



Global S&T Leadership in Transition: Opportunities and Challenges for India

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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=jF.4xyEnwpiRkEnEn15TOxqomlBkWk5I>; 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 electronic communications, biology, new materials, aeronautics etc

Policies	Key Highlights
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 etc ¹

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/stdec2.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-Backgroundunder.pdf>; 14th Five Year Plan 2021, available at <https://cset.georgetown.edu/publication/china-14th-five-year-plan/>

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.

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.

■ **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	<p>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)</p> <p>The technology areas of focus included food, health, housing and energy including non-conventional sources of energy</p> <p>Biotechnology, electronics and materials science were also identified as emerging and frontier areas that would be given attention</p> <p>Industrial R&D finds a mention. Talks about incentivising industry to set up R&D units</p>
Science and Technology Policy, 2003	<p>Technology areas of interest remained largely the same as those mentioned above in the 1983 Technology Policy Statement</p> <p>Explicitly mentions the need for fiscal measures to support industry to undertake R&D</p> <p>Focus on public private partnerships in areas like agriculture, healthcare, education, water etc</p> <p>Talks about establishing an IPR regime to incentivise IP generation and protection</p> <p>Ambitious target of investment in science and technology reaching 2 percent of GDP (to include spending by government and industry) by 2007</p>
Science, Technology and Innovation Policy, 2013	<p>Emphasis on enhancing private sector R&D</p> <p>Calls for establishing large R&D facilities through public private partnerships</p> <p>Focus on areas like agriculture, healthcare, water, telecommunications and environment</p>
Draft 5th National Science, Technology and Innovation Policy, 2020	<p>Talks about accelerating research (including multidisciplinary research) and innovation in higher education institutions</p> <p>Promoting open science and enable access to all outputs and data from public-funded research</p> <p>Emphasis on sustainable technologies, strategic technologies and mega science</p> <p>Technological self-reliance and for India to be among top three scientific superpowers in next decade</p> <p>Strengthening water, agriculture, food and nutrition security. Build a clean and equitable energy system</p> <p>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</p>

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. 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	<p>Focussed on nurturing innovation and startups to drive sustainable economic growth and generate large scale employment</p>
Atal Innovation Mission (AIM), 2016	<p>Focussed on promoting a culture of innovation and entrepreneurship across the country</p> <p>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</p> <p>Incentivising innovations in areas like education, health, water, sanitation, mobility etc. through the Atal New India Challenge</p>
National Intellectual Property Rights (IPR) policy, 2016	<p>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</p> <p>Create awareness of the socio-economic benefits of intellectual property rights (IPR)</p> <p>Support for startups and MSMEs through reduction in fees and expediting examination of IPRs</p> <p>Improving IP commercialisation through Technology Innovation Support Centres</p>
India Semiconductor Mission, 2021	<p>Intended to develop sustainable semiconductors and display ecosystem</p> <p>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</p> <p>Financial support through design linked incentive scheme and product deployment linked incentive scheme</p>
National Quantum Mission, 2023	<p>Develop intermediate scale quantum computers with 50 - 1000 physical qubits in 8 years</p> <p>Satellite based secure quantum communications between ground stations over a range of 2000 kilometres within India, long distance secure quantum communications with other countries</p> <p>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</p> <p>Areas of focus include health, finance, energy, drug design and space applications</p>

Policies	Key Highlights
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	<p>Emphasises on promotion and co-ordination of basic, applied and related research in the pharmaceutical sector</p> <p>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</p>
Anusandhan National Research Foundation (ANRF) Act, 2023	<p>To encourage investments from the private and public sector and enhance their research collaborations</p> <p>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</p>
IndiaAI Mission, 2024	<p>Aims to catalyse AI innovation</p> <p>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</p>

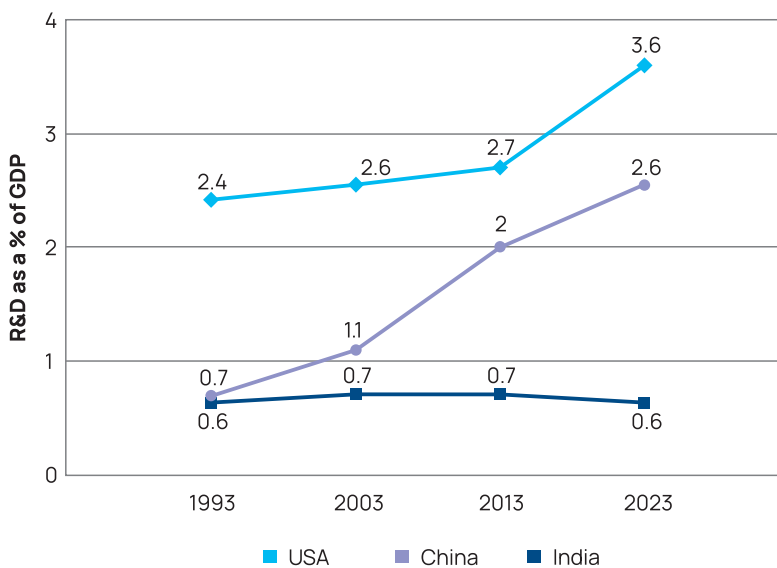
Source: Startup India 2016 available at <https://www.pib.gov.in/PressReleasePage.aspx?PRID=1703787>; Atal Innovation Mission 2016, available at <https://www.niti.gov.in/sites/default/files/2024-04/Manual%202%20%281%29.pdf>; National Intellectual Property Rights (IPR) Policy 2016, available at <https://pib.gov.in/PressReleasePage.aspx?PRID=1941489>; National Quantum Mission 2023, <https://www.pib.gov.in/PressReleaselframePage.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/PressReleaselframePage.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

