Research on Countermeasures to Enhance Shanghai's Basic Research Capability

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Abstract

The basic research is an important foundation for Shanghai to enhance the function of innovation curation and build a scientific and technological innovation center with global influence. Only by strengthening basic research can we maintain the ability to be a source of innovation in the long run. Based on the analysis of China's basic research laws and policies, this paper summarizes Shanghai's latest initiatives to promote basic research and proposes a systematic mechanism design to strengthen basic research and enhance the innovation-creating capacity in Shanghai, including: forming a dual-track support mechanism to guarantee the benign operation of strategic basic research, making up for the relevant policy hollows, encouraging enterprises and social organizations to invest in basic research, systematically optimizing the mechanism of basic research organization, and building a system that encourages originality and focuses on long-term effects. Research organization mechanism, constructing a classified evaluation and incentive mechanism for basic research that encourages originality and focuses on long-term effects, and further creating a soft and hard environment for basic research.

Keywords

Basic Research, Science and Technology Progress Law, Scientific and Technological Powerhouse

1. China continues strengthen the construction of a policy and legal support system for basic research

In chapter 4 of the 1993 version of the Science and Technology Progress Law, the chapter is under the title of "basic research and applied basic research", specifies that the country guarantees the sustainable and stable development of basic research and applied basic research, and strengthens the foundation for scientific and technological progress. In terms of funding and support, the country has set up a Natural Science Fund to support basic research and frontier scientific exploration, and set up a Youth Science Fund in the Natural Science Fund. In terms of research strength, the country has supported the construction of key laboratories and establish bases of basic research and applied basic research. In terms of support mechanism, NSFC supports basic research and applied basic research according to the prin-
ciple of expert review and preferential support.

The 2007 version of the *Science and Technology Progress Law* does not continue the reference to "basic research and applied basic research". It divides science and technology activities into three categories: "scientific research", "technology development" and "science and technology application". It mentions "basic research" in Articles 16, 19 and 23. It again emphasizes the establishment of natural science funds to support basic research, and encourages all kinds of subjects to engage in basic research. Advanced technology research and social welfare technology research. On this basis, the 2007 version of the Science and Technology Progress Law proposed for the first time that we should follow the principle of combining science and technology activities to serve the national goal and encourage free exploration, deploy and develop basic research, cutting-edge technology research and social welfare technology research in advance, and support the sustainable and stable development of basic research, cutting-edge technology research and social welfare technology research. In Article 23, it is the first time to emphasize the strengthening of basic research and applied research in the specific field of agricultural science and technology (Cooksey K E, 1992).

In recent years, the Party Central Committee has paid close attention to basic research. Relevant policies and measures have been intensively introduced. The report of the 19th CPC National Congress pointed out that to accelerate the construction of an innovative country, we should aim at the forefront of world science and technology, strengthen basic research, and achieve major breakthroughs in forward-looking basic research and leading original achievements. In September 2020, at the symposium of scientists, President Xi Jinping emphasized that we should constantly strengthen basic research, put the improvement of original innovation ability in a more prominent position, and strive to achieve more breakthroughs from 0 to 1. In May 2021, from the speech at the 20th Academician Conference of the Chinese Academy of Sciences, the 15th Academician Conference of the Chinese Academy of Engineering, and the 10th National Congress of the Chinese Association for Science and Technology, President Xi Jinping pointed out that strengthening basic research is an inevitable requirement for scientific and technological self-reliance, and an inevitable choice for us to go from unknown to known, from uncertainty to certainty.

In January 2018, the State Council issued the *Several Opinions of the State Council on Comprehensively Strengthening Basic Science Research*, in which the three-step development goal of basic science research was defined. That is: By 2020, the overall level and international influence of basic science research in China will be significantly improved, and China will rank among the world's advanced in several important fields; By 2035, the overall level of China's basic scientific research and its international influence will have risen significantly; By the middle of this century, China will be built into a major scientific center and innovation highland in the world. At the same time, the key layout and measures of building a high-level research base and strengthening the basic research talent team were clarified.

In March 2020, the Ministry of Science and Technology, the National Development and Reform Commission, the Ministry of Education, the Chinese Academy of Sciences, and the National Natural Science Foundation of China jointly issued the *Work Plan for Strengthening "From 0 to 1" Basic Research*. On the basis of implementing the spirit of the 19th National Congress of the CPC and the *Several Opinions of the State Council on Comprehensively Strengthening Basic Scientific Research*, detailed work guidance plans were proposed from various aspects. In terms of project layout, it is proposed to strengthen the original orientation of the national science and technology plan. The National Natural Science Foundation and the national science and technology plan should highlight the important original orientation and major scientific issues in key core technologies. In terms of personnel training, we should establish and improve the training mechanism for basic research talents. Special emphasis should be placed on training young talents in the field of basic research, implementing long-term projects for young scientists, and supporting young scientists in the national science and technology plan. In terms of basic construction, we should strengthen the original innovation of national key laboratories and improve the independent innovation ability of enterprises.

