500 Global R&D firms	1324	100
Top 100 Global R&D firms	673	51
89 Global R&D Spenders (in top 100 with presence in India*)	628	47
69 Global R&D Spenders (in top 100 with R&D centres in India)	504	38

*in the form of either an R&D Centre or a subsidiary

Source: EU Industrial R&D Investment Scoreboard (2023); Ministry of Corporate Affairs (MCA); Various news reports; Company Websites; Centre for Technology, Innovation and Economic Research (CTIER)

Note: Exchange rate used for calculation is from EU Industrial R&D Investment Scoreboard (2023) as on 31st December 2022; 1 EUR = 1.06 USD

The presence of MNC R&D centres in the country has increased from 981⁹ in 2010 to over 1580 in 2023.¹⁰ We have estimated MNC R&D expenditure in India through their R&D centres to be around USD 15.1 billion in 2023. This compares to our previous estimate of around USD 12.8 billion in 2021.¹¹

We have considered the top 100 global R&D spenders from the list of the top 2,500¹² to arrive at an estimate of the MNC R&D spending in India in 2023. The total R&D expenditure by the top 100 R&D spenders was USD 673 billion that accounted for 51 percent of the total R&D expenditure of the top 2,500 global R&D spenders. Of the top 100 R&D spenders, we were able to verify the presence of 89 MNCs in India, either through a subsidiary or as having a R&D centre in India. Using the Ministry of Corporate Affairs (MCA) database, individual company websites and news reports, we were able to identify the presence of R&D centres in India for 69 of the top 100 global R&D spenders. These 69 MNCs had a total expenditure on R&D amounting to USD 504 billion globally. Assuming that these 69 firms spend around 3 percent of their global R&D expenditure in India, we arrive at a conservative estimate of at least USD 15.1 billion of R&D expenditure by these firms in the country. Our estimate of USD 15.1 billion for MNC R&D activity in India would possibly be at the lower end of what global MNC R&D centres spend on R&D in India.

⁹ India is an R&D hub for MNCs. Will global protectionism play spoilsport? Rishikesh T Krishnan (2019) available at <https://www.foundingfuel.com/article/india-is-an-rd-hub-for-mncs-will-global-protectionism-play-spoilsport/>

¹⁰ New GCCs set up and existing GCCs expansion in India – An overview, Nasscom, available at <https://community.nasscom.in/communities/global-capability-centers/new-gccs-set-and-existing-gccs-expansion-india-overview>

¹¹ CTIER Handbook: Technology and Innovation in India 2023

¹² EU Industrial R&D Investment Scoreboard (2023)

8.8 | Sector-wise Funding for Companies in India

Sector	Total Funding Amount (US\$, Million)				
	2019	2020	2021	2022	2023
Consumer	10216	5512	21906	10551	4709
Retail	4745	12395	15485	5823	4538
FinTech	3787	2407	8381	5327	2940
Enterprise Applications	3179	2612	9211	7943	2546
Transportation and Logistics Tech	2363	864	3785	4255	2339
High Tech*	1931	1748	4652	6794	2186
Environment Tech	593	351	753	2490	2023
Auto Tech	1566	662	3171	2652	1985
Energy Tech	556	255	696	2248	1899
Food and Agriculture Tech	1438	1806	4215	3193	1183
InsurTech	397	776	914	625	862

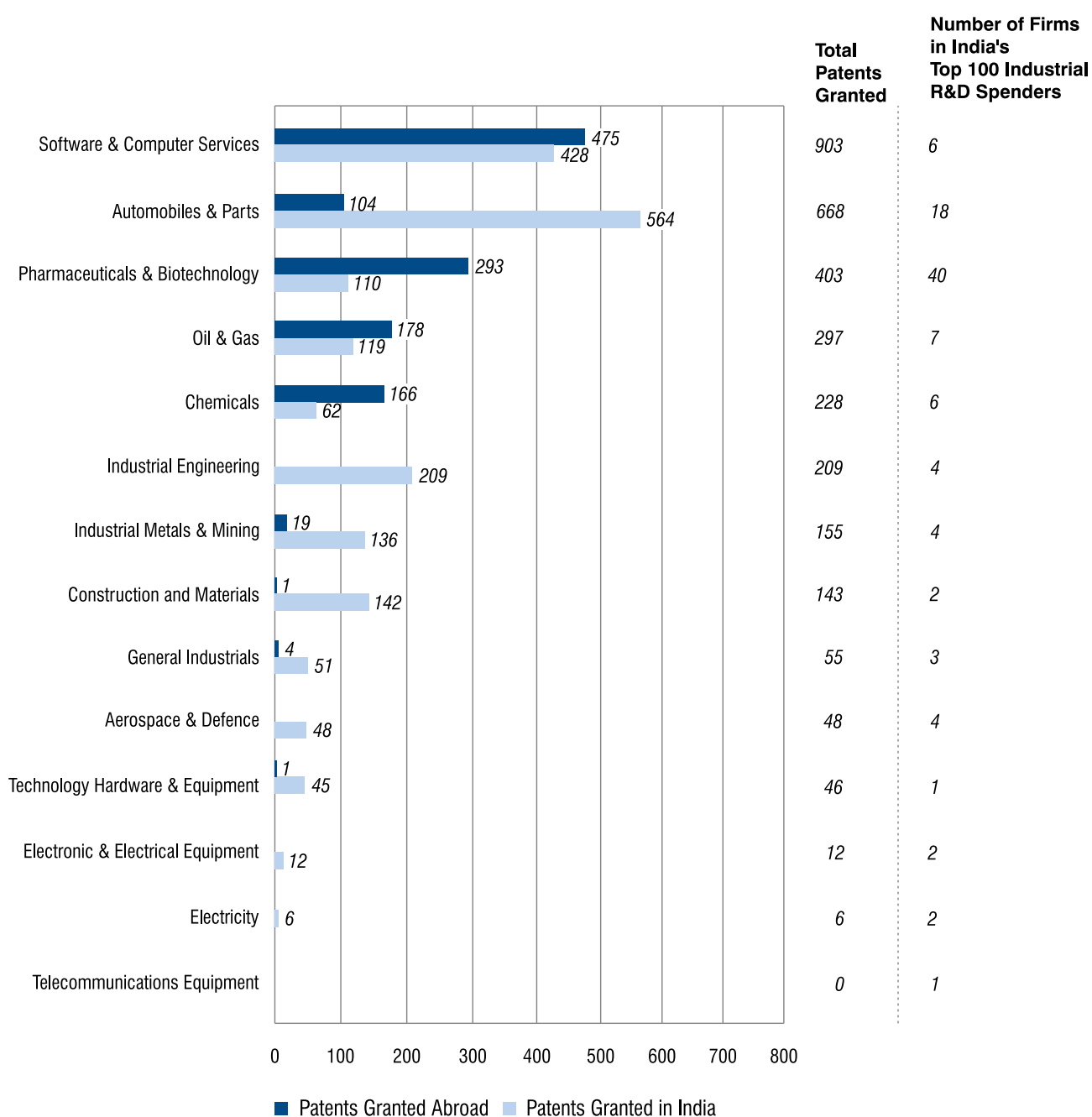
*Companies working on developing technology-intensive products and software related to products like Drones, 3D Printing, Nano Technology, Edge Computing, etc.

Source: Tracxn, data downloaded on 14 October 2024 from the platform

Note: Excludes Debt, Grant and post IPO rounds

According to data from Tracxn, sectors such as consumer, retail, fintech and enterprise applications were among the larger recipients of funding for companies in 2023. The sub-sectors B2C e-commerce dominated the funding landscape for the consumer sector, while alternative lending dominated the fintech sector. The retail sector saw retail chains as a key recipient of funding while enterprise software and SaaS were key sub-sectors for enterprise applications. The sub-sector logistics tech is one of the major recipients under the transportation and logistics tech sector and also cuts across the consumer sector. The data on funding for sub-sectors can be found in the Appendix (Table A.14).

