

12-20-2021

Strategic Positioning of National Natural Science Foundation of China within National Innovation System in New Era

Jianping CHENG

Beijing Normal University, Beijing 100875, China, chengjp@bnu.edu.cn

See next page for additional authors

Recommended Citation

CHENG, Jianping; CHEN, Li; ZHENG, Yonghe; and ZHANG, Jian (2021) "Strategic Positioning of National Natural Science Foundation of China within National Innovation System" *Bulletin of Chinese Academy of Sciences (Chinese Version)*: Vol. 36 : Iss. 12 , Article 5.

DOI: <https://doi.org/10.16418/j.issn.1000-3045.20211118002>

Available at: <https://bulletinofcas.researchcommons.org/journal/vol36/iss12/5>

This Operation System and Management of National Natural Science Foundation of China in New Era is brought to you for free and open access by Bulletin of Chinese Academy of Sciences (Chinese Version). It has been accepted for inclusion in Bulletin of Chinese Academy of Sciences (Chinese Version) by an authorized editor of Bulletin of Chinese Academy of Sciences (Chinese Version). For more information, please contact lcyang@cashq.ac.cn, yjwen@cashq.ac.cn.

Strategic Positioning of National Natural Science Foundation of China within National Innovation System in New Era

Abstract

As the main channel to support basic research, the National Natural Science Foundation of China (referred as science funds hereafter) plays a leading role in the national innovation system. During the 14th Five-Year Plan period, it is urgent to deepen the understanding of the strategic positioning of science funds in the national innovation system to optimize the national innovation system and accelerate the construction of China's strength in science and technology. This paper reviews the development process of China's national innovation system and the evolution of funding orientation of science funds, analyzes the characteristics of the national innovation system in the new era, and puts forward the function of science funds in six perspectives, namely, stimulating comprehensive innovation, cultivating innovative talents, connecting efficient system, leading open innovation, shaping scientific culture, and demonstrating deepening reform, and provides decision-making reference for systematically promoting the deepening reform of science funds and better playing the unique role of science funds in the national innovation system.

Keywords

National Natural Science Foundation of China; national innovation system; strategic positioning

Authors

Jianping CHENG, Li CHEN, Yonghe ZHENG, and Jian ZHANG

Citation: CHENG Jianping, CHEN Li, ZHENG Yonghe, ZHANG Jian. Strategic Positioning of National Natural Science Foundation of China within National Innovation System in New Era [J]. Bulletin of Chinese Academy of Sciences, 2021 (12).

Strategic Positioning of National Natural Science Foundation of China within National Innovation System in New Era

CHENG Jianping¹, CHEN Li¹, ZHENG Yonghe¹, ZHANG Jian²

1. Beijing Normal University, Beijing 100875, China;

2. Central University of Finance and Economics, Beijing 100081, China

Abstract: As the main channel to support basic research, the National Natural Science Foundation of China (referred to as science funds hereafter) plays a leading role in the national innovation system. During the “14th Five-Year Plan” period, it is urgent to deepen the understanding of the strategic positioning of science funds in the national innovation system for optimizing the national innovation system and accelerating the improvement of China’s strength in science and technology. This paper reviews the development process of China’s national innovation system and the evolution of funding orientation of science funds, analyzes the characteristics of the national innovation system in the new era, and puts forward the roles of science funds in six perspectives, namely, stimulating comprehensive innovation, cultivating innovative talents, connecting efficient systems, leading open innovation, shaping scientific culture, and demonstrating deepening reform. This paper provides decision-making reference for systematically promoting the deepening reform of science funds and better playing the unique role of science funds in the national innovation system. **DOI:** 10.16418/j.issn.1000-3045.20211118002-en

Keywords: National Natural Science Foundation of China; national innovation system; strategic positioning

At the fifth plenary session of the nineteenth Central Committee of the Communist Party of China, it was proposed that China will uphold the core position of innovation in the country’s modernization drive and take self-reliance in science and technology as the strategic support for national development. Improving the national innovation system is a key task to boost the development of China’s science and technology in the new era. As the main channel to support basic research, the National Natural Science Foundation of China (hereinafter referred to as science funds) has played a leading role as the source of knowledge in the national innovation system [1]. At the critical stage of deepening the systematic reform of science funds and promoting the modernization of governance capacity, it is urgent to deepen the understanding toward the strategic positioning and the roles of science funds in the national innovation system for promoting the high-quality development of basic research and accelerating the improvement of China’s strength in science and technology.

