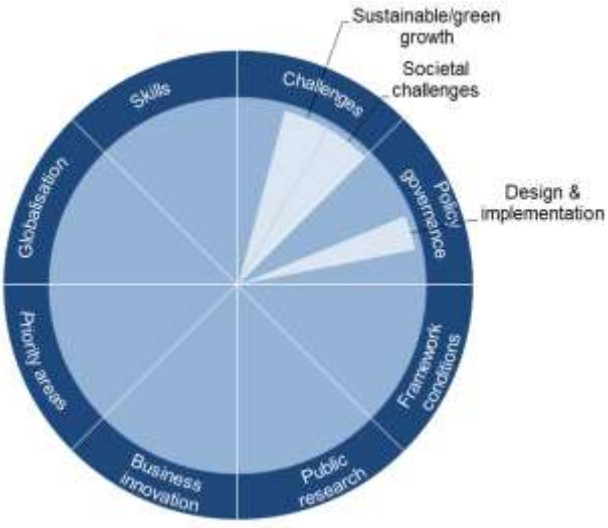
INDIA

India is one of the world's largest, fast-growing emerging economies, with a rapidly increasing population. Thanks to strong economic growth for nearly a decade, poverty has been cut in half. Growth faltered between 2012 and 2014 when it picked up again. Future growth prospects look good, although poverty continues to be a major challenge. Despite the abundant supply of a large, low-cost labour force, recent economic growth has relied mainly on capital investments and skilled labour. Innovation is seen as critical to India's socioeconomic development. Through its national strategy, Decade of Innovations 2010-20, the government aims to strengthen S&T capacities based on "a strong and visible Science, Research and Innovation System for High Technology-led path for India" (SRISHTI). The goal is to raise gross domestic expenditure on R&D to 2% of GDP with a doubling of the business contribution by 2020. The 12th Five-Year Plan (2012-17) emphasises reinforcing India's education system, boosting investment in S&T and fostering translational research.

Table 1. Gross domestic expenditure on R&D (GERD)

	IND	OECD
GERD		
USD million PPP, 2011	48 063	1 181 495
As a % of total OECD, 2011	4.5	100
GERD intensity and growth		
As a % of GDP, 2011	0.81	2.38
(annual growth rate, 2006-11)	(+10.6)	(+2.3)
GERD publicly financed		
As a % of GDP, 2014	n.a.	0.61
(annual growth rate, 2009-14)	n.a.	(+2.5)

Figure 1. Major STI policy priorities, 2016



Hot issues

Innovation to address social challenges (including inclusiveness)

India's 12th Five-Year Plan seeks to address social challenges, especially poverty and exclusion, by catalysing a growth process that will promote more inclusive and sustainable development. The Department of Science & Technology (DST) together with the Ministry of Human Resource Development (MHRD) have implemented

a series of Impacting Research Innovation and Technology projects (IMPRINT) that will address major societal and developmental needs such as healthcare, ICT, energy, sustainable habitat, water resources and river systems, security and defence, and the environment and climate. "Inclusive innovation" initiatives that focus on innovation outcomes which benefit poor and excluded groups in India receive particular attention, as do the innovation activities of the poor themselves. India's Inclusive Innovation Fund of USD 3.2 billion PPP (50 billion Indian rupees – INR) supports the development of innovative solutions targeting the "bottom 500 million", while the National Innovation Foundation (NIF) supports grassroots innovators, i.e. people from poor and excluded groups, at various stages of the innovation process. Another critical societal challenge for India is its weak healthcare capacity. Malnutrition, the lack of infrastructure for sanitation and clean drinking water, especially in fast-growing urban areas, and the shortage of health professionals, all contribute to poor public health conditions. The National Urban Health Mission has been approved in 2013 with a view to improving the health status of the urban population, especially in slum areas, by facilitating access to primary health care. India also encourages the utilisation of indigenous systems of medicine. The NIF, with the help of the Massachusetts Institute of Technology in Boston, has set up an augmented fabrication laboratory to support herbal technology R&D. As part of its mission to disseminate knowledge, the NIF also helps farmers patent their innovations and maintains an online database on technological ideas, innovations and traditional knowledge practices, including traditional medications prepared from locally available biological resources.