8.9 | Sectoral Breakdown of Patents Granted to India's Top 100 Industrial R&D Spenders (2022-23)



Source: XLSCOUT, data downloaded in October 2024, data is as of 22 October 2024; Centre for Technology, Innovation and Economic Research (CTIER)

The figure above considers the patents granted to India's top 100 R&D spenders, both in India and abroad. There were a total of 3,173 patents granted to India's top R&D spenders in 2022-23. When firm level patent data was aggregated to obtain the number of patents by sector, the sectors that dominated were software & computer services and automobiles & parts. These sectors were followed by pharmaceuticals & biotechnology and oil & gas. A higher share of patents was granted abroad for the pharmaceuticals & biotechnology, chemicals, oil & gas and software & computer services sectors, while the automobile & parts sector had a significantly higher share of patents granted by the Indian Patent Office.

8.10 | Top Patentees with the Indian Patent Office (2022-23)

Top 10 Non Resident Patentees with the Indian Patent Office (2022-23)

No.	Name of Organisation	Patents Granted
1	Qualcomm Incorporated	754
2	Samsung Electronics	581
3	Telefonaktiebolaget L M Ericsson	559
4	Huawei Technologies	525
5	Koninklijke Philips	472
6	Honda Motor Company	332
7	Microsoft	266
8	General Electric	257
9	Mitsubishi Electric	229
10	JFE Steel	220
Total		4195

Source: XLSCOUT, data downloaded in August 2024, data is as of 29 August 2024; Centre for Technology, Innovation and Economic Research (CTIER)

Note: If a patent was granted to multiple entities or applicants, only the first-named applicant was considered

The table above shows the top 10 non resident patentees with respect to the patents granted by the Indian Patent Office (IPO) in 2022-23. Qualcomm was the largest non resident patent holder followed by Samsung Electronics.

Top 10 Indian Resident Patentees with the Indian Patent Office (2022-23)

No.	Name of Organisation	Patents Granted
1	Tata Consultancy Services	230
2	Council of Scientific and Industrial Research	221
3	TVS Motor Company Limited	197
4	Bharat Heavy Electricals	194
5	Samsung R&D Institute India Bangalore	167
6	Mahindra & Mahindra	164
7	Wipro	163
8	Indian Institute of Technology Madras	161
9	Indian Institute of Technology Bombay	153
10	Defence Research & Development Organisation	149
Total		1799

Source: XLSCOUT, data downloaded in August 2024, data is as of 29 August 2024; Centre for Technology, Innovation and Economic Research (CTIER)

Note: If a patent was granted to multiple entities or applicants, only the first-named applicant was considered

The top 10 resident patentees with the Indian Patent Office are captured in the table above. The top patent holder was the Tata Consultancy Services followed by Council of Scientific & Industrial Research (CSIR).

8.11 | Top Patentees with the United States Patent and Trademark Office (USPTO) (2023)

Top Multinational Corporation Patentees (Residents in India) with the United States Patent and Trademark Office (USPTO) (2023)

No.	Name of Organisation	Patents Granted
1	International Business Machines Corporation	429
2	Texas Instruments Incorporated	221
3	Samsung Electronics Co. Ltd.	198
4	Qualcomm Incorporated	187
5	VMware	183
6	Dell Products L.P.	175
7	Adobe Inc.	152
8	Hewlett Packard	138
9	Honeywell International Inc.	124
10	General Electric Company	119

Source: XLSCOUT, data downloaded in September 2024, data is as of 9 September 2024; Centre for Technology, Innovation and Economic Research (CTIER)

The top 10 multinational corporation patentees with the United States Patent and Trademark Office (USPTO) and based in India are largely from sectors such as technology hardware & equipment, software & computer services and general industrials.

Top Indian (Resident in India) Patentees with the United States Patent and Trademark Office (USPTO) (2023)

No.	Name of Organisation	Patents Granted
1	Tata Consultancy Services Limited	144
2	Wipro Limited	36
3	Indian Oil Corporated Limited	32
4	Council of Scientific and Industrial Research	20
5	Reliance Jio Infocomm	19
6	Dish Network Tech India	18
7	HCLTech	15
8	UTC Fire & Security India	10
9	Reliance Industries	8
10	Siliconch Systems	7

Source: XLSCOUT, data downloaded in September 2024, data is as of 9 September 2024; Centre for Technology, Innovation and Economic Research (CTIER)

Note: The data for Council of Scientific & Industrial Research (CSIR) is representative of 37 CSIR research laboratories and institutes

The top 10 Indian patentees with the USPTO majorly comprised firms that have a presence in industrial sectors such as software & computer services, oil & gas and telecommunications. In 2023, software & computer services firms were granted the highest number of patents by the USPTO in the list of top 10 Indian patentees.¹³

¹³ CTIER Handbook: Technology and Innovation in India 2023

8.12 | Exports as a Share of Sales for Select Indian Firms

Sector	Company	Sales (US\$, Million)	Sales (₹, Million)	Exports as a Share of Sales (%)
Pharmaceuticals & Biotechnology	Dr. Reddy's Laboratories Ltd.	2111.6	169625	72
	Sun Pharmaceutical Inds. Ltd.	2590.8	208121.4	75.6
	Lupin Ltd.	1401.6	112588.3	40.4
	Mylan Laboratories Ltd.	1333.7	107135.2	-
	Cipla Ltd.	1807.4	145187.9	36.7
Automobiles & Parts	Tata Motors Ltd.	8185.9	657573	4.6
	Mahindra & Mahindra Ltd.	10576.4	849602.6	5.9
	Maruti Suzuki India Ltd.	14630	1175229	12.6
	Hero Motocorp Ltd.	4208.3	338056.5	3.4
	Bajaj Auto Ltd.	4534.7	364276	38.4
Oil & Gas	Reliance Industries Ltd.	67445.7	5417910	60
	Indian Oil Corpn. Ltd.	116389	9349526.6	5.3
	Oil & Natural Gas Corpn. Ltd.	19359.8	1555173.2	4.1
	Hindustan Petroleum Corpn. Ltd.	58034.7	4661923.5	1.1
	Nayara Energy Ltd.	17156.9	1378213	48.8
Software & Computer Services	Tata Consultancy Services Ltd.	23696.5	1903540	94.3
	Infosys Ltd.	15438.1	1240140	97.2
	H C L Technologies Ltd.	5760.7	462760	96.1
	Wipro Ltd.	8434.4	677534	97.2
	Intellect Design Arena Ltd.	183	14701	61
Aerospace & Defence	Hindustan Aeronautics Ltd.	3352.2	269278.5	1
	Bharat Electronics Ltd.	2196.7	176462	2.3
	Tata Advanced Systems Ltd.	416.7	33473	-
	Bharat Dynamics Ltd.	312.4	25093	4
	Mazagon Dock Shipbuilders Ltd.	974.4	78271.8	0.1
Chemicals	U P L Ltd.	2338.2	187830	89
	P I Industries Ltd.	780.6	62704	84
	Jain Irrigation Systems Ltd.	447.4	35938.3	15
	S R F Ltd.	1503	120738.4	51
	Bayer Cropscience Ltd.	639.8	51397	6
Industrial Engineering	Bharat Heavy Electricals Ltd.	2908.6	233649.4	4.9
	Escorts Kubota Ltd.	1038.8	83449.5	7.1
	International Tractors Ltd.	1113.4	89439.7	29.3
	Schaeffler India Ltd.	864	69407.5	13
	Tata Cummins Pvt. Ltd.	843.1	67726.4	-
Industrial Metals & Mining	Steel Authority Of India Ltd.	13002.3	1044473.6	2.6
	Tata Steel Ltd.	16059.6	1290066.2	7
	National Aluminium Co. Ltd.	1774.5	142548.6	29.9
	Mukand Ltd.	699.9	56220.4	7.2
	J S W Steel Ltd.	16393.3	1316870	9

Sector	Company	Sales (US\$, Million)	Sales (₹, Million)	Exports as a Share of Sales (%)
Electronic & Electrical Equipment	Havells India Ltd.	2113.7	169796.9	2.9
	Harman International (India) Pvt. Ltd.	515.5	41406.8	-
	Secure Meters Ltd.	140.8	11308.2	-
	Siemens Ltd.	2217.4	178127	16
	C G Power & Indl. Solutions Ltd.	819.8	65851.1	5
Food Producers	Venco Research & Breeding Farm Pvt. Ltd.	156.4	12563.9	-
	Mahyco Pvt. Ltd.	115.4	9266.2	9.6
	Kaveri Seed Co. Ltd.	124.6	10005.6	2
	Britannia Industries Ltd.	1944.3	156184.2	5
	Rasi Seeds Pvt. Ltd.	155.9	12527	1.1

Source: Annual Reports (2022-23) of Indian companies; Prowess, data downloaded on 28 May 2024 from the platform; Centre for Technology, Innovation and Economic Research (CTIER)

Note: Figures in rupees were converted to dollars using the USD-INR exchange rate of 80.33 calculated as an average for the fiscal year 2022-23 based on data from Federal Reserve Bank of St Louis

The top 10 industrial R&D sectors in India, as captured in Indicator 6.4.1, have been considered above. The table shows exports as a share of sales for top Indian R&D spenders in each sector. The software & computer services sector saw the highest exports as a share of sales, with 4 firms having exports as a share of sales of more than 90 percent.