1 Evolution of the national innovation system and funding orientation of science funds

1.1 Evolution of the national innovation system in China

The national innovation system was born in the 1980s,

when Freeman [2] analyzed the relationship between technological innovation and economic development while studying Japan’s pursuit development, pointing out that the national innovation system was the source of national competitiveness. Later, Lundvall [3] and Nelson [4] studied the national innovation system with focuses on the interaction between users and producers and the technological progress in the capitalist market economy represented by the United States, respectively. In the 1990s, the National Innovation Systems issued by the Organisation for Economic Co-operation and Development (OECD) defined the national innovation system as a network of institutions in the public and private sectors whose activities and interactions determine the ability to diffuse knowledge and technologies and affect the innovation performance of a country [5]. Driven by a series of research reports and evaluation activities of OECD, the concept of the national innovation system has gradually drawn attention from the policy world.

China’s research on the national innovation system begun in the middle 1990s, represented by the early exploration of such scholars as Tang Shiguo [6], Chen Jin [7], Qi Jianguo [8], Fang Xin [9], Lu Yongxiang [10], Liu Xielin [11], Feng Zhijun [12], and Hu Zhijian [13]. At the same time, the evaluation of China’s science and technology management system reform by the Canadian Expert Group invited by the State Science and Technology Commission (now the Ministry of Science and Technology) started China’s practical exploration

Received: 2021-11-24

Supported by: Emergency Management Project of National Natural Science Foundation of China (71843001); Special Project of National Natural Science Foundation of China (L1924016)

Corresponding author: ZHANG Jian, E-mail: zjpolicy@163.com

of the national innovation system^[14]. The evolution of China's national innovation system can be roughly divided into three stages (Figure 1).

The first stage (1996–2005): deepening the reform of the science and technology management system and implementing the strategy of invigorating China through science and education. Since the 1990s, the concept of the national innovation system has begun to be included in China's policy agenda. The Decision of the State Council Concerning the Deepening of the Reform of the Science and Technology Management System during the "Ninth Five-Year Plan" Period proposes that we should establish a technology development system with enterprises as the main body and combining enterprises, universities, and research institutions, a research system dominated by research institutions and universities, and a socialized science and technology service system. The implementation of the Technology Innovation Project (1996) and the Knowledge Innovation Project (1998) mark that China has gradually begun to build the national innovation system with Chinese characteristics.

The second stage (2006–2011): adhering to independent innovation and building an innovative country. Guided by the National Medium- and Long-Term Program for Science and Technology Development (2006–2020), China has comprehensively promoted the construction of the national innovation system with Chinese characteristics. Specifically, the five key construction tasks include a technological innovation system with enterprises as the main body and combining enterprises, universities, and research institutions, a knowledge innovation system integrating scientific research with higher education, a defense-related science and technology innovation system integrating military with civilian purposes, a regional innovation system integrating central and local scientific and technological forces with their own characteristics and advantages, and a socialized and networked technology intermediary service system. China has entered a new stage of independent innovation and comprehensive construction of the national innovation system.