Innovation for sustainable/green growth

India faces challenges related to water-food-energy security and the environment, since demographic and economic growth is exerting pressure on natural resources and increasing dependence on imports of coal. Waste management is also a colossal challenge, because of the large volumes of waste generated and the persisting practice of waste being disposed of in open areas, with severe environmental and public health consequences. The National Action Plan on Climate Change (2008) remains the policy framework to support the development of renewable energy (e.g. solar technology) and energy efficiency (e.g. tradable energy-savings certificates and incentives for adopting energy-efficient appliances). Efforts have been made in the agriculture and manufacturing sectors to develop climate-resilient crops and green manufacturing facilities. A joint R&D initiative between the DST and the Ministry of Railways (MoR) aims to develop alternate fuels and new technological solutions for fuel efficiency and emission control for traction vehicles. In 2015, the government launched the Clean India Mission with a view to cleaning up cities and villages, improving hygiene, waste management and sanitation systems and raising awareness among populations. Furthermore, a new competitive programme under the Technology Development Scheme has been initiated to create technological solutions for waste management, including hospital waste, plastic waste and electronic waste.

Improving the design and implementation of STI policy

The Ministry of Science and Technology operates three departments that have a wide range of activities, including human and institutional capacity-building, community engagement and STI policy support: the Department of Science & Technology (DST), which plays a pivotal role in promoting science and technology; the Department of Scientific and Industrial Research (DSIR), which supports industrial R&D and technology transfer activities; and the Department of Biotechnology, which promotes S&T in the biotechnology area. The DST has given emphasis to aligning its activities with the national agenda in various policy domains (e.g. Make in India, Startup India, Digital India, Clean India, etc.). In 2015, the government released its technology roadmap to 2035, which identifies 12 high-impact technology areas and provides a common vision of STI's contribution to India's future. The Ministry of Human Resource Development (MHRD) through the Department of School Education and Literacy and the Department of Higher Education is in charge of designing and implementing education policy. The National Policy on Skill Development and Entrepreneurship 2015 provides an umbrella framework for all skilling activities being carried out within the country, with a view to aligning them with common standards and linking them to demand.

Some key STI performance indicators

Figure 2. Environmental performance

Labour productivity, GDP per hour worked, index 2005=100

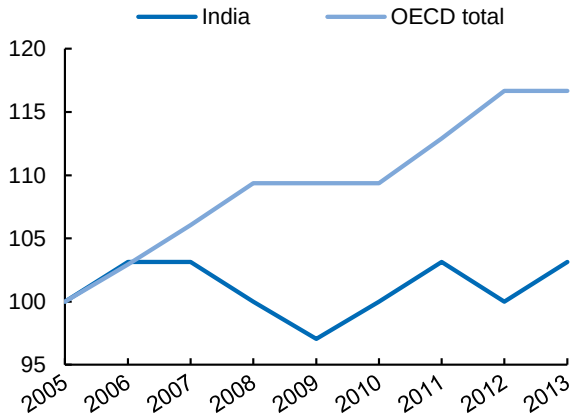
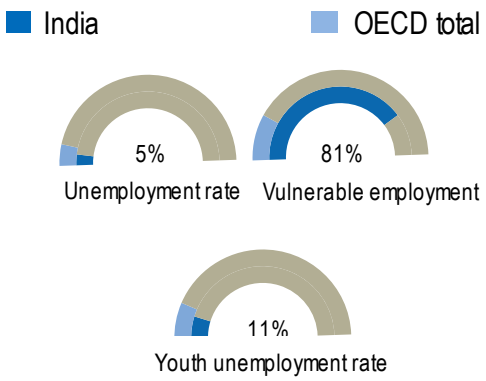