Top Indian pharmaceuticals & biotechnology firms, such as Dr. Reddy's Laboratories Ltd. and Sun Pharmaceutical Industries Ltd., have exports as a share of sales of more than 50 percent while also featuring among the top 10 industrial R&D spenders in India. Tata Motors Ltd. and Mahindra & Mahindra Ltd., two companies from the automobiles & parts sector that feature among the top 10 industrial R&D spenders in India have exports as a share of sales of around 5 percent.

From the oil & gas sector, public sector undertakings have lower exports as a share of sales than private firms like Reliance Industries Ltd. and Nayara Energy Ltd., which have exports as a share of sales close to or above 50 percent.

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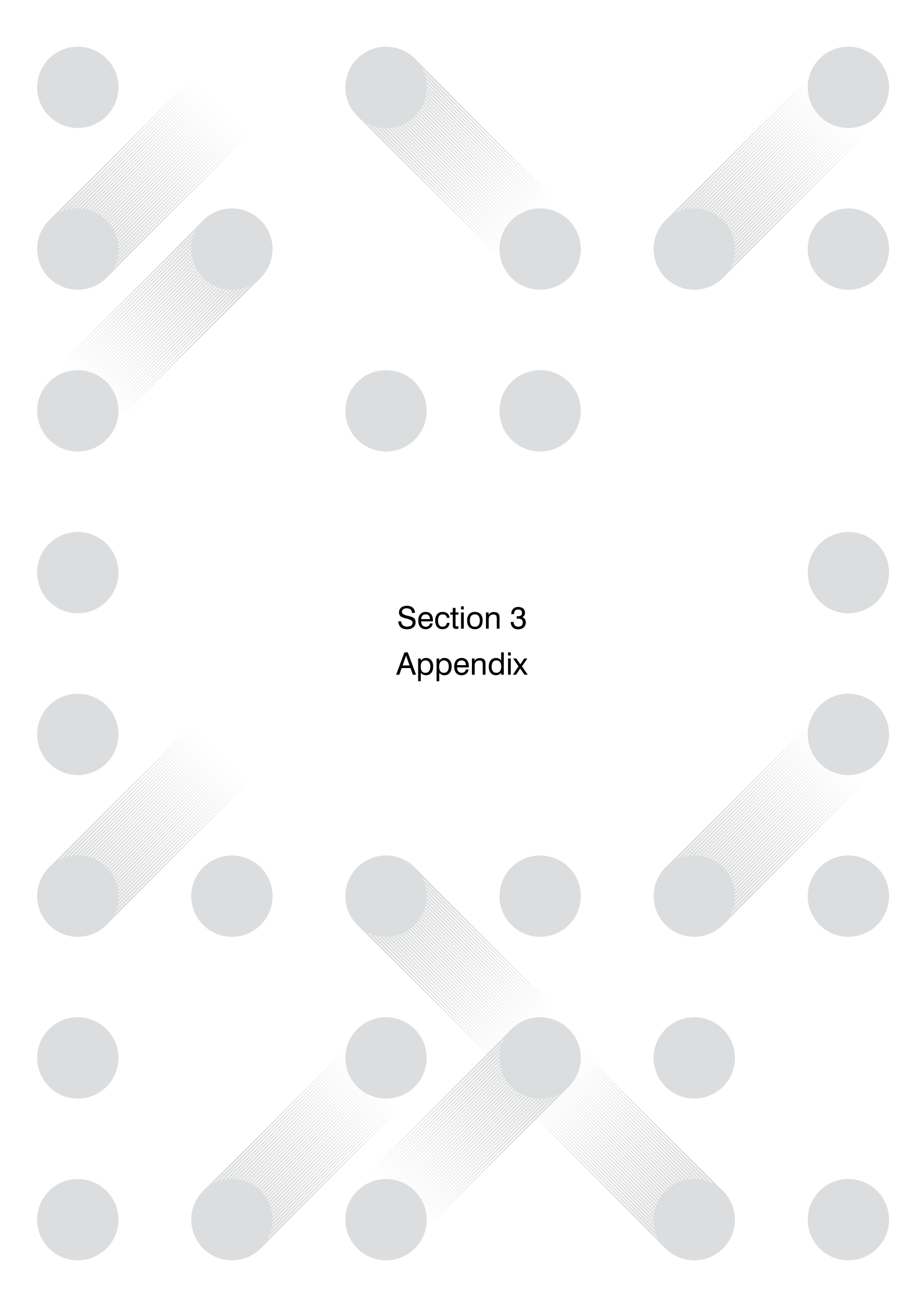
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The background of the page is decorated with a pattern of gray circles and lines. The circles are arranged in a grid-like fashion, with some lines connecting them in various directions, creating a subtle geometric pattern.

Section 3

Appendix

Appendix A

Data from Alternate Sources

Table A.1 | Country Comparison of Charges for Use of Intellectual Property (2019)

	Country	Payments (US\$, Billion)	Receipts (US\$, Billion)
Select Advanced Economies	USA	42.3	122.5
	UK	16.4	25
	Germany	17	37.5
	Japan	26.8	47.1
Select Emerging/Asian Economies	Brazil	5.2	0.6
	China	34.4	6.6
	India	7.9	0.9
	Israel	1.5	1.6
	South Korea	9.9	7.8

Source: World Development Indicators (2019), Indicators, available at <https://databank.worldbank.org/source/world-development-indicators>

Note: (i) Payments for IP here means “Charges for the use of intellectual property, payments (BoP, current US\$)” in WDI, World Bank
(ii) Payments for IP here means “Charges for the use of intellectual property, receipts (BoP, current US\$)” in WDI, World Bank

Table A.2 | Annual Foreign Direct Investment into India by Components (USD Million)

Year	Equity Inflows				Reinvested Earnings	Other Capital	Gross Inflows/ Gross Investments
	Government (SIA/FIPB)	RBI	Acquisition of Shares	Equity Capital of Unincorporated Bodies			
2018-2019	2429	36315	5622	689	13672	3274	62001
2019-2020	3265	39364	7348	1757	14175	8482	74390
2020-2021	948	51597	7091	1452	16935	3950	81973
2021-2022	1698	42932	14143	910	19347	5805	84835
2022-2023	692	37097	8245	1566	19105	4650	71355
2023-2024	585	31826	12013	1394	19768	5694	71279

Source: RBI Bulletin (various years), available at https://rbi.org.in/scripts/BS_ViewBulletin.aspx?Id=22163; Centre for Technology, Innovation and Economic Research (CTIER)