In May 2020, the General Office of the Ministry of Science and Technology and other six departments issued the *Several Key Measures to Strengthen Basic Research under the New Situation*, pointing out that with the high-quality development of the economy, the demand traction and application orientation of basic research are increasingly prominent. We will vigorously promote basic research from six aspects: optimizing the overall layout of basic research, stimulating the vitality of innovative subjects such as researchers, enterprises and research institutions, deepening the reform of project management, creating an innovation environment conducive to the development of basic research, and improving the stable support and diversified input system (ShaCheng, 2021).

Compared with the 2007 version, the 2021 version of the *Science and Technology Progress Law* separately lists basic research in the second chapter, including Articles 19 to 25. Most of the contents belong to creation clauses. It has built a basic research support system for the integrated layout of projects, talents and bases, providing direction and legal security for breaking the bottleneck of basic research. The first is clarifying the *value objectives and general development ideas of basic research*. The first paragraph of Article 19 stipulates: "The State shall strengthen the capacity
building of basic research, respect the laws of scientific development and talent growth, strengthen the systematic layout of projects, talents and bases, and provide good material conditions and strong institutional guarantees for the development of basic research." This is the first time that the legal documents clearly put forward the systematic layout of three aspects, namely, overall planning of projects, talents and bases, to systematically promote the development of basic research, which is also the deepening of the spirit of documents such as the Strengthening the Work Plan of Basic Research from 0 to 1. The second is highlighting the multiple support mechanisms for basic research (Edgerton D, 1996). Article 20 of the 21st edition revised the existing provisions of the first paragraph of Article 16 of the 2007 edition, especially emphasizing that "qualified local people's governments" should reasonably determine the financial input mechanism for basic research. The third is reposition the mission function of the National Natural Science Foundation of China. The second paragraph of Article 21 makes it clear that "local people's governments where conditions permit may establish natural science funds to support basic research in the light of the actual economic and social conditions and development needs of their respective regions." The existing provisions of the 2007 edition have been revised, which is also different from the August draft, with special emphasis on the relevant requirements for conditional local governments to support basic research, indicating the direction for local governments to support basic research. The fourth is putting forward to improve the discipline layout and knowledge system construction clearly. Article 22 of the new article: "The state improves the discipline layout and knowledge system construction, promotes interdisciplinary integration, and promotes the coordinated development of basic research and applied research." This stripe is a creative clause, which makes it clear that discipline and scientific research, basic research and applied research should be coordinated and mutually promoted. The fifth is defining the rights and responsibilities of supporting the training of basic research talents (Pavitt K, 2001). Article 23 of the new clause of the 2021 version stipulates that a stable support mechanism should be implemented for basic research talents, the resource allocation mechanism of basic research activities should be optimized, the relevant evaluation system and incentive mechanism should be optimized, and the multi-dimensional rights and responsibilities of basic research talents, such as "factor supply and high-quality guarantee", should be limited, which provides institutional guarantee for gathering basic research talents. The sixth is proposing to strengthen the construction of basic research bases. Article 24 of the new article points out that the State has strengthened the construction of basic research bases, leaving room for exploration in the construction of various types of basic research bases and large-scale scientific infrastructure.

2. Shanghai implements relevant regulations and vigorously develops basic research

Shanghai's basic research is developing well and its curatorial capacity as a research center in China has increased significantly from 2018 to 2021, the total number of papers published by Shanghai scientists in the world's three top academic journals Science, Nature, and Cell is 85, 87, 124, and 107, respectively, and the proportion of these papers to the national total in that year is 32.2%, 28.4%, 32%, and 29.8%.

First, encourage all kinds of subjects to invest and participate in basic research. Government departments to increase investment in basic research, from 2017, Shanghai's basic research expenditure for three consecutive years to maintain double-digit growth, from 2018 onwards to more than 10 billion yuan per year. Continuing to play the role of the main force of universities and research institutes, Shanghai continues to maintain its leading position in basic research fields such as life sciences and materials. Meanwhile, in the fields of mathematics, physics, chemistry, information technology and interdisciplinary disciplines, Shanghai also continues to produce high-level results. Among the top ten outstanding papers in Nature 2019, two of them are from Shanghai. Fudan University pioneered an original concept of drug development based on autophagic vesicle-bound compounds, while the Shanghai Institute of Organic Chemistry of the Chinese Academy of Sciences discovered a safe, efficient method for synthesizing the rare sulfur (VI) fluorine inorganic compound FSO2N3 (fluorosulfonyl azide) (Cooperation O, 2005).