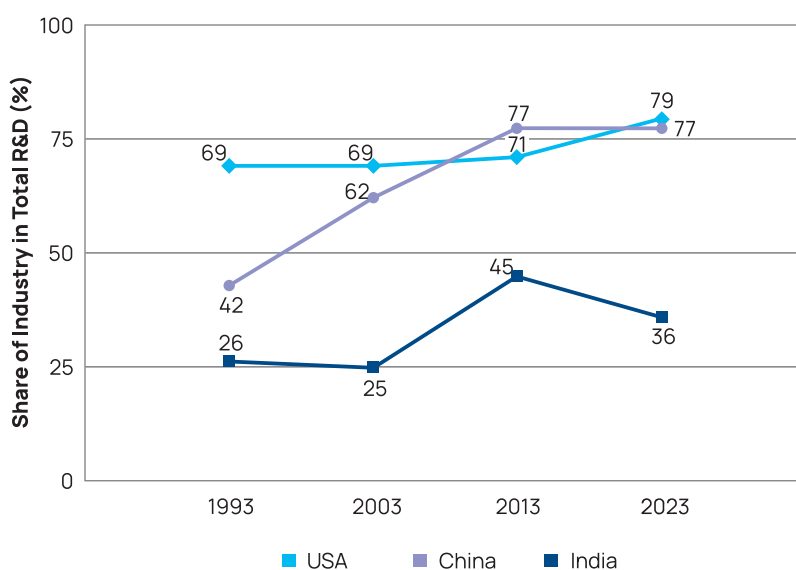


Source: OECD, Science, Technology and Innovation Scoreboard available at <https://www.oecd.org/en/data/datasets/science-technology-and-innovation-scoreboard.html> for data on US and China for 1993 - 2023; Department of Science and Technology (DST), S&T Indicators Tables 2022-23, available at <https://dst.gov.in/sites/default/files/Updated%20ST%20INDICATORS%20TABLES%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 (%)



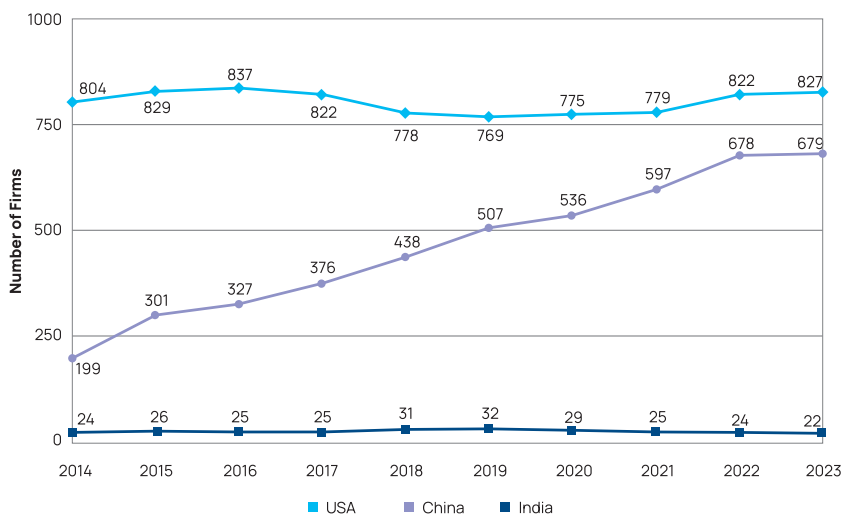
Source: OECD Main Science and Technology Indicators, available at <https://www.oecd.org/en/data/datasets/main-science-and-technology-indicators.html> for data on US and China; Department of Science and Technology (DST), Research and Development Statistics 1992-93, available at http://digitalrepository-nstmis-dst.org/files/stats/1992-93/Full_Text_1992-93.pdf; 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.