Table A.3 | FDI Equity Inflows into India by Sector - Top 10 Based on 2023-24

No.	Sector	2023-24 (₹, Billion)	2023-24 (US\$, Million)	2022-23 (₹, Billion)	2022-23 (US\$, Million)
1	Computer Software & Hardware	661	7973	747	9394
2	Services Sector*	549	6640	695	8661
3	Construction (Infrastructure) Activities	351	4232	137	1717
4	Trading	321	3865	380	4790
5	Non-Conventional Energy	312	3764	200	2500
6	Power	141	1701	55	698
7	Hospital & Diagnostic Centres	127	1530	65	810
8	Automobile Industry	126	1524	152	1902
9	Sea Transport	91	1096	43	530
10	Drugs & Pharmaceuticals	88	1064	167	2058
Total for Top 10 Sectors		2767	33390	2641	33061
Grand Total		3679	44423	3674	46034

Source: Quarterly FDI factsheet, Department for Promotion of Industry and Internal Trade (DPIIT), (for the years 2023 and 2024); Centre for Technology, Innovation and Economic Research (CTIER)

Note: * Services sector includes Financial, Banking, Insurance, Non-Financial / Business, Outsourcing, R&D, Courier, Tech. Testing and Analysis, Other

Table A.4 | Total Funding for Startups (and New Companies) by Type of Financing

Total Round Amount (US\$, Million)	2019	2020	2021	2022	2023
Angel	173	540	303	277	83
Conventional Debt	19897	10508	6314	6360	8391
Venture Debt	117	66	220	311	156
Mezzanine Debt	2	0	51	322	8
Grant (prize money)	34	16	56	32	13
PE	1895	10272	987	1907	2128
Post IPO	11148	11811	8398	3461	4648
Seed	857	904	2055	1944	1489
Series A	2030	1338	3692	4150	2542
Series B	3046	1922	3889	4558	2040
Series C	2633	2240	6211	4443	1869
Series D	4040	9261	10509	9354	4200
Series E	1381	8493	7427	2731	1601
Series F	2934	4009	6709	2523	633
Series G	411	4646	1643	359	461
Series H	250	319	995	718	0
Series I	1102	156	526	387	118
Series J	471	778	5349	845	600
Series K	0	0	0	700	46
ICO	0	4	47	109	6
Unattributed	198	83	228	653	287

Source: Tracxn (various years), data downloaded on 30 September 2024 from the platform

Table A.5 | Venture Capital Funding by Source of Data (USD Million)

	Country	2013	2018	2023
KPMG 2024	USA	-	146200	166400
	China	-	119400	62900
	India	-	9300	12800

	Country	2013	2018	2023
NSF 2024	USA	48806	145884	247925
	China	6146	123477	88303
	India	1627	9577	23957

Source: S&E Indicators Report 2024, National Science Foundation (NSF), Invention, Knowledge Transfer and Innovation - Venture capital invested in firms headquartered in selected regions, countries, or economies: 2003-22; Venture Pulse Q2 24: Global Analysis of Venture Funding, KPMG Private Enterprise

Note: Data reported as 2023 is as of 2022 for NSF

Table A.6 | Persons Employed as Researchers at Select R&D Institutions in India

Year	Number of Permanent Scientists	Year	Number of Contractual Researchers
2021-22	12053	2021-22	17234
2022-23	12042	2022-23	19625

Year	Median Share of Women Researchers* (%)	Year	Median Share of Young Researchers* (%)
2021-22	28	2021-22	53.6
2022-23	29.3	2022-23	57.7

*These include permanent scientists and contractual researchers

Source: Evaluation of Innovation Excellence Indicators, Report on Public Funded R&D Organizations (Round 2) (2025) available at <https://www.psa.gov.in/article/evaluation-innovation-excellence-indicators-public-funded-rd-organizations-round/9389>; Centre for Technology, Innovation and Economic Research (CTIER)

Table A.7 | Country-wise Comparisons by Share of Publications, Impact and Industry Collaborations in Total Publications including ESCI Journals (2019 - 2023)

	Country	Global Rank	Share in Global Publication Output (%)	Category Normalized Citation Impact	Share of Industry Collaborations (%)	Share of International Collaborations (%)
Select Advanced Economies	USA	1	22.7	1.3	4.3	34.6
	UK	3	7.1	1.5	4.5	57.4
	Germany	4	5.6	1.3	6	54.3
	Japan	7	3.8	0.9	6.1	32.1
Select Emerging Economies	Brazil	13	2.6	0.8	1.7	36
	China	2	20.6	1.2	2.3	22.8
	India	5	5.1	0.9	1	26.8
	Israel	34	0.8	1.4	3.7	50.2
	South Korea	12	2.7	1.1	4.1	32.6

Source: InCites (based on data from Web of Science), data downloaded from the platform on 6 January 2025; Centre for Technology, Innovation and Economic Research (CTIER)

Note: Data is based on cumulative publications by each country (2019 - 2023)

Table A.8 | Country Comparisons for Patents Granted Abroad

	Country	2013	2018	2023
Select Advanced Economies	USA	106258	133858	146823
	UK	13047	14584	16864
	Germany	42752	46345	45164
	Japan	113904	129610	125791
Select Emerging/Asian Economies	Brazil	780	851	1117
	China	10628	30550	69758
	India	3565	5664	8870
	Israel	4726	6600	8577
	South Korea	28077	42484	55346

Source: World Intellectual Property Organization (WIPO) IP Statistics Data Center, available at <https://www3.wipo.int/ipstats/ips-search/search-result?type=IPS&selectedTab=patent&indicator=23&reportType=13&fromYear=2011&toYear=2023&ipsOffSelValues=&ipsOriSelValues=BR,CN,DE,IN,IL,-JP,KR,GB,US&ipsTechSelValues=912>

Table A.9 | Select Policies Introduced by Union Territories

Union Territory	Industrial Policy	IT, ITeS, ICT, Electronics, ESDM Policy	Startup Policy	Renewable Energy Policy
Andaman and Nicobar Islands	-	Draft IT and ITeS Policy (2009)	2018	-
Chandigarh	2015	ICT (2011), IT and Electronics (2013)	-	-
Dadra & Nagar Haveli*	2018	IT (2019-24)	-	2024
Jammu and Kashmir	2021-30	IT, ITeS (2020)	2024-27	Wind Power Draft (2023)
Ladakh	Sustainable Industrial Policy (2022-27)	Information & Cyber Security Policy (2024)	-	-
Lakshadweep	-	IT (2015)	-	-
Puducherry	2016		2019	Solar (2015)

*Industrial Policy and Renewable Energy Policy for Dadra & Nagar Haveli are combined policies for the UTs of Daman & Diu and Dadra & Nagar Haveli

Source: Startup India, available at: <https://www.startupindia.gov.in/>; Invest India, available at: <https://www.investindia.gov.in/>; Various UTs Government Websites; Centre for Technology, Innovation and Economic Research (CTIER)

Table A.10 | Critical and Emerging Technologies Policies Introduced by Union Territories

Union Territory	Advanced Digital Production Technologies*	Green Hydrogen	Electric Vehicle
Andaman & Nicobar Islands	-	-	Draft (2022)
Chandigarh	-	-	Draft (2022)
Dadra & Nagar Haveli	-	Renewable Energy Policy (2024)	-
Jammu and Kashmir	Cyber Security Policy (2022), IT/ITES Policy (2020)	-	-
Ladakh	Information & Cyber Security Policy (2024)	-	Electric Vehicle and Allied Infrastructure Policy (2022)
Lakshadweep	-	-	-
Puducherry	Aspiring Puducherry - Innovation & Startup Policy (2019)	-	-

*Includes internet of Things, big data, artificial intelligence, robotics, cloud computing, blockchain, augmented reality, virtual reality and cyber-physical systems

Source: Startup India, available at: <https://www.startupindia.gov.in/>; Invest India, available at: <https://www.investindia.gov.in/>; Various UTs Government Websites; Centre for Technology, Innovation and Economic Research (CTIER)

Table A.11 | New Companies Registered with the Ministry of Corporate Affairs (MCA)