Secondly, the exploration of basic research management mechanism is actively carried out. 2021's "Several Opinions on Accelerating the High-Quality Development of Basic Research" will become a strong booster for Shanghai's basic R&D. The Opinions suggest that Shanghai will take the lead in the country in setting up a pilot "basic research special zone", focusing on long-term and stable funding for universities and research institutes with significant advantages in basic research in the city, supporting the free selection of topics, self-organization and independent use of funds, and guiding researchers to "prefer to drill one well rather than dig ten pits". The researcher is guided to carry out research without distractions with the attitude of "I'd rather build a well than dig ten pits" (Leonchuk O & Gray D O, 2017).

Third, to create a good environment for the development of basic research. In terms of hard environment, a number of major scientific and technological infrastructures such as ultra-intense and ultra-short laser devices, soft X-ray devices and translational medicine facilities have been completed and put into operation, and the construction of
important scientific platforms and research institutions such as the Li Zhengdao Institute and the National Center for Applied Mathematics has been promoted around the basic frontier areas of particle and nuclear physics and quantum science and technology. In terms of soft environment, we have made efforts to create an environment and atmosphere that is conducive to the researcher's dedication to research and freedom of exploration, and implemented scientific research system reform initiatives such as "Article 25" of the Science Reform. We are the first in the country to pilot a "lump sum" system for funding, significantly reducing information and supporting documents, and reducing the number of forms to be filled out by 20% for the first time by each unit. Especially for the declaration of talent program projects, the workload of filling in the forms is reduced by more than 50% (Wang Z. et al., 2019).

3. Suggestions for countermeasures

First, the "strategic science program" is coordinated with the stable funding of institutions as a directional program, constituting a dual-track support mechanism to ensure the sound operation of strategic basic research. On the one hand, a certain percentage of stable funding is given to the relevant national strategic science and technology forces, such as appropriately increasing the percentage of stable funding for the restructured State Key Laboratories. On the other hand, adopt the U.S. competitive model of directed programs, i.e., set up top-designed scientific programs targeting strategic basic research to fund mainly national strategic scientific and technological forces in the basic research category and network other high-level research forces. In this way, a dynamic and stable support system of dual-track support is formed to substantially increase stable support to national scientific research institutions of high level and capability, and to give stable support to scientific researchers in the basic and think tank categories. At the same time, different types of scientific research institutions are given classified and differentiated support mechanisms, with the "task + institution" model for basic research institutions and the "institution + competition" model for applied research institutions.

Second, to make up for the relevant policy hollows to encourage enterprises and social organizations to invest in basic research. Expand and develop new tax policy tools, improve the level of R&D tax benefits, and give a 200% R&D tax credit on the amount contributed to enterprises that support basic research. Allow enterprises to invest in laboratories or research institutions to run research funds into the enterprise R & D expenditure to enjoy the corresponding tax incentives. Support enterprises to set up basic research endowment funds, corporate donations then enjoy pre-tax deduction for public welfare donations can also be combined to enjoy the R & D tax benefit policy.

Third, systematically optimize the management mechanism of basic research and scientific research. Actively promote the implementation of the "lump sum" reform, further change the management concept, expand the scope of the pilot "lump sum" system for the use of research funds, relax the subject restrictions on the use of project funds, break the shackles on scientific researchers, and release the autonomy of scientific research to the scientific community. Establish a "negative list" for the use of funds, improve management methods, and strengthen the integrity system of scientists to prevent the irregular use of funds from the system. Establishing a "fault-tolerance" mechanism for basic research projects, following the characteristic rules of strong innovation, high risk, high difficulty, and high uncertainty in basic research activities, and establishing a "fault-tolerance" management mechanism that tolerates the results of failure and does not hold people accountable for the failure of projects caused by non-ethical factors. The fourth is to build a management mechanism that encourages originality and focuses on longevity.

Fourth, the construction of the originality is encouraged, focusing on the long-term evaluation of basic research incentive mechanism. Talent evaluation to highlight the importance of innovative thinking and creativity, to avoid the tendency of only thesis, only title, only education, only awards. Project evaluation should focus on originality, scientific value and application prospects. Add post-evaluation of basic research, pay attention to deepening research of basic research results, medium and long-term innovation performance and follow-up evaluation of results transformation. Implement an international peer review system, promote the diversification of the composition of experts in the Strategic Advisory Committee for Basic Research, and include top scientists from around the world.

References