The third stage (since 2012): implementing the strategy of innovation-driven development and building up China's strength in science and technology. Hu's report at the eighteenth National Congress of the Communist Party of China proposed to implement the strategy of innovation-driven development. The Outlines on National Strategy for Innovation-driven Development pointed out the overall efficiency of the innovation system and proposed to support the construction of China into an innovative country with an efficient innovative system. The nineteenth National Congress of the Communist Party of China proposed to build China into a leading innovative country by 2035 and specified to strengthen the construction of national innovation system and the strategic force of science and technology. At the fifth plenary session of the nineteenth Central Committee of the Communist Party of China, it was further proposed that China will take self-reliance in science and technology as the strategic support for national development. The goal of improving the national innovation system and accelerating the construction of a strong country in science and technology is taken as a priority.

1.2 Roles of science funds in the national innovation system and evolution of funding orientation

In the early 1980s, 89 academicians of the Chinese Academy of Sciences wrote to the CPC Central Committee and the State Council, recommending to learn from international successful experience and establish a national natural science fund. The recommendation was accepted by the CPC Central Committee and the State Council. Later, under the cordial care of Comrade Deng Xiaoping, the State Council approved the establishment of the National Natural Science Foundation of China (NSFC) on February 14, 1986.

After the establishment, the NSFC developed the strategic policy for economic construction and emphasized basic research and applied basic research to ensure the stable development of basic research and talent training^[15]. In 1992,



Figure 1 Evolution of the national innovation system in China

the NSFC implemented the funding principle of controlling scale, improving intensity, widening grade, and supporting innovation, and focusing on the economic construction and the assembly of a stable and powerful team for basic research^[16].

In the middle and late 1990s, the national innovation system was included in China's policy agenda. The NSFC stressed to focus on the innovation links, optimize the innovation environment, and drive the overall work. It specified that as an important part of the national innovation system, science funds should give full play to the role as a bridge and promote the socialization of basic research and the construction of the national innovation system^①.

As the reform of science and technology system is deepening, especially after the implementation of the National Medium- and Long-Term Program for Science and Technology Development (2006–2020), the national science and technology planning system has undergone major adjustments. In March 2010, the third plenary session of the sixth committee of the NSFC^② specified the strategic orientation of emphasizing the basic research, frontier technology, and talents and the requirements for independent innovation at the new stage of constructing the national innovation system. During the “12th Five-Year Plan” period when the reform of science and technology plan management of the central government was deepened, the NSFC specified such important responsibilities as supporting basic research and frontier research, cultivating talents and teams, and promoting discipline crossing. Meanwhile, it proposed the strategic orientation of focusing on forward-looking deployment, breakthroughs, and precise management, as well as the funding pattern involving exploration, talents, tools, and integration^③.

Since the nineteenth National Congress of the Communist Party of China, China has ushered into a new development stage characterized by a new round of scientific and technological revolution and industrial revolution, the conversion of momentum for high-quality development, the deep integration of science and technology with economic development, the deep adjustment of global scientific and technological innovation pattern, and the strengthening of original innovation capacity. After in-depth research and scientific verification, the NSFC specified the funding orientation of

encouraging original research, focusing on frontiers, breaking through the bottlenecks hindering development, and promoting discipline integration in the new era^④.

In 35 years of development, while insisting on supporting basic research, the NSFC has constantly adjusted the funding strategy to adapt to the evolution of the national innovation system. On the one hand, the NSFC has always insisted on the stable support of basic research, the cultivation of innovative talents, the creation of innovative culture, the original research, and discipline crossing. On the other hand, the funding orientation has evolved from meeting the need of economic development to encouraging innovation and creating an innovation environment (at the stage of greatly increasing funding scale and intensity), to emphasizing the basic research, frontier research, and talents and focusing on forward-looking deployment, breakthroughs, and precise management (after the deep adjustment of the national science and technology plan system), and then to supporting different scientific issues under the guidance of “four orientations” (global science and technology frontiers, economic development, national major demands, and public health) in the new era.