State / UT	2021-22	2022-23
Andaman & Nicobar	67	63
Andhra Pradesh	3317	2981
Arunachal Pradesh	86	85
Assam	1551	1553
Bihar	5737	5031
Chandigarh	670	569
Chhattisgarh	1482	1299
Dadra & Nagar Haveli	46	35
Daman and Diu	22	24
Delhi	16118	15575
Goa	452	582
Gujarat	8779	8921
Haryana	8080	7551
Himachal Pradesh	753	639
Jammu & Kashmir	1055	1013
Jharkhand	2073	1752
Karnataka	13402	12101
Kerala	6413	5755
Ladakh	3	3
Lakshadweep	27	12
Madhya Pradesh	4541	4753
Maharashtra	31009	29085
Manipur	236	233
Meghalaya	68	79
Mizoram	69	46
Nagaland	70	69
Orissa	3226	2816
Pondicherry	133	186
Punjab	2356	2418
Rajasthan	6132	6018
Sikkim	-	-
Tamil Nadu	11056	10565
Telangana	10874	10229
Tripura	178	113
Uttar Pradesh	16996	17297
Uttarakhand	1487	1555
West Bengal	8315	7968

Source: Ministry of Corporate Affairs (MCA), Government of India, available at <https://www.mca.gov.in/content/mca/global/en/data-and-reports/company-llp-info/incorporated-closed-month.html>, Centre for Technology, Innovation and Economic Research (CTIER)

Table A.12 | State-wise Number of Incubation Centres

State	Number of Incubation Centers in State	Number of Incubators at Academic Institutions
Andhra Pradesh	15	7
Arunachal Pradesh	1	0
Assam	10	7
Bihar	5	2
Chandigarh	2	2
Chhattisgarh	4	3
Delhi	22	15
Goa	5	3
Gujarat	26	20
Haryana	12	5
Himachal Pradesh	2	2
Jammu & Kashmir	5	4
Jharkhand	2	1
Karnataka	51	23
Kerala	14	8
Madhya Pradesh	10	4
Maharashtra	33	17
Manipur	2	0
Meghalaya	3	1
Mizoram	2	1
Nagaland	1	0
Odisha	9	7
Puducherry	1	1
Punjab	8	7
Rajasthan	11	10
Sikkim	2	1
Tamil Nadu	55	43
Telangana	23	13
Tripura	2	0
Uttar Pradesh	28	21
Uttarakhand	3	3
West Bengal	6	4
Total	375	235

Source: Technology Business Incubator (TBI), National Science & Technology Entrepreneurship Development Board, Department of Science and Technology, available at <https://www.nstedb.com/>; Technology Incubation and Development of Entrepreneurs (TIDE), Ministry of Electronics and Information Technology, available at <https://www.meity.gov.in/content/innovation-promotion>; Selected Atal Incubation Centres, Atal Innovation Mission, NITI Aayog, available at <https://aim.gov.in/index.php>; Biotech Parks and Incubators, Department of Biotechnology, available at <https://dbtindia.gov.in/scientific-directorates/bio-wealth-biosafety/biotech-park>; Bioincubators Nurturing Entrepreneurship for Scaling Technologies, BIRAC, Department of Biotechnology, available at <https://www.birac.nic.in/>; STPI Centres of Entrepreneurship, available at <https://stpi.in/en/centre-of-entrepreneurship>; India Science, Technology and Innovation Portal (ISTI), available at <https://www.indiascienceandtechnology.gov.in/innovations/incubators>; Centre for Technology, Innovation and Economic Research (CTIER)

Table A.13 | India's Import of Capital Goods by Commodity

HS Code	Product Name	US\$, Billion				
		2018-19	2019-20	2020-21	2021-22	2022-23
84	Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof	34.7	34.4	26.8	36.4	40.5
85	Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers and parts	16.9	16.8	17	25.2	20
87	Vehicles other than railway or tramway rolling stock and parts and accessories thereof	4.7	4.1	3.5	4.8	5.6
88	Aircraft, spacecraft and parts thereof	7.1	8.3	5.4	4.6	10.5
89	Ships, boats and floating structures	4.8	4.2	3.4	3.3	5.3
90	Optical, photographic cinematographic measuring, checking precision, medical or surgical inst. and apparatus parts and accessories thereof	7.5	7.3	7.1	9.1	8.4
Others		0.9	0.7	0.7	0.8	0.7
Total		76.5	75.8	64	84.2	91

Source: Import - Commodity-wise, Export Import Data Bank, Department of Commerce, Government of India, available at <https://tradestat.commerce.gov.in/eidb/icomq.asp>; World Integrated Trade Solution (WITS), available at <https://wits.worldbank.org/Product-Metadata.aspx?lang=en>; Centre for Technology, Innovation and Economic Research (CTIER)

Table A.14 | Funding for Companies for Select Sectors

Total Funding (US\$, Million)*	2019	2020	2021	2022	2023
B2C E-Commerce	5520	2266	11370	5051	3508
Marketplaces	6451	2136	11791	3460	1901
Gig Employers	3131	1137	2728	1469	1551
Enterprise Software	2850	2026	7068	6842	1514
Online Grocery	749	861	2989	2544	1244
SaaS	1698	1880	6156	5367	1109
Alternative Lending	1226	1054	1693	2294	1106
Green Transport	501	222	651	2137	858
Electric Vehicles	501	220	645	2125	854
Deep Tech	528	482	1209	2185	703

* Excludes Debt, Grant and post IPO rounds

Source: Tracxn (Data downloaded on 14 October 2024 from the platform); Centre for Technology, Innovation and Economic Research (CTIER)

Table A.15 | Exchange Rates

Indicator Name	Indicator Number	Exchange Rate used for converting to USD	Period	Source
R&D Expenditure by Select Key Scientific Agencies under Government of India	6.3	1 USD = 64.46 INR	April 1 2017 to March 31 2018	Federal Reserve Bank St.Louis
		1 USD = 74.23 INR	April 1 2020 to March 31 2021	
		1 USD = 80.33 INR	April 1 2022 to March 31 2023	
Sector-wise Global Industrial R&D Expenditure and Country-wise Number of Firms (2023)	6.4	1 EUR = 1.06 USD	31 December 2022	EU Industrial R&D Investment Scoreboard
Expenditure on R&D by Select States	7.2	1 USD = 74.5 INR	April 1 2021 to March 31 2022	Federal Reserve Bank St.Louis
		1 USD = 80.33 INR	April 1 2022 to March 31 2023	
Corporate Social Responsibility (CSR) funding towards Technology Incubators and Public Research Institutions for Top Indian States	7.7	1 USD = 69.92 INR	April 1 2018 to March 31 2019	
		1 USD = 70.90 INR	April 1 2019 to March 31 2020	
		1 USD = 74.23 INR	April 1 2020 to March 31 2021	
		1 USD = 74.50 INR	April 1 2021 to March 31 2022	
		1 USD = 80.33 INR	April 1 2022 to March 31 2023	
Total Industrial R&D Expenditure in India	8.1	1 USD = 54.36 INR	April 1 2012 to March 31 2013	Federal Reserve Bank St.Louis
		1 USD = 64.46 INR	April 1 2017 to March 31 2018	
		1 USD = 80.33 INR	April 1 2022 to March 31 2023	
CTIER's Top 100 Industrial R&D spenders in India (2021)	8.3	1 USD = 79.41 INR	31 December 2022	EU Industrial R&D Investment Scoreboard
Total Foreign Exchange Spending on Technology Payments	8.7	1 USD = 69.92 INR	April 1 2018 to March 31 2019	Federal Reserve Bank St.Louis
		1 USD = 70.90 INR	April 1 2019 to March 31 2020	
		1 USD = 74.23 INR	April 1 2020 to March 31 2021	
		1 USD = 74.50 INR	April 1 2021 to March 31 2022	
		1 USD = 80.33 INR	April 1 2022 to March 31 2023	
Import of Capital Goods by Indian Industry	8.8	1 USD = 69.92 INR	April 1 2018 to March 31 2019	Federal Reserve Bank St.Louis
		1 USD = 70.90 INR	April 1 2019 to March 31 2020	
		1 USD = 74.23 INR	April 1 2020 to March 31 2021	
		1 USD = 74.50 INR	April 1 2021 to March 31 2022	
		1 USD = 80.33 INR	April 1 2022 to March 31 2023	
Global MNCs having R&D presence in India	8.9	1 EUR = 1.06 USD	31 December 2022	EU Industrial R&D Investment Scoreboard