Figure 3. Unemployment

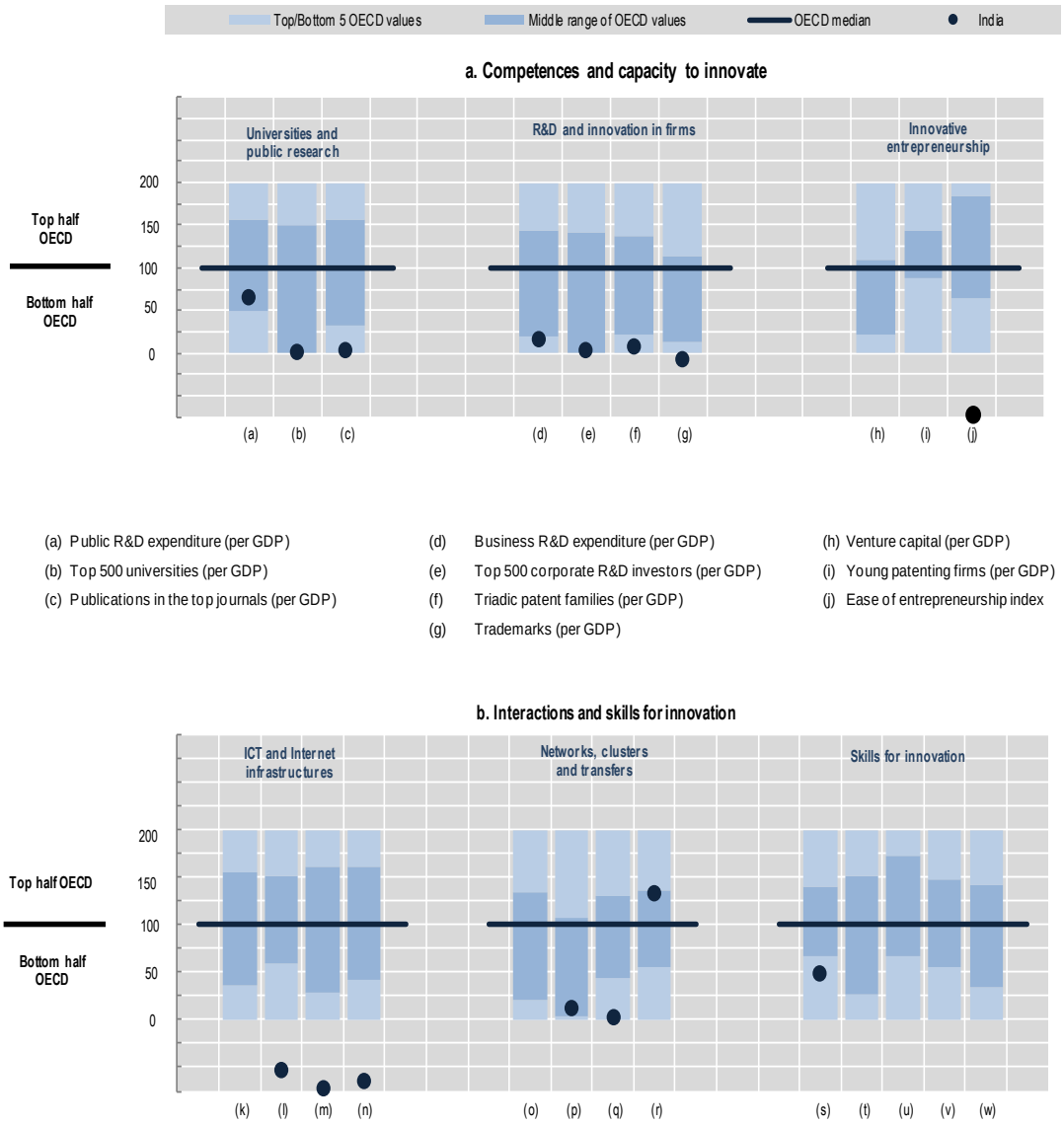
2015 or latest year available, percentages



Benchmarking national STI systems

Figure 4. Science and Innovation in India

Comparative performance of national science and innovation systems, 2016



Note: Normalised index of performance relative to the median values in the OECD area (Index median=100).

Highlights of the Indian STI system

New sources of growth

India's production has been shifting away from agriculture, but mostly into services rather than manufacturing, and the productivity of the manufacturing sector remains low. The 2011 National Manufacturing Policy (NMP) aims to drive the manufacturing sector's growth and increase its global competitiveness and environmental sustainability. The policy addresses areas of regulation, infrastructure, skills and technology development, finance availability and investment exit mechanisms. The NMP aims at raising the share of manufacturing from 16% to 25% of GDP and creating 100 million new manufacturing jobs by 2022 by focusing on the development of capital goods industries (heavy equipment and transport), labour-intensive industries (textiles, jewellery and food processing), strategic industries (aerospace, shipping, ICT and electronics, defence equipment and solar energy) and industries where India enjoys a competitive advantage (automobiles, pharmaceuticals and medical equipment). The DST initiated a competitive R&D programme for advanced manufacturing technologies, including robotics and automation, nanomaterials and precision manufacturing. In that respect, the IMPRINT projects give a strong focus on nanotechnology and advanced materials. In addition, the DST is financing R&D and the establishment of a joint technology platform for the National Mission on Electric Mobility so as to explore the potential of electric and hybrid vehicles. In the biotechnology field, India intends to consolidate its strong specialisation, which however has seen some decline in the recent past (5). India unveiled its National Biotechnology Development Strategy (NBDS) (2015-20), which aims to establish the country as a world-class biomanufacturing hub. The NBDS has launched four major missions dedicated to healthcare, food and nutrition, clean energy and education. It plans to prioritise investments in skills development, translational R&D and commercialisation infrastructures. In particular, the NBDS plans the creation of a national Technology Development and Translation network with global partnerships, including five new clusters, 40 biotech incubators, 150 Technology Transfer Offices and 20 Bioconnect centres. It also foresees the creation of a Life Sciences and Biotechnology Education Council.