2 Characteristics of the national innovation system in the new era

A new round of scientific and technological revolution and industrial revolution is advancing rapidly, which is characterized by the profound changes in the scientific paradigm, achievement of breakthroughs in the cutting-edge basic science, disciplinary integration, integration of science and technology with economic development, and reshaping of global basic research development pattern. At the new stage of development, the goal of the national innovation system has shifted from the integration of science and technology with economy to the integration of science and technology with economy, society, environment, culture, and other fields. Meanwhile, the national innovation system has evolved from a traditional system composed of separated and closed subsystems with clear functions to a collaborative system emphasizing multi-subject governance, openness, and inclusiveness (Figure 2).

① Bring about a Much More Development of Funding Work in the New Era. Working report of Chen Jia'er at the second plenary session of the fourth committee of National Natural Science Foundation of China in March 2001 (<https://nsfc.gov.cn/publish/portal0/tab440/info60435.htm>).

② Adhere to Strategic Orientation and Encourage Independent Innovation to Make Effective Contribution to the National Sustainable Development Led by Science and Technology. Working report of Chen Yiyu at the third plenary session of the sixth committee of the National Natural Science Foundation of China in March 2010 (<https://nsfc.gov.cn/publish/portal0/tab440/info57297.htm>).

③ Implementing the Development Concept, Highlighting the Strategy Orientation, Continuously Improving the Source Supply Capability Originated from Innovation-driven Development. Working report of Yang Wei at the fourth plenary session of the seventh committee of the National Natural Science Foundation of China in March 2016 (<https://nsfc.gov.cn/publish/portal0/tab440/info55847.htm>).

④ Building a Science Funding System for a New Paradigm Shift in Science. Working report of Li Jinghai at the first plenary session of the eighth committee of the National Natural Science Foundation of China in March 2018 (<https://www.nsfc.gov.cn/publish/portal0/tab440/info73881.htm>).

