中华人民共和国科学技术部
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Contents

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Focus on the Building of China's Regional Innovation System 2016-2019

Starting in 2006, the Chinese government has highlighted innovation by stepping up investment in science and technology and encouraging enterprises to invest more in R&D activities.

As global economy increasingly depends on rapid expansion of knowledge, the economic growth model has to shift from being factor-driven to innovation-driven. As an integral part of innovation, national innovation system shapes a country's global competitiveness to a big extent. No.18-21 of the Newsletter will focus on the progress of the building of China's regional innovation system from 2016 to 2019.

Policy measures

September 23, 2012	*Guidelines on Deepening the Reform of Scientific and Technological System and Accelerating the Building of National Innovation System*
The document aims to accelerate the building of an innovative country, fully implement the National Medium- and Long-term Scientific and Technological Development Program, harness the power of science and technology to bolster economic and social development and step up the building of an innovation system.	
June 16, 2015	*Guidelines on the Policy Measures for Promoting Mass Entrepreneurship and Innovation*
This aims to reform and improve relevant institutions and mechanisms to facilitate the building of innovation system.	
May 8, 2016	*Guidelines on the Building of Demonstration Bases for Mass Entrepreneurship and Innovation*
The document made it clear that an entrepreneurship and innovation ecosystem and a favorable culture will be fostered, and demonstration bases at the universities and research institutes should fully tap human resources and technologies and step up the commercialization of research results.	
June 21, 2017	*Guidelines on Building the Second Batch of Demonstration Bases for Mass Entrepreneurship and Innovation*
It set out detailed plans for the development of the second batch of demonstration bases.	
July 21, 2017	*Guidelines on Strengthening Implementation of Innovation-driven Development Strategy and Further Promoting Mass Entrepreneurship and Innovation*
It pointed out that in recent years, a large number of new market entities have been generated, which have improved the innovation efficiency and shortened the innovation cycle; next, efforts will be made to give full play to the decisive role of market in resource allocation, combine government, industry, society-wide resources, and improve the service system for innovation and entrepreneurship; efforts should be made to put in place better incentives, share innovation resources, and accelerate the translation of research results into real productivity.	
May 14, 2019	Premier Li Keqiang chaired State Council Standing Committee meeting
The meeting set out measures for bringing into play the dominant role of enterprises in raising innovation capability, in an effort to promote industrial upgrading. It pointed out that efforts will be made to improve innovation system, stimulate the innovation vitality of enterprises by encouraging them to pool various innovation resources; meanwhile, efforts should be made to accelerate the translation and dissemination of research results. China will encourage enterprises to carry out international cooperation in innovation, and participate in the development and revision of	

international technology standards; China will enhance IPR protection and toughen punishment for acts of infringement.	
February 2019	General Secretary Xi Jinping put forward a "new-style nationwide mechanism"
General Secretary Xi emphasized that the guiding role of policies should be brought into full play.	

Innovation Players' Capacity Building

➢ Universities

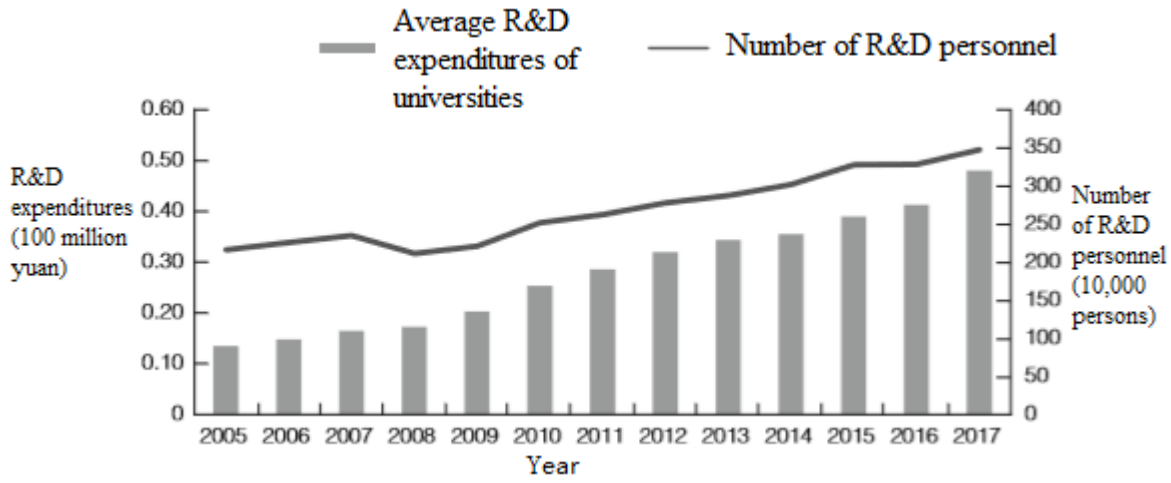

Figure 1 Average R&D expenditures and number of R&D personnel of universities

Since 2006, universities have seen a constant increase in R&D expenditures and R&D personnel (Figure 1), demonstrating an increasingly bigger role of science and technology in China's development. Universities have also sustained investment of resources to increase vitality and creativity.