Serial No.	Term	Definition	
B.1	Category Normalized Citation Impact (CNCI)	The Category Normalized Citation Impact (CNCI) of a document is calculated by dividing the actual count of citing items by the expected citation rate for documents with the same document type, year of publication and subject area. When a document is assigned to more than one subject area, an average of the ratios of the actual to expected citations is used. The CNCI of a set of documents, for example, the collected works of an individual, institution or country, is the average of the CNCI values for all the documents in the set. For a single paper that is only assigned to one subject area, this can be represented as: $NCI = c / e f t d$, where: e = the expected citation rate or baseline, c = Times Cited, f = the field or subject area, t = year, d = document type. For a single paper that is assigned to multiple subjects, the CNCI can be represented as the average of the ratios for of actual to expected citations for each subject area. And for a group of papers, the CNCI value is the average of the values for each of the papers. A CNCI value of one represents performance at par with world average, values above one are considered above average and values below one are considered below average. A CNCI value of two is considered twice world average.	
B.2	Charges for the use of intellectual property, Payments	Charges for the use of intellectual property are payments and receipts between residents and nonresidents for the authorised use of proprietary rights (such as patents, trademarks, copyrights, industrial processes and designs including trade secrets and franchises) and for the use, through licensing agreements, of produced originals or prototypes (such as copyrights on books and manuscripts, computer software, cinematographic works and sound recordings) and related rights (such as for live performances and television, cable, or satellite broadcast). Data are in current U.S. dollars.	
B.3	Corporate Social Responsibility (CSR)	Every company having net worth of rupees five hundred crore or more, or turnover of rupees one thousand crore or more or a net profit of rupees five crore or more during the immediately preceding financial year shall constitute a Corporate Social Responsibility Committee of the Board consisting of three or more Directors, out of which at least one director shall be an independent director. One of the responsibilities of the board is to ensure that the company spends, in every financial year, at least two percent of the average net profits of the company made during the three immediately preceding financial years.	
B.4	Critical and Emerging Technology	Critical and Emerging Technology (iCET) includes space, semiconductors, AI/ML, green hydrogen, EVs, quantum, biotechnology and clean energy	
B.5	Foreign Direct Investment	Foreign Investment means any investment made by a person resident outside India on a repatriable basis in capital instruments of an Indian company or to the capital of an Limited Liability Partnership (LLP). Foreign Direct Investment (FDI) is the investment through capital instruments by a person resident outside India (a) in an unlisted Indian company; or (b) in 10 percent or more of the post issue paid-up equity capital on a fully diluted basis of a listed Indian company. There are two routes under which foreign investment can be made: automatic and government. Under the automatic route, foreign Investment is allowed under the automatic route without prior approval of the Government or the Reserve Bank of India, in all activities/ sectors as specified in the Regulation 16 of Foreign Exchange Management Act, 1999 (FEMA) 20 (R). And for the government route, foreign investment in activities not covered under the automatic route requires prior approval of the Government.	

	Source	Link	Indicator Numbers
	Clarivate Analytics, InCites Indicators Handbook		6.12, 6.13, 6.13.1, 6.15, A.7
	World Bank, World Development Indicators	http://databank.worldbank.org/data/metadata/glossary/all/series	6.5, 6.5.1, 8.5, A.1
	General Circular No. 14 /2021, Government of India Ministry of Corporate Affairs; Section 135(1) of the Companies Act, 2013	https://www.mca.gov.in/bin/ebook/dms/t?doc=MzU0NzM=&docCategory=Circulars&type=open https://www.mca.gov.in/content/mca/global/en/acts-rules/ebooks/acts.html?act=NTk2MQ==	7.7, 8.2
	Joint Fact Sheet: The United States and India Continue to Expand Comprehensive and Global Strategic Partnership	https://pib.gov.in/PressReleaseDetailm.aspx?PRID=2057458&reg=3&lang=1	7.1.1
	Reserve Bank of India	https://www.rbi.org.in/scripts/FAQView.aspx?Id=26	6.6, 6.6.1, 7.4, A.2, A.3

Serial No.	Term	Definition	
B.6	Full-time equivalent (FTE) of R&D personnel	The Full-time equivalent (FTE) of R&D personnel is defined as the ratio of working hours actually spent on R&D during a specific reference period (usually a calendar year) divided by the total number of hours conventionally worked in the same period by an individual or by a group.	
B.7	Gross Enrolment Ratio in Higher Education	Students enrolled in higher education as a percentage of population between 18-23 years of age.	
B.8	High and Medium High Technology (HMT) (Also referred to as Higher Technology)	The OECD definition for High and Medium high technology (HMT) manufacturing is defined in ISIC Rev.4 as Chemicals and chemical products (Division 20), Pharmaceutical products (21), Computer, electronic and optical products (26), Electrical equipment (27), Machinery and equipment n.e.c. (28), Motor vehicles, trailers and semi-trailers (29) and Other transport equipment (30)	
B.9	High technology Exports	High-technology exports are products with high R&D intensity, such as in aerospace, computers, pharmaceuticals, scientific instruments and electrical machinery. The original high-tech products classification is based on SITC Rev. 3 and is taken from Table 4 of Annex 2 of the 1997 working paper of Thomas Hatzichronoglou, OECD.	
B.10	Industry Collaborations (%)	An industry collaborative publication is one that lists its organisation type as “corporate” for one or more of the co-author’s affiliations. The % of Industry Collaborations is the number of industry collaborative publications for an entity (as described above) divided by the total number of documents for the same entity represented as a percentage.	
B.11	Industry Classification Benchmark	The Industry Classification Benchmark (ICB) is a detailed and comprehensive structure for sector and industry analysis, facilitating the comparison of companies across four levels and across national boundaries. The classification system allocates companies to the subsector whose definition closely describes the nature of its business as determined by the source of its revenue or the source of the majority of its revenue and the appropriate sector, supersector and industry classification automatically results.	
B.12	Institute of National Importance (INI)	An Institution established by Act of Parliament and declared as Institution of National Importance such as All India Institute of Technology (IIT), National Institute of Technology (NIT).	
B.13	International Collaborations (%)	The % of International Collaborations is the number of International Collaborations for an entity (as described above) divided by the total number of documents for the same entity represented as a percentage. The % of International Collaborations is an indication of an institution or author’s ability to attract international collaborations.	
B.14	Knowledge Intensive(KI)	The OECD definition for Knowledge Intensive (KI) sectors is defined in ISIC Rev.4 as Publishing activities (58), IT and other information services (62-63) and Scientific research and development (72)	
B.15	National Industrial Classification	National Industrial Classification 2008 (NIC-2008) is a revised version of NIC-2004. The 38th session of the UN Statistical Commission recommend that countries should make an effort either to adopt national versions of the ISIC, Revision 4, or to adjust their national classifications in such a way that data can be presented according to the categories of the ISIC, 10 Revision 4. Specifically, countries should be able to report data at the two-digit (division) level of the Classification without a loss of information; that is, national classifications should be fully compatible with this level of the ISIC, or it should be possible to arrange them.	

