

China: Development of the National Innovation System

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Abstract

The author examines the development of China's national innovation system and identifies the main ways to improve this process. It is concluded that the growth of China's innovation economy is influenced by increased R&D funding. It is established that the main structural elements of China's national innovation system are state organizations, universities, research institutes, and corporate R&D departments.

Keywords: China, national innovation system, R&D funding, economic development

1. Introduction

China occupies a leading position in the global economy. In 2018, according to the IMF, China ranked second in the world in terms of GDP (14.22 trillion USD), after the United States. At the same time, China led the world in GDP by purchasing power parity (PPP), accounting for 19.24% of the global volume [1]. Over the last decade, China has made significant progress in science and technology, implementing innovations and high technologies in production.

A special stage in the formation of China's national innovation system began in 2013, following the decisions of the 18th National Congress of the Communist Party of China, when the country's economic development was reoriented toward expanding domestic consumption. According to the national plan for scientific and technological innovation (2016–2020), the goal was to increase the country's capacity for independent innovative development and to build an innovation-driven economy.

The "Made in China 2025" strategy, aimed at modernizing the country's industrial potential and advancing Chinese research and development, was implemented in 2015 [2]. To ensure sustainable economic growth and enhance competitiveness

over the next decade, China seeks to secure a leading position in high-tech sectors, including artificial intelligence.

The state plays a key role in developing China's national innovation system, coordinating development, promoting the reform of research institutes (RIs), and expanding corporate innovation capabilities.

At the 19th National Congress of the CPC, Xi Jinping emphasized the necessity of consistently implementing the new concept of innovation-driven, coordinated, green, open, and inclusive development to build a modern socialist country [5].

The main structural elements of China's national innovation system include state organizations (e.g., Ministry of Science and Technology), scientific potential (universities, academies of sciences, research institutes), and companies (R&D departments of local firms and foreign MNCs).

2. State Organizations in China's National Innovation System

The Ministry of Science and Technology of China coordinated and funded the National High-Tech R&D Program (Program 863). Implemented over three consecutive five-year plans, this program increased China's overall high-tech development, R&D capacity, socio-economic development, and national security.

In 2001, the State Council approved the continuation of Program 863, which plays an essential role in the country's innovation development [4]. The program aims to enhance innovation potential in high-tech economic sectors and achieve breakthroughs in key scientific and technical areas at the global frontier.

The need to develop fundamental scientific research led to the implementation of the National Basic Research Program (Program 973), targeting technological and strategic advantages across various scientific fields. These state programs foster interdisciplinary research and innovation, developing new ideas, concepts, theories, and inventions.

3. Universities and Research Institutes in Innovation

The development of higher education is a key driver of China's economic growth and global ranking. Expanding fundamental and applied research in universities and research institutes creates opportunities for economic diversification during the transition to a new technological paradigm.

Universities

In 2017, China had 2,631 universities with 14,971 R&D units. That year, 966,780 R&D projects were conducted (1.4 times higher than 2013), and 1,308,110 scientific articles were published (1.2 times higher than 2013), including 390,235 in international journals. In science and technology, 45,591 articles were published. Universities filed 277,524 patent applications, 2.1 times higher than in 2013 [6].

Research Institutes

In 2017, China had 3,547 research institutes [6]. From 2005–2017, the average number of scientists engaged in research and development was 1,206 per 1 million population, 1.3 times higher than in 2012. Researchers focused on fundamental research (7.2%), applied research (12.1%), and experimental development (80.7%) [6].

Chinese RIs published 426,165 scientific papers in 2016, 98.9% of which were cited in other research [7]. In 2017, 54,500 articles appeared in foreign journals [6]. That year, Chinese scientists achieved 59,792 significant scientific and technological results, receiving 66 National Invention Awards and 170 National Science and Technology Awards [6].

In 2017, 1,381,594 patent applications were filed (17.2 times higher than in 2002), with domestic developers submitting the majority; foreign researchers accounted for 9.8%. China led the world in patent applications (46.3% of global applications). Trademark applications totaled 5,739,823 (96.5% filed by Chinese inventors), and industrial designs totaled 628,658 (97.2% filed by residents) [7]. China ranked 30th globally in patent applications per 1 million people, with an inventive activity coefficient of 12.28 in 2018. Key patented areas included digital communications, computer technologies, electrical devices, instrumentation, pharmaceuticals, metallurgy, machinery, chemical materials, food chemistry, and civil construction.

In 2017, China ranked 10th globally for state orders in advanced technology; however, in 2016–2017, India surpassed China, ranking 8th.

4. Innovation Activities of Chinese Companies

In 2017, 102,218 industrial companies conducted R&D (6 times more than in 2004), representing 27.4% of all industrial enterprises. That year, 82,667 corporate RIs executed 445,029 scientific projects (9.3 times higher than in 2004). Company R&D expenditures reached \$173.6 billion, generating 477,861 new products and 320,626 patent applications (15.7 times higher than in 2004) [6].

5. Impact of R&D Funding on Economic Development

R&D funding is a crucial factor in national innovation development. In 2018, China ranked second globally after the U.S., aiming to surpass the U.S. by 2022. China's R&D expenditure in 2018 reached \$474.8 billion, 2.2 times higher than in 2010 [8]. In 2019, R&D spending exceeded \$500 billion, accounting for 22% of global R&D [9]. In 2017, funding allocations were: fundamental research 5.5%, applied research 10.5%, and experimental development 84%. State funding accounted for 19.8% of R&D, while companies contributed 76.5% [7]. Between 2013–2017, state funding decreased gradually, while corporate R&D contributions increased 1.5 times. R&D spending as a percentage of GDP (PPP) increased from 1.96% in 2017 to 1.99% in 2018.

Key technological sectors' R&D expenditures in 2015–2017 included: IT 22% (13% in 2015), advanced materials 19% (15%), ICT 17% (9%), instrumentation 16%, military, space, defense 14% (6%), energy 14% (10%), agriculture/food 11% (10%), automotive 5% (6%), pharmacology/biotech 6% (4%), commercial space 7% (3%), healthcare 4% (2%), environment 4% (1%) [8].

Correlation and regression analysis for 2010–2018 revealed a strong relationship between R&D spending and China's GDP (correlation coefficient 0.9729).

Regression equation:

$$y=18.9546x_1+3948.0612y = 18.9546x_1 + 3948.0612y=18.9546x_1+3948.0612$$

indicating that an additional \$1 in R&D expenditure increases GDP by an average of \$18.95.

6. Conclusions

Improving the national innovation system requires:

- Enhancing the quality of research institutes
- Increasing corporate R&D spending
- Strengthening university–corporate collaboration in R&D
- Expanding state support via grants and public procurement
- Developing public-private partnerships in innovation
- Promoting venture investment
- Providing tax incentives for innovative enterprises
- Transferring advanced technologies to SMEs
- Advancing R&D in big data, IoT, cloud computing, and robotics
- Supporting patent activity of universities and research institutes
- Developing innovation infrastructure (tech parks, incubators, etc.)

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