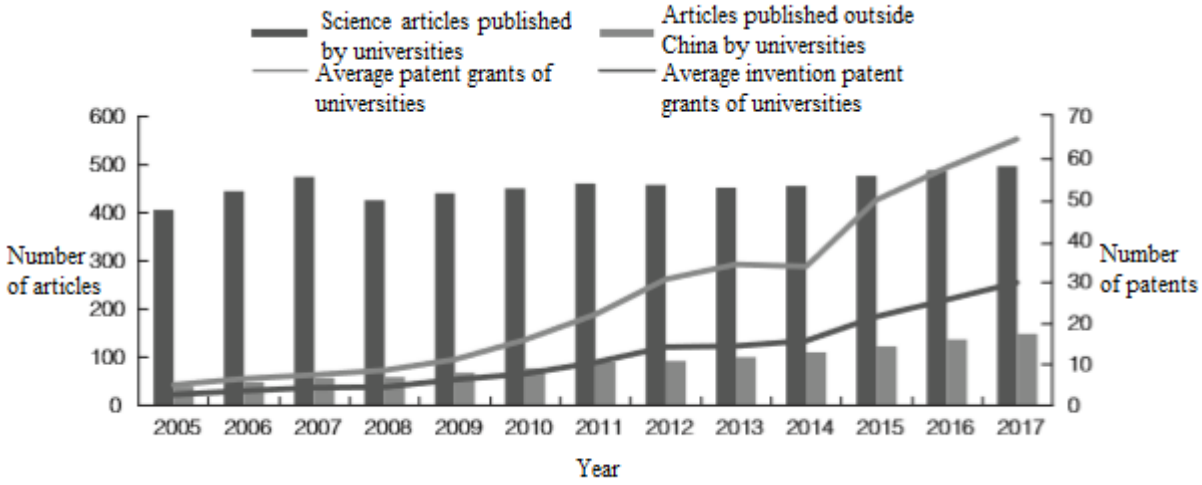

Figure 2 Average articles and granted patents of universities

Since 2006, the number of patent grants owned by universities has kept rising, but the invention patent grants show a slower growth. The universities' average number of published articles and number of articles published outside China show a low growth trend. Universities play a major role in basic research, manifested by the number of publications. Relatively, universities have seen a constant rise in their patent grants, showing their growing role in innovation. All this is achieved thanks to the National

Medium and Long-term Program. However, the average growth of science articles published by universities is beginning to decline.

- **Enterprises**

Enterprises are main players in innovation. In 2013, the General Office of the State Council issued *Guidelines on Strengthening the Dominant Role of Enterprises in Technological Innovation and Comprehensively Improving the Innovation Capability of Enterprises*, which clearly proposed to develop a business-led strategic industrial technological innovation alliance. Through the alliance, China will develop major innovative products, grasp the core key technologies, and build the industrial chain; China will develop generic technologies to tackle major problems. Finally, China will strengthen innovation in technology, business model and management and foster new forms of services.

The statistics below is mainly about large industrial enterprises, showing a marked improvement of business innovation capability.

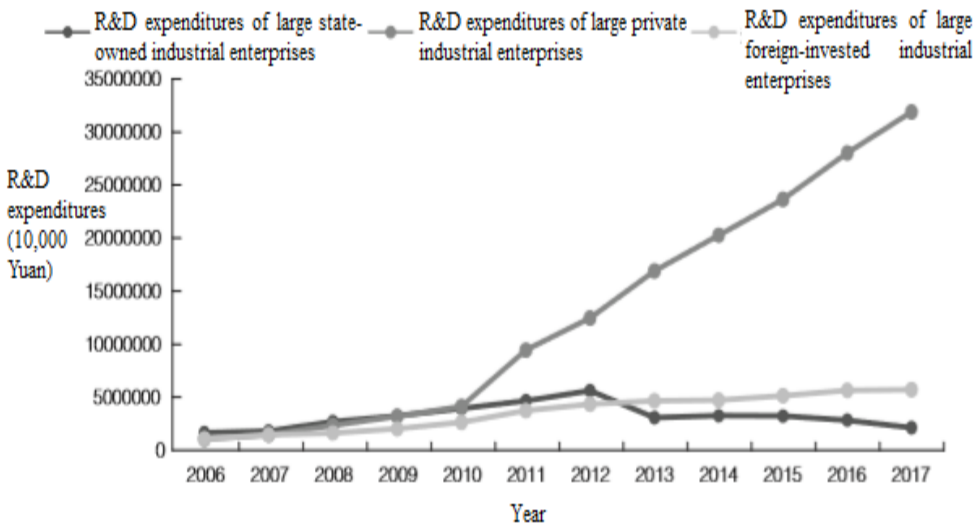

Figure 3 R&D expenditures of large industrial enterprises

First, the number of large enterprises with research and experimental development activities increased from 17,075 (2004) to 102,218 (2017), a nearly six-fold growth, accounting for 27.4% of the total in 2017. Second, the proportion of those enterprises rose year by year, from 6.2% in 2004 to 27.4% in 2017.

Figure 3 shows R&D investment of different types of enterprises. Private enterprises shows a rapid growth trend and an increasingly bigger ratio of the total R&D investment. State-owned and foreign-invested enterprises show a steady increase in R&D investment, while foreign-invested enterprises invest more than state-owned ones over the past years.