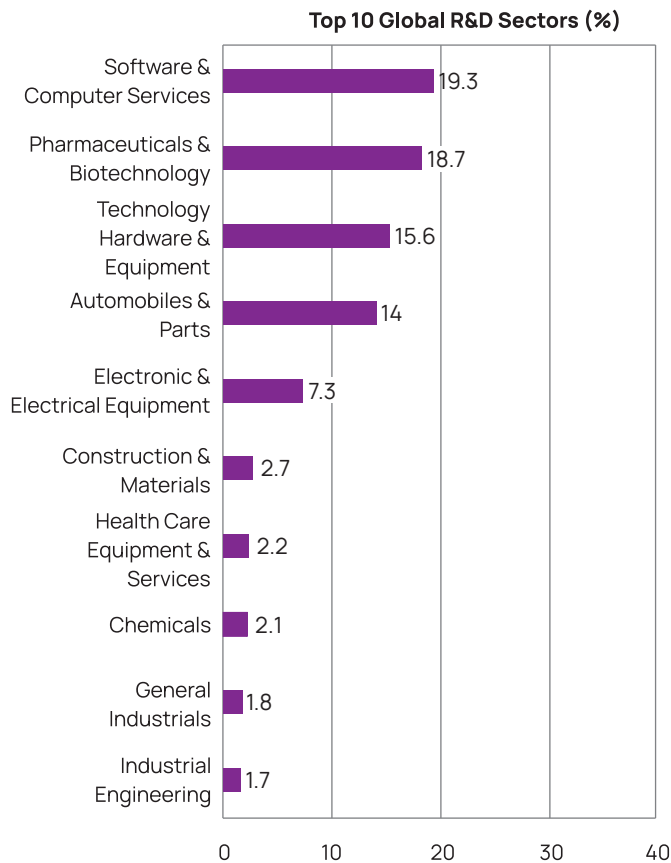
There has been a structural shift in global R&D spending. The global R&D software & computer services sector has become the top ranked global sector with total R&D spending crossing the USD 250 billion mark. It had been ranked fourth in 2015 with spending on R&D having totaled USD 86 billion. The significant 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

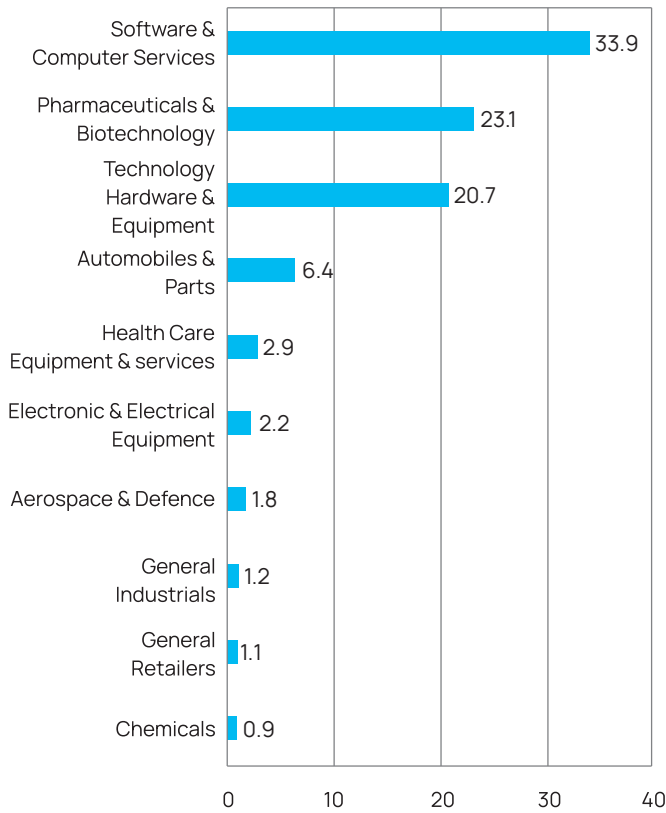
R&D spending. The top ranked sector in China is technology hardware & equipment followed by software & computer services. For China, construction & materials and industrial metals & mining are also among the top R&D sectors. The structure of China's R&D investments suggests a concerted effort to push 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.

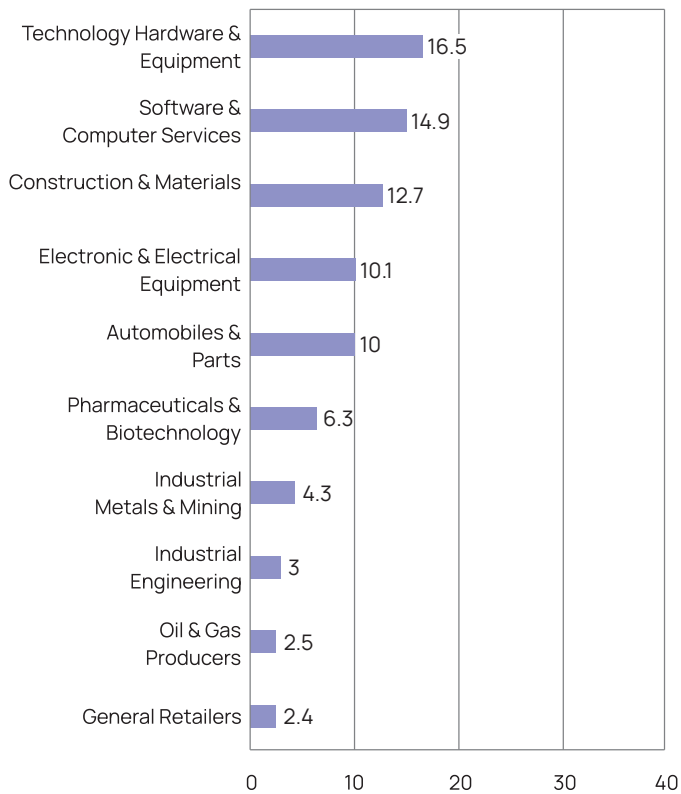
Figure 4 Sectoral Share of R&D Spending by Firms Globally and in the US, China and India (2023)