Universities and public research

India has one of the largest public research systems in the world: in terms of absolute R&D expenditure by the higher education and government sectors, it is larger than in France and almost as large as in Japan. Public R&D expenditure accounted for nearly 62% of GERD in 2007 (the latest year for which data are available). However, in relative terms, at 0.50% of GDP in 2007, India is at the bottom of the OECD middle range (4[a]). In relative terms as well, India has fewer world-class universities and a weaker S&T publication record in leading international academic journals in comparison to emerging economies such as Brazil, the People's Republic of China and South Africa (4[b,c]). As public research institutions are governed by the ministries in charge of sectoral research areas, there is no consolidated public research budget and no central research funding body. The budget for PRIs has recently declined in real terms. Evaluations are used in an increasingly systematic way to assess research performance in universities. Five Technical Research Centres (TRCs) have been created in the existing autonomous institutions of the DST in order to further enhance translational research and bring out innovative products.

Innovative entrepreneurship

Part of India's productivity issue stems from the preponderance of the informal sector and of small low-productive firms that are unable to exploit economies of scale. Firms have little incentive to grow since by staying small they can avoid regulations and taxes. The regulatory and administrative framework for entrepreneurship in India is actually complex and poorly supportive (4[i]). Numerous stringent labour laws discourage formal employment in capital-intensive activities. The complexity of the tax system, tax cascading and frequent changes in tax laws undermine business activity. In early 2016, the government announced the launch of the Start-up India initiative with a view to creating an ecosystem that is more conducive to entrepreneurship and the growth of start-ups. The action plan foresees spreading start-up dynamics from the digital sector to other sectors, including agriculture, manufacturing, the social sector,

healthcare and education, and from large cities to semi-urban and rural areas. Start-up India intends to cut red tape, administrative compliance costs and market exit constraints, create a one-stop shop (Start-up India Hub) for knowledge exchange and access to funding, develop a fast-track patent application procedure for start-ups and facilitate start-ups' access to public procurement. Start-up India also aims to improve access to funding for start-ups through a new fund of funds, a credit guarantee fund scheme and a series of tax exemptions. In addition, Start-Up India offers promotion services and improved conditions for setting up incubators, research parks and academic spin-offs.

ICT and Internet infrastructures

Within the technology sector, India is known to be the global hub of the offshore knowledge-intensive IT services and industry. Despite this, India's ICT infrastructure is poorly developed (4[i.m]). The Ministry of Electronics and Information Technology is responsible for promoting e-governance, e-industry (e.g. electronics and IT industry), e-skills development, cybersecurity and ICT-related R&D infrastructure. In 2015, India launched the Digital India programme with the vision of transforming the country into a digitally empowered society and knowledge economy. Digital India is coordinated by the Ministry of Electronics and Information Technology and cuts across various ministries and departments. It is centred on three key vision areas: digital infrastructure (broadband highways, mobile connectivity, public internet access and cybersecurity), on-demand governance and services (e-governance, electronic service delivery, electronics manufacturing, IT for jobs and early harvest programmes) and the digital empowerment of citizens (digital literacy, information for all, participative platforms, digital resources in Indian languages). In addition, India has implemented the National Data Sharing and Accessibility Policy (NDSAP) and is moving towards greater accessibility to and the easier sharing of non-sensitive data for scientific and socioeconomic purposes. The DST has become the nodal point for the overall co-ordination, implementation and monitoring of the NPDSA. All publicly funded departments, institutions and agencies, including universities, at both central and state levels, are required to conform to the NSDAP guidelines regarding the data generated from public funding. The NSDAP is likely to speed the digitalisation of large volumes of government data. Also, the National Supercomputing Mission aims to build a vast supercomputing grid comprised of more than 70 high-performance computing (HPC) facilities across the country and to develop professional HPC skills.