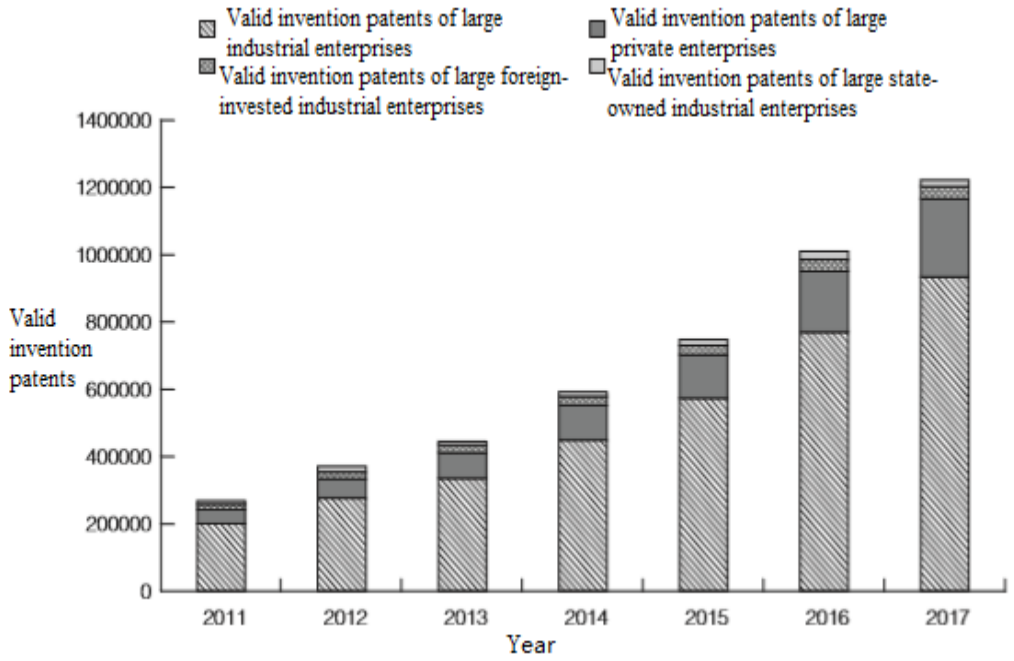

Figure 4 Valid invention patents of large industrial enterprises

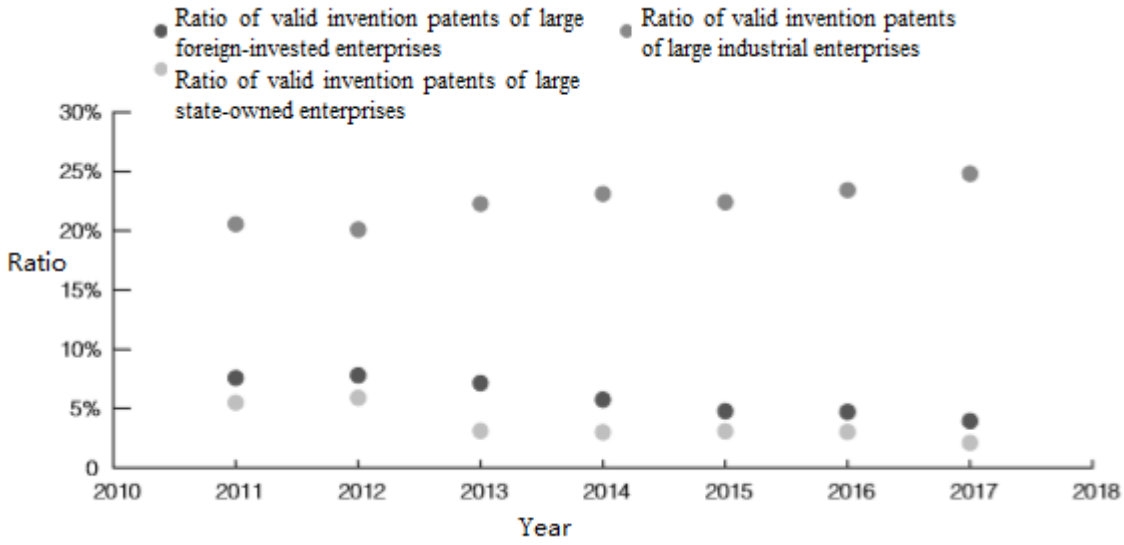

Figure 5 Ratio of valid invention patents of large enterprises

Figure 4 and Figure 5 respectively show the number and ratio of valid invention patents of large industrial enterprises, and the broken lines represent the number of valid invention patents of state-owned, private and foreign-invested enterprises. It indicates that the growth of invention patents of private enterprises is basically consistent with the trend of the total. In contrast, state-owned and foreign-invested enterprises show slower growth. Meanwhile, foreign-invested enterprises own increasingly more invention patents than state-owned ones. Similarly, state-owned enterprises' invention patents account for the slightest ratio. For example, in 2017, the ratio of patents of state-owned enterprises was 2.12%, while that of private enterprises was 24.82%, about 10 times of that of state-owned enterprises.

Private enterprises have high R&D input and output, and the growth of their invention patents is basically consistent with the overall trend, higher than that of state-owned and foreign-invested enterprises. Meanwhile, foreign-invested enterprises show a better input/output ratio than state-owned enterprises.

The number of Fortune 500 enterprises on the Chinese Mainland grew from 22 in 2007 to 105 in 2017. While State-owned enterprises took up the lion's share, a growing number of private enterprises are put on the list. For example, 81 state-owned enterprises and 24 private ones were on the list of Fortune 500 in 2017, while in 2007, all on the list were state-owned enterprises.

Through 15 years' efforts, state-owned enterprises have replaced foreign-invested ones as the most prominent force in the innovation system. More importantly, a growing number of private enterprises are beginning to show a dominant position in the market. During 2006-2019, private enterprises' role surged in national innovation system.