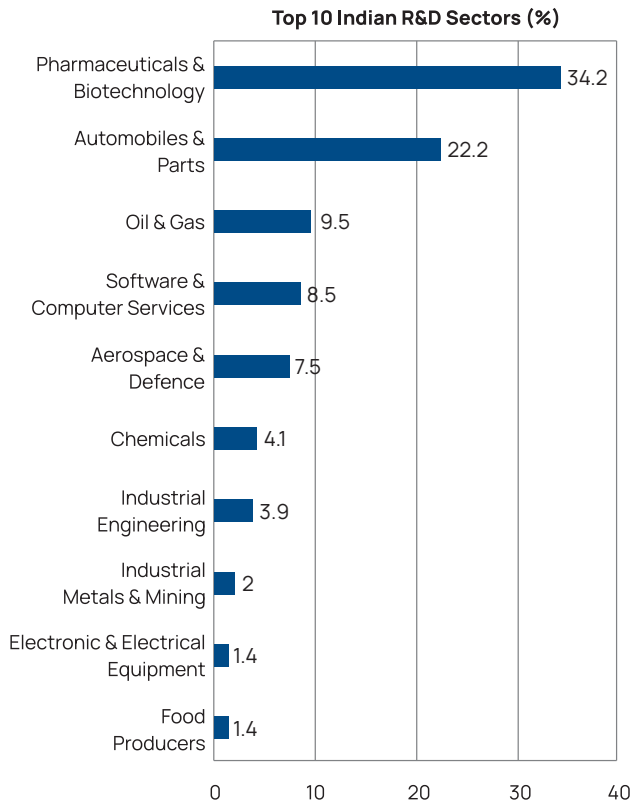


Top 10 USA R&D Sectors (%)



Top 10 China R&D Sectors (%)





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

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

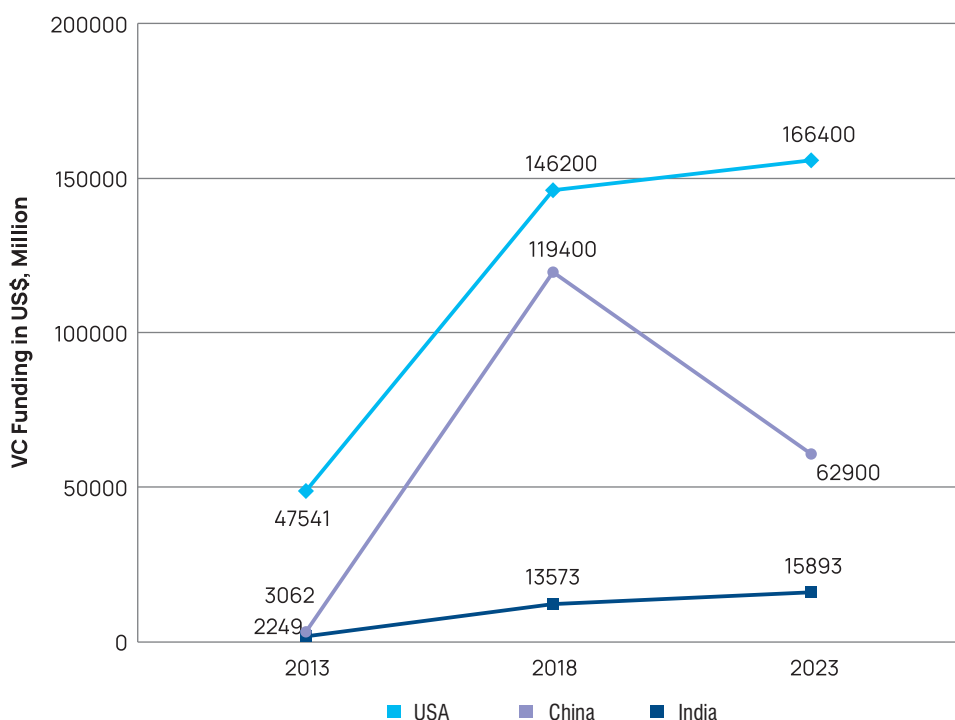
Global VC funding has slowed since peaking in 2021. In the US, VC funding stood at USD 166 billion in 2023 while in China it was USD 63 billion. In both cases, VC funding in 2023 was significantly below levels seen in 2021. India too experienced a drop in VC funding to USD 16 billion in 2023 from USD 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. Amid this recent slowdown in funding, it is instructive to see the sectors in which unicorns³ have emerged across these three countries.