Technology transfer and commercialisation

India has no legislation on technology transfer and commercialisation. Various programmes provide access to knowledge developed in PRIs higher education institutions. In 2016, India adopted its National Intellectual Property Rights Policy, which will set out the future roadmap for intellectual property. The National IPR Policy seeks to reinforce the IPR framework in the country, to improve public awareness about the economic, social and cultural benefits of IPR, to stimulate the generation and commercialisation of IPR, and to modernise IPR administration by adopting a more service-oriented approach and strengthening the enforcement and adjudicatory mechanisms for combating IPR infringements. Recognising the need to facilitate public-private partnerships, the Science and Engineering Research Board has approved a scheme in support of solution-driven collaborative research that bridges the gap between publicly funded research and industrial R&D. In addition, the government decided on the creation of a Council for Industry and Higher Education Collaboration that would serve as a nodal agency to promote and facilitate collaboration between industry and higher education. A Technology Acquisition and Development Fund has been made available to support the domestic manufacture of pollution control and energy efficiency equipment. The fund will also function as an autonomous patent pool and licensing agency.

Clusters and regional policies

Special economic zones (SEZs) are important export-focused platforms for business development in India and are attractive for IT firms. Firms enjoy simplified administrative procedures, including on labour law, and significant tax exemptions. Since 2014, newly established SEZs replaced tax holidays by offering complete first-year capital depreciation that, in turn, tends to further attract capital-intensive projects. In addition, National Investment and Manufacturing Zones (NIMZs) are a core element of the NMP that offer a

flexible regulatory framework with production units, facilities, environmental protection mechanisms and residential areas so as to provide supportive business environments.

Globalisation

The establishment of R&D centres by multinationals has accelerated India's integration into global R&D and innovation systems. Although India hosts several top corporate R&D investors in the automotive, industrial machinery and IT industries, it still lags behind China, Brazil and Russia in this regard (4[e]). Its share of internationally co-authored S&T publications is also very low, even compared to other BRIICS. However, India is on par with the OECD median, and well ahead of Brazil, China and South Africa in international co-patenting (4[f]). In 2014, India announced the Make in India campaign to promote itself as a global manufacturing hub. Make in India aims to ease policies, simplify regulations and improve policy predictability (e.g. tax policies). As part of the initiative, a one-stop shop and an Invest India team provide foreign investors with information on regulatory conditions and assistance for regulatory clearances. All central government services have been integrated into a single e-Biz online portal, and directives have been provided to streamline administrative processes. In recent years Indian universities have also progressively opened up internationally, much more than PRIs. Various government departments have programmes that facilitate the international mobility of human resources. The India Innovation Growth Programme is a joint initiative by various Indian and US stakeholders aimed at promoting innovative Indian technologies in the global market. The Programme provides innovators with training, business development assistance and awards.