- **Research institutes**

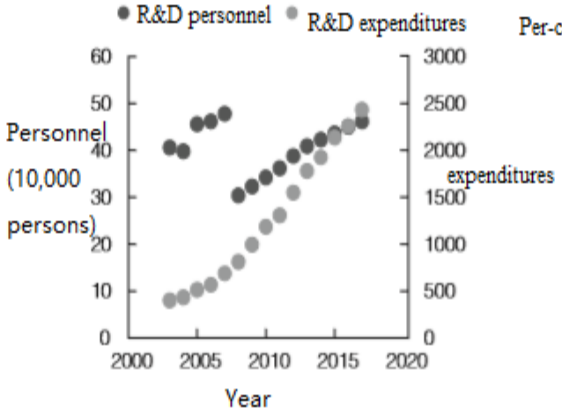

Figure 6 R&D personnel and expenditures

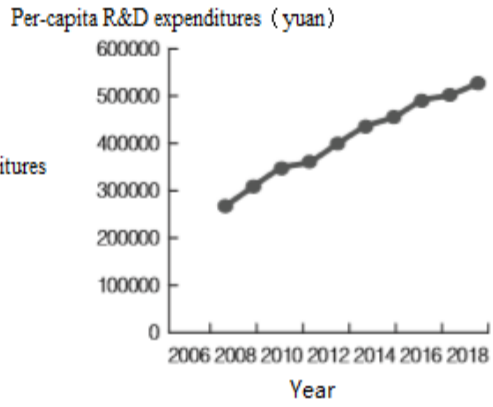

Figure 7 Per-capita R&D expenditures

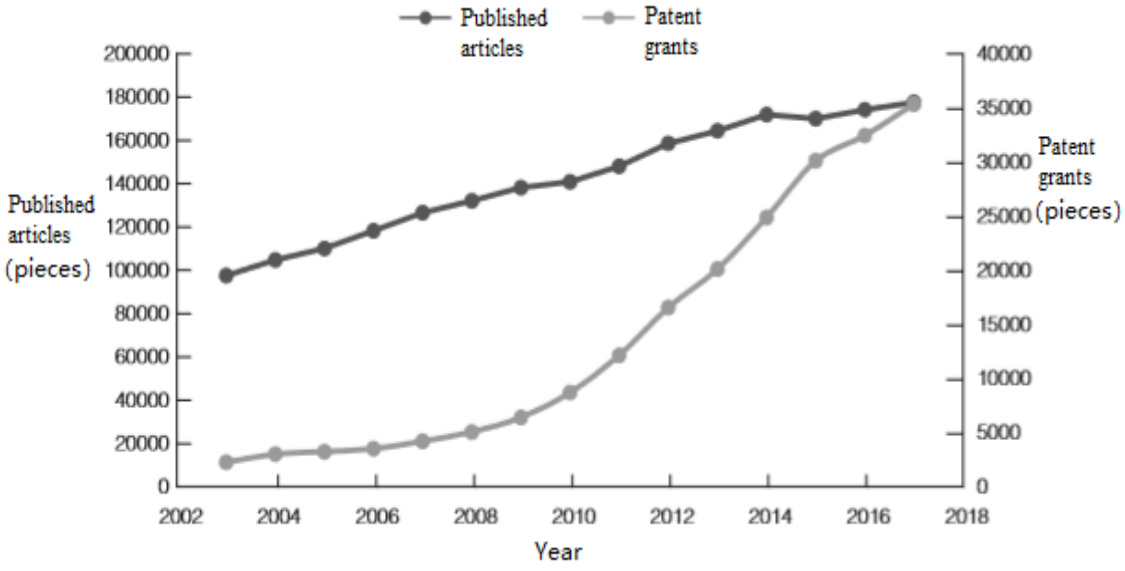

Figure 8 Published articles and patent grants

Research institutes and researchers are stable in number over the past decade. Research institutes increased from 3,727 in 2008 to 3,547 in 2017. As shown in Figure 6, the number of researchers remained stable. In contrast, both total and per-capita R&D expenditures kept rising (Figure 7), and articles published and patent grants showed the same trend. The number of patent grants outgrew that of articles, with a notable input/output ratio.

Policy and R&D investment

Government has an important role to play in national innovation system.

First, policy-led business innovation. The most important policy is tax deductions. Since 2006, the policy has substantially promoted innovation capabilities of enterprises. In order to better encourage enterprises to conduct R&D activities and deliver favorable R&D tax policies for enterprises, the Ministry of Finance (MOF), the State Taxation Administration and the Ministry of Science and Technology (MOST) jointly issued *the Notice on Improving Additional Pre-tax Deductions for R&D Expenses* in November 2, 2015, which became effective on January 1, 2016. The policy greatly encouraged R&D activities of all sectors.

Second, government science and technology programs. In order to implement the innovation-driven development strategy and deepen the reform of the S&T system, MOST and MOF jointly developed *the Plan on Deepening the Reform of the Management of the Centrally-funded Science and Technology Programs/Special Projects/Funds*. This aimed to transform the government's role in science and technology management, focus on the major tasks of strategic national importance, promote deep integration of science, technology and economy, clarify the relationship between the government and the market, commit to openness, transparency and public scrutiny, so as to best stimulate the enthusiasm of researchers in innovation.

Government R&D investment shows the extent of its support for scientific research and development. In contrast with developed countries, R&D funding from the government takes up a small proportion despite a big total investment in China, and shows a downward trend. This is largely due to the rapid growth of enterprises' investment in R&D (Figure 9, Figure 10). To enable China to become an innovation leader, government should invest more in R&D, particularly in basic research. China should increase funding to stimulate researchers' enthusiasm and ensure that R&D activities go smoothly.