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

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

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

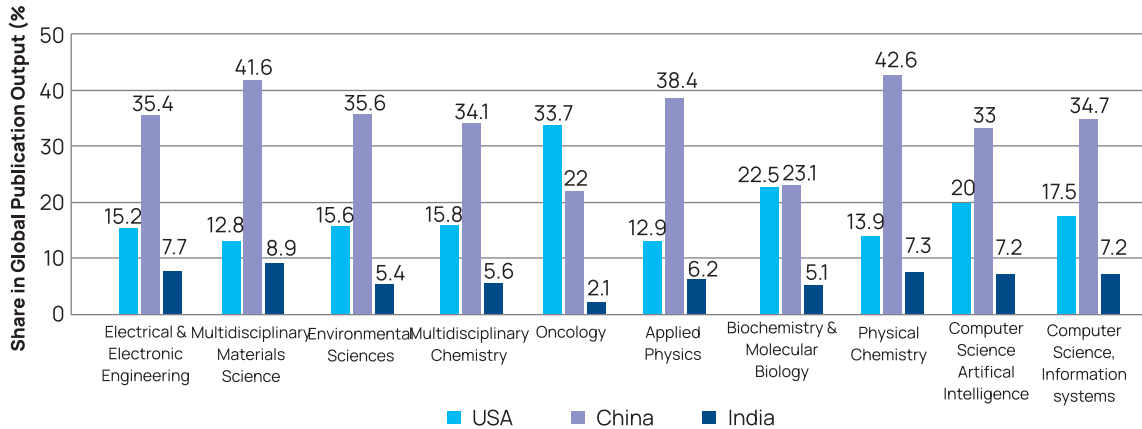
In the top areas of global publication output between 2019 and 2023, China dominates in terms of its share of publications in each of the areas except oncology. China's own top areas of publications have 8 in common with the areas mentioned in Figure 6. Several of the publication areas are key scientific 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)

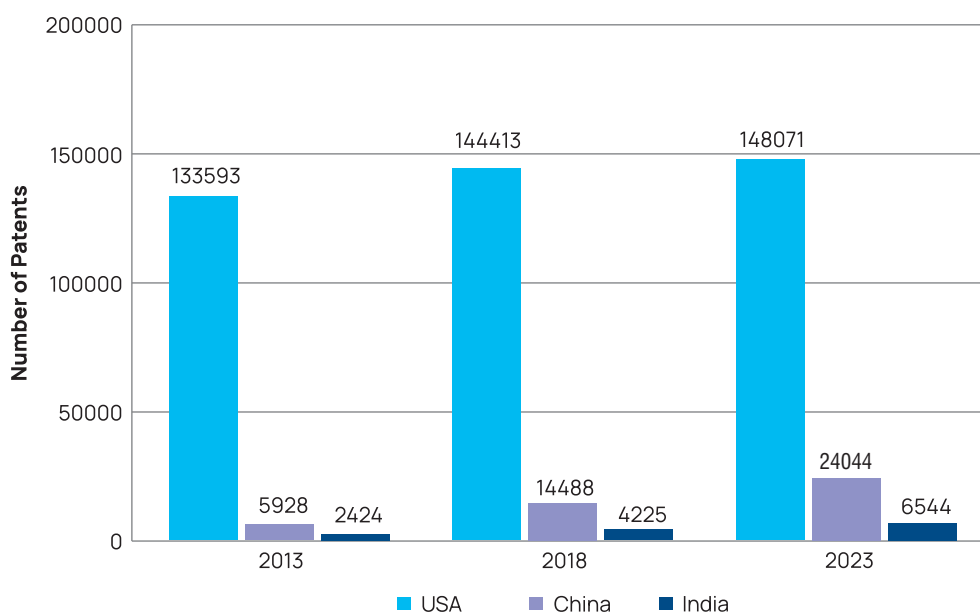
■ Patents Granted to the US, China and India

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.

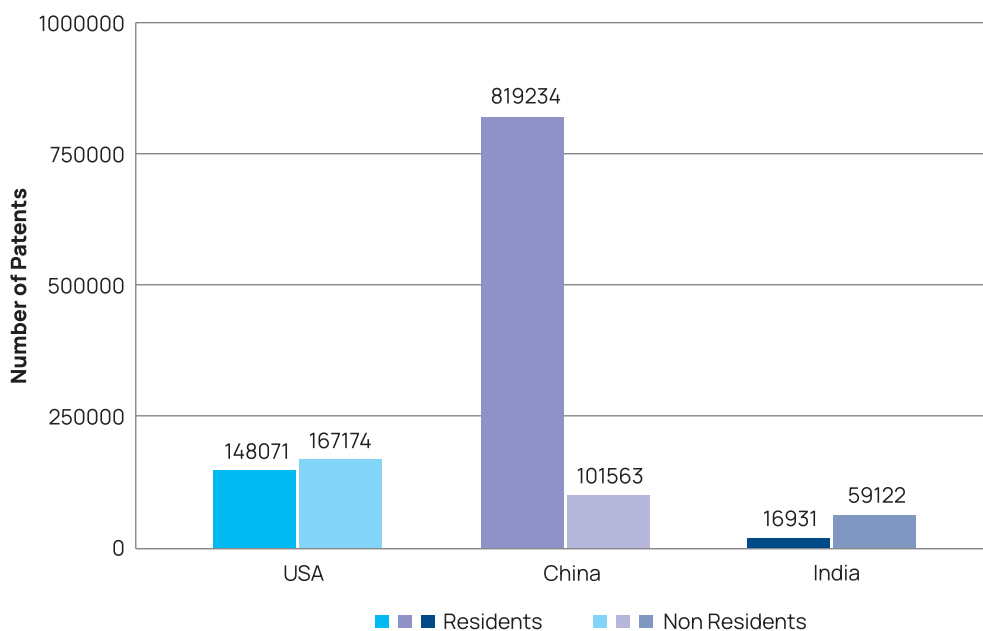
⁵ Office of the Controller General of Patents, Designs and Trademarks (CGPDTM)

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)

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.