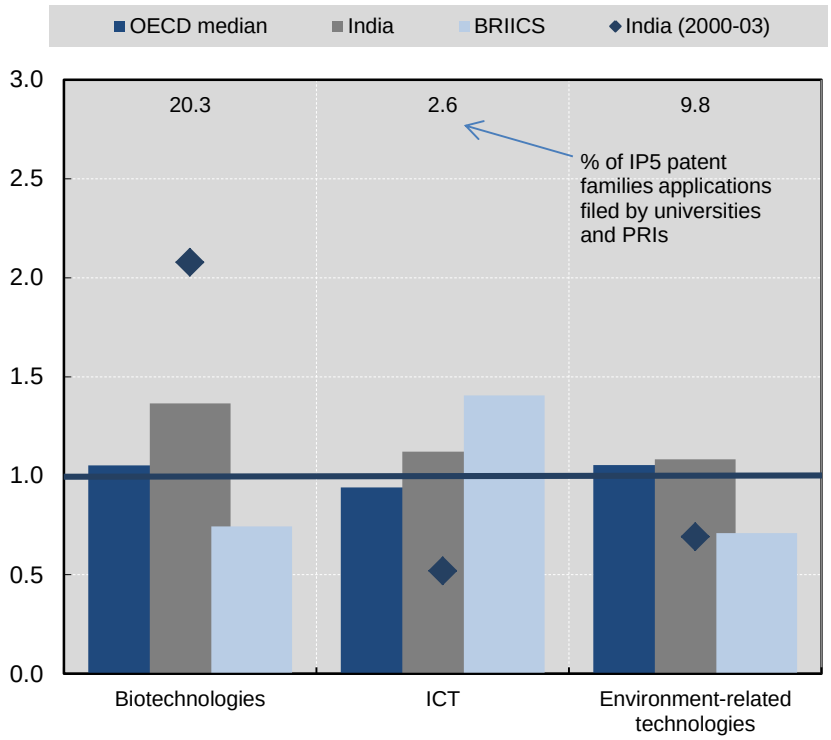
Skills for innovation

India has a large, young, low-cost and growing labour force. Improving education has been at the top of India's development agenda since independence. However, low school attainment rates and the poor quality of the education system hamper the development of skills for innovation. Improving access to education and raising literacy is crucial. The 12th Five Year Plan gives first priority to developing human capabilities. As to improving quality standards, in 2014 the central government constituted a review committee for the University Grants Commission and a Committee on National Ranking Framework to adjust the framework for ranking universities and higher education institutions. In 2015, the Education Sector Skill Council was formed to set up a Labour Market Information System (LMIS) that could assist in planning skills needs and delivering training and in supporting the development of skills competency standards and a qualifications framework. The new National Education Policy 2016 provides a framework for the development of education in India over the coming few years. It gives an unprecedented focus on improving the quality of education at all levels and on ensuring that educational opportunities are available to all segments of the society. To improve the gender balance, India offers a range of schemes and scholarships to reduce the gender and minority gap in education and S&T education. For the first time in history, two women scientists have been nominated to the Council of Indian Institutes of Technology.

Structural aspects and specialisation

Figure 5. Revealed technology advantage in selected fields, 2011-13

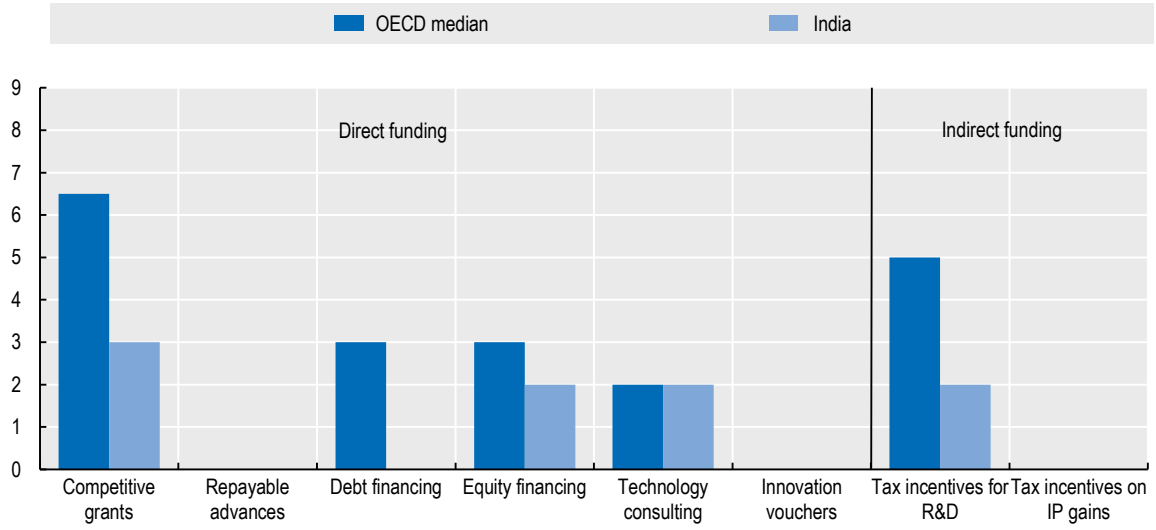
Index based on IP5 patent families applications



National STI policy mix

Figure 6. Most relevant policy instruments of funding for business R&D, 2016

Country self-assessment, index (9 = high and increasing relevance to 0 = not used)



The profile of India has been prepared by and under the responsibility of the OECD Directorate for Science, Technology and Innovation. It has not been revised by India's representatives.

The 2014 responses for India express the collective opinion of a group of researchers from the National Institute of Science, Technology and Development Studies (NISTADS). Their views do not represent the Institute or the Government of India.

Source: See the reader's guide and methodological annex.

Note: Policy information comes from country responses to the *EC/OECD International Survey on STI Policies (STIP)* 2014 and some desk-based analysis of OECD documents and official national sources. India's information is available in the EC/OECD International Database on STI Policies, edition 2016 at http://qdd.oecd.org/DATA/STIPSurvey/IND...STIO_2016.

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