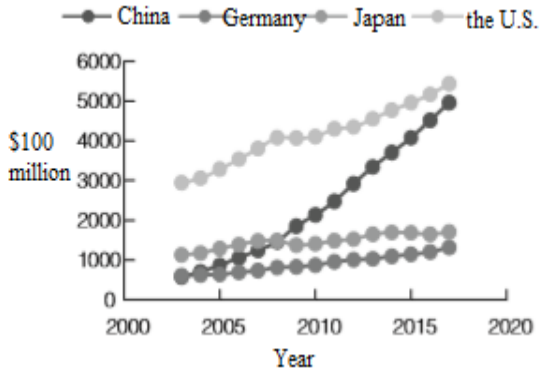

Figure 9 Government R&D investment

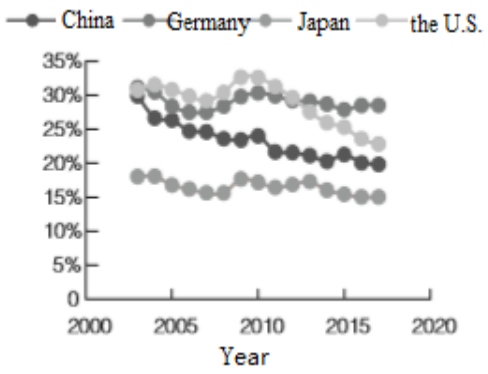

Figure 10 Government R&D investment as a ratio of GERD

In terms of capacity-building of innovation players, universities have not seen notable improvement in output in recent years, and enterprises has seen a steady growth of patent grants, with private enterprises playing a major role. Research institutes have witnessed a good input/output ratio, with a marked increase of the patents. The government has actively introduced policies and regulations to promote the building of national innovation system, but government R&D investment remains low.

Interaction within innovation network

Different players in the innovation ecosystem have dynamic links, like university-business collaboration, shift in industry--universities-research institutes structure, commercialization of university R&D results and involvement of venture capital.

➢ Industry-universities-research institutes links

Despite a sustained rise in total business investment in universities' R&D, the funding relative to the number of universities, which has been on the rise, has been declining. This reflects weakening collaboration between universities and enterprises.

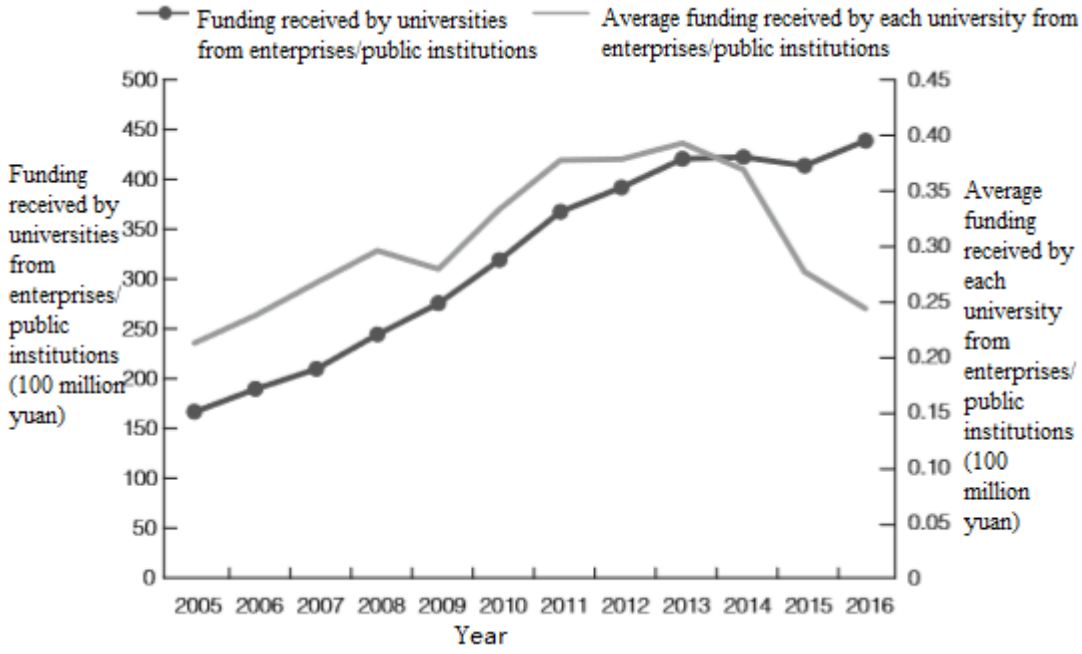

Figure 11 Funding received by universities from enterprises and public institutions

Cooperation between different players also reflects the shift of industry-universities-research institutes structure. As shown in Figure 12, joint patent applications showed a gradual increase before registering a downward trend over the recent years, which is consistent with the trend of technology transfer transactions.

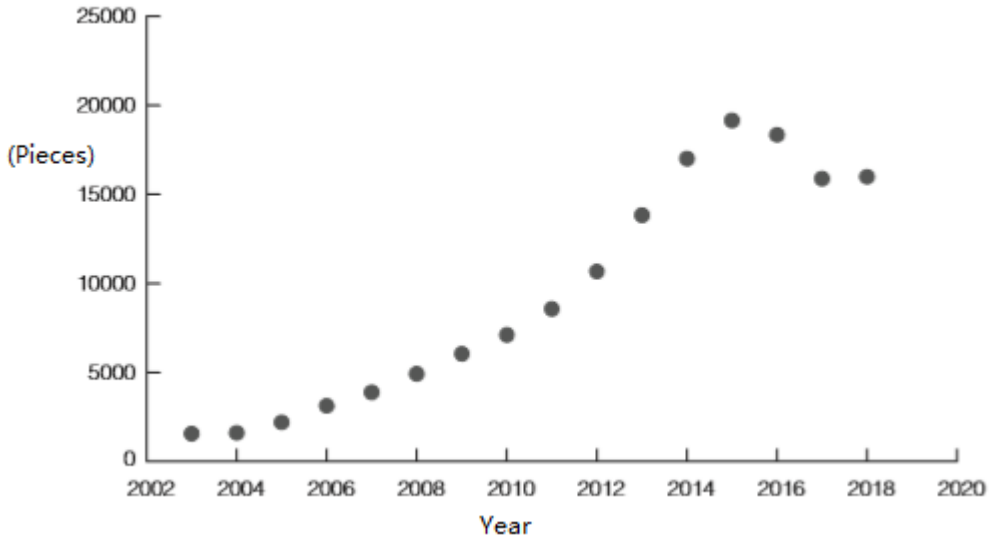

Figure 12 Joint patent applications

- **Technology transfer**

Universities' technology transfer transaction value has kept increasing, but has little to do with foreign-funded enterprises. Before 2008, a big proportion of university technologies were transferred to state-owned enterprises. After 2008, however, universities has gradually had more links with private enterprises (Figure 13)。

Overall, private enterprises take up a bigger role in university technology transfer, but the ratio of state-owned and foreign-invested enterprises remain almost unchanged.