■ References

- Ahmed, Nur & Wahed, Muntasir & Thompson, Neil. (2023). The growing influence of industry in AI research. *Science* (New York, N.Y.). 379. 884-886. 10.1126/science.ade2420, available at [https://www.researchgate.net/publication/368939275_The_growing_influence_of_industry_in_AI_research#:~:text=its%20associated%20metrology,-,.....%2C%202020\).%20...](https://www.researchgate.net/publication/368939275_The_growing_influence_of_industry_in_AI_research#:~:text=its%20associated%20metrology,-,.....%2C%202020).%20...), accessed on 13 October 2025
- ANRF Online. "About National Research Foundation." ANRF Online, available at <https://anrfonline.in/ANRF/About?HomePage=New>, accessed on 8 September 2025
- Atal Innovation Mission. (2024). Manual 2: The procedure followed in the decision-making process, including channels of supervision and accountability. Atal Innovation Mission, available at <https://www.niti.gov.in/sites/default/files/2024-04/Manual%20%20%281%29.pdf>, accessed on 25 September 2025
- Bhattacharjee, R. (2022). 75 Years of Indian Science and Technology: A Mission in Sustainability and Self-Sufficiency. Office of the Principal Scientific Adviser to the Government of India, available at <https://www.psa.gov.in/article/75-years-indian-science-and-technology-mission-sustainability-and-self/4092>, accessed on 14 October 2025
- Bush, V. (1945). *Science: The Endless Frontier*. United States Government, available at <https://ia801304.us.archive.org/29/items/scienceendlessfr00unit/scienceendlessfr00unit.pdf>, accessed on 2 May 2025
- Centre for Technology, Innovation and Economic Research (2025); CTIER Innovation Report, Industry in India: Followers or Leaders?, available at https://ctier.org/wp-content/uploads/2025/08/CTIER-Innovation-Report_Industry-in-India_Followers-or-Leaders.pdf, accessed on 10 October 2025
- Defense Advanced Research Projects Agency. "About DARPA." DARPA, available at <https://www.darpa.mil/about#history>, accessed on 7 May 2025
- Department of Agriculture & Farmers Welfare, Government of India. (2024). Detailed Demand for Grants 2024-25 (DA&FW). Government of India, available at https://agriwelfare.gov.in/sites/default/files/DDG_2024_25.pdf, accessed on 10 September 2025
- Department of Homeland Security. "Small Business Innovation Research Program." DHS Science and Technology Directorate, available at <https://www.dhs.gov/science-and-technology/sbir>, accessed on 9 May 2025
- Department of Science & Technology, Government of India. (2020). 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>, accessed on 11 August 2025
- Department of Science & Technology, Government of India. (2023). Updated RD Statistics at a Glance 2022-23. Department of Science & Technology, available at <https://dst.gov.in/sites/default/files/Updated%20RD%20Statistics%20at%20a%20Glance%202022-23.pdf>, accessed on 23 August 2025
- Department of Science & Technology, Government of India. (2023). Updated ST Indicators Tables 2022-23. Department of Science & Technology, available at <https://dst.gov.in/sites/default/files/Updated%20ST%20INDICATORS%20TABLES%202022-23.pdf>, accessed on 23 August 2025
- Department of Science & Technology, Government of India. (2024). MST DDG 2024-2025. Department of Science & Technology, available at <https://dst.gov.in/sites/default/files/MST%20DDG%202024-2025.pdf>, accessed on 8 September 2025
- Department of Science and Technology (DST), S&T Indicators Tables, Research and Development Statistics 2022-23, National R&D Expenditure and its Percentage with GDP, National R&D Expenditure by Sector, 2022-23, Expenditure on Research & Development by Select Major Scientific Agencies, available at <https://dst.gov.in/sites/default/files/Updated%20ST%20INDICATORS%20TABLES%202022-23.pdf>, accessed on 6 November 2024
- 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>, accessed on 4 October 2024, accessed on 8 September 2025
- Economic Times. (2022). Cabinet approves 50 % incentive of project cost for setting up semiconductor units. *Economic Times*, available at <https://economictimes.indiatimes.com/tech/technology/cabinet-approves-50-incentive-of-project-cost-for-setting-up-semiconductor-units/articleshow/94358549.cms>, accessed on 17 July 2025

Economic Times. (2025). Foreign recruiters step in for US scientists after major slash in their grants. Economic Times, available at <https://economictimes.indiatimes.com/nri/latest-updates/foreign-recruiters-step-in-for-us-scientists-after-major-slash-in-their-grants/articleshow/121391216.cms>, accessed on 15 October 2025