	Source	Link	Indicator Numbers
	UNESCO Institute for Statistics	http://data.uis.unesco.org/	6.8
	All India Survey on Higher Education (2018-19), Ministry of Human Resource Development	http://aishe.nic.in/aishe/viewDocument.action?documentId=262	7.8
	OECD	https://doi.org/10.1787/5jlv73sqqp8r-en	7.1, 7.3, 7.3.1, 8.5
	World Bank, World Development Indicators	http://databank.worldbank.org/data/metadata/glossary/all/series	6.24
	Clarivate Analytics, InCites Indicators Handbook		6.12, 6.13, 6.13.1, 6.15, A.7
	FTSE Russell	https://research.ftserussell.com/products/downloads/Glossary.pdf	6.4, 6.4.1, 8.3, 8.4, 8.9
	All India Survey on Higher Education (2018-19), Ministry of Human Resource Development	http://aishe.nic.in/aishe/viewDocument.action?documentId=262	7.11
	Clarivate Analytics, InCites Indicators Handbook		6.12, 6.13, 6.13.1, 6.15, A.7
	OECD	https://doi.org/10.1787/5jlv73sqqp8r-en	7.1, 7.3, 7.3.1, 8.5
	Ministry of Statistics and Programme Implementation, National Industrial Classification (2008)	http://mospi.nic.in/classification/national-industrial-classification	

Serial No.	Term	Definition	
B.16	National Institute Rankings Framework	The National Institutional Ranking Framework (NIRF) was approved by the MHRD and launched by Honourable Minister of Human Resource Development on 29th September 2015. This framework outlines a methodology to rank institutions across the country. The methodology draws from the overall recommendations broad understanding arrived at by a Core Committee set up by MHRD, to identify the broad parameters for ranking various universities and institutions. The parameters broadly cover “Teaching, Learning and Resources,” “Research and Professional Practices,” “Graduation Outcomes,” “Outreach and Inclusivity,” and “Perception”.	
B.17	Non Resident Patents	The terms “non-resident” and “abroad” both relate to filings in a foreign office. However, we use the term “non-resident” for statistics by office, while use the term “abroad” for statistics by origin. In other words, when an office receives an application filed by a foreigner, it’s a non-resident filing for that office. By contrast, when an applicant files an application at a foreign office, it’s a filing abroad from the applicant’s origin.	
B.18	Outward Mobility of Tertiary Students	Outbound tertiary students are individuals that have moved to a country other than their own for tertiary education.	
B.19	Patents	A patent is an exclusive right granted for an invention, which is a product or a process that provides, in general, a new way of doing something, or offers a new technical solution to a problem. To get a patent, technical information about the invention must be disclosed to the public in a patent application.	
B.20	Pupil Teacher Ratio in Higher Education	The ratio of students in a particular academic institution to the teachers/ instructors employed at that institution. Takes into account all institutions - university, colleges and stand-alone institutions in both regular and distant mode.	
B.21	R&D Intensity	R&D intensity is the ratio between R&D investment and net sales of a given company or group of companies. At the aggregate level, R&D intensity is calculated only by those companies for which data exist for both R&D and net sales in the specified year. The calculation of R&D intensity in the Scoreboard is different from than in official statistics, e.g. BES-R&D, where R&D intensity is based on value added instead of net sales.	
B.22	Research & Development Expenditure	Research and experimental development (R&D) comprise 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.	
B.23	Researchers per million inhabitants	Number of professionals engaged in the conception or creation of new knowledge (who conduct research and improve or develop concepts, theories, models, techniques instrumentation, software or operational methods) during a given year expressed as a proportion of a population of one million.	
B.24	Resident Patents	The term “resident” is used for filings made by applicants at their home office. The home office can be a national office and/or a regional office. The resident figures by origin may thus correspond to the sum of filings made at a national and a regional office.	

	Source	Link	Indicator Numbers
	National Institute Ranking Framework (NIRF) Rankings (2019)	https://www.nirfindia.org/OverallRanking.html	7.10
	WIPO	http://www.wipo.int/ipstats/en/help/	6.17, 6.18, 6.19, 6.22, 6.23, 8.10, A.8
	UNESCO Institute for Statistics	https://uis.unesco.org/en/glossary	6.10
	WIPO	http://www.wipo.int/patents/en/	6.16, 6.17, 6.18, 6.19, 6.20, 6.21, 6.22, 6.23, 7.12, 8.5, 8.9, 8.10, 8.11
	All India Survey on Higher Education (2018-19), Ministry of Human Resource Development	http://aishe.nic.in/aishe/viewDocument.action?documentId=262	7.9
	The 2019 EU Industrial R&D Scoreboard	https://iri.jrc.ec.europa.eu/scoreboard/2019-eu-industrial-rd-investment-scoreboard	8.4
	OECD, Frascati Manual 2015	https://www.oecd.org/sti/frascati-manual-2015-9789264239012-en.htm	6.1, 6.2, 6.2.1, 6.3, 6.4, 6.4.1, 7.2, 8.1, 8.4, 8.7
	UNESCO Institute for Statistics	http://data.uis.unesco.org/	6.8, 6.11
	WIPO	http://www.wipo.int/ipstats/en/help/	6.17, 6.18, 6.19, 6.22, 6.23, 8.10, 8.11

Serial No.	Term	Definition	
B.25	Retractions	Retractions are a mechanism to remove scientific literature published in academic journals due to serious flaws or errors. Articles may be retracted due to plagiarism, scientific misconduct, or violations of ethical guidelines.	
B.26	Science & Engineering (S&E) PhDs	S&E PhDs, as defined by the NSF, includes Physical and Biological Sciences and Mathematics and Statistics, Computer Sciences, Agricultural Sciences, Engineering and Social and Behavioural Sciences. S&E subjects considered by OECD are based on the ISCED 2011 classification and include Social sciences, journalism and information, Natural sciences, mathematics and statistics, Information and Communication Technologies, Engineering, manufacturing and construction, Agriculture, forestry, fisheries and veterinary.	
B.27	Startup	Startup means an entity, incorporated or registered in India: a) Upto a period of ten years from the date of incorporation/ registration, if it is incorporated as a private limited company (as defined in the Companies Act, 2013) or registered as a partnership firm (registered under section 59 of the Partnership Act, 1932) or a limited liability partnership (under the Limited Liability Partnership Act, 2008) in India. b) Turnover of the entity for any of the financial years since incorporation/ registration has not exceeded one hundred crore rupees. c) Entity is working towards innovation, development or improvement of products or processes or services, or if it is a scalable business model with a high potential of employment generation or wealth creation. Provided that an entity formed by splitting up or reconstruction of an existing business shall not be considered a 'Startup'.	

	Source	Link	Indicator Numbers
	Retracted Science and the Retraction Index, U.S. National Institutes of Health's National Library of Medicine (NIH/NLM)	https://pmc.ncbi.nlm.nih.gov/articles/PMC3187237/	6.14
	NSF, OECD	https://nces.nsf.gov/pubs/nsb20197/data#supplemental-tables https://stats.oecd.org/Index.aspx?DataSetCode=EDU_GRAD_FIELD#	6.9, 6.9.1, 6.9.2
	Department for Promotion of Industry and Internal Trade, G.S.R. notification 127 (E)	https://www.startupindia.gov.in/content/dam/invest-india/Templates/public/198117.pdf	6.7, 6.7.1, 6.7.2, 7.1, 7.1.1, 7.5, 7.5.1, 8.8, A.4, A.5, A.14

About CTIER

The Centre for Technology, Innovation and Economic Research (CTIER) is working to raise the level of debate and awareness amongst policy makers, industry and researchers in India about the essential role of technical capability in economic development and how it is best fostered. The Centre is committed to improving the quality of India's R&D and innovation data, assessing the impact of policy measures introduced to promote R&D and identifying ways to create systemic change in India's R&D and innovation system. We aim to inform policy making on the back of high quality empirical economic research, as well as impact higher education in India.

Naushad Forbes

Naushad is Co-Chairman of Forbes Marshall, India's leading process and energy efficiency company. He is Chairman, Centre for Technology, Innovation and Economic Research (CTIER) and Ananta Aspen Centre.

Forbes Marshall helps Industry build and sustain highly efficient plants by reducing waste, optimising process and energy efficiency and complying with regulatory requirements. Forbes Marshall has consistently ranked as a Great Place to Work and aspires to be a multinational with Indian roots.

Naushad was an occasional teacher at Stanford University from 1987 to 2004 where he developed courses on Technology in Newly Industrializing Countries. He received his Bachelor's, Master's and PhD Degrees from Stanford.

Naushad is on the board of several educational institutions and public companies. He has long been an active member of the Confederation of Indian Industry (CII) and was president of CII for 2016 – 17. He is a founding member of Nayanta University, a full-service university opening in 2024, spearheaded by CII. Naushad's book, *The Struggle and the Promise: Restoring India's Potential*, was published by HarperCollins in 2022.