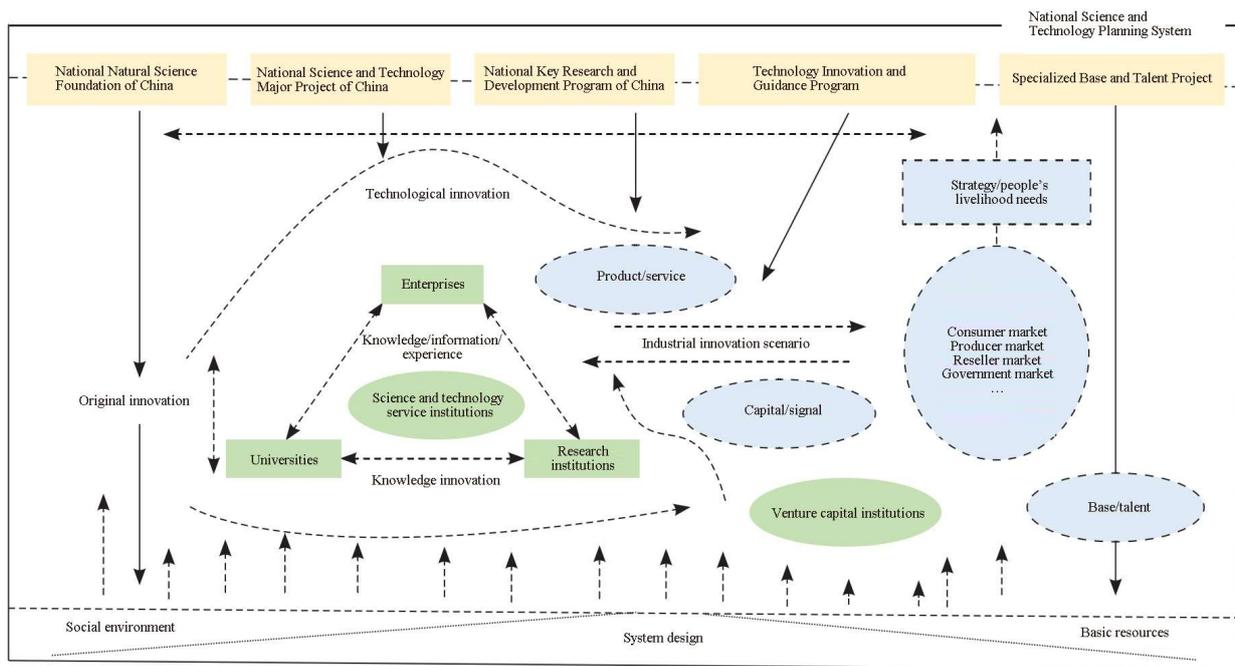


Figure 2 National innovation system of China in the new era

Under the new development situation, we need to reconsider the functional positioning of the national innovation system in China's strategy system from the perspective of governance modernization, beyond such narrow categories as knowledge innovation system and technology innovation system in the traditional policy context. The national innovation system in the new era should deeply integrate the development concept of innovation, coordination, green development, openness, and sharing, cultivate mission-oriented innovation, and strengthen the role of the government in active participation, direction guiding, and risk taking [17]. Furthermore, under the guidance of "four orientations" (global science and technology frontiers, economic development, national major demands, and public health), more attention should be paid to original innovation, responsible innovation, sustainable innovation, open innovation, and inclusive innovation.

(1) Original innovation. We should further leverage the advantages of the new nationwide system to enhance the overall layout of basic research. It is suggested to promote the original research for problem tackling in science and technology, develop the spirit of scientists in the new era, implement the national science and education projects, promote the application of frontier research achievements in education, and expand the population of innovative talents.

(2) Responsible innovation. We should shape the innovation path and direction by public deliberation, and pay attention to the social ethics and research morality in innovation [18]. We should also give consideration to the

coordinated development of regions, reduce the regional difference, and attach importance to regional linkage innovation from point to area and from area to community in Beijing-Tianjin-Hebei Region, Yangtze River Delta, and Guangdong-Hong Kong-Macao Greater Bay Area.

(3) Sustainable innovation. We should coordinate multiple innovation subjects and complex innovation problems, explore the logic of systematic policy design based on the modernization of national governance, and promote the deployment for sustainable innovation. We should focus on the sustainable economic and social transformation and create green innovation ecology, providing scientific and technological support for achieving carbon peak and carbon neutrality.

(4) Open innovation. We should, under the new development pattern, actively promote the international cooperation to jointly tackle global challenges such as climate changes, energy shortage, and public health crisis. We should break down the barriers between subsystems of the traditional innovation system and create an open innovation environment to improve the overall cooperation efficiency.

(5) Inclusive innovation. We should combine the improvement of the national innovation system with the creation of a social governance pattern featuring co-construction, co-governance, and sharing. Centering on the people-oriented concept, we should focus on the primary contradiction in the new era and promote the inclusive innovation for improving the overall welfare of the society, thus driving the coordinated economic and social development.

3 Functional positioning of science funds in the national innovation system in the new era

As the reform of science and technology system is deepening, science funds, as the important source of knowledge of the national innovation system, are facing new and higher requirements. To meet new requirements, grasp new opportunities, and address new challenges, the NSFC comprehensively deepens the reform by specifying funding orientation, improving review mechanism, and optimizing discipline layout, so as to give better play to its basic leading role in the national innovation system. To better adapt to the national innovation system in the new era, we should strengthen the roles of science funds in the following six aspects.

(1) Stimulating comprehensive innovation. As the source of science and technology, basic research involves the improvement of China's original innovation capacity and international competitiveness, and decides the construction progress of an innovative country and a strong country in science and technology. It supports the comprehensive innovation process with scientific and technological innovation as the core. Science funds are the main channel to support basic research in China. We must make and insist on problem-oriented, originality-oriented, and demand-oriented overall plan to promote the comprehensive innovation.

(2) Cultivating innovative talents. Different from the later selection of talent projects in other programs, science funds cover the full life circle of researchers with different and orderly funding patterns, and play a role in supporting the construction of talents and teams. Science funds in the new era should continue to play its role in cultivating talent teams for scientific undertakings, promoting the application of basic research achievements in education, and cultivating a number of scientifically literate talents for society.