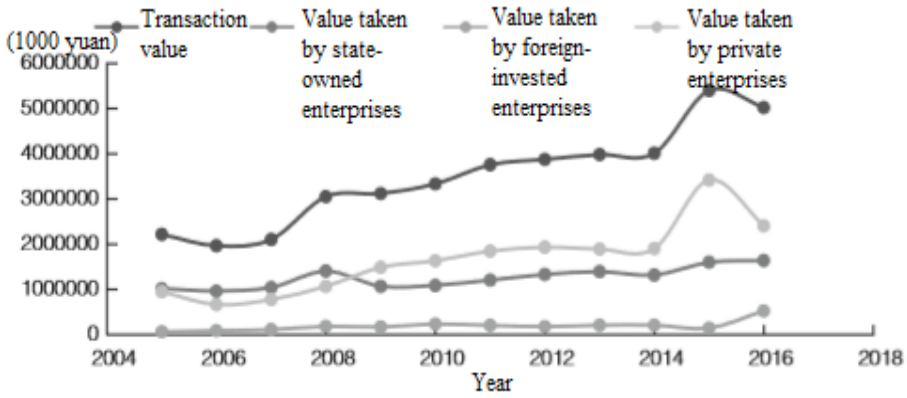

Figure 13 University technology transfer value

- **Venture capital (VC)**

The innovation ecosystem not only consists of industry, universities and research institutes, but also capital, which plays a growing role. Most notably, the role of VC is bigger than ever. Government invests directly in small high-tech start-ups in their initial stage before venture capitalists gradually assume part of the role. Many scholars believe that the involvement of venture capitalists can promote innovation to a certain extent, and can pick out promising and innovative enterprises.

Figure 14 and 15 show that China's venture capitalists grew from 150 in 2005 to 869 in 2013, with average amount of capital managed by each rising from 325 million

yuan to 1.59 billion yuan during the same period. Despite rises and falls, the number of projects and amount invested as a whole show an upward trend.

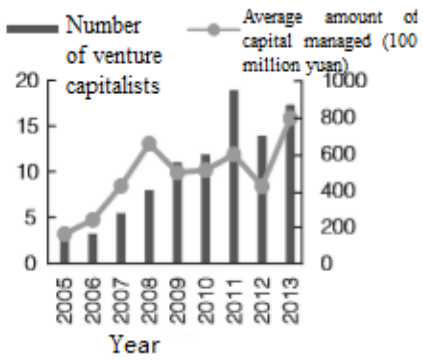

Figure 14 Number of venture capitalists and amount of capital

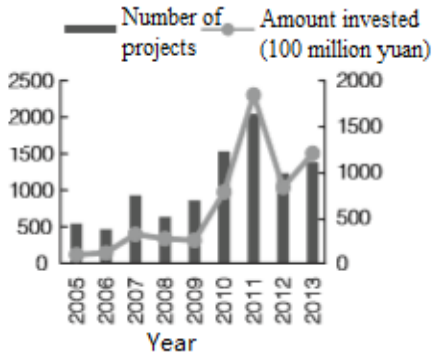

Figure 15 Number of projects and amount invested

VC comes increasingly from Chinese Mainland, while overseas capital gradually takes up a smaller ratio (Figure 16). To some extent, overseas capital can bring in not just funding but human resources and technologies to the high-tech industry.

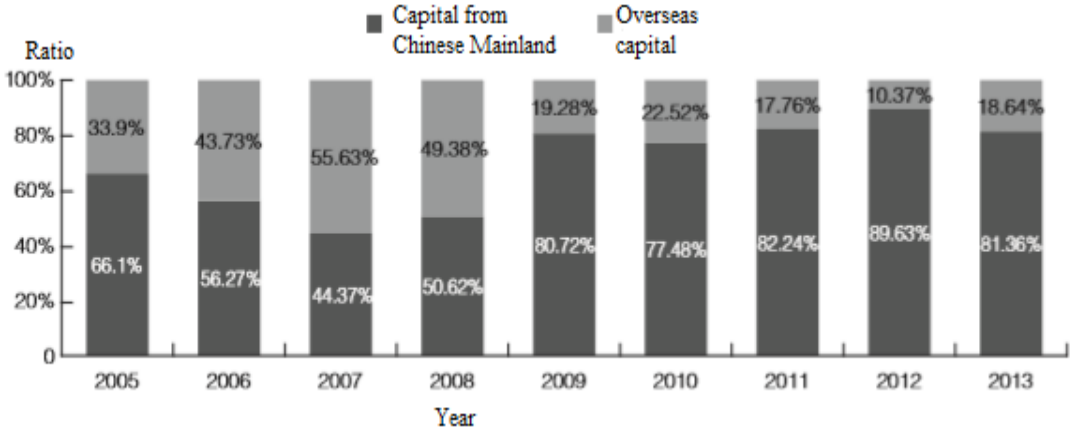

Figure 16 Ratio of different sources of VC

In recent years, the total commissioned funding, technology transaction volume and technology transfer value have increased, and the number of joint patent applications has also grown. Relatively, however, the collaboration between scientific research and industry remains inefficient. In addition, the growth of contract value between private enterprises and universities is basically consistent with the overall trend, while that of state-owned and foreign-invested enterprises remains sluggish in the past 10 years. This shows that private enterprises play a leading role in the whole innovation system, since they are more motivated to innovate and has more resources to do so than state-owned ones. This explains why they are in a dominant position in the technology market. The number of venture capitalists, the projects and funding invested in China show an upward trend, but the Chinese Mainland is the main source of the capital in recent years, and overseas capital takes up a very small ratio.