Farhad Forbes

Farhad is Co-Chairman of Forbes Marshall. He has been at Forbes Marshall since 1982. Previously, he was a member of the R&D technical staff of Hewlett-Packard Company in Palo Alto, California. He is Chairman of the CII-FBN India Chapter Council. He is immediate past Chairman of the Board of Family Business Network International (FBN). He is a former Chairman of the Confederation of Indian Industry (CII) National Committee on Affirmative Action, a former Chairman of CII Western Region and a former Chairman of the CII-FBN India chapter. He is a former member of the Advisory Council of the Graduate School of Business at Stanford University and the Advisory Board of the MSx Program (formerly known as the Sloan Program) at Stanford University's Graduate School of Business.

He received his B.S. in 1977 and his M.S. in 1979 in Electrical Engineering from Stanford University. He received his M.S. in Management in 1991 from the Sloan Master's Program at the Graduate School of Business at Stanford University.

Janak Nabar

Janak heads the Centre for Technology, Innovation and Economic Research (CTIER) and has been leading CTIER's research efforts. He has previously worked as an Economist and Investment Strategist in the private sector in Singapore. Janak's work experience includes two years with the United Nations High Commissioner for Refugees (UNHCR) in Serbia. His research interests include innovation and technology policy as well as India's macroeconomic policies. Janak is a member of the CII National Committee on Technology, Innovation and Research. He was a member of the Thematic Group on Innovation, National Science, Technology and Innovation Policy 2020 and has been part of working groups constituted by NITI Aayog, including to evaluate science indicators of publicly funded R&D laboratories.

Janak is on the Governing Council of the Society For Educational Improvement and Innovation (SEII) and on the Board of Trustees of the KEM Hospital Research Centre (KEMHRC) and the World Without GNE Myopathy (WWGM). He holds a BA in Mathematics from the University of Pune, an MA in Mathematics from the University of Oxford (as a Radhakrishnan Scholar) and an MSc in Econometrics & Mathematical Economics from the London School of Economics and Political Science.

Swati Joshi

Swati is a Senior Research Associate at CTIER. She has extensive experience working with state governments and international agencies such as UNICEF and the World Bank across different development sectors like education, WASH, public health, social security and participatory planning. She holds a MSc with Distinction in Industrial Biotechnology from Newcastle University and a BSc with Distinction from the University of Pune.

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Neha Kumari

Neha Kumari is a Research Analyst at CTIER. Her research interests include higher education, startups and their synergies. She has previously worked as a retail manager at an MNC and as a research intern at IIT Kharagpur. Neha holds an MA degree in Development Studies from the National Institute of Technology, Rourkela.

Yash Karmarkar

Yash Karmarkar is a Research Analyst at CTIER. He is a data enthusiast and his interests lie in data extraction using python. He has a MSc in Statistics from MIT-WPU, Pune and a BSc in Statistics from Abasaheb Garware College, Pune.

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Nishant Dewaney is a Research Analyst at CTIER. His research interests include the public sector's role in R&D, adoption of new technologies by firms, innovation policy and the communication of data. He has previously worked as a science communicator at an MNC and as a research intern at the DST - Centre for Policy Research at the Indian Institute of Science, Bangalore. Nishant holds an MSc degree in Science and Technology Communication from CSIR - National Institute of Science Communication and Policy Research and an BSc degree in Physics from St. Xavier's College, Mumbai.

Shrimoyee Mukherjee

Shrimoyee is a Research Analyst at CTIER. She has contributed to CTIER's in-house survey unit, specifically focusing on firm-level surveys. She has previously collaborated with government bodies, academic institutions and researchers to analyse various economic topics. Her areas of interest include international economics and development economics. She holds a master's degree in Economics with specialisation in International Trade from Symbiosis School of Economics, Pune and a bachelor's degree in Economics from Bethune College, University of Calcutta, Kolkata.

Pankaj Chandra

Professor Pankaj Chandra is the Vice Chancellor of Ahmedabad University. He was the Director of the Indian Institute of Management Bangalore (2007-2013) and Professor of Operations and Technology Management at IIM Ahmedabad. He holds a BTech from the Banaras Hindu University and a PhD from The Wharton School, University of Pennsylvania. He has been a full-time faculty member at McGill University and IIM Ahmedabad and a visiting professor at the University of Geneva, The Wharton School, International University of Japan, Cornell University and Renmin University, Beijing. He was the first Associate Dean (Academic) at ISB, Hyderabad. Professor Chandra was a member of the Government of India Committee on Rejuvenation of Higher Education (Yashpal Committee) that relooked at the Indian Higher Education system as well as the Committee on the Autonomy of Central Institutions. He was also a member of the Telecom Regulatory Authority of India (TRAI). Professor Chandra's research and teaching interests include Manufacturing Management, Supply Chain Coordination, Building Technological Capabilities, Higher Education Policy and Hi-tech Entrepreneurship. His last book titled 'Building Universities that Matter' studied issues of Governance, Change and Institution Building in Indian Universities. He serves on the board of several firms and institutions.

Rakesh Basant

Dr. Rakesh Basant is a former Professor of Economics and JSW Professor of Innovation and Public Policy at the Indian Institute of Management, Ahmedabad (IIMA). He has taught at universities abroad and worked as a consultant to several international organisations. Professor Basant's current teaching and research interests focus on firm strategy, innovation, intellectual property rights, entrepreneurial business models, public policy & regulation. His recent research has focused on capability building processes in industrial clusters, foreign direct investment in R&D, innovation-internationalisation linkages, competition policy, inter-organisational linkages for technology development (especially academia-industry relationships), incubation models in higher education institutions, emerging entrepreneurial patterns and ecosystem in India, strategic and policy aspects of intellectual property rights, linkages between public policy and technological change, economics of strategy, the small scale sector in India and policy issues in higher education. His sectoral focus of the research in the aforementioned areas has been on Pharmaceutical, IT, Electronics and Auto-component industries. He was also a member of the Indian Prime Minister's High-Level Committee (also known as Sachar Committee) that wrote a report on the Social, Economic and Educational Conditions of Muslims in India. In continuation of this work, a part of his current research focuses on issues relating to Muslims, especially affirmative action in higher education. Dr Basant's recent book 'The Black Box – Innovation and Public Policy in India' was published by Penguin in August 2021.

Sunil Mani

Dr. Sunil Mani is an Honorary Visiting Professor at the Centre for Development Studies (CDS), Thiruvananthapuram and Ahmedabad University. Formerly he was the Director (2017-2023) and the Reserve Bank of India Chair Professor at CDS. He was also a faculty member and head of graduate studies at the United Nations University-Institute for New Technologies (now known as UNU-MERIT) at Maastricht in the Netherlands. He obtained his M. Phil and PhD in Economics from Jawaharlal Nehru University, New Delhi. He has done postdoctoral research at the University of Oxford on a fellowship from Ford Foundation, New York. He has held Visiting Professorships at the National Graduate Institute for Policy Studies, Tokyo, Japan; Bocconi University, Milan, Italy—the University of Toulouse Jean Jaures, Toulouse, France and the Indian Institute of Management Calcutta. Further, he serves on the editorial boards of two international journals, Structural Change and Economic Dynamics (Elsevier) and the International Journal of Technology and Globalization (Inderscience); Dr Mani has published extensively in his area of specialisation in the form of 10 books and several articles in refereed international and national journals and chapters in books and has H-index of 24 (Google Scholar) and 10 (Scopus). His recent books include Rise to Market Leadership, New Leading Firms from Emerging Countries, Cheltenham, UK and Northampton, Mass, USA: Edward Elgar, 2017 (co-edited with Franco Malerba and Pamela Adams); and 'India's Economy and Society, Lateral Explorations' Singapore: Springer, 2021 (co-edited with Chidambaran Iyer).



The CTIER Handbook: Technology and Innovation in India presents a number of unique indicators that covers research on India and the global economy, regional innovation systems and Indian industry [including emerging startup sectors].

The Handbook is a biennial publication of the Centre for Technology Innovation and Economic Research. It is intended to bring together the latest and most comprehensive data on technology and innovation in India.