(3) Connecting efficient systems. The low efficiency of the national innovation system is an urgent problem to be solved in China, the key to which is to promote the efficient linkage between different subjects in the system. At present, science funds have realized the interactions among enterprises, universities, research institutions, and innovation subjects of different regions by joint funds and other means. In the future, we need to give further play to the core role of the collaborative innovation among the government, the scientific community, and the industry, and actively guide enterprises and social forces to increase the input in basic research.

(4) Leading opening innovation. The proposal of the goal of a great modern socialist country mark that the relationship between China and developed countries is undergoing rapid changes, and the competition in the commanding heights of science and technology is unprecedentedly fierce. Therefore, it is urgent for the NSFC to strengthen the top-level design, define the strategic priority, optimize the funding layout, give play to the unique role of science funding institutions in global innovation governance, and actively design and launch

international science programs, seeking breakthroughs in international scientific cooperation.

(5) Shaping scientific culture. Science funds with the widest supporting scope and the strongest supporting volume have demonstrated an important role in shaping scientific culture and research environment. In the future, we should further improve the responsible, trustworthy, and contributory peer review mechanism, strengthen the research and funding for philosophy of science and science education, enhance guidance for young researchers, and build a righteous scientific culture.

(6) Demonstrating deepening reform. Science funds have the nature of changes since its birth^[19]. In the practice of long-term reform, the science funds have acted as a good demonstration on project funding, talent training, research integrity construction, international cooperation and other aspects for the national science and technology funding institutions. Considering the strategic goal of self-reliance in science and technology and the new characteristics of the national innovation system in the new era, science funds should further free the minds, and intensify and accelerate reforms, so as to stimulate the innovation enthusiasm and initiative to a greater extent.

The 35 years of development of science funds have witnessed the construction of China's system and the evolution of the national innovation system, as well as the achievements of China's science and technology from the quantitative accumulation to qualitative changes and from single breakthroughs to the systematic improvement. At present, China is improving the national innovation system for realizing the self-reliance in science and technology. China's basic research meets new requirements in the new era and at the same time faces unprecedented strategic opportunities. Science funds should insist on "four orientations" and the new characteristics of the national innovation system (taking mission-oriented innovation as the leading factor, and focusing on original innovation, responsible innovation, sustainable innovation, open innovation, and inclusive innovation) in the new era. The roles of science funds in stimulating comprehensive innovation, cultivating innovative talents, connecting efficient systems, leading open innovation, shaping scientific culture, and demonstrating deepening reform should be given to full play. Furthermore, efforts should be made to speed up the construction of a fair and efficient governance system with advanced concepts and standardized institutions in the new era, so as to better promote the high-quality development of basic research, improve the efficiency of the national innovation system, and foster new advantages of China's development.

References

- 1 Li J H. Review and prospect on National Natural Science Found supporting China's basic research. *Bulletin of Chinese Academy of Sciences*, 2018, 33 (4): 390–395. (in Chinese)
- 2 Freeman C. *Technology Policy and Economic Policy: Lessons from Japan*. London: Frances Pinter, 1987.