Regional innovation capability

Since the promulgation of *the National Medium and Long-term Scientific and*

Technological Development Program (2006-2020), the regional innovation capability has been significantly enhanced, the investment of innovation resources and commercialization of research results, which used to be concentrated in East China, is starting to shift to Central and Western Areas. A better, more balanced regional innovation landscape is taking shape. China has introduced a lot of initiatives, including Great Western Development Strategy, Northeast Revitalization Plan, Rise of Central China Strategy, coordinated development of Beijing, Tianjin and Hebei, establishment of the Xiong'an New Area, the Yangtze River Delta regional integration, the development of the Yangtze River Economic Belt, the construction of the Guangdong, Hong Kong and Macao Greater Bay Area, and Belt and Road initiative, putting the building of regional innovation system high on its agenda.

- **Innovation hubs-led development**

The top three innovation hubs--Beijing, Shanghai, Guangdong-Hong Kong-Macao are three core pillars and powerhouses of innovation in China, and drive forward the innovation cooperation of Beijing-Tianjin- Hebei, Yangtze River Delta, and Pearl River Delta regions. (The three innovation hubs, taken together, make up 30% of national R&D funding, 35% of local government investment in science and technology, 38% of valid invention patents and 43% of high-tech enterprises.)

- **Innovation belts-driven growth**

Two innovation belts, consisting of 12 provinces, have taken shape. The vertical one, which runs from north to south in the coastal areas, includes Tianjin, Shandong, Jiangsu, Zhejiang, Fujian and Guangdong, and the horizontal one includes Sichuan, Chongqing, Shaanxi, Hubei, Hunan and Anhui. All of them, covering all 10 innovative provinces, 46 innovative cities and 27 innovative counties, form the backbone of an innovative country. (Beijing, Shanghai and the above 12 provinces make up 84% of national R&D investment, 80% of local government investment in science and technology, 86% of the valid invention patents and 86% of high-tech enterprises.)

- **Demonstration zones and parks-underpinned development**

China has a total of 20 National Innovation Demonstration Zones, 168 National High-tech Zones, 2 National Agricultural High-tech Industry Demonstration Zones, 3 National Demonstration Zones for Sustainable Development, 8 National Science and Technology Achievements Transfer and Transformation Demonstration Zones, 279 National Agricultural Science and Technology Parks, 189 National Sustainable Development Demonstration Zones. Together, by driving innovation and development in different regions, they contribute to the development of an innovative country.

- **East-west cooperation**

Further S&T assistance has been provided to Xinjiang, Tibet, Qinghai and Yunnan. S&T support to Nanjing has been well under way. S&T cooperation between Lanbai of Gansu and Zhangjiang of Shanghai, Xinjiang, Shenzhen, Guizhou and Zhongguancun of Beijing has been continuously deepened. This aims to address the unbalanced and inadequate development, and to raise regional innovation capability as a whole. (From 2015 to 2017, the R&D investment intensity in Ningxia jumped from 0.88% to 1.13%, and the growth rate of government science and technology expenditure exceeded 50%; the invention patent ownership per 10,000 people in Xinjiang and the number of high-tech enterprises increased by 20% annually; the

number of high-tech enterprises in Gansu doubled).

- **Distinctive features**

Based on their own resource endowment and innovation foundation, different cities have explored their unique innovation paths and models, including science and education resources-based style (Hefei, Xi'an and Wuhan), industrial technology innovation-based style (Shenzhen and Dongguan) , innovation and entrepreneurship-based (Hangzhou, Chengdu and Xiamen), collaborative innovation-based (Guiyang, Ningxia and Suzhou), green development-based (Taiyuan, Ma'anshan and Guilin) models.

But challenges remain. First, there is a widening gap in innovation capability between north and south, east and west. Such "polarization" makes it difficult for collaborative innovation to take place. Despite the narrowing gap in innovation between the eastern and western regions, challenges remain daunting to address the unbalances and inadequacy in development through innovation collaboration. Second, a coordinated innovation mechanism with enterprises as the main player is not yet in place. Regional collaborative innovation mostly takes place at the government level or under the guidance of government, with insufficient attention being paid to enterprises as the main player. The building of regional integrated innovation ecosystem has not yet taken off, and a sustained mechanism is not yet in place. More efforts need to be made to promote the full flow and sharing of innovation resources across the region and the formation of a common market.

The key input and output indicators show that since 2006, among the three main players in the innovation system, enterprises play an increasingly dominant role; there is not much change with universities and research institutes despite a considerable improvement in their capabilities (Figure 17 and 18).