Elisabeth, N., Confraria, H., Rentocchini, F., Napolitano, L., Georgakaki, A., Ince, E., Fako, P., Tuebke, A., Gavigan, J., Hernandez Guevara, H., Pinero Mira, P., Rueda Cantuche, J., Banacloche Sanchez, S., De Prato, G., & Calza, E. (2023). The 2023 EU Industrial R&D Investment Scoreboard. Publications Office of the European Union, available at <https://publications.jrc.ec.europa.us/repository/handle/JRC135576>, accessed on 15 September 2025

Forbes N (2022), "The Struggle and the Promise: Restoring India's Potential" HarperBusiness

Government of India. (1958). Scientific Policy Resolution, 4 March 1958. Government of India, available at <https://indiabioscience.org/media/articles/SPR-1958.pdf>, accessed on 11 July 2025

Government of India. (2003). Science and Technology Policy 2003. Ministry of Science & Technology, available at <https://indiabioscience.org/media/articles/STP-2003.pdf>, accessed on 8 September 2025

Government of India. (2013). Science, Technology and Innovation Policy 2013. Department of Science & Technology, available at <https://dst.gov.in/sites/default/files/STI%20Policy%202013-English.pdf>, accessed on 8 September 2025

In Cites, Clarivate Analytics, derived from Web of Science. Data downloaded with assistance from Clarivate Analytics analyst, data downloaded on 6 January 2025. This is a subscription-based database

Lakhani, Nina. "National Science Foundation Staff Decry Trump's 'Politically Motivated' Cuts." The Guardian, July 24, 2025, available at <https://www.theguardian.com/us-news/2025/jul/24/national-science-foundation-trumps-cuts>, accessed on 28 July 2025

Mohan, R. (2017). India Transformed: 25 Years of Economic Reforms. Penguin Viking

Nabar, Janak, et al. "S&T as a Driver of China's Economic Agenda." CTIER Handbook: Technology and Innovation in India, Centre for Technology, Innovation and Economic Research, 2023, pp. 51-62, available at <https://ctier.org/wp-content/uploads/2025/09/4th-Essay.pdf>, accessed on 20 August 2025

National Aeronautics and Space Administration. "History." NASA, available at <https://www.nasa.gov/history/>, accessed on 7 May 2025

National Institutes of Health. "History." NIH Intramural Research Program, U.S. Department of Health and Human Services, available at <https://irp.nih.gov/about-us/history>, accessed on 6 May 2025

National Institutes of Health. NIH Budget. National Institutes of Health, available at <https://www.nih.gov/about-nih/organization/budge>, accessed on 1 October 2025

National Science & Technology Management Information System, Department of Science & Technology. (1992-93). Full Text Report 1992-93. Department of Science & Technology, available at http://digitalrepository-nstmis-dst.org/files/stats/1992-93/Full_Text_1992-93.pdf, accessed on 18 August 2025

National Science & Technology Management Information System, Department of Science & Technology. (2018). Statistics at a Glance 2017-18. Department of Science & Technology, available at <https://www.nstmis-dst.org/Pdfs/Statistics-Glance-2017-18.pdf>, accessed on 14 August 2025

National Science Board. (2024). Federal obligations for R&D and R&D plant, by agency and performer: FY 2022. National Science Foundation, available at <https://ncses.nsf.gov/pubs/nsb20246/table/RD-11>, accessed on 1 October 2025

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, available at <https://ncses.nsf.gov/pubs/nsb20241/data>, accessed on 13 November 2024

National Science Foundation. "History." National Science Foundation, available at <https://www.nsf.gov/about/history#when-was-nsf-established-792>, accessed on 6 May 2025

National Science Foundation. "National Robotics Initiative (NSF 11-553)." NSF, available at <https://nsf-gov-resources.nsf.gov/solicitations/pubs/2011/nsf11553/nsf11553.pdf?VersionId=jF.4xyEnwpiRkEnl5TOxqmIBkWk5l>, accessed on 12 May 2025

National Strategic Computing Initiative. "Strategic Plan." Executive Office of the President, July 2016, available at <https://obamawhitehouse.archives.gov/sites/whitehouse.gov/files/images/NSCI%20Strategic%20Plan.pdf>, accessed on 15 May 2025

Notes on Demand for Grants (various Ministries), Union Budget 2024-2025, available at <https://www.indiabudget.gov.in/>; accessed on 6 November 2024

OECD Science Technology and Innovation Scoreboard, GERD as a percentage of GDP, available at <https://www.oecd.org/en/data/datasets/science-technology-and-innovation-scoreboard.html>, accessed on 17 September 2025

OECD. Main Science and Technology Indicators (MSTI) Dataset. OECD, available at <https://www.oecd.org/en/data/datasets/main-science-and-technology-indicators.html>, accessed on 17 September 2025

Office of the Principal Scientific Adviser. "Realising India's R&D and Innovation Ambitions." Vigyan Dhara, November 2024, available at https://psa.gov.in/CMS/web/sites/default/files/psa_custom_files/PSA_NOVEMBER%202024%20ISSUE_04%20DECEMBER%202024%20FINAL.pdf, accessed on 13 October 2025