- 3 Lundvall B A. National Innovation Systems: Towards a Theory of Innovation and Interactive Learning. London: Pinter, 1992.
- 4 Nelson R R. National Innovation Systems: A Comparative Analysis. New York: Oxford University Press, 1993.
- 5 OECD. National Innovation Systems. Paris: OECD, 1997.
- 6 Tang S G. China's national innovation system: Change and prospect. China Soft Science, 1993, (1): 33–35. (in Chinese)
- 7 Chen J. National innovation system: Exploration of scientific and technological development. Journal of Dialectics of Nature, 1994, 16 (6): 22–29. (in Chinese)
- 8 Qi J G. Technical Innovation: The Reform and Rebuild of National System. Beijing: Social Sciences Academic Press, 1995. (in Chinese)
- 9 Fang X. National innovation system in knowledge economy. Forum on Science and Technology in China, 1997, (4): 1–2. (in Chinese)
- 10 Lu Y X. Establishing a national innovation system geared to the era of knowledge-based economy. World Sci-Tech R&D, 1998, 20 (3): 70–72. (in Chinese)
- 11 Liu X L. Introduction of national innovation system and its significance to China. Forum on Science and Technology in China, 1998, (2): 26–28. (in Chinese)
- 12 Feng Z J. Improve and develop China's national innovation system. China Soft Science, 1999, (1): 55–58. (in Chinese)
- 13 Hu Z J. National Innovation System: Theoretical Analysis and International Comparison. Beijing: Social Sciences Academic Press, 2000. (in Chinese)
- 14 International Development Research Centre, State Science and Technology Commission, People's Republic of China. A Decade of Reform: Science and Technology Policy in China. Canada: IDRC, 1997.
- 15 Tang A Q. Improve the science fund system to promote research and serve the construction of four modernizations. Bulletin of National Natural Science Foundation of China, 1987, 1 (1): 20–34. (in Chinese)
- 16 Zhang C H. Innovative system and innovative practice. Bulletin of National Natural Science Foundation of China, 2006, 20 (3): 145–147. (in Chinese)
- 17 Zhang X W, Chen J. Mission-oriented innovation: Origin, basis, policy logic and basic standards. Science of Science and Management of S.& T., 2019, 40 (10): 3–13. (in Chinese)
- 18 Stilgoe J, Owen R, Macnaghten P. Developing a framework for responsible innovation. Research Policy, 2013, 42 (9): 1568–1580.
- 19 Tang A Q, Hu Z S. Improvement of China's science fund system in practice. Forum on Science and Technology in China, 1987, (1): 41–43. (in Chinese)



CHENG Jianping, Professor and Secretary of the CPC Committee of Beijing Normal University. His research focuses on nuclear science and technology. He has successively served as vice president of China Nuclear Energy Association, vice president of China Isotope & Radiation Association, and president of Chinese Association of University Industry. At present, he also serves as vice president of China Society of Radiation Protection. He has participated in or undertaken the national scientific and technological project, the general and key projects of the National Natural Science Foundation of China, and has achieved a number of important results. As the director of Jinping Underground Laboratory in China and the project leader of “very deep underground very low radiation background frontier physical experimental facilities” of national major scientific infrastructure during 13th Five-Year Plan period, he is responsible for the construction of China's first and the world's deepest underground laboratory and its facilities. E-mail: chengjp@bnu.edu.cn



ZHENG Yonghe, corresponding author, Professor of Faculty of Education at Beijing Normal University, President of Institute of Science Education Research. His main research fields are science and technology education strategy, science education, educational information science and technology, etc. He is the Vice Chairman of the 8th China Youth Science and Technology Counselors Association, member of the first K-12 Education Teaching Steering Committee of the Ministry of Education, member of the Information Science Department of the Seventh Science and Technology Commission of the Ministry of Education, expert of the Compulsory Education Curriculum Revision Comprehensive Group, Science Curriculum Standard Revision Group, and Information Technology Curriculum Standard Group of the Ministry of Education, and Secretary General of the Council for Excellent Computer Teachers Award Program of Colleges and Universities, Vice Chairman of the Special Committee on Science and Technology Management and Evaluation of the Society for Science of Science and Research Management. He is also the former director of Bureau of Policy, National Natural Science Foundation of China (NSFC). E-mail: zhengyonghe@bnu.edu.cn



ZHANG Jian, Associate Professor and Vice President of School of Government, Central University of Finance and Economics. His main research fields cover public policy, innovation policy, sustainable transition policy, etc. He is Under-Secretary-General of Chinese Academy of Management and Professional Committee on government strategy and public policy research. E-mail: zjpolicy@163.com