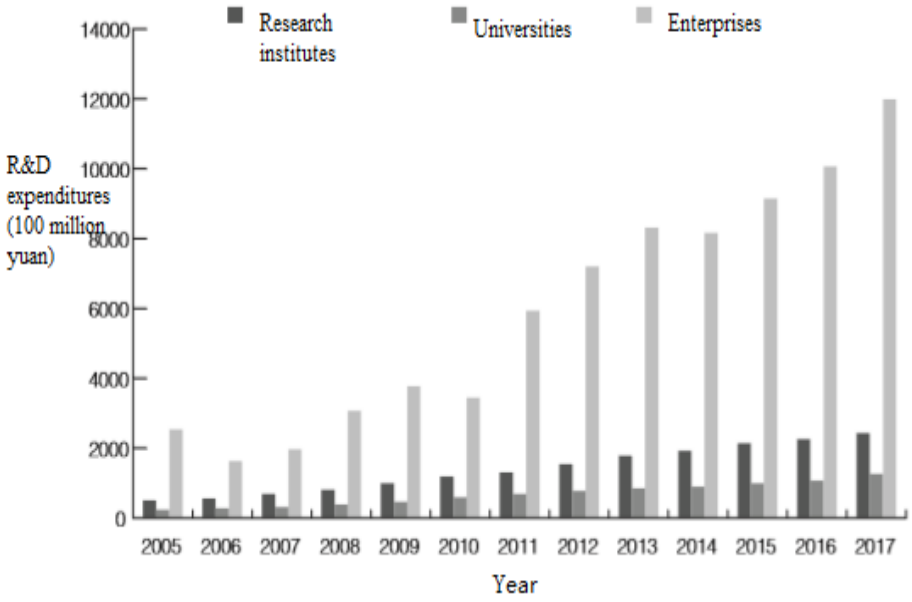

Figure 17 R&D input of research institutes, universities and enterprises

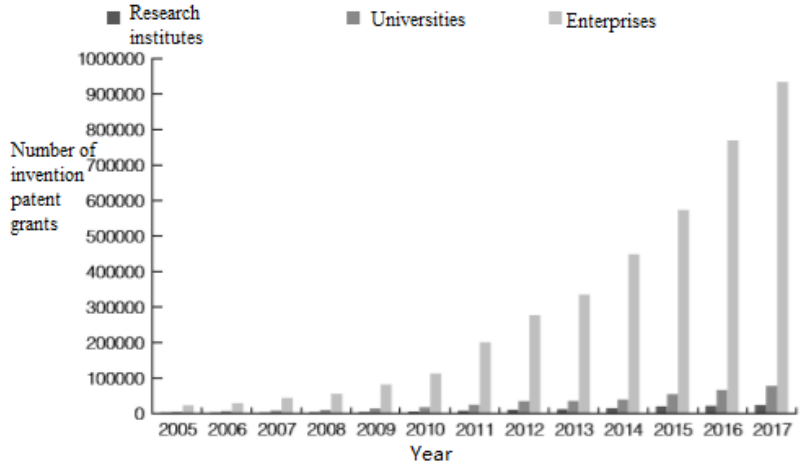

Figure 18 R&D output of research institutes, universities and enterprises

Various innovation rankings show a continued climb of China's ranking in innovation. For example, Global Innovation Index released by WIPO and Cornell University, Global Competitiveness Index released by World Economic Forum, and Global Creativity Index published by Martin Prosperity Institute of Toronto University all reflect the improvement in China's innovation capability. (Figure 19)

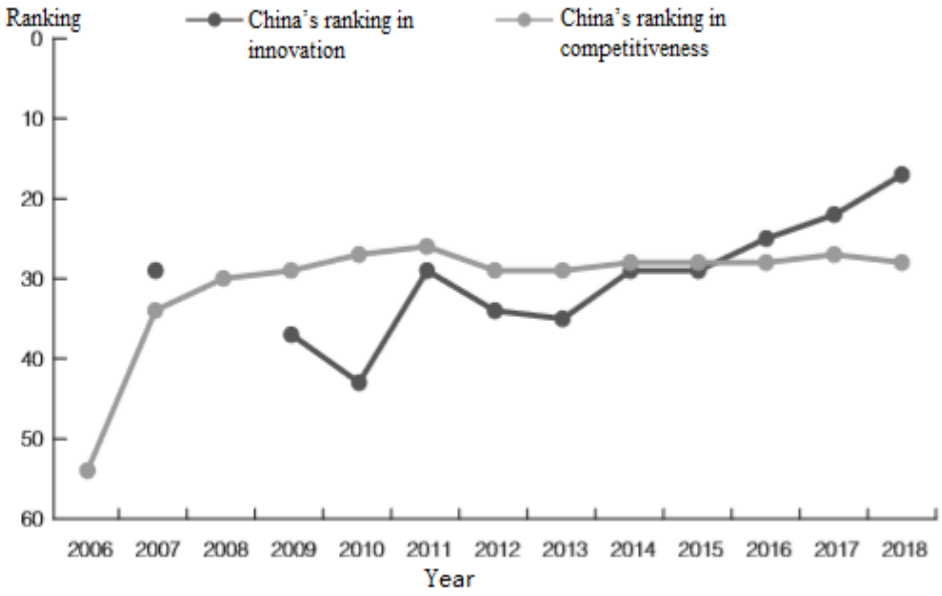

Figure 19 China's ranking in innovation and competitiveness globally

Overall, the series of policies China has introduced to encourage innovation and scientific research activities prove effective. For example, the additional tax deduction policy led to a growing number of enterprises engaged in R&D, and ever-increasing patent applications and new products sales.

Over the years, China has seen increased R&D input and output and significant improvement in innovation capability. However, there is still detachment between R&D and enterprise need. Lack of cooperation is also one factor affecting the overall

performance of the innovation system. Many R&D personnel do not know very well about production, hence lack of knowledge regarding how to combine science and industry. R&D output has increased, and private enterprises play a vital role in industry-universities-research institutes collaboration.

Going forward, in order to improve the performance of national innovation system, China needs to further enhance cooperation among innovation stakeholders at the macro-level.

（Source: *2019 Assessment Report on China's Regional Innovation Capability*）