Parliament of India. Standing Committee on Defence. "Report No. 17 of 2023-24 on Demands for Grants (2023-24)." Parliament of India, 2023, available at https://eparlib.nic.in/bitstream/123456789/2963533/1/17_Defence_43.pdf, accessed on 23 August 2025

Press Information Bureau, Government of India. (2021). Make in India and Startup India. Ministry of Commerce & Industry, available at <https://www.pib.gov.in/PressReleasePage.aspx?PRID=1703787>, accessed on 31 August 2025

Press Information Bureau, Government of India. (2023). Dr Mansukh Mandaviya launches 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). Ministry of Chemicals & Fertilizers, available at <https://pib.gov.in/PressReleasePage.aspx?PRID=196081>, accessed on 1 August September 2025

Press Information Bureau, Government of India. (2024). National Intellectual Property Rights (IPR) Policy 2016. Ministry of Commerce & Industry, available at <https://pib.gov.in/PressReleasePage.aspx?PRID=1941489>, accessed on 25 September 2025

Press Information Bureau, Government of India. (2025). Research, Development and Innovation (RDI) Scheme. Ministry of Science & Technology, available at <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2150818>, accessed on 1 October 2025

Press Information Bureau. "Cabinet Approves Ambitious IndiaAI Mission to Strengthen the AI Innovation Ecosystem." Ministry of Electronics & IT, 7 March 2024, available at <https://www.pib.gov.in/PressReleaseframePage.aspx?PRID=2012357>, accessed on 17 August 2025

Press Information Bureau. "Cabinet approves National Quantum Mission to scale-up scientific & industrial R&D for quantum technologies." Press Information Bureau, 19 April 2023, available at <https://www.pib.gov.in/PressReleaseframePage.aspx?PRID=1917888>, accessed on 21 August 2025

Prowess (various years), Centre for Monitoring Indian Economy, Annual Financial Statements, Research & Development Expenditure (Capital & Current Account), downloadable from <https://prowessiq.cmie.com/>, data downloaded on 28 May 2024

Singh, Ajit. 2008. The Past, Present and Future of Industrial Policy in India: Adapting to the Changing Domestic and International Environment. Centre for Business Research, University of Cambridge. available at <https://www.jbs.cam.ac.uk/wp-content/uploads/2023/05/cbrwp376.pdf>, accessed 10 Oct. 2025

Singhania, Dipti and Janak Nabar. "Public R&D in India: Pathways to Increasing Its Effectiveness." CTIER Handbook: Technology and Innovation in India, Centre for Technology, Innovation and Economic Research, 2023, pp. 22-30, available at <https://ctier.org/wp-content/uploads/2025/09/Essay-1.pdf> accessed on 25 August 2025

Stokes, D. E. (1997). Pasteur's quadrant: Basic science and technological innovation. Washington, DC: Brookings Institution Press.

The Science Policy Forum. (1983). Technology Policy Statement 1983. The Science Policy Forum, available at <https://thesciencepolicyforum.org/wp-content/uploads/2020/05/TPS-1983.pdf>, accessed on 27 August 2025

Tracxn (various years), Funding Summary of Indian Tech and Offline Startups (Funded Between Jan'19 - Dec'23) and State-wise Count & Funding of Indian Startups. Data downloaded with assistance from Tracxn analyst, data downloaded on 30 September 2024 and 13 September 2024. This is a subscription-based database

U.S. Congress. "H.R.4346 - CHIPS and Science Act." Congress.gov, available at <https://www.congress.gov/bill/117th-congress/house-bill/4346>, accessed on 16 May 2025

U.S. Government Publishing Office. "35 U.S. Code Chapter 18-Patent Rights in Inventions Made with Federal Assistance." GovInfo, available at <https://www.govinfo.gov/content/pkg/USCODE-2011-title35/html/USCODE-2011-title35-partII-chap18.htm>, accessed on 7 May 2025

Venture Pulse Q2 24: Global Analysis of Venture Funding, KPMG Private Enterprise, available at <https://assets.kpmg.com/content/dam/kpmg/uk/pdf/2024/07/venture-pulse-q2-2024.pdf>, accessed on 13 November 2024

White House Office of Science and Technology Policy. "American Artificial Intelligence Initiative: Year One Annual Report." Executive Office of the President, February 2020, available at <https://www.nitrd.gov/nitrdgroups/images/c/c1/American-AI-Initiative-One-Year-Annual-Report.pdf>, accessed on 15 May 2025

White House. "America's AI Action Plan." The White House, July 2025, available at <https://www.whitehouse.gov/wp-content/uploads/2025/07/Americas-AI-Action-Plan.pdf>, accessed on 20 August 2025

World Development Indicators (2023), The World Bank, Indicators - Charges for the use of intellectual property, Receipts for the use of intellectual property, payments, available at <https://databank.worldbank.org/source/world-development-indicators>, accessed on 18 October 2024

World Intellectual Property Organisation (various years), IP Statistics Data Center - United States of America, China, India, available at <https://www3.wipo.int/ipstats/key-search/indicator>, accessed on 28 May 2024

